P1
Minimally Invasive Approach in Consecutive Patients With Aortic Aneurysms

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Objective: Minimally invasive cardiac surgery is becoming more and more popular. However, there are still few data on a minimally invasive approach for patients with aortic aneurysm.

Methods: Between November 2011 and November 2016, 103 patients with aortic aneurysms were included in our study. Surgical access was via a minimally invasive upper partial V sternotomy through the third or fourth intercostal space. Cardiopulmonary bypass was provided via direct aortic cannulation and a 2-stage cannula to the right atrium. Based on our previous experience, we set that 70 mm of aortic diameter as an exclusion criterion for the minimally invasive approach.

Results: We performed 103 minimally invasive procedures in 67 patients (47.8%); supracoronary graft in 29 patients (20.7%); supracoronary graft and AVR in 26 patients (18.5%); the Bentall procedure (mechanical graft) in 10 patients (7.1%); and the David procedure in 8 patients (5.3%). The mean (SD) age was 62.9 ± 12.0 years; and the mean body mass index (kg/m^2) was 29.0 ± 4.4. Preoperative comorbidities included insulin-dependent diabetes mellitus in 12.6% and previous percutaneous coronary intervention in 4.8. The mean ejection fraction was 58.2 ± 7.8%. The mean EuroSCORE II was 2.6 ± 3.0%. We did not observe conversion to full median sternotomy in any of the groups. Reopening for bleeding was necessary in 5 patients (4.8%). We did not observe any neurological incidents, deep wound infections, or vascular complications. In 5 patients, superficial wound infections required local antibiotic therapy. The average stay in the intensive care unit was 2.2 ± 2.1 days. In first 12 hours, 68% of patients were extubated. During the first 24 hours, we observed mean drainage of 357.4 ± 206.4 ml. The blood transfusion rate was 0.8 ± 1.2; the platelet transfusion rate was 0.3 ± 1.2; the 30-day mortality rate was 0.97%.

Conclusions: Minimally invasive procedures via a minimally invasive upper partial V sternotomy are safe and feasible operative methods. They provide better hemostasis due to decreased tissue traumatization. The small incision and the partial upper sternotomy enable faster recovery. In this group of patients, the greatest benefits were early extubation (chest stability) and few in-hospital deaths.

P2
Hybrid Surgery for Complex Aortic Dissecting Aneurysm

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Objective: Our goal was to estimate the safety and results of thoracic endovascular aortic repair (TEVAR) combined with open surgery for extensive aortic dissecting aneurysms.

Methods: We performed an observational prospective study from 2013 to 2016. Of the 18 patients, 13 were men and 5 were women. The average number of stents was 1.83. The 30-day mortality rate was 5.56%. The average age was 60.06 years. Patients with extensive aortic dissecting aneurysms were treated with open replacement of the ascending arch, then with TEVAR, which landed on the prosthesis to cover the descending disease. The oversize rate was 20% to 30%, and the length of the landing zone was 3 to 5 cm.

Results: The patients were followed up with a contrast computed tomography scan at 1 and 3 months and then every 12 months postoperatively. No endoleak type 1 was observed. The survival rate was 16/17 (94%).

Conclusions: TEVAR and open surgery are useful and safe for treatment of complex aortic dissecting aneurysms.

P3
Minimally Invasive Aortic Repair for Thoracic Aortic Aneurysm

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Objective: Minimally invasive procedures have been widely adopted in contemporary cardiac surgery because of the several advantages they provide. However, the surgical management of thoracic aortic aneurysms (TAA) remains a complex and challenging process. Our goal was to describe our preliminary experiences with minimally invasive aortic repair for TAA via a partial upper sternotomy in 6 patients.

Methods: This retrospective study included 6 patients who underwent minimally invasive aortic repair for TAA between May 2016 and December 2016. Indications for minimally invasive aortic repair were (1) predicted distal anastomosis close to the sternum; (2) supra-aortic vessels close to the sternum when total arch replacement (TAR) was indicated; and (3) aneurysms limited to the ascending aorta. For TAR, antegrade cerebral perfusion was used, and for hemiarch replacement, retrograde cerebral perfusion was used. Body temperature during circulatory arrest was 25 °C in all cases. The mean age was 71 years, and 4 patients (66%) were men.

Results: The surgical procedure was successfully completed in all patients without conversion to full sternotomy. Three patients underwent TAR with the frozen elephant trunk technique, and others underwent ascending aortic replacement. Concomitant operations included aortic valve repair in 2 patients and aortic valve replacement in 1. There were no perioperative or 30-day deaths. The mean cardiopulmonary bypass time was 217 minutes, and the circulatory arrest time was 43 minutes. Even with moderate hypothermia, circulatory arrest with retrograde cerebral perfusion was well tolerated for 27 to 41 minutes. No postoperative permanent neurological complication occurred. Three patients (50%) experienced pericardiocentesis.

Conclusions: Our preliminary experience suggests that minimally invasive aortic repair for TAA is feasible and could be safely performed despite a limited operative field, without compromising surgical outcomes.

P4
Aortic Arch Repair With Single-Stage Hybrid Antegrade Thoracic Endovascular Aortic Repair Versus 2-Stage Hybrid Repair

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Objective: We compared outcomes of single-stage hybrid arch replacement using antegrade thoracic endovascular aortic repair (TEVAR) (frozen elephant trunk technique) versus 2-stage hybrid repair with the arch debranching/elephant trunk procedure in the first and TEVAR in the second stage.

Methods: We performed a single-center retrospective review (2003–2016) of 118 patients undergoing hybrid repair of the aortic arch with TEVAR at our university: 48 single-stage repairs versus 70 two-stage repairs. Patient demographics and intraoperative and postoperative outcomes were reviewed.

Results: Forty-eight patients including 31 (64.6%) men and 17 (35.4%) women with a mean ± SD age of 64 ± 11 years underwent a single-stage procedure; 70 patients, including 42 (60%) men and 28 (40%) women with a mean ± SD age of 65.67 ± 13.3 years, underwent a 2-stage procedure (age, $P = 0.46$). More emergent procedures were performed in 23/48 (47.9%) single-stage patients versus 8/70 (11.43%) 2-stage patients ($P < 0.001$). The mean cardiopulmonary bypass time for a single-stage versus a 2-stage procedure was 267.6 ± 80 hours vs. 212.2 ± 64.9 hours ($P < 0.001$). Fifty-five (84.62%) first-stage patients completed the second stage. Between the single and the 2-stage groups, there was no difference in stroke [6.25% (3/48) vs. 14.28% (10/70) ($P = 0.23$)] or spinal cord ischemia [4.16% (2/48) vs. 5.7% (4/70) ($P = 1.0$)]. There was no difference in the 30-day mortality rate: single stage 9/48 (18.75%) versus the combined 30-day mortality rate of the 2-stage group of 5/70 (16.24%): 7.14% for first stage and 5/55 (9.1%) for the second stage ($P = 0.61$), respectively. The median follow-up time was 31 months (range, 1–127 months). Overall survival including 30-day mortality at months 6 and 12 was single stage 6-months: 75% and 12 months: 75% versus two-stage completion: 6-months: 77% and 12 months: 70% versus first stage only: 6 and 12 months 47% (Fig. P4-1).

Conclusions: Both single-stage and 2-stage hybrid arch replacements are effective approaches for treating complex aortic arch diseases. Early deaths and neurological outcomes in the single-stage group are comparable to those in the 2-stage group. Furthermore, in this series, patients who had a single-stage hybrid procedure had a higher survival rate at 2 years.

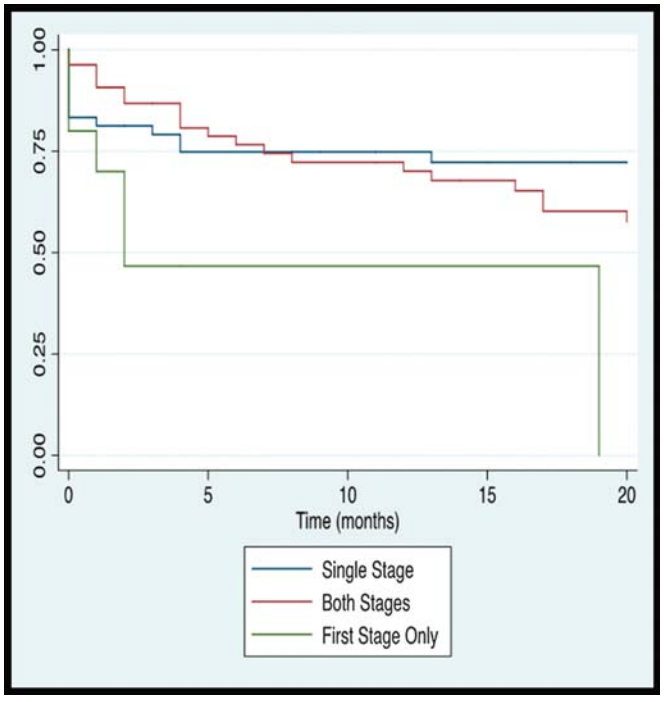

FIGURE P4-1. Midterm survival rates in patients who shad only the single-stage procedure, those who had both the first- and second-stage procedures, and those who had the first-stage procedure only.

P5

Challenge to the Aortic Arch Treatment With Fenestrated Stent Graft

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Objective: Thoracic endovascular aortic repair (TEVAR) has spread widely as treatment of thoracic aortic diseases. However, it is difficult to further expand the indications for simple TEVAR for aortic arch lesions, because additional management of the brachiocephalic and the left common carotid artery is necessary to secure sufficient length of a proximal neck. The Najuta fenestrated stent graft (Kawasumi, Inc, Tokyo, Japan) has been commercially available in Japan for repairing distal aortic arch aneurysms since June 2013. We evaluated early and midterm results of TEVAR using the fenestrated stent graft (Najuta SG) as a semi-order device for aortic arch treatment and describe its clinical usefulness and limitations.

Methods: Between January 2007 and May 2016, 29 patients were treated with the Najuta stent graft at our hospital. Early and midterm results were investigated retrospectively. The mean age of the patients was 73.9 years; 27 patients were men. Indications were degenerative aortic aneurysms 22 (76%), chronic aortic dissections 6 (21%), and pseudoaneurysm 1 (3%). Najuta stent grafts were placed in zone 2 (10) and zone 3 (19). These fenestrations preserved antegrade blood flow into the brachiocephalic and the left common carotid arteries. The left subclavian artery was simply covered by the stent graft without any reconstruction in the remaining 23 cases (79.5%). Other commercially available tube-type stent grafts were used in 15 cases (52%) due to a short proximal landing zone.

Results: The technical success rate was 100%. The overall 30-day mortality rate was 0%. Temporary paraplegia was 3.4%. There were no strokes and no retrograde aortic dissections. The mean follow-up period was 53.9 months. There were no aneurysm-related deaths. A type Ia endoleak was detected in 1 aneurysm. The rate of freedom from secondary intervention was 93. Device migration was not observed. There was 1 branch (left subclavian artery) occlusion. No other branch occlusion was seen in the follow-up period.

Conclusions: TEVAR using the Najuta stent graft was feasible, demonstrating a high rate of freedom from aneurysm enlargement and a high patency rate of the supra-aortic branches in the treatment of aortic arch diseases.

P6

Combined Aortic Replacement and Stenting of Cervicocerebral Arteries in Ascending Aortic and Arch Branches Dissection

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Objective: In one-third of patients with an ascending aortic dissection, it affects cervicocerebral arteries, which may increase the risk of perioperative adverse neurological events. The effectiveness of the hybrid approach, including ascending aortic replacement and preventive stenting of cervicocerebral arteries, remains to be evaluated.

Methods: Between January 2010 and October 2016, 42 consecutive patients (74% men, mean age 51.98 ± 11.31 years) with ascending aortic dissection (67% acute) involving the carotid arteries were operated on. All patients were divided into 2 groups: isolated ascending aortic replacement (group 1, 33 patients) and hybrid (group 2, 9 patients)—ascending

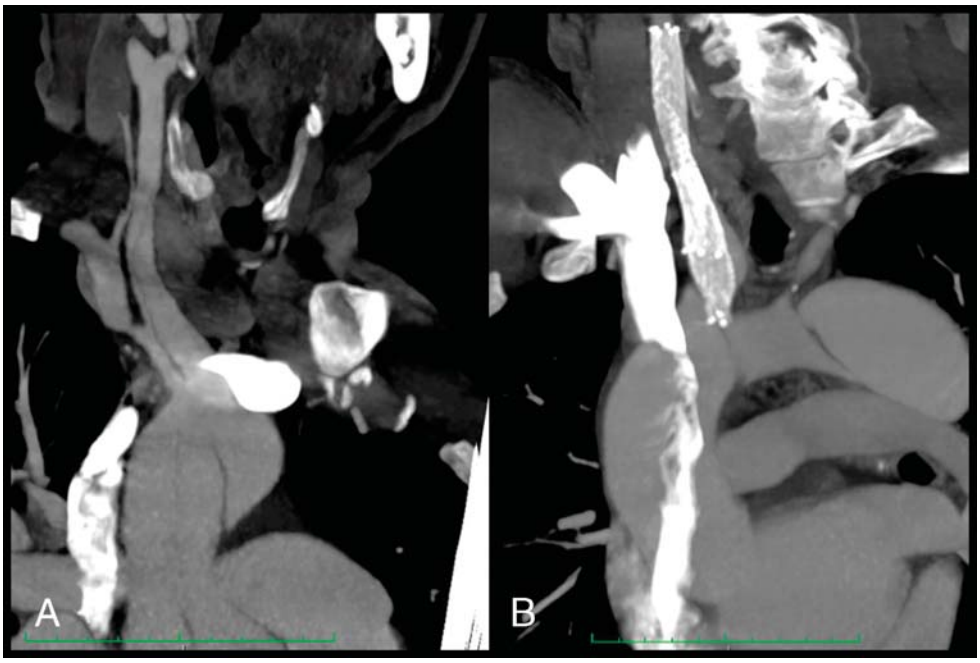

FIGURE P6-1. Dissected innominate and right common carotid arteries before (A) and after (B) stenting.

aortic replacement with preventive stenting of dissected cervicocerebral arteries due to the collapse of the true lumen >70%.

Results: The mean cardiopulmonary bypass (178.20 ± 8.53 hours in group 1 vs. 182.75 ± 15.89 hours in group 2), cross-clamp (127.43 ± 7.01 vs. 129.00 ± 13.26 hours) and circulatory arrest times (32.07 ± 14.27 vs. 26.00 ± 11.53) did not differ significantly. Hemiarch repair was performed in 35 patients (83.3%), and there were no cases of total arch replacement. In 71%, we used axillary artery cannulation; in 24%, femoral artery cannulation; and in 5%, ascending aortic cannulation. We used antegrade cerebral perfusion and moderate hypothermia in 77% and 50% of patients in groups 1 and 2, respectively, and deep hypothermia in the other cases. The overall 30-day mortality rate was 7.1% (3 patients, 1 from group 1). Freedom from stroke was 86.7% in group 1 and 83.3% in group 2. We found a negative correlation of stroke with axillary artery cannulation ($r = -0.463$), and a positive correlation with femoral cannulation ($r = 0.411$). We found an insignificantly increased mortality rate ($P = 0.05$) and a similar rate of stroke ($P = 0.443$) in group 2 compared with group 1 (Fig. P6-1).

Conclusions: Preventive stenting of cervicocerebral arteries in ascending aortic dissection is not associated with a significant increase in the mortality and stroke rates in patients with initially affected aortic arch branches. In case of femoral cannulation, such patients are at risk of adverse neurological events.

P7
Pitfalls of the Frozen Elephant Trunk Procedure: Our Experience With 54 Cases

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Objective: The frozen elephant trunk (FET) procedure has recently been performed with increasing frequency, but there are some FET-specific complications. We retrospectively analyzed the complications related to this procedure using a multicenter registry database.

Methods: A total of 54 patients who underwent the FET procedure between January 2001 and September 2016 were eligible for analysis. The mean age of the cohort was 70.9 ± 10.3 years (77.8% men). The indication for this procedure was a true aneurysm in 43 cases (79.6%), chronic aortic dissection in 3 (5.6%), and acute aortic dissection in 8 (14.8%). Handmade composite grafts with the Gianturco Cook-Z Stent (Cook Medical; Bloomington, IN USA) were used in 17 patients until December 2013, followed by the commercially available J Graft Open Stent Graft (Japan Lifeline; Shinagawa, Tokyo, Japan) in 36 cases. The conformable TAG Thoracic Endoprosthesis (W. L. Gore & Associates; Flagstaff, AZ USA) was used in 1 patient. The proximal anastomosis site of the FET procedure was zone 0 in 9 cases (16.6%), zone 2 in 24 cases (44.4%), and zone 3 in 2 cases (3.7%). Thirty-three patients (61.1%) had concomitant graft replacement of the aortic arch, whereas the other patients had an FET insertion through the anterior half incision of the aortic wall (inclusion method).

Results: Four patients died during hospitalization. One FET-related cause of death was graft kinking and occlusion at the transition from nonstented to stented graft, leading to malperfusion and multiple organ failure. Another FET-related cause of death was bleeding after the inclusion method, requiring a second circulatory arrest. Complications related to the FET procedure were paraplegia in 3 cases (5.6%), graft kinking in 2 cases (one of which was mentioned above, and endovascular reintervention in 1 case), ascending aortic dissection after the inclusion method in 1 case (1.6%), and FET inserted into the false lumen in 1 case.

Conclusions: The FET technique was developed with the expectation that it would cause less of a surgical burden. However, several FET-specific complications have been identified that have to be conquered by the surgeon technically and also by advancements in device technology.

P8

Midterm Results of Endovascular Entry Closure for Type B Aortic Dissection

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Objective: Entry closure using an endovascular technique has increasingly been applied in type B aortic dissection. However, the long-term outcomes of this approach have not been determined. We analyzed the midterm results of endovascular entry closure for aortic type B dissection.

Methods: From 2008 to 2013, 17 patients underwent entry closure using the endovascular technique. Mean age was 69 ± 9 years old. We performed 4 emergent operations (1 organ malperfusion and 3 ruptures). In 13 elective cases, the mean and median operation days from the onset of type B aortic dissection were 94 days and 50 days, respectively.

Results: Technical success was achieved in all cases. Five patients required revascularization of the left subclavian artery. Zone 2, 3, and 4 landings were 5, 7, and 5 cases, respectively. The mean operation time was 139 ± 83 minutes. We used 13 Gore TAG and 4 Zenith TX2 endoprostheses. A 79-year-old patient with chronic lung disease and renal failure died of multiorgan failure 3 months after the operation. During the follow-up period of 35 ± 27 months, there were 2 late deaths (sudden death and senility). The survival rate at 3 years was 87.1 ± 8.6%. Computed tomography was performed 3 years after the operation in 11 patients (64.7%). All these patients had regression of the false lumen and of the whole aortic diameter at the site where the stent graft was deployed. No endovascular-related complications (infection, aortic dissection at proximal or distal landing zone) were noted.

Conclusions: We had favorable midterm results after entry closure using the endovascular technique for type B aortic dissection. However, we need a longer follow-up period.

P9

Complex Thoracoabdominal Aortic Aneurysm: Hybrid Debranching With Endovascular Repair

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Objective: Thoracoabdominal aortic aneurysms remain a formidable surgical challenge with conventional open repair associated with significant rates of mortality and morbidity in the average center. The search for an alternative approach to managing these patients has led to the development of the so-called hybrid method of repair including complex visceral debranching and subsequent endovascular aneurysm exclusion.

Methods: From 2014 to 2017, 6 patients ranging from 50 to 78 years of age with Crawford type I (3), Safi V (3), and dissection (2) were operated on. Open surgery was performed at the first stage. Complex visceral debranching to the superior mesenteric artery and bilateral renal arteries was based off the concomitantly replaced infrarenal aorta using a commercially available 4-branched artificial graft (J Graft for total arch graft replacement). The celiac artery was not revascularized and ligated. Subsequent TAVR was performed a few days later.

Results: The mean operating time was 365 minutes, and the mean bleeding volume was 1243 ml. There were no operative deaths; the one major complication was right incomplete hemiplegia.

Conclusions: The visceral hybrid repair is a feasible and relatively safe procedure for an extensive thoracoabdominal aortic aneurysm. It may represent a viable alternative for patients with a high-risk thoracoabdominal aneurysm.

P10

Mini Open Stent Grafting With Half Sternotomy for Aortic Arch Aneurysm

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Objective: Aortic arch replacement is still considered invasive although organ protection and cardiopulmonary bypass during the operation have improved. Since March of 2015, we performed 5 cases of open stent grafting with a half sternotomy (mini-OSG) for an aortic arch aneurysm to reduce operation time and blood loss, both of which affect clinical outcomes. Our goal was to report our initial results.

Methods: Five consecutive patients with mini-OSG were enrolled in this study. The mean age was 62 ± 21 years (20–77 years), and all the patients were men. The etiology was dissection in 2 and aneurysm in 3 patients. An upper half sternotomy was performed until the fourth intercostal space was reached, and cardiopulmonary bypass was initiated with cannulation of the right atrium, the femoral artery, the left common carotid artery, and the right axillary artery. After induction of moderate hypothermia to a rectal temperature of 24 °C to 28 °C, selective antegrade cerebral perfusion was begun. An open stent graft (Japan Lifeline, Tokyo, Japan) that was 21 to 33 mm in diameter and 6 or 9 cm in length was inserted via an aortotomy on the aortic arch during circulatory arrest. The proximal end of the stent was sutured with the aortic wall. Two patients underwent reconstruction of the left subclavian artery with a prosthetic graft.

Results: No deaths were noted. One patient recovered to live a normal daily life although he presented with a cerebral infarction. The total operation time was 368 ± 74 minutes, the cardiopulmonary bypass time was 208 ± 54 minutes, and the arrest time was 77 ± 30 minutes. Blood loss was 528 ± 196 ml during the operation. The patients were weaned from the ventilator 7.1 ± 4.9 hours after the operation. No pseudoaneurysms or endoleaks were observed during the 2 to 20 months of the follow-up period.

Conclusions: Mini-OSG may be less invasive. Further studies with a large number of cases and intensive follow-up are needed.

P11

Thoracic Endovascular Aortic Repair and Open Operative Strategy for Chronic Type B Dissection

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Objective: Thoracic endovascular aortic repair (TEVAR) is often performed for acute type B dissection but is accompanied by complications. It is also used to prevent further expansion of a false lumen, but it has not yet been established as a treatment for chronic type B dissection. However, treatment by open surgery for this chronic condition is so invasive that the less invasive combination with TEVAR has more advantages. Therefore, we evaluated the results of staged surgical treatment using TEVAR for chronic type B dissection.

Methods: From December 2010 to May 2016, TEVAR was performed in 5 patients [mean 60 ± 15 (44–77) years old] who had chronic dissection in the arch and the descending aorta but needed additional treatment. The

cause of 4 cases was expansion of the aorta; the cause in 1 patient was disseminated intravascular coagulation by residual blood flow in the false lumen. Using an open procedure, we fixed the inner artificial vessel of the stent graft with the outer felt-like sandwich under cardiopulmonary bypass (CPB) after the stent graft was expanded by fenestration. The false lumen was closed using this procedure. We recorded the operative and CPB times, the respiratory effects such as prolonged ventilator management, the complications, the hospital stay, and the outcomes.

Results: The average operative time was 259 ± 42 minutes; the CPB time was 65 ± 30 minutes. There were no major operative complications such as respiratory failure and paraplegia. All patients were discharged well. The average hospital stay was 25 ± 9 days and the postoperative period was 15 ± 5 days. No additional treatment was needed due to enlargement of a false lumen, although the mean observational period thus far is 14 ± 11 (4–36) months.

Conclusions: First TEVAR and then a secondary open surgical false lumen closure for chronic type B dissection had acceptable results including hospital stay, postoperative period, and complication rate. This staged treatment of combining TEVAR with closure of a false lumen is less invasive than open surgery alone and may be one option for treatment of chronic type B dissection.

P12

Advantage of Intraoperative Guidance by Preoperative Computed Tomography Angiogram Fusion in Endovascular Aortic Repair

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Objective: Our goal was to evaluate the advantages of fusing preoperative computed tomography angiography (CTA) with live fluoroscopy during endovascular aortic repair.

Methods: From February to July 2016, 3 procedures [thoracic endovascular aortic repair (TEVAR: 1) and endovascular aneurysm repair (EVAR): 2] were performed in a standard angiography room without CTA fusion (group NF). After August 2016, 8 procedures (TEVAR: 2; EVAR: 6) were performed using CTA fusion with live fluoroscopy (Discovery IGS 730; GE Healthcare, England) in a hybrid room (group F). Procedure time, fluoroscopy time, radiation exposure, and dosage of contrast agent were compared between the 2 groups.

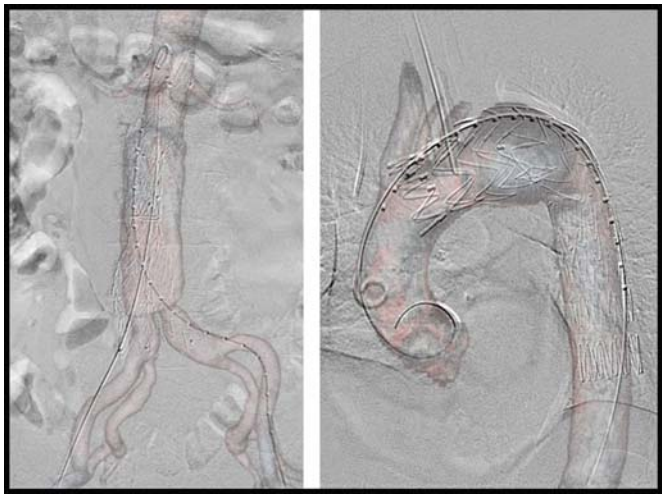

FIGURE P12-1. This image demonstrates the fusion image guidance in endovascular aortic repair.

Results: All patients in both groups underwent endovascular aortic repair successfully. There were no significant differences between the 2 groups (group NF vs. group F) in procedure time (66.7 + 5.8 minutes vs. 96.9 + 36.1 minutes, $P = 0.056$), fluoroscopy time (13.03 ± 2.95 minutes vs. 22.44 ± 9.76 minutes, $P = 0.147$), and radiation exposure (296.0 + 258.3 mGy vs. 345.3 + 209.6 mGy, $P = 0.766$). However, the dosage of the contrast agent was significantly decreased in group F (142.5 + 75.9 ml vs. 67.3 + 25.0 ml, $P < 0.05$).

Conclusions: The preoperative fusion of CTA images with live fluoroscopy results in a significantly reduced dosage of contrast agent for endovascular aortic repair.

P13

Epicardial Focal Electrocardiography Over Pulmonary Veins and Effectiveness of Surgical Ablation of Persistent Atrial Fibrillation

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Objective: In patients referred to off-pump CABG and increased operative risk, pulmonary vein isolation (PVI) may be used in patients with persistent atrial fibrillation (AF) as alternative to Cox Maze procedure. However, success rate of PVI in persistent AF is limited. Study aimed to assess the impact of recordings of epicardial focal PVs ECG on early antiarrhythmic outcomes after surgical off-pump ablation (PVI) of persistent AF.

Methods: There were 140 PVs mapped in 34 cases undergoing off-pump CABG mapped with use of sensing-pacing probe. In all patients PVI was confirmed with bidirectional conduction block assessment. Composite study end point consisted of need for electrical cardioversion due to in-hospital AF recurrence, the presence of AF at hospital discharge and after 3 months in 24-hour Holter ECG study.

Results: Four main types of electrical signals were recorded over PVs: sinus rhythm signal, focal trigger activity, fibrillation wavelet and far field signal (FF). Composite end point occurred in 61% of patients with epicardial FF signal recorded over at least one PV versus in 25% of patients with FF signal recorded over none of PVs ($P = 0.04$). Presence of epicardial FF signal in at least one PV increased the risk of composite end-point occurrence (OR 3; $P = 0.04$). Average number of PVs with epicardial FF signal recorded was significantly higher in patients with positive end point (2.2 ± 1.4) in comparison to group with no early AF recurrence (1.3 ± 1.2; $P = 0.04$). Composite end point occurred in 86% of patients in whom epicardial far field signal was recorded over all PVs and in 39% of rest study population ($P = 0.03$). Epicardial recording of FF signal over all PVs increased the risk of composite study end-point occurrence (OR 1.5; $P = 0.02$).

Conclusions: Far field signal recorded over PVs with intraoperative epicardial focal ECG is related with worsen early outcomes after surgical PVI in patients with persistent AF.

P14

Early Postoperative Pattern of Atrial Fibrillation Recurrence After Surgical Ablation Is Associated With Later AF Recurrence of Atrial Fibrillation

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[4]University of Lübeck, Lübeck, Germany; and [5]ASKLEPIOS Clinic Harburg, Hamburg, Germany.

Objective: Ablation for atrial fibrillation (AF) can introduce periods of transient electrical instability for an extended period postoperatively. Several consensus statements indicate that arrhythmias observed in this so-called 3-month blanking period should not be taken into account when evaluating the success of the procedure. The aim of the present study was to evaluate if the quantity and temporal pattern of AF during the blanking period can provide valuable insights regarding future AF recurrence and indirectly the success of the ablation procedure.

Methods: Ninety-nine patients (73 men; age 68.0 ± 9.2 years) with documented preoperative AF (29 paroxysmal; 18 persistent; 52 long-lasting persistent; mean preoperative duration, 46 ± 53 months) underwent concomitant biatrial surgical ablation (29 Cox-Maze III), full-set left atrium cryoablation (22), a high-intensity focused ultrasound box lesion (46) or right-sided ablation (2). Postoperative rhythm disclosure was provided via an implantable device. In all patients, the cardiac rhythm history was reconstructed. The quantity of AF recurrence (AF burden) and its temporal aggregation (AF density) during the blanking period were regressed on the AF burden developed in the remaining observation time.

Results: During the blanking period, AF recurrence was observed in 56/99 patients, with a median AF burden of 0.004 (interquartile range, 0.001–0.019), occurring with a median AF density of 0.87 (interquartile range, 0.68–0.96). During the remaining observation period, some AF recurred in 89/99 patients, although the AF burden of these patients during this period was negligible (median, 0.001; interquartile range, 0.0001–0.007). Both the AF burden ($P < 0.0001$) and the AF density ($P = 0.004$) observed during the blanking period were significantly associated with later AF recurrence. This effect persisted after correcting for type of AF, type of ablation (energy source), and known preoperative AF duration. A higher AF burden occurring with low AF density during the blanking period may indicate prolonged electrical instability and is associated with higher AF recurrence during the remaining observation period.

Conclusions: Small amounts of AF burden after surgical ablation are common. The quantitative and temporal characteristics of AF recurrence during the blanking period can provide valuable insights into the severity of electrical instability and the amount of later AF recurrence and may provide prognostic information on the success of the ablation procedure.

P15
Efficacy of the Left-Sided Maze Procedure During Robotic Mitral Valve Repair: The Mayo Clinic Experience

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Objective: Atrial fibrillation (AF) is common in patients with degenerative mitral valve disease. Because of a growing interest in robotic mitral valve repair (MVR), attempts have been made to concomitantly address rhythm anomalies. Our goal was to report the outcomes of a left-sided Maze (LSM) procedure for AF in patients undergoing robotic MVR.

Methods: From January 2008 to September 2016, 603 patients underwent robotic MVR for severe degenerative mitral regurgitation (MR). Medical records of 576 consenting patients were retrospectively reviewed to evaluate the efficiency of an LSM procedure. We analyzed rhythm outcomes with detailed postoperative echocardiogram findings including ejection fraction, recurrent MR, and residual gradient.

Results: A total of 55 patients out of 576 were identified as having preoperative AF: 9 were defined as persistent and 46 as paroxysmal. Of these, 39/55 underwent the LSM procedure; 8/9 patients in persistent AF were part of this cohort. Postoperatively, 15.4% (6/39) of patients in the LSM cohort had AF compared to 31.3% (5/16) in the non-LSM cohort ($P = 0.27$). The postoperative incidence of new-onset AF in a control group of patients with preoperative sinus rhythm (SR) was 19.1%. Over 1 year of follow-up, freedom from AF was 95.7% (22/23) in the LSM group vs. 83.3% (5/6) in the non-LSM group (Table P15-1). Early MVR outcomes demonstrated recurrent MR (moderate or greater) in 2% (12/575) of patients. Although univariate analysis failed to reveal a correlation between preoperative AF and postoperative MR grade, the left atrial volume index and pulmonary artery systolic pressures were risk factors for early recurrent MR.

Conclusions: Postoperative AF is common in patients undergoing robotic MVR. In patients with preoperative AF, a left-sided Maze procedure effectively restores SR and may reduce the incidence of postoperative AF. Although a concomitant LSM procedure effectively restores SR, a majority of patients convert to SR over time. AF does not portend increased risk of recurrent MR. Early referral plus improving robotic MVr outcomes will likely continue to reduce the AF burden and improve long-term outcomes.

P16
Minimally Invasive Cox-Maze IV Procedure Concomitant With Mitral Valve Repair Has Excellent Short- and Long-Term Outcomes

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Objective: The Cox-Maze IV (CMIV) procedure performed via a minimally invasive right minithoracotomy has been shown to be an effective treatment for atrial fibrillation (AF). This study examined short- and long-term outcomes with minimally invasive mitral valve repair (MIMVr) and a concomitant CMIV procedure at a single institution.

Methods: Between November 2003 and May 2016, 65 consecutive patients underwent MIMVr and the CMIV procedure [biatrial 57/65, 88%; left atrial (LA)8/65,12%] via a right minithoracotomy. Outcomes

TABLE P15-1. Sinus Rhythm at Follow-Up Time Periods

	Sinus Rhythm (n = 519)		Atrial Fibrillation Plus Left-Sided Maze (n = 39)		Atrial Fibrillation Plus Non-Left-Sided Maze (n = 16)		*P*-Value* (LSM vs. Non-LSM)
	SR (%)	AF (%)	SR (%)	AF (%)	SR (%)	AF (%)	
Postoperative values	420 (80.9)	99 (19.1)	33 (84.6)	6 (15.4)	11 (68.7)	5 (31.3)	0.27
Discharge	513 (99.0)	5 (1.0)	35 (89.7)	4 (10.3)	16 (100.0)	0 (0.0)	0.31
>1 Year	258 (99.2)	2 (0.8)	22 (95.7)	1 (4.3)	5 (83.3)	1 (16.7)	0.38

The total number of patients having robotic MVr = 603; consenting participants analyzed = 574; patients with preoperative AF = 55.
*Left-sided Maze vs. Non-left-sided Maze.

were evaluated using descriptive statistics. Freedom from atrial tachyarrhythmias (ATA) was ascertained using electrocardiography, the Holter monitor, a loop recorder, or pacemaker interrogation at 1 to 5 years. Prolonged monitoring was used in 47/65 patients (72%). Survival was ascertained from medical records. Data are expressed as median and interquartile range; freedom from ATA and from antiarrhythmic drugs (AAD) is expressed with 95% confidence intervals.

Results: Forty-nine percent (32/65) of the patients were men; the median age was 67 years. Most (38/65, 58%) had paroxysmal AF; the remainder had persistent AF (6/65, 9%) or long-standing persistent (21/65, 32%) AF. Twenty-one patients (32%) had functional mitral regurgitation (MR); 44 (68%) had degenerative MR. The median LA size was 4.7 cm (4.0, 5.4). Seven patients (11%) had a previous catheter ablation. Twenty-seven patients (42%) had New York Heart Association class III/IV heart failure. The median left ventricular ejection fraction was 0.60 (0.54, 0.65). The median cross-clamp time was 109 minutes (95, 119). There were no operative deaths or postoperative strokes. Major complications occurred in 9/65 patients (14%). The median time in the intensive care unit was 49 hours (24,96); the median hospital length of stay was 7 days (6, 9). Five patients (8%) required a postoperative pacemaker. Follow-up, freedom from ATA, and freedom from ATA and AAD were 85%, 98%, and 90% at 1 year and 80%, 88%, and 81% at 5 years, respectively (Fig. P16-1). At the median 2.3-year follow-up examination, survival was 92% (36/39). Only 3/62 patients (5%) developed ≥2+ MR at 364 days postoperatively (96, 1265).

Conclusions: MIMVr with the CMIV procedure is highly effective for AF and MR. This procedure is safe when performed at an experienced center.

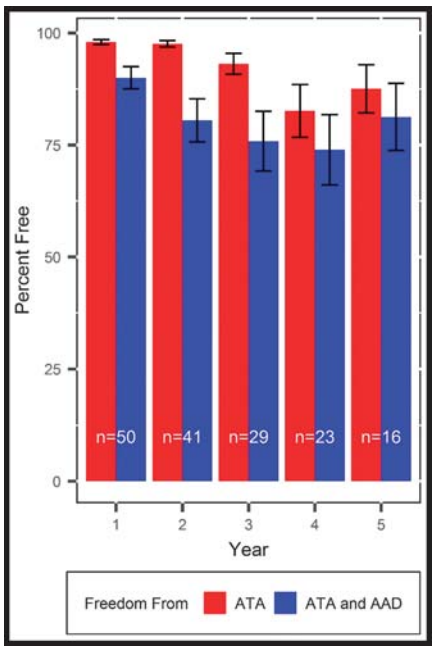

FIGURE P16-1. Freedom from atrial tachyarrhythmias (ATA) and ATA/antiarrhythmic drugs (AAD) after minimally invasive mitral valve repair concomitant with the Cox-Maze IV procedure.

P17

Perspectives and Outcomes Associated With the Convergence Procedure: A Data Review

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Objective: Atrial fibrillation (AF) remains the most common cardiac arrhythmia affecting approximately 33.5 million individuals worldwide. Many of these patients fall into the "difficult to treat" subset and often face an uncertain future. Uncontrolled or untreated AF can lead to blood clots, stroke, heart failure, and other cardiac-related complications. There are several treatment options for AF. Although medications followed by endovascular surgical procedures are often the starting point, for patients who fail these treatments, the convergent procedure may be the best option to treat their persistent AF. The convergent procedure comprises the best from electrophysiology and cardiothoracic operations to produce the best results within this patient population. The convergent procedure is a closed chest procedure with a minimally invasive abdominal incision. This procedure allows for a shorter stay in the hospital along with a faster recovery period. Our goal was to share the results of a convenience sample from 212 patients with AF who had the convergent procedure in a specialty hospital in Oklahoma City, OK in the United States.

Methods: Although multiple data points were reviewed from the sample, the main end points of this study were as follows: (1) After the convergence procedure, how long does the patient remain in normal sinus rhythm (versus return to AF)? (2) Did the convergence procedure allow a decrease in the use of anticoagulants?

Results: Of the 212 patients in our sample, 199 (94%) remained in normal sinus (AF free) for more than 2 years. These data were captured by a real-time loop placed at the time of the procedure. When we reviewed the data on anticoagulants, we found that 205 of the 212 patients (97%) remained off anticoagulants for more than 2 years.

Conclusions: When we looked at treatment options for uncontrolled AF, we found that the convergence procedure remains a strong option for this subset of patients. Although these results are positive, future research is necessary to help solidify the convergence procedure as the new gold standard for patients with uncontrolled AF.

P18

Stroke Prevention With the Totally Thoracoscopic Left Atrial Appendage Epicardial Clipping System in High-Risk Patients With Atrial Fibrillation

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Objective: In approximately 90% of patients, the source of thrombotic material is the left atrial appendage (LAA). The standard of care remains oral anticoagulation; however, not every patient is eligible for this therapy. Although results in the literature indicate that closure of the LAA might not be inferior to oral anticoagulation, a number of novel techniques for LAA exclusion have been recently described. Our goal was to present early results of the novel clipping system for the totally thoracoscopic epicardial LAA exclusion for primary and secondary stroke prevention in high-risk patients with atrial fibrillation.

Methods: Twenty patients (9 women) with a mean age of 72 (±9) years with long-standing persistent atrial fibrillation were admitted for totally thoracoscopic LAA exclusion. All patients had significant comorbidities and a history of intolerance to oral anticoagulants or prior stroke. The mean left ventricle ejection fraction was 47% (±16%); the mean left atrium dimension was 46 mm (±2 mm). The CHA_2DS_2VASC score was from 2 to 7 and the HAS_BLED score was 2 to 7. Concomitant total thoracoscopic ablation was performed in 4 patients. In 2 patients,

concomitant endoscopic coronary artery bypass grafting was performed. Transesophageal echocardiography was performed in all patients to rule out thrombus in the LAA and to guide the deployment of the clip at the base of the left atrium appendage.

Results: The perioperative period was uneventful. The clip measure and deployment took 10 (±5) minutes. Patients were extubated in the operating room directly after the procedure. Patients were discharged several days later. During the mean follow-up period of 6 to 12 months, we did not observe any bleeding events, strokes, transient ischemic attacks, or deaths. A stable clip position without a stump or leakage was confirmed by echocardiography or computed tomography.

Conclusions: Totally thoracoscopic LAA exclusion using a novel epicardial clipping system for stroke prevention in high-risk patients is safe and effective with a low risk of complications both as a stand-alone procedure or concomitant with other cardiac procedures. Our initial experiences are extremely promising: We found high efficacy and a good safety profile. Further studies are warranted.

P19

Thoracoscopic Left Atrial Appendectomy Can Be an Alternative to Anticoagulation Therapy in Patients With Atrial Fibrillation

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Objective: Although anticoagulation therapy is the gold standard of prophylaxis for cardiogenic thromboembolism in patients with atrial fibrillation (AF), thromboembolic events sometimes occur even when one is administering anticoagulants. Thoracoscopic left atrial appendectomy (TLAA) has been suggested as a new approach to prevent cardiogenic thromboembolism in patients with AF; we examined the effectiveness and safety of this surgical method.

Methods: Sixty consecutive patients (mean age, 70 ± 7 years, 46 men, mean CHA_2DS_2-VASc score, 2.9 ± 1.6 points) with a high risk of thromboembolism and/or bleeding were selected for TLAA. Fifty-seven of these patients had been treated with anticoagulants preoperatively. (Three patients had stopped anticoagulation therapy due to the negative side effect of bleeding.) Seventeen patients had suffered a stroke/transient ischemic attack (TIA), and 2 patients had a history of thromboembolism before undergoing the operation. In addition, cerebral hemorrhage had also developed in 5 patients preoperatively. The left atrial appendage was excised with an endoscopic linear cutter thoracoscopically with the patient in the right lateral recumbent position with differential lung ventilation. Four endoscopic ports (for the endoscope, endoscopic cutter and forceps) were normally made in the left thorax while the surgical team monitored the procedures using transesophageal echocardiography.

Results: TLAA (mean operation time 37 ± 9 minutes) resulted in no deaths and no major complications. All of the patients were discharged and were able to maintain their activities of daily living in the postoperative period of 4.3 ± 1.8 days. Anticoagulants were stopped postoperatively and no cardiogenic thromboembolism events occurred; the mean follow-up duration was 16 ± 7 months. The rates of freedom from cardiogenic thromboembolism were significantly different between the preoperative and postoperative periods in the same groups of patients (preoperatively with anticoagulants) ($P < 0.01$ log-rank test, Fig. P19-1).

Conclusions: TLAA is considered a safe, effective approach for the prophylaxis of cardiogenic thromboembolism. Especially for patients who are refractory to (or contraindicated for) anticoagulants, this operation would be an optimal therapeutic option.

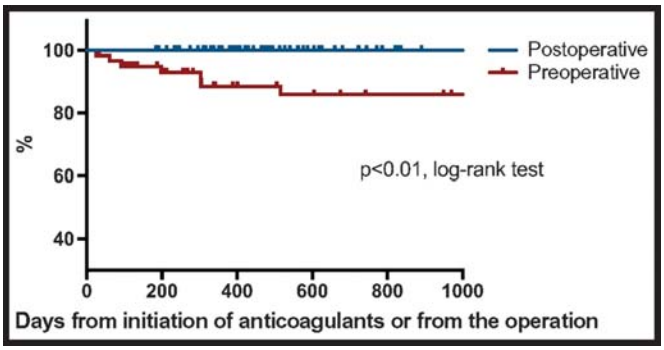

FIGURE P19-1. Freedom from stroke/transient ischemic attack/thromboembolism.

P20

Significant Elevated C-Reactive Protein Levels After Epicardial Clipping of the Left Atrial Appendage

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Objective: Closure of the left atrial appendage (LAA) is a common addition in current surgical procedures for the treatment of atrial fibrillation. Besides the mechanical and anatomical changes of the left atrium, epicardial closure of the LAA also induces biochemical effects. The aim of this study was to assess whether epicardial clipping of the LAA results in an elevated inflammatory response compared to complete removal of the LAA.

Methods: A total of 73 patients were included in this study. All patients underwent a totally thoracoscopic Maze procedure. As part of the procedure, the LAA was excluded. LAA exclusion was performed with an epicardial clip (n = 48) or the LAA was fully amputated with an endoscopic vascular stapler (n = 25). Postoperative inflammatory parameters were collected from all patients and were compared between the 2 groups.

Results: The mean age and left atrial volume index were comparable between the epicardial clip and stapler groups (64 ± 8 vs. 60 ± 9 years, $P = 0.101$; 43 ± 11 vs. 40 ± 12 mL/m^2). Patients receiving the LAA clipping had significantly elevated C-reactive protein levels compared to patients who had LAA stapling at the second, third, fourth, and fifth postoperative day (219 ± 80 vs. 149 ± 75 mg/L, $P = 0.004$; 239 ± 77 vs. 167 ± 75, $P = 0.008$; 183 ± 75 vs. 104 ± 47, $P < 0.001$; 129 ± 63 vs. 72 ± 28, $P = 0.040$, respectively) (Fig. P20-1). The white blood cell count was comparable between the 2 groups.

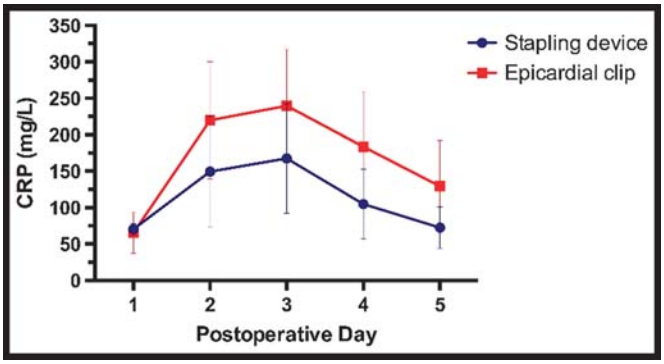

FIGURE P20-1. Postoperative levels of C-reactive protein for the stapling and epicardial clip device groups.

Conclusions: Epicardial clipping of the LAA is a surgical technique with a high success rate of mechanical closure of the LAA. We observed significant elevated levels of the C-reactive protein, which could be a result of LAA tissue necrosis. Whether this inflammatory response affects the outcome of arrhythmia surgery or induces the prothrombotic state needs to be evaluated in further studies.

P21
Endocardial Left Atrial Appendage Device Implantation During Hybrid Atrial Fibrillation Ablation (WINNING Trial): First Results

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Objective: The WATCHMAN Left Atrial Closure Device (Boston Scientific, Marlborough, MA USA) reduces the risk of stroke by closing off the left atrial appendage (LAA). We studied the safety and feasibility of implantation in a hybrid atrial fibrillation (AF) ablation setting (combination of epicardial surgical and endocardial catheter ablation).

Methods: In this prospective, single-center, nonrandomized trial (the WINNING Trial), 10 consecutive patients with drug-refractory AF who qualified for a hybrid AF ablation procedure with the necessity of LAA exclusion (CHA_2DS_2-VASc $\geq$ 1) were included. For the implantation and periprocedural care, we followed the standard protocol. The primary safety end point comprised major complications (e.g., stroke, device embolization, and device-related complications). The primary feasibility end point was successful implantation. Secondary end points were procedure time, radiation exposure, (serious) adverse device events, and (serious) adverse events. The follow-up period was 6 months.

Results: At the beginning of October 2016, the first 8 procedures were performed. The device was deployed successfully in all patients (Fig. P21-1). The total procedure time (ablation and implantation) was prolonged by a mean of 33 minutes; radiation exposure time, by 6 minutes; and radiation dose by 28 mGy. One adverse event occurred 3 days after the procedure (bleeding that required a blood transfusion). After 6 weeks, a transesophageal echocardiogram was performed that showed good positioning of the device without significant peridevice flow. Oral anticoagulation was discontinued, and clopidogrel was started.

Conclusions: The WINNING Trial (NCT02471131) investigated the safety and feasibility of the Watchman device in a hybrid AF ablation setting, with encouraging preliminary results.

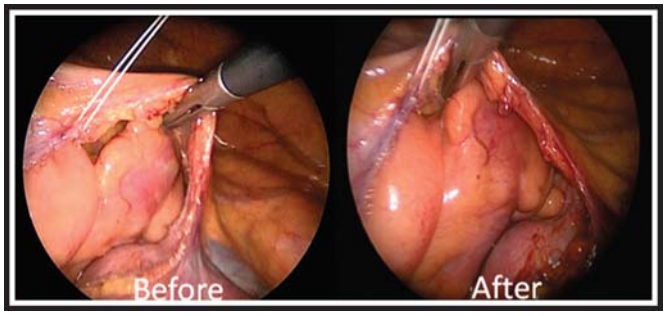

FIGURE P21-1. Left-sided thoracoscopic view of the left atrial appendage before and after implantation of the Watchman device, showing almost no difference in appearance.

P22
The Thoracoscopic Maze Procedure in Obese Patients

Tyler M. Gunn, Michael D. Bolanos, **Theodore S. Wright.** *University of Kentucky, Lexington, KY USA.*

Objective: Atrial fibrillation is a common arrhythmia that is associated with increased risk of thromboembolism, stroke, and death. Historically, the traditional open Cox-Maze procedure has been the standard for surgical management of atrial fibrillation and requires a sternal incision with cardiopulmonary bypass. However, a minimally invasive technique has been developed called the Cox-Maze IV or thoracoscopic Maze procedure, which allows for pulmonary vein radiofrequency isolation, posterior atrial wall debulking via superior and inferior connecting lesions, and epicardial left atrial appendage exclusion without requiring a sternal incision, cardiac arrest, or cardiopulmonary bypass. Risk factors for adverse outcomes for this procedure based on preoperative patient characteristics are not well understood. Obesity is a common preoperative risk factor that may increase the technical difficulty of the surgical procedures, especially minimally invasive techniques. This retrospective study investigated the impact of obesity on postoperative outcomes as well as on short- and long-term successful conversion to sinus rhythm.

Methods: Seventeen consecutive patients undergoing thoracoscopic Maze surgery at the University of Kentucky from December 1, 2013 to February 3, 2016 were included in this retrospective chart review. Preoperative characteristics, intraoperative technique, and outcomes were assessed, including short- and long-term clinical follow-up with electrocardiograms.

Results: Eleven of 17 patients in the study were obese (65%) with a body mass index greater than 30. Of those who were obese, 7 patients (64%) had persistent atrial fibrillation and 4 patients (36%) had paroxysmal atrial fibrillation. Ten obese patients (91%) had successful conversion to normal sinus rhythm documented during the clinical follow-up period. The length of the follow-up period ranged from 2 weeks to 20 months. There were no operative deaths, and no operations were converted intraoperatively to an open technique.

Conclusions: Obesity is a common preoperative characteristic that is thought to increase the difficulty of minimally invasive surgery and may worsen outcomes. In a cohort of obese patients undergoing thoracoscopic Maze procedures, we have demonstrated a high rate of successful conversion from refractory atrial fibrillation to normal sinus rhythm without adverse outcome or intraoperative conversion to an open Maze procedure.

P23
Minimally Invasive Thoracoscopic Surgery Is an Effective Approach for Inappropriate Sinus Tachycardia

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Objective: Inappropriate sinus tachycardia (IST) is an uncommon arrhythmia characterized by an increased heart rate that is out of proportion to normal physiological demand. IST is challenging for the electrophysiology community due to the risk of phrenic nerve (PN) injury during ablation. In this study, we investigated the safety and efficacy of a minimally invasive thoracoscopic procedure for elimination of the IST focus.

TABLE P23-1. Patients' Preoperative Characteristics and Postoperative Outcomes

Patient	Age	Gender	Prior Attempts	Failed Medications	Prior Cardiac Diagnosis	Baseline HR	POD 1 HR	30-Day HR
1	34	M	1	BB, CCB, and digoxin	None	117	89	–
2	47	F	1	BB and CCB	Atrial fibrillation	131	101	–
3	46	F	2	BB and CCB	Atrial fibrillation	94	88	74
4	23	M	13	BB and CCB	AVNRT	120	75	77
5	61	F	1	BB and CCB	Atrial fibrillation	104	80	75
6	44	F	2	BB and CCB	None	108	85	80
7	21	F	1	BB, CCB, flecainide, and digoxin	None	123	87	89
8	31	F	1	BB	None	106	75	74
9	28	F	3	BB, CCB, and flecainide	AVNRT	150	88	85

AVNRT, atrioventricular nodal reentrant tachycardia; BB, beta blocker; CCB, calcium channel blocker; HR, heart rate; POD, postoperative day.

Methods: Patients with IST who failed endocardial ablation underwent minimally invasive thoracoscopic epicardial ablation**.** Epicardial activation mapping was performed to identify the earliest activation site and any possible migration pathway. The phrenic nerve in each patient was protected by a pericardial retraction suture. Patients' outcomes were reviewed retrospectively.

Results: From January 2000 to September 2016, 9 patients (7 women and 2 men) underwent minimally invasive thoracoscopic IST ablation at our university center. The mean age of the patients was 37 ± 13 years. All patients were treated with rate/rhythm control medications and had prior endocardial ablation, with the highest attempt being 13 ablations. The most common concomitant comorbidity was asthma (N = 4, 45%). Two (22.2%) other patients noticed symptoms following pregnancy. The mean baseline sinus rate was 117 ± 17 beats per minute (Table P23-1). After the operation, the mean heart rate decreased significantly on postoperative day 1 (117 ± 17 versus 85.33 ± 8 beats per minute, $P < 0.001$). No in-hospital deaths, strokes, or phrenic nerve injuries were detected. One patient required re-intubation; 1 patient developed postoperative pericarditis; and 1 patient had a pulmonary embolism. The median follow-up time was 6 months (range, 1–30). Freedom from re-intervention was 88% at 6 months. All patients remained free from medication after the operation, except 2 who needed re-intervention at 4 months and 12 months (Table P23-1).

Conclusions: Minimally invasive thoracoscopic ablation for IST is a safe and effective approach that preserves the phrenic nerve. Due to the possibility of IST activation site migration, continued follow-up after the operation is required.

P24
Minimally Invasive Laser Lead Extraction: Infected Versus Noninfected Leads

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Objective: We investigated the effect of systemic infection or lead endocarditis on the difficulty and success of laser lead extraction (LLE) procedures.

Methods: Medical records of all patients undergoing LLE between January 2012 and August 2015 were screened with regard to sufficient information on systemic infection or lead endocarditis. We used high-frequency 80-Hz laser sheaths in 101 patients with a lead implant duration of ≥24 months. Indications for lead extraction were systemic infection and lead endocarditis (29.7%), local infection (49.5%), lead dysfunction (15.8%), upgrades (3.0%), and tricuspid insufficiency (2.0%). A total of 239 leads were scheduled for LLE: 175 pacing and 64 implantable cardioverter defibrillator leads; the mean time from initial lead implantation was 96.5 ± 65.5 months (range, 24–408). The patient lead distribution with regard to systemic infection or lead endocarditis was systemic infection and lead endocarditis (group A): 30 patients, 78 leads; local infection and other extraction indications (group B): 71 patients, 161 leads.

Results: Complete procedural success was significantly higher in group A than in group B (100% vs. 94.4%; $P = 0.0331$). The laser treatment time and fluoroscopy time were numerically lower in group A. Mean time from initial lead implantation (103.4 vs. 89.6 months; $P = 0.1320$), and the ratio of implantable cardioverter defibrillator leads (28.2% vs. 26.1%; $P = 0.7566$) did not differ significantly between the 2 groups. Minor and major complications were low in both groups and did not reveal any significant differences (group A: 1 minor complication—pocket hematoma; group B: 2 major complications—pericardial effusion and emergent sternotomy due to perforation of the superior vena cava). No extraction-related deaths were observed.

Conclusions: The presence of systemic infection or lead endocarditis in LLE procedures allows for more complete procedural successes. When compared with LLE of noninfected leads, the infected leads require less laser and fluoroscopy time. Due to the small number of minor and major complications, no statistical significance was found in that regard.

P25
Minimally Invasive Implantation of Left Ventricular Assist Devices: Safe Implementation Early In a Surgical Career

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Objective: Several centers offer minimally invasive surgical approaches for implantation of centrifugal left ventricular assist devices. Although these large centers have found that minimally invasive implantation can be successfully performed by experienced surgeons, it is unknown whether these techniques are widely adoptable. We compared conventional and minimally invasive surgical approaches performed by a surgeon early in his career.

Methods: All consecutive left ventricular assist device implantations by a single surgeon in his first year of practice (2015–2016) were retrospectively reviewed. Patients were stratified by the standard approach, a conventional full sternotomy (CS), versus a minimally invasive

approach, and a left anterior thoracotomy and upper hemisternotomy (LTHS). Demographic and perioperative variables and short-term outcomes were compared.

Results: Thirteen patients were identified (CS = 6, LTHS = 7). Preoperative age, INTERMACS score, and creatinine and total bilirubin levels were comparable in the CS and LTHS groups, with significantly more preoperative right ventricular dysfunction in the LTHS group ($P = 0.01$). Operative time was significantly shorter ($P = 0.02$) in the CS group compared to the LTHS group, but cardiopulmonary bypass time trended toward statistically shorter times in the LTHS group. One patient who began with the LTHS was converted to a full sternotomy due to intraoperative bleeding, but no patients in either group required a right ventricular assist device. Although not statistically significant, the lengths of stay in the intensive care unit and in the hospital were also nominally reduced in patients who received LTHS implants. The 6-month survival rate in both groups was 100%.

Conclusions: In this small series, LTHS appears at least comparable if not superior to CS in regard to perioperative outcomes**.** Although the operative time was longer in LTHS, it was still within the learning curve of a surgeon's initial experience. Overall, this minimally invasive approach appears to be safe, efficacious, and adoptable by surgeons early in their careers.

P26
Impact of Right Ventricular Function for Worse Outcome After CABG With or Without Surgical Ventricular Reconstruction

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Objective: The prognostic value of right ventricular (RV) function for patients with ischemic cardiomyopathy who underwent coronary artery bypass graft (CABG) with or without surgical ventricular reconstruction (SVR) is still unknown. The purpose of the study was to clarify whether cardiac magnetic resonance imaging (MRI)-derived RV assessment can facilitate risk stratification among patients who underwent CABG with or without SVR.

Methods: We retrospectively analyzed 163 patients (109 men; age, 66 ± 10 years) with ischemic cardiomyopathy and a left ventricular ejection fraction of 40% or less who were evaluated using cardiac MRI preoperatively and who underwent CABG with (n = 53) or without (n = 110) SVR from 2004 to 2014. Cine-MRI images had been acquired for left and RV volumetric measurements. Patients were divided into 2 groups: those with RVEF ≤ 35% (group RF: n = 38) and those with RVEF >35% (group C: n = 125). The midterm (median, 3.8 years) result of all-cause deaths was evaluated, and interactions between RV function and treatment allocation were also analyzed.

Results: The mean preoperative left ventricular end-systolic volume index was significantly higher (133 ± 44 vs. 90 ± 32 ml/m^2, $P < 0.01$) and the left ventricular ejection fractions were significantly lower (29 ± 8 vs. 18 ± 5%, $P < 0.01$) in group RF. The mean right ventricular end-systolic volume index was also significantly higher (64 ± 27 vs. 31 ± 9 ml/m^2, $P < 0.01$) and the right ventricular ejection fractions were lower (50 ± 7 vs. 26 ± 7%, $P < 0.01$) in group RF. A Kaplan-Meier analysis showed that group RF patients had a greater but not significant incidence of all-cause death (5-year; 66% vs. 78%, $P = 0.21$). A significant interaction between RV dysfunction and treatment allocation was observed. Group RF patients who underwent CABG had similar incidences of all-cause death (P = NS; Fig. P26-1A) compared with group C patients who underwent CABG. However, group RF patients who received CABG concomitant with SVR had significantly worse outcomes compared with group C patients who received concomitant SVR ($P = 0.013$, Fig. P26-1B).

Conclusions: RV dysfunction may affect the midterm outcome after CABG concomitant with SVR, despite the fact that it did not affect the outcome after CABG without SVR.

P27
Blood Flow Through the Bioprosthetic Aortic Valve: Blood Flow Visualization and Energy Dynamics Based on 4-Dimensional Flow Magnetic Resonance Imaging

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Objective: Our goal was to evaluate the flow characteristics of bioprosthetic aortic valves including porcine aortic and bovine pericardial valves based on 4-dimensional flow magnetic resonance imaging. Flow energy loss through the aortic valve and output kinetic energy (KE) at the ascending aorta were estimated from the visualized blood flow.

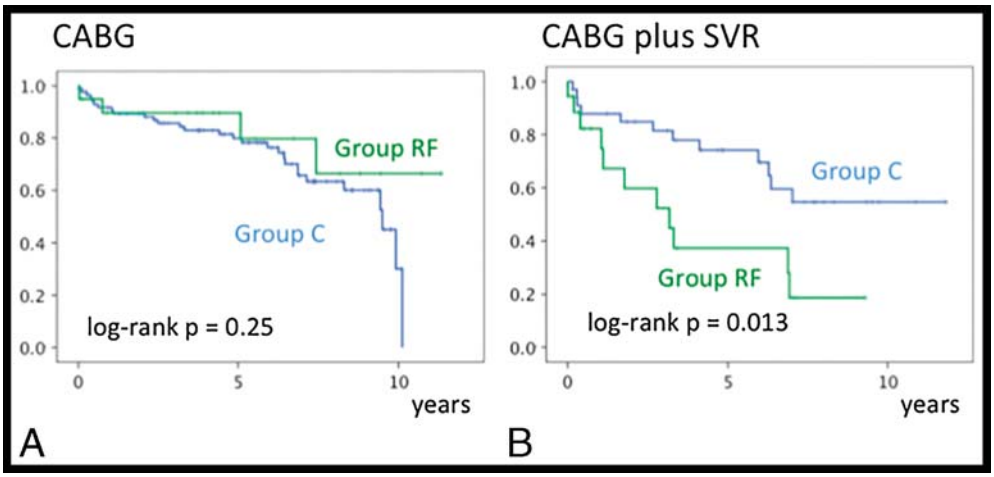

FIGURE P26-1. Kaplan-Meier curves for all-cause mortality in patients with and without RV dysfunction who underwent CABG (A) and in patients who underwent surgical ventricular reconstruction concomitant with CABG (B).

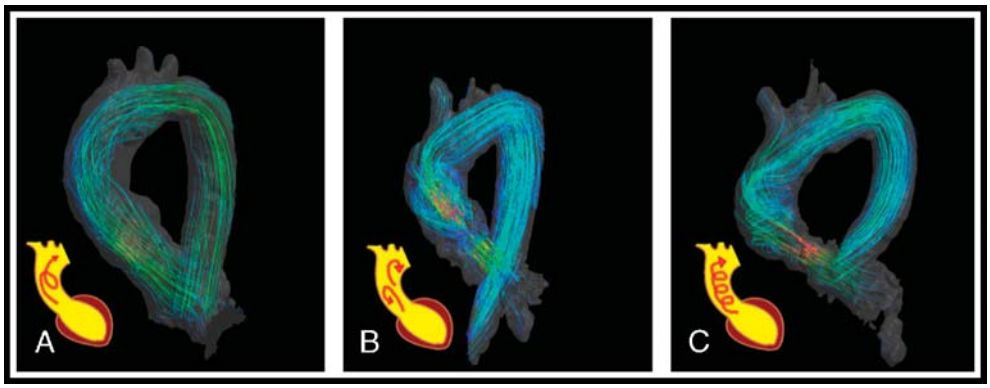

FIGURE P27-1. Flow pattern in various types of the aortic valve. A, In healthy volunteers, smooth helical flow was observed in the aorta. B, In bovine pericardial aortic valve, straightforward flow collided with the ascending aorta and vertical vortex was observed in the ascending aorta. C, In porcine aortic valve, highly helical spiral flow was observed in the aorta.

Methods: Two healthy volunteers and 5 patients were examined after aortic valve replacement (AVR) with 4-dimensional flow magnetic resonance imaging (3-dimensional time-resolved flow magnetic resonance imaging): 2 cases with a bovine pericardium valve (Carpentier-Edwards Perimount Magna, Edwards Lifesciences Corp., Irvine, CA USA) (21 and 25 mm), and 3 cases with a porcine aortic valve (Medtronic Mosaic Ultra, Medtronic Inc., Minneapolis, MN USA) (23 mm in 2 cases and 27 mm in 1 case). The cardiovascular lumen was extracted with a superimposed steady-state free precession series for pulsatile 3-dimensional flow visualization. Output kinetic energy at the ascending aortic level and flow energy loss through the aortic valve were calculated from the measured flow.

Results: The ages of the healthy volunteers and of the patients with AVR with the bovine pericardium valve and AVR with the porcine aortic valve were 35.5 ± 2.1, 77.5 ± 5.0, and 73.7 ± 8.7 years old, respectively. The flow rates of these 3 groups were 5.10 ± 0.49, 3.03 ± 0.01, and 3.39 ± 0.18 L/minute, respectively. The flow streamline of the healthy volunteers was a slightly helical flow along the curve of the arch (Fig. P27-1A), and the energy loss and kinetic energy were 1.62 ± 0.54 and 5.13 ± 3.39 mW, respectively. The flow streamline through the bovine pericardium valve became straightforward and collided with the distal portion of the ascending aortic wall, resulting in a vertical vortex inside the ascending aorta (Fig. P27-1B). The energy loss and kinetic energy were 2.98 ± 0.53 and 3.95 ± 0.21 mW. The flow streamline through the porcine aortic valve was a highly helical flow inside the ascending aorta (Fig. P27-1C); and energy loss and kinetic energy were 3.39 ± 1.09 and 5.82 ± 3.00 mW.

Conclusions: The porcine aortic valve and the bovine pericardium valve exhibited characteristic flow patterns. Compared with the normal control, flow through the bioprosthetic aortic valve caused a high energy loss. Helical flow inside the ascending aorta caused a high kinetic energy output.

P28

Usefulness of the Indocyanine Green Direct Injection Method Using the Spy System

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Objective: The SPY system is the first commercially available fluorescence angiographic device that allows surgeons to assess the bypassed graft during the surgical procedure. The prototype of the SPY system (SP1000) was introduced in 2002. The second generation (SP2000) was used from 2002 to 2015. The latest version, which includes a color mode (SP3000), was introduced in July 2015. At our institute, 100% of isolated coronary procedures were performed with off-pump coronary artery bypass grafting. SPY intraoperative graft validation was routinely used in more than 700 cases. Since May 2016, the new technique has been used for the free graft.

Methods: We first identify the target coronary artery using the SPY system. After the distal anastomosis is completed, diluted indocyanine green (ICG) is mixed with heparinized blood and injected directly into the free graft while the SPY system is recording. After the proximal anastomosis is completed, SPY imaging with natural flow is performed by injecting diluted ICG via the central venous line.

Results: Before the anastomosis, the target coronary artery can be identified using the SPY system. It is especially helpful in totally occluded branches. Just after completion of the anastomosis, visual confirmation of the patency of the graft can be obtained. The ICG direct injection method has been extremely useful (Fig. P28-1), especially when the target artery is small, about 1 mm diameter, and the surgeon is concerned about the patency of the anastomosis or when the anastomosis is performed by an inexperienced resident. The sequential bypass grafting could be avoided in 4 cases because the neighboring coronary artery could be stained just after direct injection of ICG. All bypass grafts including in-situ grafts were routinely evaluated

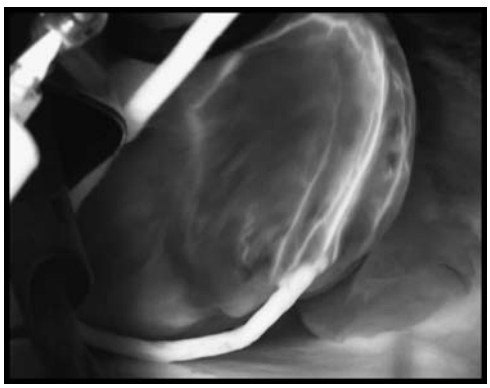

FIGURE P28-1. ICG direct injection method just after distal anastomosis of the free graft.

using the SPY system. All areas of the left anterior descending coronary artery, the circumflex coronary artery, the distal right coronary artery, and aortic proximal site could be accessed.

Conclusions: Using the SPY system intraoperatively, one can avoid technical errors while the chest is open. Distal anastomotic patency of the free graft can be confirmed using the direct injection of ICG. The latter may also be useful for a surgeon in training and may have the potential to reduce unnecessary sequential bypass grafting.

P29

Outcome of the Minimally Invasive Approach for Intracardiac Repair of Tetralogy of Fallot

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Objective: Median sternotomy has been the standard approach for intracardiac repair of patients with tetralogy of Fallot. In the era of minimally invasive surgery, left anterior thoracotomy was assessed as an alternative approach for the same procedure.

Methods: From January 2014 to October 2016, 26 patients with tetralogy of Fallot underwent intracardiac repair via a short-incision left anterior thoracotomy and minimally invasive cannulation. Sixteen patients were children and 10 were adults. The average age was 7.4 ± 2.8 years (2–32 years). The average weight was 18.6 ± 4.6 kg (10–67 kg). Patients were selected on the basis of their favorable surgical anatomy; patients with associated cardiac lesions were excluded. Skin incisions were as long as 5 cm. Intraoperative and postoperative parameters were studied. Patients were followed up postoperatively for 1 year. Outcomes were measured clinically as well as echocardiographically.

Results: The mean cardiopulmonary bypass time was 88 minutes (70–134 minutes). Ten patients were extubated within 2 hours of surgery. Cosmetic results were very good. One patient died of intractable ventricular arrhythmia. Postoperative hemodynamics, the need for inotropic support, drain output, and intensive care unit stay were similar to those of patients routinely operated on via a median sternotomy. On follow-up, none of the patients was found to have clinically significant morbidities. All patients had acceptable postoperative echocardiographic reports.

Conclusions: Intracardiac repair of tetralogy of Fallot through a left anterior thoracotomy is a safe, effective, and cosmetically better alternative compared to the same procedure via a median sternotomy.

P30

Three-Port Totally Endoscopic Repair of Atrial Septal Defects

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Objective: Substantial percentages of patients still need surgical correction of an atrial septal defect (ASD) in the era of Amplatzer septal occlusion (ASO). We assessed the validity and safety of 3-port totally endoscopic repair of ASD.

Methods: Between February 2000 and October 2016, 134 patients (median age, 37.7 years; 48 women, age range, 0–80 years) were operated on for ASD in our institution. Thirty-three patients had a 3-port totally endoscopic minimally invasive procedure and 101 patients had a classic procedure by a median incision. Propensity matching yielded 60 matched patients (minimally invasive vs. classic procedure, 30 vs. 30). In the minimally invasive procedure, all patients whose body height was >140 cm were adapted. Early results between the 2 groups were compared. For the minimally invasive procedure, the patient was set in the partial left lateral position and cardiopulmonary bypass (CPB) was established through a groin incision. The 3 ports comprised a main incision (3 cm in the fourth intercostal space), a left-handed instrument trocar (5 mm in the third intercostal space), and a camera port (5 mm in the fifth intercostal space). An additional venous cannula was inserted directly into the superior vena cava through the main incision. The ASD was closed while the patient was under cardioplegic arrest or low-body-temperature ventricular fibrillation.

Results: As concomitant procedures, tricuspid annuloplasty, mitral valve repair, the Maze operation, or repair of a partially anomalous pulmonary venous connection was performed in 11 (36%) patients using a minimally invasive procedure and in 8 (26%) patients using the classic procedure ($P = 0.41$). Major adverse cardiac events were 0 vs. 4 (13%) with the minimally invasive procedure and the classic procedure, respectively ($P = 0.06$). The minimally invasive procedure needed longer cross-clamp time (76.6 ± 12 vs. 33 ± 24 minutes, $P < 0.01$) and longer CPB time (128.0 ± 26 vs. 70.6 ± 37 minutes, $P < 0.01$). However, operating time did not differ significantly (195.8 ± 40 vs. 202 ± 49 minutes, $P = 0.555$), and the minimally invasive procedure needed a shorter postoperative hospital stay (median 7.0 vs. 17 days, $P < 0.01$).

Conclusions: Irrespective of the longer CPB and cross-clamp time compared with the classic procedure, patients who had the minimally invasive procedure tended to have fewer complications and significantly quicker recovery times. Compared with Amplatzer septal occlusion, the surgical procedure can be used to treat any type of ASD including type I, concomitant valvular lesions, and arrhythmia. The 3-port endoscopic technique was safe and cosmetically excellent, retaining the benefits of surgical intervention.

P31

Minimally Invasive Versus Conventional Sternotomy Techniques for Atrial Myxoma

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Objective: Minimally invasive cardiac surgery has evolved to become standard therapy for several cardiac diseases at specialized centers. The goal of this study was to compare this technique to the conventional access via full median sternotomy for resection of atrial myxoma.

Methods: This retrospective analysis included 65 consecutive patients who had resection of an atrial myxoma between 2008 and 2016. Diagnosis of myxoma was confirmed by histological examination. Exclusion criteria were concomitant procedures that could be performed via minimally invasive access (n = 7). Minimally invasive resection via a right anterolateral minithoracotomy was used in 31 cases (group I) whereas 27 patients were operated on via a full median sternotomy (group II).

Results: Patients in group I were significantly younger compared to those in group II (52 ± 13 vs. 63 ± 13; $P = 0.004$). The other preoperative characteristics were similar between the 2 groups. Diagnosis of myxoma was confirmed by histological examination in all patients. Cross-clamp time (84 ± 47 vs. 61 ± 37; $P = 0.070$) as well as duration of procedure (I: 204 ± 63 vs. II: 183 ± 69 minutes; $P = 0.283$) were similar in both groups. No significant differences in duration of postoperative ventilation (I: 361 ± 226 vs. II: 302 ± 183 minutes; $P = 0.422$), amount of postoperative drainage (I: 498 ± 305 vs. II:

581 ± 301 ml; $P = 0.467$), or need for red blood cell transfusion (21% vs. 19%; $P = 1.000$) were observed between the groups. The duration of intensive care unit (1.8 ± 1.2 vs. 1.9 ± 1.0 days; $P = 0.597$) and length of hospital stays (7 ± 3 vs. 7 ± 2 days; $P = 0.655$) were similar in both groups. In group I, 2 minor perioperative strokes with mild hemiplegia were observed. The rate of postoperative pacemaker implantation was 3% in group I and 7% in group II ($P = 0.593$), respectively. No wound healing disorder and no other major postoperative complications were seen in either group.

Conclusions: Minimally invasive resection of atrial myxoma is safe and feasible without significant prolongation of cross-clamp or procedural times, thereby combining reduced surgical trauma with superior cosmetic results.

P32

Brain Natriuretic Peptide As an Additional Metric for Determining Operative Candidates Among Veterans With Aortic Stenosis

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Objective: As the veteran population ages, the incidence of clinically significant aortic stenosis (AS) is becoming a health issue. Previous work has shown that brain natriuretic peptide (BNP) has a positive correlation with death in veterans undergoing coronary revascularization at a Veteran's Affairs Medical Center (VAMC). This analysis focused on BNP as an adjunct to aid decision making for early aortic valve replacement (AVR) in veterans with AS and to reduce hospital admission rates.

Methods: We retrospectively reviewed patients referred to the heart valve clinic at a single VAMC between 2006 and 2015 who were diagnosed with AS. We identified 75 male veterans who had BNP extracted in addition to traditional echocardiography during their diagnostic workup. This cohort was then subdivided into those who underwent surgery (n = 41) versus those who were managed medically (n = 34) and stratified based on their BNP values: 0–100, 101–300, 301–1000, and greater than 1000. The primary outcome of interest was admission to a VAMC for heart failure.

Results: The mean age was 76 years in the medical and 71 years in the surgical group; the mean body mass index was 29.2 and 32.3 (kg/m^2), respectively. Univariate analysis of BNP stratification and operative status showed a reduction in the number of admissions for those who underwent AVR ($P = 0.05$). Post hoc analysis clarified the reduction in average number of admissions for surgical patients vs. those treated medically, with BNP levels between 101 and 300 (0.636 vs. 3.714; $P = 0.042$) and between 300 and 1000 (1.364 vs. 4.00; $P = 0.006$). Patients with BNP values between 0 and100 and BNP values greater than 1000 showed no significant difference in average number of admissions. Post hoc testing further indicated that echocardiography values were similar between BNP stratifications except for ejection fraction in those with BNP values between 101 and 300 and BNP values greater than 1000 ($P = 0.032$).

Conclusions: BNP may be a useful adjunct for selecting patients with AS for earlier AVR or in select cohorts after AVR, leading to lower rates of hospital admissions in the population of veterans. Continued analysis using a larger cohort will be beneficial to further validate the utility of BNP stratification as a diagnostic tool to stratify patients with asymptomatic AS in a valve clinic according to level of risk.

P33

Does Ultrafast-Track Therapy After Robotic-Assisted Cardiac Surgery Increase Incidence of Medical Complications at 30 Days?

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Objective: An ultrafast-track approach to cardiac surgery has been described as an effective way to bypass the cardiac surgical intensive care unit in selected patients undergoing robotic-assisted minimally invasive coronary artery bypass surgery (RA-CABG). However, precise selection criteria for this cohort of patients are not properly defined. The goal of this study was to review 30-day follow-up data of patients following an ultrafast-track approach in order to identify optimal selection criteria for applying the ultrafast-track approach.

Methods: We retrospectively reviewed our cardiac surgery database between 2006 and 2016. We identified 90 adult patients who had undergone RA-CABG and 6 patients in whom RA-CABG was attempted but who required conversion to sternotomy. Patients were selected for ultrafast-track care by a multidisciplinary team. Postoperative follow-up care occurred either in an outpatient clinic or via telephone. We determined whether patients sought medical attention during the first 30 days postoperatively or were readmitted to hospital and the reason for seeking care.

Results: The average patient age was 61.2 ± 9.4 years; 78.1% were men; 21.9% were women. Outpatient clinic follow-up was conducted with 97.9% of patients, and 2.1% had a phone call because we were unable to arrange in-person follow-up. In total, 7.2% of patients required readmission to the hospital mainly due to underlying lung disease, and 3.1% sought medical attention within the first 30 postoperative days for superficial wound infection, shortness of breath due to atelectasis, and nonspecific back pain. There were no postoperative deaths within 30 days.

Conclusions: The ultrafast-track approach to postoperative care following RA-CABG in carefully selected patients can reduce hospital length of stay and postoperative complications as a result of prolonged stay in the cardiac intensive care unit. In this cohort, patients who underwent an ultrafast-track protocol after RA-CABG had a low incidence of complications including readmission to the hospital in 30 days. In most of the cases, this finding was due primarily to underlying chronic obstructive pulmonary disease. We therefore suggest that further investigation is warranted among patients with chronic obstructive pulmonary disease to identify strict criteria to determine eligibility for an ultrafast-track approach following RA-CABG.

P35

How Helpful Is Intravascular Ultrasonography in Thoracic Endovascular Aortic Repair?

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Objective: Appropriate treatment of aortic disease depends on the accurate visualization of the aorta. Intravascular ultrasonography (IVUS) is an emerging aortic imaging technique used during thoracic endovascular aortic repair (TEVAR). IVUS provides immediate dynamic imaging of aortic disease that contributes to the choice of the diameter of the endoprosthesis. It allows determination of the size, origin, and patency of epiaortic and visceral vessels and reduces the

time of exposure to radiation and the amount of contrast administered. To evaluate the usefulness, limitations, and accuracy of aortic parameters, IVUS was compared with transesophageal echocardiography in an experimental study on pigs and with computed tomography scans and contrast angiography in a clinical trial on patients undergoing TEVAR.

Methods: IVUS was compared with transesophageal echocardiography (TEE) in pigs who had TEVAR to test a new stent graft and to assess the accuracy of the measurements of the aortic diameter and the position of the branch vessels. We also compared IVUS with CT scans and conventional angiography in patients who had undergone TEVAR for type B aortic dissection, to assess the accuracy of IVUS in defining aortic and iliac diameters and the length of the proximal and distal landing zone and to confirm branch-vessel position, thereby reducing the contrast load compared with contrast angiography imaging.

Results: We noted a precise correspondence between the aortic measurements made with IVUS compared with those made with transesophageal echocardiography. IVUS showed better intraoperative imaging compared to TEE for precise identification of epiaortic vessels, celiac axis, and vascular access. In patients with Type B aortic dissection, we precisely identified the site of the intimal tear and its relationship with the supra-aortic vessels. In 1 patient, we could detect and treat a stent infolding of an overlapping endograft mislead by contrast angiography.

Conclusions: IVUS permits precise identification of the origins of critical vessel compared with other imaging techniques and reduction in the number of angiographic views. With IVUS, we can limit radiation and contrast exposure from both preoperative CT scans and intraoperative angiography. Many procedures can be performed with limited or no use of iodinated contrast agents in patients with renal failure, a suspected allergy to contrast agents, or anatomical difficulties.

P36

Do Enhanced Recovery Programs Improve Outcomes in Adult Cardiac Surgery?

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Objective: Enhanced recovery programs (ERP) are a major innovation in the care of general surgical patients, reducing perioperative complications, shortening length of stay (LOS), and reducing costs. It is unclear how these results relate to the postcardiac surgery population.

Methods: We analyzed all databases for studies that evaluated ERP after cardiac surgery from 1999 to 2016. A total of 5 studies were identified: 3 studies (2 prospective, 1 retrospective) compared a fast-track recovery vs. a control group; 2 studies (1 prospective, 1 retrospective) assessed the reasons for failure of fast-track recovery programs.

Results: A total of 368 patients were included. The retrospective study (n = 74) showed a significant reduction of the total LOS in the ERP group (4.05 ± 1.43 vs. 5.4 ± 1.17, $P = 0.003$). The prospective study (n = 272) showed a reduction in the LOS in the intensive care unit (ICU) (14.38 hours, range, 2.83–202.00, SD 31.27 vs. 26.79 ± 11.58 hours, range, 14.42–50.00, $P < 0.001$) in the ERP group. There was an additional reduction in the duration of intubation (3.36 ± 2.54 hours, range, 0.25–18.57 vs. 5.11 ± 2.87 hours, range, 1.17–13.17, $P < 0.001$) and in the cost effectiveness compared to conventional recovery [£4182 ± 2284 vs. £4553 ± 1355, mean difference £371(£166–£1324), $P < 0.001$]. There was a significant reduction in the number of postoperative complications (1 or more complications: 50.9% vs. 19.2%, $P < 0.01$) and an improvement in postoperative pain scores ($P < 0.01$) in the ERP cohorts. A total of 346 complications occurred in 3317 patients (1704 patients, 11.6% in-hospital complications, 5.6% complications post discharge; and 1613 patients with 3.53% readmission rate for complications). In case of readmission, there was an association with a longer second ICU stay (105 ± 180 hours vs. 19.2 ± 2.4 hours in the ICU during the initial hospitalization). The mortality rate associated with readmissions was significant (6 of 53, 11.3%) in the ERP group. Independent risk factors for ERP failure were age (in-hospital OR 1.406, $P < 0.01$; post discharge OR 1.386, $P < 0.01$), female sex (in-hospital OR 1.509, $P < 0.01$), and prolonged operating time (in-hospital OR 1.382, $P < 0.01$, postdischarge OR 1.672, $P < 0.01$).

Conclusions: Small retrospective and prospective studies demonstrate fast-track recovery after cardiac operations as an important management strategy in carefully preselected patients for decreasing the LOS in the ICU, total duration of intubation, and LOS in the hospital. Fast-track recovery is a cost- effective strategy compared to conventional recovery. There is a lack of randomized trial data assessing which components of the fast-track system contribute most to the outcomes.

P37

Totally Endoscopic Coronary Artery Bypass Grafting: An 8-Year Experience and Follow-Up of Graft Patency

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Objective: Our goal was to summarize our 8-year surgical experience with totally endoscopic coronary artery bypass grafting (TECAB) and demonstrate the long-term follow-up results of graft patency.

Methods: Between March 2007 and November 2016, a total of 114 consecutive patients (96 men) at a mean age of 58 years (range, 36–78 years) and EuroSCORE of 1.1 ± 1.3 underwent off-pump TECAB with the da Vinci surgical system (Intuitive Surgical, Sunnyvale, CA USA) in our institution. A skeletonized left internal mammary artery (LIMA) conduit was used to graft the left anterior descending (LAD) artery with S18 U-Clips. The blood flow in the LIMA graft was measured with the Medistim VeriQ C system (Medistim ASA, Oslo, Norway). The patients were followed after the operation. Coronary angiography or computed tomography angiography (CTA) was performed to evaluate LIMA graft patency.

Results: All cases (n = 114) were successfully performed by a single-console surgeon (Gao, C.) with a single LIMA graft to the LAD artery (100%). There were no operative deaths or conversions to median sternotomy. The mean duration of the operation was 219 ± 58 minutes. The blood flow of the LIMA graft was 36.8 ± 18 ml/minutes after TECAB. No major complication was observed after the operation. The postoperative ventilation time was 13.9 ± 4.0 hours. The chest draining volume was 417.4 ± 274.8 ml. Coronary angiography or CTA showed 100% graft patency before discharge. During the follow-up period, LIMA graft patency was 98.8% at 1 year, 97.8% at 2 years, and 97.1% at 3 to 5 years after surgery.

Conclusions: Off-pump TECAB using LIMA to graft the LAD coronary artery is a safe and effective procedure for single-vessel disease. The long-term graft patency is excellent.

P38

Does Robotic Beating Heart Connector TECAB Bridge the Gender Gap in Coronary Bypass Surgery?

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Objective: Previous studies have shown that women carry a higher risk of morbidity and mortality after coronary artery bypass surgery compared to men. Some studies have demonstrated improved outcomes in women undergoing off-pump coronary bypass and robotic-assisted surgery. In this study, we investigated gender differences in risk factors and outcomes in our patients undergoing robotic totally endoscopic beating heart coronary artery bypass (TECAB).
Methods: From July 2013 to December 2016, patients undergoing beating heart TECAB were reviewed. We summarized perioperative data, and compared the outcomes of men versus women.
Results: A total of 172 men and 62 women underwent robotic-assisted beating heart connector TECAB. Mean age was 65.7 ± 10.7 years old. The STS score was higher in women than men (1.46 [0.60–5.14] vs. 0.73 [0.48–1.57], $P = 0.001$), and women had a higher rate of preoperative congestive heart failure (31.1% vs. 18.9%, $P < 0.05$). Otherwise, preoperative characteristics were similar between the 2 groups. Intraoperative data in women and men were similar except for the rate of multi vessel TECAB and the rate of BIMA use which were both lower in women (50% vs. 65.7% $P = 0.029$, and 44% vs. 58% $P = 0.05$ respectively). The mean length of hospital stay (women vs. men; 4.02 ± 4.26 days vs. 3.44 ± 2.50 days) was comparable. There were no statistically significant differences in postoperative morbidity including prolonged ventilation (4.9% vs. 5.3%), acute kidney injury (3.3 vs. 1.2%), new atrial fibrillation (24.6% vs. 23.1%), stroke (0.0% vs. 0.0 %), or surgical site infection (1.6 % vs. 0.0 %). Mortality in women, and men was 1.6% (1/62), and 1.8% (3/172) respectively ($P = 0.945$) (Table P38-1).
Conclusions: We conclude that although women have more preoperative risk factors, the morbidity and mortality after robotic beating heart connector TECAB in our center was similar to that seen in men.

TABLE P38-1. Perioperative Outcomes in 172 Male and 62 Female Patients Undergoing Robotic Beating Heart TECAB

Variable	Total Population (n = 234)	Men (n = 172)	Women (n = 62)	*P* Value
STS PROM	0.83 (0.50–2.01)	0.73 (0.48–1.57)	1.46 (060–5.14)	0.001
CHF n (%)	51 (21.8)	32 (18.6)	19 (30.6)	0.049
Multi-vessel TECAB n (%),	144 (61.5)	113 (65.7)	31 (50.0)	0.029
Use of BIMA n (%)	127 (54.3)	100 (58.1)	27 (43.5)	0.049
Prolonged Ventilation >24 h, n (%)	8 (3.4)	6 (3.5)	2 (3.2)	0.922
Hospital Length of Stay, day	3.6 ± 3.0	3.4 ± 2.5	4.0 ± 4.2	0.678
AKI, n (%)	4 (1.7	2 (1.2)	2 (3.3)	0.287
Stroke/MI, n (%)	1 (0.4)	0	1 (0.4)	0.095
Mortality, n (%)	4 (1.7)	3 (1.7)	1 (1.6)	0.945

AKI, acute kidney injury; BIMA, bilateral internal mammary artery; CHF, congestive heart failure; MI, myocardial infarction; STS PROM, Society of Thoracic Surgeons Predicted Risk of Mortality; TECAB, totally endoscopic coronary artery bypass.

P39
Does Preoperative Imaging and the Learning Curve Reduce the Conversion Rate of Robotic-Assisted Coronary Artery Bypass Grafting

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Objective: Robotic-assisted coronary artery bypass grafting (RA-CABG) is a minimally invasive surgical revascularization technique that decreases patient morbidity. Multifactorial reasons can lead to conversion to sternotomy. Our study is to identify the effect of the learning curve and preoperative imaging on the conversion rate to sternotomy.
Methods: Between July 2000 and October 2016, 514 patients underwent RA-CABG. Isolated, off-pump, left internal thoracic artery (LITA) to left anterior descending (LAD) coronary artery grafting was performed either through a left anterior minithoracotomy or via the totally endoscopic (TECAB) approach following robotic harvesting of the LITA. To improve patient selection, we introduced computed tomography (CT) of the chest as part of the preoperative work-up, initially without contrast in 2005, then with contract in 2008, following the course of the LAD coronary artery. We further enhanced the preoperative imaging by analyzing the location of the LAD coronary artery within the epicardial adipose tissue in 2015. We considered 5 subgroups, each comprising 100 patients who underwent RA-CABG over the 16-year period. We analyzed the trend of conversion rate with the improvement of the preoperative imaging and the progression of the learning curve.
Results: The patients' mean age was 61.3 ± 10.7 years; 25% were women; 36.2% had morbid obesity. A total of 62 (12%) patients were converted to sternotomy. The conversion to sternotomy rate was 20% in the first group of 100 patients; 11% in the second group; 14% in the third group; 12% in the fourth group; and 4.4% in the fifth group (114 patients) (Fig. P39-1). In the subgroup analysis, we observed a significant decrease in the rate of conversion to sternotomy. We noticed a significant correlation between the decreased rate of conversion and the improvement in patient selection through the more accurate and sophisticated degree of imaging and the learning curve progression.
Conclusions: Improvement in the learning curve and use of the CT scan for detailed imaging analysis prior to RA-CABG surgery have significantly lowered the sternotomy conversion rate. Therefore, the patient morbidity rate has decreased.

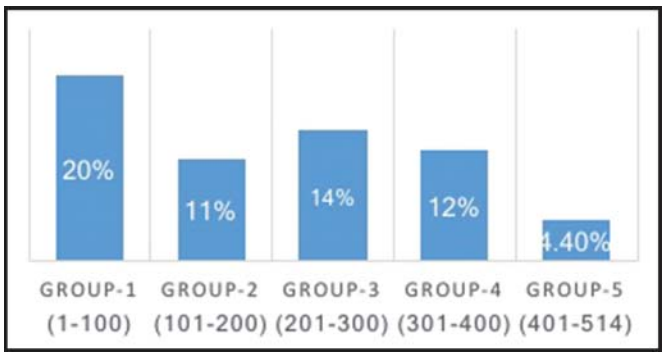

FIGURE P39-1. Sternotomy conversion rate over a 16-year period.

P40
Hybrid Coronary Revascularization in Patients with Diabetes: Pilot Randomized Controlled Trial

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Objective: The objective of this trial, which focuses on patients with diabetes who have multivessel coronary artery disease (CAD), is to

evaluate whether minimally invasive coronary artery bypass grafting (MI-CABG) with the left internal thoracic artery (LITA) to the left anterior descending (LAD) coronary artery followed by placement of drug-eluting stents (DES) in other affected coronary arteries (hybrid coronary artery revascularization [HCAR]) is more or less effective than CABG alone.

Methods: Enrollment began in December 2015 (ClinicalTrials.gov Identifier:NCT02504762). Adult patients with diabetes, multivessel coronary artery disease (with involvement of the LAD coronary artery), and angiographic lesion characteristics amenable to either percutaneous coronary intervention (PCI) or CABG were screened and enrolled in the study. Patients were randomized to either conventional off-pump CABG or MI-CABG with the LITA grafted to the LAD coronary artery followed by PCI within 3 days. The main objective of this study was to determine the number of consenting patients after 1 year of enrollment, protocol adherence, crossovers, and follow-up rates. After completion of this feasibility trial, patients will be enrolled in the main trial, the aim of which is to measure major adverse cardiac and cerebrovascular events at 5 years.

Results: After 12 months of enrollment, 60 patients were screened and a total of 11 patients were enrolled. The potential reason for nonenrollment was perceived suboptimal PCI in non-LAD coronary arteries. Patients underwent either off-pump CABG (n = 6) or HCAR (n = 5). All patients had hypertension and diabetes and were on maximal medical therapy (aspirin, beta blocker, statin, ACE inhibitor). HCAR patients underwent PCI after 1.2 ± 0.4 days following MI-CABG with placement of 2.2 ± 1.1 DES per patient. Angiography demonstrated Thrombolysis in Myocardial Infarction grade 3 flow in all LITA to LAD coronary artery grafts. Length of hospital stay was shorter in the HCAR group (5 days) compared to the CABG group (7 days) ($P = 0.04$). Protocol adherence and follow-up rates at a median of 6.3 months were 100%. No crossover/conversion to sternotomy, major adverse cardiac and cerebrovascular events, or blood transfusions occurred in either group.

Conclusions: This study is the first randomized controlled trial comparing conventional CABG to HCAR in patients with diabetes who have multivessel CAD. This feasibility study demonstrates that enrollment, crossover, and adherence to protocol rates are acceptable. The potential reason for nonenrollment is diffuse CAD felt to preclude PCI. HCAR patients demonstrated early discharge from the hospital; moreover, neither group had any major adverse cardiac and cerebrovascular events. Results of analysis of midterm outcome data and myocardial perfusion imaging are underway.

P41

Hybrid Coronary Revascularization of the Right Coronary Artery

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Objective: Hybrid coronary revascularization (HCR) has emerged as a new strategy for revascularization in multivessel coronary artery disease. However, the optimal candidate for HCR has not been clearly defined. The goal of this study was to determine the attributes of the optimal candidate for HCR.

Methods: Isolated coronary artery bypass grafting was performed in 445 patients at the Sapporo Cardiovascular Clinic between March 2012 and August 2016. Of these, 123 consecutive patients with surgical coronary revascularization whose operation was performed by a single surgeon (group S) and 56 consecutive patients with HCR (group H) were included. In group H, percutaneous coronary intervention was performed for the right coronary artery (RCA) and surgical coronary revascularization, for the left coronary artery. Outcomes were compared between groups.

Results: In group H, a sternal-sparing procedure was performed in 8 patients and a median sternotomy was used for the rest. Early outcomes were similar between the groups. Freedom from RCA revascularization was significantly higher in group S than in group H after 2 years (93% vs. 78%, $P = 0.019$). In group H, a low SYNTAX score (score 0–22) was associated with lower RCA revascularization compared with a high SYNTAX score (score 23+) group (3% vs. 33%, $P = 0.005$). Freedom from RCA revascularization after 2 years was similar when group S and low-SYNTAX-score cases in group H were compared (95% vs. 93%, $P = 0.662$).

Conclusions: Our results suggest that HCR is a feasible option only for the low-SYNTAX-score group. HCR for the high SYNTAX score group should be avoided due to the poor long-term outcome.

P42

Hospital and 1-Year Results of a Randomized Trial: Minimally Invasive Cardiac Surgery Revascularization Strategy

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Objective: We evaluated hospital and 1-year results of the prospective randomized controlled trial (RCT) Minimally Invasive Cardiac Surgery Revascularization Strategy (MICSREVS), which compared the effectiveness of multivessel small thoracotomy coronary artery bypass grafting (MVS.T-CABG) versus off-pump coronary artery bypass grafting (OPCABG) and on-pump coronary artery bypass grafting (ONCABG).

Methods: The RCT MICSREVS was started in January 2014 (http://www.clinicaltrials.gov/show/NCT02047266). In accordance with the trial design, 150 patients were included, divided into 3 groups of 50 people each. In group I, the MVS.T-CABG strategy was to perform multivessel arterial revascularization via a left minithoracotomy on the beating heart, using the aortic no-touch technique. In control groups II (OPCABG) and III (ONCABG), conventional surgery was performed via a median sternotomy. Randomization was carried out by the blind method ("envelopes"). Primary outcome measures were accepted death from any cause and major adverse cardiac and cerebrovascular events. The follow-up times were during the hospitalization period and 12 and 36 months after primary myocardial revascularization.

Results: MVS.T-CABG was associated with less perioperative blood loss, a lower number of blood transfusions, shorter hospital length of stay and time to return to full physical activity, greater improvement in the 30-day physical health component of quality of life, compared with the other groups and less postoperative ventilation time compared with the ONCAB group. The patients who had MVS.T-CABG demonstrated an associative trend toward shorter intensive care unit stays, less new-onset atrial fibrillation versus that in patients having ONCABG, and fewer deep wound infections versus those in patients having OPCABG. The mean follow-up period was 21.6 ± 8.3 months. A total of 139 (92.7%) patients have passed the 1-year control point. During the 1-year follow-up period, 1 patient died of a cardiovascular cause in the ONCABG group, and 1 patient in the MVS.T-CABG group received coronary angioplasty. Cumulative midterm survival and freedom from major adverse cardiac and cerebrovascular events did not differ significantly between the treatment groups (Table P42-1).

Conclusions: The full arterial aortic no-touch MVS.T-CABG demonstrated good results at the in-hospital and midterm follow-up examinations

TABLE P42-1. Operative Characteristics and Early Postoperative Results

Characteristics	MI-CABG (n = 50)	OPCABG (n = 50)	ONCABG (n = 50)	MVS.T-CABG vs. OPCABG	MVS.T-CABG vs. ONCABG
No. distal anastomoses, mean ± SD	2.7 ± 0.5	2.9 ± 0.6	3.1 ± 0.6	0.070	<0.001
Intraoperative blood loss, ml	250 (200; 300)	475 (350; 587.5)	400 (300; 500)	<0.001	<0.001
First 24-hour postoperative blood loss (ml)	450 (252.5; 587.5)	575 (450; 800)	500 (400; 800)	0.003	0.007
Transfusion of blood and/or derivatives, n (%)	9 (18.0)	20 (40.0)	33 (66.0)	0.015	<0.001
Deep wound infection, n (%)	–	3 (6.0)	–	0.079	–
Death, n (%)	–	–	1 (2.0)	–	0.315
Postoperative length of stay (surgical department), d	6.5 (5.0; 8.5)	8.5 (8.0; 10.0)	8.5 (8.0; 10.5)	0.003	0.008
Median time to return to full physical activity, d	14 (7; 21)	56 (42; 77)	56 (44; 79)	<0.001	<0.001
Physical health component from SF-36 Health Status Survey quality of life	50.9 (45,3; 52,8)	47.3 (44.9; 50.2)	48.3 (45.4; 50.5)	0.026	0.079

MI-CABG, minimally invasive coronary artery bypass graft; MVS.T-CABG, multivessel small thoracotomy coronary artery bypass grafting; ONCABG, on-pump coronary artery bypass grafting; OPCABG, off-pump coronary artery bypass grafting; SD, standard deviation.

of patients participating in the MICSREVS. RCT and can be applied to most patients with multivessel coronary heart disease.

P43
Results of Minimally Invasive Total Arterial Multivessel Minimally Invasive Coronary Artery Bypass

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Objective: In the current era of cardiac surgery, minimally invasive coronary artery bypass (MIDCAB) plays an important and challenging role. MIDCAB with bilateral internal thoracic conduits or total arterial grafts is also the best option for patients with coronary artery disease who are high risk for sternotomy. We evaluated 108 such selected patients who underwent minimally invasive multivessel total arterial off-pump anaortic CABG through a left anterolateral thoracotomy.

Methods: The procedure was performed using a 4 to 8 cm left anterolateral thoracotomy incision. The left internal mammary artery was harvested in every patient; the right internal mammary artery (RIMA) or radial artery was used as a second conduit. An LIMA-RIMA Y or an LIMA-RADIAL Y was made to accomplish multivessel total arterial bypass grafting. All intraoperative (hemodynamics and requirement of inotropic support, perioperative blood transfusion) and postoperative data (bleeding, wound infection, pain score, stay in the intensive care unit, duration of mechanical ventilation, arrhythmias, perioperative myocardial infarction, pleural effusion, need for intra-aortic balloon pump support, and postoperative patient satisfaction index) were collected and evaluated. Postoperative graft patency was checked in every patient by computed tomography coronary angiography 6 months following discharge.

Results: Multivessel total arterial CABG was accomplished in all selected individuals. There were no deaths or wound infections. Reexploration was done in 1 patient for bleeding. In 2 patients, the saphenous vein was used to graft the LAD coronary artery. The LIMA was used to graft diagonally because the length of the LIMA was not adequate to graft the distal LAD coronary artery. In 1 individual, conversion to sternotomy and CPB was required because of unstable hemodynamics. Muscle healing of the anterolateral thoracotomy was faster than bone healing of the conventional sternotomy incision. The LIMA-to-LAD coronary artery graft was patent angiographically in all patients postoperatively.

Conclusions: With conventional immobilization techniques and instruments, multivessel, total arterial MIDCAB can be accomplished safely in selected individuals. The RIMA can be harvested in patients with long-standing diabetes with no concern for sternal wound healing. Muscle healing of the anterolateral thoracotomy is faster compared to bone healing of a conventional sternotomy, and patients are back to normal life earlier.

P44
Minimally Invasive Direct Coronary Artery Bypass Grafting versus Percutaneous Coronary Intervention With a Drug-Eluting Stent for an Isolated Lesion of the Left Anterior Descending Artery

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Objective: Both minimally invasive direct coronary artery bypass grafting (MIDCAB) and percutaneous coronary intervention with a drug-eluting stent (DES-PCI) are established therapeutic options for coronary artery disease. However, it is still unknown which procedure is the more optimal for the long-term for revascularization of isolated disease of the left ascending artery (LAD). The scope of this study was to assess and compare the clinical outcomes of MIDCAB and percutaneous coronary intervention with a drug-eluting stent in a single LAD lesion in a real-world setting.

Methods: This study was a retrospective, observational, single-center study. The data of patients who underwent MIDCAB or PCI-DES at our institute between September 2006 and February 2010 were collected retrospectively. Among them, patients with single LAD coronary artery disease (proximal or mid-portion of the LAD coronary artery) were identified. Patients with left main trunk, right coronary artery, and left circumflex artery lesions were excluded.

Results: Twenty-eight patients were included in the MIDCAB group and 72 patients, in the PCI group. The mean age was 66.1 years in the MIDCAB group and 70.8 years in the PCI group. Only the LAD coronary artery and its branches were grafted in all included cases. The left internal thoracic artery was used as the graft in all MIDCAB cases. The average follow-up period was 6.1 years in the MIDCAB group and 7.8 years in the PCI group. Freedom from all-cause death was 96.0% and 94.2% after 7 years and freedom from repeat revascularization of

the target vessel was 91.3% and 61.8% after 8 years in the MIDACB and PCI groups, respectively, which was significantly higher in the MIDCAB group ($P = 0.02$). MIDCAB was related to a relatively decreased risk of the composite end point including death, myocardial infarction, and repeat revascularization, though it did not reach statistical significance. The incidences of periprocedural major bleeding and cerebrovascular disease were rare and did not differ between the revascularization techniques.

Conclusions: MIDCAB and stenting with DES for isolated LAD coronary artery lesions were associated with similar outcomes with a low risk of major adverse outcomes in the long term. MIDCAB showed a lower incidence of repeat revascularization. Selection of appropriate treatment is important to ensure optimal results for patients with isolated LAD coronary artery disease in terms of the characteristics of the procedure.

P45

Transit-Time Flow Measurement Equalizes 1- and 5-Year Survival Rates of Patients Who Had Off- and On-Pump Coronary Artery Bypass Grafts

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Objective: Off-pump coronary artery bypass grafting seems to be associated with worse long-term survival, a lower graft patency rate, and a higher rate of readmission for percutaneous coronary intervention procedures. The aim of this retrospective multicenter study was to evaluate if intraoperative transit-time flow measurement (TTFM) might improve 1- and 5-year event-free survival rates in patients undergoing an off-pump coronary artery bypass graft (OPCABG) compared to those having an on-pump coronary artery bypass graft (ONCABG).

Methods: From April 2004 to December 2014, 1406 patients who underwent isolated coronary artery bypass grafting (1120 ONCABG vs. 286 OPCABG at 2 university cardiac surgery departments and in whom graft flow was measured intraoperatively) were selected. A nonparsimonious propensity model (area under the curve 0.85) was built for sample matching 1:3. To check the balance between the matched groups, a standardized difference (SD) below 10% was used. Finally, 800 patients (600 ONCABG vs. 200 OPCABG) were selected, being perfectly comparable (propensity score 0.32 vs. 0.31, SD 7.1%).

Results: There were no differences in baseline and intraoperative characteristics of the groups. Intraoperative TTFM parameters did not show any differences between the 2 groups. Short-term results did not show any differences. The rates of intraoperative graft revision, mortality, myocardial infarction, and graft failure in ONCABG and OPCABG were 1.5% and 1%, 1.5 and 2.5%, 1.5 and 0.5%, and 0.7% and 0%, respectively. Long-term follow-up did not show any differences. The rates of mortality, myocardial infarction, graft failure, and new revascularization procedures in ONCABG and OPCABG were 8% and 6%, 1.5% and 0.3%, 1.5% and 1%, and 1.8% and 1%, respectively. Survival probability at 12 and 60 months was 94 ± 1% and 94 ± 2% and 82 ± 3% and 80 ± 6% for the ONCABG and OPCABG groups, respectively (log-rank: 0.57) (Fig. P45-1).

Conclusions: Our results demonstrate that the routine use of the TTFM as a tool for intraoperative graft verification can equalize the outcomes of patients who had CABG using the off- or on-pump strategy at both the short- and long-term follow-up examinations.

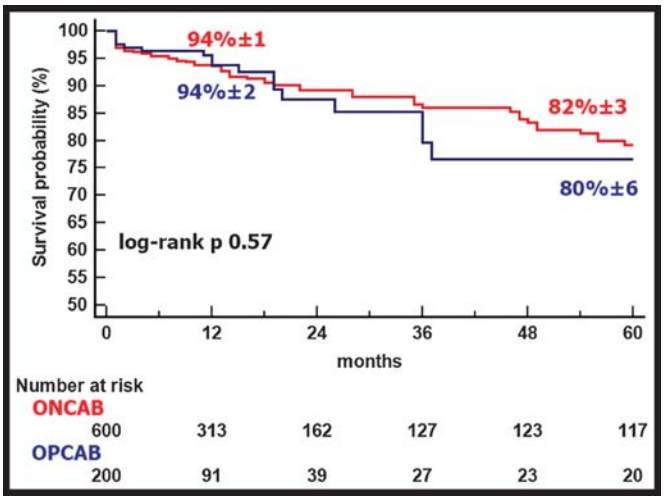

FIGURE P45-1. Survival probability at 1 and 5 years after surgery for on- and off-pump coronary artery bypass graft patients. ONCABG, on-pump coronary artery bypass graft; OPCABG, off-pump coronary artery bypass graft.

P46

Different Target Stenosis Severity for Bilateral Internal Mammary Artery Y-Graft Branches Does Not Influence the Outcome

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Objective: A great debate exists about the likelihood that an unbalanced grade of target stenosis of the Y-graft branches of the 2 bilateral internal mammary arteries could cause flow competition resulting in increased graft failure. We used transit-time flow measurement (TTFM) parameters to investigate the presence of flow competition between the bilateral internal mammary artery (BIMA) Y branches at the end of the operation.

Methods: From August 2009 to December 2014, 211 patients who had left internal mammary artery (LIMA) to left anterior descending (LAD) coronary artery and right internal mammary artery (RIMA) to lateral wall branches grafts were enrolled retrospectively in this study. "Graft flow competition" was defined as grafts with a mean graft flow ≤15 ml/minute, pulsatility index (PI) ≥3 and backward flow ≥ 3.

Results: Thirty-three (15.6%) patients showed LIMA (8 cases) or RIMA (25 cases) flow competition at TTFM (Group A). In 8 cases of LIMA flow competition, the LIMA branch showed significantly lower mean graft flow (8, 6–10 ml/minutes vs. 19 ml/minutes 12–29, $P = 0.012$) with a higher PI (5.3, 4.0–6.1 vs. 1.6, 1.4–2.0, $P = 0.010$) and a higher backward flow (17, 11–21 vs. 0, 0–2.8, $P = 0.009$) compared to the RIMA branch; the circumflex system showed a significantly higher grade of stenosis compared to the LAD coronary artery. In 25 cases of RIMA flow competition, the RIMA branch showed significantly lower mean graft flow (9, 5–12 ml/minutes vs. 18, 16–26 ml/minutes, $P < 0.001$), a higher PI (4.0, 3.5–5.1 vs. 1.9, 1.4–2.7, $P < 0.001$), and a higher rate of blood flow (7, 4–11 vs. 0.5, 0–6.9, $P = 0.014$) compared to the LIMA branch. In group B, the stenoses were balanced, and no difference in TTFM parameters was found between the BIMA branches. The early mortality rate was 1.4% without difference between the groups. No difference was found between the groups for the 5-year survival rate (group A 94% ± 4 vs. group B 93% ± 2, $P = 0.99$), cardiac survival (group A 97% ± 3 vs. group B 96% ± 2, $P = 0.96$), event-free survival (group A 87% ± 7 vs. group

B 84% ± 4, $P = 0.77$) and cardiac event-free survival (group A 94% ± 4 vs. group B 89% ± 3, $P = 0.76$).

Conclusions: A significant difference in native coronary stenosis causes different TTFM parameters between the 2 branches of a BIMA Y graft, indicating the presence of flow competition. This condition, however, does not show any clinical impact in the short and long term.

P47

Acute 30-Day Outcomes Related to Surgeons' Experience in Off-Pump Coronary Artery Bypass Grafting

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Objective: Off-pump coronary artery bypass grafting (OPCABG) is an established therapy for coronary artery disease in the elderly with or without a severely calcified aorta. Compared to the on-pump technique, OPCABG is considered to be more technically demanding. To date, no reports exist documenting acute outcomes of OPCABG related to different stages of the surgeon's experience.

Methods: From 2010 to 2015, 1049 consecutive patients (77.7% men, 69.9 ± 9.8 years, log EuroSCORE II 2.9 ± 3.6%) had OPCABG at our center. Surgeons' experience was retrospectively evaluated as follows: beginner (<50 OPCABG procedures); trained (≥50 OPCABG procedures); skilled (performing OPCABG on a daily basis). Acute 30-day outcomes were retrospectively analyzed and correlated to experience levels.

Results: The overall 30-day mortality rate was 1.7% (18/1432 patients). The 30-day mortality rate presented no significant differences related to the surgeon's level of experience. Beginner surgeons had an odds ratio (OR) of 1.7 (CI: 0.8–3.4; $P = 0.13$) compared to skilled surgeons for a 30-day mortality rate. Trained surgeons showed an OR of 1.9 (CI: 0.9–3.8; $P = 0.07$) compared to skilled surgeons. Although having a skilled surgeon did not cause a change in mortality rate in patients with increasing age, trained and beginner surgeons had impaired outcomes in the elderly patient population (Fig. P47-1).

Conclusions: OPCABG procedures can be performed safely by beginner and trained surgeons under supervision with comparable short-term outcomes compared to skilled surgeons. Patient and surgeon selection especially with regard to patient age is of crucial importance to further improve outcomes.

P48

Survival and Echocardiographic Outcomes in On- and Off-Pump Coronary Bypass for Patients With Impaired Ventricular Function

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Objective: Management of ischemic cardiomyopathies is evolving in an era of greater availability of ventricular assist devices. We examined the durability of improved left ventricular (LV) function and survival following coronary artery bypass grafting (CABG) in a poorly functioning left ventricle.

Methods: We did a retrospective analysis of 429 patients with an LV ejection fraction (EF) <40% undergoing isolated primary CABG from 2000 to 2016. CABG strategies were on-pump cardioplegic arrest (CA, n = 312), off-pump coronary artery bypass (OPCAB, n = 75), and on-pump beating heart (OBH, n = 42). A combined OPCAB and OBH group (n = 117) was propensity matched for preoperative characteristics to the CA group to obtain 114 patients per group.

Results: For the total population, the average preoperative LVEF was 31.4 + 7.1% with an average survival and echocardiographic follow-up of 3.7 + 4.2 and 2.7 + 3.3 years, respectively. Patients who had OPCAB had more hypertension ($P = 0.01$) and cerebrovascular disease ($P < 0.01$) and worse renal function ($P = 0.02$). Patients who had OBH had worse LVEF (27.7 + 7.2%, <0.01). Following CABG, there was an average LVEF increase of 10% (31.4 + 7.1 vs. 41.6 + 13.6%, $P < 0.01$) with a decrease in LV dimension ($P < 0.01$) and improvement in mitral regurgitation grade ($P < 0.01$). Despite these results, RV function worsened over time ($P = 0.04$) with no change in tricuspid regurgitation ($P = 0.49$). No difference in LVEF improvement (Δ LVEF) was seen between the time strata of <1 (9.8 + 11.2%), 1–5 (11.6 + 14.5%), and >5 (8.8 + 14.2%) years ($P = 0.442$). Posterior wall and interventricular septal thickness were unchanged ($P > 0.05$). With propensity matching, there was no difference in postoperative complications ($P > 0.05$) or survival between the CA and the combined

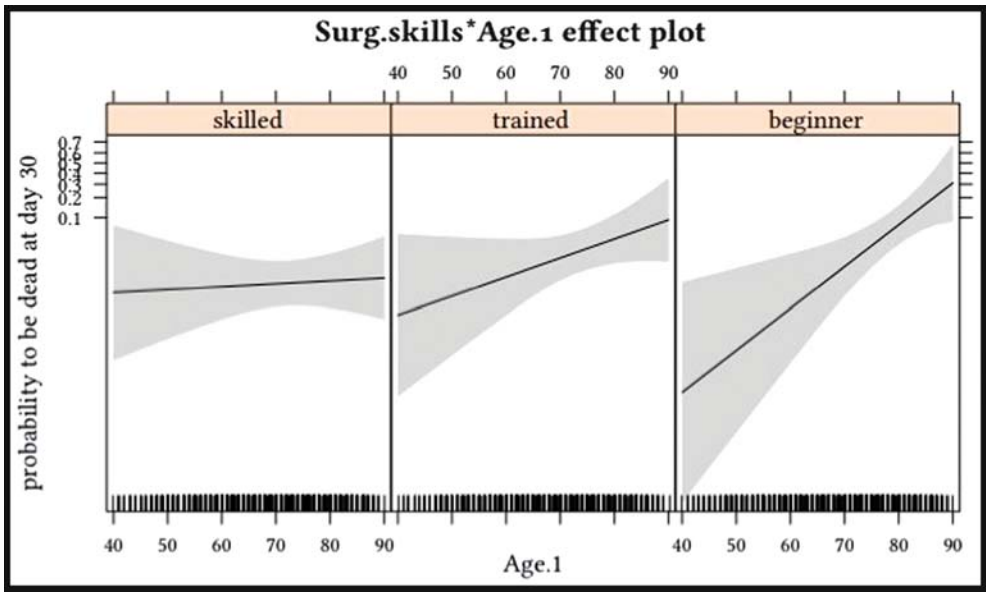

FIGURE P47-1. Risk increase for patient mortality per decade of physician age for three different physician skill levels in OPCAB surgery.

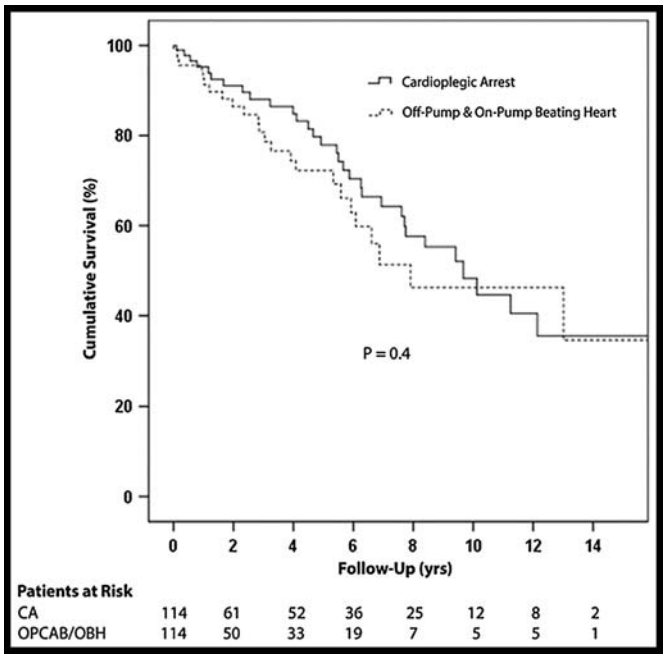

FIGURE P48-1. Survival in the cardioplegic arrest versus combined OPCAB/OBH propensity-matched groups. Following propensity matching, there was still no survival difference between the cardioplegic arrest and combined OPCAB/OBH groups.

OPCAB/OBH groups (Fig. P48-1, $P = 0.44$). Multivariate Cox regression revealed that preoperative predictors of mortality ($P > 0.05$) included age, weight, creatinine level, peripheral vascular disease, right ventricular dysfunction, and aortic valve stenosis. There were fewer circumflex territory grafts (0.68 vs. 0.97, $P < 0.01$) in the combined group.

Conclusions: Patients with moderate to severe LV dysfunction experienced long-term improvement in LVEF following CABG accompanied by a decrease in mitral regurgitation and LV dimension. Whereas there is a preference for OPCAB or OBH for patients with major comorbidities or lower EF, no difference in survival was seen compared with CA.

P49
In-Hospital Complications of Thoracic Cancer Lobectomies: Does Tumor Location Matter?

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Objective: Identification of risk factors for complications in patients undergoing thoracic lobectomies for cancer may assist with procedural risk adjustment. This study assessed whether lobe anatomy affects in-hospital complications.

Methods: The study used the Premier Perspective Database, containing billing data from more than 600 U.S. hospitals. Procedures and diagnoses were identified by International Classification of Diseases-9 codes. All elective lobectomies with a primary diagnosis of upper, middle, or lower lobe lung cancer from 2012 to 2014 were identified. Complications were identified with diagnosis codes: any air leak complications (aALC) was defined as a combination of air leak and pneumothorax, infection, and bleeding composites. Patient, procedure, and hospital factors were included in multivariable logistic regression models to assess the impact of lobe anatomy on complications. Analysis was stratified by approach and accounted for hospital clustering.

Results: A total of 8750 thoracic lobectomies for lung cancer were identified: upper lobe (n = 5284), middle lobe (n = 512), and lower lobe (n = 2954). A slightly higher fraction of surgical approaches included traditional thoracotomy (54.2%; n = 4,746) compared to video-assisted thoracoscopic surgery (VATS) (45.8%; n = 4,004). The incidence of aALC was 28.3% (air leak = 16.4% and pneumothorax = 14.8%). The incidence of bleeding and infections was 11.3% and 8.2%, respectively. Results of the multivariable analysis (Table P49-1) showed that for VATS, lobe anatomy had a significant effect on complications. The odds of having an aALC were 27% lower for lower lobe and 61% lower for middle lobe compared to upper lobe. Compared to an upper lobe lobectomy, a lower lobe lobectomy had a 25% reduction in odds of bleeding and a middle lobe lobectomy had a 67% reduction in odds of infection. For thoracotomy, only a lower lobe lobectomy had a significant reduction in the odds of aALC: a 12% reduction that was driven by a 23% reduction in air leaks compared to an upper lobe lobectomy.

Conclusions: This analysis shows that the effect of lobe anatomy is modified by surgical approach. In a VATS lobectomy for cancer, lobectomy of the upper lobe had an increased odds of air leak complications, bleeding, and infection compared to lobectomies in the middle and lower lobes.

P50
15-Year Experience with Anterior Single-Port Video-Assisted Thoracoscopy

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TABLE P49-1. Multivariate Analysis Results Comparing Results by Location of Lobe

	VATS Lobectomy (Ref = Upper Lobe) Odds Ratio (95% CI)		Thoracotomy Lobectomy (Ref = Upper Lobe) Odds Ratio (95% CI)	
	Lower Lobe	Middle Lobe	Lower Lobe	Middle Lobe
Any air-leak complications (aALC)	0.73 (0.62–0.86)*	0.39 (0.26–0.58)*	0.88 (0.78–0.99)*	0.80 (0.58–1.11)
Air leaks	0.76 (0.61–0.95)*	0.35 (0.19–0.63)*	0.77 (0.65–0.90)*	0.78 (0.52–1.17)
Pneumothorax	0.73 (0.60–0.89)*	0.45 (0.28–0.72)*	1.06 (0.92–1.23)	0.72 (0.47–1.10)
Bleeding (composite)	0.75 (0.61–0.92)*	0.75 (0.43–1.29)	0.91 (0.75–1.11)	0.84 (0.57–1.24)
Infections (composite)	1.03 (0.78–1.35)	0.33 (0.14–0.82)*	0.92 (0.75–1.13)	0.79 (0.51–1.20)

*$P < 0.05$.

CI, confidence interval; VATS, video-assisted thoracoscopic surgery.

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Objective: Uniportal thoracoscopy (VATS) through a 2.5 cm incision in the posterior-mid axillary line has been demonstrated to produce less postoperative pain than 3-port thoracoscopy. Since 2002, however, we have favored an anterior approach because of wider interspaces and less bucket-handle respiratory motion. We reviewed our cumulative, evolving experience to assess the feasibility and safety of this approach.

Methods: The clinical records of 129 consecutive anterior uniportal VATS procedures were reviewed without exclusions for surgical acuity. Mean age (±SD) was 53.6 ± 19.3 years (range, 13–92); 72% were men. Patients were positioned supine with double-lumen intubation unless they had been intubated preoperatively. A 2.5 cm incision was placed just lateral to the midclavicular line, a soft tissue retractor was inserted, and a 5 mm, 30° rigid telescope and thin-shafted instruments were used simultaneously with endoscopic staplers. Spinal needles were used for endoscopic intercostal nerve blockade. Channel drains exiting through the working interspace were tunneled subpectorally or omitted if preexisting chest drains were sufficient.

Results: Procedures included wedge resection in all except the basilar segments (46; 26 for apical blebs/bullae with abrasion), evacuation of effusion/hemothorax (32; 9 with lateral rib fractures/flail segments), talc pleurodesis (10), decortication (17), exploration/miscellaneous biopsy (22), and extended resection for lung volume reduction (2). No repositioning for dislodgement of double-lumen tubes was needed in 98.4% of patients (127/129). There were no urgent conversions to thoracotomy. Two of 5 patients intubated preoperatively died of their disease. Complications in 6 patients (4.7%) included re-explorations in 4 and prolonged air leak in 1; there were no lung hernias. Length of stay following resection in recent spontaneous pneumothorax patients was 3.3 ± 1.1 days; 2 patients with previous contralateral 3-port operations (Fig. P50-1) for this same indication experienced less postoperative discomfort following anterior single-port VATS and discharge on day 2 to immediate full activity.

Conclusions: Our 15-year experience with sublobar resection and drainage procedures confirms the complementary advantages of anterior and posterior single-port VATS over 3-port approaches. The anterior approach is anatomically favorable for upper and middle chest disease location, lateral chest trauma, or patients too unstable to tolerate lateral positioning.

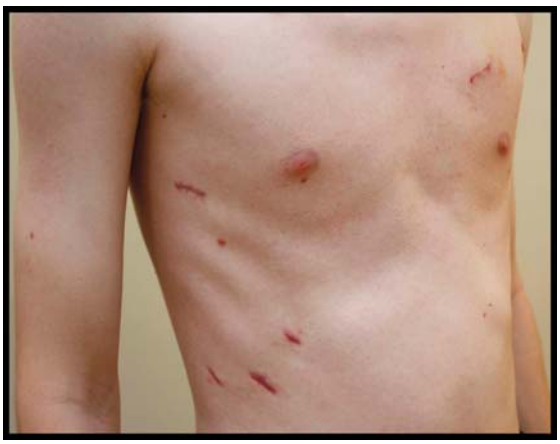

FIGURE P50-1. This 19-year-old man was 1 of 2 patients with spontaneous pneumothorax previously operated on elsewhere with 3 ports who underwent contralateral single-port procedures for the identical disease with less pain, faster recovery, and favorable cosmesis.

P51

Sentinel Node Mapping in Non-Small-Cell Lung Cancer by Radiotracer

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Objective: Lymph node metastases are the most significant prognostic factor in localized non-small-cell lung cancer (NSCLC). Identification of the first nodal drainage site may improve detection of metastatic nodes. Extended operations such as lobectomy or pneumonectomy with lymph node dissection are more acceptable for treatment. Sentinel node biopsy can be an alternative approach toward less invasive operations. In the current study, we evaluated accuracy of sentinel node mapping in 21 patients with NSCLC by intraoperative radiotracer techniques.

Methods: After thoracotomy, before mobilizing the tumor, 2 mCi/0.4 mL Tc-99m- phytate was injected around the tumor. After mobilization, the sentinel nodes were traced in the hilar and mediastinal areas. Any lymph node with an in vivo count twice that of the background was considered a sentinel node and was sent for frozen section evaluation. All dissected nodes were evaluated by step sectioning with hematoxylin and eosin staining. The variables were age, sex, kind of disease, site of the lesion, number of dissected sentinel nodes, number of sentinel nodes, and site of sentinel nodes.

Results: Twenty-one patients (male/female = 15/6), aged 58.52 ± 11.46 years, were included in study. The most common site for a tumor was the left lower lobe (30.09%). Eleven patients had squamous cell carcinoma and 10 had adenocarcinoma.One hundred twenty lymph nodes were harvested with an average of 5.71 ± 2.9 lymph nodes per patient. At least 1 sentinel node could be identified in each patient (detection rate, 95.2%). The mean number of sentinel nodes per patient was 3.61 ± 2. Frozen section results showed 100% concordance with hematoxylin and eosin staining results.

Conclusions: Sentinel node mapping is feasible and accurate for lymph node staging and NSCLC treatment.

P52

Thoracoscopic Fissureless Lobectomy Using a New Temporally Segmental Bronchus Incision Technique

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Objective: Several thoracoscopic fissureless lobectomy techniques have been reported but the indications remain controversial. The traditional technique of fissureless lobectomy is to expose the pulmonary artery at the fissure using electrocautery at first, but a persistent air leak can occur after lobectomy. Therefore, the fissure should be stapled completely after dissecting the arteries or between the artery and the lung parenchyma. Moreover, the fissure-first technique, including the traditional procedure and the thoracoscopic tunnel technique, cannot be used in some patients because the pleural fissure line is uncertain, especially in patients with a completely fused fissure. In a thoracoscopic fissureless lobectomy, one of the reasons for conversion to open lobectomy is the swelling or inflammation of lymph nodes between the lobar bronchus and the adjacent pulmonary artery. We developed a thoracoscopic technique of fused fissure lobectomy for patients with lung cancer, advocate T-BIT (temporary segmental bronchus incision technique), and describe its application for lung cancer patients with fused fissures.

Methods: T-BIT involves an initial segmental bronchus incision before stapling of the lobar bronchus to safely dissect the lymph nodes between the lobar bronchus and the pulmonary artery. To achieve a completely fused fissure using the "hilum first, fissure last" method, we used the intravenous indocyanine green method after dealing with all of the lobe vessels. Ten patients who underwent thoracoscopic fissureless lobectomy with T-BIT between August 2014 and November 2016 were included in the study. Seven patients underwent left upper lobectomy, 1 underwent left lower lobectomy, and 2 underwent right middle lobectomy.

Results: With T-BIT, complete peribronchial lymph node dissection was easily performed in all patients. There were no intraoperative complications such as pulmonary artery bleeding or pulmonary parenchymal injury. The postoperative chest tube drainage time was 2.5 ± 0.5 days postoperative persistent air leak did not occur. The length of hospital stay (5.3 ± 2.1 days) was the same as that with the nonfissureless lobectomy (5.1 ± 3.1 days).

Conclusions: T-BIT appears useful for lymph node dissection in thoracoscopic fissureless lobectomy. This technique prevents conversion to open lobectomy and persistent air leak and can be performed safely at no additional cost.

P53
Robotic Pulmonary Lobectomy Compared With Thoracotomy and Video-Assisted Lobectomy in a Cardiothoracic Training Program: A 6-Year Analysis

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Objective: Our understanding of robotic lobectomy comes largely from established thoracic surgical programs with experienced teams without trainee involvement. Our objective was to assess the effect of robotic lobectomy on patient care, cardiothoracic training, and the health care system.

Methods: Clinical data were obtained from a prospectively maintained database of anatomic lung resections performed from 1 January 2006 to 30 June 2016. Cost and oncological data were collected from the analytics department and the tumor registry, respectively. Based on age, sex, and 5 comorbidities, propensity scores were assigned. Differences were confirmed using multiple regression analysis. Survival was analyzed by the Kaplan-Meier method and compared to the SEER database. Our robotic cardiothoracic training method consists of a 6-month program over 3 years; the first 3 months focus on simulation and bedside assist and the last 3 months, on complete case set-up and console training.

Results: A total of 523 consecutive cases were identified; 91 cases were excluded. The query identified 212 robotic [179 non-small-cell lung cancer (NSCLC)], 160 thoracotomy (117 NSCLC), and 60 video-assisted (44 NSCLC) cases. Multiple surgeons performed each approach. Operative results and clinical and oncological outcomes favored robotic surgery compared to thoracotomy and showed little difference with video-assisted cases (Table P53-1). A cardiothoracic resident served as the console surgeon in 35% of all cases: 0% in the first 2 years, increasing to 79% in the latest year. Minimally invasive procedures increased from 32% of all cases in the first year of using

TABLE P53-1. Results From Propensity-Matched Groups and Non-Small-Cell Lung Cancer

Analysis Category	Outcomes	Robotic (212)	Thoracotomy (160)	VATS (60)	Robotic vs. Open (*P*-Value)	Robotic vs. VATS (*P*-Value)
Surgical	Median skin-to-skin resection time (minutes)	150	162	175	0.0579	0.0048
	Median estimated blood loss (mL)	75	200	100	<.0001	0.0961
Post-op	Median length of stay (days)	3	7	5	<.0001	0.0004
	Median initial ICU days	0	1	1	<.0001	0.0095
	Overall morbidity (cases, %)	69 (32.5)	90 (56.3)	25 (41.7)	<.0001	0.8500
	Unexpected return to OR (cases, %)	11 (5.2)	21 (13.2)	3 (5.0)	0.0113	0.6966
	Air leak greater than 5 days (cases, %)	16 (7.5)	34 (21.7)	6 (10.0)	0.0014	0.7685
	Atelectasis requiring bronchoscopy (cases, %)	13 (6.1)	21 (13.3)	2 (3.3)	0.0375	0.5586
	Pneumonia (cases, %)	16 (7.5)	19 (12.0)	5 (8.3)	0.4557	1.0000
	Atrial arrhythmia requiring treatment (cases, %)	31 (14.6)	36 (22.2)	14 (23.3)	0.0538	0.6561
	Average pain on POD1 (1–10 scale)	3	3	3	.0429	.6724
	Average inpatient narcotics (MME) *Morphine Milligram Equivalents – CDC-defined conversion factors for measuring total opioid dosage	72	219	92	<.0001	.1255
	30-Day readmissions (cases, %)	24 (11.7)	21 (14.3)	6 (11.9)	0.7351	0.7685
Cost	Median total inpatient cost	$25,844	$32,024	$26,531	0.0004	0.4231
Oncologic	NSCLC Cases	179	117	44	–	–
	Median lymph nodes resected	23	13	14	<.0001	.0005
	Median nodal stations sampled	5	3	4	<.0001	.1134
	R0 resections (cases, %)	150 (97.4)	102 (98.1)	39 (92.9)	.4241	.4239
	Rate of upstaging (cases, %)	27 (18.2)	12 (12.4)	3 (8.1)	.2299	.1500
	Stage I survival at 36 months (initial cases, survival) SEER survival: 63.7%	52, 80.3%	48, 79.1%	19, 78.4%	*P* > .25	*P* > .25
	Stage II survival at 36 months (initial cases, survival) SEER survival: 43.4%	21, 81.0%	27, 66.7%	3, 66.7%	*P* > .25	Insufficient data

ICU, intensive care unit; NSCLC, non-small cell lung cancer; POD1, post-operative day 1; R0, resection with negative margins; SEER, Surveillance, Epidemiology, and End Results Program; VATS, video-assisted thoracic surgery.

robotics to 89% in the latest year. The total volume of lung cancer cases increased by 51%, surgical cases by 92%, and clinical trial accrual by 70%.
Conclusions: In the setting of a cardiothoracic training program, robotic lobectomy can be performed without sacrificing quality. Robotic surgery in this setting offers similar or better clinical results, is cost-effective, and is oncologically sound. Additionally, a robotic program may increase an institution's volume of lung cancer cases, enhancing resident training and clinical research. Finally, this analysis has identified opportunities to improve efficiency and reduce costs.

P54
Pulmonary Fissure Development Affects the Number of Stapler Cartridges in Complete Video-Assisted Lobectomy for Non-Small-Cell Lung Cancer

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Objective: Video-assisted lobectomy is considered an effective surgical treatment modality for patients with non-small-cell lung cancer (NSCLC). The number of stapler cartridges required for video-assisted lobectomy and the factors affecting the number of stapler cartridges used have not been studied. This study investigated factors affecting the number of stapler cartridges used for video-assisted lobectomy.
Methods: A retrospective analysis of patients who underwent complete video-assisted lobectomy for NSCLC between January 2013 and December 2015 was conducted. The number of stapler cartridges and the pulmonary fissure development score (FDS) were collected prospectively for all patients (Table P54-1). Pulmonary fissure status was quantified by the FDS and was divided into 4 groups based on the fissure sum average (FSA = summation of 3 FDS ÷ 3). Surgeons were divided into 2 groups according to the preference for the method of pulmonary fissure division.
Results: A total of 596 patients had a complete video-assisted lobectomy. The average number of stapler cartridges used was 6.3 ± 2.4 (range, 2–17). Except for a stapler cartilage used for diagnostic wedge resection, the number of stapler cartridges used for video-assisted lobectomy was 5.3 ± 1.9 (range, 2–14). The number of stapler cartridges used to perform video-assisted lobectomy was higher in men (5.5 ± 1.9 vs. 5.0 ± 18, P = 0.006), in patients more than 70 years (5.5 ± 2.1 vs. 5.1 ± 1.7, P = 0.038) old, with upper or middle lobectomy (5.7 ± 1.9 vs. 4.1 ± 1.2, P < 0.001), a higher FSA (P < 0.001), and in the group of surgeons (5.6 ± 2.0 vs. 4.9 ± 1.6, P < 0.001) who preferred to divide the pulmonary fissure with a stapler.
Conclusions: The number of stapler cartridges required to perform video-assisted lobectomy in patients with NSCLC is affected by gender, age, location of the tumor, degree of fissure development, and preference of the surgeon.

TABLE P54-1. The Number of Stapler Cartridges Used for Video-Assisted Lobectomy in 596 Patients

Variables	Patient	Cartridge	P*
Lobectomy stapler cartridge	596 (100)	5.3 ± 1.9	
Sex			0.006
Male	324 (54.4)	5.5 ± 1.9	
Female	272 (45.6)	5.0 ± 1.8	
Age			0.038
<70	375 (62.9)	5.1 ± 1.7	
≤70	221 (37.1)	5.5 ± 2.1	
Tumor site			<0.001
Upper + middle lobe	356 (59.7)	5.7 ± 1.9	
Lower lobe	240 (40.3)	4.6 ± 1.6	
Pleural adhesion			0.053
No	408 (68.5)	5.2 ± 1.8	
Yes	188 (31.5)	5.5 ± 2.1	
Surgeon			<0.001
Surgeon 1 + 2 + 4 + 6	256 (43.0)	4.9 ± 1.6	
Surgeon 3 + 5	340 (57.0)	5.6 ± 2.0	
Fissure sum average			<0.001
0 (complete fissure)	108 (18.1)	4.1 ± 1.2	
0 < FSA ≤ 1 (incomplete fissure 1)	309 (51.8)	5.0 ± 1.7	
1 < FSA ≤ 2 (incomplete fissure 2)	163 (27.2)	6.4 ± 1.9	
2 < FSA ≤ 3 (incomplete fissure 3)	16 (2.7)	7.2 ± 1.8	

Data are presented as number of patients (%) or mean ± standard deviation.
*P**, *P*-value for the number of stapler cartridges.
FSA, summation of 3 fissure development scores ÷ 3.

P55
Technique of Robot-Assisted Thoracoscopic Lobectomy for Intralobar Pulmonary Sequestration: A Single-Center Experience

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Objective: Intralobar pulmonary sequestration (IPS) is a rare congenital condition that is accompanied by an abnormal arterial blood supply in part of the lung and the absence of bronchial communication with the normal tracheobronchial tree. The standard approaches for operative procedures are video-assisted thoracoscopic surgery and a thoracotomy. There are minimal studies on the role of robotic surgery for this condition.[1] Our goal was to report 2 cases of robotic-assisted thoracoscopic lobectomy for IPS.
Methods: Between 2013 and 2016, 2 female patients (15 and 25 years old) with IPS had a robotic-assisted thoracoscopic pulmonary lobectomy. The patients presented with an unproductive cough and recurrent pneumonic infiltration in the left lower lobe. The diagnosis was made by a chest computed tomography scan. The first patient had a secondary nontuberculosis mycobacterial infection that required an accurate preoperative course of antibacterial therapy.
Results: The operation comprised careful division of the abnormal vessels. We used a video-assisted thoracoscopic-based approach and inserted 3 robotic ports and 1 assistant port as low as possible. The first step was to divide the pulmonary ligament and isolate an additional vessel (Fig. P55-1). The remaining steps were for a left lower lobectomy. The operative times were 515 and 245 minutes. There were 1 and 3 additional vessels from the descending thoracic aorta in the first and second cases, respectively. Adhesions in the hilum were denser in the patient with IPS and nontuberculosis mycobacterial infection. There were no major postoperative complications. In the first patient, the chest tube was in place for >5 days due to a large daily volume of serous fluid. The second patient had a seroma in the area of the assistant port (without additional intervention). A follow-up examination 3 and 1 years after the operation, respectively, showed no late complications.
Conclusions: A robotic approach is a viable alternative procedure for IPS in some patients. Adhesions in the hilum and a cavity in the lung are not contraindications for robotic surgery.
1. Melfi FM, Viti A, Davini F, Mussi A. Robot-assisted resection of pulmonary sequestrations. *Eur J Cardiothorac Surg.* 2011;40:1025–1026.

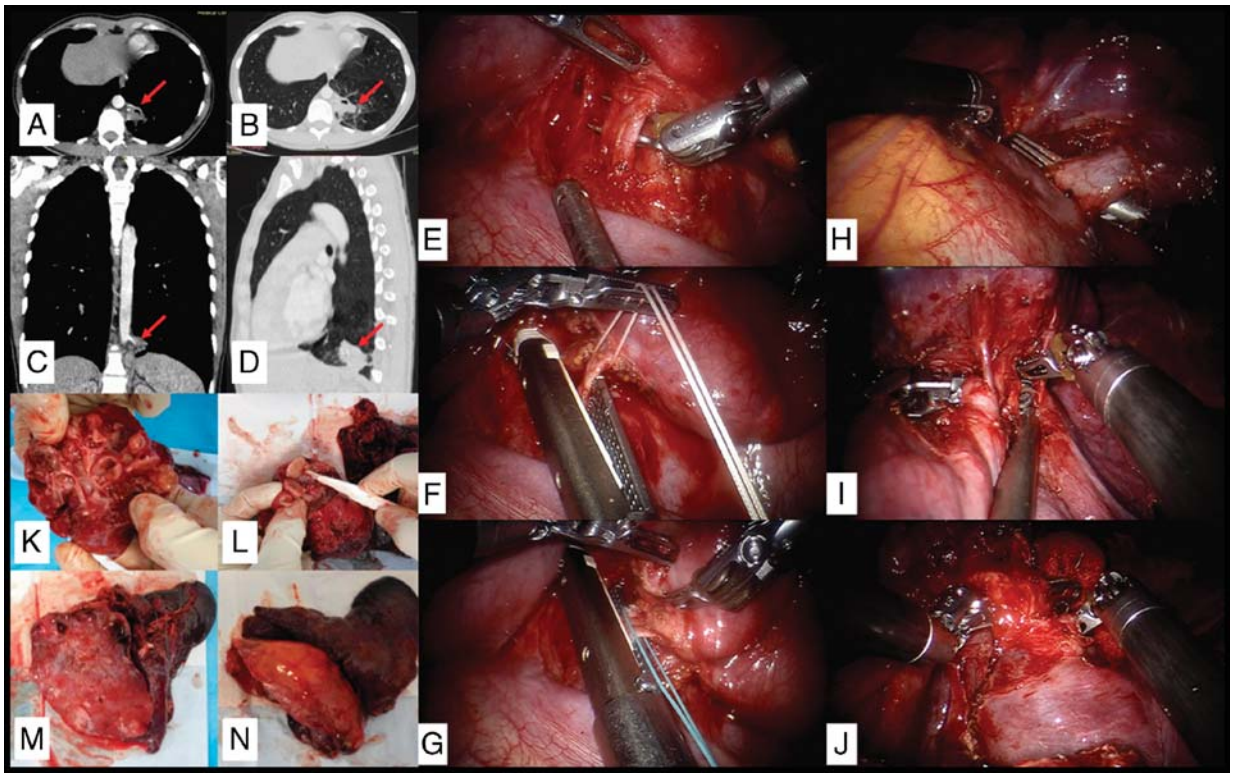

FIGURE P55-1. A–D, Chest computed tomographic scans before the operation. E–G, Steps of a robotic-assisted thoracoscopic lobectomy for intralobar pulmonary sequestration. K–N, Specimens.

P56

Treatment of Persistent Air Leak Following Lung Resections With Autologous Blood Patch Pleurodesis

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Objective: Management of a persistent air leak (PAL) after lung resections is frustrating for thoracic surgeons. Our goal was to present 15 patients who underwent autologous blood patch pleurodesis for PAL following lung resection.

Methods: Between January 2015 and July 2016, 64 patients underwent lung resections at our center for different diseases. Fifteen patients (23.4%) had PAL of more than 5 days' duration and a bronchopleural fistula grade 2 or less (Fig. P56-1). On the sixth postoperative day, 2 ml/kg body weight of autologous blood was drawn from the femoral vein and immediately introduced into an intercostal chest tube with no additives. The chest tube was connected to a water seal and kept 60 centimeters above the patient's chest and left unclamped. The patient was positioned in 4 different positions for 20 minutes each. After 48 hours of this procedure, with no clinically evident air leak, the chest tube was clamped for 2 hours and a chest radiograph was done. If it showed no evidence of pneumothorax, the chest tube was removed. Follow-up chest radiographs were done at 14 days, 1 month, and 3 months.

Results: Within 24 hours of autologous blood instillation, the air leak stopped in 14 patients (93%). One patient required a second instillation after 24 hours. Another patient developed recurrence and required a second instillation of autologous blood. Both of these patients had complete cessation of the air leak. In all, 13 patients (86%) had complete cessation of PAL following a single instillation with chest tube removal at 48 hours. Two patients required a second instillation resulting in complete cessation of air leak. No patient experienced pain, breathlessness, fever, or residual pleural effusion. On follow-up, there was no evidence of pneumothorax or empyema.

Conclusions: Autologous blood patch pleurodesis for PAL following lung resections is safe, effective, and an easy bedside procedure and allows for early chest tube removal. An autologous blood quantity of 2 ml/kg body weight is effective.

FIGURE P56-1. Autologous blood patch pleurodesis for persist air leak being performed at the bedside.

P57

Continuous Intercostal Nerve Block for Single-Port Video-Assisted Thoracoscopic Surgery of Primary Spontaneous Pneumothorax

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Objective: Single-port video-assisted thoracoscopic surgery (VATS) is widely used for primary spontaneous pneumothorax. Postoperative pain is less after single-port VATS. Our goal was to verify the clinical effects of continuous intercostal neve block (CINB) in patients with primary spontaneous pneumothorax.

Methods: We reviewed the records of 65 patients who had single-port VATS bullectomy for primary spontaneous pneumothorax between March 2012 and August 2016. Thirty-five patients were identified who had CINB and compared with 30 patients without CINB. The clinical variables that were compared between the 2 groups included pain score; supplemental narcotic use from postoperative days 0, 1, 2, 3, and 4; postoperative air leak; apical lung atelectasis; and hospital length of stay.

Results: Thirty patients in the CINB group had clinical data similar to that of 35 in the group without ICNB. No complications related either to the procedure or to the infusion of bupivacaine occurred. There were statistically significant lower mean pain scores on days 0, 1, 2, 3, and 4 ($P < 0.001$, <0.001, 0.008, 0.01, 0.001) (Fig. P57-1). The median operation time, duration of chest tube drainage, and supplementary narcotic utilization use did not differ between the 2 groups.

Conclusions: Thoracoscopic intercostal nerve block with continuous infusion of bupivacaine 0.5% is safe and effectively reduces the postoperative pain associated with single-port VATS for primary spontaneous pneumothorax. Further prospective trials are needed to determine the long-term outcomes.

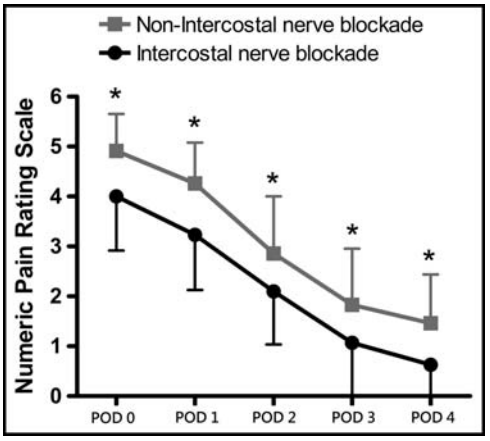

FIGURE P57-1. From POD 0 to POD 4 the numeric ranking scale (NRS) differed significantly between the two groups. POD, postoperative day.

P58

Smoking History as a Risk Factor for Atrial Fibrillation Following Robotic-Assisted Video-Thoracoscopic Pulmonary Lobectomy

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Objective: This study sought to determine whether smoking status and pulmonary function of patients having robotic-assisted pulmonary lobectomy are risk factors for development of atrial fibrillation (AF) in the early postoperative period to allow for more targeted dispositioning of post-lobectomy patients.

Methods: We retrospectively analyzed 353 consecutive patients without a history of AF who underwent robotic-assisted video-thoracoscopic (RAVTS) lobectomy by 1 surgeon from September 2010 through August 2016. Patients were analyzed with respect to smoking status, pack-years, months of smoking cessation, and pulmonary function. The χ^2 test, the Fisher exact test, and the Student t test were used to compare variables, with significance at $P \leq 0.05$.

Results: In our study, 17 of 144 men (11.8%) and 16 of 209 women (7.7%) experienced new-onset AF following RAVTS lobectomy ($P = 0.19$). The mean age of our patients who developed AF was 72.8 years and 66.4 years for those who did not ($P < 0.001$). Former smokers represented 72.7% of new AF cases, current smokers 21.2%, and never smokers 6.1% ($P = 0.009$). Former smokers were at higher risk than either never (OR 5.30, 95% CI 1.22 to 23.09, $P = 0.03$) or current smokers (OR 2.62, 95% CI 1.09 to 6.31, $P = 0.03$). Former smokers who developed AF were older (74.6 vs. 69.1 years, $P = 0.004$) and more often diabetic (OR 3.27, 95% CI 1.31 to 8.17, $P = 0.01$). There was no difference in AF rates for light (≤15 pack-years) versus heavy (>15 pack-years) smokers ($P = 0.21$). Never smokers fared better than light ($P = 0.02$) but not heavy ($P = 0.13$) smokers. There was no difference in pack-years for former versus current smokers who developed AF ($P = 0.11$). For all groups, development of AF was independent of preoperative pulmonary function, as measured by percent of predicted forced expiratory volume in 1 second (FEV1%) or by percent of predicted diffusion capacity of the lung for carbon monoxide (DLCO%) ($P = 0.09$ and $P = 0.63$, respectively), and was also unaffected by the presence of chronic obstructive pulmonary disease ($P = 0.80$).

Conclusions: Former and light smokers are at higher risk than both current and never smokers for developing AF after RAVTS lobectomy, independent of pack-years and preoperative pulmonary function. Duration of smoking cessation before lobectomy does not change the likelihood of developing AF.

P59

Innovative Treatment of Metastatic Pleuritis

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Objective: A frequent complication of lung cancer is metastatic carcinomatosis of the pleura. The main treatment methods for these patients are thoracentesis, systemic chemotherapy, intrapleural chemotherapy, and various types of pleurodesis. The effectiveness of intrapleural chemotherapy is estimated at 30% to 40% complete remission, i.e. the absence of pleural effusion for more than 1 month. The use of different types of pleurodesis has a positive effect in 68% to 89% of cases. Our goal was to encourage the search for the most effective treatment techniques for metastatic pleuritis.

Methods: We have proposed an innovative method for the treatment of metastatic pleuritis. The first step was to remove a large metastasis (up to 3 cm) via thoracoscopic radiofrequency (RF) pleurodesis using an RF generator Fotek 150 with monopolar electrodes. The power was 60 W for 20–40 seconds per part of the pleura. The second stage comprised intrapleural hyperthermic chemotherapy. For this purpose, we used the Performer HT, mode 42°C–43°C, time 50–60 minutes; the medicine was cytostatic cisplatin, 50 mg per m^2. We used this method in 11 patients with metastatic pleuritis. The follow-up period was 5 months.

Results: During the 5-month follow-up period, pleuritis relapse was observed in 1 (9%) patient at 3 months of treatment. There were no serious complications during the postoperative period; only 2 patients had inflammation in the area of pleural drainage. This complication is associated with low immunity after prior systemic chemotherapy.
Conclusions: RF pleurodesis with pleural hyperthermic chemotherapy improves the patients' quality of life and extends the period of survival. This method requires further clinical study.

P60
Comparison of Health Care Utilization and Outcomes of Video-Assisted Thoracoscopic Surgery with Thoracotomy in Lung Lobectomy

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Objective: Video-assisted thoracoscopic surgery (VATS) has been established as a minimally invasive alternative for major lung lobectomy. However, there is a lack of broad-based data about hospital health-care utilization and costs associated with VATS compared to traditional thoracotomy. The goal of this study was to assess the impact of the surgical approach on outcomes such as total hospital costs, length of stay, operating room time, discharge status, and most frequent complications in real-world settings.
Methods: The study was conducted using the nationally representative Premier Perspective database of hospital discharges in the United States. We included patients who were 18 years of age or older and had an elective lung lobectomy from January 2008 to December 2014. Multivariable models controlling for patient, provider, and procedure-specific characteristics were used to estimate the adjusted impact of approach on outcomes.
Results: A total of 22,946 patients underwent elective lung lobectomy; the average age was 66.6 (18–89) years. Of these, 57.2% (n = 13,114) had an open procedure and 42.8% (n = 9832) had VATS (including procedures that were converted to an open procedure). Adjusted total in-hospital costs were $24,918 (95% CI: $23,871–$26,010) for VATS patients, and $27,790 (95% CI: $26,727–$28,895) for open-surgery patients, respectively ($P < 0.0001$). Room-and-board costs contributed primarily to this difference. VATS patients had shorter ($P < 0.0001$) lengths of stay (6.5 days, 95% CI: 6.2–6.7) than open patients (8.0 days, 95% CI: 7.8–8.2). The operating room time was almost the same for VATS and open-surgery patients (242.5 vs. 242.1 minutes). VATS patients were 36.5% less likely to be discharged to a skilled nursing facility (odds ratio: 0.634, 95% CI: 0.556–0.724), and 21.3% less likely to have 1 of the 10 most frequently occurring complications (OR: 0.787, 95% CI: 0.711–0.870). The number of in-hospital deaths between the 2 groups did not differ significantly (OR: 0.831, 95% CI: 0.661–1.045).
Conclusions: VATS required a shorter length of stay and incurred lower hospital costs than traditional open lobectomy. This minimally invasive surgical approach also was associated with reduced number of discharges to a skilled nursing facility and lower risks of complication.

P61
Fewer Port Sites in Video-Assisted Thoracoscopic Surgery?

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Objective: Video-assisted thoracoscopic surgery has developed significantly over the last 2 decades, representing the gold standard for the majority of lung resections. The use of the percutaneous Teleflex MiniLap instruments has led to better cosmetic results and more minimally invasive procedures. Our goal was to present our experience with the application of the MiniLap percutaneous surgical system in sublobar lung resections.
Methods: The MiniLap instruments have a slim 2.3 mm shaft diameter and are inserted percutaneously using an integrated needle tip. Following insertion, the grasper jaws, with an opening of 12.5 mm, or the probe is deployed to grasp or coagulate lung tissue. At the same time, the proprietary steel shaft provides the strength and necessary stiffness for secure tissue retraction.
Results: All procedures (including bullectomies and wedge lung resections) were performed with the clutch grasper for lung retraction and manipulation. The overall aesthetic result was excellent, eliminating the need of a third working port. The 2.3 mm skin incision did not require the need for stitches and all procedures were performed with 2 port sites.
Conclusions: The application of the percutaneous surgical system in sublobar lung resections allowed better retraction of the parenchyma with no lung tissue damage. It was associated with elimination of 1 port site, resulting in patient cosmetic satisfaction and reduced postoperative pain. Overall, it represents a step forward in the development of minimally invasive thoracic surgery procedures.

P62
Dual Chest Drain Technique in Uniportal Major Lung Resections: Our Experience

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Objective: Video-assisted thoracic surgery for major lung resection is the gold standard for enhanced recovery after surgery. Uniportal video-assisted thoracoscopic lung resection is a promising technique in which the chest drain is inserted through the same port incision. Our goal was to determine if the use of 2 considerably smaller chest drains than usual would make a difference in terms of pain and recovery.
Methods: We modified the standard technique of a chest drain between 24F and 28F through the same port incision. We calculated that 2 smaller curved chest drains of 18F could provide adequate air flow if needed. We registered this study with our audit service, and we analyzed the results of 25 consecutive cases in terms of pain, mobilization, duration of postoperative air leak, the quantity of painkillers, and the day of discharge.
Results: We found that the patients with the dual chest drain experienced less pain than those with the single chest drain. There was no difference in the use of painkillers. There was a trend toward earlier discharge but it could not be statistically attributed only to this technique because it might be a result of the evolution of the learning curve in the surgical technique.
Conclusions: This modification showed that the use of 2 chest drains, even though the same port, can have numerous benefits. The fluid drainage was less, with less pain; in 2 cases, the chest drains were kept in for more than 3 weeks and there were no signs of discomfort or local inflammation that can be seen with bigger drains kept in for the same amount of time. The fact that the diameter of the chest drain is less than the average intercostal space is definitely beneficial. More studies are needed to reach statistical significance.

P63

Minimally Invasive First-Rib Resection: Is a Positive Elevated Arm Stress Test 50 Years Later an Indication for Surgery?

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Objective: In 1966, Roos published a revolutionary minimally invasive transaxillary approach for resection of the first rib "to relieve thoracic outlet syndrome" (TOS). The same year, Roos and Owens described a modification of the abduction external rotation test that they called a "claudication test" for TOS, now widely known as the elevated arm stress test (EAST). Because this test has never been validated, we analyzed a population alleged to have neurogenic thoracic outlet syndrome (N-TOS) to determine whether the EAST is a reliable test for N-TOS.

Methods: During the 10-year period January 2001 through December 2010, we examined a total of 263 patients alleged to have N-TOS following a motor vehicle accident. We graded the accuracy of the diagnosis made from the objective data from our physical examination and from the results of investigations. We recorded the results of the EAST but did not use them to make our diagnosis. Instead, we used them later to assess the value of the EAST.

Results: At the highest grade of accuracy, there were 56 cases of ulnar entrapment syndrome (UES), 40 with carpal tunnel syndrome (CTS), 55 with nonorganic disease, and 3 with cervical radiculopathy for a total of 154 (58.5%) patients in whom the diagnosis of N-TOS was excluded with reasonable certainty. The EAST had reproduced the symptoms of UES in 33 of the 56 patients with UES (58.9%) and in 18 of the 40 (45.0%) patients with CTS. We did not find any case with involvement of the dermatomes or of the myotomes of C8 and T1 that would justify a diagnosis of N-TOS.

Conclusions: The EAST appears to be a test for UES and for CTS, and a "positive" test should not be used as an indication for transaxillary resection as originally suggested in 1966. There appears to be a high incidence of misdiagnosis of N-TOS after motor vehicle accidents, and the use of the EAST as a test for N-TOS can only contribute to these misdiagnoses.

P64

Totally Endoscopic Treatment of Thoracic Outlet Syndrome

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Objective: Thoracic outlet syndrome (TOS) is a condition arising from compression of the subclavian vessels and/or brachial plexus as the structures travel from the thoracic outlet to the axilla. TOS may be classified as neurogenic TOS and vascular TOS: venous TOS or arterial TOS. The basis for the surgical treatment of TOS is resection of the first rib, and it may be combined with scalenectomy or cervical rib resection. Our goal was to report a case of thoracic outlet syndrome that was successfully treated with totally endoscopic video-assisted thoracoscopic first rib resection.

Methods: A 56-year-old woman presented with a severe right anterior chest pain radiating to her arm and back, with arm paresthesia, following a fall and a rib injury a few months ago. Diagnosis of TOS was based on clinical history, a physical examination, and additional diagnostic studies. Magnetic resonance imaging confirmed compression in her right subclavian artery and in the intrascalene triangle distally even in the adduction. She underwent video-assisted thoracoscopic resection of the first rib following failure of symptom improvement with physiotherapy. Three standard video-assisted thoracoscopic ports were used. The first rib was identified, and both the parietal pleura and periosteum overlying it were stripped off. The rib was resected completely with an endoscopic rib cutter. All periosteal remnants were trimmed, releasing the neurovascular bundle completely.

Results: The postoperative course was uncomplicated, and the patient was discharged within 24 hours following the operation in good condition. At the follow-up examination, the patient exhibited significant improvement of her main symptoms.

Conclusions: Complete thoracoscopic resection of the first rib provides superior visualization due to the magnified video-assisted thoracoscopic view and perfect illumination by the scope, allowing complete resection of the first rib. It also results in patient cosmetic satisfaction and reduced postoperative pain.

P65

Cone-Beam Computed-Tomography Guided Localization and Video-Assisted Thoracoscopic Resection of Peripheral Pulmonary Nodules

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Objective: Our goal was to illustrate the technique and report preliminary results of C-arm cone-beam computed tomographic (CBCT) -guided localization and video-assisted minimally invasive thoracoscopic resection of small peripheral pulmonary nodules and ground-glass opacities (GGO).

Methods: A retrospective review of CBCT-guided localization followed by video-assisted minimally invasive thoracoscopic resection done between December 2013 and 2016 was performed. CBCT images were acquired using a robotic C-arm angiography system in a hybrid operating room. Pulmonary nodules or GGOs were targeted under fluoroscopic and laser guidance using a breast hook-wire localization needle and coils. Then the procedure was converted to a video-assisted thoracoscopic procedure for minimally invasive wedge resection.

Results: A total of 15 patients underwent CBCT-guided localization followed by video-assisted minimally invasive thoracoscopic resection for small peripheral nodules (n = 10) and GGOs (n = 5) during the study period. Median (± range) lesion size and distance from pleural surface were 9.85 mm (5.1–24.3) and 15.1 mm (0–47) respectively. In all patients, CBCT imaging identified all the pulmonary lesions diagnosed on preoperative multislice computed tomography imaging. The median number of CBCT (including collimated scans) and radiation dose-area-product (DAP) per scan for lesion localization were 2 scans (1–4) and 1145.1 microGy-m2 per scan. The median time from planning CBCT until lesion localization was 33–46 mins.

Conclusions: C-arm cone-beam computed tomography image-guided localization followed by minimally invasive thoracoscopic resection of peripheral pulmonary nodules and GGOs is technically feasible in a hybrid operating room setup. Current challenges associated with CBCT-guided localization include field of view, patient positioning (in obese patients), respiratory motion (in lower-lobe lesions), and additional learning curve for intraoperative 3-dimensional imaging.

P66

Intraoperative Indirect Localization of Small Ground-Glass Nodules with Electromagnetic Navigation Bronchoscopy

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SEQUENCE	AGE	SEX	LOCATION	REMARK	SIZE	DISTANCE	MARKING NUMBER (#)	LOCALIZATION	TIME_SPENT_IN_ENB	OPERATIVE_DETAILS	FINAL_PATHOLOGY
1	69	M	RLL	r/o double primary lung cancer, RUL	4	8.7	1		18	wedge	MIA, pT1aNoMo
2	58	F	LLL		16	24	1		11.5	segmentectomy	Adenoca., pT1aNoMo
3	68	F	LUL	Breast ca., Lt. DCIS	18	7.6	2		12.5	segmentectomy	MIA, pT1aNoMo
4	83	M	RLL	Lung cancer, RML, SqCC, cT1aNoMo	7	0.2	1		25	wedge	MIA, pT1aNoMo
5	51	M	RLL		14	8.1	1		40	wedge, then segmentectomy	Adenoca., pT1aNoMo
6	48	F	RLL		7	0	1		12.5	wedge, then lobectomy	Adenoca., pT2aNoMo
7	67	M	LLL		16	22.3	2		9.5	segmentectomy	Adenoca., pT1aNoMo

FIGURE P66-1. Summary of patient demographics and results.

Objective: Peripheral pulmonary lesions are being diagnosed with increasing frequency, which makes the role of localization important. Electromagnetic navigation bronchoscopy (ENB) can provide a more obvious target for the surgeon to facilitate intraoperative resection when combined with dye marking.

Methods: Patients with subcentimeter peripheral ground-glass nodules (GGN) underwent ENB-guided dye marking and minimally invasive resection from July 2016 to September 2016. Indications of ENB-guided dye marking were GGNs ≤ 10 mm adjacent to the visceral pleura or GGNs ≤ 20 mm located more than 10 mm deep from the visceral pleura. Marking was done with 0.5 ml of indigo carmine dye under ENB guidance without a fluoroscope after induction of general anesthesia.

Results: A total of 9 ENB-guided marking procedures were performed for 7 GGNs (Fig. P66-1). An additional 2 marking procedures were performed to delineate the resection margin. The median nodule size was 14 (4–18) mm, and the median distance from the pleural surface was 8.1 (0–22.3) mm. The median navigation time was 12.5 (9.5–40) minutes. Localization failed in 2 out of 9 markings due to invisible dye. GGNs were resected primarily by thoracoscopic segmentectomy or by wedge resection if indicated, with the right lower lobe (4/7) being the most common site. All GGNs were primary lung cancers and resected completely. There were no complications related with the localization procedure, e.g. bleeding or pneumothorax.

Conclusions: Intraoperative ENB-guided dye marking for GGN is a simple and effective method for localization of the nodule and for estimating the segmental resection margin. More experience with navigational planning and the concomitant aid of the fluoroscope would increase the success rate of localization.

P67
Computed Tomography-Guided Percutaneous 20-Gauge Core-Needle Biopsy in Pulmonary Nodules ≤ 20 mm: Technique and Factors Affecting Accuracy

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Objective: Computed tomography (CT) screening of the lung has evolved, allowing identification of a large number of small (≤20 mm) pulmonary nodules. The main options for managing highly suspicious nodules are follow-up CT scans at 3 to 12 months or histopathological evaluation. We evaluated the overall diagnostic accuracy of the CT-guided percutaneous 20-gauge core needle biopsy (CNB) for small pulmonary nodules and factors that may influence the accuracy.

Methods: We performed a single-center study with a retrospective analysis from January 2010 to August 2015 of patients who had CT-guided percutaneous CNB of small pulmonary nodules (≤20 mm). The institution's ethics committee approved this study. A multislice CT scanner (Somatom Definition AS 40-slice, Siemens) guided all biopsies.

Results: A total of 156 biopsies were performed with an overall diagnostic accuracy of 92.3%. Among the conclusive biopsies, 101 were malignant and 43 were benign. Larger lesions were associated with high overall accuracy, whereas parenchymal hemorrhage during the procedure had lower accuracy rates. Surgical resection was performed in 46 patients; 42 of those had malignant lesions. Pneumothorax was the most common complication. In the multivariate analysis, lesion-pleural distance >30 mm was identified as a risk factor for pneumothorax (OR = 16.94, 95% CI; 2.39–120.26); performing a blood patch in the needle track after the biopsy was a protective factor for pneumothorax (OR = 0.18 95% CI: 0.04–0.86). Alveolar hemorrhage occurred with15 biopsies (9.6%), which was mild in 10 patients and moderate in 5. One patient had a mild hemothorax.

Conclusions: CT-guided percutaneous 20-gauge CNB of pulmonary lesions ≤20 mm yields high overall accuracy. The variables associated with lower accuracy were lesion size and presence of parenchymal hemorrhage. The blood patch technique reduced overall morbidity.

P68
Three-Dimensional Changes of the Thorax After the Nuss Procedure for Pectus Excavatum

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Objective: The Nuss procedure is used to correct a chest wall deformity via the insertion of a metal bar in a pectus excavatum. Considering the 3-dimensional structure of the thoracic cavity, we evaluated the thoracic dimensional changes after the procedure based on the anatomical landmarks that indicated where the metal bar was inserted.

Methods: We performed a retrospective review of 141 patients who had undergone the Nuss procedure. The thoracic dimensions were measured

TABLE P68-1. Comparison of Dimensional Changes to the Thorax After Insertion of the Bar in Different Locations

	Jugular Notch						Manubriosternal Joint						Xiphisternal Joint					
	AP Diameter			LAT Diameter			AP Diameter			LAT Diameter			AP Diameter			LAT Diameter		
	Pre	Post	*P*	Pre	Post	*P*	Pre	Post	*P*	Pre	Post	*P*	Pre	Post	*P*	Pre	Post	*P*
Age																		
<6	39.9	38.2	0.038	180.2	178	0.318	61.9	78.4	0.220	219.3	213.2	0.000	68.3	86	0.000	234.5	210.9	0.000
7–12	38.4	37.9	0.671	174	173.6	0.845	62.9	64.7	0.345	216.2	212.7	0.014	72.2	84.2	0.000	231.7	216.1	0.000
>13	38.9	39.6	0.146	181.6	179.7	0.037	59.2	66.	0.000	211.9	207.4	0.000	64	83.	0.000	222.9	206.6	0.000
Type																		
Sym	39.6	39.4	0.735	180	179	0.386	61.9	73.8	0.119	216.1	211.5	0.000	68.1	87	0.000	230.2	210.7	0.000
Asym	38.5	38.3	0.079	180	177.3	0.013	58.8	64.6	0.000	212.6	207.6	0.000	64.4	81.2	0.000	224.2	207.4	0.000
Inserted bars																		
S	35.7	34.1	0.011	143.8	146.4	0.108	55.2	65.4	0.276	181.4	178.9	0.003	61.2	76.3	0.000	198.7	182.8	0.000
M	41.3	42	0.155	202.4	197.6	0.000	63.8	71.5	0.000	234.8	228.5	0.000	69.7	88.9	0.000	245.0	225.3	0.000

AP, anteroposterior; Asym, asymmetry; LAT, lateral; M, multiple; Post, postoperative; Pre, preoperative; S, single; Sym, symmetry.

using anteroposterior and lateral diameters at 3 anatomical landmarks (jugular notch, manubriosternal joint, and xiphisternal joint) in computed tomographic scans. The patients were divided in groups in terms of where the metal bar was inserted: the jugular notch, the manubriosternal joint, or the xiphisternal joint. Preoperative and postoperative Haller indexes and thoracic dimensions were compared among the groups (according to age, symmetric or asymmetric, and where the bars were inserted). The paired *t* test was used to compare the differences within each group.

Results: Of the 141 patients (115 men, 26 women), 87 patients were symmetric and 54 patients were asymmetric. The postoperative anteroposterior diameters in the manubriosternal and xiphisternal joints were significantly higher than the preoperative values. The Haller index and the lateral diameters in the jugular notch, the manubriosternal joint, and the xiphisternal joint were significantly lower than the preoperative values. In patients older than 13 years, asymmetric type, and with multiple bars inserted, the postoperative anteroposterior diameters of the manubriosternal joint and the xiphisternal joint were significantly higher than the preoperative values. However, the postoperative lateral diameters of the 3 anatomical landmarks were significantly lower than the preoperative values (Table P68-1).

Conclusions: Increased anteroposterior and decreased lateral diameters in the 3 anatomical landmarks were noted in patients with a pectus excavatum after the Nuss procedure. These results were related to the postoperative changes of thoracic cavity volume. Further research is warranted to determine the relationship between this phenomenon and the pump handle action and postoperative changes in total lung volume.

P69
Comparison of Perioperative Outcomes Following Open Versus Hybrid Minimally Invasive Ivor Lewis Esophagectomy for Esophageal Cancer

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Objective: Several different approaches are possible for minimally invasive esophagectomy via thoracoscopy, laparoscopy, or both with various patient positions and anastomotic techniques. The aim of this study was to assess the impact of the hybrid minimally invasive Ivor Lewis esophagectomy (laparoscopy and thoracotomy) for cancer on perioperative outcomes.

Methods: This study is a retrospective review of 149 patients undergoing an Ivor Lewis esophagectomy for squamous cell carcinoma from October 2006 to September 2016. Patients who received neoadjuvant treatment prior to the operation (n = 22) and who had complete minimally invasive procedures (n = 16) were excluded. Clinical characteristics and perioperative outcomes of patients undergoing hybrid esophagectomy (HE; n = 48) were compared with findings in patients undergoing open esophagectomy (OE; n = 63).

Results: There were 108 men (97.3%) and 3 women (2.7%); the mean age was 65.3 ± 8.1 years (range, 45–83 years). The 2 groups were comparable with respect to age, sex, preoperative pulmonary function (FEV1 ratio), clinical stage, and location of tumor. There was no significant difference between the 2 groups with regard to operating times and postoperative pain scores. Postoperative complications occurred in 17 (35.4%) who had HE and in 24 (38.1%) who had OE ($P = 0.772$). The in-hospital mortality rate was 4.2% for HE and 9.5% for OE ($P = 0.280$). However, the HE group had a higher immediate postoperative albumin level (3.3 vs. 2.9 g/dL, $P < 0.001$) and a shorter hospital stay (13.7 vs. 19.5 days, $P = 0.008$).

Conclusions: Hybrid minimally invasive Ivor Lewis esophagectomy for esophageal cancer showed the advantages of better postoperative nutrition status and a shorter hospital stay compared to the conventional open approach. Further studies are needed to evaluate the long-term oncological outcome of this hybrid approach.

P70
Robotic Totally Endoscopic Retrosternal Gastric Pullup

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Objective: It is sometimes necessary to use the retrosternal route for gastric or colonic esophageal replacement. This procedure is often indicated for patients who have had an esophageal diversion procedure either for severe esophageal injury or as an anastomotic complication from esophagectomy. Less common it is used to bypass an unresectable esophageal malignancy. Patients who require this operation have usually experienced significant sepsis and malnutrition. Unfortunately, this operation routinely requires an open laparotomy, which may add to the surgical morbidity in these high-risk patients. We have developed a novel robotic totally endoscopic technique for this operation that requires only laparoscopic ports.

Methods: Three patients required retrosternal gastric pull-up in our institution from 2013 to 2016. One had unresectable squamous cell carcinoma of the esophagus invading the left main-stem bronchus. Another had a delayed presentation of spontaneous esophageal perforation that could not be primarily repaired. The third patient had a severe esophageal iatrogenic injury from dilation of a chronic ischemic stricture. A retrospective review of the patient charts was performed with institutional review board approval. Standard robotic-assisted laparoscopy was performed. After creating the gastric conduit, the substernal plane was entered by dividing the phrenosternal attachments. A simultaneous cervicotomy was performed, and the left sternoclavicular junction was resected. The transabdominal retrosternal space was then connected to the cervicotomy, and the conduit was passed to the neck where it was anastomosed to the cervical esophageal.

Results: We have performed this procedure in 3 patients. No operative deaths occurred. One patient had a minor anastomotic leak that resolved spontaneously. There were no incidents of vocal cord paralysis or delayed gastric emptying. Average postoperative length of stay was 10.3 days (7, 10, 14 days). All 3 patients were able to resume a normal diet within 1 month of the operation.

Conclusions: Retrosternal gastric pull-up is not a common operation. However, it is usually required in patients who have needed esophageal diversion. Our small series illustrates the possibility of performing this operation, which has always required laparotomy, in a minimally invasive fashion.

P71

A Single-Institution Experience with Robotic Thymectomy for Thymoma

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Objective: Several centers have reported good outcomes with robotic-assisted thymectomy for thymoma. In our institution, the first robotic thymectomy was performed in 2012. The aim of our study was to review our institution's experience with robotic thymectomy for thymoma.

Methods: We retrospectively analyzed all patients who underwent robotic-assisted thymectomy for thymoma at our institution from 2012 to 2015. The following data were collected and reviewed: demographics, co-morbidities, operative data, and morbidity and mortality rates.

Results: Twenty patients underwent robotic-assisted thymectomy using a right-sided (n = 8), left-sided (n = 11), or bilateral (n = 1) approach during the study period. Median age was 55 years (27–71 years); 11 patients were women. Thirteen patients had myasthenia gravis. The median operative time was 121 minutes (71–380 minutes). The World Health Organization (WHO) grades of thymoma were as follows: type A (n = 0), type AB (n = 4), type B (n = 8), and type C (n = 1). Six patients had mixed WHO thymomas and 1 patient had a thymoma that could not be classified according to WHO criteria. The Masaoka stages were as follows: stage I (n = 7), stage II (n = 12), and stage III (n = 1). There was 1 conversion to median sternotomy because of concerns of invasion of the great vessel. One patient developed atrial fibrillation; there were no perioperative deaths. The median hospital stay was 3 days (2–13 days). At the last follow-up (median duration 27 months), 19 patients were alive and 1 had died of metastatic colorectal carcinoma. One patient with stage I type B2 thymoma experienced a recurrence at 15 months that was managed with surgical resection via median sternotomy.

Conclusions: Our experience suggests that robotic-assisted thymectomy for thymoma can be performed safely and effectively. The benefits include reduced length of stay and early recovery. Outcomes at the 1-year follow-up are promising. However, further studies to determine long-term outcomes are required.

P72

Thymectomy for Nonthymomatous Myasthenia Gravis: Comparison of Video-Assisted Thoracoscopic and Transsternal Thymectomy

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Objective: Thymectomy is considered the standard procedure for treatment of all forms of myasthenia gravis. Video-assisted thoracoscopic thymectomy is one of the minimally invasive procedures that, because of the short duration of hospitalization and reduced postoperative pain and scarring after a surgical procedure, has replaced the traditional operations for patients with myasthenia gravis, but there are still differences and concerns. The aim of this study was to compare the outcomes of 2 different surgical techniques: video-assisted thoracoscopic versus a transsternal thymectomy in the treatment of myasthenia gravis.

Methods: Forty-two patients with myasthenia gravis and no thymus tumor were evaluated in a pilot program organized on the basis of the classification system of the Myasthenia Gravis Foundation of America and drug consumption. Then, the patients randomly underwent 2 different surgical techniques: video-assisted thoracoscopic thymectomy versus transsternal thymectomy Patients were evaluated on the basis of preoperative and postoperative variables.

Results: Lengths of stay in the intensive care unit and the hospital were reduced in patients who underwent the video-assisted thoracoscopic thymectomy technique. Also, the duration of the surgical procedure was reduced significantly in these patients. These patients had less blood loss during the surgical procedure than the TS group. The Myasthenia Gravis Foundation of America classification system for VATS thymectomy indicated that the number of persons with complete stable remission postoperatively was higher and the number of persons who remained unchanged was lower.

Conclusions: Video-assisted thoracoscopic thymectomy is a safe and appropriate approach versus traditional methods such as transsternal thymectomy for patients with myasthenia gravis. This method has better postoperative results and can be used as an alternative minimally invasive method instead of a transsternal thymectomy.

P73

The Use of the COR-KNOT Device Decreases the Incidence of Paravalvular Leak During Aortic Valve Replacement

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Objective: A paravalvular leak (PVL) is a serious complication after aortic valve replacement (AVR). We evaluated the impact of the COR-KNOT automated suture-fastening system on the incidence of PVL in isolated AVR procedures.

Methods: This study was a retrospective review of prospectively collected data from all patients who underwent isolated AVR between

2006 and 2016. In 1 group, the COR-KNOT was used to secure the sutures (CK group, n = 331), whereas in the other group, the knots were hand-tied (HT group, n = 321).

Results: There were 208 (62.9%) men (mean age, 71.5 ± 9.9 years) in the CK group, and 171 (53.3%) men (mean age, 73.2 ± 9.9 years) in the HT group. A partial sternotomy (minimally invasive) AVR (MIAVR) was performed in 261 (78.8%) patients in the CK group and in 158 (49.2%) patients in the HT group ($P < 0.001$). Aortic stenosis was present in 312 (94.2%) vs. 301 (93.7%) patients ($P = 0.206$); hypertension in 278 (84%) vs. 245 (76.3%) patients ($P = 0.014$); diabetes, in 89 (26.9%) vs. 73 (22.7%) patients ($P = 0.221$); hypercholesterolemia, in 262 (79.1%) vs. 231(71.9%) patients ($P = 0.033$) in the CK vs. the HT group, respectively. The mean cross-clamp time was 84.7 ± 21.6 vs. 87.6 ± 22.7 minutes ($P = 0.026$), and the mean pump time was 111.1 ± 27.9 vs. 111 ± 28.5 minutes ($P = 0.948$) for the CK and HT groups, respectively. The mortality rate, stroke, new onset renal insufficiency, and atrial fibrillation were 6 (1.9%), 2 (0.6%), 12 (3.6%), 103 (31%) vs. 7 (2.2%), 9 (2.8%),14 (4.3%), and 95 (29.6%) for the CK and HT groups, respectively ($P > 0.05$). The average intubation time was 0.8 ± 1.9 vs. 0.8 ± 2.6 days ($P = 0.916$); the stay in the intensive care unit was 4.4 ± 6.5 vs. 4.5 ± 7.3 days ($P = 0.876$), and the hospital stay was 7.4 ± 6.7 vs. 8.5 ± 7.7 days ($P = 0.007$) for the CK and HT groups, respectively. The total number of significant PVLs was 14. There were 3 (0.9%) PVLs (2 mild and 1 moderate) in the CK group and 11(3.4%) (7 mild, 2 moderate, and 2 severe) in the HT group ($P = 0.013$). In the MIAVR group, there were 10 PVLs. In the CK-MIAVR group (n = 261), there were 3 (1.2%) (2 mild and 1 moderate) PVLs, and in the HT-MIAVR (n = 163) group, there were 7 (4.4%) PVLs (4 mild, 2 moderate, and 1 severe) ($P = 0.017$). There was no statistically significant difference in the PVLs (0 vs. 4, $P = 0.091$) between the CK group and the HT group in the full sternotomy AVRs.

Conclusions: The use of the COR-KNOT device significantly decreased the incidence of PVL, particularly in the minimally invasive approach, thus decreasing the possibility of early and late reintervention.

P74
Use of Adjuncts Reduces Cardiopulmonary Bypass Time During Minimally Invasive Aortic Valve Replacement

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Objective: Minimally invasive aortic valve replacement (MIAVR) through a minithoracotomy has comparable outcomes to aortic valve replacement (AVR) through a median sternotomy but at the cost of increased cross-clamp and cardiopulmonary bypass (CPB) times. Development of adjunct technologies such as the automatic knot fastener and the percutaneous retrograde coronary sinus catheter may decrease surgical times.

Methods: After approval by the institutional review board, a retrospective review of prospectively collected data for patients undergoing surgical AVR from 2002 to 2015 at a single institution was undertaken. MIAVR with adjuncts was performed on 78 patients. The automatic knot fastener was used on all patients, and a percutaneous coronary sinus catheter was placed and confirmed by transesophageal echocardiography in 67 (86%) patients. Patients were propensity matched for major comorbidity against those who underwent an MIAVR without adjuncts (n = 78) and with a median sternotomy (n = 78). Continuous variables were compared using the unpaired *t* test, the Wilcoxon rank sum test, and ANOVA. Categorical variables were compared using the χ^2 test and the Fisher exact test.

Results: Patients who underwent MIAVR with adjuncts had shorter cross-clamp (70.5 vs. 108.1 and 84.4 minutes, $P < 0.0001$) and CPB times (101.1 vs. 166.12 and 127.7 minutes, $P < 0.0001$) than patients who underwent MIAVR without adjuncts and through a median sternotomy. Patients who had MIAVR with or without adjuncts received fewer blood transfusions compared to those who had an AVR through a median sternotomy (0.6 and 1.2 vs. 2.5, $P < 0.001$). Patients who received MIAVR with adjuncts had similar rates of atrial fibrillation compared to those who had MIAVR without adjuncts (48.7% vs. 35.9%, $P = 0.11$) but had higher rates compared to those who had a sternotomy (48.7% vs. 30.8%, $P = 0.02$). In-hospital morbidity and mortality rates were similar among all groups (Table P74-1).

Conclusions: The use of adjuncts during MIAVR led to significant shortening of cross-clamp and CPB times and required fewer transfusions with similar rates of major in-hospital morbidity and mortality compared to those with median sternotomy. The use of adjuncts may ameliorate previously reported operative disadvantages through a minimally invasive approach.

TABLE P74-1. In-Hospital Outcomes

	MIAVR with Adjuncts (n = 78)	MIAVR Without Adjuncts (n = 78)	Sternotomy (n = 78)	*P* Value
Hospital stay, d (SD)	6.86 (3.58)	6.94 (15.3)	7.72 (7.0)	0.64
New onset atrial fibrillation, (%)	26 (33)	17 (22)	13 (17)	0.04
Pneumonitis	3 (4)	4 (5)	0 (0)	0.17
Tracheostomy	0 (0)	1 (1)	1 (1)	1.00
Stroke	0 (0)	3 (4)	0 (0)	0.11
Permanent pacemaker	2 (3)	6 (8)	2 (3)	0.23
Acute kidney injury	8 (10)	4 (5)	12 (15)	0.11
Dialysis	0 (0)	1 (1)	1 (1)	1.00
IABP or ECMO	1 (1)	1 (1)	1 (1)	1.00
Re-operation	3 (4)	0 (0)	0 (0)	0.11
Deaths	0 (0)	1 (1)	0 (0)	1.00

ECMO, extracorporeal membrane oxygenation; IABP, intra-aortic balloon pump; MIAVR, minimally invasive aortic valve replacement; SD, standard deviation.

P75
A Sutureless Versus a Sutured Bioprosthesis: A Prospective Randomized Evaluation of Surgical Times

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Objective: The introduction of the sutureless valve represents one of the most important innovations in cardiac surgery. Many retrospective studies demonstrated that the use of these prostheses reduced the cardiopulmonary bypass (CPB) and cross-clamp times. To date, no randomized studies have analyzed these aspects. Our aim was to evaluate whether the use of a sutureless prosthesis reduces CPB and X-clamp times during isolated aortic valve replacement.

Methods: The primary end points were CPB and cross-clamp times. Secondary end points were mortality rates, lengths of stay in the intensive care unit and on the ward, intubation time, and rate of pacemaker implantation. The inclusion criteria were patients who had aortic valve

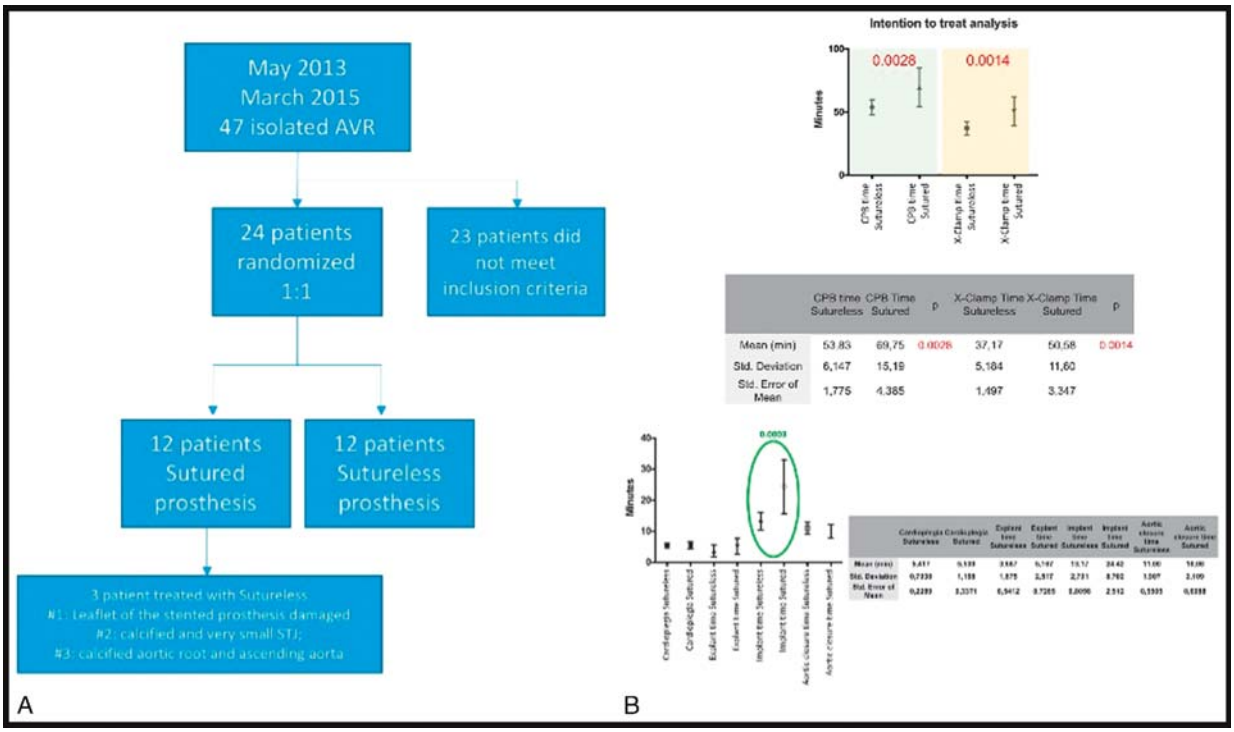

FIGURE P75-1. A, B, Study flow chart, cardiopulmonary bypass and aortic cross-clamp times, and procedural details. AVR, aortic valve replacement; STJ, sinotubular junction; CPB, cardiopulmonary bypass; X-clamp, cross-clamp.

replacement for predominant aortic valve stenosis with anatomical characteristics suitable for both a sutured prosthesis and a sutureless valve implantation (sinotubular junction/annulus diameter ratio ≤ 1.3) and a single surgeon as the first operator. The power of the study was calculated from retrospective data. For the primary end points of CPB and cross-clamp time with a type I alpha error of .01, a type II beta error of .02, and a power of the study of 80%, the sample size was 12 patients for each arm of the study. The patients were randomized intraoperatively before cross-clamping of the aorta. The data are reported as mean and standard deviation (SD) or median and 25th–75th percentile based on a normality test analysis (D'Agostino-Pearson test). The results were analyzed using the intention to treat analysis. A diagram of the study is shown in Figure P75-1A.

Results: There were no differences in patient characteristics. The duration of CPB was 53.83 ± 6.14 minutes and 69.75 ± 15.6 minutes (P = 0.0028); the duration of the cross-clamp was 37.17 ± 5.18 and 50.58 ± 11.6 (P = 0.0014), respectively, for the sutureless and the sutured valve groups. An analysis of the detail of the surgical procedure indicated that the only significantly shorter time in the Perceval group was the valve implant time (13.17 ± 2.79 vs. 24.42 ± 8.7; P = 0.0003) (Fig. P75-1B). There were no differences among the secondary end points.

Conclusions: We confirm that the use of a sutureless bioprosthesis reduces the CPB and cross-clamp times, mainly because of a reduction in prosthesis implantation time. A multicenter trial is ongoing and will provide more information about clinical outcomes.

P76
Redo Aortic Valve Operations Using the Minimally Invasive Approach: Preliminary Results

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Objective: A redo aortic valve procedure is often a surgical challenge with many described strategies to reduce intraoperative or postoperative complications, even including avoiding the operation (e.g. transcatheter aortic valve implantation). We recently performed redo procedures using a minimally invasive approach.

Methods: Since 2010, a total of 162 patients underwent a redo procedure (first procedure: aortic valve replacement performed via a full sternotomy) in our institution. Among these, 31 patients re-treated with a J sternotomy (partial) were compared with 131 patients who had a cardiac procedure with a "new" full sternotomy (full).

Results: We found no significant differences between the 2 groups in terms of preoperative clinical risk factors and characteristics. Cardiopulmonary bypass, cross-clamp, and operation times did not differ between the 2 groups. The minimally invasive procedure tended to be shorter: The full procedure was 117, 74, and 235 minutes; the partial procedure was 101, 68, and 202 minutes, respectively (P = 0.08, 0.23, 0.09). The in-hospital mortality rate did not differ significantly between patients who had a full or a partial sternotomy (18–13.7% vs. 3–9.7%; P = 0.77). Similarly, postoperative complications were comparable between the groups (stroke: full 3–2.3% vs. partial 0, P = 1; dialysis: full 25–19.1% vs. partial 4–12.9%, P = 0.6; wound complications: full 20–15.3% vs. partial 1–3.2%; P = 0.08). Postoperative "steps" were faster in the minimally invasive group, but only the hospitalization time showed a statistical advantage: intubation time, full procedure: 74 hours vs. partial procedure: 61 hours, P = 0.77; stay in the intensive care unit, full procedure: 6.8 days vs. partial procedure: 3.6 days, P = 0.06; hospital stay, full procedure: 19 days vs. partial procedure: 15 days, P = 0.025. Patients who had a partial sternotomy recorded minimal drainage problems and minimal need of transfusion, but without statistical significance: drain, full procedure: 624 mL vs. partial procedure: 466 mL, P = 0.62; blood, full procedure: 2.0 units vs. partial procedure: 1.3 units,

$P = 0.55$; plasma. Full procedure: 2.3 units vs. partial procedure: 1.0 units, $P = 0.05$; platelets, full procedure: 0.7 units vs. partial procedure: 0.4 units, $P = 0.09$.

Conclusions: Minimally invasive redo aortic valve surgical procedures are safe and do not require a lot of time. Our results demonstrate possible clinical advantages, especially in terms of fewer transfusions, fewer wound complications, and shorter duration of hospitalization.

P77

Feasibility and Benefit of the Right Minithoracotomy Approach in Patients with a Previous Sternotomy

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Objective: Minimally invasive cardiac surgery via a right minithoracotomy has become a popular choice for mitral valve and other cardiac procedures. On the other hand, redo cardiac procedures requiring resternotomy have a higher potential risk. To solve this problem, we applied a minimally invasive right minithoracotomy in patients with a previous sternotomy. The feasibility and benefit of a minimally invasive right minithoracotomy with a previous sternotomy were verified by comparing redo (group R) and primary procedures (group P).

Methods: In 113 minimally invasive cases via a right minithoracotomy [mitral valve plasty (MVP) 70, mitral valve replacement (MVR) 4, aortic valve replacement (AVR) 5, left atrial myxoma 5, atrial septal defect (ASD) 10], 19 cases (group R) had a history of a previous sternotomy [MVP 5, MVR 12, thrombus 1, tricuspid annuloplasty (TAP) 1]. In group R, we used an on-pump beating-heart surgical procedure without aortic cross-clamping in 5 cases.

Results: In group R, no cardiac injury occurred while the heart was exposed. Between the 2 groups (group R vs. P), age (71.1 vs. 62.1 years), ejection fraction (57.3% vs. 65.8%), and left atrial diameter (50.1 vs. 42.0 mm) were significantly different preoperatively. Although the aortic cross-clamping time was the same, the extracorporeal circulation time (141.9 minutes vs. 178.2 minutes) and operating time (295.8 minutes vs. 241.5 minutes) were significantly longer in group R. The amount of transfusion (red blood cells, fresh frozen plasma, and platelets) was higher in group R. One hospital death occurred in each group (5.3% vs. 1.1%). Respirator support time and stays in the intensive care unit and the hospital were significantly longer in group R. There was no difference in the rate of major complications between the 2 groups (10.5% vs. 12.8%).

Conclusions: A right minithoracotomy was a feasible and beneficial solution for patients with a previous sternotomy needing a redo procedure, even though they required more medical resources, such as blood transfusions and hospital facilities. The surgical risk of right minithoracotomy approach in redo setting was equivalent to the risk in a primary surgery.

P78

A Rapid-Deployment Valve Is an Excellent Tool for Patients With Small Aortic Roots in Minimally Invasive Surgery

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Objective: Surgical management of patients with a small aortic root planned for aortic valve replacement (AVR) remains challenging. The mortality rate of patients undergoing isolated AVR and aortic root enlargement is still around 6% according to the most recent Society of Thoracic Surgeons dataset. The goal of the present study was to examine the impact of the rapid-deployment Edwards INTUITY valve (RDV) on the mortality rate in this patient cohort operated on through a minimally invasive approach.

Methods: All patients who underwent AVR with RDV in our institution between May 2010 and November 2016 were enrolled and retrospectively analyzed with regard to postoperative transvalvular gradients and deaths.

Results: A total of 422 patients received an RDV at our institution. Of these, 145 (34%) patients had a small aortic root as defined by implant sizes 19 mm and 21 mm. A total of 125 (86%) patients underwent isolated AVR, with 44% (n = 55) through a minimally invasive approach. Upper hemisternotomy was the preferred approach in 19 patients (34%), and 36 (66%) were operated on by an anterior right thoracotomy. Postoperative gradients in RDV 19 mm and 21 mm were 12 ± 4 mmHg and 14 ± 6 mmHg, respectively. Notably, not a single patient scheduled for a minimally invasive approach had to be excluded, and we had no conversion to root enlargement within the 6-year study period. In patients with a small aortic root, the hospital mortality rate was 0.7% (n = 1) and, during the follow-up period (up to 5 years), the late mortality rate was 7% (n = 10).

Conclusions: Implantation of an RDV is a highly reproducible technique. It facilitates a minimally invasive procedure, even in patients with small aortic roots, with excellent results.

P79

Impact of Minimally Invasive Surgery by Rapid-Deployment Aortic Valve Replacement

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Objective: Minimally invasive aortic valve replacement (MIAVR) was performed for the first time in 1993. The implantation of an aortic valve using this approach is still rare. We examined the impact of MIAVR in all patients who received a rapid-deployment aortic valve (RD-AVR) at our center.

Methods: We enrolled 422 consecutive patients in whom an RD-AVR was implanted from May 2010 until December 2016 at our institution. We analyzed the postoperative outcome and survival rate. Implementation of RD-AVR via the minimally invasive surgical approach was examined. Due to the learning curve in the first 2 years, RD-AVR was exclusively done through a full sternotomy. Beginning in 2012, MIAVR was used with increasing frequency and is now the standard technique for all patients with an indication for an isolated AVR.

Results: Between May 2010 and December 2016, 422 patients had an RD-AVR. Among these patients, 44% (n = 186) were operated on through a minimally invasive approach, of which 48% (n = 92) were operated on through an upper hemisternotomy and 52% (n = 94) through an anterior right thoracotomy. Intraoperatively, 3 patients (1.6%) were converted to median sternotomy due to bleeding. Isolated AVR was performed in 84% of patients operated on through a minimally invasive technique. Concomitant procedures done with a minimally invasive approach were aortic reduction plasty for ascending aortic dilatation and decalcification of a calcified anterior mitral leaflet. The perioperative mortality rate for the minimally invasive cases was 0.53% (n = 1) and the overall mortality rate was 1.61% (n = 3).

Conclusions: The implantation of an RD-AV using a minimally invasive approach in selected patients with aortic valve stenosis has shown

excellent results for early and late mortality rates. This approach is increasingly used and tends to completely replace full sternotomy for patients in whom an isolated AVR is required.

P80

Does High Body Mass Index Increase Operative Risk in Minimally Invasive Aortic Valve Replacement?

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Objective: Minimally invasive aortic valve replacement (MIAVR) via an upper partial sternotomy is becoming increasingly routine. Trials are under way to compare the outcomes of MIAVR with conventional sternotomy. However, one of the exclusion criteria is often high body mass index (BMI). We compared the outcomes of our patients with high BMI to those of the normal group.

Methods: A prospective database of operative records between 2006 and 2016 was examined to retrieve all patients who had undergone MIAVR, including patient demographics, premorbid status, and intraoperative and postoperative details. Survival data were obtained from the Registry at the Welsh Demographic Service. Blood product usage data were obtained from the blood bank database. SPSS v23 was used to undertake an unpaired *t* test with 95% confidence intervals where appropriate to analyze the results. The logistic EuroSCORE was used for risk stratification.

Results: A total of 210 patients who underwent MIAVR were placed in 2 groups: group 1 (n = 142) with a BMI less than 30 kg/m^2, and group 2 (n = 68), with a BMI greater than 30 kg/m^2. The 2 groups were matched with no significant differences in logistic EuroSCORE, age, ventricular function, sex, renal function, and preoperative hemoglobin level. There were no significant differences in bypass time, cross-clamp time, or length of stay between the 2 groups ($P > 0.05$). Patients with a higher BMI required fewer units of packed red cells (1.70 vs. 2.44, $P = 0.046$). There was also no difference between the 2 groups in the 30-day all-cause mortality rate, re-exploration rate for bleeding, length of hospital stay, and conversion to sternotomy rate.

Conclusions: We have shown that patients with a high BMI can routinely undergo the minimally invasive sternotomy approach for aortic valve replacement. It is associated with a lower need for blood transfusions. High BMI should not be considered an exclusion criterion for undertaking MIAVR. This group may be the one to gain the most benefit by reducing the morbidity associated with a full sternotomy.

P81

Outcomes of Aortic Valve Replacement With Two Different Surgical Approaches: A Propensity-Score Matched Study

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Objective: Minimally invasive aortic valve surgery by way of a ministernotomy has shown excellent results in terms of mortality, morbidity, and patient satisfaction. The aim of the present study is to analyze the early and midterm outcomes after the implementation of a minimally invasive aortic valve replacement (MIAVR) program at our institution.

Methods: A retrospective, observational, cohort study was performed by collecting data from 371 consecutive patients undergoing isolated aortic valve surgery from January 2011 to December 2015. Propensity.score matching 1:1 was based on 12 preoperative risk factors. A total of 150 patients were selected (MIAVR group = 75 and conventional group = 75). Patients in the MIAVR group in whom reconversion to full sternotomy (n = 2) was required were excluded from the study.

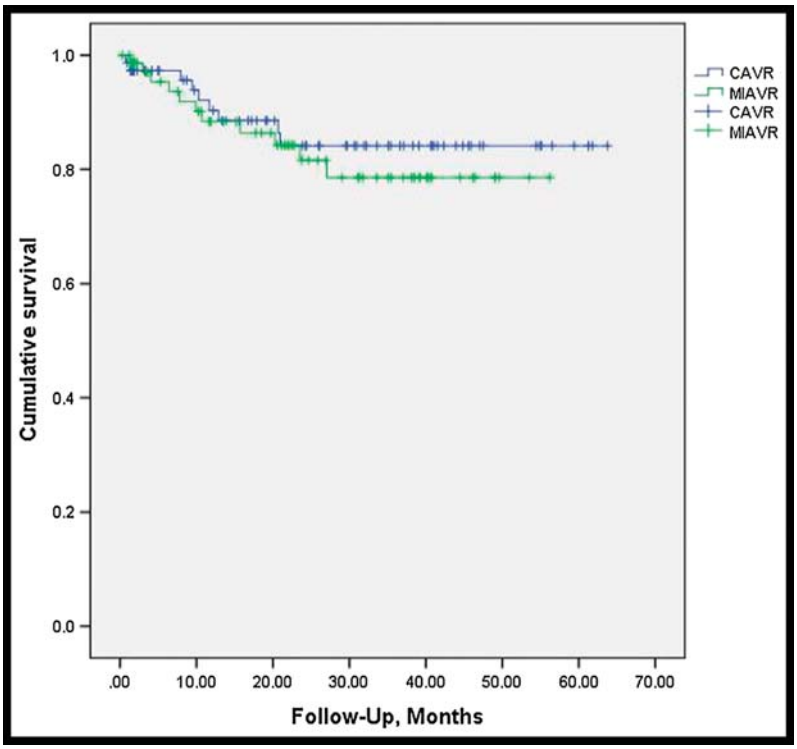

FIGURE P81-1. Kaplan-Meier overall survival rate was 54.4 months (CI 95%: 50.6–58.1; log-rank $\chi^2 = 0.3$; $P = 0.57$).

Results: No differences were found in in-hospital mortality rates (1.3% vs. 1.3%). The ventilation time (7.4 ± 7.3 vs. 8.7 ± 6.8 hours), postoperative bleeding (320.4 ± 143.7 vs. 362.1 ± 141.2 ml), rate of major cardiovascular events (2.7% vs. 4%), and re-exploration for bleeding (1.3% vs. 2.7%) or cardiac tamponade (1.3% vs. 4%) were similar in both groups. The total length of stay was shorter in the MIAVR group (9.7 ± 6.5 vs. 13.3 ± 8.8 days; $P = 0.006$). Mean cardiopulmonary bypass time was longer in the MIAVR group (88.2 ± 23.1 minutes vs. 81.7 ± 17.6 minutes; $P = 0.03$) but cross-clamp time was not (64 ± 16.2 minutes vs. 58.5 ± 14.8 minutes; $P = 0.06$). The median follow-up time was 54.4 months (95% CI, 50.6-58.1), the overall survival rate was 85% vs. 88%; the log-rank $\chi^2 = 0.3$; $P = 0.57$ (Fig. P81-1).

Conclusions: MIAVR can be safely implemented as a routine cardiac surgery procedure, although the operative times were significantly longer in our series. This approach is not associated with an increased rate of complications. On the other hand, the total length of stay was shorter.

P82
Prospective Nonrandomized Comparative Study of Aortic Valve Replacement for Severe Aortic Stenosis With a Right Minithoracotomy and a Full Sternotomy Approach in Septuagenarians

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Objective: Our goal was to report early clinical results and hemodynamic performance comparing a right minithoracotomy (RMT) versus a full sternotomy (FS) aortic valve replacement (AVR) for severe aortic stenosis (AS).

Methods: A total of 172 consecutive patients with severe AS who underwent isolated AVR from January 2003 to October 2016 were reviewed in a nonrandomized prospective study. Patients under 70 years old were excluded. There were 92 patients in the study: 52 in the FS group and 40 in the RMT group. We implanted 92 aortic valve bovine pericardial bioprostheses: 70 sutured and 22 sutureless. We assessed and compared the 2 groups as to early clinical outcomes of 30-day mortality rate, stroke, prolonged ventilation, renal failure, permanent pacemaker implantation, and echocardiographic hemodynamic performance.

Results: Similar results were found between RMT and FS AVR groups including age (76.08 ± 4.97 years, 76.10 ± 3.59 years, $P = 0.8$), valve sizes (21.90 ± 2.72 mm, 21.08 ± 1.68 mm, $P = 0.9$), aortic cross-clamp time (63.33 ± 12.21 minutes, 69.15 ± 10.28 minutes, $P = 0.3$), cardiopulmonary bypass time (100.88 ± 12.46 minutes, 107.81 ± 12.11 minutes, $P = 0.2$). Early clinical results of the 30-day mortality rate, stroke, renal failure, new pacemaker, and hemodynamic performance of aortic valve prostheses at 1 month, 3 to 6 months, and 1 year were comparable in both groups.

Conclusions: The RMT approach for isolated severe AS in elderly patients is associated with cosmetic satisfaction, similar effective hemodynamic performance, and comparable early clinical results compared to FS AVR.

P83
Ascending Aorta and Aortic Valve Replacement With a Sutureless Valve Through a Ministernotomy

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Objective: A significant proportion of patients undergoing aortic valve replacement (AVR) have a dilated ascending aorta that needs surgical replacement. Aortic valve surgery combined with surgery of the ascending aorta is not yet widely performed through a minimally invasive incision. Moreover, the presence of a concomitant ascending aorta aneurysm is viewed as a contraindication for sutureless valve implantation because of the potential risk of prosthesis dislodgment. Our goal was to describe our first experience of sutureless prosthesis implantation and concomitant ascending aorta replacement through an upper ministernotomy.

Methods: A retrospective study was undertaken on 7 consecutive patients undergoing AVR with a sutureless valve and ascending aorta replacement between November 2014 and October 2016.The upper ministernotomy comprised a 6 to 7 cm midline skin incision and a J-shaped sternal midline incision made into the second or third intercostal space. Cardiopulmonary bypass was established using direct cannulation of the aortic arch and with a double-stage venous return cannula placed percutaneously into the right femoral vein. The diameter of vascular graft for ascending aorta replacement was chosen according to the size of the selected prosthesis, to recreate a ratio between diameters of the new sinotubular junction and the aortic annulus that should be less than 1.3. Technically, it is mandatory to perform the proximal anastomosis of the tubular Dacron graft before implanting the sutureless prosthesis.

Results: The mean age was 74.6 ± 8.7 years. Three patients underwent a previous cardiac operation. No patient died postoperatively in the hospital. No paravalvular leakage or prosthesis dislodgment was reported. The mean cardiopulmonary bypass and cross-clamp times were 142 ± 52 minutes and 85 ± 18 minutes, respectively.

Conclusions: In patients undergoing AVR and ascending aorta replacement, sutureless valve implantation is a safe and reproducible procedure associated with good postoperative results.

P84
Outcomes After Minimally Invasive Aortic Valve Replacement in Patients With Liver Disease

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Objective: Patients with liver disease are at increased risk of death after cardiac operations. The objective of this study was to examine risk in patients with liver disease undergoing isolated aortic valve replacement (AVR) and to determine if the operative approach [full sternotomy (SAVR) vs. ministernotomy (miniAVR) vs. transcatheter (TAVR)] is related to mortality and complication rates.

Methods: Between July 2011 and May 2016, 935 patients underwent AVR at a single institution. Of those, 40 had liver disease as defined by the Society of Thoracic Surgeons criteria: cirrhosis, viral hepatitis, alcohol dependence, portal hypertension, or congestion. Data were obtained from an institutional database and medical records. Baseline characteristics and outcomes were compared.

Results: Patients with liver disease had higher operative mortality rates compared with those without, but the results were not statistically significant (3/40, 8% vs. 25/895, 3%, $P = 0.11$). Among patients with liver disease, those undergoing TAVR were older and had higher rates of diabetes and peripheral vascular disease. Those undergoing SAVR were more likely to be treated emergently and had higher rates of infective endocarditis. TAVR and miniAVR were associated with shorter intensive care unit times and a lower rate of prolonged ventilation compared

with SAVR. There was no statistical difference in operative mortality associated with the approach (miniAVR 0/5, 0%, vs. SAVR 3/18, 17%, vs. TAVR 0/17, 0%, $P = 0.3$). One- and 2-year survival rates among patients undergoing miniAVR, SAVR, and TAVR were 75%, 83%, and 81% and 75%, 75%, and 49%, respectively (Fig. P84-1). Four patients had Model for End-Stage Liver Disease (MELD) scores ≥20; The operative mortality rate was 50%; both surviving patients were alive at 2 years.

Conclusions: Patients with liver disease and aortic valve disease had acceptable operative mortality rates after AVR with minimally invasive or standard approaches, but long-term outcomes were poor. The mortality rate was high among those with severe hepatic dysfunction. A minimally invasive approach was associated with a lower incidence of prolonged ventilation and a shorter stay in the intensive care unit.

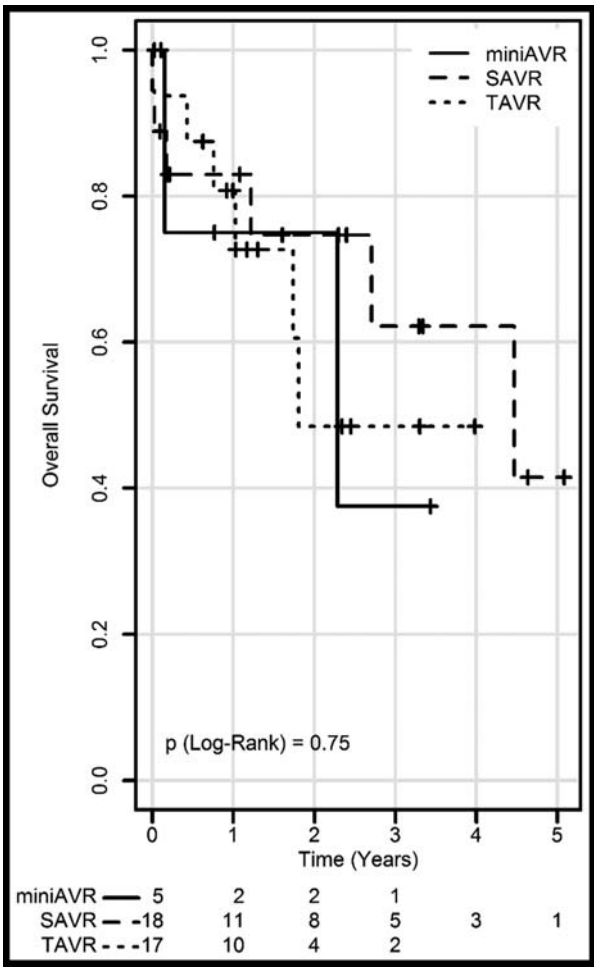

FIGURE P84-1. Survival after aortic valve replacement in patients with liver disease.

P85

The Advantages of Minimally Invasive Mitral Valve Operations Can Be Safely Translated to the Elderly: A Propensity-Matched Analysis

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Objective: Increasingly more patients over age 80 are referred for mitral valve operations. Though techniques associated with improved recovery are desirable in this population, minimally invasive approaches are technically challenging. We hypothesized that mitral valve surgery with a minimally invasive thoracotomy has outcomes equivalent to those obtained with a traditional median sternotomy.

Methods: A retrospective review of patients undergoing mitral valve surgery from 2002 to 2015 was performed at a single institution. Patients were stratified by operative approach via a full sternotomy or minimally invasive port access techniques. Cox proportional hazard modeling was performed to assess predictors of the 30-day hazard of death. Clinically important patient characteristics were adjusted for, including age, sex, body mass index, diabetes, renal failure, hypertension, smoking status, previous myocardial infarction, creatinine level, mitral procedure, and cardiopulmonary bypass (CPB) time. Propensity score matching allowed for a comparison of postoperative complications.

Results: Of 6386 patients who underwent mitral valve surgery, 718 (11%) were age 80 or older. Patients who underwent concomitant cardiac surgery or an emergent salvage procedure were excluded. Median sternotomy was performed for 136 patients and minithoracotomy for 55 patients. Hazard ratios for 30-day mortality were increased in patients with diabetes (HR = 3.7, $P = 0.021$) and longer CPB time (HR = 1.4, $P = 0.016$) but equivalent in patients who had a minithoracotomy compared to those who had a sternotomy. Propensity-score matching identified 50 patients each in the sternotomy and the minithoracotomy groups. CPB time was significantly prolonged in the minithoracotomy group: 117 (103–148) minutes, compared to the sternotomy group, 83 (69–110) minutes, $P < 0.001$ (Table P85-1). However, the postoperative transfusion rate was higher in the sternotomy group: 2.5 (1–6) units vs. 1.0 (1–2) units, $P = 0.032$. Other postoperative characteristics were equivalent between the groups.

Conclusions: Though sternotomy is the gold standard for mitral valve surgery, minimally invasive thoracotomy can be performed with equivalent short-term outcomes in patients age 80 and older, as seen in this propensity-score analysis. In this population, the improvement in pain and sternal stability associated with the minimally invasive approach may confer the benefit of early mobilization and rapid recovery.

TABLE P85-1. Postoperative Characteristics of Propensity-Matched Patients Who Underwent Mitral Valve Surgery

	Full Sternotomy	Minithoracotomy	*P*-Value
Bypass time (min)	83 (69, 110)	117 (103, 148)	<0.001
Cross-clamp time (min)	63 (50, 76)	83 (67, 110)	<0.001
Stroke, n (%)	3 (9.7%)	0	0.076
Pneumonia, n (%)	2 (6.5%)	2 (6.3%)	0.974
Renal failure, n (%)	2 (6.5%)	1 (3.1%)	0.535
Red blood cell transfusion (units)	2.5 (1–6)	1 (1–2)	0.032
Total time in the intensive care unit, h	50 (27–123)	48 (26–81)	0.309
Length of stay after the operation, d (d)	9 (7–11)	8.5 (7–12)	0.989
30-day mortality rate, n (%)	4 (8.0%)	2 (4.0%)	0.400

P86

The Nipple-Cut Approach in Minimally Invasive Mitral Valve Repair Surgery: A Feasible, Safe, and Cosmetically Appealing Technique

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Objective: Minimally invasive mitral valve repair has become a routine procedure in specialized centers. The most widely used minimally invasive mitral valve repair is performed through a right anterolateral minithoracotomy, primarily under direct vision. Our goal was to report our early experience of an endoscopic nipple-cut access approach, the goal of which was an optimal cosmetic result.
Methods: From November 2015 to October 2016, we performed a nipple-cut approach in 30 male patients (mean age, 60.4 years; EuroSCORE, 4.2%; EuroSCORE II 1.0%: Society of Thoracic Surgeons-Predicted Risk of Mortality score, 0.6%). Twenty-five patients (83%) presented with prolapse including anterior and/or bileaflet disease; 4 patients (14%) with functional mitral regurgitation; and 1 patient (3%) with left atrial myxoma. All procedures were performed using a non-rib-spreading procedure with 3-dimensional endoscopic visualization. Cross-clamping was achieved using the endoballoon technique. To objectively assess the cosmetic result, a battery of patient questionnaire tests, commonly used with patients who have had aesthetic procedures, was used (the Vancouver Scar Scale, the Manchester Scar Scale, the Patient Scar Assessment Scale, the Dermatology Quality-of-Life Index, and the Stony Brook Scar Evaluation Scale). The median time from operation to scar assessment was 216 days.
Results: Mitral valve repair was successful including a full semirigid annuloplasty ring and neochordae in cases of mitral valve prolapse. A concomitant cryoablation was performed in 4 patients (14%), and a tricuspid valve annuloplasty was done in 1 patient. Mean procedure-, CPB-, and cross-clamp times were 172 ± 23.03, 112 ± 16.51 and 70 ± 7.45 minutes, respectively. Conversion to a minithoracotomy or sternotomy was not required in any case. Postoperatively, no stroke or other major adverse cardiac and cerebrovascular events were observed. Follow-up was complete with 100% overall survival. Total scar assessment scale scores are depicted in Figure P86-1.
Conclusions: The endoscopic nipple-cut approach proved to be safe and reproducible and even allowed complex mitral valve repair or additional tricuspid procedures. The scar assessment battery (cosmetic result, sensory function) demonstrated high patient satisfaction.

P87
Periareolar Approach in Cardiac Surgical Procedures

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Objective: The aim of this report was to describe the 38 patients who underwent minimally invasive cardiac surgical procedures by the periareolar approach and their outcomes in the first 30 days.
Methods: From January 2015 to August 2016, we included 38 patients who underwent a minimally invasive cardiac surgical procedure by periareolar incision. For those patients who had cardiopulmonary bypass (37 of 38), we used femoral vessels for cannulation. For those patients who had procedures on the right atrium, we used the internal jugular vein on the same side for bicaval cannulation. All cannulations were performed with the Seldinger technique and by transesophageal echocardiographic guidance. Cardiac arrest was induced with Del Nido cardioplegia. Only 1 operation was performed without cardiopulmonary bypass.
Results: The majority of patients were women (35/38). The mean age was 49 ± 9.7 years; the body mass index was 26 ± 4. The procedures were 14 atrial septal defect closures (12 ostium secundum and 2 sinus venosus), 10 mitral valve replacements, 6 mitral valve repairs, 3 mitral replacements with concomitant procedures (Maze, tricuspid repair, and atrial septal repair), 2 myxoma resections in the left atrium, 1 tricuspid repair with atrial septal closure, 1 atrial septal closure with peacemaker wire removal, and 1 atrial repair due to a peacemaker wire perforation. The

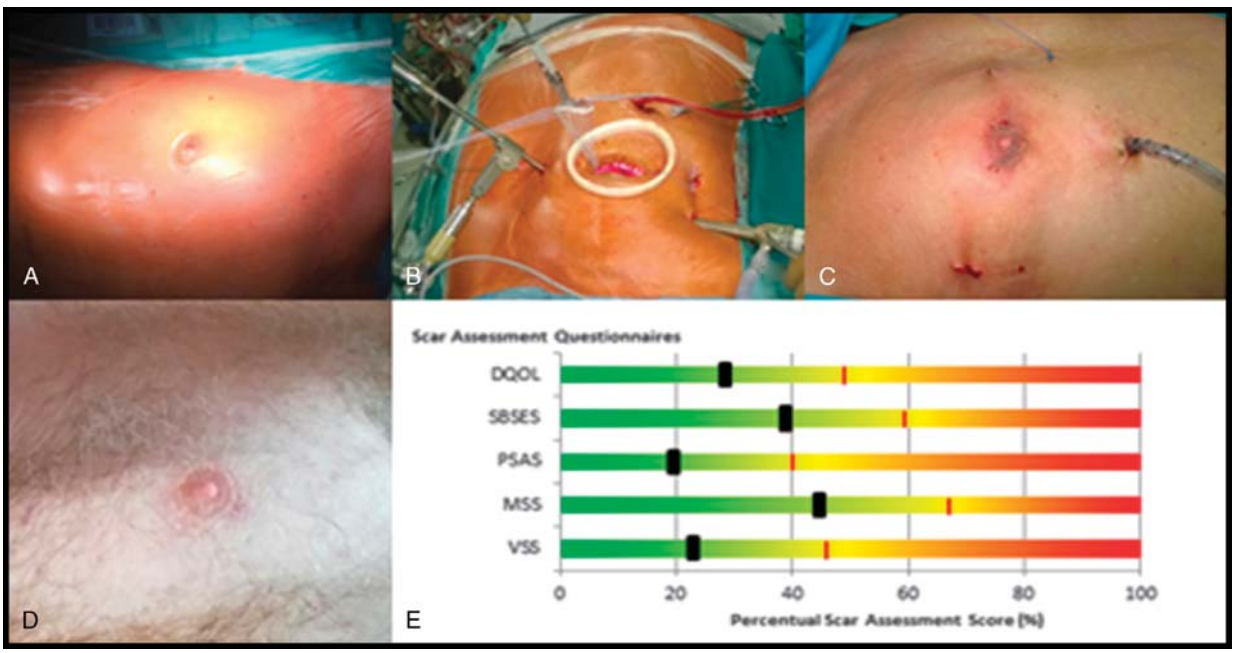

FIGURE P86-1. A, Minimally invasive nipple-cut approach for mitral valve repair: periareolar incision approximating the right nipple. B, Intraoperative view: soft tissue retractor in situ. C, Intracutaneously sutured periareolar incision. D, Postoperative scar: 1-year follow-up. E, Chart exhibiting respective scar assessment scale scores (black bars). Red bars indicate patient scar satisfaction cut-off valve per scar assessment scale. DQOL, Dermatology Quality-of-Life Index; SBSES, Stony Brook Scar Evaluation Scale; PSAS, Patient Scar Assessment Scale; MSS, Manchester Scar Scale; VS.S, Vancouver Scar Scale.

mean cross-clamp time was 64 ± 24 minutes and the perfusion time was 103 ± 44 minutes. The mean chest drainage was 305 cc during the first day. The median stay in the intensive care unit was 26 hours (0–120) and the mean postoperative stay was 5 days (2–17). We had 3 complications: 2 hemothoraxes and 1 atrioventricular block. We reported 0 deaths.
Conclusions: The periareolar approach for minimally invasive cardiac surgical procedures is a good choice for mitral valve and tricuspid valve operations, atrial septal defect (ostium secundum and venous sinus), concomitant procedures like the Maze procedure, and removal of peacemaker wires. The incidence of complications is similar to that with the traditional minimally invasive incision with excellent esthetics results.

P88
Influence of Preoperative Computed Tomography on the Operative Strategy During Minimally Invasive Mitral Surgery

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Objective: Minimally invasive mitral valve operations have become a regular approach in many centers across the globe, but different opinions exist on the usefulness of preoperative computed tomography (CT) to plan these operations. The aim of this study was to evaluate the influence of the preoperative use of CT in the operative planning for minimally invasive mitral valve operations.
Methods: From 2007 to 2016, 222 consecutive patients were operated on for an isolated operation by a single surgeon in our center. Of those patients, 202 patients were evaluated with CT for a minimally invasive approach, and their files were retrospectively reviewed to look for the influence of the results of the CT scans on their operative planning.
Results: Of the 202 patients evaluated, 22 patients (10.1%) had a contraindication, identified on the preoperative CT scan, for using a minimally invasive approach through the right chest. The reasons were vascular disease or aortic thrombus (n = 11, 50%), leaking mammary prosthesis (n = 5, 22.5%), chest deformity without enough working space (n = 1, 4.5%), and significant right pleural scarring due to previous operation(s) (n = 5, 22.5%). For the 158 patients who underwent a minimally invasive approach, 22 patients (13.9%) needed a modification of the preoperative strategy secondary to findings on the CT scan: modification of the cannulation site in 15 patients (77.3%) or type of aortic occlusion in 5 patients (22.7%). One hundred thirty-two patients underwent mitral valve repair (84%) and 26 had mitral valve replacement (16%). With these modifications, operative results were repair rate 99.3%, mortality rate 1.2%, conversion rate 2.4%, stroke 1.8%, and vascular injury 0.8%. All the patients left the hospital with no or trivial residual mitral regurgitation.
Conclusions: In 20% of patients evaluated for minimally invasive mitral valve surgery, preoperative CT influenced the operative strategy (Fig. P88-1). These modifications in operative strategy allowed us to achieve excellent clinical outcomes with this procedure. Thus, a systematic, thorough preoperative screening for anatomical or vascular contraindications is the cornerstone to safely perform minimally invasive mitral valve operations.

P89
Middle Eastern Experience in Minimally Invasive Mitral Valve Surgery

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Objective: Our aim was to evaluate our center's experience and outcomes in minimally invasive mitral valve surgery through a right minithoracotomy.
Methods: Between January 2005 and November 2016, a total of 386 patients underwent mitral valve operations through a right

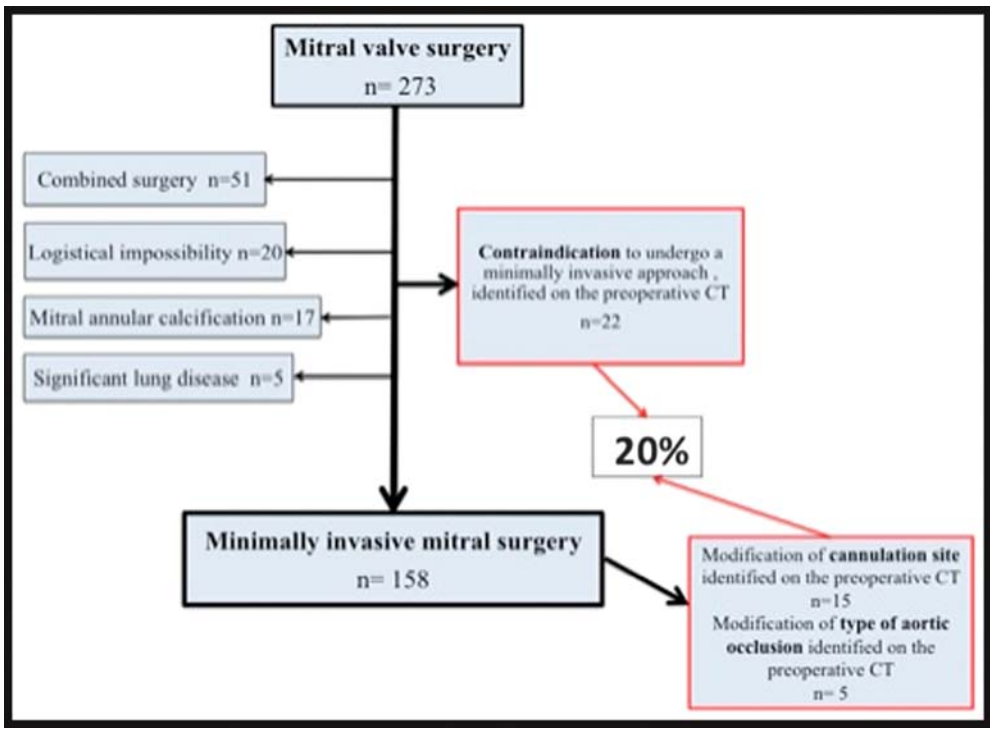

FIGURE P88-1. Flow chart. CT, computed tomography.

minithoracotomy: 265 (68.6%) were isolated mitral valve operations and 121 (31.3%) had concomitant tricuspid valve surgery at King Fahad Armed Forces Hospital. The mean age was 39 ± 20 years and the mean left ventricular ejection fraction was 45.6% ± 7.2%. The average logistic EuroSCORE was 10.2% ± 4.4%; the patients had an average follow-up period of 36 ± 12 months.

Results: Intraoperatively, the patients had a mean bypass time of 155 ± 60 minutes, mean cross-clamp time of 70 ± 30 minutes, and conversion to sternotomy in 3 patients (0.7%). The overall in-hospital mortality rate was 0.7% with 3 in-hospital deaths; the mean stay in the intensive care unit was 4 ± 2 days and the length of stay was 7 ± 2 days. The stroke rate was 0.2% (1 patient); no patient had lower limb ischemia; and 4.1% (16) patients had groin wound infections. At the 4-year follow-up, we found New York Heart Association functional class I in 90.7%, II in 5.9%, and III and IV in 3.3%. Freedom from a mitral valve-related reoperation was 95.3%, and the survival rate was 90.1%.

Conclusions: The results of our experience with minimally invasive mitral valve surgery through a right minithoracotomy for patients with both degenerative and rheumatic mitral valve disease indicate that it is a safe and feasible procedure with excellent short- and midterm outcomes and improved patient satisfaction.

P90

A Matched Pairs Analysis of Totally Endoscopic Versus Minithoracotomy for Mitral Valve Operation

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Objective: Minimally invasive access through a right thoracotomy has become the preferred route for mitral valve surgical procedures; video-assisted technology has also developed to allow a completely endoscopic procedure. The aim of this paper was to compare a standard right minithoracotomy (sRMT) with an endoscopic non-rib-spreading (eNRS) approach regarding feasibility, safety, and functional results.

Methods: A matched pair analysis was undertaken of retrospectively collected 286 patients who underwent mitral valve surgery from January 2010 to November 2016. Eighty-six patients who had an sRMT procedure were compared with 86 patients who had an eNRS endoscopic operation. In the sRMT group, the access was a 5 to 6 cm incision in the inframammary fold through the fourth intercostal space with the insertion of a rib spreader; in the eNRS group, the access was periareolar in men, whereas in women it was a 3 cm incision in the inframammary fold; in the eNRS group, only a soft-tissue protector was used.

Results: The procedures were successful in all patients. There were no 30-day deaths in either group. The duration of anesthesia and the overall procedure did not differ. Cardiopulmonary bypass time and cross-clamp time were higher in the eNRS group: 146 ± 27 minutes vs. 122 ± 28 minutes ($P < 0.001$) and 92 ± 20 minutes vs. 79 ± 18 minutes ($P < 0.001$). This difference did not affect the overall repair rate (94% vs. 88%, eNRS vs. sRMT; $P = 0.17$). The hospital stay was shorter in the eNRS group (6 days vs. 7 days, eNRS vs. sRMT; $P = 0.19$) with a higher rate of home discharge (95% vs. 88%; $P < 0.05$). Patient satisfaction was higher in the eNRS group.

Conclusions: Endoscopic mitral valve procedures are safe and reproducible and yield comparable results when compared with a standard minimally invasive mitral valve procedure. Higher cardiopulmonary bypass and cross-clamp times were part of the learning curve but did not affected the operative results or early deaths. Recovery times and discharge home rates were higher in the eNRS group, as was cosmetic satisfaction.

P91

Thoracoscopic Mitral Valve Repair: 5-Year Results of 516 Cases in a Single Center

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Objective: The objective of our study was to review the results of thoracoscopic mitral valve repair in our center since the beginning of our program.

Methods: The study cohort comprised 516 consecutive patients who underwent thoracoscopic mitral valve repair at our center from February 2012 to September 2016. The mean age was 45.02 ± 16.44 years; 239 patients (46.31%) were women. The mean left ventricular ejection fraction was 66.68% ± 6.74%.

Results: The procedure was successfully performed using a right lateral minithoracotomy and femoral cannulation for cardiopulmonary bypass in 487 patients; 29 patients (5.62%) required intraoperative conversion to full sternotomy. Mitral valve repair techniques consisted of ring annuloplasty with or without chordae replacement or leaflet resection. Concomitant procedures included ablation of atrial fibrillation in 33 patients (6.40%), closure of a patent foramen ovale/atrial septal defect in 105 patients (20.35%), and removal of an atrial myxoma in 3 patients. The mean duration of cardiopulmonary bypass was 147.60 ± 45.38 minutes, and the mean aortic cross-clamp time was 96.22 ± 32.51 minutes. The 30-day mortality rate was 0.39%, and the rate of important postoperative adverse morbidities was 21.32%.

Conclusions: Our study shows that thoracoscopic mitral valve repair, with or without concomitant procedures, can be performed in the vast majority of patients, with low perioperative complication rates.

P92

Non-Rib-Spreading Totally Endoscopic Mitral Valve Repair Using a 3-Dimensional Camera

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Objective: Minimally invasive cardiac surgical procedures for mitral valve repair have been performed successfully over the past decade. However, the postoperative pain related to rib-spreading negates the value of these procedures. Although robot-assisted mitral valve repair is one of the least invasive procedures, it has been limited by the cost involved. We reviewed the early results of our totally endoscopic procedure using a 3-dimensional (3D) camera (SHINCO OPTICAL Co. ltd, Tokyo, Japan).

Methods: From January 2013 to December 2015, 27 patients underwent totally 3D endoscopic mitral repair for severe degenerative mitral regurgitation or functional mitral regurgitation. Under general anesthesia with 1-lung ventilation, we performed a right anterior minithoracotomy in the fourth intercostal space. We used a soft tissue retractor without a rib spreader. The 3D camera was inserted laterally in the same space. Cardiopulmonary bypass was established with femoral (axillary) cannulation. The ascending aorta was cross-clamped with a transthoracic clamp.

Results: The procedures were successful in all patients. The mean cardiopulmonary bypass and cross-clamp times were 152 ± 40 minutes and 99 ± 23 minutes, respectively. Resection techniques were performed in 10 patients, and chordal replacement was performed in 10 patients. A

combined procedure for both leaflets was performed in 3 patients. Ring annuloplasty was combined with those procedures in all patients. Two patients had annuloplasty alone. Endocardial surgical Cox-Maze ablation of the left atrium using a pen radiofrequency device was performed in 6 patients who had persistent atrial fibrillation. No patients required conversion to sternotomy. There were no deaths and no re-exploration due to bleeding. No patients had severe operative pain. Twenty-three patients had no or trivial mitral regurgitation, and 2 patients had mild regurgitation at discharge. One patient required re-operation due to recurrence of moderate regurgitation, and 1 patient required re-operation due to hemolysis 2 months after the operation.

Conclusions: Based on our experience, non-rib-spreading, totally 3D endoscopic mitral valve repair provides effective and relatively painless treatment without robotic assistance.

P93

The Impact of 3-Dimensional Endoscopy on the Learning Curve of Minimally Invasive Mitral Valve Procedures

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Objective: Minimally invasive mitral valve surgery (MIMVS) has become the routine approach at many centers. The use of 3-dimensional (3D) endoscopy is the latest step of continuous technical refinement. We analyzed the impact of 3D endoscopy on the learning curve for MIMVS.

Methods: From 2010 to 2016, 362 patients underwent MIMVS. Of these, 243 were treated using standard 2-dimensional endoscopy (group 1) and 119 were treated using 3D endoscopy (group 2). These procedures were performed by 6 surgeons with similar individual caseloads but at different stages of training. Individual and cumulative learning curves regarding operation times and perioperative complications were assessed for 3D endoscopy-guided procedures. Operation times, complications, and functional results of both groups were compared.

Results: The median age was 55.3 ± 12.4 years (group 1) vs. 57.7 ± 10.6 years (group 2; $P = 0.07$); 31.3% vs. 31.1% ($P = 0.91$) were women, respectively. Bileaflet prolapse was seen in 21.4% (group 1) versus 14.3% (group 2; $P = 0.11$). Complexity and number of repair techniques performed were not significantly different for both groups. We did not observe an obvious overall or individual learning curve regarding operation times for 3D endoscopy-guided procedures. Surgeons in earlier training stages did not show significantly longer operation times than experienced surgeons. Individual and cumulative learning curves for perioperative complications also did not show any obvious learning effects. Operation times were 263.34 ± 62.48 minutes vs. 262.59 ± 52.13 minutes in groups 1 and 2, respectively ($P = 0.91$). Re-exploration for bleeding was performed in 1.6% vs. 1.7% ($P = 0.98$); conversion to sternotomy was performed in 1.6% vs. 0.8% ($P = 0.49$). Impaired wound healing was not seen in group 2, but it was found in 1.6% of group 1 ($P < 0.01$). Discharge echocardiography showed excellent results in both groups, with 1.6% vs. 0.8% > mild recurrent regurgitation in groups 1 and 2, respectively ($P = 0.49$).

Conclusions: In our early experience with 3D endoscopic minimally invasive mitral valve repair, we could not identify typical learning curve patterns, and operating times were stable from the beginning for each surgeon. Compared to the established procedure used in group 1, we found lower complication rates, equal functional results, and equal operation times in group 2. Therefore, we think that the use of 3D endoscopy can support learning minimally invasive operative techniques by increasing orientation and depth perception.

P94

Impact of Minimally Invasive Mitral Valve Surgery in Elderly Patients

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Objective: Due to demographic changes, an increasing number of elderly patients present with mitral valve disease. Minimally invasive cardiac surgery has evolved to become standard therapy for several cardiac diseases at specialized centers. The goal of this study was to compare this technique to conventional access via a full median sternotomy in the elderly population.

Methods: This retrospective analysis included 330 consecutive patients who had a mitral valve repair between 2012 and 2016 at the age of 70 or older. A total of 193 patients underwent concomitant procedures while isolated mitral valve surgery and/or ablation was performed in 137 patients. Anterolateral minithoracotomy was used in 46 cases (group I); 91 patients were operated on via a full median sternotomy (group II). Groups I and II served as our study population.

Results: Patients in group I were significantly younger compared to those in group II (I: 73 ± 2 years vs. II: 76 ± 4 years; $P < 0.001$). Further preoperative characteristics were similar between the 2 groups. The EuroSCORE II (I: 1.68 ± 1.58 vs. II: 4.21 ± 2.91; $P < 0.001$) and the Society of Thoracic Surgeons score (I: 1.33 ± 0.64 vs. II: 2.10 ± 1.19; $P < 0.001$) were significantly higher in group II. Cardiopulmonary bypass time (I: 175 ± 51 vs. II: 125 ± 38 minutes; $P < 0.001$) and duration of procedure (I: 256 ± 67 vs. II: 231 ± 69 minutes; $P = 0.044$) were significantly longer in group I. Stays in the intensive care unit (I: 2 ± 1.2 vs. II: 3 ± 2.7 days; $P = 0.003$) and in the hospital (I: 7.02 ± 1.7 vs. II: 9.8 ± 5.5 days; $P < 0.001$) were shorter in group I, respectively. Perioperative stroke occurred in 4 patients in group II; none, in group I. The in-hospital mortality rate was 0% in group I compared to 1.09% in group II. Postoperative complications involved a postoperative drain due to pneumothorax (I: 4.3%; II: 2.2%; $P = 0.602$); postoperative pacemaker implantation (I: 0%; II: 12.1%; $P = 0.016$); re-thoracotomy due to bleeding (I: 3 patients, 2 requiring sternotomy; I: 3 patients) and wound healing disorder (I: 0%; II: 4.4%; $P = 0.300$).

Conclusions: Minimally invasive mitral valve surgery is safe and feasible in patients older than 70 years, with significantly shorter stays in the intensive care unit and in the hospital. Given the appropriate institutional expertise in minimally invasive mitral valve procedures, such procedures can be safely performed in patients >70 years without in-hospital deaths.

P95

Is a High Mitral Repair Rate Through a Minithoracotomy Always Possible?

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Objective: Mitral valve repair is the operation of choice for degenerative diseases. When the anterior leaflet is involved, it is considered a challenge for surgeons, namely via a minimally invasive access. Our goal was to analyze our results to determine if a complex anatomy results in a high repair rate.

Methods: From January 2009 to September 2016, we operated on 312 patients for severe mitral regurgitation due to a degenerative disease. Thirty-eight percent had a bileaflet or anterior prolapse or flail and 62% had isolated posterior prolapse. We used a simplified minimally invasive technique with direct aortic cannulation and single venous drainage even in combined tricuspid repair. An intraoperative transesophageal echocardiographic echo analysis of each scallop was performed. In all cases, we implanted a prosthetic complete ring.
Results: The mortality rate was 0.3%. The repair rate was similar in posterior leaflet prolapse (100%) and in bileaflet and anterior prolapse (100%). In the first 12 cases, 1% converted to sternotomy. In 3% of cases, we had to go back on pump to reduce residual regurgitation. In all patients, we obtained a good length of coaptation, at least 7 mm.
Conclusions: In our experience, a high repair rate is achievable through minithoracotomy in single and bileaflet prolapse or flail with a simplified technique. Proper intraoperative transesophageal echocardiographic analysis of each scallop is mandatory together with previous experience with complex repair via sternotomy.

P96

Minithoracotomy Approach for Repair of Mitral and Tricuspid Valves, Atrial Septal Defects, and Removal of Cardiac Tumors in 250 Consecutive Patients: 5-Year Follow-Up

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Objective: Minimally invasive cardiac surgery is becoming more and more popular because of its proven advantages of decreased tissue traumatization, which provides better hemostasis, and an untouched shoulder

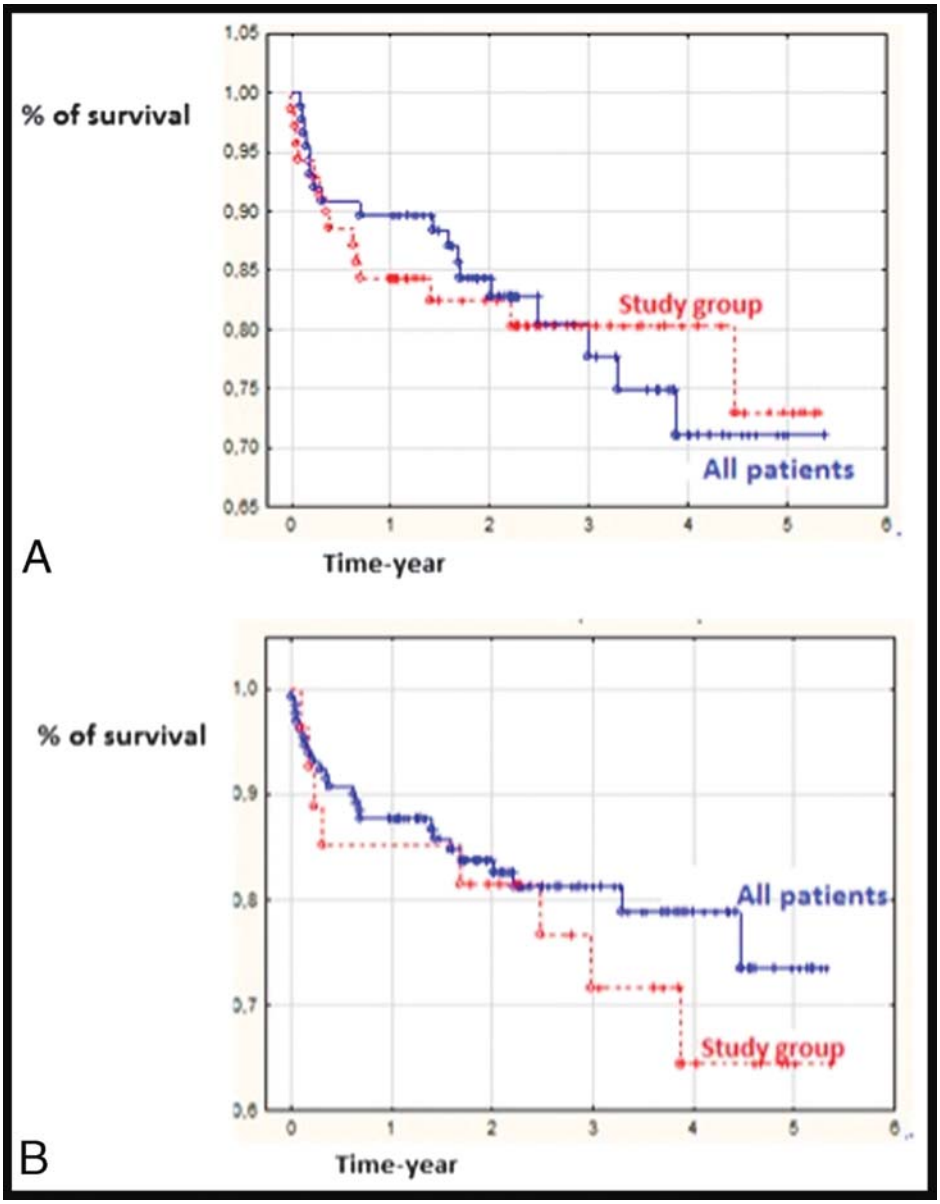

FIGURE P96-1. A, Kaplan-Meier analysis in patients after mitral repair. B, Kaplan-Meier analysis in patients after mitral replacement.

girdle, which enables fast recovery. We analyzed consecutive 250 "all-comer" patients who were operated on via a right minithoracotomy.
Methods: Between November 2011 and January 2016, we performed right minithoracotomies in 250 consecutive patients. Surgical access was through a right lateral minithoracotomy with the use of extracorporeal circulation via the femoral and cervical vessels. When the tricuspid valve was also involved, the right internal jugular vein was cannulated.
Results: The mean (SD) age was 63.9 ± 12.8 years. Preoperative comorbidities included diabetes mellitus in 12.7%; chronic obstructive pulmonary disease in 5.5%; chronic renal failure in 10.6%; and active endocarditis in 2.5%. The mean ejection fraction was 54.7 ± 12.0%. The mean EuroSCORE II was 6.9 ± 7.0%. Three different groups of patients were selected according to the most common "high risk" definitions: patients over 80 years old, patients with an ejection fraction below 35%, and patients with a EuroSCORE above 6 points. The median cardiopulmonary bypass time was 166.2 ± 71.7 minutes, and the median cross-clamp time was 87.0 ± 49.5 minutes. We did not observe conversion to full median sternotomy. Reopening for bleeding was necessary in 9 (3.8%) patients. Acute kidney injury was reported in 6 patients (2.5%). Four patients had neurological complications (1.7%). The average stay in the intensive care unit was 2.4 ± 1.6 days. During the first 24 hours, we observed mean drainage values of 395.2 ± 332.0 ml. The blood transfusion rate was 1.7 ± 2.8 units. The 30-day mortality rate was 2.9%. The Kaplan-Meier 5-year survival rate was 73 ± 7.8% patients after mitral valve repair and 60 ± 4.5% patients after mitral valve repair (Fig. P96-1A,B)
Conclusions: Minimally invasive procedures via minithoracotomy are safe and feasible in consecutive all-comers. In the group who had minimally invasive mitral repair, we observed better survival rates than in the group who had mitral valve replacement.

P97

1-Year Outcome of a Multicenter Clinical Study Evaluating a Novel Self-Expanding Transcatheter Aortic Valve System

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Objective: The Portico transcatheter aortic heart valve (St. Jude Medical, St. Paul, MN USA) is a fully resheathable, repositionable, and self-expanding bioprosthesis designed to achieve optimal valve position and hemodynamic performance and to limit conduction disturbances. Our goal was to present 1-year outcomes in patients implanted with the full range of Portico valves in a prospective, multicenter cohort study.
Methods: Between December 2011 and September 2015, 222 patients with symptomatic [≥New York Heart Association (NYHA) class II] severe aortic stenosis (AS) considered by a multidisciplinary heart team to be high risk for surgery were enrolled at 12 sites in Europe and Australia. Patients were implanted with the full range of Portico valves (23, 25, 27 or 29 mm) using an 18F or 19F transfemoral delivery system. Adverse events were defined according to Valve Academic Research Consortium criteria and adjudicated by an independent clinical events committee. Echocardiographic data were evaluated by an independent core laboratory. Functional status was assessed by NYHA class.
Results: A total of 220 patients (mean age: 83.0 ± 4.6 years, 74.3% women, mean Society of Thoracic Surgeons score 5.8%) were implanted with the Portico valve. One-year clinical follow-up data were available for 160 patients. Resheathing and repositioning of the valve were performed in 33% of procedures and were successful in all instances. The average depth of implant into the left ventricular outflow tract was 6.1 ± 2.2 mm. Vascular access, valve delivery and deployment, and retrieval of the delivery system were successful in 97.3%. Kaplan-Meier estimates of all-cause mortality were 3.6% and 13.1% at 30 days and 1 year, respectively. Permanent pacemaker implantation was required in 13.5% of patients at 30 days, and increased marginality was required in 14.9% at 1 year. Compared with baseline, indexed valve area, valve mean gradient, and peak velocity significantly improved at 30 days and at 1 year (all comparisons, $P < 0.0001$). Paravalvular aortic regurgitation was absent/trace in 48.3%, mild in 44.2%, moderate in 6.8%, and severe in 0.7% patients at 1 year. NYHA functional class improved in 74.8% of patients at 1 year compared to baseline ($P < 0.0001$).
Conclusions: At 1 year, the resheathable Portico transcatheter aortic heart valve was safe and was associated with good hemodynamic performance, significant improvements in functional class, and low rates of permanent pacemaker implantation in high-risk patients.

P98

Symetis Transcatheter Aortic Bioprostheses for the Treatment of Severe Aortic Stenosis: First North American Experience With 1-Year Follow-Up

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Objective: Newer generation transcatheter aortic valve prostheses introduce technological and design advantages that may improve patient outcomes. Our goal was to present our initial experience with the Symetis ACURATE transcatheter aortic valve implantation technology with 1-year follow-up.
Methods: From January 2014 to October 2016, 87 high-surgical-risk patients with symptomatic severe aortic stenosis underwent transcatheter aortic valve implantation (TAVI) using the transapical Symetis ACURATE TA and the transfemoral Symetis ACURATE *neo* devices. In-hospital and 30-day outcomes were evaluated and reported according to the Valve Academic Research Consortium-2 definitions. Clinical and echocardiographic follow-up examinations were performed up to 1 year.
Results: The mean age was 82.4 ± 8.1 years with a mean logistic EuroSCORE of 16.35 ± 11.26% and a Society of Thoracic Surgeons score of 5.3 ± 3.8. The transapical Symetis ACURATE TA was used in 65 patients (74.7%); the transfemoral Symetis ACURATE *neo* was used in 22 patients (25.3%). The procedure was performed successfully in 85 patients. Two patients (2.3%) required an emergency conversion to conventional cardiopulmonary bypass due to embolization of the bioprosthesis. No coronary obstruction occurred. Paravalvular leak was identified in 32 patients (38.1%), and it was evaluated as mild in all of these cases. The average peak gradient on the prosthetic valves was 16 ± 8.5 mmHg; the average mean gradient was 8 ± 4.6 mmHg. Nine patients (10.5%) required a permanent pacemaker implant. The mean stay in the intensive care unit was 1 ± 0.9 days; the mean hospital stay was 7 ± 5.5 days. The in-hospital mortality rate was 3.4% (n = 3); the 30-day mortality rate was 3.6% (n = 3). At the end of the follow-up (11.5 ± 7.6 months) period, 10 more patients (11.8%) had died, so the overall mortality rate was 18.4% (n = 16). The majority of the patients were in New York Heart Association (NYHA) class 1 (76.1%), 10.5% of the patients were in NYHA class 2, 11.9% of the patients were in

NYHA class 3, and the remaining 1.4% were in NYHA class 4. The rate of readmission to the hospital for congestive heart failure was 16.4%.
Conclusions: This initial experience shows that TAVI procedures using the Symetis ACURATE bioprostheses can be performed safely in a selected subset of patients with short-term results comparable with those of other TAVI devices.

P99

One-Year Outcome of Transapical Transcatheter Aortic Valve Replacement Procedure With Sutures Secured Using Automated Fasteners and Rapid Pacing: A Safe Technique for Transapical Access

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Objective: Our goal was to evaluate the clinical outcomes of patients who had transcatheter aortic valve replacement (TAVR) via a transapical approach with prosthetic attachment sutures secured by automated titanium fasteners and who were followed for at least 1 year.
Methods: We conducted a single-institution retrospective review of clinical outcomes for patients involved in an on-going study of the transapical TAVR approach that was approved by the institutional review board. During the 34-month period from January 2014 to October 2016, 164 transapical TAVR procedures were performed at our institution using automated titanium fastener technology. We used echocardiographic guidance to determine the best point of entry and then placed two 2-O Prolene vertical mattress sutures under rapid ventricular pacing. We removed the 24F sheath after TAVR placement, with rapid ventricular pacing and automated titanium fasteners. In-hospital and 1-year clinical outcomes were evaluated. Patient postoperative histories, the Transcatheter Valve Therapy Registry, physician records, and follow-up studies, such as echocardiography, were analyzed.
Results: We reviewed the records of 164 consecutive patients who had a transapical TAVR. All transapical TAVR sites were successfully closed with automated titanium fasteners. The mean age for all patients was 84 years. The median Society of Thoracic Surgeons' Predicted Risk of Mortality score was 7.6%. Other concomitant comorbidities included previous sternotomy (40.2%), peripheral artery disease (51.2%), diabetes mellitus (28%), dialysis (1.2%), and home O_2 (6.7%). The 30-day mortality rate was 3.7%; the 1-year mortality rate was 5.5%; and the 30-day stroke rate was 1.2%. The valve-in-previous-surgical-valve procedure rate was 9.8%. Other complications included permanent pacemaker (11%), conversion to sternotomy (0.6%), vascular complications (0%), wound infection (0.6%), and atrial fibrillation (7%). No adverse outcomes were attributable to the use of automated titanium fasteners. Discharge echocardiograms showed aortic insufficiency classified as none, 36.6%; trace, 42.7%; mild, 18.3%; moderate, 2.4%; and severe, 0%. The mean gradient pre TAVR was 47.3 mmHg vs. 8.0 mmHg after TAVR.
Conclusions: At a minimum of a 1-year follow-up, automated titanium fasteners appear to be safe and effective for securing the ventriculotomy site after transapical TAVR. The use of titanium fasteners along with rapid ventricular pacing seems to be a reliable technique for apical closure.

P100

Transcatheter Aortic Valve Replacement Without Preballoon Aortic Valvuloplasty

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Objective: Balloon aortic valvuloplasty (BAVP) facilitates transcatheter aortic valve replacement (TAVR) but may (1) increase the number of strokes because of additional wire manipulation and potential emboli and (2) increase perivalvular leak (PVL) because of repeated valve dilation. In a TAVR procedure, the latest generation SAPIEN 3 transcatheter valve, TAV can be placed without BAVP. However, outcomes of patients undergoing TAVR without BAVP have not been defined.
Methods: We performed a retrospective review at a single university center of TAVR without BAVP using the SAPIEN 3 (S3) valve. Patient demographics, operative, and postoperative outcomes including stroke, and intraoperative transesophageal echocardiography measurements for PVL were reviewed.
Results: From March 2012 through March 2016, 544 patients underwent TAVR, of which 84 had TAVR using the S3 valve. Procedural success was 98.8%; 1 patient (1.19%) developed intraoperative device embolization and was converted to an open surgical procedure. Finally, 83 patients [48 (58%) men and 35 (42%) women] with a mean ± SD age of 77 ± 10 years and a mean ± SD Society of Thoracic Surgeons risk score of 7.05 ± 3.7 were included. Post-TAVR intensive care unit admission and ventilation hours were 65.53 ± 107.12 and 3.25 ± 1.96, respectively. Length of hospital stay was 2.86 ± 3.06 days. No in-hospital death occurred, and the 30-day mortality rate was 3.6% (n = 3). There were no (0%) in-hospital procedural strokes, though 1 patient (1/83, 1.2%) had a stroke outside of the hospital within 30 days of the TAVR. Two (2.4%) patients needed permanent pacemakers inserted after TAVR, and 5 (6.02%) patients developed new left bundle branch block. During the 12-month follow-up period, no other stroke was detected. There were no other postoperative complications, reoperations, or 30-day readmissions (Table P100-1). On post-TAVR

TABLE P100-1. Preoperative Characteristics and Postoperative Outcomes of Patients Who Had Transcatheter Aortic Valve Replacement Without Preballoon Aortic Valvuloplasty

Variables	Results
Age, mean ± SD	77.56 ± 10.09
Society of Thoracic Surgeons risk score, mean ± SD	7.05 ± 3.7
Male, n (%)	49 (59)
Diabetes mellitus, n (%)	24 (28.9)
Hypertension, n (%)	64 (77.1)
Hyperlipidemia, n (%)	50 (60.2)
Prior stroke, n (%)	10 (12.1)
Prior transient ischemic attack, n (%)	4 (4.8)
Length of stay (d), mean ± SD	2.86 ± 3.06
Intensive care unit hours, mean ± SD	65.53 ± 107.12
Ventilation hours, mean ± SD	3.25 ± 1.96
Postoperative kidney injury, n (%)	0 (0)
Re-intubation, n (%)	0 (0)
Major vascular complications, n (%)	0 (0)
Postoperative infections, n (%)	0 (0)
In-hospital strokes, n (%)	0 (0)
30-day strokes, n (%)	1 (1.2)
In-hospital deaths, n (%)	0 (0)
30-Day deaths, n (%)	3 (3.6)
30-Day readmission	0 (0)

SD, standard deviation.

transesophageal echocardiography scans, 95.2% (79/83) of the patients had no PVL; 3 (3.6%) patients had trace PLV; and 1 (1.2%) patient had mild PVL (Table P100-1). Kaplan-Meier survival analysis showed a 92% survival rate at 30 days and 90% at 12 months.

Conclusions: TAVR without BAVP using the SAPIEN 3 valve is safe and effective. The rates of postoperative strokes and perivalvular leak rates are low and should be followed in a larger study.

P101
Surgical Aortic Valve Replacement Wins the Hearts of Intermediate- and Low-Risk Patients for the Transcatheter Approach in a 3-Year Outcome Study

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Objective: Transcatheter aortic valve replacement (TAVR) is a novel therapy for inoperable and high-risk patients with severe aortic stenosis. Long-term data comparing the operative procedure and TAVR in intermediate-risk patients continue to undergo investigation. We sought to present a compilation of data addressing 3-year outcomes between the 2 interventions in intermediate and low-risk patients.

Methods: We performed a literature search to identify randomized or observational, propensity-matched studies comparing the survival of intermediate- and low-risk patients undergoing TAVR or surgical aortic valve replacement (SAVR) for severe aortic stenosis. Intermediate risk and low risk were defined by either a Society of Thoracic Surgeons score ≤8%, a EuroSCORE ≤20%, or a EuroSCORE II ≤10%. Primary end points included 1-, 2-, and 3-year survival rates. Secondary end points included strokes, transient ischemic attacks, major vascular complications, permanent pacemaker implantations, life-threatening bleeding, acute kidney injury, and atrial fibrillation.

Results: After exclusions were identified, 5 studies were used to present 1- and 2-year data, and 2 studies were used for 3-year data. One-year and 2-year survival rates were similar for the 2 therapies [OR (95% CI): 0.84 (0.70, 1.02) for 1 year and 0.79 (0.52, 1.21) for 2 years]. The 3-year survival rate was statistically significant in favor of SAVR compared to TAVR [OR (95% CI): 0.56 (0.42–0.76)] (Fig. P101-1). TAVR presented with more major vascular complications [OR (95% CI): 7.50 (1.81–31.03)], permanent pacemaker implantation [OR (95% CI): 3.49 (1.65–7.38)], and moderate-severe aortic regurgitation [OR (95% CI): 8.15 (4.04–16.42)]. SAVR presented with more life-threatening bleeds [OR (95% CI): 0.36 (0.17–0.78)], acute kidney injury [OR (95% CI): 0.51 (0.33–0.79)], and atrial fibrillation [OR (95% CI): 0.35 (0.20–0.60)]. Stroke and transient ischemic attacks were similar between the 2 groups.

Conclusions: SAVR is associated with a better long-term survival rate than TAVR for intermediate- and low-risk patients. One- and 2-year survival rates are similar between the 2 interventions, but SAVR has a statistically significant increased survival rate. Improvements in factors affecting transcatheter longevity are necessary to meet the standards of the surgical approach.

P102
Transcatheter Aortic Valve Replacement Is More Effective Than Surgical Aortic Valve Replacement in Decreasing an Aortic Valve Gradient

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Objective: We investigated the effect of transcatheter aortic valve replacement (TAVR) and surgical aortic valve replacement (SAVR) on aortic valve gradient (AG) among inoperable and operable patients with aortic stenosis.

Methods: From March 2012 to September 2015, 563 consecutive patients underwent TAVR (419 patients) or isolated SAVR (144 patients).

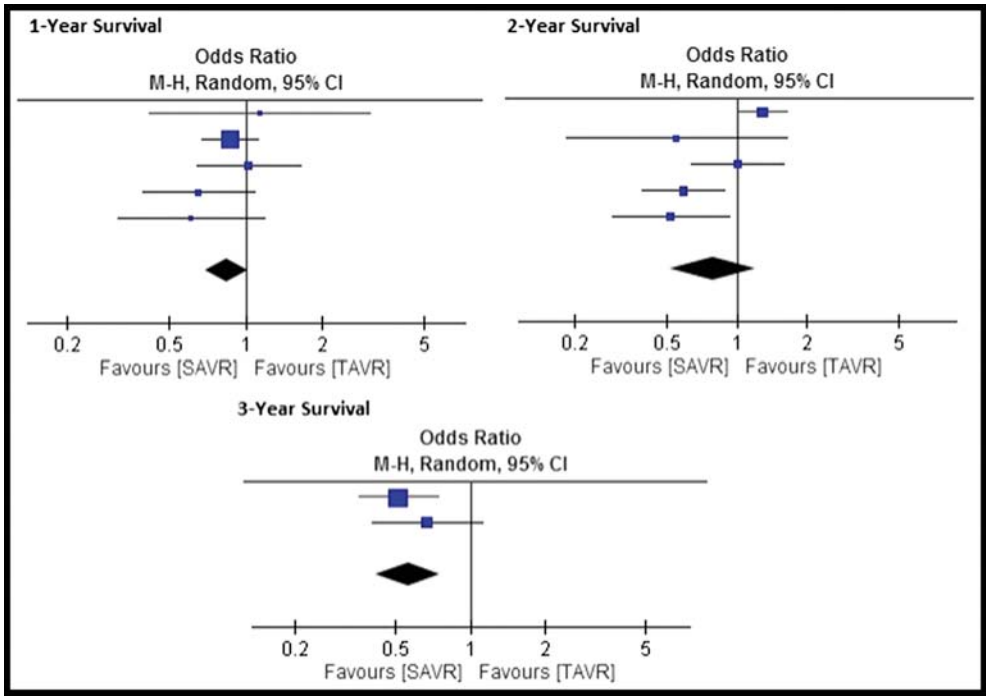

FIGURE P101-1. 1-, 2-, and 3-year survival rates for transcatheter aortic valve replacement compared with surgical aortic valve replacement.

The postoperative AG was evaluated with echocardiography (within 30 days). The American Heart Association/American College of Cardiology definitions include: mild (<20 mmHg), moderate (20–40 mmHg), and severe (>40 mmHg) mean AG.

Results: Of 563 patients, 463 (82.2%) (TAVR, n = 381 and SAVR, n = 82) had both preoperative and postoperative AG measurements. One hundred seventeen (30.7%) patients in the TAVR group and 54 (65.9%) patients in the SAVR group underwent replacement with valve size ≤23 mm. The TAVR patients were significantly older and had more preoperative comorbidities than the SAVR patients (Table P102-1), but the mean preoperative AG and mean aortic valve area were not significantly different between the 2 groups (Table P102-1). The AG decreased significantly in both the TAVR (42.0 ± 15.3 vs. 7.7 ± 5.4, $P < 0.001$) and the SAVR (40.0 ± 16.1 vs. 14.2 ± 8.2, $P < 0.001$) groups after the operation. However, the postoperative AG was significantly lower in the TAVR group than in the SAVR group (Table P102-1). Before the operation, there was no difference in moderate or severe AG between the TAVR and the SAVR (Table P102-1) groups; however, more SAVR patients had residual moderate or severe AG than those in the TAVR group postoperatively (Table P102-1). Importantly, we found that patients who underwent SAVR with valve size ≤23 mm were 3 times more likely to have greater than mild AG after the operation compared with the TAVR patients who had surgery with valve size ≤23 mm, (OR: 3.1, 95% CI: 1.1–8.9). This association was not applicable for patients who had an operation with valve size >23 mm. A change in AG was not associated with any other variable.

Conclusions: TAVR was more effective than SAVR in decreasing AG independent of patients' baseline characteristics, especially in patients receiving a valve size ≤23 mm.

TABLE P102-1. Patients' Baseline Characteristics and Study Outcomes

Variable	TAVR	SAVR	*P*-Value
Patients, n (%)	381 (82.28)	82 (17.71)	–
Patients with valve size ≤23 mm	117 (30.70)	54 (65.85)	–
Male, n (%)	207 (54.33)	58 (70.73)	0.009
Age, y, mean ± SD	79.43 ± 8.66	65.09 ± 12.01	<0.001
Preoperative AG (mmHg)	42.02 ± 15.33	40.03 ± 16.05	0.308
Smallest aortic area (cm^2) mean ± SD	0.67 ± 0.23	0.72 ± 0.21	0.124
Peripheral artery disease, n (%)	61 (16.01)	3 (3.65)	0.002
Hypertension, n (%)	320 (83.98)	55 (67.07)	0.001
Diabetes mellitus, n (%)	143 (37.53)	23 (28.04)	0.127
Myocardial infarction, n (%)	104 (27.29)	8 (9.75)	0.001
Heart failure, n (%)	251 (65.87)	33 (40.24)	<0.001
Stroke, n (%)	66 (17.3)	9 (10.97)	0.187
Preoperative moderate/severe AG, n (%)	356 (93.43)	74 (90.24)	0.342
Postoperative AG (mmHg), mean ± SD	7.74 ± 5.39	14.27 ± 8.16	<0.001
AG valve size ≤23 mm	9.39 ± 6.64	16.25 ± 9.12	<0.001
AG valve size >23 mm	7.0 ± 4.57	10.57 ± 3.64	<0.001
Postoperative mild AG, n (%)	371 (97.37)	73 (89.02)	0.002
Postoperative moderate/severe AG, n (%)	10 (2.62)	9 (10.97)	0.002

AG, aortic valve gradient.

P103
Current Transcatheter Aortic Valve Implantation of Heart Valve Prostheses: The Kiel Experience With the Transaortic and Transfemoral Approaches

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Objective: Transcatheter aortic valve implantation (TAVI) has evolved as an important therapeutic option for symptomatic aortic stenosis. Since its introduction in 2012, the transaortic approach has developed as the standard surgical approach at our center. Our goal was to present our experiences with the transaortic (TAo) and the transfemoral (TF) approaches using 2 current TAVI prosthesis types, the SAPIEN 3 (S3, Edwards Lifesciences Corp, Irvine, CA USA) and the CoreValve Evolut-R (ER; Medtronic, Inc., Minneapolis, MN USA).

Methods: After informed consent, all TAVI patients were included in a prospective registry. Baseline demographics and medical histories were collected. Periprocedural parameters were documented. Patients were followed up at 7 days, 30 days, and annually thereafter. Valve performance was evaluated with transthoracic echocardiography (TTE). The current Valve Academic Research Consortium-2 criteria were applied.

Results: Between February 2014 and September 2016, a total of 462 patients had a TAVI procedure using the TF or the TAo access. The S3 was used in 73.8% (341) and the ER in 26.2% (121) cases. In 67.7% (313), TF access was chosen and in 32.3% (149) TAo access was chosen for TAVI implantation. The mean age at implantation was 81 ± 7 years in the S3 and 82 ± 6 years in the ER group. The S3 group included more male patients (46% vs. 30.6%, $P = 0.0037$). The preoperative EuroSCORE II was 7.16 ± 6.23 (S3) and 7.21 ± 6.33 (ER), (P = n.s.) and further cardiovascular baseline characteristics were comparable. The TTE performed on postoperative day 7 revealed no paravalvular leakage (PVL) in more patients with the S3 valve (74.5% vs. 37.2%, $P < 0.001$). Likewise, mild PVL was less frequent in the S3 group (15.5% vs. 47.1%, $P < 0.001$) as was moderate PVL (0.3% vs. 4.1%, P = n.s.). Severe PVL occurred in only 1 case (ER, 0.8%). The rate of required permanent pacemaker implantations was comparable at 13.8% (S3; n = 39) vs. 13.2% (ER, n = 14), (P = n.s.). Life-threatening bleeding according to VARC-2 criteria occurred in 2.9% of the TF group and in 4.7% of the ER group (P = n.s.). The 30-day mortality rate was acceptably low at 6.5% (S3, n = 22) and 4.1% (ER, n = 5), (P = n.s.).

Conclusions: Our initial results with the current TAVI valves using the transfemoral or transaortic approach indicated that the occurrence of paravalvular leakages was more likely in the ER group, whereas the rate of permanent pacemakers and the 30-day mortality rates were similar with both groups.

P104
Predictors of 1-Year Mortality Rates After Transcatheter Aortic Valve Replacement: Role of Albumin and the MELD Score

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Objective: Transcatheter aortic valve replacement (TAVR) outcomes have improved, and, as we look to the low-risk patient population, we must be mindful of patient selection. It is well known that existing metrics such as the Society of Thoracic Surgeons (STS) risk score and the EuroSCORE do not accurately predict outcomes after TAVR; therefore, new risk models have been proposed.

Methods: A single-center transcatheter valve therapy database was queried between January 2012 and December 2015 to identify patients undergoing TAVR procedures. Creatinine and bilirubin levels and international normalized ratio scores were used to generate Model for End-stage Liver Disease (MELD) scores. A multivariate logistic regression model was generated to identify preoperative factors associated with the 1-year mortality rate. The multivariate model included factors such as age, serum albumin level, MELD score, preprocedure hemoglobin level, sex, body mass index, long-term use of home oxygen, previous myocardial infarction, diabetes, and prior aortic valve replacement.
Results: There were a total of 231 nonresearch patients included in the study, of which 21 (9%) had died at 1 year. The median age was 81 years; 44% were women. The median STS 30-day mortality risk was 9.2% and the median Kansas City Cardiomyopathy Questionnaire score was 40. The multivariate logistic regression model (C-statistic, −0.71) showed that a lower (<3.2) serum albumin level (OR = 0.36, CI = 0.14–0.94, P = 0.03) and a higher (>14) MELD score (OR = 1.09, CI = 1.01–1.19, P = 0.03) at the time of TAVR were independent predictors of the 1-year mortality rate (Table P104-1). Age, preprocedure hemoglobin level, sex, body mass index, home oxygen use, previous myocardial infarction, diabetes, and prior aortic valve replacement were not significantly associated with the 1-year mortality rate.
Conclusions: In a single-center cohort of high-risk patients undergoing TAVR, serum albumin level and MELD score are independent predictors of the 1-year mortality rate. A study using a larger cohort to validate risk using albumin levels and MELD score can be beneficial, in addition to the STS risk score, in predicting outcomes of patients who have TAVR.

TABLE P104-1. Multivariate Logistic Regression Model for the 1-Year Post TAVR Mortality Rate

Effect	Odds Ratio	95% Confidence Limits	
Age	0.972	0.925	1.021
Serum albumin	0.368	0.142	0.949
MELD score	1.095	1.005	1.192
Preprocedure Hgb	1.272	0.951	1.703
Sex female vs. male	0.657	0.224	1.924
Body mass index	1.032	0.956	1.114
Home O_2 (no vs. yes)	1.127	0.289	4.388
Prior myocardial infarction	0.978	0.352	2.721
Diabetes (no vs. yes)	1.495	0.517	4.319
Prior AVR (no vs. yes)	1.579	0.404	6.173

AVR, aortic valve replacement; Hgb, hemoglobin; MELD, Model for End-Stage Liver Disease.

P105
MitraClip Implantation in a Surgical Department as a First-Line Treatment Alternative To Implantation of an Assist Device

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Objective: MitraClip implantation has become a widely accepted alternative treatment option for patients with severe mitral valve regurgitation and a high-calculated perioperative risk. In this study, we assessed the value of MitraClip interventions in a high-risk surgical patient population with heart failure, evaluated for heart transplantation or implantation of an assist device.
Methods: Between December 2014 and July 2016, 49 patients underwent MitraClip implantation in our surgical department. The patients had high-calculated perioperative risks and functional mitral valve insufficiency with severely decreased left ventricular function. Retrospective data analysis of the prospectively collected data was performed.
Results: The mean age of the patients was 66 ± 7 years; 61% were men. All patients were at least New York Heart Association level II. The mean logistic EuroSCORE was 26 ± 17%, the mean EuroSCORE II was 10 ± 8%, and the mean Society of Thoracic Surgeons Predicted Risk of Mortality score was 4 ± 4%. The mean left ventricular ejection fraction was 27 ± 12%. The mean left ventricular end diastolic diameter was 57 ± 10 mm. The mean sphericity index of the left ventricle was 0.8 ± 0.2. The mean procedure time was 122 ± 46 minutes. Most patients (33) had 2 clips implanted.Reduction of functional mitral valve insufficiency of at least 2 grades could be achieved in all patients. One patient had a major complication (pericardial effusion), and 1 patient died within 30 days. Six additional patients died during the follow-up period. Four patients (8%) had implantation of a left ventricular assist device. One patient died 1 and a half years after the MitraClip procedure, and 3 patients died within 6 months after the implantation. The estimated Kaplan-Meier survival at 1 year was 72.5%.
Conclusions: MitraClip implantation in patients evaluated for assist device implantation or a heart transplant is a safe alternative option for potential bridging. The future challenge will be to define independent predictors to identify nonresponders.

P106
Mitral Valve Replacement After Failed MitraClip Intervention

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Objective: Edge-to-edge repair of mitral valve regurgitation (MR) is increasingly performed by percutaneous MitraClip (Abbott Vascular, Santa Clara, CA USA) implantations. Although residual MR grade 2+ is common after implantation, only limited data are available for those cases that require surgical revision. Our goal was to report procedural outcomes from 19 patients after failed MitraClip implantation.
Methods: Between 2011 and 2016, 19 patients (74 ± 9 years; 42.1% men) underwent surgical revision at a median of 54 days (range, 1–1496 days) after MitraClip implantation. All patients with a mean EuroSCORE of 17.1 (1.9–81.6) were deemed high-surgical risk. The etiology of the MR was dilated cardiomyopathy (n = 4), ischemic cardiomyopathy (n = 8), dilated and ischemic cardiomyopathy (n = 1), or other disease (n = 6); a mean of 2.1 MitraClip devices were implanted. Primary indications for an operation were severe MR (n = 16), clip detachment or failed procedural success (n = 16), or endocarditis (n = 3).
Results: All patients had mitral valve replacement by full sternotomy (n = 14) or right-lateral minithoracotomy (n = 5). Additional procedures included closure of an iatrogenic atrial septal defect (n = 7), tricuspid valve repair (n = 4), atrial fibrillation ablation (n = 3), aortic valve replacement (n = 1), and left atrial appendage closure. The 30-day mortality rate was 26.3%. Modes of deaths included cardiogenic shock, liver and renal failure, and sepsis. Non-survivors had a higher preoperative surgical risk (EuroSCORE 41.9 vs. 8.2), underwent surgery on an emergent basis (71.8 vs. 7.0), and had septic and cardiogenic shock.
Conclusions: Surgical revision of a failed MitraClip implantation is feasible and provides a viable option for this high-risk patient group.

Because bailout operations are less likely to succeed, we recommend individual risk assessment of MitraClip candidates by heart teams only. Patients with risk factors for unsuccessful MitraClip implantation should be sent to institutions with an ongoing heart surgery program.

P107
Acute Heart Failure at the Time of TAVR Does Not Increase the Mortality Rate

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Objective: Patients presenting for transcatheter aortic valve replacement (TAVR) are often in acute or chronic heart failure, as indicated by an elevated proBNP level. Many believe an elevated proBNP level is an indication to treat medically, reserving an operative procedure until the patient is medically optimized.
Methods: A single-center transcatheter heart valve therapy database was queried from December 2015 to November 2016 to identify patients undergoing TAVR. Patients were divided into 2 cohorts based on preoperative proBNP levels. Patients in cohort 1 had proBNP ≤ 3000 pg/mL and patients in cohort 2 had proBNP >3000 pg/mL. An analysis was then conducted to assess outcomes such as length of stay in the intensive care unit, total length of in-hospital stay, discharge to home, and the mortality rate at 30 days.
Results: There were 142 patients (median age: 80 years; 44% women) with preoperative proBNP data included in the final dataset (range, 106–73,500 pg/mL). The mean Society of Thoracic Surgeons risk was 8%; the albumin level was 3.5 ± 0.6 mg%. There were 46 patients (32%) with proBNP levels >3000 pg/mL. A ProBNP level >3000 pg/mL was associated only with increased length of stay in the intensive care unit (35% vs. 9%, $P = 0.0001$). There was no statistical difference between cohorts in regard to total length of stay (24% vs. 15%, $P = 0.2$), discharge home (74% vs. 83%, $P = 0.3$), and death at 30 days (2.1% vs. 2.1%, $P = 0.6$) (Fig. P107-1).
Conclusions: TAVR is an effective treatment for patients presenting with acute or chronic heart failure. Specifically, TAVR is appropriate and effective for patients with high levels of proBNP and is associated with statistically similar lengths of stay and mortality rates at 30 days.

P108
Transcatheter Aortic Valve Implantation Is Feasible and Safe in High-Risk Patients With a Sigmoid Septum

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Objective: Severe aortic stenosis (AS) is frequently associated with a sigmoid septum, for which transcatheter aortic valve implantation (TAVI) is reportedly technically challenging; also, the therapeutic efficacy of TAVI might be limited due to the remaining pressure gradient in the left ventricular outflow tract (LVOT) after the procedure. In contrast, we have performed TAVI for this disease by pin-point deployment of the prosthesis in the annulus. Our goal was to review the clinical outcomes of our series of cases who had TAVI for AS with LVOT stenosis.
Methods: Among a consecutive series of 200 patients having TAVI in our institute in the last 5 years, 91 patients (46%) who were preoperatively diagnosed by computed tomography and echocardiography studies as having a structural LVOT stenosis with a pressure gradient, were designated as the study cohort. The Society of Thoracic Surgeons Predicted Risk of Mortality score of the cohort was 7.3 ± 3.2%. Echocardiographically, the peak jet velocity across the aortic valve was 4.4 ± 0.6 m/s, whereas the peak flow velocity across the LVOT was 1.1 ± 0.4 m/s.
Results: TAVI was successfully performed in all cases with no in-hospital deaths, no severe morbidities, and a moderate degree of paravalvular leak postoperatively, via the transfemoral approach in 55 patients (60%), the transapical approach in 21 patients (23%), or the transaortic approach in 15 patients (16%) using a balloon-expandable device in 64 patients (70%) or a self-expandable device in 27 patients (30%).

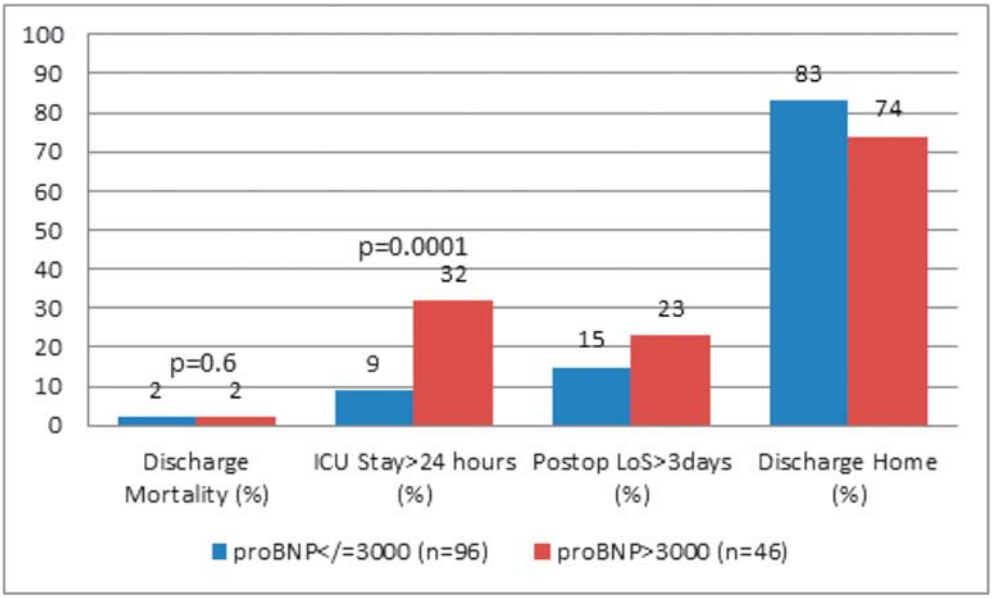

FIGURE P107-1. Assessment of outcomes based on preoperative proBNP levels. No difference in the number of deaths at 30 days but a statistically significant increase in hours in the intensive care unit for patients presenting with proBNP >3000 pg/mL.

As determined postoperatively with echocardiographic scans, the peak velocity across the aortic valve was 2.0 ± 0.4 m/s with a mean gradient of 9.2 ± 3.7 mmHg. Three patients who preoperatively had ≥ 2 m/s peak velocity in the LVOT showed a decrease of the peak velocity in the LVOT (1.4 ± 0.3 m/s) at 1 week post-TAVI. During the complete postoperative follow-up period of 584 ± 400 days, 8 patients died of sudden death, pulmonary disease, cancer, and cerebral hemorrhage, producing a cumulative overall survival rate of 94% at 1 year and that of 85% at 3 years.

Conclusions: The sigmoid septum did not preclude feasibility, safety, or efficacy of TAVI for severe AS. Further study would be of interest to determine structural and/or functional change or the mechanism of the sigmoid septum after the release of the valvular stenosis.

P109

A Novel Shape-Memory Monofilament Suture for Minimally Invasive Cardiac Surgery

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Objective: Thoracoscopic knot tying can complicate or prolong minimally invasive surgical procedures. A novel shape-memory monofilament suture with the spiral in its tail has been developed to speed up suture fixation during minimally invasive cardiac surgery. The purpose of this study was to evaluate its usefulness and safety in minimally invasive cardiac procedures.

Methods: We installed a needle with a 4–0 monofilament suture composed of a copolymer of polyvinylidene difluoride and hexafluoropropylene to an originally invented jig (Fig. P109-1) and heated it in an oven. By passing the needle into the spiral made at the tail of the suture, a hangman's knot was easily made. For the fundamental experiment, which was to evaluate the effectiveness of the novel shape-memory monofilament suture, 2 surgeons with varying levels of experience tying knots under thoracoscopic guidance within a simulated minimally invasive setting, used both the novel shape-memory suture and the conventional monofilament suture. The elapsed time for knot tying and the tensile strength of each knot were measured. For the clinical experiment, we applied the novel suture in a robot-assisted cardiac surgical procedure and conducted a follow-up survey of complications to determine any flaws in the novel suture.

Results: The mean knot-tying time was significantly shorter with the novel suture than with the conventional suture (114 ± 33 vs. 173 ± 47 seconds, $P < 0.05$). The ultimate tensile strength of each knot was 17.4 N in the novel suture and 16.5 N in the conventional suture. Among the 121 cases treated with robotic-assisted cardiac surgical procedures, there were no complications related to the novel suture, such as suture leakage, bleeding, or infection.

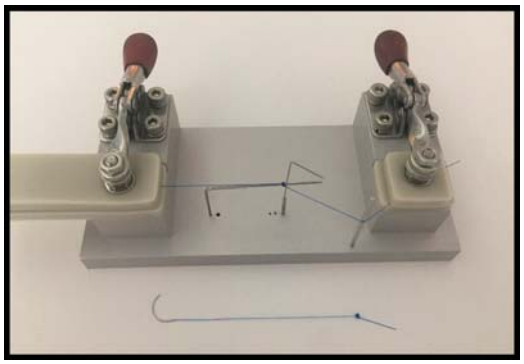

FIGURE P109-1. The novel shape-memory monofilament suture and the jig.

Conclusions: The novel shape-memory monofilament suture has a great potential for speeding up minimally invasive cardiac surgical procedures while retaining the strength of the knot and can be safely used.

P110

A New Approach for Replacement of a Thoracoabdominal Aorta

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Objective: Fenestrated endovascular treatment for the thoracoabdominal aorta still has serious limitations and complications (endoleaks, redo, and rupture). The hybrid approach, a promising option, leaves the aneurysmal sac and is a time-consuming and expensive procedure. A conventional surgical procedure for thoracoabdominal aortic aneurysms, even if associated with a high-mortality rate and neurological and visceral complications, remains the gold standard because it minimizes the risk of visceral ischemia, limits the risk of paraplegia, and avoids the need for circulatory support.

Methods: The modified graft is connected proximally to the left subclavian artery (LSA) and distally to both iliac arteries by shunt branches. The graft body and branches are cross-clamped and blood flows antegradely through the graft and the thoracoabdominal aorta. All visceral branches are revascularized with limited ischemia time while the patent thoracoabdominal aorta perfuses the thoracic and lumbar arteries. Then the aorta is cross-clamped between the LSA and the sixth thoracic artery level. The thoracic arteries are ligated, and an anastomosis is performed between the graft and the aortic neck while the shunts perfuse the critical area of the supraceliac aorta. The cross-clamp is moved to the infrarenal aorta. The LSA shunt branch is interrupted and sutured to the critical area ("cobra-head technique"). During this step, the lumbar and limb arteries are perfused by shunts. The origin of the iliac arteries is clamped above the shunt branches. The abdominal aorta is opened, and the lumbar arteries are ligated by an end-to-end anastomosis between the graft and the distal abdominal aorta while the limbs are perfused by shunt branches. Finally, the distal shunt branches are also ligated.

Results: We conducted an experimental study on 5 pigs who had a thoracoabdominal aorta replacement with a modified vascular shunt graft. We achieved technical success in 3 pigs.

Conclusions: Despite our encouraging results, more cases are needed to obtain more data about the value of this procedure.

P111

A New Device for Aortic Arch Replacement: A Work in Progress

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Objective: Conventional surgical procedures for aortic arch aneurysms are still hampered by high rates of mortality and neurological complications. Alternative endovascular options are not suitable. The hybrid approach, consisting of the primary revascularization of epiaortic vessels

followed by endovascular stent grafting, is a promising option; nevertheless, this hybrid approach leaves the aneurysmal sac with an increased risk of endoleaks, sealing, and infection and is a time-consuming, expensive procedure. Our aim was to treat aortic arch aneurysms in one-step using an open approach with no aortic cross-clamping, no cardiopulmonary bypass, and selective cerebral perfusion and to resect the aneurysmal sac.

Methods: The prosthesis comprised a main body with proximal and distal stent tips and 3 side stent branches. Previous purse-string-packaging on the aorta and the epiaortic vessels and the deployment of the prosthesis to open the 3 side-branch grafts and the proximal and distal stent zones, should be quick, either in rapid succession or preferably simultaneously.

Results: The prosthesis was granted an international patent and was approved by the Ministry of Health for use in animals. Ten pigs were treated: 8 had aortic arch replacement and 2 had abdominal aortic replacement.

Conclusions: This concept appears feasible, given the relatively successful bench deployment of this first prototype. The requirement for stability and orthogonal deployment of the proximal stent in the ascending aorta must be considered. The peel-away sheath concept appears the most promising option and should be considered further, in conjunction with a deployment method that can be used by one person.

P112

No Deep Hypothermic Circulatory Arrest in Aortic Arch Surgery with Antegrade Transfemoral Perfusion

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Objective: Standard arterial cannulation for cardiopulmonary bypass is achieved through the ascending aorta. When aneurysms or dissections involve the ascending aorta and render the vessel fragile and unstable with of the risk of rupture, the femoral artery is preferred for cannulation. This cannulation, though, inverts the flow in the thoracoabdominal aorta from antegrade to retrograde, leading to possible thrombus displacement toward the epiaortic vessels and subsequent strokes. For this reason, femoral cannulation is often replaced by right subclavian/axillary artery cannulation, because the latter allows an antegrade flow. However, this latter solution does not allow thoracoabdominal perfusion during the aortic arch procedures, making deep hypothermic circulatory arrest mandatory. We designed a new cannula in order to achieve antegrade flow in the aortic arch and in the thoracoabdominal aorta and to avoid deep hypothermic circulatory arrest.

Methods: The cannula is 70 cm or longer, with an inflatable balloon at the distal portion and with tip holes, a main central hole, and at least 4 to 6 side holes to ensure a flow rate of 4 to 5 liters/minutes. The deployment of the cannula is achieved in a two-step operation: In the first step, the cannula is introduced over a stiff guidewire through the femoral artery; its distal longitudinal end is positioned inside the aortic arch, whereby the cannula allows cardiopulmonary bypass with anterograde blood flow into the aortic arch and the thoracoabdominal aorta (antegrade cardiopulmonary bypass, ARMY). In the second step, the same cannula moves under the left subclavian artery and, after the balloon is inflated, the aortic arch can be opened: At this time, the perfusion of the aortic vessels is guaranteed by Kazui cannulation (selective antegrade thoracoabdominal perfusion, "STONE").

Results: The patent application has been filed, so there are no results to report at this time.

Conclusions: This new cannula could enable antegrade flow throughout the entire thoracic aorta (ARMY) and perfusion of the thoracoabdominal aorta (STONE) without deep hypothermic circulatory arrest. In this way, we could decrease the risk of bleeding, pulmonary complications, and visceral and/or limb ischemia and contain the risk of paraplegia.

P113

Histological Analysis of Radial Artery Grafts Following Endoscopic Harvesting With an Impedance-Controlled Vessel-Sealing System

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Objective: Endoscopic radial artery harvesting (ERAH) leads to a reduced incidence of wound complications and improved recovery. Nevertheless, there are concerns due to potential conduit damage occurring during the use of a minimally invasive approach. We investigated the histological features of radial artery grafts following ERAH with a nonsealed approach.

Methods: Twenty consecutive patients undergoing coronary artery bypass grafting with a radial artery were included in the study. ERAH was performed in all cases with a nonsealed approach, thus combining a reusable retractor and an impedance-controlled bipolar radiofrequency vessel-sealing system. Samples from harvested radial arteries were immediately collected and fixed with 6% neutral formalin and then embedded in paraffin. Histological evaluation was performed through optical microscopy and staining by hematoxylin and eosin and acid orcein in order to evaluate potential damage occurring in the arterial wall.

Results: The mean age was 65.12 ± 11.29 years; 20% (4/20) of the patients were women.Four patients (20%) had diabetes and 5 (25%) had peripheral artery disease. ERAH was successfully performed in all cases, and no conversions to the open approach were required; the mean harvesting time was 37.5 ± 5 minutes. No postoperative complications at the harvest site (such as bleeding, wound infection, or tunnel hematoma) occurred in the current series. No macroscopic damage could be visually detected. At histological evaluation, no apoptotic signs of the nuclei of endothelial cells stained with hematoxylin and eosin could be identified as a consequence of thermal injury. Furthermore, no significant endothelial loss or damage to the internal elastic lamina could be observed. Finally, no significant margination of white blood cells secondary to an inflammatory response was noted.

Conclusions: ERAH by means of a nonsealed approach with an impedance-controlled bipolar radiofrequency vessel sealing system is a safe and feasible procedure, with negligible damage to the harvested conduits at histological analysis. In particular, histological integrity and the advantages of the endoscopic procedure should encourage the use of this approach as the first choice in radial artery harvesting.

P114

Minimally Invasive Replacement of the Pulmonary Valve: Histological Effects of Nonorthotropical Placement of the Valve-Carrying Stent

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Objective: The minimally invasive replacement of heart valves is done with increasing frequency in daily clinical practice. The experimental percutaneous, transluminal replacement of the pulmonary valve with a tissue-engineered heart valve carried in a nitinol stent is the focus of our recent research. Due to the size of the stent and the fact that, once it is placed, the position of the stent is not correctable, the position may be nonorthotopic. Our goal was to explore the consequences of such an incorrect position.
Methods: We implanted pulmonary valve stents in sheep: 5 were placed correctly and 5 were put in a nonorthotopic position after placement. After 3 to 6 months, the animals were sacrificed, and the histological architecture and amount of collagen were analyzed and evaluated using the Movat Pentachrome stain and van Gieson and immunhistochemical staining of collagen I and III. With the aid of native valves, a classification for the amount of collagen, the quantity of cells and the development of the architecture of the valves was defined.
Results: The layering and the core architecture of the valves were identical in both groups and were, therefore, not modified in response to the nonorthotopic position. However, the amount of collagen III, the most important structural protein in the heart valve, was lower in the valves that were placed incorrectly than in those placed correctly. In addition, the number of cells was much higher in the valves placed nonorthotopically than in the valves that were placed correctly.
Conclusions: At first, the tissue-engineered heart valves seemed to develop normally in their layering even if the conditions were not ideal. But the underdevelopment of collagen III and the higher number of cells, as we see in hyperplasic or inflamed tissues, seemed to be a result of the incorrect placement of the valve. The incorrect placement of a valve-carrying stent, therefore, not only affects the hemodynamics, but also affects the development of the histological structure of the valve. In conclusion, the correct positioning of the stent is very important for the outcome of the replacement and should be improved to guarantee good outcomes in our future patients.

P115
Clinical Experience With New Wall-Less Cannulas

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Objective: Inadequate venous drainage during minimally invasive cardiac surgery is a major challenge and cannot always be solved with increased vacuum levels or centrifugal pump speed. The present study was designed to assess the benefit of virtually *wall-less* venous cannulas designed for remote venous cannulation in combination with augmented venous drainage.
Methods: Transfemoral venous cannulation with virtually *wall-less* cannulas designed for augmented venous drainage (3/8" 24F 530–630 mm ST) was studied in 10 consecutive patients (59 + 10 years, 8 men, 2 women) undergoing minimally invasive cardiac surgery for mitral (6), aortic (3), and other (4) procedures (combinations possible). Prior to the transfemoral insertion of *wall-less* venous cannulas, a guidewire was positioned in the superior vena cava under echocardiographic control. A *wall-less* cannula was then fed over the wire and connected to a minimal extracorporeal system in combination with a sealed hard-shell venous reservoir. Vacuum assist was used to reach a target flow of 2.4 L/minutes m^2 with augmented venous drainage of less than −80 mmHg.
Results: *Wall-less* venous cannulas measuring either 630 mm (n = 8) or 530 mm (n = 2) in length were implanted successfully in all patients. For a body size of 173 + 11 cm and a body weight of 78 + 26 kg, the calculated body surface area was 1.94 + 0.32 m^2. As a result, the estimated target flow was 4.66 + 0.78 L/minutes, whereas the achieved flow accounted for 4.98 + 0.69 L/minutes (107% of target) at a vacuum level of 21.3 + 16.4 mmHg. Excellent exposure and a "dry" intracardiac surgical field resulted.
Conclusions: The performance of virtually *wall-less* venous cannulas designed for augmented venous drainage tested in the clinical setting provided excellent flows at minimal vacuum levels and thus confirmed the performance increase over traditional thin-wall cannulas previously demonstrated in vitro and in vivo. Superior results can be expected for routine use.

P116
Impact of a Newly Designed Retractor for Partial Sternotomy

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Objective: Partial sternotomy has been established as one approach for cardiac surgical procedures. The approach is also useful for aortic procedures. A regular retractor could be used for a partial sternotomy; however, the stress on the sternum with the regular retractor is sometimes excessive, and the retractor damages the sternum. At the same time, a protective retractor is too bulky for the short skin incision. Our goal was to present a newly developed sternal retractor.
Methods: Since 2013, more than 70 patients underwent aortic root surgery or aortic arch surgery through a partial sternotomy. Original Dubost blades (Delacroix-Chevalier, Paris, France) were used for the partial sternotomy initially; however, the opening in the skin was limited. The Finochietto retractor (Scanlan, St. Paul, MN USA) had less of a limitation for the skin opening, but often caused severe damage to the lower plate of the sternum. The newly designed blades had an isthmus, which permits wider opening of the skin incision (Fig. P116-1).
Results: The skin incision was 15 cm at the beginning; however, it could be safely shortened to 7 cm. More than 20 patients had an aortic root operation or aortic arch operation with the retractor.

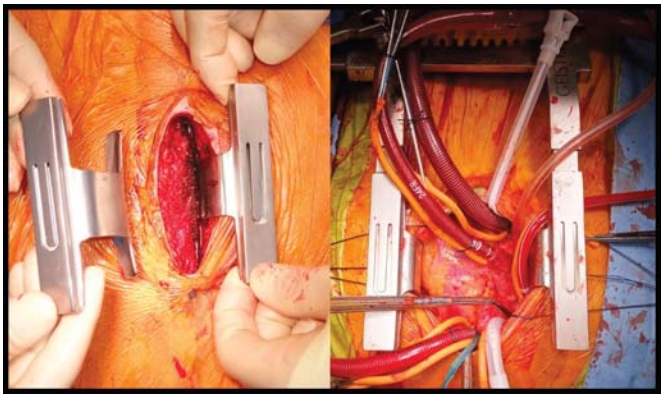

FIGURE P116-1. The newly designed retractor and its degree of exposure.

Conclusions: All operations through the partial sternotomy were performed safely under fine exposure. Our newly developed retractor makes the aortic root and aortic arch procedures safer and permits a shorter skin incision.

P117
A New Portable Computerized Minimally Invasive Aortic Valve Replacement Training Simulator

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Objective: Mastering a complex surgical procedure requires extensive training. Developing the techniques and skills for minimally invasive aortic valve replacement can be prohibitively inconvenient for busy cardiac surgeons. A self-contained comprehensive training simulator platform may optimize the limited time available for both surgeons and their staff, while enabling technique refinement outside of the clinical setting.

Methods: A computerized training system was developed to simulate the "hands-on" surgical setting of a minithoracotomy aortic valve replacement (Fig. P117-1). This portable, comprehensive simulator incorporates video image acquisition and display, a realistic plastic anatomical chest wall, and cardiac tissue structures that can be dissected and sutured, along with retractors and other aids to replicate surgical ergonomics. Plastic anatomical model components can be readily replaced for repeat training activities. This simulator enables cardiac surgery training with manual instruments and automated surgical devices to achieve various tasks, which may include cardioplegia catheter placement, aortotomy incision, leaflet removal, annular and sewing cuff suture placement, valve fixation, and aortotomy closure.

Results: This simulator successfully modeled minithoracotomy aortic valve replacement, providing an opportunity to hone skills toward improved surgical proficiency through the use of integrated computerized instructions, authentic tissue models, and appropriate imaging. Annular sutures were placed through the right second intercostal space. Representative prosthetic valves were installed efficiently at the simulated aortic annulus and were reliably secured. The trainees' learning experience mimicked the operating room setting while they developed a more thorough understanding of a minithoracotomy aortic valve replacement.

Conclusions: By providing realistic training, surgical simulators can be used to enhance surgical skills and improve technique knowledge without risk to the patient. This customized minimally invasive aortic valve replacement simulator training platform provides an effective option to potentially reduce the learning curve for minimally invasive aortic valve replacement surgery and to accommodate busy cardiac surgeons.

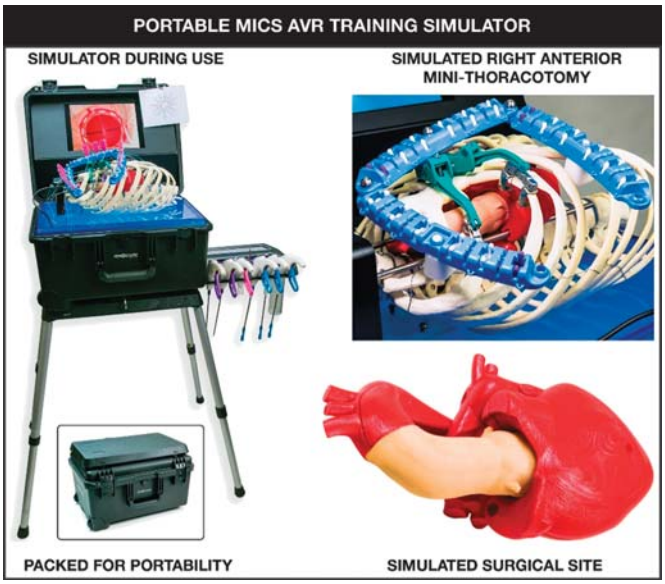

FIGURE P117-1. Portable minimally invasive aortic valve replacement training simulator.

P118
A Controllable Canine Model of Mitral Regurgitation to Study Mechanical and Electrical Remodeling of the Atria

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Objective: Atrial fibrillation (AF) occurs in up to 30% of patients with mitral regurgitation (MR) referred for valve surgical procedures. However, the mechanisms of AF in MR are poorly understood. The purpose of this study was to determine the effects of chronic left atrial (LA) volume overload on atrial anatomy, hemodynamics, and electrophysiology using a ventriculoatrial shunt in a canine model.

Methods: Eleven normal canines underwent implantation of a shunt between the left ventricular (LV) apex and the LA appendage. The shunt fraction was titrated to 40% to 50% of the cardiac output. Eight canines underwent a sham procedure. At baseline and at 6 months, an epicardial plaque with 250 bipolar electrodes was used to determine atrial activation times (AT) and effective refractory periods (ERP) on the LA and right atrium. Biatrial and systemic pressures, aortic and shunt flow, and AF duration and inducibility were recorded at baseline and at 6 months. LA and LV diameters and volumes were determined using transesophageal echocardiography.

Results: There were no differences between the sham and shunt group in any physiological variable measured. The mean shunt fraction was 45 ± 8%. At 6 months, the LA pressure increased from 10.8 ± 3.3 to 13 ± 3.1 mmHg, $P < 0.001$. The LA diameter increased from 2.96 ± 0.1 to 4.13 ± 0.1 cm ($P < 0.001$) and the LV ejection fraction decreased from 65 ± 2 to 54 ± 3% ($P < 0.001$, Fig. P118-1). The induced AF duration was 224 ± 288 seconds compared to 16 ± 17 seconds in the sham group ($P = 0.009$). There was a trend toward longer AT in the shunt group versus the sham group (71 ± 13 vs. 62 ± 3 ms, $P = 0.06$). The average right atrium and LA ERP were shorter in the shunt group compared to the sham group (right atrial ERP: 151 ± 21 vs. 138 ± 14 ms, $P = 0.12$, left atrial ERP: 150 ± 17 vs. 134 ± 1 ms, $P = 0.035$).

Conclusions: This model reproduces the physiological remodeling seen in clinical MR. LA size increased, with a corresponding decrease in LV systolic function. These changes were associated with increased AT, lower ERP, and increased AF inducibility. This model provides a means to understand the dynamic proarrhythmic remodeling by which MR causes AF.

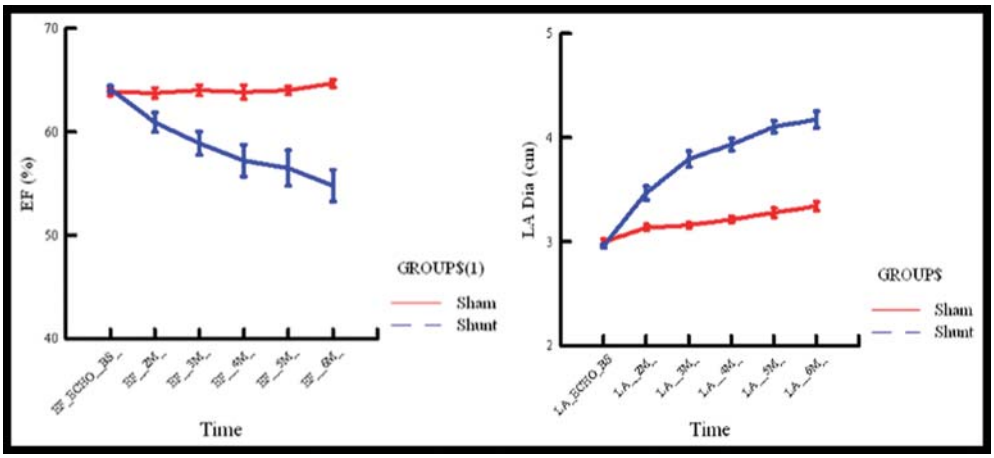

FIGURE P118-1. The left panel shows the change in LV ejection fraction over 6 months in the sham (red) and shunt groups (blue). The right panel shows the change in LA diameter over 6 months in both groups. In both panels the sham and shunt groups are significantly different ($P < 0.001$).

P119
Feasibility of Minimally Invasive Cardiac Surgery Without One-Lung Ventilation

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Objective: Minimally invasive cardiac surgery (MICS) has been more widely adopted to facilitate early recovery. For the right anterior thoracotomy approach, one-lung ventilation using a double-lumen tube (DLT) is required but complications related to the DLT can be considerable. Therefore, we investigated the feasibility and efficacy of a single-lumen endotracheal tube (SLT) during MICS.

Methods: We conducted a retrospective review of the clinical data of 370 patients who underwent MICS via a thoracotomy between August 2009 and March 2016. Patients in whom we used an SLT (n = 167) were compared with those in whom we used a DLT (n = 203). In the SLT group, exposure of the pleural and pericardial spaces was assisted with intermittent lung deflation and low tidal/high frequency ventilation.

Results: The preoperative variables were comparable between the groups except for age (SLT: 56.1 ± 15.1 years vs. DLT: 51.2 ± 16.4 years, $P = 0.003$), emergency [SLT: 12 (7.2%) vs. DLT: 4 (2.0%), $P = 0.019$], and New York Heart Association class IV [SLT: 32 (19.2%) vs. DLT: 20 (9.9%), $P = 0.01$]. There were no differences in postoperative results except duration of mechanical ventilation and the rate of extubation in the operating room (Table P119-1).

Conclusions: Compared with the insertion of a DLT, MICS with SLT provided equivalent clinical results with shorter mechanical ventilation time. MICS procedures with SLT appear to be a feasible alternative to 1-lung ventilation with DLT and may facilitate faster recovery.

TABLE P119-1. Postoperative Results

Overall (N = 370)	Group SLT (n = 167)	Group DLT (n = 203)	*P* Value
Extubation in operating room	119 (71.3%)	76 (37.4%)	<0.001**
Mechanical ventilation hour (IQR)	0 (0–3)	3 (0–4)	<0.001***
Re-intubation within 1 day	4 (2.4%)	5 (2.5%)	1.000****
Drain within 12 hours (ml) (IQR)	217 (152–351)	201 (121–347)	0.063***
Re-exploration for bleeding	4 (2.4%)	3 (1.5%)	0.706****
Incidence of transfusion	46 (27.5%)	60 (29.6%)	0.670**
RBC transfusion (unit) (IQR)	0 (0–3)	0 (0–3)	0.813***
Hospital stay (day)	5 (4–7)	5 (4–7)	0.256***
Early deaths	0	3 (1.5%)	0.255****

*Independent *t* test.
**χ^2 test.
***Mann–Whitney test.
****Fisher exact test.
IQR, interquartile range; RBC, red blood cell.

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Minimally Invasive Transaortic Mitral Decalcification for Extended Aortic Valve Calcifications

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Objective: Extended aortic valve calcifications to the left ventricular outflow tract (LVOT) increase the risk of annulus rupture or paravalvular leak in transcatheter aortic valve replacement. Our goal was to demonstrate the efficacy of transaortic mitral decalcification (TMD) during minimally invasive aortic valve replacement (MIAVR).

Methods: The extended calcifications to the LVOT were carefully removed with an ultrasonic aspirator prior to MIAVR. From May 2007 to April 2016, 97 patients with aortic stenosis (AS) underwent MIAVR via a right minithoracotomy. Eighteen patients (19%) underwent MIAVR after TMD (TMD group). The perioperative outcomes of these patients were compared with those of the remaining 79 patients who underwent MIAVR without TMD (control group).

Results: In the TMD group, 10 patients (56%) were octogenarians and 4 patients (22%) had mitral stenosis due to extended calcifications. The preoperative peak aortic valve pressure gradient in the TMD group was significantly higher than that in the control group. There were no cases of TMD-related complications such as leaflet perforation, stroke due to fallen debris, and paravalvular leak. The aortic cross-clamping time in the TMD group was significantly longer than that in the control group; however, there were no significant differences between the 2 groups in in-hospital mortality, ventilation time, and length of hospital stay.

Conclusions: Minimally invasive TMD is a safe and secure procedure for the treatment of AS with extended calcifications.