P1
David-V Aortic Valve–Sparing Procedure: Midterm Results

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Objective: Aortic valve–sparing David procedure has gained broad acceptance by avoiding prosthetic valve replacement. One of these procedures, David V, is thought to imitate the natural anatomy of aortic root most similarly. The early and midterm results of our clinic are satisfactory; however, midterm results are uncertain.
Methods: Between April 2009 and December 2015, David-V operation was performed in 43 patients with a mean age of 57.6±13.3 years (24–79 years), and 30 of them (69.8%) were male. Mean pathology was aneurysm in 33 patients, acute aortic dissection in 5 patients, and bicuspid aortic valve in 5 patients. Fifteen patients received additional procedures. Mean follow-up was 37.4±23.1 months.
Results: Hospital mortality rate was 6.9% (two low cardiac output syndrome, one sepsis). Late mortality was 7.5% with three deaths. Reoperation rate was 2.5% with one patient who was reoperated during the early postoperative period because of severe aortic regurgitation. One patient is followed up with moderate (>2) aortic regurgitation, and the others had mild aortic regurgitation. Thirteen patients (81.1%) were in New York Heart Association functional class I, and seven patients (18.9%) were in New York Heart Association class II. Early transient cerebrovascular event was observed in one patient. There was no rhythm problem.
Conclusions: Aortic valve–sparing procedure provides excellent midterm effectiveness with very low risk of late events. Midterm durability of the aortic valve is satisfactory and encourages us to prefer this approach.

P2
Aortic Root Surgery Through Lower Partial Sternotomy

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Objective: Partial sternotomy has been established as one of the approaches for cardiac surgery. The approach, however, is not well established yet for aortic surgery. Recently, upper partial sternotomy has been reported for aortic root replacement. We have applied lower partial sternotomy for aortic root replacement.
Methods: Since 2013, 34 patients (42.2±14.2 years; range, 14–66 years; 17 male patients) underwent aortic root surgery through lower partial sternotomy. The preoperative diagnoses were annuloaortic ectasia in all, and 21 patients showed aortic regurgitation. Nineteen patients had connective tissue disorder including Marfan syndrome. The skin incision was 15 cm at the beginning; however, it is shortened to 7 cm recently.
Results: Skin incision was 9.8±2.5 cm. Valve-sparing root replacement was performed in 31 patients, and composite graft replacement was performed in 3 patients. As concomitant procedures, mitral valve repair was performed in three patients, atrial septal defect closure was performed in one, and Maze procedure was performed in one. Twenty-nine patients had open distal anastomosis, and they all had antegrade or retrograde cerebral perfusion under hypothermia. Cardiopulmonary bypass time was 296±65 minutes, cardiac ischemic time was 247±53 minutes, and lower body circulatory arrest was 19.2±5.8 minutes. There was no hospital mortality. No postoperative cerebral and renal complications were found. One patient had mediastinitis. One patient after valve-sparing root replacement needed reoperation because of graft infection 2 months after the first operation.
Conclusions: All operations through the partial sternotomy were performed safely under fine exposure. Lower partial sternotomy has a more cosmetic benefit (Fig. P2-1). The partial sternotomy could be an excellent option for aortic operations in selected patients.

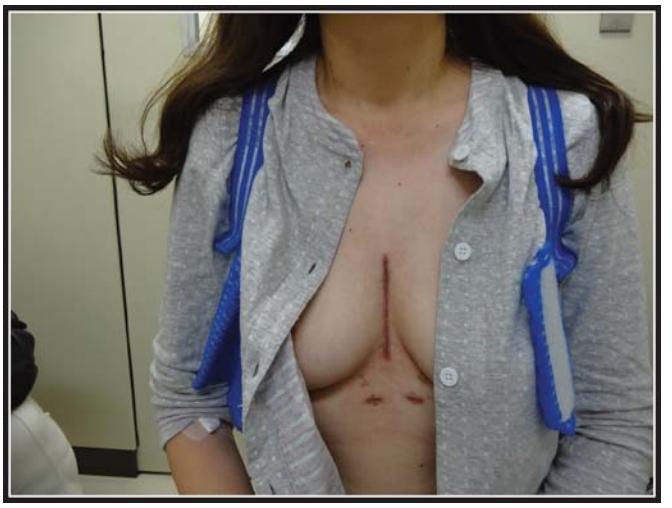

FIGURE P2-1. A 31 year-old woman with Marfan syndrome. Valve-sparing root replacement, MAP, ascending aortic replacement. Incision was 9 cm.

P3
The Florida Sleeve Procedure Improves Aortic Valve Function in Patients With Marfan Syndrome

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Objective: The Florida Sleeve (FS) procedure was developed as a simplified approach for the repair of functional type I aortic insufficiency (AI) secondary to aortic root aneurysm. We evaluated postoperative aortic valve function and long-term survival of patients with Marfan disease who underwent the FS procedure at our center.
Methods: Patients with Marfan syndrome undergoing FS between May 2002 and March 2014 were examined for in-hospital and long-term outcomes. Echocardiographic assessment included left ventricular end-diastolic diameter, left ventricular end-systolic diameter, ejection fraction, and degree of AI (none, 0; minimal, 1; mild, 2; moderate, 3; severe, 4). SSDI was used for long-term follow-up.
Results: Thirty-four patients with Marfan syndrome, 21 (61.8%) male and 13 (38.2%) female, with a mean age of 35.29±13.78 years, had FS repair at our center. There was no in-hospital or 30-day death or stroke (Table P3-1). Two patients required reoperation because of bleeding. One-year and 2-year survival rates were 98%, and 88% at 5 years (Fig. P3-1). Fifteen patients had postoperative follow-up echocardiography at 1 week. Aortic insufficiency grade significantly decreased after the procedure (preoperative mean, 2.13±1.06 vs. 1-week postoperative mean, 0.84±0.89, P=0.020), mean left ventricular end-diastolic diameter decreased from 55.77±7.51 to 50.07±8.36, and mean left ventricular end-systolic diameter decreased from 38.66±8.27 to 35.64±10.57 (P=0.16 and P=0.77, respectively). There was no significant change in ejection fraction (P=0.19). Seven patients with more than 1-year postoperative echocardiographic follow-up showed persistent improvement of AI grade and stable ventricular dimensions.
Conclusions: The FS procedure can be performed safely in patients with Marfan syndrome with immediate improvement in aortic valve function. Long-term survival rate is acceptable, although further follow-up is required.

TABLE P3-1. Preoperative Characteristics and Study Outcome

Preoperative characteristics	
Age, mean±SD, y	35.29±13.78
Male, n (%)	21 (61.8)
Hypertension, n (%)	14 (41.17)
Diabetes, n (%)	2 (5.88)
Prior cerebrovascular attack, n (%)	2 (5.88)
Prior transient ischemic attack, n (%)	1 (2.94)
Prior myocardial infarction, n (%)	0 (0)
Intraoperative and postoperative outcome	
Cardiopulmonary bypass time, mean±SD, min	173.11±69.90
Intensive care unit hours, mean±SD	99±88.67
Ventilation hours, mean±SD	15.59±20.02
Intraoperative blood product transfusion, n (%)	10 (29.41)
In-hospital myocardial infarction, n (%)	0 (0)
In-hospital stroke/transient ischemic attack, n (%)	0 (0)
Length of stay, mean±SD, d	8.7±6.63
In-hospital death, n (%)	0 (0)
Readmission within 30 d, n (%)	4 (11.76)
30-d mortality, n (%)	0 (0)

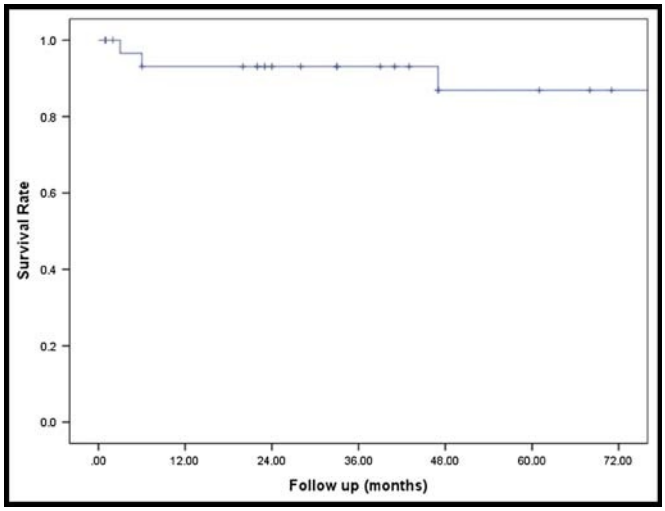

FIGURE P3-1. Survival rate of patients with Marfan syndrome after FS procedure.

P4
Surgical Strategy to Balance Less Invasiveness With Complete Aortic Repair and Less Neurologic and Aorta-Related Complications for Extended Thoracic Aortic Disease Including Aortic Arch

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Objective: Treatment of extended thoracic aortic disease including aortic arch has dramatically progressed since stent grafts were commercially available. To obtain excellent postoperative results, it is important to balance less invasiveness with complete aortic repair and less early and long-term complications.

Methods: From 2007 to 2015, we treated 99 patients who had extended thoracic aortic disease including aortic arch. Regarding our present surgical strategy, total arch replacement (TAR) is the first choice for aortic arch disease, and thoracic endovascular aortic repair (TEVAR) is also the first choice for distal arch and thoracic descending aortic disease to avoid left thoracotomy as much as possible, but left thoracotomy (LT) approach is selected if TEVAR is difficult or even contraindicated. Hybrid approach is indicated in patients whose aortic disease is expanded from aortic arch to thoracic descending aorta, and two-stage operation (LT after TAR) is necessary if TEVAR is not indicated. We evaluated our present surgical strategy.

Results: One-debranching TEVAR was performed in 14 patients, TAR in 46, open stent surgery (OS) in 8, total debranching TEVAR (TDT) in 19 (Bavaria type II, 15), and LT in 12, including four two-stage operations. There was no operative mortality in total, but there was one in-hospital mortality in TAR (rupture case). All patients were extubated in the operation theater in one-debranching TEVAR; 84% of the patients in TDT could be extubated within 24 hours after surgery, 57% in TAR, and 33% in LT; and respiratory support in LT was significantly longer than that in TAR and TDT (P=0.003). No spinal cord injury occurred in TDT, but SPI was more frequent in OS. Endoleak did not occur in TDT and OS except for one patient, whose endoleak disappeared after coiling to the left subclavian artery. Localized aortic dissection was observed perioperatively in one patient in type I TDT, which was treated with ascending aorta replacement. The 3-year freedom from aorta-related complication was 0% in all groups except for OS (two stent graft migrations in OS).

Conclusions: Our surgical strategy with a combination of open repair and TEVAR is effective to balance invasiveness with postoperative outcomes.

P5
Staged Thoracic Endovascular Aortic Repair of Extensive Aortic Arch Aneurysm

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Objective: Extensive aortic arch aneurysms (ascending aorta, aortic arch, and descending aorta) require innovative surgical techniques. We adopted a two-stage procedure, open total arch replacement with elephant trunk as a first stage and thoracic endovascular aortic repair (TEVAR) as a second stage, for elective repair of extensive aortic arch aneurysms. The objective was to evaluate the perioperative and midterm results of staged TEVAR to extensive aortic arch aneurysms.

Methods: Between January 2009 and September 2015, we planned staged TEVAR in 42 patients with a mean age of 70.6 years. Of these, all of the patients were treated with total arch replacement with elephant trunk procedures as first stage. Second stage (TEVAR) was completed in 40 (95.2%) of the 42 patients. Median duration between the two stages was 2 months (range, 0–22 months).

Results: There was no hospital mortality at the first and second stages. Mortality rate during the interval between the first and second stages was 4.9% (2 of 41), of which one patient died 2 months after the first stage and the other 11 months after the first stage operation because of aneurysm rupture. Of the 42 first-stage patients, 1 (2.4%) had stroke. No stroke occurred in the second stage. No spinal cord dysfunction occurred both in the first and second stages. The cumulative survival rates were 100% and 84.8% at 1 and 3 years, respectively. Rates of freedom from aortic related reoperation were 97.0% and 93.6% at 1 and 3 years, respectively.

Conclusions: Extensive aortic aneurysms can be treated with acceptable morbidity and mortality rates through the use of staged TEVAR. After staged TEVAR was performed, patients had acceptable midterm survival.

P6
Four-Branch Elephant Trunk Prosthesis for the Treatment of Type A Aortic Dissection: Midterm Follow-up Advantages

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Objective: Frozen elephant trunk (FET) surgery is a modern treatment modality that should be considered for complex type A aortic dissection (TAAD). Reimplantation of the supra-aortic vessels can be performed by either using a so-called *island technique* (island group) or, individually, using a four-branched FET graft (branched group) (Vascutek, Ltd., Glasgow, Scotland).
Methods: Between July 2011 and December 2015, a total of 56 consecutive patients (mean age, 65.1±10.7 years) underwent FET surgery. Of these, 37 patients were operated on for TAAD and further evaluated for midterm follow-up. In six patients, left common carotid artery (LCCA)–to–left subclavian artery (LSA) bypass was performed, followed by proximal stent graft deployment in zone 2 with overstenting of LSA and single-branched reimplantation of the innominate artery and LCCA. Patients were routinely followed up by computed tomography at 3 months postoperatively and annually thereafter.
Results: There were 15 patients in the island group and 22 in the branched group. Overall, there were seven deaths within 30 days (mortality, 18.9%). Of these, five patients experienced acute aortic rupture. The incidence of cerebral ischemia was 10.8% (n=4). Spinal ischemia was only documented in one patient (2.7%) who had previous thoracic endovascular aortic repair and endovascular aortic repair. There were no statistically significant differences (*P*=nonsignificant) regarding mortality, neurological complications (26% vs. 10%), cerebral perfusion (89±45 vs. 108±42 minutes) and circulatory arrest (93±40 vs. 90±40 minutes) times, transfusion rates (5±3 vs. 4±3 U), and reexplorations for bleeding (3 vs. 2) between the groups. In the island group, follow-up computed tomographic scans revealed a remaining aneurysm of the brachiocephalic trunk in two patients and a false lumen arch aneurysm of the island reimplanted supra-aortic vessels in one patient. The branched group did not show any pathology of the arch or the supra-aortic vessels.
Conclusions: Although early results did not differ among groups, patients being operated on for TAAD using FET surgery might benefit from reimplantation of the supra-aortic vessels using a branched prosthesis to avoid further vascular complications. Overstenting of LSA at zone 2 level combined with LCCA-to-LSA bypass may facilitate the procedure. Larger studies or registries and longer follow-up periods are needed to establish the significance of these reimplantation techniques.

P7
Thoracic Endovascular Aneurysm Repair Versus Open Heart Surgery for Aortic Aneurysm in Octogenarian and Older: Single-Center Experience

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Objective: Recently, the technology of thoracic endovascular aneurysm repair (TEVAR) has been expanding the possibilities of treatment of very elderly people such as octogenarians or nonagenarians who may be hesitant to perform open heart surgery. So, we evaluated the results of TEVAR or open heart surgery for arch or descending or thoracic abdominal aortic aneurysm of very elderly people.
Methods: From May 2005 to November 2015, 256 consecutive patients who had arch or descending or thoracic abdominal aortic aneurysm except for type A aortic dissection were treated in our hospital. Of these, we retrospectively reviewed 59 patients in octogenarians or nonagenarians and compared 34 cases (SG group) that were treated by TEVAR with 25 cases (OS group) that were treated by open heart surgery.
Results: The average age was 83.7±3.0 years (80–91 years). Among the two groups, there were no significant differences regarding background such as sex, age, and emergency rate as well as medical history such as hypertension, diabetes, renal dysfunction, and chronic obstructive pulmonary disease. The SG group demonstrated significantly shorter respiratory management (*P*=0.005), low rate of tracheotomy (*P*<0.001), less postoperative cerebral infarction (*P*=0.002), and shorter postoperative days (*P*=0.047). Occurrence of paraplegia, additional treatment, and 30-day mortality of the SG group were not significantly different from those of the OS group. Although there were no significant differences between the two groups, the SG group had less tendency of long-term hospital death compared with the OS group [3/34 (8.8%) vs. 4/25 (16.0%), *P*=0.403].
Conclusions: The patients of TEVAR had shorter respiratory management, low rate of tracheostomy, less postoperative cerebral infarction, and shorter postoperative days than those of open heart surgery. Considering the damage of respiratory and complications, TEVAR is less invasive and may be preferable for high-risk patients like very elderly people.

P8
Quantitative Evaluation of Endoleakage by Transesophageal Echocardiography During Thoracic Endovascular Aortic Repair

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Objective: Thoracic endovascular aortic repair (TEVAR) has been a standard therapy for thoracic aortic aneurysm. However, postoperative endoleak occurs frequently, and it affects the long-term outcome. Although transesophageal echocardiography (TEE) is known as a useful modality during TEVAR, there is no report describing the quantitative evaluation of endoleak by TEE. In this study, we hypothesized that the high-velocity flow (HVF) measured by TEE in the aneurysmal sac is associated with postoperative endoleak.
Methods: A total of 246 consecutive patients who underwent TEVAR between December 2009 and August 2015 were reviewed. In these patients, 56 patients were evaluated intraoperatively by TEE from July 2014. These patients were divided into two groups as follows: (i) group nEL consisted of patients with no endoleak by angiography (n=46) and (ii) group EL consisted of patients with endoleak by angiography (n=10). High-velocity flow was measured by TEE. Postoperative remaining endoleak was detected by computed tomographic scan. To determine the cutoff point of HVF, receiver operating characteristic curve was analyzed with HVF and postoperative endoleak.
Results: There were no significant differences between the preoperative characteristics of the two groups, except for sex (group EL vs. group nEL, 80% vs. 76%, *P*=0.02). In the group EL, endoleak types 1, 2, 3, and 4 were detected in three, one, four, and two patients, respectively. The cutoff point of HVF was calculated to be 30.3 cm/s by receiver operating characteristic curve analysis (sensitivity, 0.8; specificity, 0.45).
Conclusions: We evaluated endoleak quantitatively by using HVF with TEE. High-velocity flow is a useful value to find out small endoleak, which was not detected by angiography. This value may give a meaningful information on whether endoleak should be treated or not.

P9
Total Arch Replacement Using Frozen Elephant Trunk Technique for Residual Dissection After Acute Type A Dissection Repair

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Objective: The purpose of this study was to assess the result of total arch replacement using manufactured frozen elephant trunk (FET) for chronic

TABLE P9-1. Preoperative and Postoperative Aortic Diameter

Aortic Level	Diameter of True Lumen, mm			Diameter of False Lumen, mm			Total Diameter, mm		
	Preoperative	Postoperative	*P*	Preoperative	Postoperative	*P*	Preoperative	Postoperative	*P*
Tracheal bifurcation	15.9±4.8	23.3±7.5	0.002	43.7±5.3	37.5±6.7	0.002	59.6±4.5	60.8±5.7	0.032
Pulmonary bifurcation	16.1±4.8	23.4±5.5	0.001	39.1±6.1	33.5±6.8	0.003	55.2±6.9	56.9±7.9	0.008
Aortic valve	13.8±3.1	19.6±6.4	0.007	38.5±8.7	33.7±9.4	0.007	52.4±8.6	53.4±9.4	0.042
Diaphragm	13.0±2.6	16.4±3.2	0.003	29.2±5.3	27.1±4.4	0.041	42.2±5.4	43.5±5.4	0.0009

aortic dissection after initial repair including the effect of aortic remodeling by the FET.

Methods: Between 2003 and 2015, in our institution, we performed 62 operations for chronic aortic dissection after initial acute type A dissection repair. Total arch replacement was performed for 32 patients by using manufactured FET in 11, handmade FET in 6, and elephant trunk in 12. The patients treated by manufactured FET were reviewed in this study. The average age was 66.2±8.0 years. Initial repairs before 6.6±4.1 years were nine ascending aortic replacements and two Bentall operations. The entry of residual dissection was located at arch in seven and at distal anastomosis site in four. The length of manufactured FET was 6 cm in two, 9 cm in three, and 12 cm in six, and the average length of inserted elephant trunk was 14.1±2.1 cm. Computed tomographic scan was performed 2.1±1.9 months after operation. Descending aorta was assessed at each level of tracheal bifurcation, pulmonary bifurcation (P), aortic valve (A), and diaphragm (D).

Results: Postoperative intensive care unit stay was 8.4±9.7 days, and hospital stay was 37.7±20.9 days. There was no hospital death. The operative complication included two surgical site infections, one interstitial pneumonia, and one paraplegia, which was recovered except for sensory impairment. Postoperative computed tomography at intervals of 2.1±1.9 months showed no entry at new distal anastomosis site, thrombosed false lumen above P in two, above A in one, and above D in seven. Distal end of the FET located at A in seven and at P in four. Although significant aortic remodeling (increased diameter of true lumen and decreased diameter of false lumen) was achieved, the total diameter of the aorta was increased at each level (Table P9-1).

Conclusions: Total arch replacement using manufactured FET after acute type A dissection repair promoted entry closure and thrombosis of false lumen. It requires long-term observation to judge the effect for aortic remodeling.

P10
Sliding Arch Aortoplasty With Continuous Coronary Perfusion for Aortic Arch Hypoplasia Beyond Infancy

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Objective: This study aimed to demonstrate an innovative technique for hypoplastic arch reconstruction in children beyond infancy.

Methods: The operation was performed via a median sternotomy. A Gore-Tex graft was sewn onto the innominate artery and used for selective antegrade flow, while the right atrium was cannulated for venous drainage. Control was obtained of the arch vessels. Once on bypass and cooled, an accessory perfusion line was used to provide coronary flow throughout the procedure via cannulation of the proximal ascending aorta with a small cardioplegia needle. The ascending sliding arch aortoplasty was then performed as previously described.

Results: The patient tolerated the procedure well and with a good clinical outcome. There was no arch gradient postoperatively.

Conclusions: Although there are no definitive data to show that continuous coronary perfusion significantly improves outcomes, there is theoretical benefit to operating without inducing cardioplegic arrest. Admittedly, for isolated arch repair, cardioplegic arrest time should be well tolerated. However, knowledge of this beating heart technique for sliding arch aortoplasty repair could save valuable arrest time when concomitant intracardiac procedures are required. The typically long ascending aorta in patients with coarctation and hypoplasia of the aorta not only lends itself to performing a sliding arch aortoplasty but also allows sufficient space on the ascending aorta for maintaining continuous coronary perfusion without additional difficulty.

P11
Combined Open and Endovascular Treatment for Extensive Aortic Diseases Using the Frozen Elephant Trunk Technique: Early Mortality Is Mainly Influenced by the Underlying Pathology

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Objective: The frozen elephant trunk (FET) procedure is a technique for combined, single-stage open and endovascular treatment of patients with extensive diseases of the thoracic aorta. Despite modern cerebral perfusion techniques, morbidity and mortality remain high. This study aimed to evaluate early mortality using FET technique according to the underlying pathology.

Methods: Between July 2011 and December 2015, a total of 56 consecutive patients (mean age, 65.1±10.7 years) underwent FET surgery using moderate circulatory arrest and selective antegrade cerebral perfusion. Underlying pathologies were complex thoracic aneurysm in 19 (33.9%), acute aortic dissection in 21 (37.5%), and chronic dissection in 16 patients (28.6%). Six patients (10.7%) experienced acute aortic rupture, 23 patients (41.1%) underwent emergency procedures, and 13 patients (23.2%) had a redo operation. Connective tissue disease was genetically diagnosed in six patients (10.7%).

Results: Cardiopulmonary bypass, cross-clamp, circulatory arrest, and selective antegrade cerebral perfusion times were 248.0±54.6, 151.6±66.3, 78.0±38.0, and 86.0±41.0 minutes, respectively. Overall 30-day mortality rate was 16.1% (n=9 patients). In patients who underwent emergency operation, 30-day mortality was 30.4% (7/23 patients). Of these, five patients experienced acute aortic rupture and were referred in critical preoperative status. In patients who underwent elective operation, early mortality (2/31 patients) was significantly lower compared with emergency cases (6.0% vs. 30.4%, $P<0.03$). Both patients died as a result of multiple embolization due to severe arteriosclerosis. None of the redo patients and patients with connective tissue disease died. New postoperative strokes were observed in six patients (10.7%) and spinal cord injury in one patient (1.8%).

Conclusions: The FET technique remains a challenging surgical technique. However, early mortality is mainly influenced by the underlying pathology more than by the technique itself. In elective cases, connective tissue disease, and redo operations, FET can be performed with good early results in experienced centers.

P12

Novel Noninvasive Evaluation Method of Cerebral Microcirculation During Hypothermic Circulatory Arrest Using Laser Speckle Flowgraphy: A Pilot Study

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Objective: The ophthalmic artery is the first branch of the internal carotid artery distal to the cavernous sinus. Branches of the ophthalmic artery supply the ocular fundus, especially that there are many small vessels around the optic nerve head (ONH). Thus, the blood flow of OHN reflects cerebral microcirculation. A laser speckle flowgraphy (LSFG) is a novel modality to evaluate ONH blood flow. Here, we present our initial experience of LSFG measurement as an evaluation method of cerebral microcirculation during hypothermic circulatory arrest.
Methods: In LSFG measurement, the mean blur rate (MBR) is an indicator of blood velocity and blood flow. In two patients undergoing total arch replacement with hypothermic circulatory arrest, the MBR in ONH and regional cerebral oxygen saturation at the forehead (rSO2) were measured at the following points: T0, after anesthetic induction; T1, after establishment of cardiopulmonary bypass; T2, at the circulatory arrest with retrograde cerebral perfusion; T3, after initiation of antegrade cerebral perfusion; and T4, after cessation of cardiopulmonary bypass (Fig. P12-1). The MBR value and the rSO2 value at T0 were defined as the baseline value. Measurement values at other points were demonstrated as percent values from the baseline.
Results: In patient 1, MBR and rSO2 were 63% and 97% at T1, 7% and 74% at T2, 70% and 93% at T3, and 134% and 101% at T4, respectively. In patient 2, MBR and rSO2 were 75% and 88% at T1, 6% and 46% at T2, 75% and 122% at T3, and 100% and 160% at T4, respectively.
Conclusions: In this pilot study, deterioration of cerebral microcirculation during retrograde cerebral perfusion could be detected more sensitively with LSFG measurement than with rSO2 measurement. This novel modality may reveal further information on cerebral microcirculation in cardiac surgery.

P13

Reliable Prediction of Postoperative Atrial Fibrillation From High-Resolution Electrocardiography-Based Assessment of Cardiac Autonomic Derangement and Altered Heart Rhythm Dynamics

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Objective: We and others have shown that patients developing postoperative atrial fibrillation (POAF) after cardiac surgery have severe cardiac autonomic derangement and altered heart rhythm dynamics already preoperatively. In the way toward electrocardiography (ECG)–based online POAF prediction, we present a novel approach further improving the performance of POAF prediction.
Methods: A total of 179 consecutive patients scheduled for cardiac surgery were enrolled in our study prospectively. Eight were excluded, 4 died, and 17 had high ectopical activity not amenable to analysis, so 150 represented the final study sample. High-resolution 20-minute ECG recordings were obtained 1 day before surgery to determine RR, PQ, and QT intervals as well as linear (time and frequency domain) and nonlinear heart rate variability parameters such as fractal dimension and detrended fluctuation analysis (DFA). Statistical

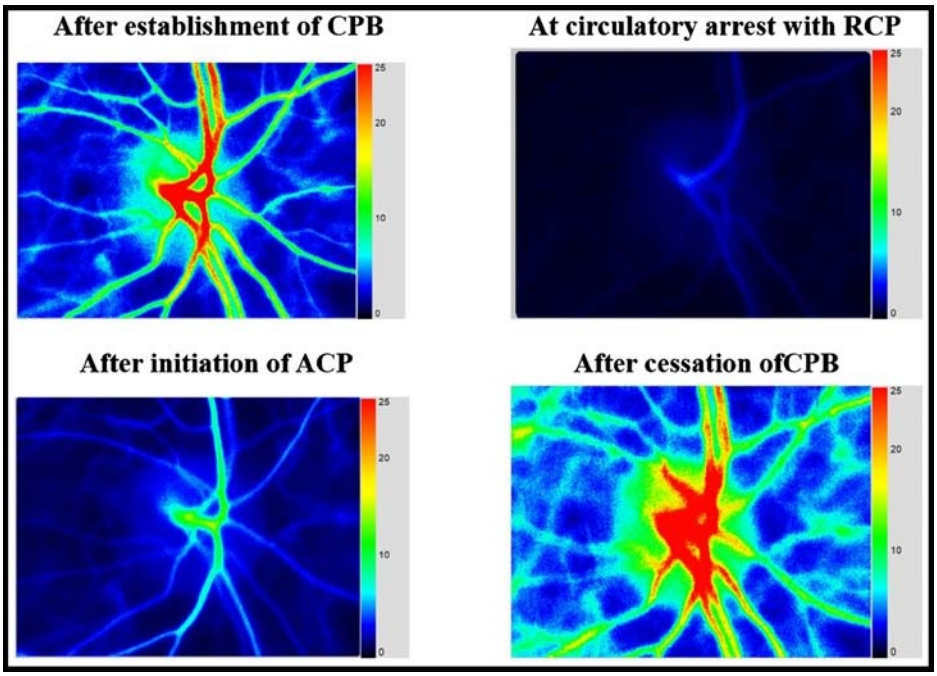

FIGURE P12-1. Laser speckle flowgraphy of ONH in total arch replacement. ONH, optic nerve head.

analyses were performed, and $P \leq 0.05$ was considered significant. Relevant predictors of atrial fibrillation (AF) were determined by using logistic (stepwise) regression modeling. To estimate the classification performance, the final model was built by using the nine most powerful predictors of AF in logistic regression and evaluated with leave-one-out cross-validation approach. The prediction of AF was measured with area under the curve (AUC) in receiver operating characteristic analysis.

Results: Thirty-one patients developed POAF after operation (POAF group), and 119 did not. The two groups were similar, except for more arterial hypertension as well as higher age, EuroSCORE II, and leukocyte count on the second postoperative day in POAF group. PQ intervals were shorter in the POAF group (156±23 vs. 173±31 milliseconds, P=0.011). Among nonlinear parameters, DFAα1 was lower in the POAF group (0.95±0.36 vs. 1.11±0.30, P=0.032). Nine of the most relevant predictors of POAF were preoperative heart rate, use of inotropes, DFAα2, fractal dimension (high), ejection fraction, cardiopulmonary bypass and aortic cross-clamp times, age, and PQ interval. The AUC of POAF prediction on train data was 88.2%, whereas leave-one-out cross-validation approach produced an AUC of 79.6%.

Conclusions: Determination of cardiac autonomic modulation and heart rhythm dynamics through digital ECG offers a platform for a true prediction of POAF now in the good-to-excellent range.

P14
The Use of Continuous Loop Recorders in Accurately Determining the True Success of Cox-Cryomaze Procedures

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Objective: Gauging the true success of maze procedure for atrial fibrillation (AF) has been problematic largely because of the inconsistency in modalities detecting rhythm. We report our initial experience with using a continuous loop recording device for assessing true AF burden in post–Cox-Cryomaze patients.

Methods: A retrospective analysis revealed that 59 patients, who had undergone Cox-Cryomaze between February 2011 and March 2015, were implanted with a continuous loop recording device [Reveal-XT (n=41) or Reveal-LINQ (n=18), Medtronic, Inc., Minneapolis, MN USA] and followed up at 1- to 3-month intervals thereafter. These Reveal devices were optimized to detect AF episodes of at least 2-minute duration.

Results: The mean age was 67.4±10.6 years, and 54% were male. Twenty percent underwent robotic procedures. Atrial fibrillation type included 56% paroxysmal and 44% longstanding persistent. Eighty percent of the patients underwent mitral surgery (MVR, 83%; MVR, 17%). All patients were discharged in NSR. The median time of Reveal-XT's implantation after surgery was 26 days (mean±SD, 43±71 days). There was no perioperative mortality. Three patients were lost to follow-up, three were upgraded to pacemaker, and three had their Reveal devices removed (patient requested in two and cardiologist recommended in one). The last follow-up (9.1±8.3 months; range, 0.9–38 months) was available for 56 patients, whereas 29 patients had completed their 1-year follow-up in this cohort. Freedom from AF, antiarrhythmic drugs (AADs), and anticoagulants (ACs) was 93%, 70%, and 52%, respectively, at the last available follow-up (Fig. P14-1). Similarly, freedom from AF, AADs, and ACs was 90%, 76%, and 76%, respectively, at 1 year (Fig. P14-1). During the course of the follow-up, two patients who first got Reveal-XT were implanted with Reveal-LINQ devices secondary to battery failures.

Conclusions: These results of the Cox-Cryomaze procedure are consistent with those reported following the traditional cut-and-sew Cox-Maze procedure and are highly effective in relieving patients of their clinically relevant AF burden. Continuous monitoring of patients undergoing surgery for AF using the Reveal-XT or Reveal-LINQ provides the ability to tailor the use of AADs and AC in these patients.

P15
To Detect or to Ablate: Determinants of Successful Left Atrial Ganglionated Plexi Detection During Surgical Ablation of Persistent Atrial Fibrillation

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Objective: Left atrial ganglionated plexi (GP) ablation is an adjuvant technique to increase the success rate of surgical ablation of atrial fibrillation

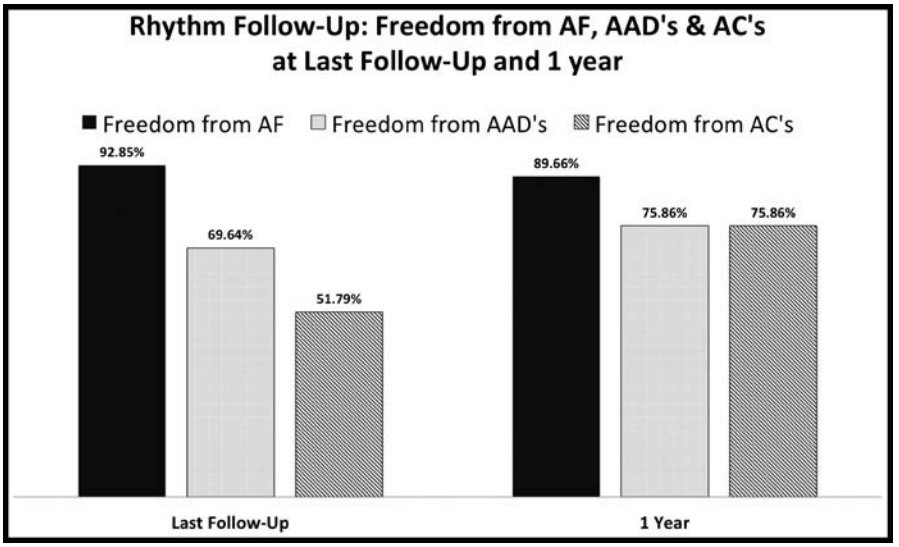

FIGURE P14-1. The use of continuous loop recorders to assess the rhythm follow-up in patients undergoing Cox-Cryomaze. Freedom from AF, AADs, and ACs at last follow-up and at 1 year. AADs, antiarrhythmic drugs; ACs, anticoagulants; AF, atrial fibrillation.

(AF). Effectiveness of this procedure is still to be proven. Ganglionated plexi ablation requires its detection with rapid atrial pacing to provoke vagal reflex. We aimed to assess preoperative determinants of successful GP detection and factors correlating with the number of GP detected.
Methods: The study involved 22 consecutive patients with persistent and long-lasting persistent AF and coronary artery disease referred for surgical revascularization with concomitant left atrial ablation and left atrial appendage epicardial occlusion. Ganglionated plexi detection was performed with rapid stimulation (800 beats per minute) to induce the vagal reflex in the area of the pulmonary veins and left atrial fat pads.
Results: Detection of GP was successful in 77% (17 patients). In 23% of the study population, during epicardial mapping, no signs of vagal reflex were observed. Significantly more GP were detected on the right side (29 GP; mean, 1.7±0.9) than on the left side (16 GP; mean, 0.9±1; P=0.03). There was no significant difference in preoperative characteristics and the type of AF between patients in whom detection was successful and unsuccessful. Ganglionated plexi were detected in 71% (12) of patients with persistent AF and in all patients (5 patients) with long-lasting persistent AF (P=0.3). The number of detected GP correlated significantly only with preoperative rest heart rate (HR). Negative correlation was still significant when study population was divided into the following groups: HR greater than 60 beats per minute (r=−0.6531, P=0.004); HR greater than 70 beats per minute (r=−0.5489, P=0.02), and HR greater than 80 beats per minute (r=−0.5401, P=0.02).
Conclusions: The number of detected GP is related only with preoperative HR. This observation may support the rationale for direct ablation of potential ganglia location without its previous detection.

P16
Pulmonary Vein Anatomy Impact to Long-term Results of Surgical Minimally Invasive Ablation of Persistent and Long-standing Persistent Atrial Fibrillation Using Bipolar Radiofrequency Ablation Device: Case Series of 75 Patients

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Objective: In our study, we wanted to check if pulmonary vein (PV) anatomy is related with long-term results of minimally invasive surgical ablation.
Methods: This observational, retrospective study included 75 patients who underwent minimally invasive stand-alone surgical epicardial ablation for nonvalvular, persistent, or long-standing persistent AF and had available preoperative multidetector row computed tomographic scans. The box isolation of PVs was created using a bipolar radiofrequency clamp. Only patients with confirmed PV isolation were included in the evaluation. Absence of arrhythmia was confirmed at 3, 6, and 12 months and annually thereafter with 24-hour Holter monitoring. A PV classification based on both the number of venous ostia on each side and the drainage patterns of PV was used.
Results: Sixty-seven patients (89%) had usual left-sided PV drainage pattern (two pulmonary veins, left common trunk<1 cm). Eight patients (11%) had unusual left-sided PV drainage pattern (common trunk>1 cm or three left-sided PVs). Patients with unusual left-sided PV drainage more frequently had AF reoccurrence at long-term follow-up (χ^2=5176, P=0.023). Only 15 patients (20%) had late PV (>1 cm) division on the right side. The seven patients (8%) who had usual left-sided PV drainage pattern and had late PV division on the right side had the highest rate of sinus rhythm at long-term follow-up (χ^2=4598, P=0.032) (Fig. P16-1). There were no other significant differences between those patient groups.
Conclusions: Pulmonary vein anatomy is related with long-term results of minimally invasive surgical ablation for persistent or long-standing persistent AF compared with when bipolar radiofrequency ablation clamp is used.

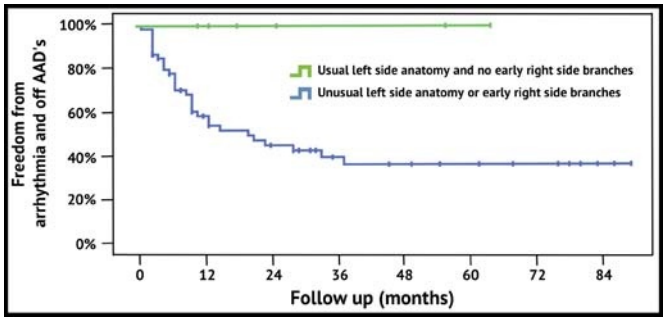

FIGURE P16-1. Freedom from arrhythmia and without antiarythmic drugs in patients with usual (two pulmonary veins, left common trunk<1 cm) left-sided pulmonary vein anatomy and no early right-sided pulmonary vein branches and in patients with unusual pulmonary vein anatomy or early right-sided pulmonary vein branches.

P17
Lack of Atrial Contraction as a Predictor for Permanent Pacemaker Implantation

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Objective: The lack of atrial contraction (AC) after Maze procedure is reported to cause subsequent annulus dilatation and an increase in embolic stroke. We hypothesized that the lack of AC could increase the risk of permanent pacemaker (PPM) implantation in patients undergoing the Maze and valve surgery.
Methods: In 376 consecutive patients who had undergone the Cryomaze and combined valve operation, recovery of AC was assessed using Doppler echocardiographic measurement of the transmitral A-wave velocity at baseline, immediate (≤2 weeks), early (≤1 year, 4.6±3.8 months), and late (>1 year, 3.5±1.1 years) postoperative stages.
Results: During the median 53-month follow-up, 10 patients (8 female, 61±13 years) underwent PPM implantation; 7 for sinus node dysfunction (pause, 9.6±2.4 seconds), 1 for marked sinus bradycardia, and 2 for advanced/complete atrioventricular black. Median time to the PPM implantation was 13.8 months (interquartile range, 0.5–68.2 months). Patients with PPM implantation showed a more frequent lack of AC versus those without PPM implantation in the early stage (P=0.005). Multivariate analysis revealed that the lack of AC in the early stage was identified as an independent predictor for PPM implantation (odds ratio, 5.62; 95% confidence interval, 1.06–30.0, P=0.039).
Conclusions: The lack of AC was independently associated with subsequent risk of PPM implantation. Therefore, close follow-up might be needed when the AC is not recovered during follow-up.

P18
Minimally Invasive Cox Maze IV Ablation Procedure Performed Entirely by Bipolar Clamp Concomitant to Mitral Valve Surgery Through Right Lateral Minithoracotomy

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Objective: This study aimed to introduce the technique of performing minimally invasive concomitant Cox Maze IV ablation procedure entirely by bipolar clamp through right lateral minithoracotomy for patients with atrial fibrillation (AF) associated with mitral valve diseases.

Methods: Sixty-nine patients (43 males, 52–71 years) with mitral valve disease and longstanding persistent AF received minimally invasive Cox Maze IV ablation procedure combined with mitral valve surgery from June 2012 to January 2015. Diameter of the left atrium ranged from 42 to 60 mm. Left ventricle ejection fraction ranged from 45% to 67%. A 6-cm right lateral incision was made over the fourth intercostal space. After peripheral cardiopulmonary bypass was established, left pulmonary vein (PV) was ablated by bipolar clamp through right lateral minithoracotomy (Fig. P18-1). Then, ablation line around right PVs, ablation line from the right superior PV to the left superior PV, ablation line from the right inferior PV to the left inferior PV, ablation line from the right inferior PV to the mitral valve annulus, excision of the left atrial appendage, ablation line from the base of left atrial appendage to the left superior PV, and right atrial ablation were performed.
Results: All patients successfully underwent this minimally invasive Maze IV ablation procedure and mitral valve surgery. The mean cardiopulmonary bypass time was 130.3±17.7 minutes. The mean aortic cross-clamp time was 91.8±12.7 minutes. No patient needed conversion to sternotomy during the surgery. There was no early death or pacemaker implantation in the perioperation. The average length of hospital stay was 9.8±3.3 days. At discharge, 65 patients (65/69, 94.2%) maintained sinus rhythm. At a mean follow-up time of 21.0±8.6 months, sinus rhythm was restored in 62 patients (62/69, 89.9%). Cumulative maintenance of normal sinus rhythm without AF recurrence at 2 years postoperatively was 85.1%±5.8%.
Conclusions: The minimally invasive concomitant Maze IV ablation procedure performed entirely by bipolar clamp through right lateral minithoracotomy was a safe, feasible, and effective technique for patients with AF associated with mitral valve diseases.

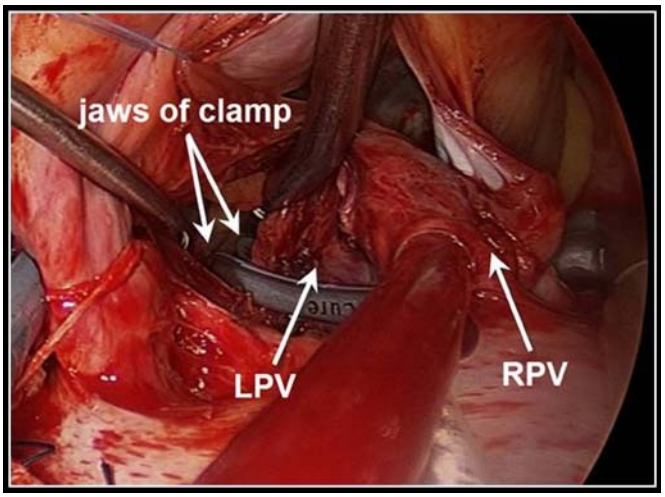

FIGURE P18-1. Ablation of left pulmonary veins by clamp. LPV, left pulmonary vein; RPV, right pulmonary vein.

P19
Midterm Results of Five-Box Biatrial Thoracoscopic Ablation of Advanced Atrial Fibrillation on the Beating Heart

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Objective: Thoracoscopic ablation of longstanding persistent atrial fibrillation (AF) is emerging as an alternative to more invasive surgical options and to poor results from catheter ablation in this challenging patient population. Herein, we report midterm outcomes of the five-box biatrial thoracoscopic ablation of longstanding persistent AF on the beating heart.
Methods: This is a single-center, retrospective review of 29 consecutive patients from January 2012 to July 2014 who underwent thoracoscopic epicardial AF ablation. Bipolar radiofrequency was used to create the five-box lesion set and ablate ganglionic plexi, with subsequent entrance and exit block confirmation. The left atrial appendage was occluded. Perioperative and follow-up data were collected.
Results: The mean duration of preoperative longstanding persistent AF was 8.6±8.8 years. Twenty-six patients (90%) had previous percutaneous ablations. The left atrium was enlarged (>4.0 cm) in 16 patients (55%). Peripheral cardiopulmonary bypass support with a small thoracotomy was needed to stop bleeding in two patients with heavy adhesions from previous percutaneous ablation. Procedure-related complications included pneumothorax in 10 patients (34%), of which only 1 occurred in the last 12 cases, and permanent pacemaker insertion in 3 patients (10%). Four patients (14%) required electrical cardioversion postoperatively, and three patients (10%) were ablated percutaneously because of recurrent AF (n=2) and atrial flutter (n=1). There were no deaths or strokes during the hospitalization. The mean hospital length of stay was 6.4±5.3 days, and 86% of the patients were discharged in sinus rhythm. Follow-up was completed with at least an electrocardiography in all patients (100%) with a mean follow-up of 23±2.3 months. Nineteen patients (66%) had Holter monitoring (mean, 11±3 days of monitoring). At the latest follow-up, one patient (4%) was in atrial flutter, none was in atrial fibrillation, seven patients (24%) were on antiarrhythmic medications, and eight patients (28%) were anticoagulated. Freedom of AF was observed in 89% of the patients at 3 and 6 months and in 96% of the patients at 12 months.
Conclusions: Thoracoscopic AF ablation on the beating heart for the treatment of longstanding persistent AF is technically feasible and achieves high success rates with low procedure-related morbidity at midterm follow-up.

P20
Surgical Ablation of Atrial Fibrillation: The Maze IV Procedure Is Significantly Superior to Other Ablation Procedures

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Objective: The Maze III procedure is the most effective surgical technique to treat atrial fibrillation (AF), and it is also the criterion standard to judge the clinical effects of the so-called *modified Maze procedure*. Since several new ablation tools were developed, the ablation lesions have been changed, which leads to the fall of success rate. Maze IV procedure is closer to the Maze III procedure than any other modified Maze procedures. We performed Maze IV procedure using monopolar together with bipolar ablation tools simultaneously. This study examined the preoperative and perioperative variables to assess the clinical effect and safety of Maze IV procedure.
Methods: From December 2014 to April 2015, 23 patients with valvular longstanding atrial fibrillation and 3 patients with isolating atrial fibrillation (paroxysmal AF, 1; longstanding AF, 2) underwent Maze IV procedure. All these cases were compared with cases in an existing database to determine the heart rhythm on 24-hour Holter monitoring at discharge, 3 months, and 6 months after the operation.
Results: No hospital mortality was observed. The ablation time of the Maze IV group was significantly longer than that of the control group (15.7 vs. 10 minutes, $P<0.01$). One patient in the Maze IV group had AF recurrence before discharge, and the heart rhythm returned to sinus rhythm (SR) after electrical cardioversion and remained at SR at 3-month follow-up. Sick sinus syndrome revealed in one case that a permanent pacemaker was implanted. All the patients were followed up. During the follow-up, no stroke and death were observed. The SR rate at discharge was 96.2% versus 46.2% ($P=0.04$). The SR rate at follow-up of 3 or 6 months was 95.5% versus 88.5% and 95.5% versus 61.3% ($P=0.03$), respectively. The atrial flutter rate was 0% versus 11.5% ($P=0.07$).
Conclusions: The Maze IV procedure has higher success rate and lower atrial flutter rate but has longer ablation time and increased cost.

P21
Long-term Results of Concomitant Surgical Ablation for Atrial Fibrillation

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Objective: Concomitant surgical atrial fibrillation (AF) ablation is an established procedure, recommended in guidelines for patients with AF undergoing cardiac surgery. According to the guidelines, ablation success should be reported by 24-hour Holter ECG results. However, information on long-term success, especially obtained by 24-hour Holter ECG, is rare. We therefore analyzed the rhythm course and long-term outcomes of our patients undergoing concomitant surgical AF ablation.
Methods: Between January 2003 and April 2011, 486 patients underwent concomitant surgical AF ablation in our institution. Patients with 24-hour Holter ECG rhythm status available between 5 and 11 years postoperatively were included in this retrospective data analysis (n=163). Ablation lesions were limited to a pulmonary vein isolation (n=25, 15.3%), a more complex left atrial lesion set (n=97, 59.5%), or biatrial lesions (n=41, 25.2%). All follow-up rhythm evaluations were based on 24-hour Holter ECG; successful ablation was defined by the absence of AF episode longer than 30 seconds. The primary end point of the study was freedom from AF during long-term follow-up. Univariate and multivariate logistic regression analyses were used to identify predictors for rhythm outcome.
Results: The mean age of the patients was 67.1 years, and 56.2% were male. The mean follow-up time was 5.5 years (5–11 years). Surgical AF ablation provided a rate of freedom from AF of 57.2% during long-term follow-up, with significantly better results in patients with paroxysmal compared with those with persistent AF (67.9% vs. 52.1%, P=0.322). A stable rhythm course was observed during follow-up, without statistically significant differences between 12 months and latest follow-up (mean, 5.5 years; 63.3% vs. 57.2%; P=0.29). Irrespective of ablation success, 53% of the patients who were in sinus rhythm at latest follow-up were still on oral anticoagulation drugs. Univariate and multivariate logistic regression analyses identified preoperative paroxysmal AF and left atrial diameter as predictors of long-term ablation success.
Conclusions: Surgical AF ablation provided a rate of freedom from AF of 57.2% during long-term follow-up. Statistically significant predictors for ablation success at latest follow-up were preoperative paroxysmal AF and a preoperative smaller left atrial diameter.

P22
Use of Del Nido and Blood Cardioplegia in Adult Cardiac Surgery

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Objective: We compared early results including myocardial troponin level with clinical outcomes after adult cardiovascular surgery using del Nido and blood cardioplegia.
Methods: A total of 140 patients (59±14 years) who underwent cardiovascular surgery using del Nido (DN group, n=38) or blood (BC group, n=102) cardioplegia were enrolled. Propensity-score analyses were performed, and the levels of troponin I (TnI) and early clinical outcomes in the two groups were compared.
Results: In the DN group, cardioplegia was infused with an initial dose of 1127±224 mL, and an additional 500 mL was reinfused in 12 patients 92.2 minutes after initial infusion. In the BC group, the number of infusions and infused volumes were 4.0±1.6 and 2746±1220 mL, respectively. After release of aortic cross-clamp (ACC), spontaneous defibrillation was achieved more frequently in the DN than in the BC groups (34/38 vs. 26/102, P<0.001). The peak TnI levels after surgery were 10.2 ng/mL (2.0–90.2 ng/mL) and 17.8 ng/mL (3.5–153.9 ng/mL) in the DN and BC groups, respectively. There were no differences in the peak level and serial changes of TnI between the two groups (P=0.802). In the DN group, ACC time was not associated with the peak TnI level. In the BC group, however, ACC time was a significant factor associated with peak TnI after surgery (P<0.001). There were no significant differences in early mortality (n=3) and postoperative complication rates between the two groups. Propensity-score matching extracted 30 pairs. The levels of TnI and clinical outcomes were similar between the two propensity score–matched groups.
Conclusions: Del Nido cardioplegia is as effective as blood cardioplegia for adult patients in terms of myocardial protection and early clinical outcomes, and its single-dose and small-volume properties might be beneficial in minimally invasive adult cardiac surgeries.

P23
Initial Experience With Minimally Invasive Surgical Exclusion of Left Atrial Appendage With an Epicardial Clip

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Objective: Atrial fibrillation (AF) is the primary cardiac abnormality associated with ischemic stroke. Atrial fibrillation affects 2.7 million people with a stroke rate of 3.5% per year. Most of the emboli in patients with nonvalvular AF originate in the left atrial appendage (LAA). Surgical exclusion of the LAA decreases the yearly risk of stroke to 0.65% when combined with a Maze procedure. Traditional oversewing of the LAA from inside the left atrium is associated with a significant number of recanalizations of LAA. An alternate technique is epicardial clipping, which has been approved through sternotomy for permanent exclusion of LAA. We present our initial experience of epicardial clipping of the LAA using a minimally invasive approach.
Methods: Between May 2012 and December 2015, 24 consecutive patients underwent minimally invasive, echocardiography-guided epicardial clipping. Indications for the procedure were persistent (n=11) or paroxysmal (n=13) AF in patients who could not tolerate full anticoagulation because of a combination of gastrointestinal bleeding (n=6), hemorrhagic stroke (n=5), ischemic stroke (n=5), intramuscular bleeding (n=3), falls (n=2), GU bleed (n=2), subdural hematoma (n=1), Osler-Weber-Rendu syndrome (n=1), and a traumatic aortic intramural hematoma (n=1). The clipping was performed through three 5-mm ports in the left seventh intercostal space (n=22) or a 5-cm incision in the fifth intercostal space (n=2). Echocardiography was performed to exclude the presence of LAA thrombus and to confirm exclusion of LAA before final deployment of the clip.
Results: The mean age of the patients was 74.4 years. The mean CHADS2VASC score was 4.6, and the mean HASBLED score was 3.8. The mean postoperative length of stay was 5.3 days, and the mode was 1 day. One patient died of stroke-related complications 10 days after successful clipping. There were no unexpected adverse events. All patients had successful exclusion of LAA defined as residual sac of less than 1 cm.
Conclusions: Isolated epicardial left atrial clipping is a safe treatment option in high-risk patients with AF. Long-term success in preventing stroke is still to be determined, but short-term results are very encouraging.

P24
Definition of Success After Epicardial Left Atrial Appendage Occlusion: Formation of Left Atrial Diverticulum and Remnant Stump

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Objective: Left atrial appendage (LAA) closure with the use of epicardial occluders is an emerging technique in stroke prevention in patients with atrial fibrillation (AF). Remnant LAA stump is a major success criterion, and it is needed to elaborate its early method of assessment. The aim of the study was to assess early success rate of epicardial LAA closure and factors leading to remnant LAA stump formation with proposed echocardiographic method.

Methods: Fifteen consecutive patients with persistent AF and coronary artery disease underwent surgical off-pump revascularization with concomitant left atrial ablation and LAA epicardial occlusion with the use of either Tiger Paw System II (MAQUET Medical Systems, Wayne, NJ USA) or AtriClip (AtriCure, Inc., West Chester, OH USA). Before surgery start and after chest closure, transesophageal echocardiography was performed to assess LAA morphologic type and length, LAA orifice diameter, diameter of left atrial ridge, and remnant LAA stump.
Results: In 80% (12) of the patients, formation of left atrial diverticulum was observed, and left atrial ridge formed its superior boundary. In five patients (33%), minimal remnant LAA stump was found but in none exceeding 1 cm (average length, 1.5±2.3 mm). In all patients' blood flow in LAA, cavity distally to occluder was excluded. In the AtriClip group, LAA remnant stump was observed in three cases (43%) and in the Tiger Paw group in two patients (25%, P=0.6). There was no significant difference in LAA type, average diameter of the left atrium, LAA orifice, LAA length, left atrial ridge, and size of occluder used between patients with and without remnant LAA stump. Occurrence of remnant LAA stump correlated significantly with unfavorable anatomy (LAA orifice, 5 mm; r=0.5774, P=0.02).
Conclusions: Early success of epicardial LAA occlusion is not dependent on the anatomy of LAA and the type of occluder used. Minimal remnant LAA stump not exceeding 1 cm in length and with no blood flow in LAA is observed in one third of the cases. Diverticulum should not be considered as part of remnant LAA stump because it is formed with intracardiac left atrial ridge.

P25
Improved Flow Modeling Using a Modified Aortic Arch Advancement for Neonatal Arch Hypoplasia

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Objective: Numerous surgical approaches regarding aortic arch advancement for neonatal arch hypoplasia have been described. These repairs can be classified into two categories, those that incorporate a patch and those that do not. The decision between repairs remains largely experiential, rather than empirical, because of the limited number of reported outcomes. We report early outcomes from neonates undergoing aortic arch advancement with an anterior patch (±performed without cardioplegic arrest) and our experience using computational flow modeling to better understand the hemodynamic consequences associated with these repairs.
Methods: This is a single-institution review of neonates undergoing aortic arch advancement with anterior patch during 2014. Anatomical, perioperative, and follow-up data were collected. Postoperative three-dimensional magnetic resonance imaging aortic arch reconstructions were used to generate a computational flow model of the repair. Parameters of the anterior patch were manipulated virtually to create idealized direct end-to-side and modified anterior patch models. Hemodynamic changes were recorded. Results were reported as median (interquartile range).
Results: Ten neonates underwent modified aortic arch advancement. No hemodynamically significant gradients or velocities were observed at a median follow-up of 282 days (109–454 days). Higher peak systolic velocities across the transverse arch were observed in the direct end-to-side flow model relative to the anterior patch model (3.16 vs. 2.54 m/s) (Fig. P25-1A and P25-1B, respectively). Distally, these same velocities depreciated to a greater extent in the direct end-to-side model (P=0.0026). Asymmetrical flow was observed throughout the direct end-to-side model, whereas concentric lamellar flow was observed in the descending aorta of the anterior patch model. Further pattern analysis is being performed.
Conclusions: Early outcomes after the use of an anterior patch for neonatal hypoplastic aortic arch repair show favorable hemodynamic outcomes. Furthermore, continuous coronary perfusion as part of the modification did not diminish the quality of the repair as assessed by postoperative gradients.

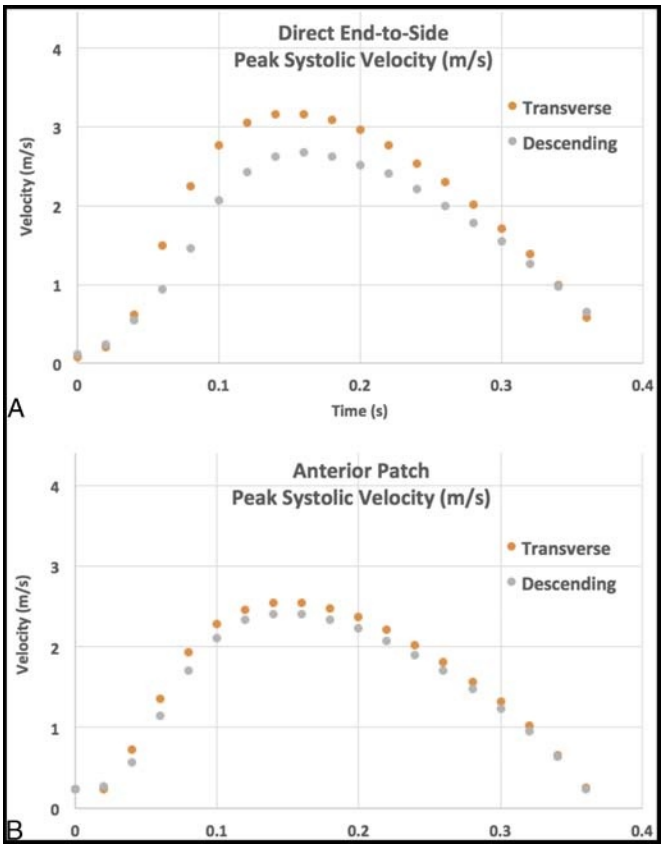

FIGURE P25-1. Peak systolic velocities measured at transverse and descending aorta. A, Direct end-to-side repair. B, Modified advancement with an anterior patch. Orange represents transverse arch velocities. Grey represents descending velocities.

P26
Treatment of Isolated Ventricular Septal Defects in Children: A Comparative Analysis Between Minimally Invasive Transthoracic and Percutaneous

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Objective: Since the introduction of off-pump minimally invasive transthoracic device closure (MITDC) of isolated ventricular septal defect (VSD) in 2007, the management of isolated VSD has evolved. It has been proven that MITDC of isolated VSD is a safe and effective alternative to conventional surgical treatment. A comparative analysis of MITDC versus the other conventional treatment, percutaneous transcatheter device closure (PTDC), for isolated VSD is needed.
Methods: A total of 215 patients with isolated VSDs were enrolled from March 2011 to March 2014. The patients were divided into off-pump MITDC group and PTDC group. Patients were followed up with the same standard

protocol. Clinical, electrocardiographic, and echocardiographic data before and after operation were analyzed. Several characteristics (eg, operating time, complications, hospital stay, cost of hospitalization, and complications) were also compared between the two groups.
Results: The MITDC group was significantly younger ($P<0.01$) and smaller in size ($P<0.001$) than the PTDC group. In PTDC group, 72 cases were successfully closed, and 5 were converted to MITDC, 4 with successful closure and 1 converted to surgical closure after failed MITDC. In MITDC group, 135 cases were successfully closed, and 3 were converted to surgical closure. There was no occurrence of main complications in both groups during the hospital stay and follow-up. There was no difference between the two groups according to incidence of major complications, hospital stay, and cost of hospitalization, but the operating time, incidence of minor complications during hospitalization, and follow-up period were significantly shorter or lower in MITDC group than in PTDC group (Table P26-1).
Conclusions: Minimally invasive transthoracic device closure of isolated VSD is an effective method with fewer complications, shorter operating time, higher safety, and a wider range of indications than PTDC. It not only can serve as a reasonable alternative treatment for PTDC but also has a wider range of indications.

TABLE P26-1. Treatment Characteristics and Follow-up Data of Patients Undergoing Minimally Invasive Transthoracic or Percutaneous Transcatheter Device Closure of Isolated VSDs

Characteristic	MITDC	PTDC	*P*
n	138	77	
Age, mo	12.3±8.5 (3–36)	36.8±15.6 (26–78)	0.001
Weight, kg	8.9±7.6 (4.5–15.6)	19.6±11.3 (15–36)	0.003
Operating time, min	18.5±15.7 (5–45)	85.6±53.8 (55–168)	0.001
Successful rate (%)	135 (97.8)	72 (93.5)	0.121
Hospital stay, d	6.5±3.7 (4–11)	5.6±4.6 (4–9)	0.663
Cost of hospitalization (10,000 RMB)	3.2±2.4 (2.6–5.9)	3.23±2.79 (2.2–6.3)	0.567
Complications before discharge			
Hydropericadium (%)	6 (4.4)	16 (22.2)	0.000
ECG			
iRBBB or cRBBB (%)	21 (9.30)	23 (19.79)	0.000
iLBBB	0	1 (1.4)	0.170
cAVB	0	0	
Echocardiography			
Trace to mild TR (%)	13 (9.6)	23 (31.9)	0.000
Trace to mild AR (%)	3 (2.2)	9 (12.5)	0.003
Residual shunting			
Trivial to small (%)	11 (8.1)	17 (23.6)	0.002
Moderate	0	1 (1.4)	
Follow-up time, mo	32.7±18.8 (18–54)	33.5±15.9 (18–84)	1.793
Follow-up rate (%)	130 (96.3)	69 (95.8)	0.948
Complications during follow-up			
ECG			
iRBBB or cRBBB (%)	15 (11.1)	20 (27.8)	0.002
iLBBB	1 (0.7)	0	0.464
cAVB	0	0	
Echocardiography			
Trace to mild TR (%)	12 (8.9)	23 (31.9)	0.000
Trace to mild AR (%)	1 (0.7)	3 (4.2)	0.088
Residual shunting			
Trivial to small (%)	7 (5.2)	11 (15.3)	0.019
Moderate	0	0	

AR, aortic regurgitation; cAVB, complete atrioventricular block; cRBBB, complete right bundle branch block; iLBBB, incomplete left bundle branch block; iRBBB, incomplete right bundle branch block; MITDC, minimally invasive transthoracic device closure; PTDC, percutaneous transcatheter device closure; TR, tricuspid regurgitation.

P27
Outcomes of a 2-cm Incision as a Routine Approach for Ventricular Septal Defect Repair in Infants Younger Than 6 Months

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Objective: This study aimed to retrospectively evaluate the surgical outcomes of ventricular septal defect (VSD) repair in patients younger than 6 months with the approach of 2-cm-long incision and partial sternotomy.
Methods: From January 2012 to November 2014, 56 infants underwent surgical repairs for VSD through midline minimal incisions and partial sternotomy. The routine incision started from 2 cm below the nipples level, going downward with the length of 2 cm. A skin flap was then created to expose the lower sternum. Partial sternotomy was performed with regular sternum saw. The thymus was dissected but not removed. The pericardium was opened and was hung up anteriorly and inferiorly. Regular cardiopulmonary bypass was established with aorta and right atrium cannulation. One or two of the venous cannulae went through a minimal incision, which would be chest tube site. Regular cross-clamp and cardioplegia technique were applied. The age of the patients ranged from 3 to 6 months (mean, 5.3 months), with body weight from 4.3 to 6.5 kg (mean, 5.2 kg). The associated anomalies included left superior vena cava, patent ductus arteriosus, mitral and tricuspid insufficiency, and subpulmonary stenosis. The cardiopulmonary bypass time ranged from 26 to 71 minutes (mean, 40 minutes). The cross-clamp time ranged from 12 to 51 minutes. The length of incision ranged from 1.9 to 2.5 cm (mean, 2.2 cm).
Results: There was no mortality and no major complication. Two patients had minimal residual VSDs, which did not need intervention. One had mild pneumatoma, and two had hematomas that were relieved after the treatment. During follow-up, all patients were doing well and did not need any reoperations.
Conclusions: Surgical outcomes of VSD repair in patients younger than 6 months with 2-cm-long incision are excellent, and the cosmetic incision scar is anticipated to leave the patients less psychological concern while they are growing up.

P28
Minimally Invasive Video-Assisted Surgical Closure of Atrial Septal Defect on Beating Heart Without Aortic Clamping

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Objective: This study aimed to evaluate the feasibility and outcome of minimally invasive video-assisted surgical closure of atrial septal defect (ASD) on beating heart without aortic cross-clamping techniques.
Methods: From May 2013 to December 2015, 52 patients underwent ASD closure using video-assisted minimally invasive surgical methods via right submammary minithoracotomy (Fig. P28-1). Cardiopulmonary

bypass was established via femoral artery as well as femoral venous and right internal jugular vein (Fig. P28-2). Atrial septal defects were closed with patches on a beating heart, under normothermia without aortic cross-clamping.

Results: Fifty-one patients were successful with the method, one case had a larger incision to reclose the ASD, and no patient required conversion to sternotomy. Cardiopulmonary bypass mean time was 80 minutes, and ventilated mean time was 4.5 hours. There had been no hospital mortality and no major complications. Mean follow-up time was 14 months. All patients were good and had no late complications.

Conclusions: Minimally invasive video-assisted surgical closure of ASD on beating heart without aortic cross-clamping techniques is feasible and safe. Submammary incisions and peripheral cardiopulmonary bypass were acceptable and allowed for adequate surgical exposure with a satisfactory cosmetic result.

FIGURE P28-1. Right submammary approach.

P29
Transverse Sternal Split: A Safe Minimally Invasive Approach for Repair of Tetralogy of Fallot

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Objective: Right minithoracotomy or lower partial sternotomy have been used as an alternative approach for minimally invasive repair of congenital cardiac defects with a better cosmetic outcome. However, these approaches restrict the exposure of the right ventricular outflow tract and pulmonary arteries. We performed transverse sternal split to improve the exposure of the heart with the advantage of mini-incision for surgical correction of patients with Tetralogy of Fallot (TOF).

Methods: From January 2015 to September 2015, 11 pediatric patients (7 male), with a mean age of 1.5 years (11 months to 3 years) and a mean weight of 9 kg (7.5–14 kg), underwent surgical correction for TOF. Surgery was performed through transverse sternal split in the third intercostal space involving a 3- to 5-cm skin incision as well as cervical (right common carotid artery and right internal jugular vein) and inferior vena cava cannulation for the conduct of cardiopulmonary bypass. In seven patients, infundibular muscle resection was performed through right atrium and small right ventriculotomy. In these patients, ventricular septal defect (VSD) was repaired through the right atrium. In the remaining four patients, transannular patch was inserted for hypoplastic pulmonary artery annulus. In these patients, infundibular muscle resection and closure of VSD were performed through the ventriculotomy.

FIGURE P28-2. Cardiopulmonary bypass via femoral artery.

Results: There was no mortality or significant morbidity in the postoperative period or during follow-up. Mean cross-clamp time was 98±27 minutes (range, 75–169 minutes), and mean cardiopulmonary bypass time was 137±25 minutes (range, 103–205 minutes). All patients were weaned off mechanical ventilation within 16 hours of surgery. Cosmetic result was satisfactory in all patients with no incidence of sternal mobility or dehiscence. There was no neck wound-related or neurological complication. There was significant residual defect in any patient. Two patients had tiny flow across VSD patch. During the follow-up, two patients had residual gradient of 45 mmHg across right ventricular outflow tract without symptoms.
Conclusions: The transverse sternal split incision with cervical cannulation for cardiopulmonary bypass is a safe and effective alternative to a median sternotomy for surgical repair of TOF in selected group of patients with satisfactory cosmetic results.

P30
Right and Left Anterolateral Minithoracotomy for Repair of Congenital Ventricular Septal Defect in Vietnam

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Objective: Much more concern has been recently paid to the cosmetic aspect of the repair of simple congenital heart disease.
Methods: From June to December 2015, 12 patients (5 female, 7 male; age, 3–50 years) underwent repair of congenital ventricular septal defects (VSDs) using right (n=6) (Fig. P30-1) and left (n=6) (Fig. P30-2) anterolateral minithoracotomy. Ventricular septal defects were of the perimembranous (n=6) and subarterial (n=6) type. Peripheral cardiopulmonary bypass was set (superior vena cava and inferior vena cava were drained through internal jugular and femoral veins; arterial cannulae were set up through the femoral artery directly in three and indirectly in nine patients) (Fig. P30-3).
Results: We present here the perioperative data and early result of these patients. Closure of VSDs was successfully performed in all patients (Fig. P30-4–6). Mean cardiopulmonary bypass time was 162.5±58.9 minutes, and mean aorta cross-clamp time was 116.6±49.0 minutes. Intubation time was 3.8±0.6 hours, intensive care unit stay was 1.6±0.5 days, and postoperative hospital stay was 9.3±2.0 days. There were no complications related to surgery and peripheral cannulation. All of the patients and their family were satisfied with the cosmetic result of the scars.
Conclusions: This method was safe and effective especially for girls and women with VSDs.

FIGURE P30-2. Left submammary incision for outlet ventricular septal defect closure.

FIGURE P30-1. Right submammary incision for perimembranous and subaortic ventricular septal defect closure.

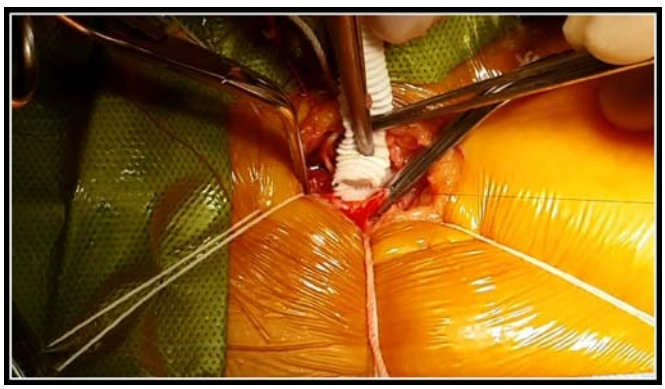

FIGURE P30-3. Anastomosing a Dacron with femoral artery for setting up peripheral cardiopulmonary bypass.

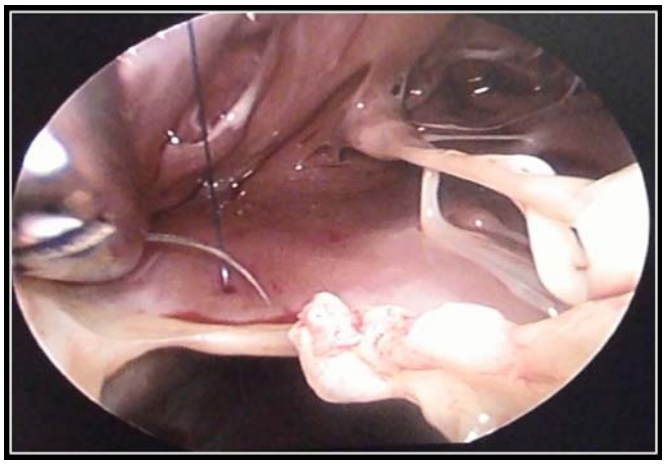

FIGURE P30-4. Taking the first stitch on the border of perimembranous ventricular septal defect.

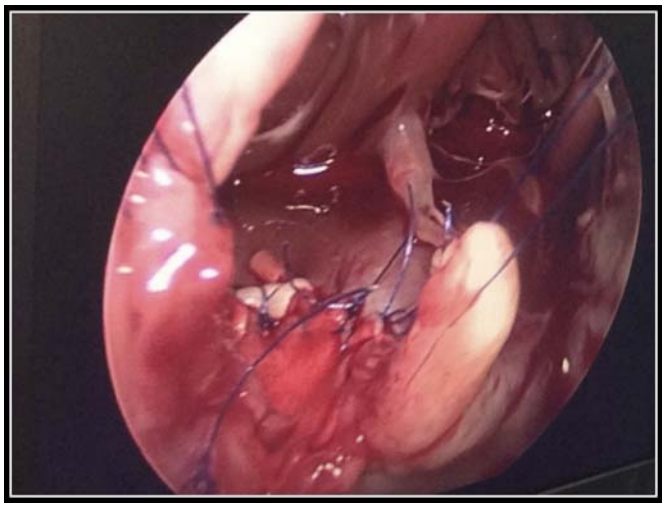

FIGURE P30-5. Finished closing ventricular septal defect.

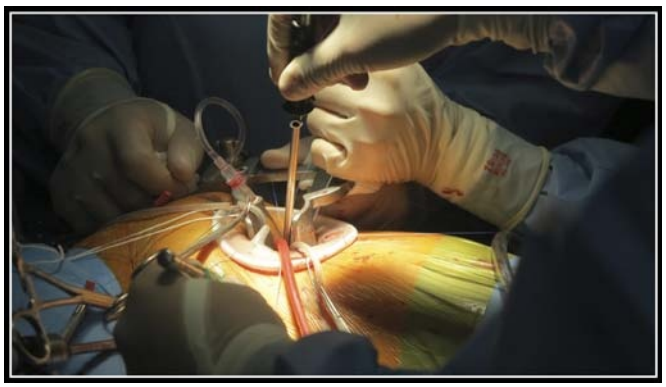

FIGURE P30-6. Manipulations of the surgeon during operation. Cardioplegia solution distributed to the myocardium directly though the hole. Chitwood clamp was used for aortic cross-clamping.

P31
Interventional Procedures for Congenital Heart Disease

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Objective: Interventional techniques available for use in treating congenital heart disease include balloon dilation of valves and vessels, stent placement and coil embolization of collaterals, patent ducts, and other arterial fistulae. In addition, a variety of devices for the closure of atrial and ventricular septal defects and patent ducts currently are under investigation. Radiofrequency ablation of arrhythmias is also applicable to the pediatric population.
Methods: During the last 12 years, 522 patients with congenital heart disease had been treated with interventional procedures in our hospital. All of them had been diagnosed by transthoracic and transesophageal echocardiography. All patients had 1-day hospitalization.
Results: A total of 268 patients with atrial septal defects had been occluded with Amplatzer septal occluder, 50 patients had interventional closure of the persistent arterial channel between the aorta and pulmonary artery by Amplatzer AGA vascular plug and coil, and 35 patients achieved ventricular septal defect occlusion by Amplatzer septal occluder; balloon valvuloplasty of the congenital aortic valve stenosis was performed in 17 patients, and balloon valvuloplasty for pulmonary valve stenosis was performed in 120 patients. Aortic stent for the treatment of the aortic coarctation was implanted in 29 patients with an Amplatzer AGA vascular plug; coronary arteriovenous fistula was occluded in 3 patients. No mortality and no complications were noted. Follow-up period is up to 12 years.
Conclusions: Interventional catheterization has become solidified as an integral component of the comprehensive management of patients with essentially all forms of congenital heart disease. Patients are getting permanent solution with minimum adverse effects on their health.

P32
Small Is Beautiful: But Is It Also Better? An Evaluation of Different Minimally Invasive Repair Techniques of Atrial Septal Defects

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Objective: Minimally invasive techniques evolve in the repair of simple congenital heart defects. We evaluated our operative results using simplified operative methods to repair atrial septal defects, taking into consideration the safety of the circuit and the effectiveness of the repair.
Methods: Eighty-two adult patients underwent repair of atrial septal defects through minimal lateral thoracotomy, aortic clamping, and cardioplegia (group A, n=51) or minimal lateral thoracotomy and electrically induced fibrillation without aortic manipulation (group B, n=31). The patients were operated on at our institution between 2010 and 2015.
Results: The mean age of the cohort was 45 years (17–78 years) with an average weight of 79 kg (42–132 kg). Operation time took 161 minutes on average (72–390 minutes) with an average bypass time of 84 minutes (19–259 minutes). The cohort includes 79 patients with an ostium secundum defects and 3 patients with a sinus venosus defect. Group A received a single dose or subsequent doses of blood cardioplegia, whereas in group B, electrical ventricular fibrillation was induced. Group B showed a significantly shorter operation time (P=0.001) and bypass time (P=0.001) compared with group A.

Also, postoperative ventilation time was reduced significantly (P=0.001) in group B. There was no difference between the two groups concerning blood transfusion and hospital stay. In one patient of group A, a rest defect was identified in echocardiography postoperatively. In another three patients, an occluder implantation was necessary. There were no operative or late deaths.
Conclusions: Minimally invasive atrial septal defect closure gains popularity because of the superior cosmetic results combined with excellent repair results. The modification without aortic manipulation reduces the operative and perfusion time providing safety and effectiveness.

P33
Secundum Atrial Septum Defect Closure in Neonates and Infants: Scrutinizing Three Different Surgical Approaches Closely

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Objective: Surgical treatment of secundum atrial septal defect (ASD) in neonates and infants represents a standard procedure with very low morbidity and mortality. Variability in operative management of this lesion exists among surgeons. This study sought to compare the safety, efficacy, and clinical outcome of three different surgical approaches.
Methods: Between May 2009 to April 2015, 77 neonates and infants underwent surgical ASD closure. In 27 patients (mean age, 3.4±1.8 years), aortic cross-clamping, cardioplegia, and full sternotomy were used (group A); in 21 patients (mean age, 3.1±2.1 years) aortic cross-clamping, ventricular fibrillation, and full sternotomy were performed (group B), and 29 patients (mean age, 3.8±2.5 years) were operated on via ventricular fibrillation and lower partial sternotomy (group C). In all three groups, ascending aortic cannulation was performed to establish cardiopulmonary bypass.
Results: Thirty-day and overall mortality was zero in groups A, B, and C. There were no severe intraoperative complications or no conversion to full sternotomy in group C. Follow-up was 100% complete (2.4±1.8 years). Mean operation time and extracorporeal circulation time were significantly shorter in group C (P=0.001) (group A, 142±19/57±16 minutes; group B, 123±22/50±17 minutes; and group C, 118±14/41±11 minutes). Direct ASD closure was performed in 89% (group A), 85% (group B), and 81% (group C) of the patients. Blood transfusion requirement was lower in group C (P<0.05). There were no significant differences among groups A, B, and C regarding postoperative cardiac biomarker elevation, ventilation time, wound healing, and intensive care unit/hospital stay. Atrial septal defect closure rate was 100%. During follow-up, no redo surgery had to be performed.
Conclusions: Secundum ASD closure can be performed safely and effectively independent of the surgical approach used without impairment of perioperative and clinical outcome.

P34
Percutaneous Device Closure of Atrial Septal Defect Under Transesophageal Echocardiography With a Newly Designed Adjustable Sheath Through Right Internal Jugular Vein Without Fluoroscopy

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Objective: Transcatheter intervention through femoral veins under fluoroscopy has been the criterion standard for selected secundum atrial septal defects (ASD) with good results in the past 20 years. However, potential radiological injury and induced psychological worry have been a big problem. Furthermore, for small infants, this method is limited for the improper femoral vein. The diameter of internal jugular veins in young children is bigger than that of their femoral veins. We, therefore, tried percutaneous device closure of ASD under transesophageal echocardiography (TEE) through the right internal jugular vein without fluoroscopy.
Methods: Between June 2015 and September 2015, nine selected patients with secundum atrial septal defects were recruited. Their age ranged from 9 to 26 months, and their body weight ranged from 7 to 13.5 kg. The right internal jugular vein was punctured by a 20-gauge trocar. A guide wire and then a delivery sheath were introduced into the right atrium under real-time guidance of TEE. The sheath was curved into the left atrium by rotating the button at the end of the sheath. A proper device was selected according to the ASD size from TEE, and then, the device was released under real-time monitoring of TEE if no residual shunt and abnormal atrioventricular valvular motion appeared.
Results: Eight of the nine children were successfully device-closed through the right internal jugular veins without fluoroscopy. The other one was converted to conventional open heart repair because of an abnormal occluder shape. There was no operative or late mortality or major morbidity. All of them were followed up at 1 to 4 months. No residual shunt, increased aortic prolapse or regurgitation, or serious AVB was recorded until the most recent follow-up.
Conclusions: Selected secundum ASD can be safely closed with a proper occluder through the right internal jugular veins without fluoroscopy with satisfactory results.

P35
Percutaneous Transfemoral Technique for Atrial Septal Defect Closure Under Transesophageal Echocardiographic Guidance

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Objective: A sequential therapy for atrial septal defect (ASD) involves transcatheter closure, minithoracotomy peratrial device closure, minimally invasive endoscopic repair, and traditional median sternotomy approach. This retrospective study was aimed to introduce a percutaneous transfemoral technique for ASD closure under transesophageal echocardiographic (TEE) guidance to supply the therapy strategy.
Methods: Patients with isolated secundum ASD that underwent percutaneous transfemoral device closure between January and July 2015 were reviewed. The defects' morphological characteristics and the size of occluder were assessed by transthoracic echocardiography and intraoperative TEE. Under TEE guidance, a guide wire was placed into the right atrium from the right femoral vein percutaneously and was replaced by a deliver sheath to deploy the occluder (Fig. P35-1). The procedure and special relationship between the device and neighboring structures were examined.
Results: A total of 22 patients were enrolled, and their preoperative electrocardiogram revealed no significant abnormalities except one sinus rhythm with right bundle branch block. The diameter of the defects was 19.3±8.6 mm, and five patients presented with multiple defects. Finally, 95.55% (21/22) of the patients received closure successfully through this approach. The failed case was subsequently switched into a right anterior minithoracotomy device closure. The main reason for this failed closure was that the atrial septum was weak and dilated and developed into an atrial septal aneurysm, which partially covered the defect and made it difficult for the deliver sheath to cross. The size of occluder used was 24.6±5.7 mm (12–32 mm), and the deliver sheath was between 8F and 14F. No severe complications such as residual shunt, vascular dissection, embolism, or occluder shift were observed during the 3-month follow-up.

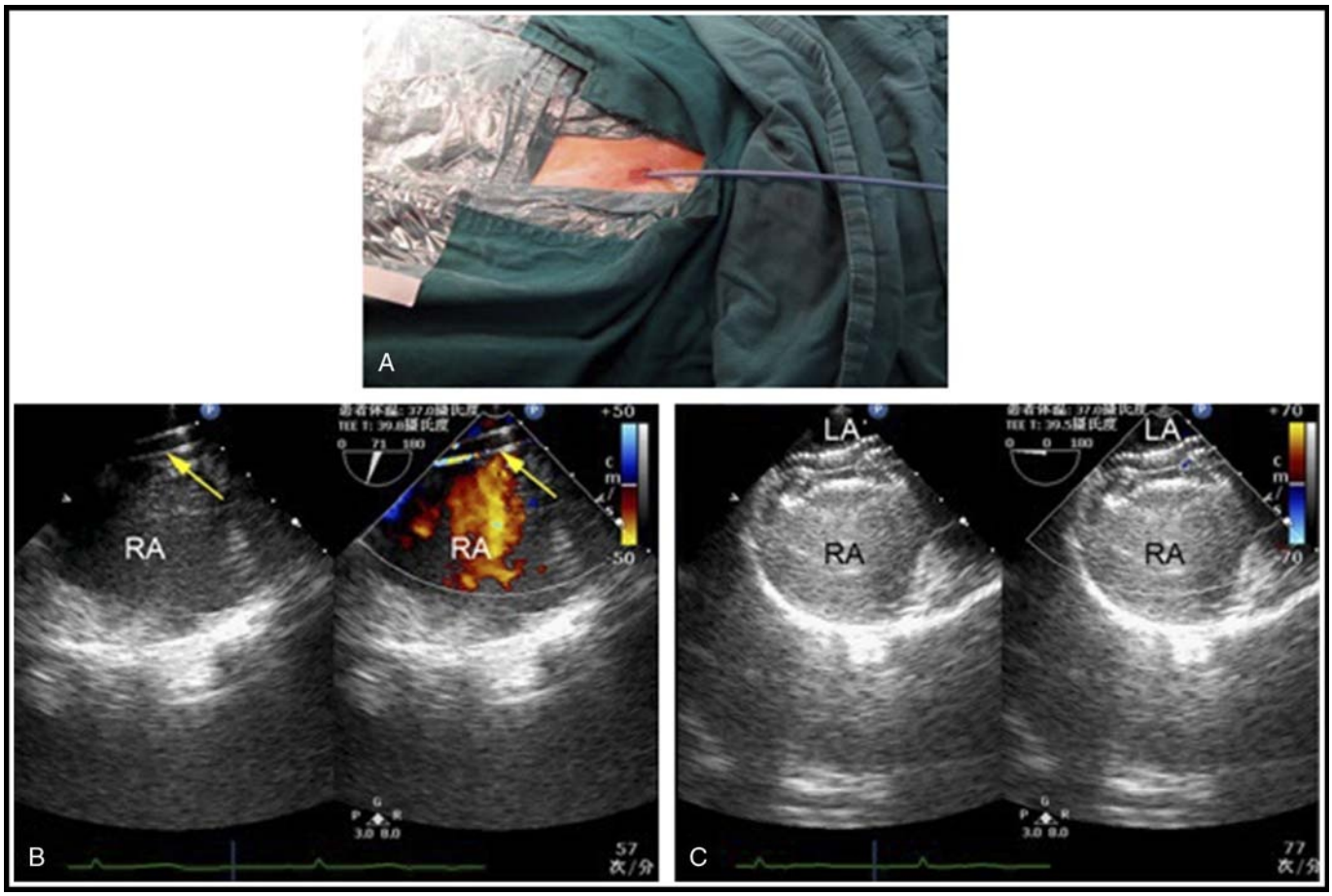

FIGURE P35-1. Sequential pictures showed a deliver sheath was placed into the RA from the right femoral vein percutaneously (A). The arrows indicate that the deliver sheath crosses the defect into the LA by adjusting the segment outside of the vessel (B), then the occluder was deployed step by step under TEE guidance (C). LA, left atrium; RA, right atrium; TEE, transesophageal echocardiography.

Conclusions: It is feasible and safe to perform percutaneous transfemoral approach for ASD device closure by skilled surgeons. Transesophageal echocardiography can be used as a primary tool for the assessment and guidance during the deployment, which can avoid both patient's and surgeon's exposure to radiation. Combined with previous approaches, percutaneous transfemoral technique could be applied as a supplement to ASD sequential therapy strategy.

P36
Two-Port Robotic Cardiac Surgery for Atrial Septal Defect Using Cross-Arm Technique

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Objective: We successfully performed totally endoscopic atrial septal defect (ASD) repair via two ports using the da Vinci surgical system (Intuitive Surgical, Inc, Sunnyvale, CA USA), and we named this procedure TROCS [two-port robotic cardiac surgery].
Methods: Anesthesia was induced using a double-lumen endotracheal tube. The patients were placed in a left hemilateral decubitus position. After systemic heparinization, an outflow cannula inserted transcutaneously into the right internal jugular vein and an inflow cannula and an outflow cannula were inserted into the right femoral artery and vein, respectively. Two ports were placed on the right side of the chest, and one of the ports was for robotic endoscope. Two robotic instruments were inserted through another port and crossed while preventing them from colliding with each other. At the same time, the master-instrument association at the surgeon console was set to the reverse of default settings so that the right master would control the left instrument and the left master would control the right instrument. Cardiopulmonary bypass (CPB) was initiated, and the superior vena cava was occluded with a small clamp. We performed ASD repair with the 0-degree robotic endoscope and 5-mm robotic instruments using cross-arm technique. Ventricular fibrillation (VF) is induced using combined methods of electrical fibrillator, injection of potassium, and hypothermia without aortic cross-clamp. The ASDs were directly closed with 4-0 Gore-Tex in-running suture. After defibrillation, the patient was weaned from CPB. The integrity of the ASD repair was confirmed by transesophageal echocardiography.
Results: Seven patients with secundum ASD underwent robot-assisted ASD repair under VF without aortic cross-clamp. The operation time was 133±29 minutes, CPB time was 69±26 minutes, VF time was 10±6 minutes, and no patient needed blood transfusion.
Conclusions: Two-port robotic cardiac surgery ASD repair using cross-arm technique was achieved safely with good clinical results and excellent cosmetic results.

P37
Endoscopic Radial Artery Harvesting Using a New ''Direct Heat'' Dissector in an All-Comer Clinical Setup

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Objective: Common endoscopic graft harvesting devices, based on ultrasound or bipolar cautery, take advantage of the surrounding tissue for heat application. In comparison, the MiFusion TLS2 system (Endotrust, Nettetal, Germany) applies a ''tissue-welding'' technique for direct tissue sealing and graft preservation. The device is used in an open nonsealed CO_2 insufflating setup.
Methods: We retrospectively analyzed the data of 337 consecutive all-comer patients who underwent endoscopic radial artery (RA) harvesting using the MiFusion TLS2 system for coronary artery bypass grafting between August 2014 and August 2015. Endoscopic RA harvesting is our standard graft harvesting technique, and all surgeons learn this technique since the beginning of their surgical training. There is no age limit and no general exclusion of emergency procedures. An Allen test result of 12 seconds or less is required for RA use.
Results: Mean age was 67±10 years with 81% male patients. Median body mass index was 28.6 kg/m^2, and 37% had diabetes mellitus. Eighty-five percent were isolated coronary artery bypass grafting procedures, and 60% of the RA grafts were used to bypass the circumflex territory. Of the patients, 14.3% had myocardial infarction within 30 days before surgery, and 4% were emergency procedures. Median RA harvesting time was 30 minutes. There was no graft injury caused by the harvesting technique. Thirty-day mortality was 0.8% for all patients, and the median length of stay was 8 days. No RA harvesting-associated wound healing complications occurred, and there were no neurological arm complications. Two patients (0.6%) required surgical removal of hematoma.
Conclusions: Endoscopic RA harvesting using the MiFusion TLS2 system is safe, demonstrates excellent graft results, and can be easily used in an all-comer daily routine.

P38
Non–Rib-Spreading Minimally Invasive Coronary Artery Bypass Grafting Using Three-Dimensional Endoscope

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Objective: Minimally invasive coronary bypass grafting (MICS CABG) through a left minithoracotomy may be associated with earlier recovery, better cosmetics, fewer transfusion, and fewer infections. We performed three-dimensional (3D) endoscopic harvesting of the left internal thoracic artery (ITA) for this procedure since 2012. However, we used hard retractor during harvesting left ITA and anastomosis of coronary arteries in early cases. Fully endoscopic harvesting of bilateral mammary arteries under closed chest using CO_2 insufflation has nowadays been established.
Methods: Five patients (3 female and 22 male; average age, 66 years) underwent MICS CABG using a 3D endoscope between February 2013 and December 2015. The 3D endoscope is inserted into the fifth or sixth intercostal space at the anterior axillary line. Another two or three additional 5-mm ports were used for harvesting ITA. Internal thoracic artery harvesting was performed using Harmonic Scalpel under fully endoscopic vision with closed chest. Right ITA harvesting was performed using the same method in three cases and using bilateral endoscope insertion in one case. We performed off-pump anastomosis of left ITA to the left anterior descending coronary artery through 5-cm left thoracotomy using soft tissue retractor without rib spreading. Right ITA was used on the diagonal branch in two cases and the obtuse marginal artery in two cases through a 7-cm skin incision.
Results: The endoscopic procedures were successful in 24 cases. Conversion to full sternotomy occurred in one case because of failure of harvesting left ITA. All patients underwent off-pump CABG. There was no operative mortality. Staged hybrid percutaneous coronary intervention was performed in three cases. Postoperative pain was less compared with MICS CABG procedure before using 3D endoscope.
Conclusions: Minimally invasive coronary bypass grafting using 3D endoscopic harvesting and non–rib-spreading anastomosis is a less invasive and painless procedure compared with conventional MICS CABG under direct vision using a hard retractor. The experience of harvesting bilateral ITA is a little and early stage of learning curve. However, this procedure might have the potential to develop MICS CABG for patients with multiple-vessel coronary artery disease with or without hybrid revascularization.

P39
Surgical Treatment of Single-Vessel Disease Increases

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Objective: Does the ability to perform beating heart robot-assisted small thoracotomy coronary artery bypass grafting (rCAB) change the patient population referred for coronary artery bypass (CAB)?
Methods: The safe introduction of rCAB was accomplished in 2005. We incorporated a weekly collaborative heart team approach to discuss cardiac catheterization findings for the treatment of patients with coronary artery disease. Since then, we have successfully performed 1320 rCAB procedures. The robotic procedure entails three port sites: two 1-cm ports at the third and seventh intercostal spaces and a camera port at approximately the fifth intercostal space, all approximately at the midclavicular line. After harvest of the left internal mammary artery and opening the pericardium, the camera port is converted to a small non–rib-spreading thoracotomy (approximately 4.2 cm), and with the use of a Medtronic nonthoracotomy stabilizer, beating heart surgery is performed. Patency is checked with transit time ultrasound, local analgesia is injected, and the incision is closed.
Results: In a retrospective review of all CAB, we have seen an increase in single-vessel disease ($P<0.0001$) and double-vessel disease ($P<0.05$, paired t test), as compared with The Society of Thoracic Surgery adult cardiac surgery database. Thirty-nine percent of all rCAB cases underwent hybrid coronary revascularization. This technique has safely and effectively reduced complications, length of stay (mean, 4 days), and mortality by 1% (predicted, 2%).
Conclusions: More patients enjoy the survival benefit of the left internal mammary artery to the left anterior descending artery when rCAB is available. Clearly, collaboration and a heart team approach are important in achieving these results. One could extrapolate that these same patients would otherwise be treated with medicine or stents. Offering rCAB as an alternative to on-pump CAB, sternotomy, or traditional mid-CAB approach has had a significant impact on the surgical treatment of coronary artery disease at the our institution. We agree that there are many cofounding factors to these changes seen in patients referred for CAB. Finally, having the ability to perform successful rCAB offers an important alternative to the traditional treatment of coronary disease and ultimately to patient care.

P40
Are Two Internal Thoracic Grafts Better Than One? Analysis of 4247 Cases Between 1996 and 2010

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Objective: Bilateral internal thoracic artery (BITA) grafting is associated with improved survival. However, many surgeons are reluctant to use this revascularization technique in patients with comorbidities such as diabetes and in elderly patients because of the risk of sternal infection and the excellent survival obtained with single internal thoracic artery (SITA). The purpose of this study was to compare early and long-term outcome of BITA grafting with that of SITA grafting and other conduits such as saphenous veins and radial artery in patients with multivessel coronary disease.
Methods: Two thousand seven hundred seventy-six patients who underwent BITA grafting between 1996 and 2010 were compared with 1471 who underwent SITA grafting.
Results: Patients undergoing SITA were older, more often female, more likely to have chronic obstructive lung disease, ejection fraction of less than 30%, recent myocardial infarction, diabetes, previous coronary artery bypass grafting, renal insufficiency, peripheral vascular disease, and emergency operation. They also had significantly higher mean EuroSCORE (7.6±4.3 vs. 5.4±3.9 in the BITA group, $P<0.001$). Operative mortality (3.7% vs. 2.2%, in the SITA and BITA, respectively; $P=0.003$) and occurrence of sternal infection (3% vs. 2%, $P=0.019$) were lower in the BITA group. Patients who underwent BITA grafting also had improved 10-year Kaplan- Meier survival (72.2% vs. 56.6% $P=0.037$); however, after propensity-score matching (1213 well-matched pairs), BITA was not associated with better adjusted survival (HR, 0.964; 95% confidence interval, 0.874–1.097; $P=0.574$, Cox model).
Conclusions: This large study does not support the routine use of BITA in all patients. Earlier mortality from noncardiac causes reduces contribution of BITA and increases the influence of comorbidities on Cox-adjusted survival. Selective use of BITA in lower-risk patients might unmask the benefits of BITA.

P41
Robot-Assisted Direct Coronary Artery Bypass: Does the Addition of Hybrid Increase Morbidity and Length of Stay in the Hospital?

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Objective: Patients after coronary revascularization surgery often receives blood product transfusion, which could delay their intensive care unit and hospital discharge. We elaborate the blood transfusion rate in all our robot-assisted direct coronary artery bypass (RADCAB) and compare their long-term outcome.
Methods: Between November 2003 and November 2015, 483 consecutive patients underwent RADCAB surgery. They were divided into two groups. One hundred forty-seven consecutive patients (group 1: mean age, 61.4±11.1 years; 22.5% female) underwent robot-assisted hybrid coronary artery revascularization with left internal thoracic artery to the left anterior descending artery and percutaneous coronary intervention to a non–left anterior descending vessel. Group 2 (336 patients) was composed of patients who underwent nonhybrid RADCAB, with a mean age of 61±10.4 years (37–87 years) and 25% of whom were female. Perioperative and late postoperative follow-up has been obtained with an average of 83.6±11.1 months.
Results: Blood transfusion rate in group 2 was 6.8% (23 patients), which included transfusion of fresh frozen plasma, platelet, and packed red blood cells in 15, 8, and 22 patients, respectively (Table P41-1). Based on the intraoperative cardiac catheterization, 12 grafts required revision. Four patients required exploration for bleeding. Postoperative gastrointestinal bleeding occurred in two patients. No patient developed renal failure. Postoperative coronary angiogram control and follow-up were performed in 100% of patients showing a 98% graft patency.
Conclusions: Despite the matched propensity of patient demography in both groups, we have observed a significant increment in the blood transfusion rate in group 1 that also led to a significant increment in reexploration for bleeding rate. Dual anticoagulation therapy in the hybrid group might be the cause. Nevertheless, it did not affect the length of intensive care unit or hospital stay. Moreover, the trend of having a better survival in the multiple coronary artery revascularizations through hybrid technique is encouraging to enroll more patients into this technique.

TABLE P41-1. Patients Outcome and Complication After RADCAB

% (n)	Group 1	Group 2
Hospital mortality	0	0.4 (2)
Conversion to sternotomy	4.7 (7)	16 (55)
Preoperative HBG level	140±16	110±16
Postoperative HBG level	144±13.4	114±15.9
Blood transfusion	14.2 (20)	6.8 (23)
ICU stay, d	1±1	1.2±1.6
Hospital LOS, d	4±2	5±3.7
Reexploration for bleeding	3.4 (5)	1.2 (4)
Reintervention for graft review	0.7 (1)	3.6 (12)
Wound infection	0	0.6 (2)

ICU, intensive care unit; LOS, length of stay; RADCAB, robot-assisted direct coronary artery bypass.

P42
Safety and Efficacy of Multivessel Off-Pump Coronary Artery Bypass Grafting Using Proximal Suture Device

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Objective: A proximal suture device (PSD) facilitates multivessel off-pump coronary artery grafting (OPCAB) without clamping the ascending aorta. The aim of this study was to investigate the results of OPCAB with the PSD regarding postoperative stroke and graft patency.
Methods: From 1997 to 2012, 1176 patients underwent isolated coronary artery bypass grafting (CABG). Since 2002, we have been using the PSD in OPCAB. The PSD was used for 376 patients (32.0%), aorta-no-touch OPCAB was performed in 532 patients (45.2%), on-pump beating CABG (on-beat group) was used in 125 patients (10.6%) including 51 conversions (conversion rate, 5.4%), and CABG with an aortic clamp was used in 152 patients (clamp group). In the PSD group, Enclose II (Vitalitec, Plymouth, MA USA) was used in 267 patients (71.0%).
Results: The overall incidences of hospital mortality and stroke were 1.53% and 1.79%, respectively. In patients with conversion from OPCAB, the rate of postoperative stroke was 0%. There was no early stroke (recovered from anesthesia with neurological deficit) in OPCAB, whereas it occurred in 0.8% in the on-beat group and 2.6% in the clamp group. The incidences of stroke at 1 month were as follows: PSD group, 1.6%; no-touch group, 1.3%; on-beat group, 1.6%; and clamp group, 4.6% ($P=0.018$). The rates of complete revascularization were higher in the PSD and clamp groups (94.7%, 81.5%, 84.9%, and 94.0%, respectively,

$P<0.001$). The patency rates of vein grafts and distal anastomosis were comparable between the PSD and clamp groups (proximal, 94.9% vs. 93.9%, $P=0.774$; distal, 93.9% vs. 95.7%, $P=0.656$). Multiple logistic regression analysis demonstrated that OPCAB reduced the risk of stroke compared with on-pump CABG [adjusted odds ratio (AOR), 0.34; 95% confidence interval (CI), 0.13–0.89; $P=0.029$]. Off-pump coronary artery grafting using the PSD did not increase the risk of stroke compared with the no-touch group (AOR, 1.40; 95% CI, 0.40–4.89; $P=0.594$) or the on-beat group (AOR, 0.99; 95% CI, 0.14–2.45; $P=0.206$) but reduced the risk of stroke compared with the clamp group (AOR, 0.19; 95% CI, 0.06–0.61; $P=0.005$).

Conclusions: Off-pump coronary artery grafting using the PSD demonstrated lower incidences of postoperative stroke and similar rates of graft patency and complete revascularization compared with conventional CABG.

P43
Single-Center Outcome of Coronary Artery Bypass Grafting for Kawasaki Disease Mainly With Arterial Graft Revascularization

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Objective: The aim of this study was to evaluate the midterm results of coronary artery bypass grafting for stenotic lesions by Kawasaki disease (KD).

Methods: From 2002 to 2014, 20 patients with stenotic coronary lesions caused by KD underwent coronary artery bypass grafting. Basic operative strategies were off-pump coronary bypass grafting with arterial graft revascularization. All clinical data and outcomes were retrospectively reviewed.

Results: There were 4 male (20%) and 16 female (80%) patients with age at operation ranging from 2 to 42 years (median, 17.5 years). The mean numbers of bypass grafts per patients was 1.7±0.6 (range, 1–3) and grafted target vessels per patients were 2.2±1.1 (range, 1–4). The left internal thoracic arteries were used in 19 patients, and right internal thoracic arteries were grafted in 10 patients. Gastroepiploic arteries and saphenous vein grafts were used in three and one patient, respectively. Mean follow-up duration from the operation was 59.5±48.5 months (range, 1–159 months). There was no early and late mortality. Among 20 patients, 2 underwent reintervention with balloon angioplasty because of graft failure. A patient also had graft failure, but reintervention was not performed. Two other patients underwent intervention because of new obstructive lesions that were not significant at the initial operation. Of the latter two, one was performed using percutaneous transluminal rotational ablation and another was performed using a redo operation. All patients but one are in good clinical condition without significant angina.

Conclusions: Off-pump coronary bypass grafting with mainly arterial graft revascularization can be considered a good surgical option for coronary lesions caused by KD.

P44
Off-Pump and On-Pump Coronary Artery Bypass Grafting by Experienced Surgeons: Excellent Contemporary Outcomes Regardless of Use of Cardiopulmonary Bypass

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Objective: This study aimed to compare the outcomes of on- and off-pump coronary artery bypass grafting (CABG) performed by two experienced surgeons (>15 years of clinical experience) in a single institution, one of whom exclusively intends to perform off-pump and the other, on-pump CABG.

Methods: We retrospectively analyzed prospectively collected data of 590 consecutive patients undergoing isolated CABG by two surgeons between July 2011 and February 2015; 293 (49%) off-pump procedures were performed by surgeon A, and 297 (51%) on-pump procedures were performed by surgeon B. Off-pump patients were more likely to have diabetes and severe lung disease, whereas on-pump patients were more likely to have higher number of previous percutaneous interventions and Syntax score (Table P44-1). The mean Society of Thoracic Surgeons score was not different between the two groups. Outcome measures for this study included hospital mortality, major postoperative complications, and length of hospital stay.

Results: The mean number of grafts was 3.4 in both groups. The overall hospital mortality was 0.85% (n=5). The mortality was not different between the groups (off-pump with 1.00% compared with on-pump with 0.70%, $P=0.6$). When comparing the off-pump with the on-pump group, the rate of major morbidities was not different (stroke, 1.4% vs. 1.3%, $P=0.99$; renal failure, 1.7% vs. 0.3%, $P=0.1$; and atrial fibrillation, 24% vs. 21%, $P=0.3$). Likewise, the median length of hospital stay (5 days for each group) was similar.

Conclusions: Excellent results after contemporary CABG can be obtained by experienced surgeons with an operative mortality of less than 1%. Among experienced surgeons, similar outcomes can be expected regardless of cardiopulmonary bypass with respect to completeness of revascularization and morbidity/mortality. Long-term studies are required to further confirm these early results.

TABLE P44-1. Preoperative Characteristics (590 Patients)

Variable	Off-Pump Group, Total, 293 Patients, n (%)	On-Pump Group, Total, 297 Patients, n (%)	*P*
Diabetes	195 (66.6)	175 (58.9)	0.060
Lung disease, moderate or severe	16 (5.5)	4 (1.3)	0.006
LVEF<20%	8 (2.7)	7 (2.4)	0.770
Previous PCI	78 (26.6)	112 (37.7)	0.004
Syntax score, median	27.0	37.8	<0.001
STS predicted mortality	1.9	1.5	0.057

LVEF, left ventricular ejection fraction; PCI, percutaneous coronary intervention; STS, The Society of Thoracic Surgeons.

P45
Benefit of Off-Pump Coronary Artery Revascularization Technique in Diabetic Patients

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Objective: Diabetes mellitus is recognized as a risk factor for mortality and morbidity after coronary artery bypass grafting (CABG). There is some evidence of off-pump surgery (OPCAB) being beneficial in diabetic patients. The aim of this study was to examine if the strategy of revascularization had an impact on outcomes.

Methods: This was a single-center, retrospective study in which during a 4-year period, 2202 consecutive patients undergoing isolated, primary, CABGs were included. Diabetes was defined as those having an HbA1c level greater than 6.5 and were on medications for diabetes. Based on the strategy of revascularization, the patients were placed in group A (OPCAB) or group B (conventional CABG). The groups were compared for baseline, operative characteristics, and postoperative outcomes.
Results: Incidence of adverse neurological and renal complications were significantly lower in diabetic patients undergoing OPCAB. The need for higher inotropic support or intra-aortic balloon pump, incidence of atrial fibrillation, and respiratory complications were all significantly higher in patients undergoing revascularization using cardiopulmonary bypass (Table P45-1). Early mortality in diabetic patients was significantly better with OPCAB as the strategy of revascularization (1.89% vs. 4.79%; odds ratio, 2.61; 95% confidence interval, 1.52–4.02).
Conclusions: Off-pump coronary artery bypass as a strategy of revascularization in diabetic patients undergoing coronary artery bypass leads to significantly better outcomes.

TABLE P45-1. Comparison of Postoperative Outcomes in OPCAB and Conventional On-Pump

Outcomes	OPCAB (n=1639)	On-Pump (n=563)	*P*
High inotropic support	14 (0.9%)	38 (6.7%)	<0.001
Atrial fibrillation	197 (12%)	117 (20.8%)	<0.001
Need for intra-aortic balloon pump	63 (3.8%)	46 (8.17%)	<0.001
Postoperative renal impairment	37 (2.3%)	39 (6.92%)	<0.001
Neurological complications	40 (2.4%)	32 (5.7%)	<0.001

OPCAB, off-pump coronary artery bypass.

P46
Effect of Surgical Timing and the Use of Bilateral Internal Thoracic Artery Grafting on Outcome of Patients After Acute Myocardial Infarction

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Objective: The long time required to get patients with myocardial infarction (MI) to surgery and the efficiency of primary percutaneous intervention and fibrinolysis in restoring myocardial blood supply have resulted in the less common use of coronary artery bypass grafting (CABG) as the first-line reperfusion strategy for patients with acute MI. The purpose of this study was to compare early and long-term outcome of CABG for patients with acute MI, according to the time interval between hospital admission and surgery and the use of bilateral internal thoracic (BITA) grafting.
Methods: Eight hundred ninety-one patients with multivessel coronary disease underwent CABG after acute MI (<7 days) between 1996 and 2010. They were stratified according to the timing of surgery: 336 were operated on within 24 hours of symptom onset (emergency group), whereas 555 were operated on between 1 and 7 days (nonemergency group).
Results: Emergency patients were older, less often female or diabetic, and more likely to have unstable angina, ejection fraction of less than 30%, preoperative critical state, and left main disease. They were less likely to undergo BITA grafting and more likely to have their surgery performed after percutaneous intervention. Operative mortality (9.2% vs. 2.2%, $P<0.001$) and occurrence of perioperative MI (5.4% vs. 1.1%, $P<0.001$) were higher in the emergency group. Sternal wound infection (3% vs. 1.8%) and stroke (3.9% vs. 2.5%) were not significantly different between the groups. Mean follow-up was 12.9±2.2 years. Kaplan-Meier 10-year survival of BITA patients was better in both groups [66.4% vs. 49.9.9% ($P=0.004$) in the emergency group and 73.9% vs. 52.9% ($P<0.001$) in the nonemergency group; $P=0.004$]. After adjustment for propensity score, operative timing and assignment to BITA were not predictors of improved long-term survival; however, the interaction of BITA grafting and nonemergency operation was associated with improved survival. Thus, nonemergent patients undergoing BITA grafting have significantly better survival (HR, 1.256; $P=0.038$).
Conclusions: This study shows better early outcome for patients with acute MI operated on later than 24 hours after symptoms onset; this improved early outcome is associated with better long-term survival when CABG is performed using BITA grafting.

P47
Repeat Revascularization After Minimally Invasive Coronary Artery Bypass Grafting: Is It a Problem?

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Objective: Minimally invasive coronary artery bypass grafting (MICS CABG) via a small left thoracotomy is a novel technique for coronary revascularization that is increasingly used around the world. However, multivessel MICS CABG is difficult, and concerns about repeat revascularization have been raised. This study describes the rates of repeat revascularization among patients who have undergone MICS CABG and identifies targets for improvement.
Methods: A prospective observational study was performed on the 306 MICS CABG patients operated on by a single surgeon from 2005 to 2015. Minimally invasive coronary artery bypass grafting was performed through a small thoracotomy, using the in situ left internal mammary artery, ± a radial artery, and 1 to 3 saphenous veins anastomosed proximally to the aorta. Patients were followed annually. We examined the difference between the first and second half of the series to ascertain the effects of a learning curve.
Results: Eighty percent of the procedures were done off-pump. The median number of grafts done was 2, and the LAD, diagonals, OMs, and PDA were the distal targets in 94%, 12%, 44%, and 26%, respectively. The graft-ability index (grafts/acceptable distal territory targets of ≥1.5 mm) was 0.93. Revascularization of targets less than 1.5 mm decreased from 69% to 50% ($P=0.002$) between the series' first and second halves. Overall, repeat revascularization was needed in 21 patients (6.9%) and was performed at a mean (SD) of 629 (600) days postoperatively. The culprit lesion was attributed to the index surgical procedure (''graft-associated'') in 52%, to a stent stenosis or progression of native disease in 43%, and was unidentified in 5%. Patients with graft-associated repeat revascularization had a lower graft-ability index at operation (0.73 vs. 0.94) and more frequent involvement of the circumflex system (0.8 vs. 0.3, $P<0.05$). The overall rate of repeat revascularization at 3 years decreased from 11% in the first half to 2.6% in the second half ($P=0.001$).
Conclusions: The need for repeat revascularization is part of the learning curve with MICS CABG, involves a graft in half of the cases, is more common in patients who had a lower graft-ability index at operation, and markedly improves with experience.

P48
The Midterm Clinical Outcomes of Hybrid Procedure for Treating Patients With Multivessel Coronary Artery Diseases

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Objective: This study aimed to evaluate the midterm clinical outcomes of using lower partial sternotomy off-pump coronary artery bypass (OPCAB) and percutaneous coronary intervention (PCI) to treat patients with multivessel coronary diseases.
Methods: From March 2010 to May 2015, 132 patients with multivessel diseases underwent hybrid procedure of OPCAB and PCI for myocardium revascularization. There were 79 male and 53 female patients; the average age was 64.5 years. Two-vessel diseases were 26 cases, and triple-vessel diseases were 106 cases. Left ventricular diameters were 4.7±0.8 mm, and left ventricle ejection fraction was 0.42 to 0.65. All patients accepted PCI and were implanted drug-eluting stents before OPCAB. Lower partial sternotomy was used to graft the left internal mammary artery to the left anterior descending artery under general anesthesia 3 to 5 days after PCI procedure.
Results: A total of 286 drug-eluting stents were implanted in 132 patients, and all patients successfully underwent OPCAB for left internal mammary artery–to–left anterior descending artery grafting. The average number of revascularization vessels was 3.16. The intensive care unit stay was 21.6 hours, and the average hospital stay was 8.5 days after OPCAB. There was no perioperative myocardial infarction and no hospital mortality. All patients were followed up for 3 to 62 months, and there were no major adverse cardiovascular events.
Conclusions: Our limited experiences of hybrid coronary revascularization indicate that lower partial sternotomy OPCAB combined with PCI is a safe and feasible hybrid coronary revascularization for treating patients with multivessel coronary disease. The long-term outcomes need to be observed.

P49
Comparison of the Outcomes Between Open Thoracotomy Versus Minimally Invasive Thoracoscopic Esophagectomy in Esophageal Cancer

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Objective: The first choice for treatment of esophageal cancer is surgery. There is controversy in the selection of the best surgical approach. We compared minimally invasive versus open esophagectomy in short-term outcomes and preoperative complications.
Methods: We performed a clinical trial between 2011 and 2013 in Ghaem Hospital (Mashhad, Iran). Sixty-one patients underwent minimally invasive esophagectomy (MIE) or open surgery (OE). The parameters included age, sex, site of lesion, amount of bleeding, duration of surgery, rate of conversion to OE, postoperative morbidity, duration of hospitalization, and mortality.
Results: Sixty-one patients (60.7% male, 39.3% female) were enrolled in this study, with a mean age of 62.39±11.91 years. There was no significant statistical difference in the site of lesion and stage of tumor (site of lesion, P=0.014; stage of tumor, P=0.108). There was no statistical difference in blood transfusion between the two groups (P=0.981). In postoperative complications, we found one fistula (1.6%) in the MIE group and two pleural effusions (3.3%) and one wound infection (1.6%) in the OE group. There was no significant difference between the two groups in postoperative complications. Surgery duration took longer in the MIE group than in the OE group (170.68 vs. 150.47 minutes, P<0.001). There was one patient in the MIE group whose procedure was converted to an open approach. Hospitalization duration was significantly longer in the OE group (MIE group, 7.68 days; OE group, 9.13 days; P<0.001). We did not have any mortality in our cases.
Conclusions: Our evidence shows that the MIE result is comparable with that of the OE and improves short-term outcomes.

P50
First-Year Experience in Minimally Invasive Robot-Assisted Esophagectomy in a Large Academic Referral Center

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Objective: Radical transthoracic esophagectomy with en bloc lymphadenectomy is based on multimodal treatment with curative intent for cancer but is associated with higher incidence of complications. Minimally invasive and robot-assisted esophagectomy are being used to reduce surgical trauma and morbidity. The aim was to report our initial experience with robot-assisted minimally invasive esophagectomy, evaluating its feasibility, safety, and oncological adequacy.
Methods: This is a retrospective study using a prospective database of 20 consecutive patients (16 men and 4 women; mean age, 62.8 years) who underwent subtotal (robot-assisted Ivor-Lewis esophagectomy) or total esophagectomy (robot-assisted McKeown esophagectomy) for esophageal cancer from July 2014 to December 2015 at our institution.
Results: We performed 15 subtotal esophagectomies (robot-assisted Ivor-Lewis esophagectomy) and 5 total esophagectomies (robot-assisted McKeown esophagectomy) without intraoperative complication and conversion. Median operative time was 553 minutes (including cart setup and positioning), and estimated blood loss was 100 mL. Median intensive care unit stay was 1 day, and median overall postoperative hospital stay was 10 days. In-hospital mortality rate was 5% (n=1), and overall morbidity rate was 45% (n=9): pulmonary complications were observed in two patients (10%), gastric conduit ischemia in one (5%), symptomatic anastomotic leak in two (10%), and radiological leak in one (5%). Two clinical anastomotic leaks were surgically treated, whereas the others were managed conservatively. The majority of patients had T3 disease (7 patients, 35%) and 45% had nodal involvement. All resections were radical (100% was R0), and the median number of lymph nodes was 30.
Conclusions: This preliminary experience suggests that robot-assisted transthoracic esophagectomy for malignant lesions is a real surgical option to conventional surgery with satisfying results in terms of feasibility, safety, and oncological adequacy.

P51
Early Experience With Robot-Assisted Minimally Invasive Collis Gastroplasty

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Objective: Collis gastroplasty is often necessary to obtain adequate, tension-free subdiaphragmatic esophageal length during gastric fundoplication. We wanted to report our early experience with a robot-assisted approach to these procedures.
Methods: This study was a retrospective review of patients undergoing Collis gastroplasty via a robot-assisted minimally invasive approach.
Results: From June 2014 to December 2015, a total of 29 sequential patients underwent robot-assisted minimally invasive repair of hiatal hernia with or without gastric fundoplication. Of the 18 patients undergoing fundoplication, 10 received Collis gastroplasty. Patient demographics and selected perioperative outcomes for these procedures are reported in Table P51-1. Median operative time, estimated blood loss, and hospital length of stay were within reported norms. There were no open conversions or postoperative leaks observed.

Conclusions: Our early institutional experience suggests that Collis gastroplasty can be safely used. Although robotic assistance, including the use of improved stapler technologies, may potentially improve the conduct of operation in these procedures, this needs to be evaluated in a larger series of patients.

TABLE P51-1. Patient Demographics and Perioperative Outcomes of 10 Patients Undergoing Robot-Assisted Nissen Fundoplication With Collis Gastroplasty

	n (%)
Hernia type	
1	5 (50)
2	0 (0)
3	4 (40)
4	1 (10)
Fundoplication	
Nissen	5 (50)
Near-Nissen	5 (50)
Conversions	0 (0)
Postoperative leak	0 (0)
	Median (IQR)
Age, y	70 (67–74)
Operating time, min	354 (222–417)
Estimated blood loss, mL	30 (20–50)
Hospital LOS, days	5 (4–6)

IQR, interquartile range; LOS, length of stay.

P52
Advantages of Robotic Approach for Plication of Diaphragm for Eventration

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Objective: Diaphragm plication surgery is performed for symptoms of dyspnea, which results from mediastinal shift, atelectasis, and ventilation/perfusion dyssynchrony in lungs, which occur because of an eventrated diaphragm. We describe our experience with robotic thoracoscopic plication for the treatment of diaphragmatic paralysis.
Methods: Seven patients underwent diaphragm plication surgery by robotic approach from 2012 to 2015. All patients underwent left sided eventration repair. A three-arm approach for plication was used. Carbon dioxide insufflation was performed to bring the hemidiaphragm down to create working space. Nonabsorbable suture was used to plicate.
Results: Six of the seven patients successfully underwent robotic plication. One patient had to be converted open because it was difficult to achieve single-lung ventilation. Mean operating time was 203 minutes; no major complications occurred during the surgery or the postoperative period. All patients were discharged after postoperative day 3. At 12-month follow-up, no recurrence was observed.
Conclusions: Advantages of robotic plication compared with thoracoscopic include ease of endoplication of the diaphragm, working on three-dimensional system, less postoperative pain, and shorter hospital stay, yet technical difficulties due to limited workspace and by the ribcage and the elevated hemidiaphragm have been a major drawback in using the robotic approach for this disorder.

P53
Redo Paraesophageal Hernia Repair Is Associated With Excellent Symptomatic and Objective Outcomes

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Objective: Recurrence after primary paraesophageal hernia (PEH) repair is common. Each attempt to repair recurrent hernias at other sites such as the abdominal wall is associated with worse outcomes. The aim of this study was to evaluate the outcome with redo PEH repair.
Methods: A retrospective chart review of all patients who underwent a redo PEH repair from September 2009 to July 2015 was performed.
Results: There were 29 patients (16 female and 13 male patients) who had a redo repair for PEH recurrence. The median age was 60 years. The previous operation was performed a median of 97 months (range, 3 days to 31 years) before the reoperation. The previous operation was performed laparoscopically in 83% of the patients and included a Nissen (n=19), partial (n=2), or unspecified fundoplication (n=8). The indication for the reoperation was recurrence of symptoms (83%), persistent dysphagia (10%), and early recurrence of an intrathoracic stomach (7%). All patients had objective evidence of a PEH. The reoperation was laparoscopic in 13 (45%) and open in 16 (55%). The laparoscopic procedure was converted to open in four patients. During the reoperation, a Collis gastroplasty was added for esophageal shortening in 16 patients (55%), and 2 patients had diaphragmatic relaxing incisions to reduce crural tension. An absorbable mesh was placed to reinforce the crural closure in all patients. Median operative time was 171 minutes, estimated blood loss was 150 mL, and the median hospital stay was 6 days. There were two postoperative complications, a reintubation, and postoperative atrial fibrillation. There were no mortalities. At a median follow-up of 10 months, symptoms were resolved or improved in all patients. Objective follow-up was available from 79% of the patients, and there were no recurrent hernias.
Conclusions: Recurrence after PEH is common, and some patients require reoperation. Redo repair is more complicated and is more commonly performed as an open procedure. During the reoperation, 55% of the patients had an adjunct procedure for esophageal shortening or crural tension. Early symptomatic and objective results are excellent, supporting the value of reoperation in appropriate patients.

P54
Uniportal Video-Assisted Thoracoscopic Surgery Thymectomy for Myasthenia Gravis

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Objective: Advances in minimally invasive thoracic surgery have encouraged more and more neurologists to refer patients with myasthenia gravis to thoracic surgeons for thymectomy as a potential cure of their disease. We present our experience with uniportal thymectomy.
Methods: A 38-year-old Afghani national with myasthenia gravis under treatment for the last 2 years was referred to our team by our neurologist. Computed tomographic scan showed no evidence of a mediastinal mass. Uniportal video-assisted thoracoscopic surgery (VATS) was performed through a single incision of 3.0 cm, and the thymus gland along with the entire anterior mediastinal fat was resected. Chest drain insertion was performed through the same incision
Results: The total operative time was 132 minutes, and there was minimal blood loss. Patient was extubated on table and sent to the intensive care unit. Chest drain was removed on postoperative day 1, and the patient was discharged on postoperative day 2 with oral analgesics.
Conclusions: Video-assisted thoracoscopic surgery thymectomy is now an acceptable technique for complete thymectomy for myasthenia gravis and avoids a big sternotomy. Uniportal or single-incision VATS is a step forward

in this direction. It offers a quicker, less painful recovery, and an excellent cosmesis without compromising the principles of thymic resection.

P55
Unilateral Video-Assisted Thoracoscopic Thymectomy in the Treatment of Thymic Tumor: A Single Surgeon's Experience

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Objective: A standard surgical treatment of thymoma and thymic carcinoma is a complete en-bloc resection of the tumor and thymus. Video-assisted thoracoscopic thymectomy is commonly performed bilaterally to remove thymus. We performed unilateral approach and evaluated the surgical and oncological outcomes of thymoma and thymic carcinoma.
Methods: We retrospective reviewed 31 consecutive patients from 2011 to 2014 who received unilateral video-assisted thoracoscopic near total thymectomy for thymic tumor at single institution in Korea. In the case of stage IVA, thymectomy with partial pleurectomy was performed for removal of all metastatic lesions. We analyzed patient demographics, perioperative management and patient outcomes.
Results: A total of 31 patients were included in our study. The mean age was 52.5 years (range, 28–77 years). 26 patients were thymoma (type A(2), Type AB(3), Type B1(10), Type B2 (4) Type B3 (7)) and 5 patients were thymic carcinoma. 10 patients were stage I, 19 patients were stage II, and 2 patients were stage IVA. The right side approach was often preferred (Rt; 21 cases, Lt; 10 cases). The mean hospital stay was 2.4(±2.0) days and mean duration of chest tube drainage was 1.3(±1.2) days. There was no morbidity and mortality. The conversion rate to open thymectomy was 6.4% (N=2). The median follow-up time for all patients was 28.3 month (range, 0.3–51.5 months). During follow-up period, disease recurrence occurred in 1 (3.2%) with stage I thymoma (type B1). The 3-year overall survival rate was 100%, and the 3-year recurrence free survival was 96.3%.
Conclusions: Unilateral video-assisted thoracoscopic thymectomy for thymoma or thymic carcinoma is feasible with good surgical and early oncological outcomes. Further investigation for long-term oncological outcomes is required to confirm these findings.

P56
Video-Assisted Thoracoscopic Surgery Resection of Mediastinocervical Thymic Cysts

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Objective: It is very rare for a thymic cyst to manifest as a lateral neck swelling. It usually requires a cervical incision and a sternotomy for complete resection. We have a series of three pediatric patients who were managed by a combined mediastinocervical approach using video-assisted thoracoscopic surgery (VATS) and would share one such video.
Methods: Between August 2014 and May 2015, three pediatric patients (<10 years) presented in the outpatient with intermittently appearing painless neck swelling especially upon coughing. All were diagnosed to have mediastinocervical cysts, and they underwent simultaneous resection of the neck component by a transverse cervical incision and mediastinal component resection by VATS.
Results: All three cysts were left sided, and their mediastinal component was seen arising from the substance of the thymus gland. Mediastinal resections could be completed by VATS. Chest drains were removed on first postoperative day in all patients. One patient developed left lower lobe atelectasis.
Conclusions: The use of VATS for the resection of the mediastinal part of thymic cysts helps avoid a big sternotomy in these young group of patients, leading to a quicker and less painful recovery, and gives better cosmesis.

P57
Robotic Surgery Compared With Median Sternotomy for Thymic Mass Resection

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Objective: The aim of this study was to compare outcomes between open and robotic surgery for resection of thymic masses.
Methods: A retrospective review was conducted on patients with surgically resected thymic masses from 2000 to 2014. Data collected included patients' demographics, history of myasthenia gravis, medical comorbidities, and histopathology. Postoperative morbidity and mortality were analyzed and compared.
Results: A total of 49 patients were eligible for this study. Twenty underwent open surgery via median sternotomy (40.8%), and 29 underwent robotic surgery (59.2%). Patients' characteristics and outcomes are presented in the figure and stratified according to surgical approach (Table P57-1). Postoperative complications occurred in three patients who had open surgery and none of the robotic surgery patients (P=0.062). One patient required reopening for bleeding, and the other two patients developed myasthenic crisis postoperatively. In patients with thymoma, the Masaoka stages and World Health Organization grades were similarly distributed across both groups.
Conclusions: Our study shows that the robotic approach in resection of thymic masses is associated with a decreased postoperative intensive care unit and hospital length of stay. Robotic surgery is currently the approach of choice at our institution in suitably selected patients.

TABLE P57-1. Patient Characteristics and Outcomes

	Open Surgery (n=20)	Robotic (n=29)	*P*
Preoperative data			
Age, y	50 (36.8–58.5)	55 (39–66.5)	0.392
Male	11 (55%)	15 (52%)	0.821
Myasthenia gravis	11 (55%)	15 (52%)	0.821
Diabetes	3 (15%)	2 (7%)	0.387
Hypertension	4 (20%)	14 (48%)	0.07
Hyperlipidemia	3 (15%)	13 (45%)	0.035
Ischemic heart disease	1 (5%)	0	0.408
Operative data			
Operative time, min	100 (77.5–107.8)	100 (86–162.3)	0.855
ICU stay, d	1 (0–1)	0 (0–1)	0.001*
Postoperative hospital stay, d	5 (4–5)	2 (2–3)	0.007*
Histopathology			
Thymoma	13 (65%)	12 (41%)	0.039*
Thymic cyst	0	8	0.017
Benign thymic hyperplasia	2	5	0.692

*Statistically significant values.
ICU, intensive care unit.

P58
Experiences of Single-Port Video-Assisted Thoracoscopic Surgery Thymectomy Through the Subxiphoidal Incision Without CO_2 Insufflation

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Objective: Single-port video-assisted thoracoscopic surgery (VATS) thymectomy through the subxiphoidal incision was introduced by some authors.

They reported that CO_2 insufflation to the mediastinum was needed for securing the retrosternal space with an air-tight trocar sleeve. It is useful, but sometimes, it causes hypotension because of extrinsic compression of the heart and cannot provide the optimal space for the surgery. We present our experiences of single-port VATS thymectomy through the subxiphoidal incision using a wire and Kent retractor under the one-lung ventilation without CO_2 insufflation.

Methods: Single-port VATS thymectomy through the subxiphoidal incision was attempted in eight patients in our institute from August 2014 to November 2015. Two patients were converted to sternotomy or bilateral VATS thymectomy because of uncontrollable bleeding due to an injury of the internal mammary artery and technical difficulties. Six patients underwent the surgery as planned. Surgical procedure was performed in the supine position and under the general anesthesia using a double-lumen endotracheal tube. A subxiphoidal incision (approximately 4 cm) was made on the xiphoid process. The xiphoid process was resected. After blunt dissection of the retrosternal space, an X-small sized wound retractor was applied. The mediastinal pleura were opened bilaterally, and a wire was passed the retrosternal space through the bilateral fourth intercostal space. The wire was lifted up using a Kent retractor for securing the retrosternal space. After the bilateral phrenic nerves were examined, the thymectomy was performed with an ultrasonic scalpel and a 5-mm 30-degree thoracoscope under one-lung ventilation.

Results: We performed the thymectomy in four patients with thymoma and extended thymectomy and in two patients with thymic hyperplasia and myasthenia gravis successfully. The mean operation time was 180 minutes. The mean duration of the chest tube drainage was 3.7 days. The mean duration of the hospital stay was 7.5 days. There was no surgical mortality and complication.

Conclusions: In our experiences, single-port VATS thymectomy through the subxiphoidal incision using a wire and Kent retractor under one-lung ventilation without CO_2 insufflation was feasible. To evaluate the feasibility of single-port VATS thymectomy through the subxiphoidal incision, more experiences would be required.

P59
Lessons Learned: Minimally Invasive Resection of Mediastinal Pathology

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Objective: This study aimed to review our experience using minimally invasive techniques including carbon dioxide insufflation to resect pathology of the mediastinum.

Methods: An institutional review board–approved retrospective review of a prospectively maintained database was performed from January 2013 to October 2015. Patients undergoing minimally invasive resection of a mediastinal mass were selected for review.

Results: Twenty-five patient charts were reviewed. Location of the pathology was anterior in 16, middle in 2, and posterior in 7. Pathologic diagnoses are seen in Table P59-1. Carbon dioxide insufflation was used in all cases. There were no adverse events related to carbon dioxide insufflation. A single-lumen tube was used in 19 of the 25 patients. Three patients underwent conversion: one was aborted, and two underwent resection. Length of stay ranged from 0 to 9 days with a mean of 2 days for video-assisted thoracoscopic surgery and a mean of 4 days for those that were converted (range, 2–6 days). Of the video-assisted thoracoscopic surgery procedures, 3 patients were discharged on postoperative day 0 and 12 were discharged on postoperative day 1. There were no readmissions. There were no complications.

Conclusions: The majority of mediastinal pathology is amenable to a minimally invasive approach. Large substernal goiters are least likely to be successfully resected with this approach. Carbon dioxide insufflation facilitates resection without the need for double-lumen tube placement in many patients. The majority of patients undergoing a minimally invasive approach for mediastinal pathology have a short length of stay. The use of these techniques when possible will likely be associated with better outcomes and lower costs when compared with open approaches.

TABLE P59-1. Pathologic Diagnosis from Mediastinal Mass Resection

	VATS (n=22)	Conversion (n=2)
Cyst	3	—
Goiter	1	2
Schwannoma	4	—
Thymic hyperplasia	4	—
Thymoma	3	—
Other	7	—

VATS, video-assisted thoracoscopic surgery.

P60
The Incidence and Clinical Burden of Air Leak Complications in Lung Surgeries: A Retrospective Analysis of a US Hospital Database

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Objective: Prolonged air leaks (>5 days) are a commonly studied complication with significant patient morbidity, but the impact of any air leak is less well understood. This study assesses the incidence, risk factors, and clinical impact of air leaks during the hospital episode of care.

Methods: The Premier Perspective Database contains billing data from more than 600 hospitals in the United States. All elective primary lobectomy, segmentectomy, and wedge resections from 2012 to 2014 were identified. During the index hospitalization, air leak complications (ALCs) were identified as a composite of air leak and pneumothorax *International Classification of Diseases, Ninth Revision*, diagnosis codes. Patient, procedure, and hospital factors were identified (Table P60-1) and included in multivariate models evaluating ALC risk factors and the impact of ALC on index hospitalization mortality and length of stay (LOS). The multivariate models accounted for the clustering of patients within hospitals; $P<0.05$ was considered to be statistically significant.

Results: A total of 21,150 patients undergoing lung surgery were included in the analysis: lobectomy (n=10,946), segmentectomy (n=1788), and wedge (n=8416). The overall incidence of ALC was 24.26% [95% confidence interval (CI), 23.68–24.83] and varied with resection type: lobectomy, 29.20% (95% CI, 28.35–30.05); segmentectomy, 22.04% (95% CI, 20.11–23.96); and wedge, 18.30% (95% CI, 17.47–19.12). Relevant risk factors for ALC included (Table P60-1) resection type, thoracotomy surgical approach, male sex, indication for surgery, and presence of chronic obstructive pulmonary disease. The overall mortality in the study sample was 1.06% (95% CI, 0.92–1.20), and the mean±SE LOS was 5.7±0.04 days. After controlling for patient, procedure and hospital factors, ALC was associated with increased mortality (odds ratio, 1.90; 95% CI, 1.42–2.55) and increased mean LOS of 2.5 days ($P<0.01$).

Conclusions: This analysis shows that multiple patient, procedural, and provider characteristics increase the risk for ALC. Air leak complications after lung resections not only are a frequent complication but also are associated with increased mortality and hospital LOS.

TABLE P60-1. Logistic Regression Model for Occurrence of ALC (n=21,150)

Variable	Effect	OR	95% CI	
Resection type (reference: lobectomy)	Segmentectomy	0.769	0.668	0.885
	Wedge	0.726	0.661	0.798
Approach (reference: VATS)	Thoracotomy	1.132	1.008	1.271
Race (reference: white)	African American	0.958	0.835	1.100
	Other	1.055	0.902	1.234
Sex (reference: female)	Male	1.108	1.037	1.184
Age (reference: >74 y)	18–44	1.369	1.098	1.705
	45–54	0.928	0.786	1.096
	55–64	0.899	0.789	1.026
	65–74	1.012	0.926	1.105
Marital status (reference: single)	Married	0.928	0.858	1.004
	Other	1.035	0.805	1.331
Payer (reference: other)	Commercial	0.915	0.708	1.182
	Medicaid	0.923	0.699	1.219
	Medicare	0.948	0.734	1.225
Year of surgery (reference, 2014)	2012	0.854	0.751	0.971
	2013	0.960	0.866	1.064
Primary indication (reference: cancer)	Pulmonary fibrosis	0.803	0.687	0.938
	Other	1.177	1.026	1.351
Teaching status (reference: nonteaching)	Teaching	0.996	0.829	1.197
Hospital bed size (reference: >500 beds)	1–300	1.078	0.832	1.397
	301–500	1.084	0.842	1.395
Provider region (reference: West)	Midwest	1.065	0.792	1.430
	South	0.905	0.707	1.158
	Northeast	0.691	0.497	0.963
Provider urbanicity (reference: urban)	Rural	1.088	0.854	1.385
Hospital volume of lung resections (reference: >300 surgeries)	1–50	0.927	0.601	1.429
	51–150	0.927	0.589	1.460
	151–300	1.203	0.740	1.955
Provider costing type (reference: RCC)	Procedural	1.067	0.894	1.274
Physician specialty (reference: thoracic surgeon)	Cardiac surgeon	1.046	0.895	1.222
	General surgeon	0.939	0.767	1.148
	Other	0.996	0.812	1.221
Charlson comorbidity index (reference: >4)	Score of 0	0.648	0.555	0.758
	Score of 1–2	1.024	0.923	1.136
	Score of 3–4	1.260	1.156	1.373
Specific comorbid conditions	COPD	1.803	1.630	1.994
	Depression	0.963	0.865	1.073
	Hypertension	0.911	0.852	0.975
	Diabetes	0.821	0.746	0.903
	Obesity	0.631	0.554	0.719

CI, confidence interval; COPD, chronic obstructive pulmonary disease; OR, odds ratio; RCC, Ratio of cost to charge method; VATS, video-assisted thoracic surgery.

P61
Is There Clinical Benefit in 12-mm Single-Port Surgery in Spontaneous Pneumothorax?

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Objective: In recent years, thoracic surgeons have attempted single-port surgery, which is expected to provide less pain and early recovery. However, the benefits are unclear. The purpose of this study was to determine the benefits of 12-mm single-port surgery in spontaneous pneumothorax.
Methods: A total of 86 patients in primary spontaneous pneumothorax treated by surgery were reviewed retrospectively between July 2013 and May 2015. Visual analog scale, paresthesia, and clinical outcomes were reviewed [46 patients: with three-port video-assisted thoracoscopic surgery (VATS) and 40 patients with a 12-mm single port].
Results: The mean age was 23.4 years in three-port VATS and 22.4 in single port (P=0.247). The height and body weight were not significantly different between two groups. The mean operation time was 39 minutes in three-port VATS and 37.3 minutes in single port, without statistically significant difference (P=0.204). The visual analog scale scores were not significantly different at the immediate postoperative period, at 8 hours, and at 16 hours (P=0.552, P=0.687, and P=0.176, respectively). The pain score in single-port surgery was significantly lower at 24, 32, and 40 hours (P=0.028, P=0.008, and P=0.011, respectively). The postoperative hospital stay was significantly longer in three-port surgery (P<0.001). However, the pain score was not different 1 week after discharge.
Conclusions: The pain score reduction was found 1 day after the operation in the single-port group. However, the score is only improved by 1 point, and the pain score was not different 1 week after discharge. Considering young age in primary spontaneous pneumothorax, the benefit of single-port surgery in spontaneous pneumothorax was minimal.

P62
Does Abrasion Pleurodesis Increase the Morbidity of Video-Assisted Thoracic Surgery for Primary Pneumothorax?

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Objective: Pneumothorax surgery is a frequently used model to investigate the impact of surgical approach on postoperative morbidity. However, the criticism that abrasion pleurodesis during such surgery may confound results by introducing additional morbidity has not been specifically investigated.
Methods: Prospectively collected data on consecutive patients receiving video-assisted thoracic surgery (VATS) for primary pneumothorax were retrospectively reviewed. Patients with secondary pneumothorax were excluded. All patients received similar surgery with bleb resection, with or without pleural abrasion performed according to surgeon preference. The size of the study cohort was calculated to demonstrate a difference in 1 point on a 10-point analog pain score (α=0.05; power, 80%).
Results: The data for this cohort are summarized in the Table P62-1. There was no difference between the study arms in all major demographic and clinical characteristics. There was no mortality or major complication in all patients. Intraoperatively, pleural abrasion did not increase operation times or blood loss. Postoperatively, mean chest drain durations and lengths of stay were similar in the two study arms. Abrasion patients had a trend for higher total volume of fluid drained at the time of drain removal, but the absolute difference was clinically trivial (63 mL). On a 10-point analog scale, pain scores on the first and second days after surgery were similar between the study arms, with a nonsignificant trend for lower mean score in the abrasion group on the first postoperative day. All patients were given regular acetaminophen, and the requirement for additional analgesia (oral tramadol) for breakthrough pain was similar in the two study arms. After discharge, the study arms were similar in terms of time until complete resolution of pain, time until resumption of normal activity/work, and incidence of paresthesia.
Conclusions: Abrasion pleurodesis does not add significant pain or morbidity to primary pneumothorax surgery. The pneumothorax surgery model can continue to be used to assess different surgical approaches. Further study is needed to determine the role of abrasion pleurodesis on pneumothorax recurrence.

TABLE P62-1. Characteristics and Outcomes of the Study Cohort

	No Abrasion (n=22)	With Abrasion (n=14)	*P*
Baseline characteristics			
Sex	18 (81.8%)	11 (78.6%)	0.810
Mean age, y	26.9±7.7	31.9±8.7	0.092
Smoking history	6 (27.3%)	5 (35.7%)	0.592
Previous episodes of pneumothorax	11 (50.0%)	4 (28.6%)	0.204
Duration of symptoms prior to admission, h	65.3±101.6	121.1±140.5	0.211
Presentation with chest pain	22 (100.0%)	13 (92.9%)	0.204
Presentation with dyspnea	2 (9.1%)	4 (28.6%)	0.126
Presentation with cough	3 (13.6%)	1 (7.1%)	0.546
Right-sided pneumothorax	13 (59.1%)	7 (50.0%)	0.593
Estimated size of pneumothorax on presentation, %	50.5±24.3	57.1±24.2	0.430
Outcomes			
Mean operation time, min	75.9±31.9	81.3±32.4	0.641
Mean blood loss, mL	16.4±7.7	18.6±18.8	0.681
Mean chest drain duration, h	40.1±77.2	37.1±26.6	0.872
Mean total drainage at time of drain removal, mL	76.3±97.6	139.3±110.1	0.097
Mean length of stay, d	3.7±1.6	3.9±1.9	0.687
Mean pain score on postoperative day 1 (0–10)	3.0±0.9	2.4±0.8	0.068
Mean pain score on postoperative day 2 (0–10)	2.5±0.6	2.1±0.9	0.172
Mean use of ''as required'' tramadol on postoperative day 1, mg	125.0±99.7	146.4±79.6	0.481
Mean use of ''as required'' tramadol on postoperative day 2, mg	104.5±104.6	100.0±76.0	0.881
Mean duration until complete absence of pain, d	45.5±53.1	37.9±30.8	0.586
Mean duration until resumption of normal activity/work, d	21.7±12.7	26.4±25.4	0.530
Paresthesia after surgery	14 (63.6%)	5 (35.7%)	0.102

P63
Video-Assisted Thoracoscopic Surgery Versus Axillary Thoracotomy in Primary Spontaneous Pneumothorax

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Objective: Video-assisted thoracic surgery (VATS) has expanded its role in the treatment of primary spontaneous pneumothorax. We performed this study to compare the outcomes of this technique with those obtained by thoracotomy.
Methods: Forty patients were divided into two groups: VATS (n=20) and thoracotomy (n=20). In both groups, the blebs were resected and pleural abrasion was performed with a mesh put on the apical surface of the parietal pleura, and patchy pleurectomy and mechanical abrasion with gas were performed. Two groups were well matched for age, sex, side of bleb, indication for surgery, and smoking habit. Conversion from VATS to thoracotomy and early complications including wound infection, air leakage, and intraoperative bleeding were evaluated. After discharge, follow-up included visits at 1, 3, and 6 months as well as 1 year after the operation to evaluate the recurrence rate.
Results: Mean age of these 40 patients (34 males and 6 females) was 28.4±8.74 years. There was no conversion from VATS to thoracotomy. Complications including prolonged air leakage and wound infection were seen in three patients of each group (P=0.712). One patient in the VATS group experienced recurrence (P=0.235). Average hospitalization time (P=0.043), duration of surgery (P<0.001), and intraoperative bleeding (P<0.001) were significantly less in VATS group.
Conclusions: Video-assisted thoracic surgery seems to be superior to thoracotomy when it is indicated due to recurrence or other reasons because despite similar therapeutic efficacy and recurrence rate, VATS is associated with less traumatization of tissues and less hospital stay.

P64
Can Neurovascular Bundle-Sparing Thoracotomy Rival Video-Assisted Thoracoscopic Surgery in Terms of Pain Scores?

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Objective: Video-assisted thoracoscopic surgery (VATS) has become the criterion standard for lung cancer resection and constitutes a key component of enhanced recovery programs. However, certain patient characteristics ensure that an open approach may sometimes be essential. Numerous publications have championed VATS to be superior primarily because of better postoperative pain scores. We postulated that post-thoracotomy pain can be reduced by protecting the neurovascular bundle. We sought to determine whether there is a difference in patient-reported pain scores and hospital length of stay (LOS) between those undergoing lobectomy via VATS compared with neurovascular bundle-sparing thoracotomy (NVBST).
Methods: We retrospectively analyzed an e-database of prospectively entered data of all lobectomies for primary lung cancer performed by one surgeon over 1 year. For VATS, standard three-port posterior approach was used (Fig. P64-1). For NVBST, 8-cm serratus-sparing posterolateral incision was used; closure was effected using intracostal sutures (Size 2 Vicryl) running through four holes drilled into the lower rib (Fig. P64-2). In all patients, paravertebral catheters and a single chest drain were sited. Pain scores on postoperative days 0, 1, 2, and 3 and LOS were compared.
Results: From September 2014 to September 2015, there were 93 lobectomies (39 NVBST, 54 VATS). There was no significant difference between the age, sex, and side of surgery. Postoperatively, pain scores were similar in both groups, although there was a shorter length of stay in patients who underwent VATS lobectomies. There was no statistically significant difference between pain scores, but LOS was longer for NVBST (8 vs. 6.5 days, P=0.004).
Conclusions: Our study shows that there is no difference in pain scores after lobectomy via VATS versus NVBST. However, LOS is shorter for VATS. The establishment of VATS as a standard technique for lung resection has catalyzed the parallel evolution of improved thoracotomy techniques. Continued development of both techniques as part of enhanced recovery programs will ensure better outcomes for all patients undergoing lung cancer resection.

FIGURE P64-1. 3-port approach for Video Assisted Thoracoscopic Surgery (VATS).

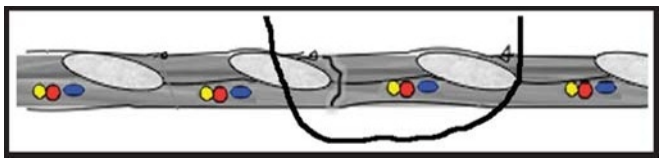

FIGURE P64-2. Intracostal placement of sutures.

P65
Patient-Controlled Epidural Analgesia Provides Better Analgesia Than Intravenous Patient-Controlled Analgesia for Patients After Thoracotomy

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Objective: Intravenous patient-controlled analgesia (IVPCA) and patient-controlled epidural analgesia (PCEA) were studied in terms of analgesic efficacy, respiratory function, and adverse effects after thoracic surgery for 24 hours. Patient-controlled epidural analgesia using fentanyl and bupivacaine as compared with IVPCA using morphine provides better pain relief both at rest and during coughing and is associated with fewer adverse effects. This study compares IVPCA and PCEA in terms of analgesic efficacy, respiratory function, and adverse effects after thoracic surgery.
Methods: Thirty ASA I or II patients undergoing thoracotomy were assigned randomly to receive either IVPCA using morphine or PCEA using fentanyl and bupivacaine combination postoperatively. No background infusion was administered in either group. Postoperative evaluation included pain intensity both at rest and during coughing, degree of sedation, arterial blood gas, forced

vital capacity, peak expiratory flow rate, presence of adverse effects (such as nausea/vomiting), and pruritus at 0, 2, 8, 12, and 24 hours. The primary outcome of the study was the percentage of patients with analgesia failure defined as a VAS score greater than 30 despite three consecutive PCA boluses requiring rescue analgesia with intravenous fentanyl. The data were analyzed using *t* test, χ^2 test, and Mann-Whitney *U* test.
Results: Significantly fewer patients required rescue analgesia in the PCEA group ($P<0.05$). Pain relief was better both at rest and during coughing ($P<0.05$) in the PCEA group as compared with those in the IVPCA group. Patients in the PCEA group were less sedated and had fewer incidences of adverse effects, that is, nausea/vomiting and pruritus. Postoperative forced vital capacity and peak expiratory flow rate were reduced significantly compared with baseline only in the IVPCA group ($P<0.05$).
Conclusions: After thoracotomy, PCEA using fentanyl and bupivacaine as compared with IVPCA using morphine provides better pain relief both at rest and during coughing and associated with fewer adverse effects.

P66
The Role of Single-Photon Emission Computed Tomography–Computed Tomography to Predict Postoperative Pulmonary Function in Patients With Marginal Pulmonary Function

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Objective: In the current era of minimally invasive thoracic surgery, an accurate estimation of postoperative pulmonary function in a patient with marginal pulmonary reservoir is important because it can guide in the determination of the optimal extent of safe surgical resection at the segmental level. Integrated single-photon emission computed tomography–computed tomography (SPECT/CT) provides patient-specific three-dimensional images, which can overcome the limitations of planar images related to overlaps of anatomic segments and variability of lobar shape, which can vary according to patient's underlying pulmonary conditions. We compared SPECT/CT with planar perfusion scintigraphy (PPS) in terms of predicting postoperative pulmonary function.
Methods: From March to October 2015, we selected 12 patients whose predicted forced expiratory volume in 1 second (FEV1) or diffusing capacity of the lung for carbon monoxide were less than 80% of normal. Single-photon emission computed tomography–computed tomography was performed using Technetium-99m–labeled macroaggregate of albumin, and PPS was conducted at the same time. We compared the predicted postoperative (ppo) values calculated from PPS and SPECT/CT and analyzed the differences of the two methods according to the underlying lung disease.
Results: The median age was 65 years (range, 53–82 years). Underlying lung diseases varied; bronchiectasis, obstructive lung disease, emphysematous lung, interstitial lung disease, and chronic empyema. The median preoperative predicted FEV1 and diffusing capacity of the lung for carbon monoxide were 76.5% (range, 28%–111%) and 65% (range, 31%–118%), respectively. The median estimated ppoFEV1 using PPS and SPEC/CT were 59.2% (28.0%–101.8%) and 60.2% (26.4%–101.2%), respectively. We found significant correlation between the two methods evaluating lobar perfusion (right upper lobe, $r=0.663$; right lower lobe, $r=0.883$; left upper lobe, $r=0.734$; left lower lobe, $r=0.706$) except for right middle lobe ($P=0.339$, $r=0.303$). We found that if the patient had localized destructive lesions (patients 1, 2, 3, and 8), the ppoFEV1 estimated by SPECT/CT and that measured by PPS were different by more than 5% points. On the other hand, if the patients had either diffuse parenchymal abnormality or obstructive lung disease without definite parenchymal lesions, the ppoFEV1 estimated both methods showed similar values (Table P66-1).
Conclusions: Single-photon emission computed tomography–computed tomography seems to be useful in estimating postoperative pulmonary function if patients have localized parenchymal destructive lesion. In patients with either diffuse parenchymal disease or normal lung, PPS can provide comparable postoperative lung function with SPECT/CT. In addition, SPECT/CT may guide surgeons to decide the extent of segmentectomy as it can visually display the amount of perfusion.

TABLE P66-1. Patients Characteristics and Estimated Pulmonary Function by SPECT/CT and PPS

Case Number	Sex/ Age	Underlying Lung Disease	Abnormal Lobe	Clinical Diagnosis	Target Lobe	Resection Type	Predicted FEV1, %	Predicted DLCO, %	ppoFEV1 (PPS), %	ppoFEV1 (SPECT), %	ppoDLCO (PPS), %	ppoDLCO (SPECT), %
1	F/60	BE, COPD	LLL	Lung cancer	LLL RML	Lobectomy Lobectomy	48.0	59.0	37.4	46.2	46.0	56.8
2	M/63	BE, fungus ball	LUL/LLL RUL/RLL	Inflammatory lung disease	LUL/LLL RUL/RLL	Segmentectomy (S1–2)/wedge resection (S6) Segmentectomy (S1–2)/wedge resection (S6)	98.0	73.0	54.4	60.4	40.5	45.0
3	F/53	BE, ILD, right-sided diaphragmatic eventration	BLL	Suspicious lung cancer	LLL	Wedge resection (S10)	80.0	31.0	56.1	75.8	21.7	29.4
4	M/54	IPF	BLL	Lung cancer	LLL	Lobectomy	68.0	67.0	63.7	66.0	62.8	65.1
5	F/68	Huge empyema	LLL	Inflammatory lung disease	LLL	Wedge resection (S9)/decortication	28.0	41.0	28.0	26.4	41.0	38.7
6	M/62	Emphysema, COPD	Diffuse	Lung cancer	RLL	Segmentectomy (S7–10)	103.0	63.0	81.1	84.3	49.6	51.5
7	F/67	IPF	BLL	Lung cancer	LUL	Wedge resection (S4)	78.0	43.0	64.9	60.0	35.8	33.1
8	F/55	BE, emphysema	BLL	Lung cancer	RUL	Segmentectomy (S2)	78.0	80.0	56.6	47.7	58.1	49.0
9	M/70	COPD	No	Lung cancer	RML	Lobectomy	75.0	118.0	65.8	69.2	103.5	108.8
10	F/74	Asthma	No	Lung cancer	RLL	Lobectomy	71.0	82.0	61.8	59.4	71.4	68.6
11	M/70	Emphysema, COPD	Diffuse	Lung cancer	RUL	Lobectomy	48.0	72.0	40.2	42.0	60.2	63.1
12	F/82	PTE	RML	Lung cancer	RML	Lobectomy	111.0	59.0	101.8	101.2	54.1	53.8

BE, bronchiectasis; BLL, bilateral lower lobe; COPD, chronic obstructive pulmonary disease; CT, computed Tomography; DLCO, diffusing capacity of the lung for carbon monoxide; FEV1, forced expiratory volume in 1 second; ILD, interstitial lung disease; IPF, idiopathic pulmonary fibrosis; LLL, left lower lobe; LUL, left upper lobe; ppoDLCO, predicted postoperative DLCO; ppoFEV1, predicted postoperative FEV1; PPS, planar perfusion scintigraphy; PTE, pulmonary thromboembolism; RLL, right lower lobe; RML, right middle lobe; RUL, right upper lobe; S1, apical segment; S10, posterobasal segment; S2, posterior segment; S4, superior lingular segment; S6, superior segment; S7, mediobasal segment; S8, anterobasal segment; S9, laterobasal segment; SPECT, single-photon emission computed tomography.

P67
Minimally-Invasive Sublobar Resection of Tiny Pulmonary Nodules With Real-Time Image Guidance in the Hybrid Theater

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Objective: Localization of tiny lung nodules during video-assisted thoracic surgery (VATS) sublobar resection can be challenging. Real-time image-guided

hook wire localization of target lesions immediately preceding lung resection in the hybrid operating theater setting is an emerging approach.
Methods: We retrospectively reviewed our experience with the real-time image guidance of hook wire insertion for lung nodules 1.5 cm or less using cone beam computer tomographic scan, followed immediately by VATS sublobar resection in the same operating suite and session.
Results: From February 2014 to October 2015, tiny lung nodules of indeterminate nature in 19 consecutive patients with mean nodule size 7.7±3.4 mm (range, 2–15 mm) underwent the procedure. All were localized accurately by hook wire and successfully resected. Five patients (26.3%) developed pneumothorax after hook wire insertion, but none required intervention. The mean operative time was 128.5±60.6 minutes, and the mean blood loss was 25.5±15.0 mL. The mean chest drain duration was 2.6±0.9 days, and the mean postoperative length of stay was 3.6±1.7 days. There were no postoperative complications or mortality. There were 14 malignant (73.7%) and 5 benign lesions, all with adequate resection margins.
Conclusions: Real-time image-guided hook wire localization in the hybrid theater setting is a safe and effective technique for VATS resection of tiny lung nodules. Its potential advantages over the traditional approach warrant further studies.

P68
Minimally Invasive Treatment of Metastatic Pleuritis

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Objective: Metastatic pleuritis is one of the most frequent complications of malignancy. The course of the disease in more than half of the patients with disseminated forms of cancer is complicated with the development of metastatic pleuritis. One of the key moments in the treatment of metastatic pleuritis is the formation of pleurodesis. The most effective of the known methods is chemical pleurodesis with talc (90%). Suggested method allows us not only to create a pleurodesis but also to maximize the chance in the removal of metastases of the parietal pleura. The aim of the study was to assess the results of thoracoscopic treatment of metastatic lesions of the pleura.
Methods: This method is used by us in the treatment of 34 patients with metastatic pleuritis. Primarily, these patients had lung cancer (24 patients), breast cancer (8 patients), and ovarian cancer (2 patients). To create pleurodesis and destruction of metastases, we used a radiofrequency ablation device Fotek-150 with monopolar electrode. Under control of the thoracoscopy, the electrode was introduced through the thoracoport metastasis on the parietal pleura. Then, the current of high frequency was supplied with power of 60 W at an exposure time of 1 minute. Within a radius of 3 cm around the electrode, the coagulation zone with the destruction of metastatic node was formed. Operation was finished with pleural cavity drainage followed by 30 mg of bleomycin introduced into the pleural cavity.
Results: Recurrence of metastatic pleuritis appeared in three patients after 1 and 2 months after surgical intervention. In 91.2% of the patients, effective pleurodesis with the decrease in pleural exudation during 5 months was achieved.
Conclusions: (1) The use of radiofrequency ablation combined with the use of bleomycin not only allows to achieve stable pleurodesis but also liquidates metastasis on the parietal pleura. (2) This method requires additional clinical research.

P69
Use of Hybrid Techniques to Improve the Learning Curve for Video-Assisted Thoracoscopic Surgery

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Objective: Video-assisted thoracoscopic surgery (VATS) has been gaining importance as the criterion standard technique for various thoracic resections. This article presents the use of videoscope along with minithoracotomy to perform technically difficult VATS and improve the learning curve for performing VATS.
Methods: A series of 1043 VATS procedures were performed between 2011 and 2015. Of which, 103 cases were performed as a hybrid technique where minithoracotomy was made along with video-telescope at the thoracoscopic port. The advantages of this dual access were ease in instrumentation, visualization, lighting, retraction, and hand-eye coordination. In addition, this technique allows immediate access under direct vision for urgent control of bleeding, which can be difficult using a conventional thoracoscopic approach.
Results: Of 103 cases, 74 were males and 29 were females, with a mean age of 54 years (range, 22–82 years). The cases included anatomical anomaly, severe dense adhesions, identifications of very small/deep seated malignant lesions for biopsy, lobectomy, decortication, pneumonectomy, sleeve resections for carcinoid, and bronchoplasty. The mean operative time was 92 minutes. There were no conversions to conventional thoracotomy. Mean hospital stay was 3 to 4 days. Chest tube duration was 2 to 3 days. There was no mortality. The results were favorable compared with conventional VATS procedures and showed a feasibility of the hybrid technique.
Conclusions: The results suggest that every open thoracic surgery should have a thoracoscopic port for better visualization of anatomy, technique, and hand-eye coordination, which will further enhance the learning curve for VATS.

P70
A Uniportal Thoracoscopic Major Pulmonary Resection

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Objective: The preferred thoracoscopic approach to lung resection varies among surgeons. Typically, three or four incisions are required. We have a fundamental commitment to a ''reduced-port surgery,'' and our approach has evolved from a three-incision method to use of a single incision 3 to 3.5 cm in length. Herein, we report our early experience (2 years) with uniportal thoracoscopic major pulmonary resections.
Methods: We analyzed the outcomes of successful uniportal thoracoscopic lobectomies and anatomical segmentectomies with special reference to the methodologies used and whether conventional instruments were used. However, we prefer the following techniques: the shaft-on-shaft approach, pulley method, one-hand encircling, one-hand exposure, extra vessel exposure, and ''move-the-ground.''
Results: Of 14 attempted uniportal approaches to major lung resections (primary lung cancer in 11 patients and metastatic cancer in 3), 11 were successfully completed (in three patients, the operations were converted to three-port approaches). The procedures included eight lobectomies (right lower in five cases, left lower in one, right upper in one, and right middle in one) and three segmentectomies (one each in the right S6 region, the left basal, and the left lingular). The median surgical time was 180 minutes; the median duration of chest tube residence was 2 days; and the median hospital stay was 4 days. No major complication developed, and no hospital death was recorded.
Conclusions: Uniportal thoracoscopic anatomical resection is feasible, is safe, and affords good perioperative results. However, the selection criteria for the approach will limit the use thereof.

P71
Treatment Outcomes of Anatomical Lung Resection in Single-Port Video-Assisted Thoracoscopic Surgery for Stage I Lung Cancer

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Objective: We have already reported the beneficial effects of single-port video-assisted thoracoscopic surgery (SPVATS) for patients with stage I lung cancer (*Eur J Cardiothorac Surg* 2016;49:i37–i41). So far today, the anatomical lung resection in SPVATS has been performed in 84 patients. We examine the effectiveness of SPVATS and elucidate on its technical knack.

Methods: In the SPVATS, an approximately 4-cm small incision was placed at the fourth or fifth intercostal space from the anterior to posterior axillary line.
Results: A total of 84 patients underwent anatomical lung resections, of whom 80 underwent lobectomy while 4 underwent segmentectomy. The ratio of sex (male to female) was 51:33, and the median age was 68.5±9.5 years. The mean forced expiratory volume in 1 second and maximum size of tumor were 1.85±0.31 L and 2.8±0.3 cm, respectively. The median operation time and blood loss were 175±35 minutes and 85±25 mL, respectively. The median drainage duration and postoperative hospital stay were 1.6±0.7 and 7.5±1.9 days, respectively, and the mean number of dissected lymph nodes was 14.8±3.5. The mean maximum of CPK showed 360±29 IU/mL. The mean of NRS on postoperative day 7 and 30 was 2.7±0.4 and 1.6±0.5, respectively. The number of days when analgesic agents were used within a month after surgery was 8.3±1.2. Two patients (2.4%) were required conversion to open thoracotomy.
Conclusions: Anatomical lung resection in SPVATS should be considered as a treatment option for stage I lung cancer. The knack of SPVATS is presented as follows. (1) To perform a safer operation, the operator should manipulate the forceps to raise the vascular sheath above the scissors, avoiding touching the tips. This creates a more three-dimensional view, prevents chances of damage, and provides an easier line of sight. (2) Dissecting the vessels and bronchus to the peripheral side is needed more than usual. (3) There is a need to master the ligation treatment including transfixing suture to the vessels via the single access at the fourth or fifth intercostal space. In SPVATS, the handling of forceps and scissors and the acquirement of the vessel ligation technique are difficult for the surgeon at first; however, I believe that practiced surgeons can master this operative procedure.

P72
Single-Port Video-Assisted Thoracoscopic Surgery for Primary Lung Cancer: A Single-Center Experience

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Objective: As the technique of video-assisted thoracoscopic surgery (VATS) evolved, single-port VATS lobectomy became possible, and its advantages have been reported. We analyzed our experiences to evaluate the feasibility of single-port VATS lobectomy for primary lung cancer.
Methods: Single-port VATS lobectomy for primary lung cancer was attempted in 40 patients in Haeundae Paik Hospital from June 2012 to November 2015. In seven patients, the surgery was converted to open thoracotomy or three-port VATS lobectomy. Single-port VATS lobectomy was performed in 33 patients as planned. All patients underwent a lobectomy and systematic lymph node dissection using 5-mm 30-degree thoracoscope through 4- to 5-cm single incision. R0 resection was performed in all patients. We reviewed the medical records of these patients retrospectively.
Results: There were 23 male and 10 female patients. Left upper lobectomy was the most frequent resection (11 patients). There was severe pleural adhesion in 10 patients. Twenty-two patients (66.7%) had an incomplete fissure. The mean number of the dissected lymph node was 29.3±13.3 (range, 10–63). The mean number of the explored nodal stations was 6.4±1.3 (range, 4–9). The mean size of tumor was 2.7±1.2 cm (range, 1.3–6.0). The mean operation time was 224.7±81.5 minutes (range, 100–495), and it was getting shorter gradually as our experience with the procedure grew. The operation time of the patients with complete fissure was shorter than that of the patients with incomplete fissure (P=0.003). However, pleural adhesion and tumor size was not associated with the operation time. The mean duration of the chest tube drainage was 6.5±3.9 days (range, 2–22). The mean duration of the hospital stay was 11.0±5.8 days (range, 6–34). There was no surgical mortality. There was a postoperative chylothorax in one patient.
Conclusions: In our experience, single-port VATS lobectomy for primary lung cancer was safe and feasible. To evaluate the feasibility of single-port VATS for primary lung cancer, more experiences and long-term follow-up would be required in well-selected patients.

P73
A Simplified Minimally Invasive Technique Operation for Mitral Valve Repair: Better With Less Risk

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Objective: Mitral valve repair (MVR) has been proven to be the best treatment of mitral regurgitation in degenerative disease. Repair rate is high in dedicated centers through sternotomy. Right minithoracotomy is an appealing approach because of its minimal surgical trauma but entails greater technical difficulties. A simplified minimally invasive technique (SMIT) allows an easier approach with a smooth learning curve. Here, we analyze our experience with SMIT operation for elective MVR.
Methods: From January 2009 to January 2015 we operated on 262 patients (mean age, 55.7±12 years) for degenerative prolapse or flail with the SMIT procedure as follows: (1) chest opening in the third intercostal space, (2) insertion of a percutaneous venous cannula in the femoral vein, (3) direct cannulation of the ascending aorta, (4) a flexible aortic cross-clamp applied through the skin incision, and (5) antegrade cardioplegic arrest with crystalloid solution.
Results: There were no technical complications related to the perfusion technique and/or surgical access. Repair rate was 99.6% (261 patients); a second pump run was necessary in 2.67% of the patients (7 patients). Hospital mortality rate was 0.38% (one patient) but not related to the operative technique. We had three conversions to sternotomy (1.1%). No patient had a low output syndrome or a poor myocardial protection or wound infections. Mean follow-up was 3.6±1.6 years (range, 1.2–6.9). Actuarial freedom from reoperation at 6 years was 100%; actuarial freedom from greater than 2+ mitral regurgitation recurrence at 6 years was 96.8%; actuarial freedom from valve endocarditis was 100%; actuarial freedom from atrial fibrillation at 6 years was 82.1%; and global survival at 6 years was 97.9%. New York Heart Association class of 2 or lower at 6 years is present in 92.4% of the patients. Overall freedom from event was 77.7% at 6 years (95% confidence interval, 5.4–6.5).
Conclusions: The MVR with SMIT operation provides a less invasive and easier approach with a very high repair rate. We recommend the SMIT operation for every new program for minimally invasive MVR.

P74
Incremental Improvements in a Minimally Invasive Mitral Repair Program

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Objective: The learning curve for minimally invasive mitral valve surgery is long. As our program continues to grow, we examine whether there are incremental improvements in patient outcomes.
Methods: We retrospectively examined a prospectively collected database of all patients in our minimally invasive mitral valve program. Patients were divided into tertiles according to the date of their procedure, and comparison was made between the first and third tertiles. Procedures were performed between March 2011 and November 2015.
Results: A total of 140 minimally invasive procedures were performed in total, of which 114 were minimally invasive mitral valve repairs with or without concomitant procedures. There were no differences between the two groups in terms of baseline characteristics: age (60.2 vs. 59.0 years, P=0.69); female sex (34% vs. 34%, P=1.0), baseline New York Heart Association class 3/4 (26% vs. 26%, P=1.0), body mass index (25.9 vs. 25.4, P=0.58), and left

ventricular ejection fraction of less than 30% (0% vs. 2.6%, *P*=0.3141). There were no deaths or cerebrovascular complications in either group. Ten patients in the most recent tertile had concomitant procedures (one tricuspid annuloplasty, six cryoablations, three PFO closures, one myxoma excision), compared with four (one tricuspid repair, three cryoablations) in the earliest tertile (*P*=0.076). There was a reduction in cardiopulmonary bypass (210.7±33.2 vs. 171.4±32.9 minutes, *P*<0.0001) and aortic cross-clamp time (141.4±29.0 vs. 118.3±26.7 minutes, *P*=0.001) during this study. Postoperative bleeding was significantly less in the latter group (414±213 vs. 673±422 mL, *P*=0.002). Hospital stay (6.4±3.3 vs. 6.4±3.3 days, *P*=0.94) and intensive care unit stay (2.1±1.5 vs. 2.6±1.8 days, *P*=0.39) did not differ between groups.
Conclusions: Minimally invasive mitral valve repair is safe. We have seen a reduction in the cross-clamp and cardiopulmonary bypass times despite an increase in the number of concomitant procedures performed. The amount of postoperative blood loss has also decreased. Despite these changes, we are yet to see a reduction in the intensive care stay or the postoperative length of stay.

P75
Robotic Mitral Valve Repair: Midterm Follow-up Results

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Objective: This study aimed to summarize our surgical experience with robotic mitral valve repair and demonstrate the follow-up results out to 7 years.
Methods: From 2007 to 2014, 110 consecutive patients underwent robotic mitral valve repair with the da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA USA) in our center. The patients' average age was 45±13 years (14–70 years), with a male-to-female ratio of 2.3:1. Mitral regurgitation (95.5%) or stenosis (4.5%) was diagnosed. The triangular or quadrangular resection was the most performed type of repair (63.3%). Nitinol U-clips (58.1%), running suture (31.1%), and COR-KNOT suture device (LSI Solutions, Victor, NY USA) (10.8%) were used to secure the annuloplasty ring. The operative data were collected, and patients were echocardiographically followed up regularly up to 7 years.
Results: All cases were performed by the same surgeon. One case of conversion to sternotomy was noted. The mean cardiopulmonary bypass time was 121±34.3 minutes (range, 70–152 minutes), and the mean cross-clamp time was 82.6±25.3 minutes (range, 47–122). After surgery, one death (0.91%) happened and two cases of transient neurocognitive defect (1.82%) occurred. Three cases of early prosthetic failure (2.73%) were noticed. All patients were successfully followed for a median of 4.1 years (range, 1 month to 7 years), and 94.5% had freedom from reoperation.
Conclusions: Robotic mitral valve repair is a safe and effective procedure with excellent intermediate-term outcomes.

P76
Minimally Invasive Mitral Surgery Versus Sternotomy Approach: A Meta-analysis of ''Statistically Sound'' Studies

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Objective: The purpose of this study was to evaluate the postoperative, midterm, and long-term results of minimally invasive mitral surgery (MIMS) versus classical sternotomy approach (SMS).
Methods: To minimize possible bias, we decided to use for our meta-analysis only ''statistically sound'' studies in practice studies that had used at least one patient-matching technique. Potentially eligible trials were identified by searching the MEDLINE, EMBASE, Scopus, ISI Web of Knowledge, and The Cochrane Library. Searches were not restricted by language or publication status and were updated in October 2015. Statistically sound studies comparing MIMS and SMS were identified. The primary end points were postoperative mortality, postoperative renal failure, postoperative pulmonary failure, postoperative neurological complications, as well as cardiopulmonary bypass and cross-clamping times; secondary end points were midterm and long-term survival. Dichotomous data were summarized using risk ratio with a 95% confidence interval (CI). Heterogeneity was quantified with the I^2 statistic. Publication bias was assessed using a funnel plot and Begg asymmetry test.
Results: Six trials met the inclusion criteria. A total of 4272 patients (2136 in MIMS group and 2136 in SMS group) were enrolled in this meta-analysis. We found no difference in 30-day mortality [1.07% vs. 1.07%; odds ratio (OR), 1.04; 95% CI, 0.56–1.91; *P*=0.91], in postoperative renal failure (1.63% vs. 1.96%; OR, 0.83; 95% CI, 0.52–1.31; *P*=0.42), in postoperative pulmonary complications (4.23% vs. 4.28%; OR, 1.02; 95% CI, 0.62–1.66; *P*=0.95), and in postoperative cerebrovascular complications (1.02% vs. 1.35%; OR, 0.78; 95% CI, 0.44–1.37; *P*=0.39). Both cardiopulmonary bypass and aortic cross-clamp times were longer in the MIMS group [MD, 30.13 (17.90–42.36), *P*<0.001; MD, 14.25 (6.14–22.37), *P*<0.001). Follow-up data were similar between the two groups (1-year survival: 96.3%±1.24% vs. 95.6%±1.24%; OR, 0.99; *P*=0.83; 3-year survival: 95.3%±0.62% vs. 94.3%±1.24%; OR, 1.23; *P*=0.42; 5-year survival: 93.6%±2.05% vs. 91%±1.41%; OR, 0.76; *P*=0.41; 7-year survival: 81.5%±4.5% vs. 81%±3%; OR, 1.07; *P*=0.85).
Conclusions: Minimally invasive mitral valve surgery is safe. In addition, midterm and long-term results are similar between minimally invasive and sternotomy approaches.

P77
Endoscopic Mitral Valve Surgery Following Basic Setting of Video-Assisted Thoracic Surgery

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Objective: Endoscopic surgery is a common technique in other surgical fields, but endoscopic cardiac surgery is not yet popular. We applied standard techniques of video-assisted thoracic surgery to mitral valve surgery and evaluated its feasibility and safety.
Methods: Femorofemoral cardiopulmonary bypass was established. Right fourth intercostal thoracotomy was made through a 3- to 6-cm of skin incision. An additional 5.5-mm trocar was inserted through the third intercostal space, for insertion of the forceps controlled by the surgeon's left hand. Another trocar was inserted through sixth intercostal space for the endoscope. Rib spreader was not used. The endoscope was manually controlled by an assistant. From October 2010 to November 2015, 231 patients underwent endoscopic minimally invasive cardiac surgery for the mitral valve. Exclusion criteria were advanced peripheral vascular disease and calcification of the ascending aorta. Fifty patients were excluded from endoscopic minimally invasive cardiac surgery during that period. Average age was 63.3 years (range 22–88). A total of 104 were male. Etiologies were fibroelastic deficiency in 142, Barlow disease in 13, endocarditis in 14, rheumatic in 24, consolidating degeneration in 7, annular dilatation in 15, and others. Sixteen were redo cases. Regarding concomitant surgeries, 37 Maze procedures, 46 tricuspid annuloplasties, and 8 aortic valve replacements were performed. For the concomitant aortic valve replacement, a rib spreader was applied. Early results were evaluated.
Results: No in-hospital death occurred. Regarding complications, stroke occurred in two, reexploration for bleeding in three, superficial wound infection in one, and renal failure in one. Eight patients required mechanical ventilation longer than 24 hours. Mitral valve replacement was performed in 24, of these 23 as a scheduled procedure and 1 as conversion from attempted repair in active endocarditis. Two patients needed conversion to sternotomy because of bleeding. A total of 63% of the patients had no blood transfusion. Average operation, bypass, and aortic clamp times were, 258, 176, and 127 minutes, respectively. Average intensive care unit stay was 1.3 and postoperative hospital stay was 9.7 days. In patients who underwent mitral valve plasty, three had mild mitral regurgitation at discharge, and others had none or trivial.
Conclusions: Endoscopic mitral surgery with additional working port and handheld endoscope was reproducible and safe.

P78
Three-Port Thoracoscopic Techniques for Mitral Valve Replacement Without Robotically Assisted Surgical System: Technical Challenges and Solutions

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Objective: This study aimed to investigate the feasibility and safety of totally thoracoscopic mitral valve replacement (MVR) through three ports in the right chest.
Methods: A total of 262 patients with rheumatic heart disease were selected from cardiac surgery of our hospitals; 157 were males; mean age was 51.7±5.6 years; and mean body weight was 69.8±8.7 kg. An additional 36 patients undergoing open-chest MVR were selected as a control group. Using three-port incisions in the right chest, pericardiotomy, bicaval occlusion, atriotomy, and MVR were performed by thoracoscopy without the aid of a robotically assisted surgical system.
Results: The cardiopulmonary bypass and aortic cross-clamp times were 62.2±9.8 and 46.5±7.3 minutes, respectively. There were no mortalities. The intensive care unit (14.1±4.5 vs. 24.5±5.6 hours, $P<0.01$) or postoperative hospital stays (6.5±1.8 vs. 8.6±2.1 days, $P<0.05$) in the thoracoscopic group were shorter than those in the control group. The percentage of patients who required postoperative opioid analgesics in the thoracoscopic group was lower than those in the control group (21.0% vs. 75.2%, $P<0.01$). Rate of blood transfusion during the operation was 17.6% vs. 69.8%, $P=0.001$. Transesophageal echocardiographic analysis 5.2±3.9 months after the operation showed that heart function improved and prosthesis was normal.
Conclusions: Three-port thoracoscopic technique for MVR by totally thoracoscopic is safe and effective. This technique is associated with reduced intensive care, rate of blood transfusion during the operation, and hospital stay in comparison with the conventional MVR.

P79
Mitral Valve Procedures Without Aortic Cross-Clamping via Right Minithoracotomy Using Titanium Fasteners

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Objective: We sought to review our experience with the use of new titanium knot fastener devices. We hypothesized that in selected cases, its use could importantly reduce the induced ventricular fibrillation (IVF) or beating heart procedure and cardiopulmonary bypass (CPB) time.
Methods: We reviewed retrospectively our electronic records to identify patients who underwent mitral valve repair and replacement without aortic cross-clamping (on beating heart or induced ventricular fibrillation, mainly redo operations). Surgical approach was through right minithoracotomy with mainly femorofemoral arteriovenous cannulation. A portion of the group of patients have used fast knotting system (FK group; COR-KNOT Device; LSI Solutions Inc, Victor NY USA), and the remaining served as a control group (conventional hand knotting). We identified the FK patients and performed propensity-score matching to match 1:1 ratio from main population using FK versus hand knotting.
Results: A total of 55 underwent mitral valve repair or replacement on fibrillating or beating heart without aortic cross-clamping. A total of 13 patients (24%) underwent operation using FK. There were no statistical differences in total population while ignoring the procedure type and complexity on mitral valve. However, when subsetting procedures on native valve, there was an approximately 35-minute reduction of CPB time ($P=0.06$). Same pattern persisted when considering only IVF, and there was time reduction by 9 minutes ($P=0.38$). In the propensity-matched population, the effect of CPB and IVF reduction was consistent and repeated by an 18-minute ($P=0.45$) and a 15.5-minute ($P=0.29$) reduction, respectively.
Conclusions: Titanium fasteners are a useful tool to have in minimally invasive approaches, especially in complex cases and redo interventions. Titanium fasteners can reduce IVF time and overall CPB time in selected complex population. In matched group, the pattern of reduction of the two variables was consistent.

P80
Beating Heart Mitral Valve Surgery: Results in 120 Consecutive Patients Considered Nonsuitable Candidates for Conventional Mitral Valve Surgery

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Objective: This study aimed to assess whether beating heart mitral valve surgery is a valuable option in patients considered very high-risk candidates or inoperable for conventional mitral valve surgery.
Methods: One-hundred twenty patients (mean age, 63.7±12.1 years; range, 25.3–88.8 years; mean logistic EuroSCORE, 26.1%±20.6%; range 1.5%–84.3%) undergoing beating heart mitral valve surgery using normothermic cardiopulmonary bypass without aortic cross-clamping and without cardioplegia between September 2002 and April 2014 were included in this retrospective, single-center, observational cohort study. Preoperatively, 14 patients (11.7%) were in cardiogenic shock, 16 (13%) were on ventilator, 33 (27.5%) received inotropic support, 12 (10%) had dialysis, and 1 was on an extracorporeal membrane oxygenator. Sixty-five patients (54%) had at least one previous heart operation (range, 1–6). Mean follow-up was 920±973 days.
Results: Isolated mitral valve surgery was performed in 75 patients (62.5%). Combined mitral valve procedures were performed in 45 patients (37.5%). Fifty-eight patients (49%) had emergency or urgent procedures, and 62 (51%) were treated elective. Mean cardiopulmonary bypass time was 103±39 minutes (median, 94 minutes; range 45–252 minutes; interquartile range, 75–121.5 minutes). There were no conversions to conventional surgery. Overall 30-day mortality was 10% including patients in cardiogenic shock and 7.5% for patients without preoperative cardiogenic shock. Five patients (4.2%) had early rethoracotomy for bleeding, three (2.5%) had disabling stroke, and two (1.7%) had nondisabling stroke. Overall 6-month, 1-year, 2-year, and 5-year survival were

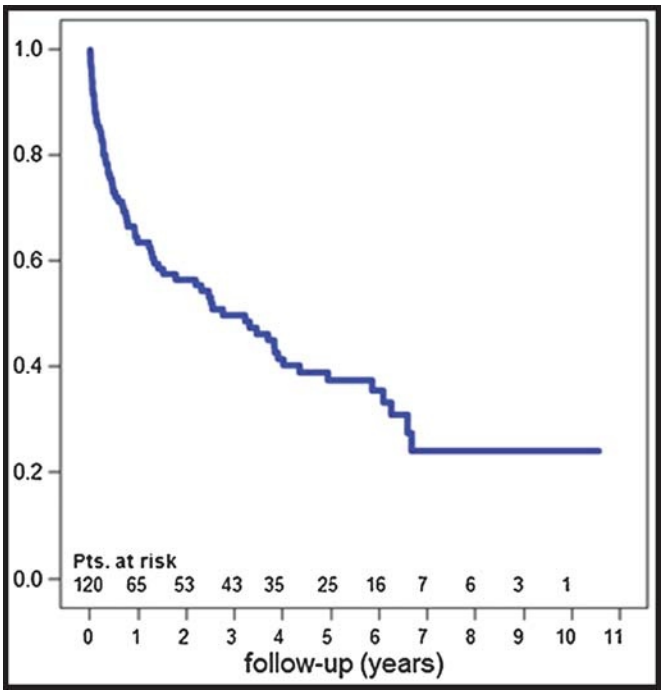

FIGURE P80-1. Kaplan-Meier survival function. Overall survival at 6-month, 1-year, 2-year and 5-year.

73.0%±4.2%, 63.5%±4.6%, 56.5%±4.8%, and 37.4%±5.0%, respectively (Fig. P80-1). Multivariate analysis revealed age (HR, 1.04; 95% confidence interval, 1.01–1.06; P=010) and creatinine (HR, 1.53; 95% confidence interval, 1.23–1.91; P<0.001) to be relevant for late survival.
Conclusions: Patients considered nonsuitable candidates for conventional mitral valve surgery had favorable postoperative course and survival if the operation was performed on the beating heart.

P81
Transapical Off-Pump Implantation of Artificial Cordae in Mitral Valve Regurgitation

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Objective: The present study describes the initial experience with the NeoChord DS System that allows transapical implantation of artificial neochordae in terms of periprocedural safety, clinical success, and short-term outcome in four patients.
Methods: Patients with dyspnea and New York Heart Association functional classes II to IV with severe mitral regurgitation (MR) that did not accept open heart mitral valve repair were included (female, 70 years old, MR III-IV due to P2-P3 prolapse; male, 88 years old, MR IV due to A1-A2 prolapse; male, 76 years old, MR III due to P2-P3 prolapse with previous mitral valve annuloplasty and chordae implantation at P2/P3; and female, 75 years old, MR IV due to P2-P3 prolapse). We decided in the heart team on transapical repair with NeoChord under general anesthesia. The NeoChord procedure was performed under two- and three-dimensional transesophageal guidance using a transapical access. After grasping the mitral valve leaflet with two grippers, valvular piercing and fixation and retraction of the neochordae were performed. In any patient, six neochordae were implanted (three pairs).
Results: The patients received multiple chordae. The procedures were uneventful with no hemodynamical instability. The perioperative results were excellent with no regurgitation left in three patients and MI I in one patient. There was no bleeding no infection. Discharge was performed within 7 to 10 days after the procedure. No cardiovascular or neurological complications were observed (no adverse event).
Conclusions: Despite the small patient population, off-pump transapical implantation of neochordae seems feasible, efficient, and safe without actual increase in the transvalvular gradient in comparison with mitral clip. It is even successful after previous mitral valve annuloplasty and chordae implantation. The dynamic physiological approach with stepwise resuspension of a leaflet without use of cardiopulmonary bypass has to be reserved for high-risk patients as long as long-term results are not available.

P82
Three-Dimensional Imaging in Minimally Invasive Mitral Valve Surgery: An 18-Month Single-Center Experience

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Objective: Minimally invasive mitral valve surgery (MIMVS) through minithoracotomy is facilitated by video assistance. Because of difficult depth perception with two-dimensional (2D) video systems, most steps of the procedure by most surgeons are performed under direct vision. We report our results of an 18-month period using three-dimensional (3D) video endoscopy.
Methods: A continuous series of 65 patients who underwent totally endoscopic operations with 3D imaging is included. Perioperative and short-term results are analyzed retrospectively. Cross-clamping and cardiopulmonary bypass (CPB) times for isolated MIMVS in 45 patients were compared with those from 275 MIMVS patients operated on from 2001 to 2014 with 2D and direct vision. A total of eight surgeons either operated on their own or were assisted by the MIMVS program director.
Results: From June 2014 to December 2015, 65 patients (median age, 63 years), of whom 37 (56.9%) were male, underwent totally endoscopic MIMVS with 3D imaging. In 63 patients (96.9%), transthoracic aortic clamping with cardioplegic arrest median ischemic and CPB times were 123 minutes (SD, 32.2) and 222 minutes (SD, 65.1), respectively; in two patients (3.1%), a redo procedure was performed under ventricular fibrillation. In 59 patients (90.8%), mitral valve (MV) repair was possible; 5 received planned MV replacement. Additional tricuspid valve repair, ASD/PFO closure, and left atrial ablation were performed in 8 (12.3%), 13 (20%), and 6 (9.2%) cases, respectively. In two patients (3.1%), conversion to median sternotomy was necessary, one because of bleeding and another one because of unsuccessful reconstruction with final MV replacement. Thirty-day mortality was 0. In 45 patients with isolated MIMVS, CPB times were longer with 3D (221.0 minutes; SD, 63.9) compared with 275 patients with 2D imaging (194.5 minutes; SD, 64.6; P=0.011). Cross-clamp times were comparable [121.9 (SD, 28.9) vs. 110.4 (SD, 41.9) minutes, P=0.082].
Conclusions: Totally endoscopic MIMVS with 3D imaging is safe. Standard Carpentier techniques for repair or replacement can be performed without direct vision even in a training institution. Cross-clamping times using 3D imaging are not different; however, total CPB times are longer because preparative and final steps from pericardiotomy to cross-clamping and vice versa were performed mostly by surgeons less experienced with the MICS approach.

P83
Totally Thoracoscopic Mitral Valve Repair With Modified Loop Technique

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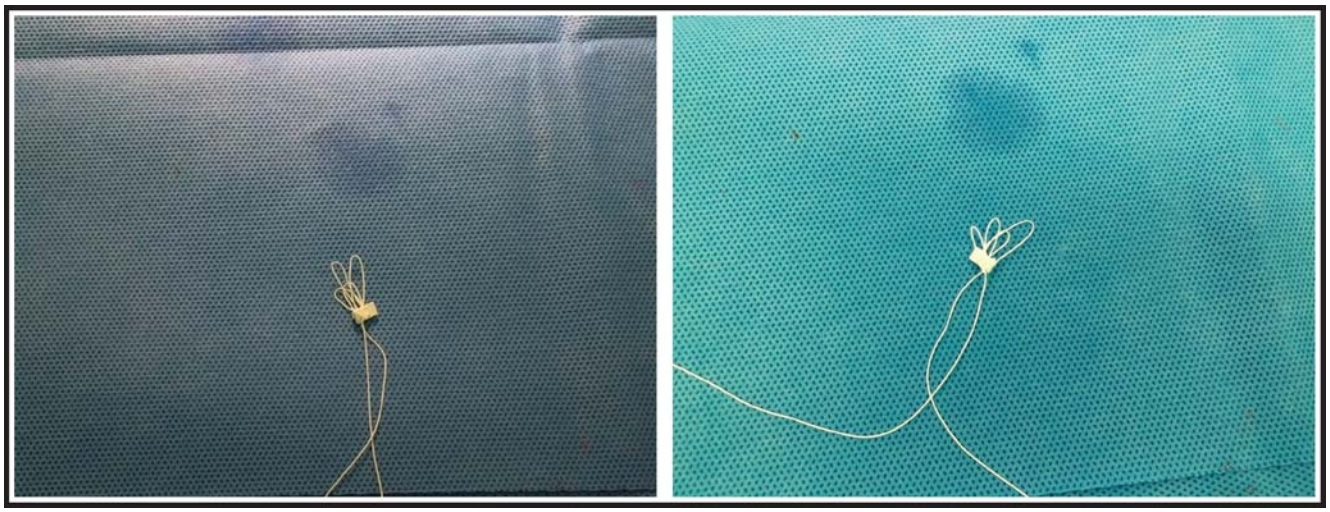
Objective: This study aimed to summarize the experience of totally thoracoscopic mitral valve repair with modified loop technique.
Methods: From July 2011 to July 2015, only one surgeon performed 65 cases of totally thoracoscopic mitral valve repair with a modified loop technique. The whole group has 38 male and 27 female patients. Age was 19 to 79 years (48.9±24.3). Weight was 43 to 90 kg (51±15). Combined procedure involved TVP Ring in 16 patients. Twenty-one cases were anterior leaflet prolapse, 27 cases were posterior leaflet prolapse, 17 cases were bileaflet prolapse. All patients underwent right anterior minithoracotomy with three holes with double-lumen trachea cannula. The femoral artery, vein, and vena jugular external cannulae were used to set up cardiopulmonary bypass. Regarding Gore-Tex loop stitch point, one side was on the junction between papillary muscle and chordae, another side was on the edge of the prolapse leaflet. The number of chordae was 3.5±1.3. The lengths of artificial chordae were as follows: anterior leaflet, 1.65 to 1.88 cm (1.7±0.8); posterior leaflet, 1.5 to 1.7 cm (1.6±0.1). All cases used Carpentier-Edwards Physio I or II annuloplasty ring (Edwards Lifesciences, Inc., Irvine, CA USA). For bileaflet prolapse cases, we used a modified loop technique where a hand-made artificial chorda with a different length in one group of loop was used.
Results: There was no mortality. Two cases were converted to MVR. Cardiopulmonary bypass time was 123.24±38.22 minutes. Cross-clamp time was 79.83±29.48 minutes. Ventilation time was 14.2±8.8 hours. Drainage was 327.5±311.5 mL. Intensive care unit stay was 24.3±14.2 hours. Hospital stay was 6.4±3.9 days. Reoperation for bleeding occurred in two cases. There was pulmonary infection in six cases and wound infection in one case. Mitral insufficiency during the preoperative period was 12.6±5.09 cm^2, 0.83±1.29 cm^2 during discharge (P<0.001), and 1.58±2.01 cm^2 at 3 months. Involution height was 0.5 to 1.5 cm (0.85±0.43).
Conclusions: Mitral valve repair with totally endoscopic is feasible, safe, and reproducible and has good clinical result. Modified Gore-Tex loop technique can simplify the request of implanting artificial chordae especially for bileaflet prolapse.



FIGURES P83-1 AND P83-2. Describe the modify Loop technique, not like the original Loop, the modify Loop is handmade and the length of artificial chords (premeasure by echo) are different, that means only stitch on one papillary muscle, we can fix four prolapse points of mitral valve, no matter anterior or posterior leafleat, especially for bileaflet prolapse, usually only 2–3 papillary muscle can be easy exposed under totally endoscopic and strong enough to stitch the Loop, two Loops can provide 8 points to fix the most complex prolapse Barlow's disease.

P84
A New Twist on an Old Problem: Robotic Septal Myectomy and Anterior Mitral Valve Leaflet Enlargement for Hypertrophic Obstructive Cardiomyopathy

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Objective: Open transaortic myomectomy is the traditional treatment of hypertrophic obstructive cardiomyopathy (HOCM). Although the defining feature of HOCM is left ventricular hypertrophy, the condition is also characterized by anterior mitral valve leaflet enlargement. As a result, surgical treatment should simultaneously address the ventricular septum and the mitral valve. Our minimally invasive method uses robotic techniques and a transmitral approach to perform an extended septal myectomy along with anterior mitral valve leaflet augmentation. We reviewed our experience with this technique to understand the hemodynamic effects and outcomes of this novel robotic approach.
Methods: We conducted a retrospective review of 10 consecutive patients with HOCM who underwent robotic septal myectomy and anterior mitral valve leaflet augmentation from August 2012 to September 2015. We received institutional review board approval. Chart review was conducted to determine patient demographics and procedural outcomes. Data were analyzed using Microsoft Excel.
Results: Totally endoscopic robotic septal myectomy and anterior mitral valve leaflet augmentation was successfully completed in 10 patients (100%). The mean age of the patients undergoing the procedure was 53.6±9.0 years (42–66 years), and 40% (4/10) were male. The baseline mean left ventricular ejection fraction was 64.5%±7.6% (50%–80%). The patients had an average preoperative mitral valve regurgitation of 2.8±0.6, with 70% (7/10) of the patients presenting with 3+ or greater mitral regurgitation. The mean basal septal thickness was 22.3±5.3 mm (17–32 mm). All patients demonstrated systolic anterior motion of the mitral valve and left ventricular outflow tract (LVOT) obstruction. The average gradient across the LVOT was 128.2±38.9 mmHg (57–186 mmHg) with or without provocation. There were no mortalities, and no patients have required reoperation. Postoperative echocardiograms showed single-digit gradients and no mitral regurgitation or systolic anterior motion of the mitral valve. The mean follow-up was 8.9±13.2 months (2 weeks to 3 years), and follow-up transthoracic echocardiograms completed in 6/10 patients showed consistently low LVOT gradients.
Conclusions: Totally endoscopic robotic septal myectomy and anterior mitral leaflet augmentation is a safe and effective procedure for the treatment of HOCM. The totally endoscopic robotic approach increases visualization of the LVOT and expedites patient recovery. Continued evaluation and longer-term follow-up are needed.

P85
Sutureless Aortic Perceval Bioprosthesis: Single-Center Experience in Cardiac Reoperations

Giovanni Concistrè, Francesca Chiaramonti, Giacomo Bianchi, Michele Murzi, Egidio Varone, Tommaso Gasbarri, Filippo Santarelli, Enkel Kallushi, Alfredo Cerillo, Pierandrea Farneti, Marco Solinas. *Ospedale del Cuore ''G. Pasquinucci''—Fondazione G. Monasterio CNR, Massa, Italy.*

Objective: Perceval sutureless aortic bioprosthesis (Sorin Group, now LivaNova, London, UK) represents an innovative approach for surgical aortic valve replacement (AVR), to reduce operative time and facilitate prosthesis implantation, especially in complex procedures. We described our experience with Perceval bioprosthesis in cardiac reoperations (REDO).
Methods: From March 2011 to January 2015, 517 patients underwent AVR with sutureless aortic Perceval bioprosthesis at our institution. Of these, 58 patients had previously undergone cardiac surgery. Mean age was 71±8.7 years, 27 patients were female (46.5%), and mean logistic EuroSCORE was 26.3%±6.9%. Preoperative, periprocedural, and echocardiographic parameters and clinical outcomes were analyzed.
Results: The primary procedure was aortic valve surgery (isolated or associated with concomitant procedures) in 41 patients (71%). Isolated REDO AVR was performed in 35 patients (60%). REDO surgery was performed via full sternotomy in 51 patients (88%) and via right minithoracotomy in 7 patients (12%). Cardiopulmonary bypass and aortic cross-clamp times were 97±42.1 and 53.5±28.4 minutes for isolated AVR and 155.8±82.7 and 95.4±43 minutes for combined procedures, respectively. In-hospital deaths occurred in three patients (5%), one patient had cardiac death, and all patients were alive at a mean follow-up of 19.3 months (range, 0–52.7 months). Events at

follow-up included cerebral hemorrhage in one patient and the need of pacemaker implantation in three patients. On echocardiographic evaluation, no patient showed paraprosthetic leakages, and mean transprosthesis gradient was 10±5.2 mmHg.
Conclusions: Perceval sutureless AVR is a fast and safe procedure, even in high-risk REDO surgery, providing a good hemodynamic performance with excellent clinical results.

P86
Single-Center Experience of Aortic Valve Replacement with Rapid-Deployment Bioprosthesis: One Hundred Fourteen Implantations

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Objective: The growing elderly population increases the number of patients with aortic valve stenosis and multiple comorbidities. In this patient population, the sutureless and rapid-deployment bioprosthesis can represent a good option to reduce surgical risk. We report our experience with a fast-deployment bioprosthesis, the EDWARDS INTUITY Valve System (Edwards Lifesciences, Inc., Irvine, CA USA).
Methods: Between June 2012 and December 2015, 114 patients with symptomatic aortic stenosis were scheduled for aortic valve replacement with EDWARDS INTUITY Valve System. Mean age was 74.9±6.6 years, and mean logistic EuroSCORE was 8.6±6.5. Eighty-five patients were male (75%). Sixty-eight patients underwent isolated aortic valve replacement. Concomitant procedure were coronary artery bypass graft (n=32), mitral valve procedures (n=6), mitral valve procedure combined with coronary artery bypass graft (n=6), and tricuspid annuloplasty (n=2). Three-month and 1-year follow-up were performed.
Results: Implantation success was 99% (113/114). Prosthesis size were 19 (n=7), 21 (n=23), 23 (n=35), 25 (n=34), and 27 (n=14). In 66 patients (58% of all patients and 97% of patients with isolated aortic valve disease), a minimally invasive approach was performed. Deployment time was 13.7±4.5 minutes. Cardiopulmonary bypass and aortic cross-clamp times were 86.9±20.5 and 50.3±15 minutes, respectively, for standalone procedures. Two patients who underwent a ministernotomy approach needed a conversion to full sternotomy because of aortic wall tear after weaning from cardiopulmonary bypass. Median mechanical ventilation time was 6 hours (range, 2–63). Median intensive care unit stay was 1 day (range, 1–27). Median length of stay was 5 days (range, 0–14). The mean transvalvular gradient was 10.3±3.9 mmHg at discharge, 8.3±4.3 mmHg at 3-month follow-up, and 8.9±4.2 mmHg at 1-year follow-up. A trivial paravalvular leakage in six patients and a moderate paravalvular leakage in one patient were accepted at discharge and were stable at follow-up. Survival was 98% at discharge, 98% at 3-month follow-up, and 97% at 1-year follow-up.
Conclusions: Aortic valve replacement using the EDWARDS INTUITY Valve System in our experience is a feasible and reproducible procedure associated with excellent results in terms of survival and hemodynamic performance. However, experience with a larger number of patients and longer-term follow-up are necessary to validate these data.

P87
Sutureless Prosthesis Option in Patients Undergoing Concomitant Aortic Valve and Ascending Aorta Replacement: First Experience in 13 Cases

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Objective: A significant proportion of patients undergoing aortic valve replacement (AVR) have a dilated ascending aorta that needs concomitant surgical replacement. The objective of this study was to report our first experience on 13 patients undergoing AVR and concomitant ascending aorta replacement (AAR), with implantation of a sutureless prosthesis.
Methods: A retrospective study was undertaken on 189 consecutive patients undergoing AVR and AAR between January 2001 and December 2015. Propensity-score matching was used to reduce selection bias. Thirteen patients treated with a sutureless prosthesis implantation (study group) were compared with a control group of 13 patients undergoing AVR and AAR with conventional mechanical/biological prosthesis.
Results: Both patients with aortic stenosis and patients with aortic regurgitation were treated with sutureless valve implantation. In the sutureless group, patients were more likely treated with a minimally invasive approach. Only one patient died in the hospital. No paravalvular leakage or prosthesis dislodgment was reported. Permanent pacemaker implantation was needed only in one patient. The sutureless group has shown shorter cardiopulmonary bypass (142±52 vs. 167±38 minutes, P=0.01) and cross-clamp times (85±18 vs. 101±29 minutes, P=0.01) (Table P87-1).
Conclusions: In patients undergoing AVR and AAR, sutureless valve implantation is a safe and reproducible procedure associated with good postoperative results (Table P87-1).

TABLE P87-1. Preoperative, Operative, and Postoperative Results

Variables	Perceval S Group (n=13)	Control Group (n=13)	*P*
Age, mean±SD, y	74.6±8.7	74.4±9.6	NS
Male, n (%)	7 (54)	6 (46)	NS
NYHA class (3–4), n (%)	4 (31)	4 (31)	NS
Diabetes, n (%)	1 (7.5)	1 (7.5)	NS
Previous operations, n (%)	5 (38)	4 (31)	NS
Pulmonary hypertension	2 (15)	3 (6.2)	NS
LVEF (%)	54.7±7.9	53.1±13.6	NS
Aortic stenosis, n (%)	7 (54)	6 (46)	NS
Aortic regurgitation, n (%)	6 (46)	6 (46)	NS
Sternotomy, n (%)	6 (46)	10 (77)	0.03
Ministernotomy, n (%)	7 (54)	3 (6.2)	0.03
CPB time, mean±SD, min	142±52	167±38	0.01
Cross-clamp time, mean±SD, min	85±18	101±29	0.01
Hospital mortality, n (%)	1 (7.5)	1 (7.5)	NS
Permanent neurologic injury, n (%)	1 (7.5)	2 (15)	NS
Acute renal failure, n (%)	2 (15)	1 (7.5)	NS
Permanent PMK, n (%)	1 (7.5)	1 (7.5)	NS
ICU stay, median (IQR), d	1 (1–6)	1 (1–7)	NS

CPB, cardiopulmonary bypass; ICU, intensive care unit; IQR, interquartile range; LVEF, left ventricle ejection fraction; NS, nonsignificant; NYHA, New York Heart Association; PMK, pacemaker.

P88
Minimally Invasive Aortic Valve Replacement via Right Anterior Minithoracotomy and Central Aortic Cannulation: A 13-Year Experience

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Objective: The study objective was to evaluate the clinical outcomes of a minimally invasive aortic valve replacement (mini-AVR) technique by a right

anterior minithoracotomy approach with central aortic cannulation using a 5- to 6-cm second intercostal incision and transection of one (or two) ribs.
Methods: In this observational, two-hospital cohort study from 2003 to 2015, demographic and operative outcomes were evaluated, including surgical and ventilator times, length of stay, stroke, reoperation, and mortality. Statistical analyses were performed using two-tailed analyses.
Results: A total of 202 patients underwent mini-AVR over 13 years, divided into two periods, 2003 to 2009 (n=65, ''early'') and 2010 to 2015 (n=137, ''late''). Mean age was 72.5±12.9 years; 60% were male. Beginning in 2006, mean cardiopulmonary bypass and aortic cross-clamp times decreased significantly each year with Bonferroni adjustment (Fig. P88-1). Demographic data were similar, except for weight, 75.3±14.7 kg for the early versus 80.9±20.8 kg for the late period (P=0.03). Compared with the early study period patients, those from the late study period were more often extubated intraoperatively (52% vs. 12%, P<0.001), had less prolonged ventilator use postoperatively (6% vs. 16%, P=0.018), required less blood transfusions (mean, 2.0±2.3 vs. 3.6±3.0 U, P=0.011), and had shorter postoperative stay (6.3±4.5 vs. 8.0±5.9 days, P=0.026). Numerically, fewer postoperative strokes (1% vs. 6%, P=0.09) and fewer reoperations for bleeding (3% vs. 6%, P=0.3) occurred in the late period. In-hospital mortality did not differ (1/65 early vs. 3/137 late).
Conclusions: Minimally invasive AVR intraoperative and postoperative clinical outcomes improved over a 13-year experience.

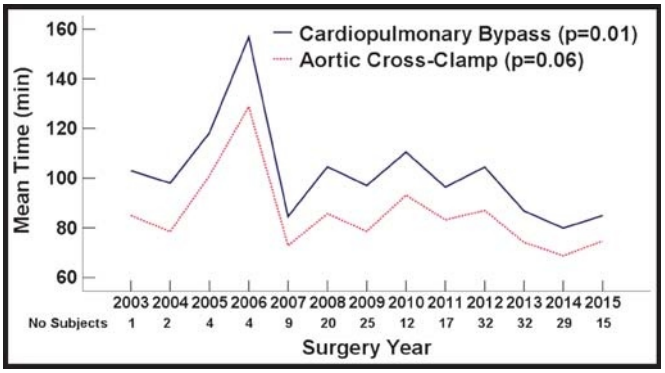

FIGURE P88-1. Mean cardiopulmonary bypass and aortic cross-clamp times were significantly decreased, particularly starting in 2006. The number of cases were limited from 2003–2005.

P89
Full or Partial Sternotomy Rather Than Right Minithoracotomy: Tailoring the Best Approach for Each Patient in Aortic Valve Replacement

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Objective: During the past decade, minimally invasive cardiac surgery has emerged as a valid approach to treat aortic valve disease. Various techniques have been developed: partial sternotomy (V-shaped, Z-shaped, inverse-T, J reverse-C, and reverse-L partial) and right minithoracotomy at the second or third intercostal space. We describe our 6-year, single-center experience, using either standard full sternotomy or upper J hemisternotomy or right minithoracotomy.
Methods: From January 2010 to October 2015, 1550 isolated, aortic valve operations were performed at our institution. Surgical approach included standard sternotomy (509, 32.8%), minimally invasive technique using upper J hemisternotomy (695, 44.8%), or right anterior minithoracotomy (346, 22.4%). Aortic clamping was direct in all patients. Total central cannulation was used whenever possible.
Results: Bivariate and multivariate regression analyses revealed that preoperative renal insufficiency is a common independent risk factor for death. In addition, in case of minimally invasive approach with upper hemisternotomy, obesity results as an independent risk factor (P=0.05; adjusted odds ratio, 5.06; confidence interval, 1.01–25.28) as well as peripheral extracardiac vascular disease for the full sternotomy group (P=0.02; adjusted odds ratio, 4.42; confidence interval, 1.27–15.34). Hospital mortality rate in minimally invasive approach (right minithoracotomy, 1.7%; upper hemisternotomy, 2.9%) was at least comparable with that in the standard full sternotomy (3.5%).
Conclusions: Minimally invasive surgery must be considered as a safe option for aortic valve replacement. Our experience shows that in case of high body mass index or peripheral vascular disease, the right minithoracotomy could have some advantages over other surgical approaches.

P90
Mini-Bentall: An Attractive Approach for Elective Patients

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Objective: Minimally invasive surgery through an upper J sternotomy for aortic valve replacement has become routine approach with excellent results. Complex ascending aortic procedures are performed through the same minimally invasive access only in few centers. We describe our experience using either standard full sternotomy or minimally invasive approach for Bentall operation.
Methods: From January 2010 to October 2015, 240 patients received elective ascending aorta and aortic valve replacement using Bentall De Bono procedure at our institution. Of 240 patients operated on, 53 had minimally invasive ministernotomy and 187 had full median sternotomy. Median age was 63 years (25th percentile, 51; 75th percentile, 73) for the minimally invasive group and 68 years (25th percentile, 54; 75th percentile, 73) for the full sternotomy group (P=0.365). No statistically significant differences in terms of body mass index (P=0.678), left ventricular ejection fraction (P=0.319), diabetes mellitus (P=0.988), chronic obstructive pulmonary disease (P=0.5), and renal insufficiency (P=0.198) have been found between the two groups.
Results: The partial sternotomy was performed from the notch to the third right intercostal space. A Bentall De Bono procedure, using a pericardial Mitroflow bioprosthesis implanted in a Valsalva graft or a standard mechanical conduit, was performed in all patients. Median cardiopulmonary bypass time and median cross-clamp time were 84 (74.25–103) and 73 (64–89) minutes, respectively, for the minimally invasive group and 101 (80–133) and 81 (67–112.5), respectively, for the full sternotomy group, with significant difference (P=0.007 and P=0.029, respectively). Postoperative ventilation time resulted lower in patients treated with ministernotomy (median, 8 vs. 8.5 hours without statistically difference; P=0.069) as well intensive care unit stay (P=0.281), incidence of atrial fibrillation (P=0.62), and hospital mortality (P=0.126).
Conclusions: Our experience confirms that a minimally invasive approach using a partial upper J-shaped sternotomy could be an attractive and safe alternative approach to the standard one also in selective patients affected by complex aortic root pathology.

P91
Feasibility of Minimally Invasive Aortic Root Surgery

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Objective: Traditionally, proximal aortic surgery has been performed through a midline sternotomy. We describe our outcomes in patients who underwent aortic root surgery via an upper hemisternotomy (mini-Root).
Methods: This is a retrospective analysis of 13 mini-Roots performed from June 2014 to October 2015 at our institution. A minimally invasive approach was achieved through a standard hemisternotomy with lateral extension to the fourth intercostal space. Central aortic and femoral venous cannulations were used using the Seldinger technique with transesophageal echocardiography guidance. Antegrade HTK-Custodial (Essential Pharmaceuticals, LLC, Ewing, NJ USA) cardioplegia was used in all patients. There were 10 Bentall and 3 David procedures.
Results: There was no in-hospital mortality or postoperative strokes. Median ICU stay was 2 days, and median hospital stay was 5 days. Ventilatory support

was 7.5±16 hours. Three patients (23%) had postoperative atrial fibrillation, and five (38%) required transfusion.
Conclusions: A minimally invasive approach can be safely applied in proximal aortic surgery with excellent outcomes.

P92
Intermediate-Term Evaluation of Hemodynamic Behavior and Patient Prosthesis Mismatch at Rest and Under Stress After Aortic Valve Replacement With Sorin Freedom Pericardial Stentless Prosthesis

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Objective: This study aimed to evaluate the hemodynamic behavior of Sorin Freedom stentless valve under stress conditions and to encourage the choice of an aortic prosthesis in relation to a better quality of life of the patient.
Methods: Between March 2003 and April 2010, 184 patients who received a Pericarbon Sorin Freedom stentless aortic prosthesis (Sorin Group; now LivaNova, London, UK) at our unit underwent an echocardiographic evaluation at rest and under stress conditions at a mean follow-up time of 6.8 years. The mean age of the patients was 69.7±10.9 years. Mean Log EuroSCORE was 7.73±7.03. Concomitant procedures were performed in 41.3% of the cases. The stress protocol consisted of a maximum exercise of 100 w for 6 minutes at cycle-ergometer. Assessment of maximum-mean aortic gradient, effective orifice area, effective orifice area index were obtained by echocardiographic examination, along with the assessment of patient-prosthesis mismatch, New York Heart Association functional class, and percentage of reduction in ventricular mass.
Results: A low increase of mean (from 7.8±3.3 to 11.6±4.0 mmHg) and peak (from 14.9±5.2 to 21.6±6.5 mmHg) gradients even under maximum exercise was observed. Interestingly, there was an increase in the effective orifice areas related to a possible dynamical valve adaption to the changes of a patient's hemodynamics. The patient-prosthesis mismatch was virtually absent. The clinical conditions were excellent for the majority of the patients.
Conclusions: The hemodynamic evaluation of Sorin Pericarbon Freedom at rest and under stress showed excellent performances. A good capability of valve adaption to changes in cardiac output has been observed. Therefore, the Sorin Pericarbon Freedom can be considered a good option within the aortic valve substitutes in the younger, active population and an excellent prosthesis in cases of bacterial endocarditis.

P93
Minimally Invasive Aortic Valve Replacement in Patients With Concomitant Coronary Artery Disease

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Objective: Minimally invasive aortic valve replacement (mAVR) has become the standard of care for isolated aortic valve disease. In patients with asymptomatic one- or two-vessel coronary artery disease (CAD) not involving the left main or the ostial left anterior descending coronary artery, isolated mAVR may be a viable option. We compared the outcomes of mAVR patients with concomitant CAD with those of the mAVR patients without concomitant CAD.
Methods: From January 2006 to May 2015, 517 patients underwent mAVR at our institution. Sixty-nine patients (70% male) had concurrent CAD (>50% stenosis, CAD group), and 448 patients (58% male) had no CAD (nCAD group). Mean age was 74.1 years (in the CAD group vs. 68.5 years in the nCAD group; $P<0.05$). There was a higher incidence of hypertension (82.6% vs. 71%, $P=0.041$) and hypercholesterolemia (88.4% vs. 62%, $P<0.05$) in the CAD group.
Results: The mean cardiopulmonary bypass and cross-clamp times were 114.9 versus 125 and 86.9 versus 96 minutes for the CAD group versus the nCAD group, respectively. There was no difference in the use of packed red blood cell (2.3 vs. 2.1), fresh frozen plasma (0.77 vs. 0.43), platelets (1 vs. 1), and cryoprecipitate (1.2 vs. 1.2 U) in the CAD group versus the nCAD group, respectively. There was no difference in postoperative stroke [2 (2.9%) vs. 5 (1%)], new onset renal insufficiency [5 (7.2%) vs. 18 (4%)], and atrial fibrillation [29 (33.3%) vs. 126 (28%)] in the CAD group versus the nCAD group, respectively. In-hospital mortality was higher (5.8% vs. 2%) in the CAD group ($P<0.05$). The actuarial survival at 1, 3, and 5 years was 90.87% versus 96.88%, 87.36% versus 93.45%, and 74.27% versus 89.57% in the CAD group versus nCAD group, respectively ($P<0.05$).
Conclusions: Although CAD did not directly contribute to postoperative mortality, the presence of CAD had a negative impact both on short- and on long-term survival.

P94
Reduced Length of Hospital Stay for Minimally Invasive Aortic Valve Replacements After Implementation of an Enhanced Recovery After Surgery Program

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Objective: There is presently a warm enthusiasm for enhanced recovery after surgery (ERAS) program. A recent review indicates that length of hospital stay and postoperative complication could be reduced by 30% and 50%, respectively. However, most of the studies analyzed encompassed solely colorectal and orthopedic surgeries. Only one retrospective ERAS program has been described for minimally invasive cardiac surgery. Thus, in an effort to provide more evidence to the literature, we have investigated prospectively the feasibility and clinical effectiveness of a dedicated ERAS program for minimally invasive aortic valve replacements (AVRs).
Methods: Data were collected prospectively from consecutive patients scheduled for an AVR via a ministernotomy during two periods, before (PRE-AVRERAS group) and after application of a dedicated ERAS pathway specifically designed for this minimally invasive cardiac procedure (AVRERAS group). Operative data, postoperative morphine consumption, postoperative data of interest, postoperative infection rates, types and rate of complications, 30-day type and rates of readmission were collected.

TABLE P94-1. Operative and Postoperative Data of Interest

	PRE-AVRERAS (n=22)	AVRERAS (n=14)	*P*
Logistic EuroSCORE (%)	12.4±4.1	15.5±3.2	0.06
Cross-clamp time, min	68±15.5	41±8.2	0.002
Sutureless valve implantation, n (%)	0	14 (100)	<0.001
Postoperative morphine consumption	8±10	3±3	0.079
Mobilization on a chair on the day of the surgery, n (%)	0 (0)	11 (79)	<0.001
Transurethral catheter removal on the morning after surgery, n (%)	1 (4.5)	9 (64)	<0.001
Overall infections during the hospitalization, n (%)	8 (36)	1 (7)	0.06
Readmission for cardiac reasons, n (%)	2 (9)	0 (0)	0.51
Extubation in operative room, n (%)	0	13 (92.8)	<0.001

AVRERAS, after application of a dedicated ERAS pathway specifically designed for this minimally invasive cardiac procedure; PRE-AVRERAS, before application of a dedicated ERAS pathway specifically designed for this minimally invasive cardiac procedure.

Results: There were 22 patients in the PRE-AVRERAS group and 14 in the AVRERAS group. The median length of hospital stay was 9 days in the PRE-AVRERAS group compared with 5 days in the AVRERAS group ($P<0.05$). The results of postoperative interest are described in Table P94-1. An ERAS pathway envisioned for minimally invasive AVR seems feasible and associated with a shorter hospital stay.
Conclusions: Our study indicates that an ERAS pathway could be implemented effectively with interesting results when a minimally invasive AVR is planned.

P95
Aortic Valve Replacement Using a Rapid Deployment Valve Through Anterior Right Thoracotomy: A Single-Center Study

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Objective: Aortic valve replacement through anterior right thoracotomy (ART) using a rapid-deployment valve combines two surgical innovations that despite technical challenge might have a beneficial effect on patients with severe aortic stenosis. In this study, we revised our experience.
Methods: Between April 2011 and November 2015, 76 patients (39 male, 51.3%) with a mean age of 73±10 years underwent aortic valve replacement for severe aortic stenosis through ART with an 8-cm skin incision using direct cannulation of the aorta and the right atrium. Mean logistic EuroSCORE and EuroSCORE II were 6.9±5.3 and 2.3±2.1, respectively.
Results: Implantation of the rapid-deployment valve was successful in all patients using ART. Mean cross-clamp time and perfusion time were 86.8 and 123.6 minutes, respectively. A total of 30 patients (39.4%) had an annulus of 21 mm or less, with the most common implanted prosthesis size being 21 mm (n=22, 28.9%). One major bleeding event (1.3%) necessitating rethoracotomy occurred immediately after the patient was transferred to the intensive care unit postoperatively. In one patient (1.3%), a stroke occurred, whereas no transient ischemic attack was observed. No other valve-related complications were observed such as valve thrombosis, valve endocarditis, or reoperation due to structural and nonstructural valve deterioration. Mean and peak prosthesis gradients at discharge were 14.1±4.8 and 25.5±8.5 mmHg, respectively. Permanent pacemaker dependency with postoperative implantation of a pacemaker was 13.2% (n=10). Thirty-day mortality was 1.3% (n=1), whereas overall mortality was 2.7% (n=2).
Conclusions: Despite a higher-than-expected permanent pacemaker rate, overall results show a safe and feasible implantation technique using ART with a rapid-deployment valve with a remarkably low complication and mortality rate.

P96
The Use of Rapid Deployment Valves in Combined Aortic and Mitral Valve Surgery: One-Year Clinical and Echocardiographic Outcomes

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Objective: Patients undergoing multiple-valve surgery represent a high-risk group who could potentially benefit from a reduction of cross-clamp and cardiopulmonary bypass times because prolonged bypass and cross-clamp times are considered independent risk factors for increased morbidity and mortality after cardiac surgery.
Methods: Between July 2013 and November 2014, 16 patients underwent rapid-deployment aortic valve replacement with the EDWARDS INTUITY Valve System (Edwards Lifesciences, Inc., Irvine, CA USA) in the setting of concomitant mitral disease. Fifteen patients showed mitral regurgitation, whereas one patient had severe mitral stenosis. Fourteen patients received mitral valve repair, and two patients biological mitral valve replacement. Tricuspid valve repair was performed additionally in two patients. The mean age was 72.8±8.4 years, and the mean logistic EuroSCORE II was 8.7%±3.4%.
Results: Within a 30-day perioperative period, no patient was lost (n=0). The mean follow-up time was 11±2 months. At 1 year, the overall survival was 81% (n=13). A mean transaortic gradient of 10.7±2.3 mmHg and a mean effective orifice area of 1.7±0.3 cm^2 were measured echocardiographically. No higher grade paravalvular leak (AI>1+) occurred. Eight patients (61%) had no residual mitral regurgitation, four patients (30%) showed trivial regurgitation (1/4), and one patient (7.3%) had moderate mitral regurgitation (2/4). No interference of the subannular stent frame with the reconstructed valve or the biological mitral prosthesis was seen.
Conclusions: Rapid-deployment aortic valve replacement with the EDWARDS INTUITY Valve System in combined aortic and mitral valve surgery can be performed safely with reproducible results. One-year follow-up data of this small series show encouraging results potentially justifying the extension of the indication for rapid deployment valves to patients with concomitant mitral disease. Especially elderly patients undergoing multiple valve surgery may benefit from a reduction of cardiopulmonary bypass und myocardial ischemic times.

P97
The Influence of Left Ventricular Hypertrophy on Mortality in Patients Undergoing Transcatheter Aortic Valve Replacement

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Objective: Severe left ventricular hypertrophy (LVH) is known to increase mortality risk in patients undergoing surgical aortic valve replacement. It is unknown whether severe LVH also increases the risk of mortality after transcatheter aortic valve replacement (TAVR). This study aimed to determine the effect of LVH (as indicated by increased relative wall thickness on preoperative echocardiogram) on 30-day and late mortality in patients undergoing TAVR.
Methods: A retrospective review of a single-institution TAVR database from 2007 to 2014 was conducted to review preoperative echocardiograms. Six hundred thirty-three patients were identified. Severe LVH is defined in this study as a relative wall thickness (RWT) greater than 0.45, a validated measure of concentric LVH. Patients were stratified into groups with severe LVH (RWT>0.45) and those without severe LVH (RWT<0.45). Logistic regression analysis was used to examine the effect of RWT on 30-day mortality after TAVR, and Kaplan-Meier curves were created to plot the effects of RWT on late mortality.
Results: Echocardiograms were reviewed from 633 patients, and these individuals were stratified into those without severe LVH as measured by an RWT of 0.45 (RWT, 0.64±0.18, n=411). Logistic regression analysis revealed similar 30-day mortality in patients with and without LVH [n=18 (8%) vs. n=23 (6%); $P=0.24$]. However, late mortality was increased in patients with preoperative evidence of LVH at 12 months (log-rank $P<0.001$, Fig. P97-1). Patients with severe LVH were noted to be slightly older (84.1±7.1 vs. 82.0±7.88 years, $P=0.001$) and more likely to be female (56% vs. 39%, $P<0.001$). The Society of Thoracic Surgeons score was similar for both groups of patients (10.6±4.3 vs. 10.5±4.3, $P=0.84$).
Conclusions: Preoperative LVH is predictive of increased mortality risk in patients planning to undergo transcatheter aortic valve replacement. Preoperative risk stratification should include elevated RWT on echocardiogram to help inform surgical management.

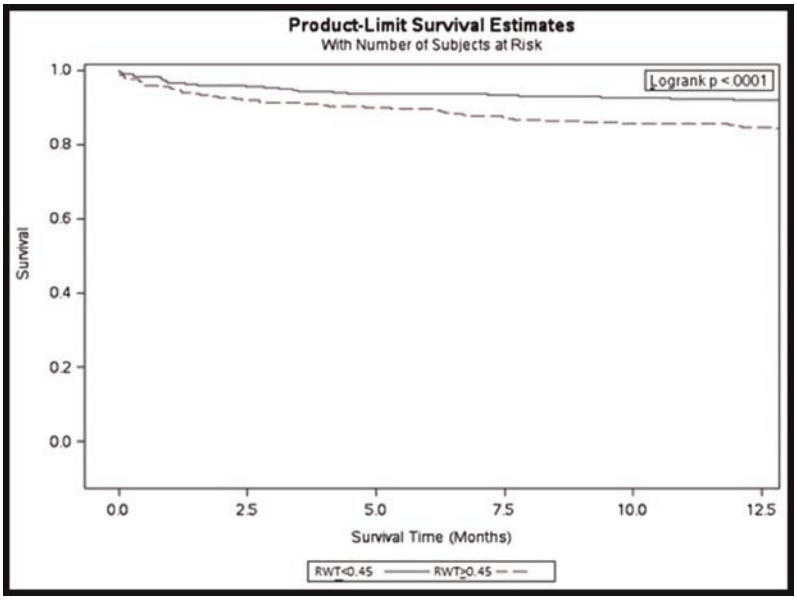

FIGURE P97-1. Kaplan-Meier survival estimates of patients with and without left ventricular hypertrophy.

P98

Reduced Ejection Fraction: Is There an Improvement After Transcatheter Aortic Valve Replacement?

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Objective: Transcatheter aortic valve replacement has expanded the treatment of aortic stenosis to patients who are too sick for traditional open procedures. Transcatheter aortic valve replacement in low-gradient, low ejection fraction (EF) patients has been an area of controversy. We sought to examine if there is an improvement in the EF of this cohort of patients after undergoing transcatheter aortic valve replacement.

Methods: Patients undergoing transcatheter aortic valve replacement at our institution between January 2012 and 2015 were reviewed. Those with EF less than 35% were included in the study. These were substratified into those with severely depressed EF (<20%) and EF of 20% to 35%. Primary end points were EF measured on echocardiography at immediate postoperative, 1-month, and 1-year follow-up.

Results: Forty-seven patients with preoperative EF of less than 35% underwent transcatheter aortic valve replacement procedure. Sixty-six percent of the patients were male (n=31), with a mean age of 78.4 years (range, 52–93 years). Forty-one patients (n=19) had undergone previous sternotomy. There was a statistically significant improvement in EF in postoperative echocardiograms performed within 24 hours postoperatively (25% vs. 33%, *P*=0.003), at 1 month (25% vs. 33.7%, *P*=0.0043), and at 1 year (25% vs. 34.5%; *P*=0.00036) (Fig. P98-1). When substratified to two groups, that is, to EF less than 20% versus 20% to 35%, there was still a statistically significant improvement in EF between the two groups.

Conclusions: Transcatheter aortic valve replacement in low-EF patients is safe and effective. It may also help improve EF in these patients, both in the immediate postoperative period as well as at 1-year follow-up. Whether this confers an improvement in overall survival or heart failure symptoms and readmissions remains to be seen.

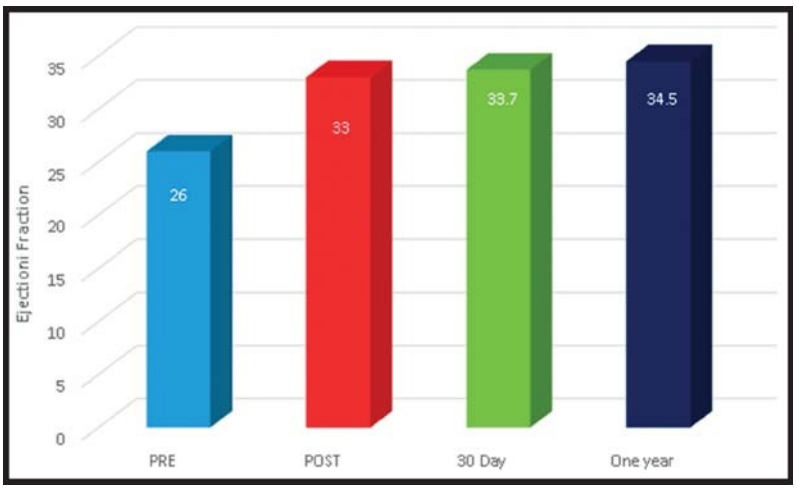

FIGURE P98-1. Change in ejection fraction at 1 month, 6 months, and 1 year.

P99
Outcome After Aortic Valve Replacement for Low-Flow/ Low-Gradient Aortic Stenosis With Poor Contractile Reserve on Dobutamine Stress Echocardiography

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Objective: Few data are available on risk stratification for valve replacement in patients with aortic stenosis (AS), left ventricular (LV) dysfunction and low transvalvular gradients. We assessed risk stratification by using dobutamine stress echocardiography (DSE) in patients with AS and severe LV dysfunction.
Methods: Low-dose DSE was performed in 10 patients [3 women and 7 men; median (quartile range) age in years, 47 (32–78); left ventricular ejection fraction, 0.29 (0.23–0.32); aortic valve area (in cm^2): 0.7 (0.5–0.8); mean transaortic gradient (in mmHg): 26 (21–33)]. Patients were classified into two groups as follows: group I (n=6, LV contractile reserve on DSE) and group II (n=4, poor contractile reserve). Valve replacement was performed in six and three patients in groups I and II, respectively.
Results: Perioperative mortality was 0% in group I and 0% in group II. Survival at 2 years after the operation was 100% in group I. The effect of valve surgery on survival remained significant in both groups after adjustment for age, diabetes, respiratory disease, and hypertension. Medical therapy had the same effect in both groups.
Conclusions: In patients with AS, LV dysfunction and low transvalvular gradients, contractile reserve on DSE is associated with a low operative risk and good long-term prognosis after valve surgery. In contrast, operative mortality may be high in the absence of contractile reserve. Light premedication, thermodilution cardiac output pulmonary artery catheters, and omniplanar transesophageal echocardiography remains essential armamentariums for perioperative anesthetic managements in this high-risk group of the patients.

P100
Perioperative Outcome of Low-Flow Low-Gradient Aortic Stenosis in Transcatheter Aortic Valve Implantation: Insights From a Two-Center Study With More Than 700 Patients

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Objective: Our aim was to investigate the outcome of low-flow low-gradient aortic stenosis (LFLG-AS) after transcatheter aortic valve implantation (TAVI). Furthermore, we analyzed the impact of the ejection fraction (EF) on the outcome of patients with LFLG-AS after TAVI.
Methods: From 2008 to 2015, a total of 747 consecutive patients underwent TAVI for severe AS in this two-center study. We compared patients with LFLG-AS (stroke volume index>35 mL/m^2 and mean gradient<40 mmHg, n=113) with patients showing typical characteristics of severe AS (n=514). To further elucidate the impact of left ventricular EF (LVEF) on the perioperative outcome of patients with LFLG-AS, we divided LFLG patients into two subgroups according to the LVEF, with a cutoff of 50% to distinguish between reduced and preserved LVEF. Overall, mean age was 81.7±5.7 years, and the overall mean Society of Thoracic Surgeons score was 7.0%±5.5%. Valve Academic Research Consortium (VARC)-2 criteria were used to define clinical end points.
Results: Device success, early safety, and clinical efficacy were not significantly different in patients with LFLG-AS (all $P>0.05$). The stroke rate [LFLG-AS, 0.9% vs. high gradient (HG) AS, 3.7%; $P=0.148$] was similar between the groups. Incidence of stage 2 acute kidney injury (LFLG-AS, 20.4% vs. HG-AS, 11.5%; $P=0.012$) and renal replacement therapy (LFLG-AS, 15.9% vs. HG-AS, 9.3%; $P=0.039$) were significantly higher in the LFLG group. Perioperative mortality was significantly higher in LFLG-AS (LFLG-AS, 13.3% vs. HG-AS, 7.4%; $P=0.042$). The EF had no impact on perioperative mortality of patients with LFLG-AS (LFLG-reduced EF, 10.9% vs. LFLG-preserved EF, 14.0%; $P=0.765$).
Conclusions: Patients with LFLG-AS showed a worse outcome regarding VARC II end points. In our cohort, reduced EF did not impact the outcome of LFLG-AS patients undergoing TAVI.

P101
Impact of Gradient and Flow on Perioperative Renal Function After Transcatheter Aortic Valve Implantation

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Objective: Postoperative acute kidney injury was shown to be associated with an increased mortality after transcatheter aortic valve implantation (TAVI). In this analysis, we aimed to investigate the impact of preoperative gradient and flow on kidney function after TAVI.
Methods: From 2008 to 2015, a total of 717 consecutive patients underwent TAVI for severe aortic stenosis (AS) in this two-center study. We divided our study population into four groups and compared patients with high-gradient AS (n=520; mean gradient≥40 mmHg; HG-AS) to those with low-gradient AS (n=197; mean gradient, 35 mL/m^2; HF-AS) to those with low-flow AS (n=314, stroke volume index<35ml/m^2; LF-AS). Overall mean age was 81.7±5.6 years, and the overall mean Society of Thoracic Surgeons score was 6.9%±5.5%. VARC II criteria were used as clinical end point.
Results: Perioperative mortality did not differ between patients with low- versus high-gradient AS (LG-AS, 10.0% vs. HG-AS, 7.9%; $P=0.368$). Device success, early safety, and clinical efficacy were similar between the groups (all $P>0.05$). Acute kidney injury of stage 2 or higher was detected significantly more often in the low-gradient group (LG-AS, 16.8% vs. HG-AS, 10.8%; $P=0.032$). With regard to the impact of flow, no difference was seen on mortality between patients with low- versus high-flow AS $P=0.322$). Device success, early safety, and clinical efficacy were also similar between the two groups (all $P>0.05$). The incidence of acute kidney injury of stage 2 or higher was higher in the low-flow group (LF-AS, 18.2%), as compared with the high-flow group (HF-AS, 7.6%; $P<0.001$). Time-related valve safety was not different between all four groups.
Conclusions: Although we were able to show very good results regarding clinical outcome, we identified low flow and low gradient to have an impact on renal function in patients undergoing TAVI.

P102
Transcatheter Aortic Valve Implantation in Redo Patients With Native Aortic Valve Stenosis: A Meta-analysis

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Objective: Redo surgical aortic valve replacement (SAVR) is technically challenging especially in the presence of a patent ITA graft. We investigated whether transcatheter aortic valve implantation (TAVI) is advantageous in the redo setting.

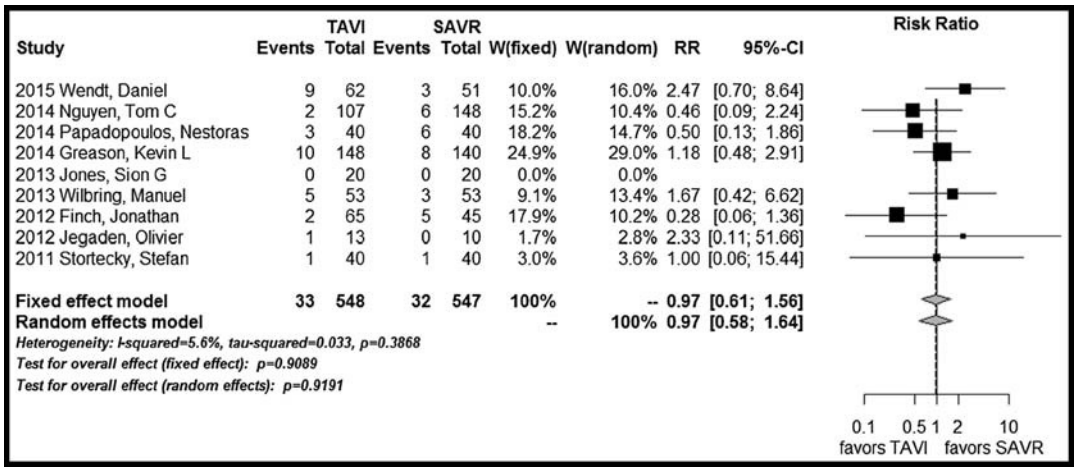

FIGURE P102-1. Forest plot for 30-day mortality.

Methods: We performed a systematic review comparing SAVR with TAVI in redo cases with native aortic valve stenosis. Defined end points were 30-day mortality, postprocedural stroke, necessity for pacemaker implantation, occurrence of a relevant paravalvular leakage (PVL), and in-hospital length of stay. Case-control studies and case series reports were not considered for analysis.
Results: The PubMed query on September 27, 2015, retrieved 337 records. After screening, 328 were excluded: 251 hits did not address the research question, 1 article was not retrievable, and 76 studies were performed with a study design not eligible for inclusion. Overall, we pooled 9 studies with 1095 patients (TAVI, n=548; SAVR, n=547). Thirty-day mortality did not differ between TAVI and SAVR (Fig. P102-1). In the TAVI cohort, stroke rate was markedly reduced. The difference was significant in the fixed-effects (FE) model, but not in the random-effects (RE) model (FE: risk ratio, 0.51; 95% CI, 0.28–0.94, P=0.032; RE: risk ratio, 0.58; 95% CI, 0.28–1.18, P=0.13). Necessity for pacemaker implantation was almost double in TAVI patients compared with SAVR patients (FE: risk ratio, 1.95; 95% CI, 1.28–2.97, P=0.0018; RE: risk ratio, 2.08; 95% CI, 0.85–5.07, P=0.11). Only four of the nine studies reported data on PVL. Pooling these data showed no significant difference in relevant PVL (FE, P=0.12; RE, P=0.45). Similarly, length of stay was only reported in five studies, and pooled results did not differ (FE, P=0.78; RE, P=0.20).
Conclusions: For redo patients with native aortic valve stenosis, TAVI can be considered a safe alternative with similar short-term outcomes compared with SAVR in high-risk patients. Transcatheter aortic valve implantation offers a safe and effective treatment option in a challenging patient cohort. A randomized controlled trial in a lower-risk redo population seems warranted.

P103
Transcatheter Aortic Valve Implantation Versus Minimally Invasive Aortic Valve Replacement With Sutureless Valve: A Single-Center Matching Study

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Objective: Surgical aortic valve replacement is still the treatment of choice for patients with severe symptomatic aortic valve stenosis (SSAVS). During the last few years, novel technologies such as transcatheter [transcatheter aortic valve implantation (TAVI)] and sutureless bioprosthesis (whether or not with minimally invasive approaches) have shown early good results. The aim of this study was to compare early and midterm outcomes of high-risk patients undergoing TAVI procedures versus patients undergoing minimally invasive aortic valve replacement (MIAVR) with sutureless or rapid-deployment bioprosthesis.
Methods: From January 2011 to December 2013, 69 patients with SSAVS underwent TAVI procedure at our center (TAVI group). This prospective cohort of patients was matched by four categories of risk profile and three categories of age, to a prospective cohort of patients undergoing MIAVR with a sutureless/rapid-deployment bioprosthesis from January 2011 and December 2013 (sutureless group, n=73 patients) at our center. We created a group of 40 pairs of patients with comparable preoperative risk profile and age.
Results: Major/minor vascular complications were significantly more frequent in the TAVI group than in the sutureless group (15.0% vs. 0%, P=0.0255). Median mechanical ventilation time and median intensive care unit stay were significantly lower in the TAVI group compared with the sutureless group. In the sutureless group, the rate of new onset of atrial fibrillation was higher with respect to the TAVI group [38.5% (n=15) vs. 10.8% (n=4), respectively; P=0.0083]. At discharge and at 1-year follow-up, mean transvalvular gradient was comparable between the two groups, whereas paravalvular regurgitation was more frequent after TAVI (P<0.001), but paravalvular regurgitation was not associated with increased 1-year mortality (P>0.001). At discharge, mortality rate was higher in the TAVI group compared with sutureless group (7.5% vs. 2.5%; P=0.6153), but 1-year mortality rate was 5.6% (n=2) in the TAVI group and 13.2% (n=5) in the sutureless group (P=0.4310), and the 1-year cumulative mortality was not significantly different between the two cohorts.
Conclusions: In high-risk patients with SSAVS, transcatheter procedures and MIAVR with sutureless/rapid-deployment bioprosthesis were associated with similar rates of survival at 1 year, although 30-day mortality was considerably lower in the sutureless group. Moreover, there were some differences in periprocedural complications and midterm outcomes.

P104
Transapical Aortic Valve Implantation in Dialysis-Dependent Patients

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Objective: The treatment of dialysis-dependent patients is associated with increased postoperative morbidity and in-hospital mortality. The purpose of this study was to evaluate outcome in those patients who underwent transapical aortic valve implantation for severe aortic valve stenosis.
Methods: A total of 47 dialysis-dependent patients underwent transapical aortic valve implantation between 2008 and 2015. The mean age was 75±8 years, and 66% were male. The mean Society of Thoracic Surgeons score and EuroSCORE logistic II score were 14.5±10.6 (range, 30.4–2.1) and 8.4±6

(range, 48.5–2.8), respectively. The most common comorbidities were diabetes (38.3%), chronic obstructive pulmonary disease (39.1%), peripheral vascular disease (40.4%), and pulmonary hypertension (36.2%).
Results: In-hospital mortality was 25.5% (n=12) for all patients. Sternotomy and conventional aortic valve replacement were necessary in one patient (2.1%) because of annulus rupture. The most common reasons for death were sepsis, heart insufficiency, and multiorgan failure. Other postoperative complications were pneumonia (15.2%), low cardiac output (10.9%), bleeding (6.5%), atrioventricular block with pacemaker implantation (17.4%), stroke (6.3%), and sepsis (8.7%). Wound healing complication was observed in one patient (2.2%). One-year survival was 44%±1% with estimated mean survival time of 2.5±0.5 years.
Conclusions: Transapical aortic valve implantation in dialysis-dependent patients was associated with low rate of intraoperative complication. However, the early and midterm mortality were significantly increased because of high-risk profile of the patient. The most common postoperative complications were pneumonia and low-cardiac output.

P105
Right Thoracotomy: The Access of Choice for Transaortic Transcatheter Aortic Valve Replacement

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Objective: Transcatheter aortic valve replacement (TAVR) is now a well-established option in high-risk patients with aortic stenosis. In cases unsuitable for the transfemoral approach, transaortic access offers an alternative approach. A right thoracotomy offers a better technical coaxial angle for transaortic TAVR implantation compared with a median sternotomy, which may lead to less paravalvular leak. We report a series of transaortic TAVRs performed via right thoracotomy incisions with emphasis on technical success, morbidity, and mortality.
Methods: All TAVR patients in our cardiac surgery database from November 2011 to May 2015 were queried. Of 353 TAVRs, 42 cases of transaortic performed via right thoracotomy were identified for analysis. Median follow-up time was 1.5 years [interquartile range (IQR), 0.8–2.2].
Results: Mean age of the cohort was 80.7±8.4 years, and 26/42 (61.9%) were women. At baseline, 31% were diabetic, 9.5% had renal failure, 7.1% had previous strokes, and 11.9% had previous myocardial infarctions. Mean ejection fraction was 55±10.1, and 61.9% were in class III/IV New York Heart Association heart failure. A total of 47.6% had previous cardiac surgery, and mean Society of Thoracic Surgeons PROM score was 7.85.7. Balloon expandable valves were used in 40 patients (95%) and self-expandable valves in the rest. Technical success rate was 97.6% (41/42). One patient required open conversion and cardiopulmonary bypass. Operative mortality was 7.2% (3/42). There were no reoperations for bleeding and no postoperative stroke, and 7.1% (3/42) had new-onset renal failure. No patient required permanent pacemaker postoperatively. Six patients (14.3%) had mild paravalvular leaks, and none had more-than-moderate paravalvular leak. Median intensive care unit and hospital lengths of stay were 45 hours (IQR, 26–68 hours) and 7 days (IQR, 5–8 days), respectively. One- and 2-year survival rate were 73.7% (95% confidence interval, 60.3%–87.1%) and 67.8% (95% confidence interval, 53.5%–82%), respectively.
Conclusions: Transaortic TAVR via a right thoracotomy allows accurate positioning and low rate of paravalvular leak. Right thoracotomy should be the access of choice for transaortic TAVR.

P106
Improved Outcomes in Transcatheter Aortic Valve Replacement Using a Minimalist Approach: A Single-Center Experience

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Objective: Transcatheter aortic valve replacement (TAVR) has transformed the management of aortic stenosis (AS). A minimalist approach (MA) to TAVR, relying on local anesthesia and conscious sedation (MAC) has been used and has a reported benefit of improved outcomes.
Methods: This is a single-center, prospective, study of 50 consecutive MA-TAVR patients compared with 50 patients who underwent TAVR under general anesthesia (GA-TAVR). The MA-TAVR protocol included intraoperative MAC and transthoracic echocardiogram guidance and a postoperative protocol including no narcotics, mobilization within 4 hours of intensive care unit arrival, and the goal of discharge directly from the intensive care unit on postoperative day 1. Patients were treated with balloon expandable or self-expanding valves. Preoperative, intraoperative, and postoperative data were collected.
Results: Fifty consecutive patients with appropriate anatomy for a percutaneous approach were assigned to the MA-TAVR protocol. Preoperative variables and comorbidities were not significantly different between the MA-TAVR and GA-TAVR cohorts, with the exception of fewer female patients undergoing MA-TAVR [26% (13) vs. 56% (28), P=0.002] and higher Society of Thoracic Surgeons PROM (10.7±3.3 vs. 9.1±5.5, P=0.002) in the MA-TAVR group. Intraoperative variables were similar with the exception of a lower volume of contrast used during the MA-TAVR (126.9 vs. 207.7 mL, P<0.0001). Postoperatively, there was no difference in in-hospital mortality, mortality at 30 days,

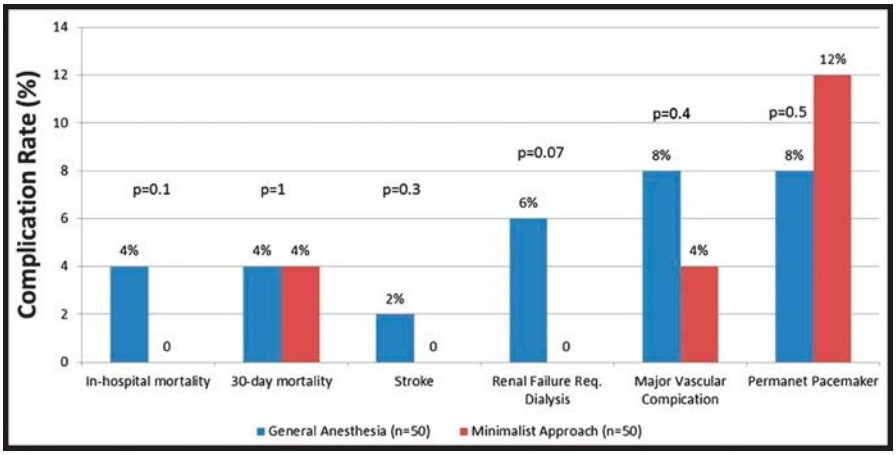

FIGURE P106-1. Post-operative outcomes of TAVR procedure by type of anesthesia. There was no difference in outcomes for MA-TAVR patients compared to GA-TAVR.

major vascular complication, need for permanent pacemaker, or stroke. There was a clinical increase in the number of patients who developed renal failure and required dialysis in the GA-TAVR group [6% (3) vs. 0 in MA-TAVR, P=0.07]. A higher proportion of MA-TAVR patients were discharged home [78% (39) vs. 58% (29), P=0.05] with a significantly shorter postoperative length of stay [2.5±3.3 (median. 1) vs. 5.1±3.8 (median, 4) days, P<0.0001].

Conclusions: Minimalist approach TAVR is safe and associated with low morbidity and mortality. Implementation of an MA-TAVR protocol resulted in shorter length of hospitalization with the majority of patients being discharged home. The improved outcomes associated with MA-TAVR illustrate increased efficiency and potential cost savings.

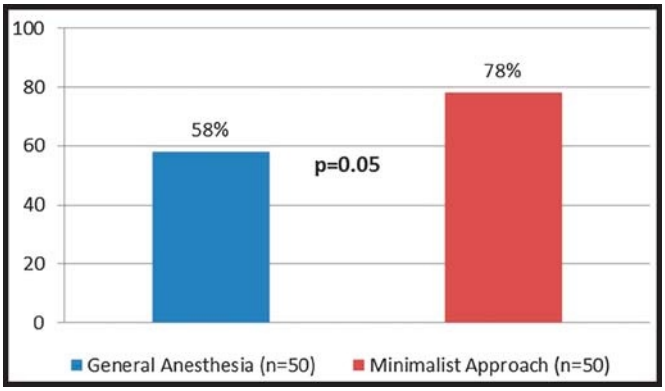

FIGURE P106-2. Discharge location home by type of anesthesia. A significantly higher proportion of MA-TAVR patients were discharged to home.

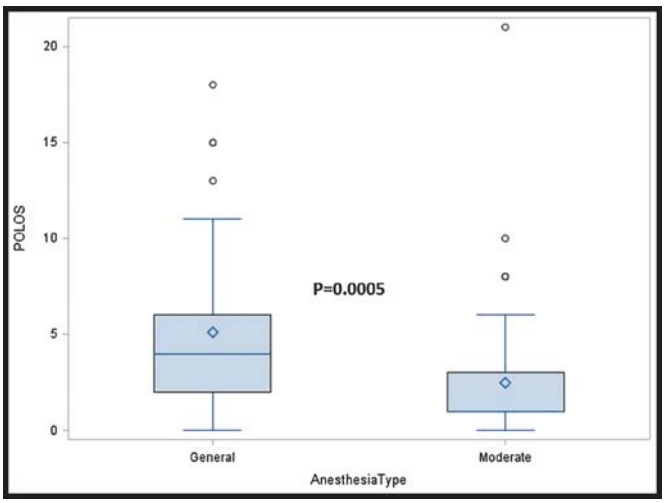

FIGURE P106-3. Post-operative median length of stay (days) by type of anesthesia. The post-operative median length of stay was significantly shorter in the patients having their TAVR procedure completed by the minimalist approach as compared to under general anesthesia.

P107
The Surgical Experience of Transcatheter Aortic Valve Replacement for Bicuspid Aortic Valve

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Objective: Bicuspid aortic valve (BAV) remains a challenging structural valve disease of transcatheter aortic valve replacement (TAVR). The aim of this study was to evaluate the efficacy and safety of TAVR in patients with severe aortic stenosis described as BAV.

Methods: Between October 2013 and December 2015, 104 consecutive patients underwent TAVR for severe aortic stenosis in our institute. Of those, BAV was diagnosed based on transesophageal echocardiography and multidetector computed tomography in four patients (3.9%; median age, 85.4 year; range; 69.0–88.5; three female patients). Transcatheter aortic valve replacement with balloon-expandable prosthetic valve was performed in each patient. The median Society of Thoracic Surgeons Predicted Risk of Mortality (STS) score was 5.5% (range, 2.7%–5.9%). We examined clinical outcomes as well as intraoperative and postoperative complications.

Results: The median aortic annulus diameter was 25.8 mm (range, 23.1–28.1) by 20.1 mm (range, 16.2–21.5), and the median aortic valve area was 448 mm^2 (range, 404–465) detected by preoperative multidetector computed tomography during end-systolic phase. Each BAV had a raphe between the right and left coronary cusp in three patients and left coronary cusp in one patient. Transaortic approach and transfemoral approach were performed in one patient and three patients, respectively. Annulus rupture occurred in one patient who had a bulky calcification of the raphe and was cured by immediate subxiphoid pericardial drainage. The patient required permanent pacemaker implantation after TAVR. Stroke of the cerebellum occurred in another patient. Although the postoperative rehabilitation was required, neurologic symptoms were improved. There were no other major complications and conversions to surgical aortic valve replacement. Transcatheter aortic valve replacement except annulus rupture was accomplished without blood transfusion. The median operation time was 2.4 hours (range, 1.8–2.7); median intensive care unit stay was 2.5 days (range, 1–6). Postoperative paravalvular leak was less than mild in all patients, and severe aortic stenosis disappeared by transthoracic echocardiographic follow-up. There were no rehospitalizations due to cardiac events including heart failure and no early or late mortality.

Conclusions: Transcatheter aortic valve replacement for BAV is feasible in selected patients with low to intermediate STS score. Understanding of the aortic valve anatomy and preparation for major adverse complications such as annulus rupture or valve malposition are crucial to achieve successful outcomes.

P108
Transcatheter Transapical Mitral Valve-in-Valve Implantation: The Singapore Experience

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Objective: This study reports the results of transcatheter mitral valve-in-valve implantations in our center to review the safety and efficacy as a complementary approach to reoperative mitral valve surgery.

Methods: We present a prospective study of six patients (age, 59–85 years) who received transapical implantation of a transcatheter prosthesis in the mitral position at our institution over 4 years. All patients were considered to be at an increased risk after evaluation by an interdisciplinary heart team. We analyzed the outcomes with up to 2-year follow-up.

Results: The average Society of Thoracic Surgeons score for the cohort was 11.85% (range, 5.46–22.32). The average EuroSCORE was 12.66 (range, 5.62–27.80). Implantation was successful in all patients. All patients were implanted with SAPIEN XT transcatheter valves: one #29, one #23, and four #26 size valves. Five patients underwent implantations into previous mitral valves, and one patient who had a previous mitral ring repair had a transcatheter valve implanted. One patient experienced intraoperative hypotension requiring hemodynamic support. There were no other clinically significant complications encountered. Mean reduction in transvalvular gradients from 12.26 to 6.25 at 1 year was shown, with a corresponding decrease in mean New York Heart Association scores. The mean duration of hospital stay was 7.5 days (range, 6–13).

Conclusions: Transapical mitral valve-in-valve implantation provides a promising complementary approach to reoperative mitral valve surgery in carefully selected patients with satisfactory clinical outcomes.

P109
Efficacy of Intraoperative Monitoring of Limb Perfusion With Near-Infrared Spectroscopy in the Prevention of Lower-Limb Neuropathy After Minimally Invasive Cardiac Surgery

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Objective: Lower-limb neuropathy (LLN) sometimes occurs after minimally invasive cardiac surgery with peripheral perfusion access. As insufficient distal perfusion is a possible cause of this complication, aggressive intraoperative management including alternative perfusion strategies by monitoring lower-limb perfusion with near-infrared spectroscopy (NIRS) may be useful.
Methods: Minimally invasive cardiac surgery via right minithoracotomy was performed in 487 patients between 2009 and 2015. Surgical procedures included mitral valve surgery in 310 patients, aortic valve surgery in 131, and the other procedures in 36. Near-infrared spectroscopy was used in the recent 227 patients (NIRS group). Occurrence of LLN was retrospectively compared between the NIRS group and the remaining 260 patients (control group). In most patients, cardiopulmonary bypass (CPB) was established with single femoral arterial access. The size of the femoral arterial cannula was selected based on necessary flow dynamics and the diameter of the femoral artery measured by preoperative contrast-enhanced computed tomography. When the femoral artery was too small, alternative perfusion access was considered, including bilateral femoral artery, the right axillary artery, and central aortic cannulation. In the NIRS group, perfusion status of lower-limbs was continuously monitored during the period of CPB, and further alternative strategies were considered when tissue oxygen saturation decreased by more than 30% of the preoperative values.
Results: The duration of CPB was similar between the two groups (NIRS vs. control: 170±52 vs. 167±52 minutes). More patients received intraoperative change of perfusion access in the NIRS group, including additional distal limb perfusion using a small catheter in five patients (Table P109-1). As a consequence, the incidence of LLN was significantly lower in the NIRS group than the control group (0.4% vs. 5.5%, P=0.0014).
Conclusions: Intraoperative monitoring of tissue-oxygen saturation with NIRS is useful for optimal lower-limb perfusion to prevent LLN after minimally invasive cardiac surgery.

TABLE P109-1. Cannulation Site and the Ratio of Additional Distal Lower Limb Perfusion During Minimally Invasive Cardiac Surgery

	Control Group (n=260)	NIRS Group (n=227)	*P*
Single femoral artery	247 (95%)	160 (70%)	<0.0001
Bilateral femoral artery or femoral artery plus axillary artery	9 (3.4%)	39 (17%)	<0.0001
Ascending aorta	4 (1.5%)	28 (12%)	<0.0001
Distal lower limb perfusion	0 (0%)	5 (2.3%)	

NIRS, near-infrared spectroscopy.

P110
Low Incidence of Cerebral Microembolization During Convergent Procedure for Atrial Fibrillation

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Objective: This study aimed to assess the rate of cerebral microembolization during the convergent procedure (CP) for the treatment of atrial fibrillation.
Methods: A prospective study included 22 consecutive patients [age 58.9±6 years; 68.2% (15/22) male] who underwent hybrid CP for the treatment of paroxysmal atrial fibrillation. Patients received intravenous heparin to reach the ACT of at least 300 seconds before the transseptal punctures. Magnetic resonance scans (diffusion-weighted and FLAIR) were performed the day before and the day after the procedure. Presence of new cerebral ischemic lesions was assessed.
Results: Only one patient (4.5%, 1/22) had two new ischemic cerebral lesions (diameter, 1–2 mm) and was without any clinically detectable neurologic deficit.
Conclusions: The incidence of periprocedural cerebral microembolization in patients with paroxysmal atrial fibrillation undergoing CP is low.

P111
Impacts of Size and Viability of Revascularized Area on Graft Flow and Patency in Off-Pump Coronary Artery Bypass Grafting

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Objective: Graft flow is an important predictor of patency of arterial and vein graft and is determined by balance against native coronary flow and flow demand. Although evaluation of native coronary stenosis has been improved, the impact of flow demand has not yet been fully discussed. We examined the impact of flow demand in the grafted region on the graft flow and patency.
Methods: We examined 692 bypass grafts in 376 patients who underwent off-pump coronary artery bypass grafting and postoperative angiography between 2007 and September 2014. They consisted of 310 in situ internal thoracic artery (ITA)–to left anterior descending, 121 in situ ITA and 63 aortocoronary saphenous vein graft (SVG)–to–left circumflex (LCX), and 135 in situ gastroepiploic artery and 63 aortocoronary SVG–to–right coronary artery (RCA). Only bypass grafts, which were individual, and created as the sole bypass graft for each vascular region were selected. Flow insufficiency (FI) was defined as 20 mL/min or less in intraoperative flowmetry, and graft failure was defined as occlusion or string sign in postoperative angiography. MLD was measured at the narrowest portion of the target vessel. Proximal lesion was defined as stenosis at #1 to 3, 5, 6, and 11, whereas distal lesion was defined as stenosis at #4, 7, and 12 to 14.
Results: There were 120/692 (17.3%) FIs and 46/692 (6.6%) failures. Flow insufficiency significantly correlated with graft failure of ITA (x3.1), gastroepiploic artery (x2.8), and SVG (x5.8) (P<0.001). By multivariate logistic regression analysis, distal lesion [odds ratio (OR), 3.45; P<0.001], RCA (OR, 13.3; P<0.001) and LCX (OR, 2.23; P=0.01) region, previous myocardial infarction in the grafted region (OR, 3.72; P=0.02), and large MLD (OR, 3.72; P<0.001) were identified as significant predictors of FI. For RCA, there were 52/198 (26.3%) FIs and 26/198 (13.1%) failures. The causes of FI were competitive flow in 23.1% (11/52), small revascularized area due to hypoplastic RCA or stenosis at midportion of posterior descending branch at 34.7% (17/52), history of myocardial infarction at 34.7% (17/52), and LCX ectasia providing abundant collaterals at 5.8% (3/52).
Conclusions: Since graft selection based on the severity of native coronary stenosis has been introduced, the incidence of competitive flow decreased, whereas the influence of flow demand and collateral circulation became evident. The size and viability of revascularized area should be taken into account for surgical decision-making to achieve sufficient graft flow and patency.

P112
IntraClude Device: How to Predict the Balloon Volume Inflation From Previous Experience Analysis

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Objective: The heart-port procedure is performed using the endo-balloon for aortic cross-clamping. The new IntraClude (Edwards Lifesciences, Inc., Irvine, CA USA) features a new design of both catheter and balloon, resulting in an easier clamping technique. A balloon filling strategy based on an initial volume of 10 mL of saline, followed by additional injections of 2 mL up to complete aortic occlusion, is suggested by the producer. We report a simpler and faster filling procedure based on a relationship between balloon pressure and volume and the size of the ascending aorta.
Methods: From August 2012 to November 2015, 33 patients (20 were male) underwent minimally invasive valve surgery with the use of IntraClude (22 had repair, 11 had replacement, 2 had redo); mean age was 58±9.2 years. All these patients have been selected based on the analysis of a preoperative thoracic and abdominal computed tomographic scan performed to analyze aortic course and diameters. During the first four surgeries, we observed that the aortic occlusion was complete and stable when the balloon pressure was kept between 300 and 350 mmHg; an additional 2-mL volume was injected whenever this value got close to 300 mmHg. We analyzed the final balloon volume and the aortic diameter of each patient within a balloon pressure between 300 and 350 mmHg.
Results: Mean ascending aorta diameter was 31.45±2.12 mm, mean cross-clamping time was 120.73±41.01 minutes, mean saline volume inflated was 27.73±4.24 mL, and mean balloon pressure was 340.94±53.74 mmHg. There is a significant relationship between ascending aorta diameter and total balloon inflation volume calculated by linear regression (Fig. P112-1) (inflation volume=1.54× ascending aorta diameter−20.81). The Pearson product moment correlation showed an R=0.84 (P<0.001), R^2=0.7 with an adjusted R^2=0.69, and an SE of estimate=4.06.
Conclusions: The presence of a relationship well correlating ascending aorta dimensions and the saline volume necessary to reach an effective aortic cross-clamp is important to guarantee a stable occlusion throughout the operation. Additional saline volume can be required to keep the balloon pressure between 300 and 350 mmHg.

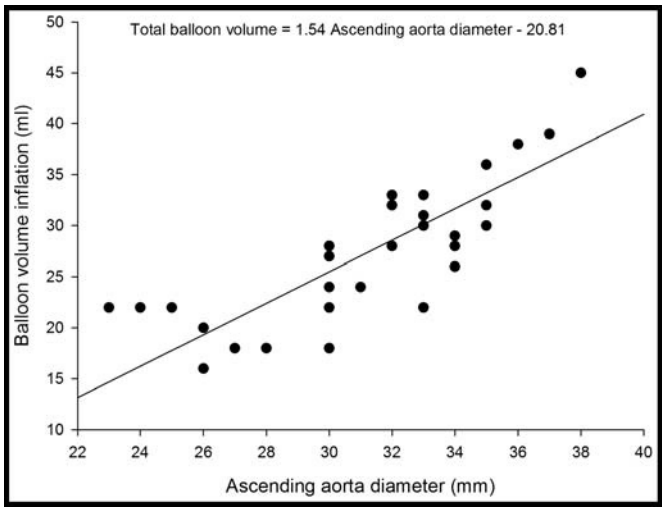

FIGURE P112-1. Graph showing the relationship existing between ascending aorta diameter and total balloon inflation volume.

P113
Risk Stratification and Care Bundle Approach Including Endoscopic Vein Harvesting Reduces Sternal and Donor Site Infection Rates to 0%

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Objective: Surgical site infection (SSI) after coronary artery bypass surgery causes significant morbidity, but to date, there is a lack of risk stratification tool to identify patients at high risk of SSI. We report a risk stratification model developed at our institution and externally validated at three additional institutions. The risk stratification model was used to focus our efforts at reduction of SSI at the highest-risk group.
Methods: The Brompton Harefield Infection Score (BHIS) was developed using binary logistic regression analysis to identify independent predictors of SSI in coronary artery bypass grafting patients. Area under the receiver operating characteristic curve for the model was 0.727. A series of ''care bundle'' interventions were targeted at patients identified by the BHIS as high risk. These included extended preoperative antibacterial wash, endoscopic vein harvesting, modified sternal closure, extended antibiotic prophylaxis, negative pressure wound therapy (PICO), and patient involvement in self-care using wound photographs at hospital discharge.
Results: Diabetes, HbA1c greater than 7.5%, body mass index greater than 3, female sex, left ventricular ejection fraction of less than 45%, and emergency surgery were identified as independent risk factors for SSI. Patients with a score of 4 or higher were identified as high risk with a predicted SSI risk in excess of 16%. Concerted effort was made to implement the care bundle approach for high-risk patients belonging to two consultant firms. The remaining patients in the institution were treated routinely. Between October 2013 and October 2015, in the high-risk group (n=29) treated with the care bundle approach, the SSI rate was reduced to 0%. In the same period, SSI rate in high-risk patients not treated with the care bundle approach was 12.5% (7 of 56). The difference between the two groups did not reach statistical significance (P=0.08 by Fisher exact test).
Conclusions: The BHIS identified high-risk patients for SSI, in whom a targeted multidisciplinary care bundle approach was successfully implemented. Although the data were not statistically significant, the abolition of sternal and leg wound infections in the highest-risk group had a great impact on quality improvement for our patients. This model and treatment approach warrant further validation because of its potential to have significant impact on SSI after coronary artery bypass grafting.

P114
Preoperative Eligibility for Minimally Invasive Coronary Artery Bypass Grafting: An Examination of Epicardial Adipose Using Computed Tomography

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Objective: One of the primary concerns necessitating conversion to a conventional full sternotomy coronary artery bypass procedure from a robot-assisted endoscopic single-vessel small thoracotomy (endo-SVST) is the inability to visualize the left anterior descending (LAD) coronary artery within the surrounding epicardial adipose tissue using the endoscopic camera. The purpose of this study was to determine whether the analysis of anatomical properties of the epicardial adipose tissue, along with anthropometric parameters examined using patient data and preoperative computed tomographic (CT) images, is able to predict and thus reduce the need for intraoperative conversion based on effective preoperative exclusion criteria.
Methods: A retrospective analysis of patient preoperative CT angiographic scans from both converted (n=13) and successful robot-assisted (n=13) procedures was performed. Where possible, measurements of thoracic cavity dimensions and epicardial adipose tissue thickness were acquired from axial slices, at the most accessible segment of the LAD, in the fourth anterior intercostal space. An independent-samples Student t test (α=0.05) was performed using IBM SPSS Statistics 22 (IBM, Armonk, NY USA).
Results: Results indicate that patients who successfully underwent the endo-SVST procedure (mean thickness, 5.0±2.0 mm) had significantly less epicardial adipose tissue (34%, P=0.03) overlying the LAD in the transverse [Fig. P114-1, LAD to pericardium (II)] measurement than those who were converted to the full sternotomy approach intraoperatively (mean thickness,

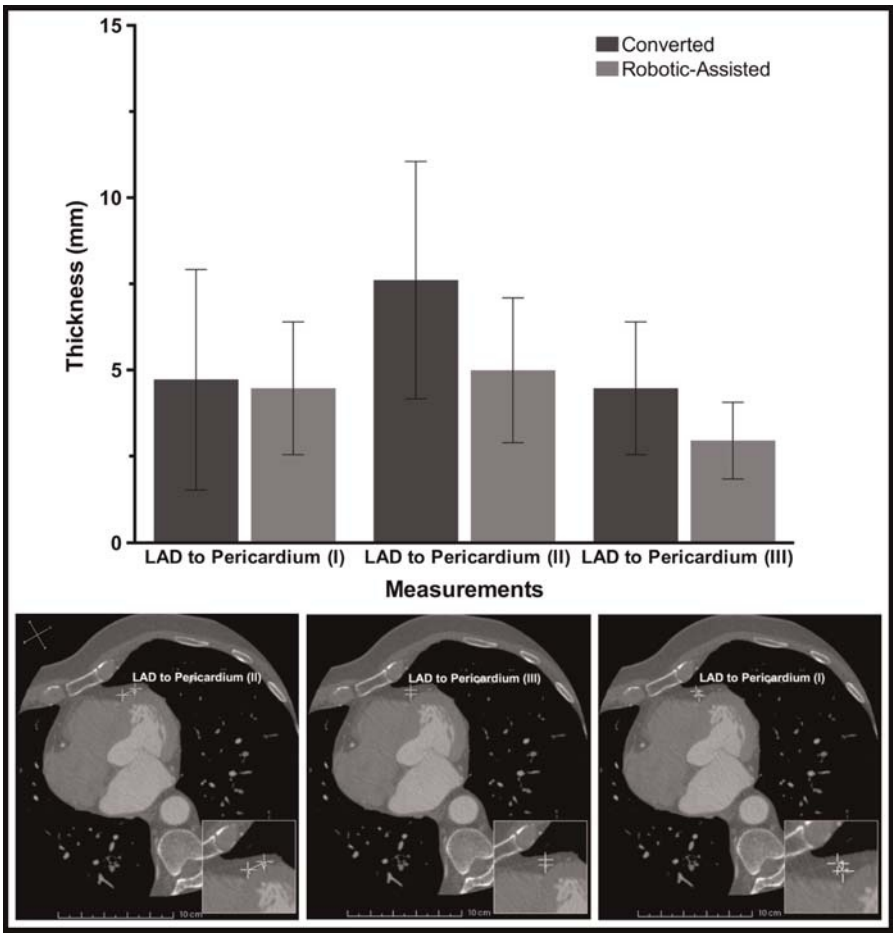

FIGURE P114-1. Thickness of epicardial adipose (mean±SD) overlying the LAD to the pericardium (I) toward the anterior chest wall, (II) transversely toward the lateral chest wall, and (III) bisecting (I) and (II) of the patients who successfully underwent robotically assisted endo-SVST (n=13) and patients who underwent intraoperative conversion to full sternotomy procedures (n=13). *P=0.03. Endo-SVST, endoscopic single-vessel small thoracotomy; LAD, left anterior descending.

7.6±3.3 mm). Using this mean thickness as the baseline for exclusion reduces the conversion rate for this group by 46%. Preliminary data suggest that no significant differences exist between the two groups with respect to the remaining epicardial adipose tissue and anthropometric data.

Conclusions: The addition of CT measurements of the epicardial adipose tissue overlying the LAD may enhance preoperative surgical planning for the endo-SVST procedure, thereby reducing the instances of procedural changes, which have been shown to lead to higher patient morbidity, along with increased operative time and costs.

P115
Minimally Invasive Aortic Valve Replacement: No Groin, A New Perfusion Technique: The ''R-R India Method''

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Objective: The main objective of our study was to develop a technique for performing minimally invasive aortic valve replacement (MIAVR) that should avoid all complications of the groin incision involved in femoral cannulation and cannula traffic in central cannulation.

Methods: For MIAVR, the most popular cannulation technique among surgeons worldwide is still total femoral cannulation, and few surgeons adopt

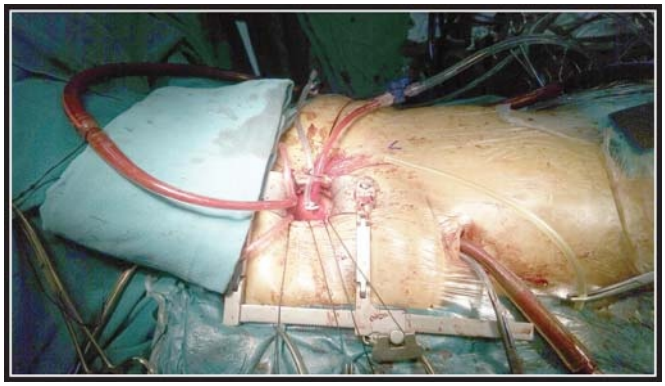

FIGURE P115-1. The final view of the surgical field after completion of cardiopulmonary bypass cannulation. It shows the aortic cannula and antegrade root cardioplegia cannula coming out of the surgical incision and the right hemithoracotomy and venous cannula coming out of the chest through the right fifth intercostal space.

direct ascending aorta cannulation and femoral vein cannulation for venous drainage. Both techniques are associated with groin incision's complications. Some adopt totally central arterial and venous cannulation technique but reluctant for the same because of the crowding of cannulae in the surgical field of interest. We have developed our direct technique of perfusion to avoid all complications related to retrograde perfusion, groin exposures, and cannula traffic. In our technique, we can avoid extra incision in the groin for femoral cannulation, and the three-stage venous cannula comes out from the midaxillary line through the fifth intercostal space (the site is used for pleural chest tube insertion after the completion of procedure). Venous cannula completely avoids the surgical field, so that there is no crowding by the venous cannula (Fig. P115-1).

Results: We have just used this technique in our practice, and now, we are performing all our MIAVRs with this technique successfully. To date, we have performed this technique in five cases with 100% success rate, no mortality, no morbidity, involving four female and one male patient. Mean age was 51.8 years (27–63 years), mean weight was 66.6 kg (37–95 kg), mean cardiopulmonary bypass time was 216.8 minutes (169–241 minutes), and mean aortic cross-clamp time was 143.2 minute (123–168 minutes).

Conclusions: Our technique can be used for MIAVR with good success results without involving any complications of groin incision and retrograde perfusion.

P116
Single-Stage Hybrid Coronary Intervention With Concomitant Minimal Invasive Valve Surgery

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Objective: In high-risk patients requiring open heart surgery, hybrid procedures offer less invasive methods of addressing patient cardiac pathology. We report our single-institution outcomes of a single-stage hybrid strategy for high-risk patients with concomitant valvular and coronary artery disease.

Methods: From 2010 to 2015, 24 patients underwent single-stage hybrid surgery consisting of percutaneous coronary intervention (PCI) followed by minimally invasive valve replacement/repair. In all cases, a loading dose of 300-mg clopidogrel was given before induction of anesthesia and PCI. Aortic valve replacement (n=21) was performed via a partial sternotomy approach, and mitral valve repair (n=3) was performed through a right minithoracotomy approach. Patient records were retrospectively reviewed.

Results: Mean patient age was 71.2±10.3 years (29.2% female), with the majority of patients presenting with one vessel disease (n=18). Aortic valvular pathology was severe aortic stenosis in all cases (mean aortic valve area, 0.8±0.2 cm^2; mean gradient, 41.6±9.5 mmHg). Mitral valvular pathology was severe mitral regurgitation (functional, n=1; leaflet prolapse, n=2). There were no intraoperative conversions to full sternotomy. Percutaneous coronary intervention was successfully performed in 96% (n=23) of the cases, with successful minimally invasive surgery in all cases. Mean cardiopulmonary bypass time was 97±24 minutes, and mean aortic cross-clamp time was 69±19 minutes. Intraoperative transfusion requirement was zero. In-hospital and 30-day mortality was 4% (n=1). Stroke rate, reoperation for bleeding, and renal failure rate were zero. Ten patients (42%) required blood product transfusion postoperatively, with a mean transfusion rate of 0.8±1.6 U per patient for the entire group. On discharge echocardiography, paravalvular leak rate was zero in patients undergoing aortic valve replacement, and mitral regurgitation rate was also zero.

Conclusions: This study demonstrates the feasibility and early safety of single-stage hybrid strategy with PCI followed by valvular surgery in high-risk patients (Table P116-1). This strategy enables the use of minimally invasive surgical approaches to treat combined valvular and coronary artery pathology, which may have decreased operative morbidity in high-risk patients.

TABLE P116-1. Postoperative Outcomes

Variable	Outcome
Stroke/TIA	0 (0)
Atrial fibrillation	13 (54.2)
Multiple system failure	1 (4.2)
Cardiac tamponade	0 (0)
Renal failure	1 (4.2)
Creatinine	1.1±0.4
Reoperation for bleeding	0 (0)
Intervention for graft occlusion	0 (0)
Structural valve dysfunction	0 (0)
Nonstructural valve dysfunction	0 (0)
Residual mitral insufficiency	0 (0)
Hospital length of stay, d	8.9±3.4
ICU length of stay, h	49.7±33.9
Readmission to ICU	2 (8.3)
Duration of ventilation, h	16.0±11.8
Requirement for reintubation	2 (8.3)
Total transfusions administered/patient	0.8±1.6

Values are n (%) for categorical variables and mean±SD for continuous variables.

ICU, intensive care unit; TIA, transitory ischemic attack.

P117
Comparison of COR-KNOT Device Suture-Fastening System Versus Hand Tying In Conventional Open Cardiac Surgery: A Retrospective Study

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Objective: The COR-KNOT device is an automated suture-fastening system, which enables the operator to secure the knot as well as to trim and cut the suture without the need for hand tying and cutting the sutures. The COR-KNOT device is used mainly in minimally invasive valve surgery to facilitate easier access and remote suture tensioning. In this study, our aim was to evaluate the safety and speed of the COR-KNOT device compared with hand tying in conventional open surgery.

Methods: This is a retrospective study on patients who underwent cardiac surgery by a single surgeon in one center between October 2013 and June 2014. Procedures included conventional aortic valve replacement with or without concomitant coronary artery bypass graft and major aortic surgery. The cohort of patients was divided into two groups based on the suturing technique used; the COR-KNOT device was used in patients between December 2014 and June 2015. The outcomes were compared to a historical control of patients between October 2013 and December 2014 where conventional hand tying and cutting with scissors was used. The primary outcome measure in each group was the cross-clamp time. We performed multivariate linear regression analyses to compare differences in means of cross-clamp times between the two groups.

Results: In the analysis of the entire cohort, the mean cross-clamp time in the hand tying group was 15.6 minutes longer compared with the COR-KNOT group [95% confidence interval (CI), 8.6–22.6; $P<0.05$]. In the subgroup of patients who underwent isolated aortic valve surgery, the mean cross-clamp time was 15.96 minutes longer in the hand tying group compared with the COR-KNOT group after adjustment (95% CI, 7.55–24.37; $P<0.05$). The mean cross-clamp time in patients who underwent aortic valve replacement and concomitant coronary artery bypass graft using hand tying was 15.5 minutes longer compared with the COR-KNOT group (95% CI, 5.85–25.1; $P<0.05$).

Conclusions: Our study has demonstrated that the COR-KNOT device is a safe suture-fastening system and reduces the cross-clamp times significantly in conventional surgery. Larger randomized controlled trials with longer follow-up times are necessary to further evaluate the safety and efficacy of this device compared with conventional hand tying, especially in the context of concomitant aortic and multiple valve procedures.

P118
Robotic Assistance in Reoperative Cardiac Surgery: Feasibility and Early Outcomes

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Objective: Robotic cardiac surgery is well established in the literature and can improve outcomes by eliminating the potential complications of sternotomy, decreasing hospital length of stay, and improving recovery times. These benefits are enhanced in patients who have had previous cardiac surgical procedures by eliminating the added risk of redo sternotomy. We reviewed our robot-assisted reoperative cardiac surgical procedures
Methods: We performed a retrospective chart review of our robotic redo cardiac surgical procedures from 2008 to 2015. The surgical approach was to introduce a 5-mm scope into the appropriate pleural space away from previous incisions. A limited video-assisted thoracoscopic surgery dissection was then performed as necessary to create a space for the robotic camera and arms after which the robot was docked and the rest of the redo dissection was performed. Valve and intracardiac procedures were performed with peripheral cannulation and endoballoon cardiac arrest. Totally endoscopic coronary artery bypass was performed on the beating heart with anastomotic devices.
Results: From 2008 to 2015, 851 patients underwent robot-assisted cardiac surgery. Forty-four patients had one or more previous cardiac surgical procedures. Forty patients had one previous cardiac surgical procedure, and four patients had two previous cardiac surgeries. Demographics are shown in Table P118-1. Ten patients underwent robotic beating heart totally endoscopic coronary artery bypass, 10 patients underwent epicardial left ventricular lead placements, one patient underwent atrial myxoma removal, and 23 patients underwent valve procedures (15 mitral valve, 5 combined mitral and tricuspid valve, and 3 isolated tricuspid valve). Of the 20 mitral valve procedures, 14 were repairs and 6 were replacements; of the 8 tricuspid valve procedures, 7 were repairs and 1 was a replacement. There were eight concomitant Cryomaze procedures for atrial fibrillation. Median length of stay was 4 days. One patient was converted to sternotomy. Perioperative mortality was 2.3%.
Conclusions: Robot-assisted reoperative cardiac surgery is feasible with excellent clinical outcomes. A large experience in robotic cardiac surgery is necessary. Initial careful thoracoscopic dissection allows for safe placement of robotic ports and instruments. Further studies of robotic reoperative cardiac surgery are needed.

TABLE P118-1. Robotic Redo Cardiac Surgery: Demographics in 44 Patients

Age	66±14
Male	28 (64%)
Ejection fraction	49.6±16.6%
Diabetic	10 (23%)
Hypertension	29 (66%)
Chronic kidney disease	7 (16%)
Hyperlipidemia	22 (50%)
Cerebrovascular accident	7 (16%)
Redo procedure	4 (9%)
EuroSCORE	6.7±6.1

P119
Alteration of Echocardiographic Findings and Analysis of the Long-term Survival Factors After Pericardiectomy

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Objective: Echocardiographic findings before pericardiectomy of constrictive pericarditis are well documented. However, there were only few reports on sequential alteration of echocardiogram after pericardiectomy. The purpose of this study was to analyze alteration of echocardiographic findings after pericardiectomy and to uncover the long-term perioperative survival factors for constrictive pericarditis.
Methods: A total of 90 consecutive patients who underwent pericardiectomy from 1995 to 2015 in Seoul Samsung Medical Center were analyzed retrospectively. Patients were categorized into the conventional group and the extended group according to the extent of removal of pericardium based on the relative position to the phrenic nerve. Echocardiographic findings were sorted into three groups: preoperative, immediate postoperative, and the most recent. The median follow-up period was 37.6 months.
Results: The early mortality rate was 4.4%, and the late mortality rate was 4.4% as well. The 10-year survival rates were 70.3%±12.3% for the conventional group and 95.0%±4.9% for the extended group, which were calculated by the Kaplan-Meier method (P=0.021). When multivariate analysis was applied to analyze the long-term survival factors, the odd of survival was 24.9 times greater for the extended group (P=0.021), and the odd of survival was 17.8 times greater when cardiopulmonary bypass was used (P=0.008). When the predictive factors for major adverse cardiocerebral events (MACCEs) were analyzed, patients who had atrial fibrillation before the surgery had 29.3 times greater chance of MACCE (P=0.015), and the patients with early morbidity had 13.6 times higher chance of MACCE (P=0.015). On echocardiographic findings of the immediate postoperative and the most recent examination for both groups, the medial mitral annulus velocity during diastole was significantly decreased, and the ratio of the lateral mitral annulus velocity to the medial mitral annulus velocity during diastole was significantly reduced as well.
Conclusions: Although the postoperative echocardiography may show diminished clinical findings of constrictive physiology regardless of the extent of pericardiectomy, using cardiopulmonary bypass and removal of pericardium beyond the phrenic nerve posteriorly significantly increased the long-term survival rate. Atrial fibrillation before the surgery and early morbidity were the predictive factors for MACCE.

P120
Evaluation of the Efficacy of a Novel Medial Adhesive, MAR VIVO-107, in a Vessel Burst Pressure Study

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Objective: Invasive surgical procedures carry a high risk of bleeding. One of the main causes of bleeding is vascular damage. Our aim was to test the efficacy and adhesive properties of novel synthetic glue, MAR VIVO-107 (Adhesys Medical, Aachen, Germany), in comparison with ligation, coagulation, and TachoSil (Baxter Healthcare, Deerfield, IL USA) (a fibrin patch).
Methods: Arteries and veins were freshly explanted from a porcine. The vessels were sectioned into a desired length of 1 cm. The cuts were sealed with MAR VIVO-107, ligation, coagulation, or TachoSil. The vessels were then connected to an infusion pump. Physiological saline was pumped into the vessels at a constant flow (99 mL/h), and the opposite ends of the vessels were ligated. The maximum pressure at which the vessels burst was recorded using

a digital pressure meter. The results were documented and statistically analyzed using one-way analysis of variance and Tukey post hoc test.

Results: MAR VIVO-107 showed superior sealing performance in comparison with TachoSil. The results of MAR VIVO-107 were comparable with those of coagulation, which is the clinical standard for hemostasis during laparoscopic surgery. The mean venous pressure was assumed to be 20 to 25 mmHg, whereas, MAR VIVO-107 (150±56.14 mmHg) showed numerically higher values compared with TachoSil (19±4.07 mmHg); however, ligation (620±136 mmHg) was significantly stronger compared with the other groups. Meanwhile, the mean systolic arterial pressure is 120 mmHg; MAR VIVO-107 (334±130.63 mmHg) provided sufficient and safe sealing for a pressure, which is two-fold higher than the normal. TachoSil (21±3 mmHg) and MAR VIVO-107 were significantly lower compared with ligation (1196±173 mmHg).

Conclusions: MAR VIVO-107 showed an efficient, strong, and reliable sealing under high pressure in comparison with TachoSil.

