Aesculap® Valve XS

OP Manual for Minimally Invasive Mitral Valve Repair

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Aesculap Surgical Technologies

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OP Manual for Minimally Invasive Mitral Valve Repair

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Introduction

Mitral valve (MV) repair is the gold standard for the treatment of mitral regurgitation (MR)[1–5] today. There is currently no reasonable alternative to surgery which can be curative and results in the prevention of subsequent heart failure [6, 7]. Mitral valve repair has been conclusively demonstrated to be superior to MV replacement with improved post-operative survival rates and preserved left ventricular function. Modern cardiac surgery programs with a high volume number have achieved very high MV repair rates with minimal peri-operative mortality and long-term outcomes that are comparable with the general population. [1–5, 8, 9]

The mitral valve is a highly complex structure based upon five different components (Figure 1): the mitral annulus, the anterior and posterior leaflet, the chordae tendinae, the papillary muscles, and the left ventricle. An exceptionally complex mechanism underlies the systolic and diastolic function of the MV. Even today, the complete task and function of the MV is not fully understood and continues to be the subject of a tremendous amount of research activities. Detailed pathophysiogical mechanisms regarding the two highest prevalence entities – degenerative and functional MR – remain uncertain. The goal of a mitral valve repair procedure for degenerative disease follows two fundamental principles: restore a good surface of leaflet coaptation and correct for annular dilatation [1, 10]. A leaflet coaptation line of 5–8 mm is considered essential to provide a durable repair result.

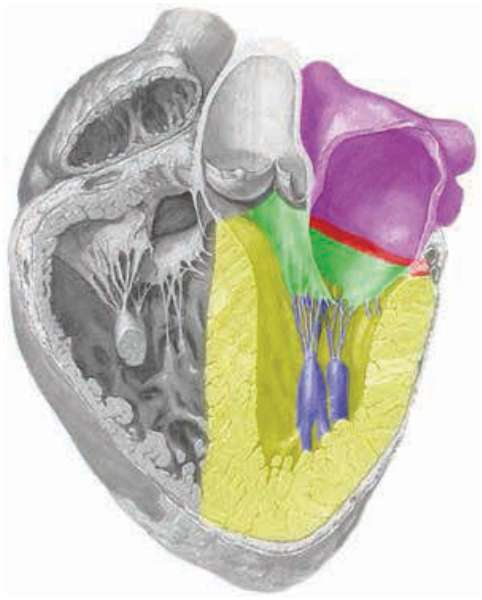

Figure 1: *Purple: left atrium (LA); red line: mitral annulus; green: anterior and posterior leaflet; blue: chordae and papillary muscle*

Pathology of mitral valve disease

Degenerative mitral valve disease is a common disorder affecting around 2% of the population [6]. The most common finding in patients with degenerative valve disease is leaflet prolapse due to elongation or rupture of the chordal apparatus, resulting in varying degrees of mitral valve regurgitation due to leaflet malcoaptation during ventricular contraction (Figure 2). The emphasis of clinical decision-making in patients with degenerative disease centers around the severity of regurgitation and its impact on symptom status, ventricular function and dimension, the sequelae of systolic flow reversal such as atrial dilatation/fibrillation and secondary pulmonary hypertension, and the risk of sudden death [1, 11, 12].

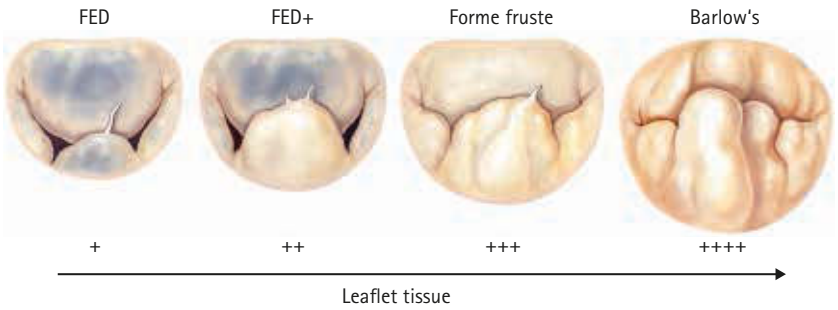

Figure 2: *Spectrum of degenerative mitral disease ranging from fibroelastic deficiency (FED) to Barlow's disease*

Functional MR arises as a consequence of left ventricular dilatation with or without leaflet tethering due to either ischaemic or dilatative cardiomyopathy [6, 15]. The most commonly used classification of MV dysfunction and MR has been introduced by Carpentier, consisting of types I–IIIb (Figure 3) and have been extensively described elsewhere [6, 14, 15].

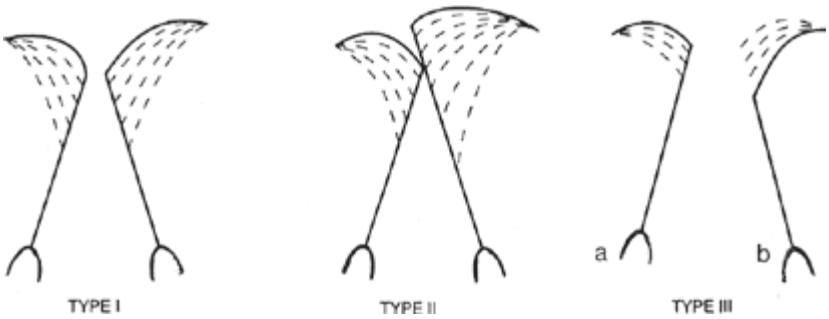

Figure 3: *Type I: normal leaflet motion; Type II: leaflet prolapse; Type III: restricted leaflet motion a.) diastolic b.) systolic (ICM, DCM)*

Timing of surgical intervention

Controversy exists as to whether early surgical intervention in asymptomatic patients, before the onset of ventricular changes, improves the outcome of patients with chronic severe degenerative mitral valve disease [1,13]. This debate has put emphasis on the lack of predictability of mitral valve repair, despite broad consensus that this is the procedure of choice for patients undergoing surgical intervention. The confidence gap in predicting successful mitral valve repair is one of the factors responsible for the lack of adherence to guidelines directed toward timely referral of patients with indications for surgery. An emerging accord is building that current medical and surgical practice often results in suboptimal care for the individual patient with degenerative mitral valve disease, and indeed a paradigm shift or 'revolution' through education is not only predictable but essential to advance the field. All practicing cardiovascular specialists should have familiarity with the 'state of art' in terms of degenerative disease differentiation, timing of intervention, and surgical techniques and results in order to improve patient care [7].

Principles for mitral valve repair

Three principle goals of MV repair were introduced by Carpentier: Stabilization of the annulus with the retention of an adequately sized mitral orifice, restoration of physiological leaflet motion and recreation of a sufficient line of coaptation [10]. Specific techniques such as ring annuloplasty, resection of leaflet prolapse, leaflet sliding plasty, and others have been ascribed to Carpentier and are together known as the 'French correction.' These 'classical' repair techniques have proved excellent results with a high durability and high freedom from reoperation rate [1–5, 8, 9]. Numerous additional repair techniques such as implantation of neo chordae, edge-to-edge repair, papillary muscle shortening, leaflet reduction plasty, and others have been developed, affording the surgeon a wide armamentarium of approaches [1–5, 16–22]. For patients with degenerative MV disease, a surgical repair rate of nearly 100% has been reported in select reference centers [8]. Simultaneously, peri-operative mortality and morbidity rates for complications such as stroke and valve-related reoperation have been excellent, occurring in 2% of patients. It has also been recently shown that even the historically more difficult repair of anterior or bileaflet mitral prolapse can be achieved in 90% of

patients, with long-term survival and freedom from reoperation rates that are similar to the more straightforward isolated posterior prolapse pathology [2, 4]. These superb results can also be achieved through a minimally invasive technique leading to a better cosmetic result, a decreased incidence of respiratory failure, decreased post-operative pain, and a faster recovery [4, 8, 9, 23]. For patients with functional MR, undersized mitral annuloplasty is the current surgical gold standard. This strategy attempts to reshape the mitral annulus to a more anatomically correct form, thus leading to increased leaflet coaptation and a competent MV. It is of utmost importance for this operation that a complete rigid annuloplasty ring is implanted, rather than an open flexible band [24, 25]. Undersized annuloplasty has been associated with left ventricular reverse remodeling and improvement of symptoms in the majority of patients, but recurrent MR occurs more frequently than in patients with degenerative disease. Recently developed strategies such as the 'ring and string' concept, secondary chordal cutting, septal-lateral banding, and posterior leaflet extension have been suggested as additional techniques that may minimize the risk of recurrent MR [26–28]. Current surgical MV repair offers a highly effective and safe treatment for patients with MR, even in those patients who require reoperative procedures [1–5, 8, 9, 23, 29]. Most important, however, is the fact that surgery frequently results in a complete correction of the MR and normalization of valve morphology, and thus represents the only curative treatment strategy for patients with MR. The high mountain of surgical MV repair therefore represents the current gold standard for the treatment of MR.

Surgical procedure – Step by step:

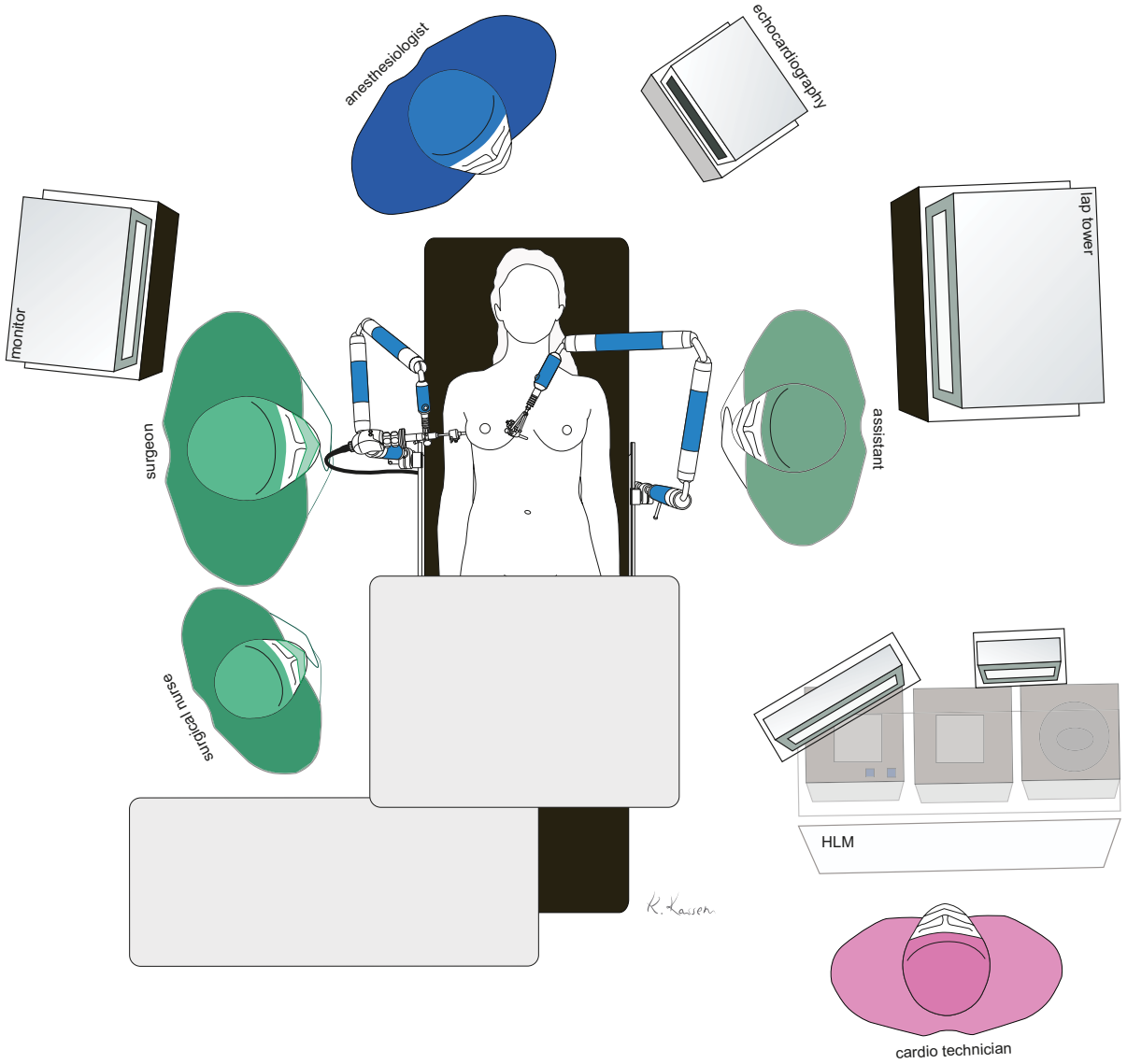

Figure 4: *OR Setting*

The right groin is favored for cardio pulmonary bypass cannulation due to anatomical reasons since it allows easier venous cannulation. Thus in case of a preoperative angiogram for exclusion of any relevant coronary artery vessel disease, the left groin should be used for access.

Intraoperative set-up including anesthesiologist, surgeon, surgical assistant, scrub nurse and perfusionist, in a standard fashion (Figure 4). Two monitors for endoscopic view are recommended, one each for the leading surgeon and the surgical assistant.

Standard monitoring for cardiac surgery is used: a central and arterial line is placed and defibrillator pads are placed on the back and towards the right chest (as laterally as possible). A double-lumen endotracheal tube can be helpful but is basically unnecessary. For selection of the most appropriate repair technique a complete understanding of the underlying degenerative etiology, anatomical lesions, and leaflet dysfunction (excess or restricted leaflet motion) is mandatory. Intraoperative transesophageal 2D and – increasingly used – real time 3D transesophageal echocardiography (TEE) is performed to guide the procedure and finally confirm the postoperative result.

In case of tricuspid valve surgery, the right superior vena cava (SVC) must be cannulated for venous drainage of the upper body (Figure 5).

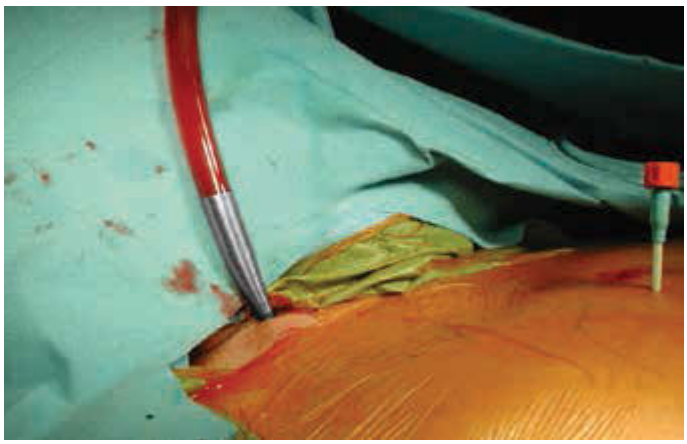

Figure 5: *SVC cannulation*

The patient is placed in a supine position with a positioning roll placed caudal to the right scapula parallel to the spine in order to lift the right thorax up in an angle of 35 to 45°. The patient is then draped in a way to allow for right lateral minithoracotomy and in case of an emergency for standard full median sternotomy. The lower axillary line must be accessible for placement of the transthoracic aortic clamp.

Two holding arms (Unitrac RT040R), one for the endoscope and one for the left atrium retractor, are mounted on the OR table rail on each side at the level of the patient's head. The operating table is rotated 10° to 15° to raise the patient's right side. Final patient positioning should allow for easy access to the right chest and right groin (Figure 6).

Figure 6: *Positioning of the patient*

After administration of heparin cardiopulmonary bypass is instituted via femoral arterial and venous cannulation through a 3- to 4-cm oblique incision in the right groin (Figure 7).

Figure 7: *Cannulation for extra corporal bypass*

Figure 8: *Right lateral thoracotomy in the fourth intercostal space.*

The tip of the venous cannula is positioned under transesophageal echocardiographic guidance at the junction of the inferior cava and the right atrium. Mild hypothermia (34 °C) and vacuum-assisted venous drainage is applied. After the extracorporeal circulation has been instituted, adequate exposure of the right and left atrium and thus the mitral valve (MV) is mandatory by termination of ventilation with disconnection of the endotracheal tube. A four to five centimeter incision in the fourth intercostal space gives access to the intra-thoracic cavity (Figure 8).

Figure 9: *Soft tissue retractor*

As the next step a soft tissue retractor is introduced (Figure 9).

Figure 10: *Stay suture for diaphragm*

After mini-thoracotomy it is mandatory to scan the thoracic cavity for adhesions in order to safely install additional ports, the camera, atrial retractor and aortic clamp. In case of an elevated diaphragm, which inhibits direct vision to the left atrium, a stay suture is recommended to bring the diaphragm "down" (Figure 10).

In case of a limited surgical field, the thoracic retractor can be introduced but it is not prerequisite (Figure 11).

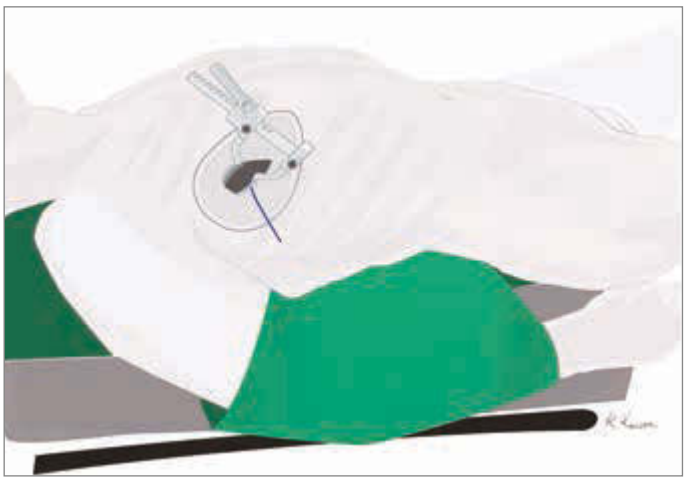

Figure 11: *Thoracic retractor*

The camera port is placed in the second intercostal space lateral to mid-clavicular line followed by insertion of the camera. In addition CO_2-insufflation is initiated to improve de-airing at the end of procedure. Then the transthoracic "Chitwood" clamp is used for cross clamping of the aorta. The clamp is introduced through an extra incision medial to anterior axillary line (Figure 12).

Figure 12: *Position of camera port and "Chitwood "clamp*

To ensure an optimal surgical exposition it is recommended to dissect the adjacent pericardial fatty tissue (Figure 13).

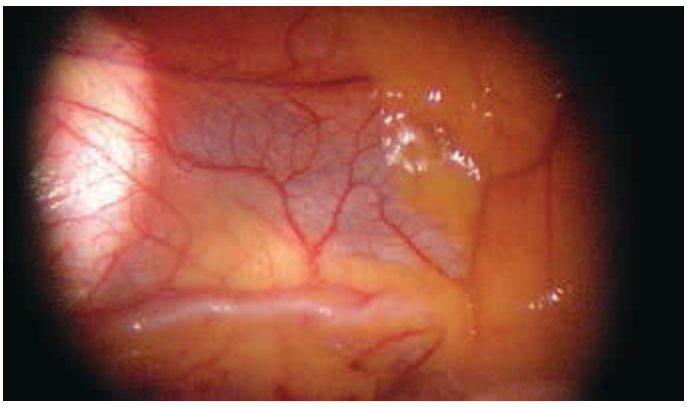

Figure 13: *Phrenic nerve and pericardial fat tissue*

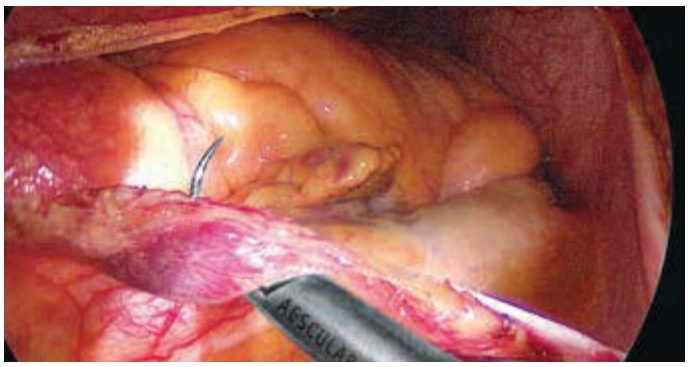

Figure 14: *Placement of pericardial retraction sutures*

The pericardiotomy is performed with a longitudinal incision of the pericardium approximately three to four centimeters parallel to the phrenic nerve. Two stay sutures can be placed close to the phrenic nerve for retraction in order to improve exposition and clear visualization of the left atrium (LA) (Figure 14).

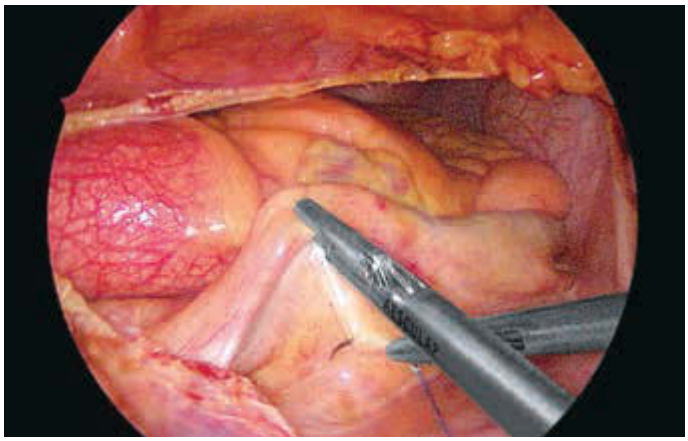

Figure 15: *Placement of the LA suture for better visualization*

A retraction suture is placed into the inter-atrial groove to lift up the left atrium (Figure 15). Identification of the best spot is facilitated by identifying anatomical landmarks.

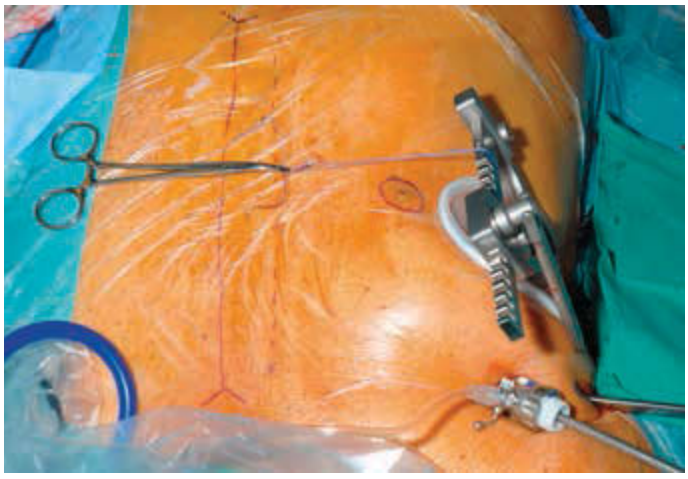

Figure 16: *Anatomical orientation to guide placement of LA retraction suture*

For better orientation the suture can be aligned outside the chest wall (Figure 16), the continuous line marks the sternum and the dotted line identifies the right internal thoracic artery (ITA).

The ideal site for the execution of the suture can be determined by the dotted line, which reminds a safety gap to avoid any injury of the ITA. The suture is easily pulled through using a clamp (Figure 17).

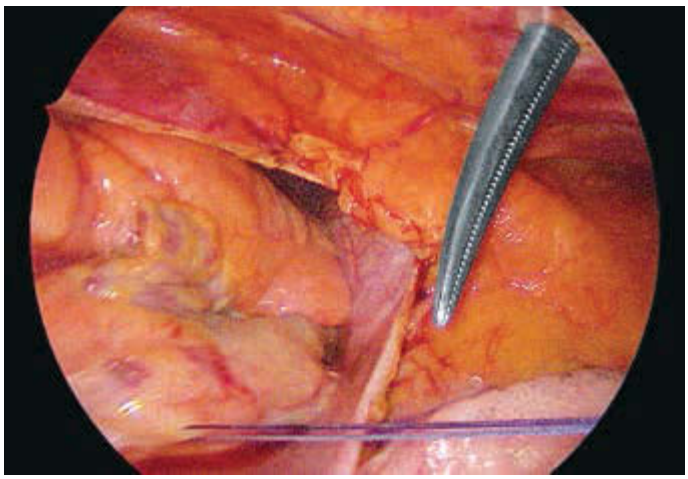

Figure 17: *Placement of the retraction suture*

With blunt dissection, the LA can be separated from the inferior vena cava (IVC, Figure 18).

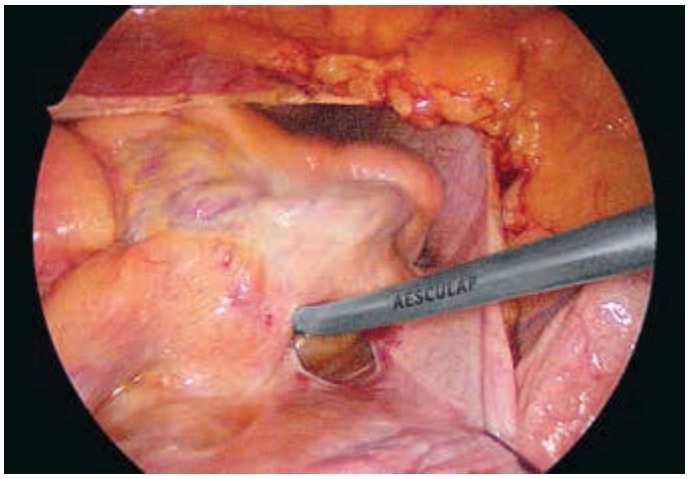

Figure 18: *Blunt dissection of LA an IVC*

The transthoracic aortic clamp can be introduced medial to the anterior axillary line in the second ICS (Figure 19). Care has to be taken to avoid damaging the pulmonary artery and/or the left atrial appendage (LAA) when closing the Chitwood clamp. As a hint, the aortic occlusion is best performed by pushing the LAA aside with the suction device. The convex side of the clamp is supposed to face toward the head of the patient.

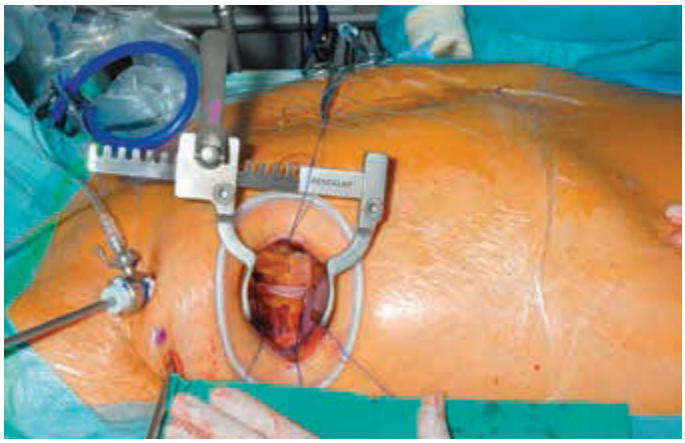

Figure 19: *Intraoperative set-up immediately after aortic cross clamping*

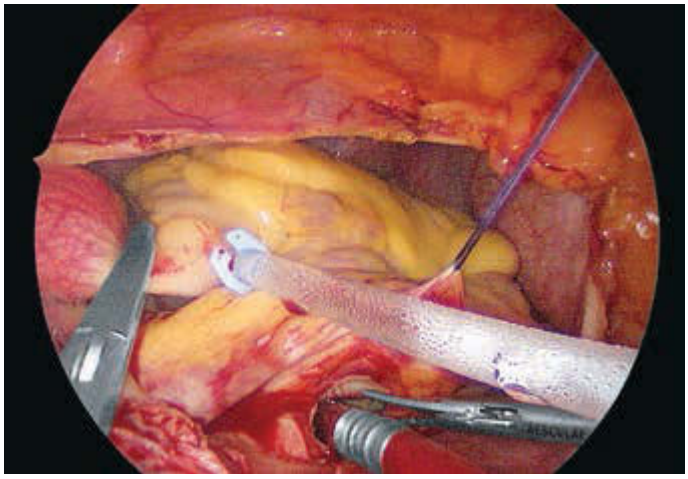

Figure 20: *Application of 2000 ml crystalloid cardioplegia as a single shot*

Then crystalloid Bretschneider cardioplegia (2000 ml) is administered antegrade directly into the aortic root over a commercially available modified needle-vent. In case of aortic occlusion of more than 90 minutes this procedure can be repeated. While applying the cardioplegia the LA is incised (Figure 20).

The LA incision is extended to allow for a suitable access to the MV. It can be opened as far as 1 cm to the SVC and midway between the right inferior pulmonary vein and the IVC. The surgical field is flooded throughout the operation with carbon dioxide and a left atrial vent is placed to drain the pulmonary venous return.

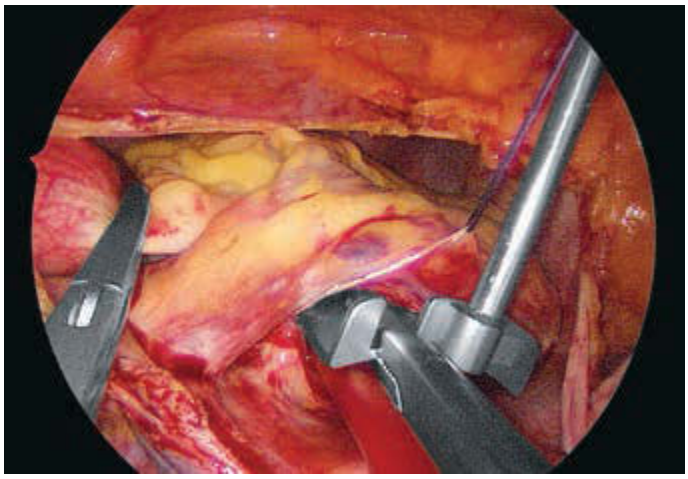

Figure 21: *Introduction of the left atrial roof retractor*

Maximal exposure of the MV is obtained using an atrial roof retractor. The size of the roof blade needs to be chosen according to the size of the LA. If the exposure remains suboptimal, then the LA incision can be enlarged and/or another intercostal space is selected (Figure 21).

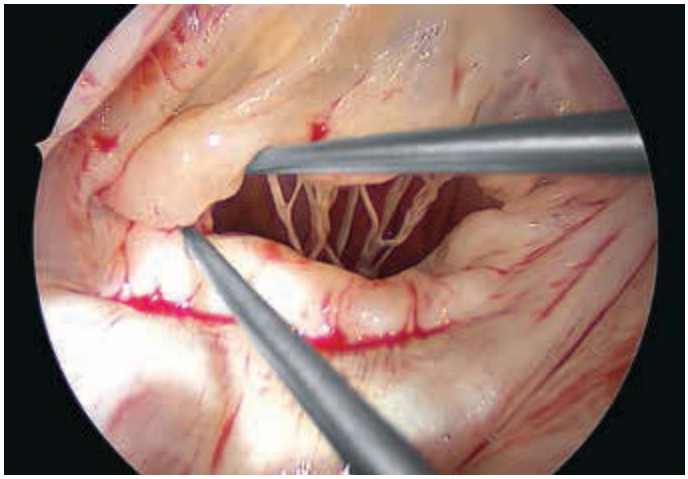

Figure 22: *Analysis of valve morphology using nerve hooks*

The aim of MV analysis is to confirm or modify the planned repair strategy based on the preoperative echocardiography. This includes selection of functional type and identification of morphology, such as segmental location and others. The leaflets are examined with two nerve hooks to allow comprehensive analysis of all leaflet segments and subvalvular apparatus. Valve analysis is carried out in an organized manner using P1 as a reference point in most instances (Figure 22). Whenever P1 motion and/or morphology are abnormal, another segment needs to be identified to serve as the reference point.

In this case a large P2 prolapse is obvious due to chordae rupture (Figure 23). With regards to repair strategy, any leaflet pathology should be corrected in first place, followed by annuloplasty using complete ring implantation. For better exposure and visualization of the subvalvular apparatus, the anterior leaflet can be gently retracted by loading the leaflet onto the blade of the atrial roof retractor.

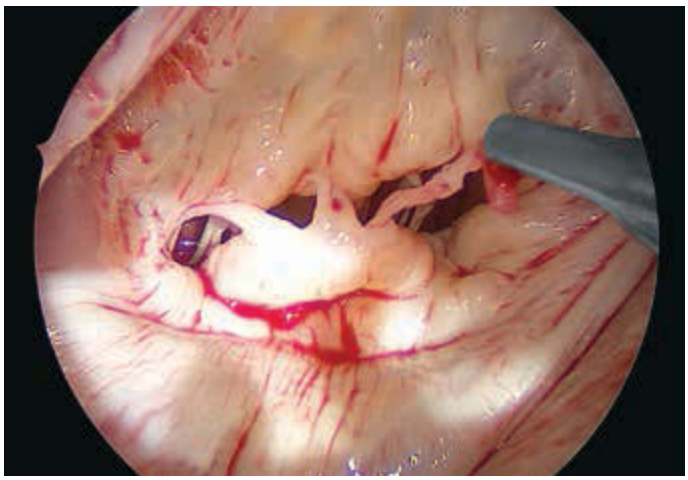

Figure 23: *P2 prolapse due to chordae rupture*

To restore the P2 prolapse, the loop technique, using 4 pre-made PTFE (5/0 sutures with four loops of identical length), is a favorable repair technique. The length of required loops is determined by measuring the appropriate distance from the body of the papillary muscle to the free edge of a non-prolapsing portion of the MV leaflet using a custom-made caliper FC357R (Figure 24).

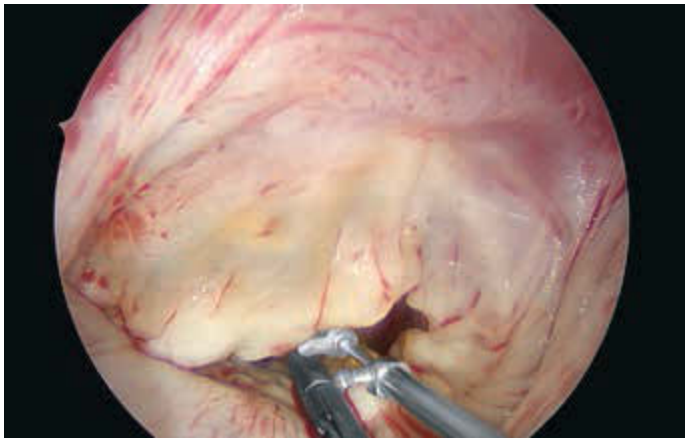

Figure 24: *Measurement of the length of the artificial chords*

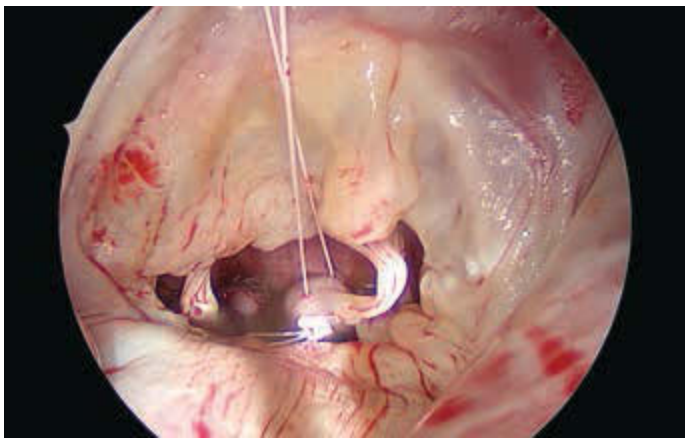

Figure 25: *Fixation of artificial chords at the head of the papillary muscle*

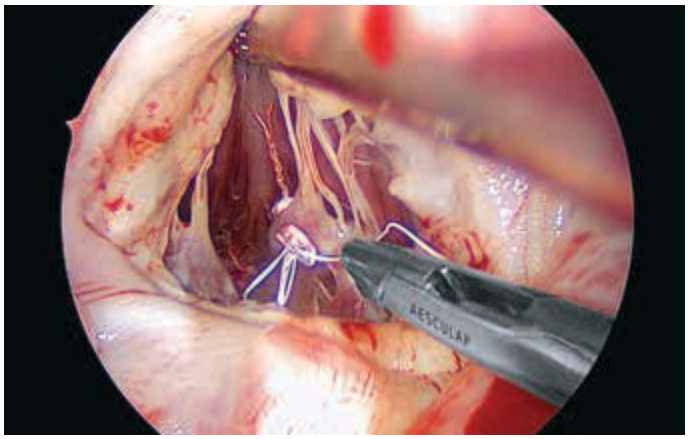

Figure 26: *Connection of the artificial loops with 5/0 PTFE suture*

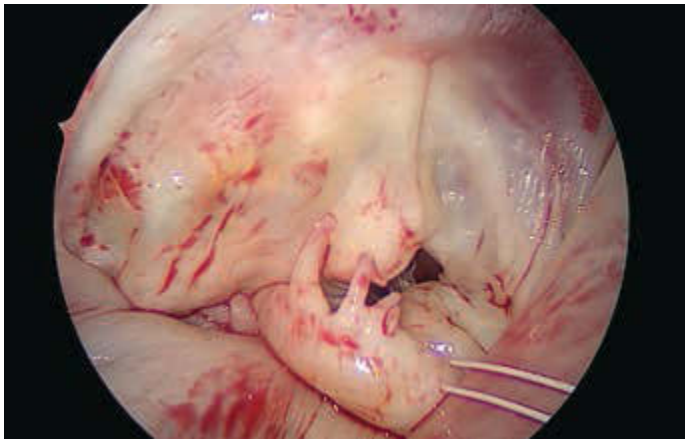

Figure 27: *Fixation of artificial loops at the free margin of the leaflet*

The loops are commercially available (Santec Medical, Grosswallstadt, Germany) or can be manufactured in-house by a dedicated individual using a single 5/0 PTFE suture. A so called "loop" consists of a central pledget with four premade single loops, ranging from 10 to 26 mm in length. The needles of the sutures originating from the pledget are then passed through the tip of the respective papillary muscle and tied over a second pledget. The free loops are fixed to the prolapsing leaflet segment using additional 5/0 PTFE sutures, placing the knot on the ventricular surface of the leaflet whenever possible (Figure 25 to 27).

The saline probe confirms successful (or unsuccessful) repair of the mitral valve (Figure 28). For restoring and remodeling the shape of the annulus, a prosthetic ring is implanted. Regardless of the type of ring, ring selection is based on the measurement of the anterior leaflet, first with regards to the basal portion (trigone to trigone), then with regards to the anterior-posterior diameter of the anterior leaflet height (Figure 29).

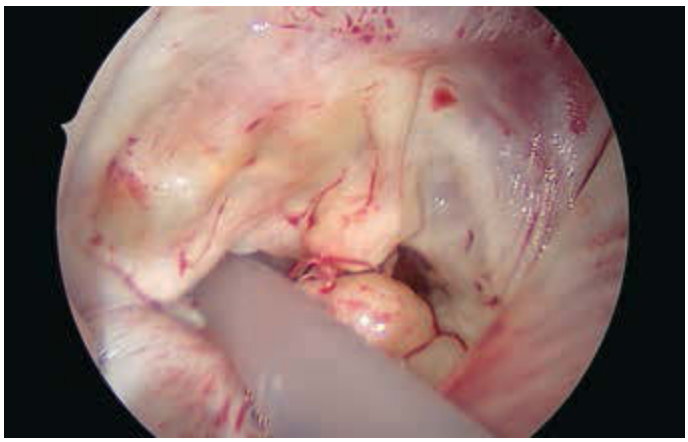

Figure 28: *Saline probe*

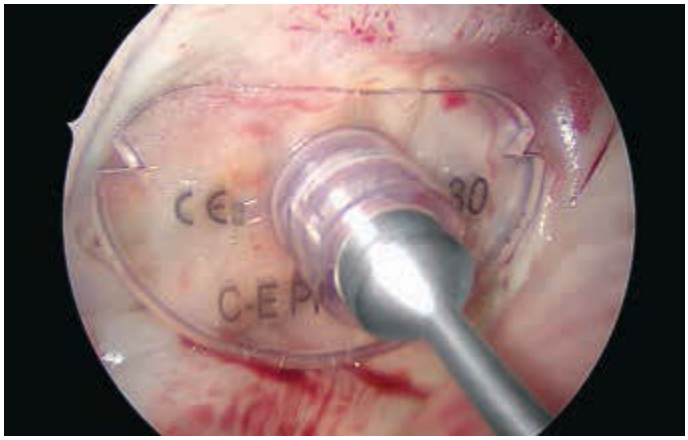

Figure 29: *Measurement of annuloplasty ring size under direct vision*

Ring implantation is achieved by placing a series of 12 to 15 standard sized 2/0 Premicron mattress sutures through the mitral annulus (Figure 30).

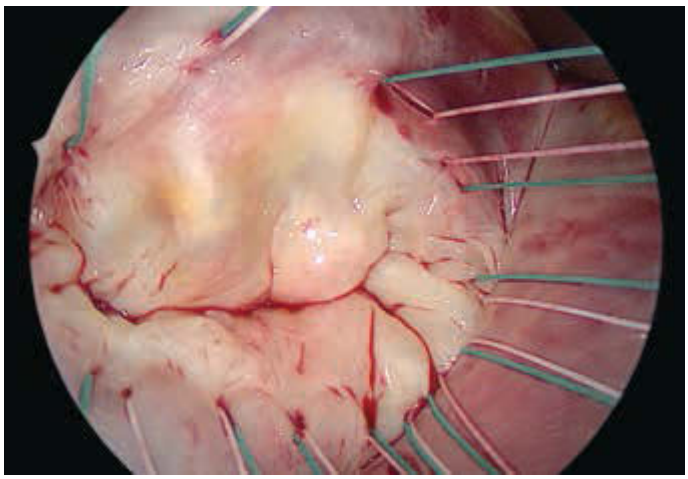

Figure 30: *Placement of annuloplasty ring sutures within the annulus*

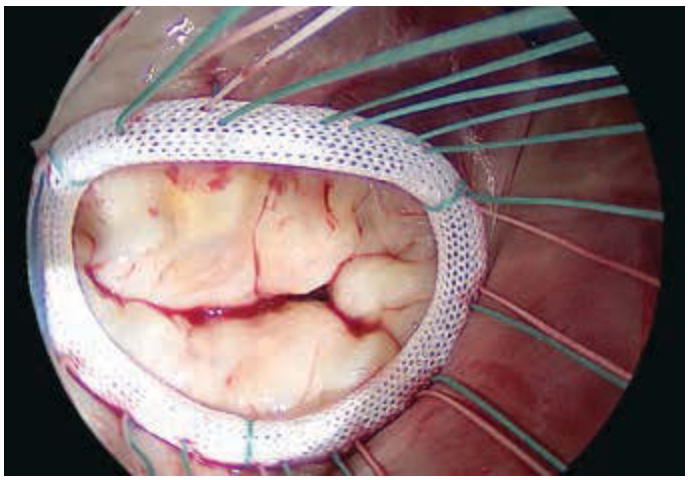

Figure 31: *Fixation of annuloplasty ring*

The two key factors for the success of ring annuloplasty are (1) proper placement of the sutures within the annulus fibrosus to avoid ring dehiscence and (2) accurate placement of the sutures into the prosthetic ring to avoid annular distortion (Figure 31).

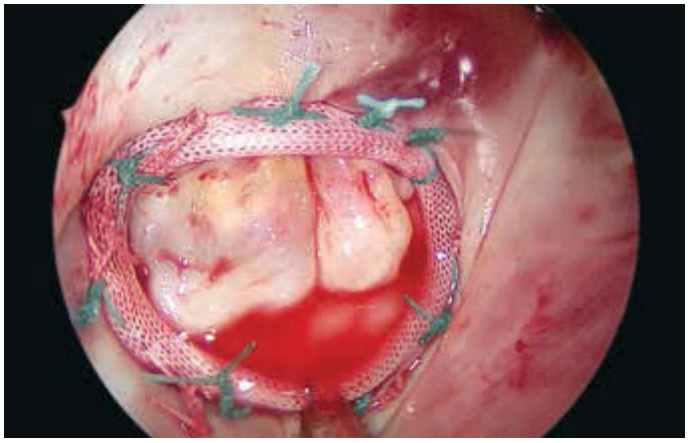

Figure 32: *Competent restored mitral valve with saline probe*

At the end of the repair the final saline probe confirms a successful procedure: the MV should then smile at you (Figure 32).

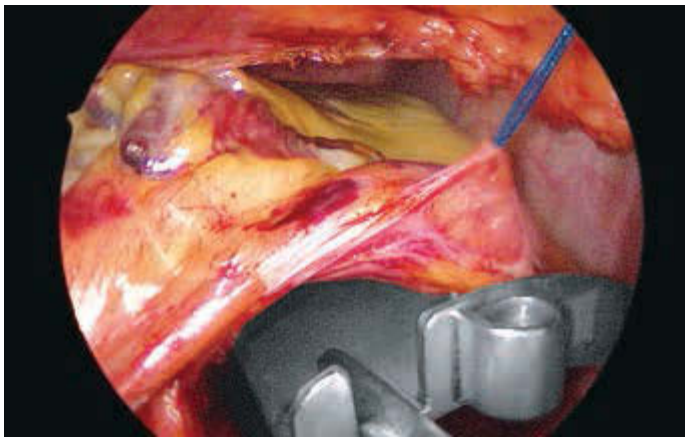

Figure 33: *Release of atrial roof retractor*

The atrial roof retractor is released and the left atrium is closed with standard 3-0 Premilene suture (Figure 33 and 34). De-airing is performed by completely filling the heart while simultaneously inflating both lungs. During this maneuver it is recommended to retrieve the camera and the pericardial retracting suture to allow for complete de-airing.

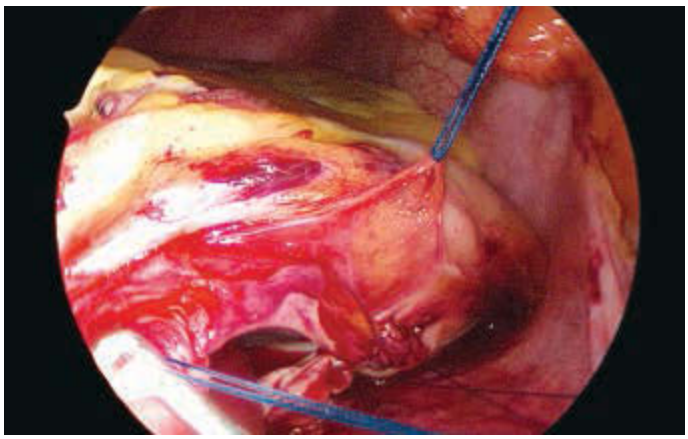

Figure 34: *Left atrium closure with 3-0 Premilene and de-airing*

After closure of the left atrium, CO_2 insufflation is terminated. In case tricuspid valve repair is planned, silastic tapes or large "bull dog" clamps can be placed around the SVC and IVC. Then beating heart annuloplasty ring implantation on the tricuspid valve can be conducted. Before de-clamping the aorta a pacemaker wire is placed at the right ventricle (Figure 35), since the arrested heart allows for enough operative space – a beating heart would highly limit the access to the right ventricular wall.

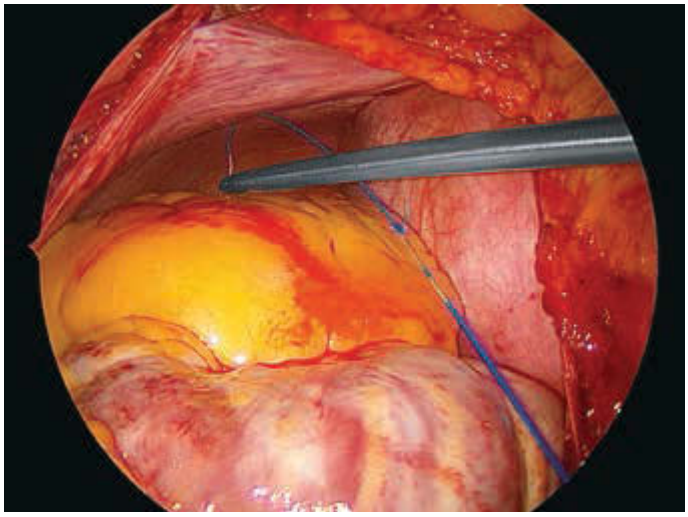

Figure 35: *Placement of pacemaker wire*

Subsequently the aortic root vent is released and the purse string suture is closed (Figure 36). Then the aortic root clamp is released and the patient rewarmed. Ventilation is started again and the extra corporal bypass is reduced to 50 % flow. Transesophageal echocardiogram determines the immediate success of the procedure. To exclude impairment of the circumflex artery, lateral wall motion should be monitored instantly and needs to achieve a comparable level as seen preoperatively. In addition, flow in the circumflex artery should be verified.

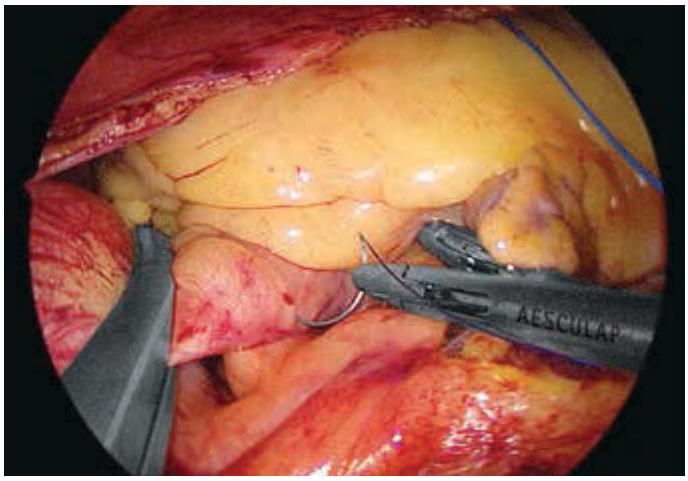

Figure 36: *Closure of needle vent puncture with 4-0 Premilene*

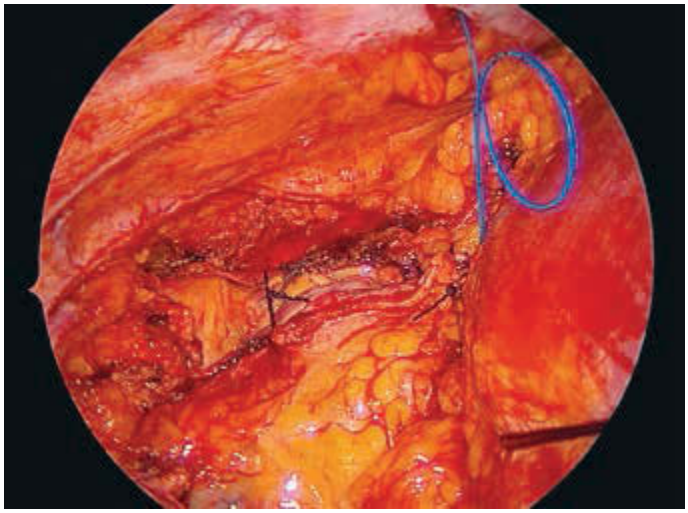

Figure 37: *Pericardial closure*

When extra corporal bypass flow returns 100%, ventilation is stopped to allow for access to the heart again. After careful inspection of the suture lines, the pericardium is closed using the pericardial retraction sutures (Figure 37).

Figure 38: *End of procedure*

After drainage of potential pleural effusion under direct vision, both lungs are ventilated. A chest tube is inserted through the initial camera port, any other access ports are closed and protamine is given. Extra corporal weaning is followed by closure of the intercostal space and the lateral thoracotomy (Figure 38).

All patients undergoing mitral valve repair should have a post-repair intraoperative transesophageal echocardiogram to determine the immediate success of the procedure [30]. A finding of more than mild mitral regurgitation should lead the surgeon, except in certain high-risk patients, to perform valve re-exploration to identify and correct any the source of potential *residual* regurgitation.

Summary

Traditionally, mitral valve repair procedures have been performed through a 15–20 cm skin incision and full median sternotomy. The less invasive approach via right sided mini-thoracotomy with video assistance and femoral cannulation for cardiopulmonary bypass is now successfully performed in many expert centers [31]. The minimally invasive technique has achieved results that are comparable with the standard conventional approach via a complete sternotomy. A high rate of repair can be achieved in MR patients undergoing minimal invasive mitral valve surgery with low rates of perioperative morbidity and mortality [9, 23].

Early echocardiographic findings and mid-term valve reoperation rates are very encouraging.

Potential benefits of the minimal invasive approach include shorter ventilation times and ICU stays, less pain and bleeding, faster recovery, and a better cosmetic result [29].

In the near future, this operation may become the gold standard for MV surgery.

As with all new technologies, a learning curve has to be overcome and a structured training is considered essential for the procedural success. This includes a principal understanding of the mitral valve pathology and repair techniques. A team approach is crucial for success.

After overcoming the initial learning curve this procedure is limited only by massive calcification of the mitral annulus. All other mitral valve pathologies are suitable for this access.

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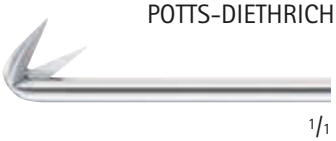
Aesculap® Valve XS

Instruments for Minimally Invasive Mitral Valve Repair

Aesculap Surgical Technologies

Aesculap® Valve XS

Scissors

	Art. No.	Version	Jaw type	Working length	Total length
 1/1	**FC470R**	short	15° curved, 2 movable blades	175 mm	315 mm
	FC265R	standard		235 mm	370 mm
	FC370R	long		285 mm	420 mm
 1/1	**FC471R**	short	30° curved, 2 movable blades	175 mm	315 mm
	FC266R	standard		235 mm	370 mm
	FC371R	long		285 mm	420 mm
 1/1	**FC472R**	short	30° curved, 1 rigid and 1 movable blade	165 mm	300 mm
	FC267R	standard		220 mm	360 mm
	FC372R	long		270 mm	410 mm
 1/1	**FC473R**	short	70° curved, 2 movable blades	175 mm	310 mm
	FC268R	standard		230 mm	370 mm
	FC373R	long		280 mm	420 mm
POTTS-DIETHRICH  1/1	**FC474R**	short	45° angled, 1 rigid and 1 movable blade	155 mm	295 mm
	FC269R	standard		215 mm	355 mm
	FC374R	long		265 mm	405 mm
POTTS-DIETHRICH  1/1	**FC475R**	short	125° angled, 1 rigid and 1 movable blade	150 mm	285 mm
	FC271R	standard		205 mm	345 mm
	FC375R	long		255 mm	395 mm

Blade length	Shaft diameter
15 mm	5 mm
15 mm	5 mm
10 mm	5 mm
15 mm	5 mm
12 mm	3.5 mm
8 mm	3.5 mm

FC470R – FC475R
Short version

FC265R – FC271R
Standard version

FC370R – FC375R
Long version

Aesculap® Valve XS

Needleholders

with catch and tungsten carbide inserts

	Art. No.	Version	Jaw type	Recommended suture size	Working length	Total length
 1/1	**FC478R**	short	straight	2/0, e.g. Premicron®	170 mm	305 mm
	FC275R	standard			225 mm	365 mm
	FC378R	long			275 mm	415 mm
 1/1	**FC479R**	short	curved	2/0, e.g. Premicron®	170 mm	305 mm
	FC276R	standard			225 mm	365 mm
	FC379R	long			275 mm	415 mm
 1/1	**FC480R**	short	curved	2/0, e.g. Premicron®	170 mm	305 mm
	FC277R	standard			225 mm	365 mm
	FC380R	long			275 mm	415 mm
"RYDER type"  1/1	**FC481R**	short	straight	5/0 and smaller	170 mm	305 mm
	FC278R	standard			225 mm	365 mm
	FC381R	long			275 mm	415 mm
"Mini-Jaw"  1/1	**FC482R**	short	curved	5/0 and smaller	160 mm	300 mm
	FC279R	standard			220 mm	360 mm
	FC382R	long			270 mm	410 mm

Jaw size	Shaft diameter
3.0 x 8.0 mm	5 mm
3.0 x 8.0 mm	5 mm
2.0 x 8.0 mm	5 mm
1.5 x 7.0 mm	5 mm
1.5 x 6.0 mm	2.7 mm

FC478R – FC482R

Short version

FC275R – FC279R

Standard version

FC378R – FC382R

Long version

Aesculap® Valve XS

Forceps

DeBakey toothing

	Art. No.	Version	Jaw type, jaw size	Working length
 1/1	**FC485R** **FC285R** **FC385R**	short standard long	straight, 1.5 x 11.0 mm jaw serration	175 mm 230 mm 280 mm
 1/1	**FC486R** **FC286R** **FC386R**	short standard long	45° upwards angled, 1.5 x 15.0 mm jaw serration	170 mm 230 mm 280 mm
 1/1	**FC487R** **FC287R** **FC387R**	short standard long	45° angled to side, 1.5 x 15.0 mm jaw serration	170 mm 230 mm 280 mm
RESANO toothing  1/1	**FC488R** **FC288R** **FC388R**	short standard long	straight, 3.0 x 16.0 mm jaw serration	175 mm 230 mm 280 mm
 1/1	**FC489R** **FC289R** **FC389R**	short standard long	straight, 2.8 x 11.0 mm jaw serration	175 mm 230 mm 280 mm
 1/1	**FC490R** **FC290R** **FC390R**	short standard long	straight, 1.5 x 11.0 mm jaw serration	170 mm 230 mm 280 mm
Suture forceps  1/1	**FC491R** **FC291R** **FC391R**	short standard long	straight, 8.0 mm jaw	170 mm 225 mm 280 mm
Knot pusher  1/1	**FC492R** **FC292R** **FC392R**	short standard long	45° angled	175 mm 230 mm 280 mm

Total length	Shaft diameter	Miscellaneous
310 mm 365 mm 415 mm	5 mm	-
310 mm 365 mm 415 mm	5 mm	1 rigid and 1 movable jaw part
310 mm 365 mm 415 mm	5 mm	1 rigid and 1 movable jaw part
310 mm 370 mm 420 mm	5 mm	1 rigid and 1 movable jaw part
310 mm 370 mm 420 mm	5 mm	-
310 mm 365 mm 415 mm	3 mm	malleable shaft
305 mm 365 mm 415 mm	5 mm	suture forceps with tungsten carbide inserts
310 mm 370 mm 420 mm	5 mm	knot pusher

FC485R – FC492R
Short version

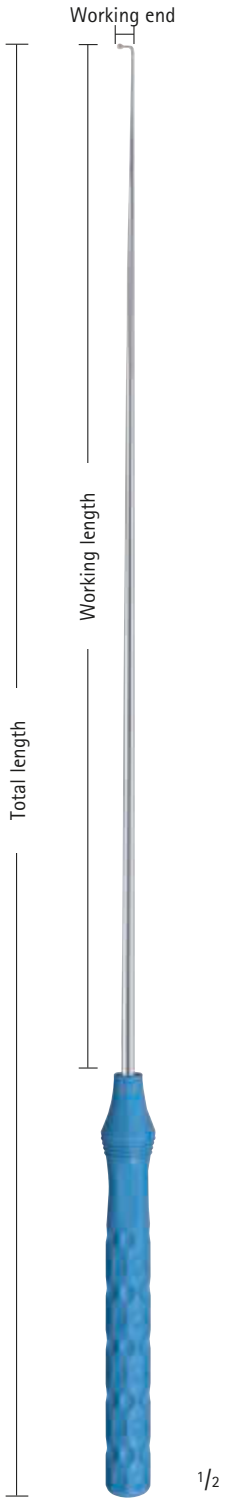
FC285R – FC292R
Standard version

FC385R – FC392R
Long version

Aesculap® Valve XS

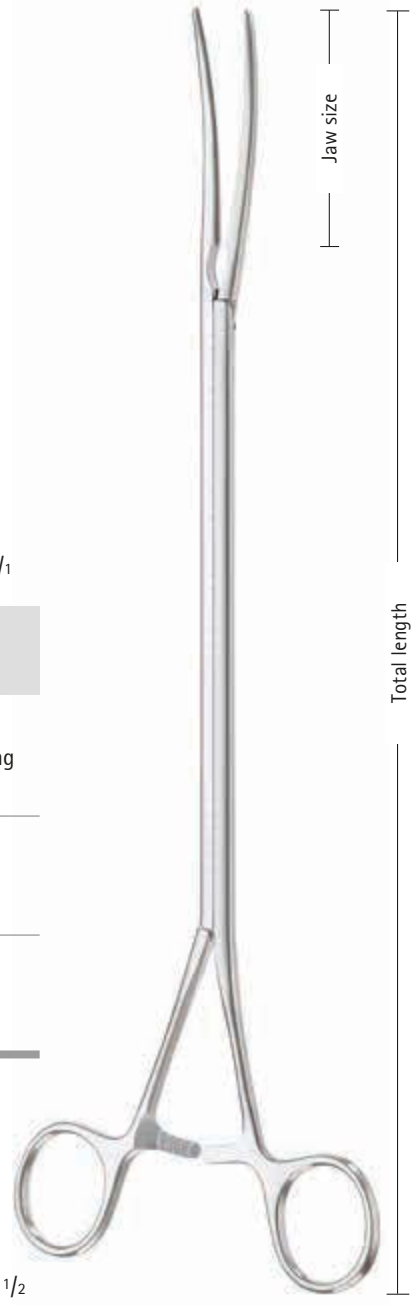
Nerve Hooks

	FC350R	FC351R	FC352R
Working end	4.5 mm probe ended	5 mm	9 mm
Working length	260 mm	260 mm	260 mm
Total length	385 mm	385 mm	385 mm



FC350R – FC352R

	FC295R	FC296R	FC297R
Toothing	1:2 DeBakey toothing	1:2 DeBakey toothing	2:3 DeBakey toothing
Jaw size	2.8 x 60 mm	2.8 x 60 mm	4.8 x 85 mm
Total length	330 mm	290 mm	360 mm

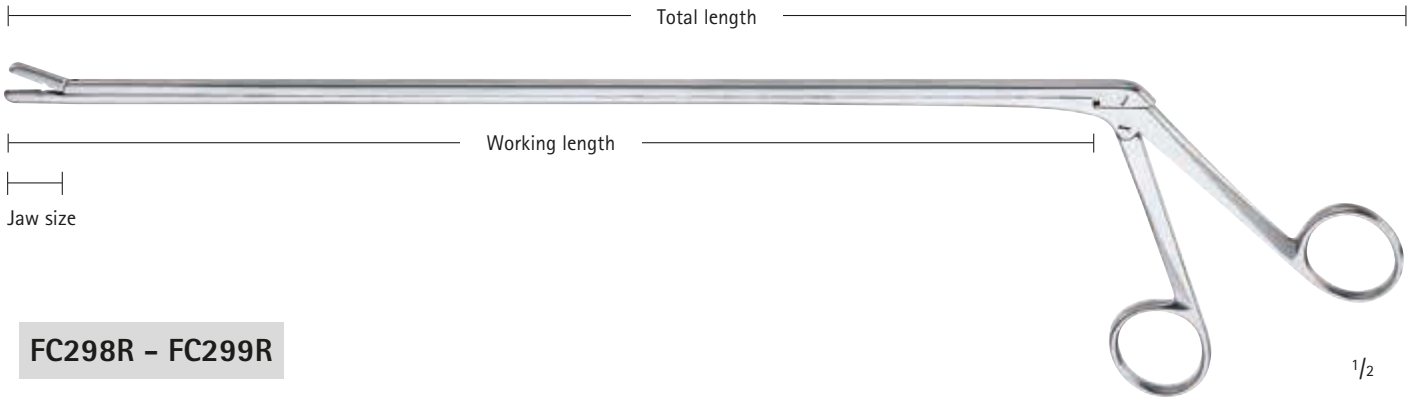


FC295R – FC297R

Aesculap® Valve XS

Miscellaneous

	Art. No.	Jaw type	Jaw size	Working length	Total length
 1/1	**FC298R**	straight	3 x 10 mm	290 mm	370 mm
 1/1	**FC299R**	30° upwards angled	3 x 10 mm	290 mm	370 mm



FC298R – FC299R

1/2

BB060R

Scalpel handle, diam. 5 mm, Total length 450 mm
for micro scalpel blades BB365R

BB365R

Sterile micro scalpel blades mini fig. 11
PAK = package of 10 pieces

FC355R

Knot Pusher
Total length 370 mm
Working length 260 mm

FC356R

Magnetic Needle Finder
Total length 370 mm
Working length 260 mm

FC357R

Tendinous Cords Ruler
Total length 355 mm
Working length 250 mm
Measuring range 5-40 mm

FC358R

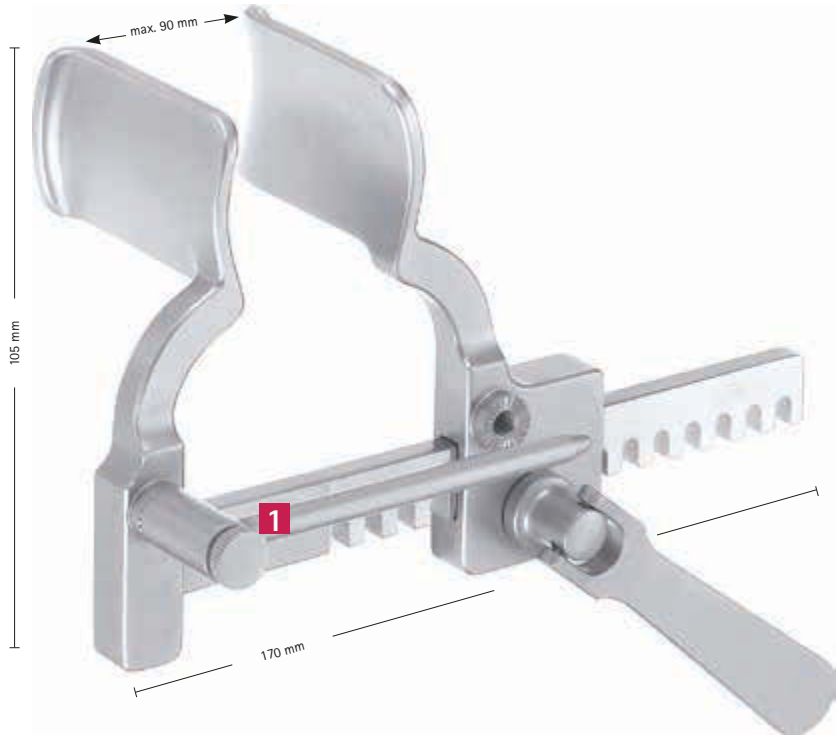
Suture Catcher
Total length 390 mm
Working length 260 mm

FC359R

Valve Pusher
Total length 370 mm
Working length 260 mm

Aesculap® Valve XS

Lateral Rib Retractors



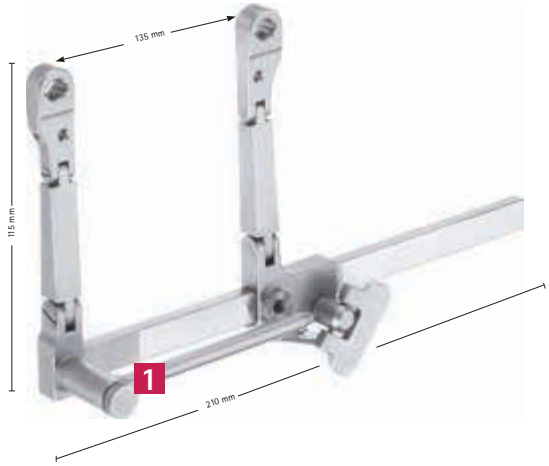
FC145R

Valve XS rigid retraction system for
lateral approach
Blade size: 59 x 37 mm (depth x width)

1 Fixation rod removable

FC140R

Set Valve XS retraction system for lateral approach with double joint, consisting of
1x FC143R Spreader only
2x FC141R Blade



FC143R

Spreader only
1 Fixation rod removable

BV399R

Forceps to remove
the retractor blades

FC142R

Blade only
with ball snap closure
Blade size: 53 x 36 mm

FC141R

Blade only
with ball snap closure
Blade size: 36 x 36 mm

Aesculap® Valve XS

Accessories for Lateral Rib Retractors

FC121R – FC123R

Heart XS malleable valve hook

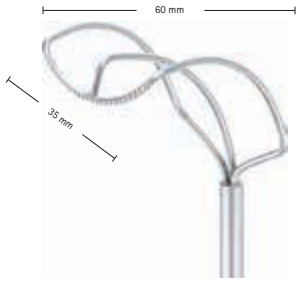
Art. No.	Blade size	Total length
FC121R	65 x 18 mm	250 mm
FC122R	95 x 18 mm	280 mm
FC123R	95 x 22 mm	280 mm

FC124R

Heart XS malleable deaver valve hook

Art. No.	Blade size	Total length
FC124R	75 x 25 mm	250 mm

Dimensions for blade size of retractors
1st number = depth Example: 60 x 35
2nd number = width



FC125R – FC127R

Heart XS cooley atrium retractor

Art. No.	Blade size	Total length	Shaft
FC125R	60 x 20 mm	250 mm	rigid
FC126R	60 x 35 mm	250 mm	rigid
FC127R	60 x 45 mm	250 mm	rigid

BT751R – BT755R

Spatula, malleable

Art. No.	Blade size
BT751R	12 x 200 mm
BT752R	17 x 200 mm
BT755R	25 x 250 mm

Aesculap® Valve XS

Accessories for Lateral Rib Retractors

Configuration samples

FC146R

Valve XS connecting clamp type A

FC147R

Valve XS connecting clamp type B

FC148R

Valve XS connecting clamp type C

FC149R

Valve XS connecting clamp type D

FC360R

Set atrium lift retractor complete
consisting of FC361R - FC367R:

FC367R

Retraction rod

230 mm

FC361R

30 x 35 mm

Blade only

FC362R

40 x 35 mm

Blade only

FC363R

50 x 35 mm

Blade only

FC364R

50 x 45 mm

Blade only

FC365R

60 x 45 mm

Blade only

FC366R

75 x 45 mm

Blade only

BM069R

Applying instrument
for atrium lift
retractor blades

Aesculap® Valve XS

Atrium Retraction set

FC420R

Atrium Retraction set complete.
Consiting of FC423R - FC430R.

FC423R

Insertion Instrument

300 mm

FC427R

Rod for Retractor Blades

242 mm

Retractor Blades for Mitral Valve

Art. No.	Height	Width
FC424R	50 mm	35 mm
FC425R	60 mm	35 mm
FC426R	70 mm	35 mm

Art. No.	Height	Width
FC428R	50 mm	45 mm
FC429R	60 mm	45 mm
FC430R	70 mm	45 mm

Blades for Tricuspid Valve

Art. No.	Height	Width
FC431R	25 mm	20 mm
FC432R	25 mm	25 mm
FC433R	40 mm	25 mm

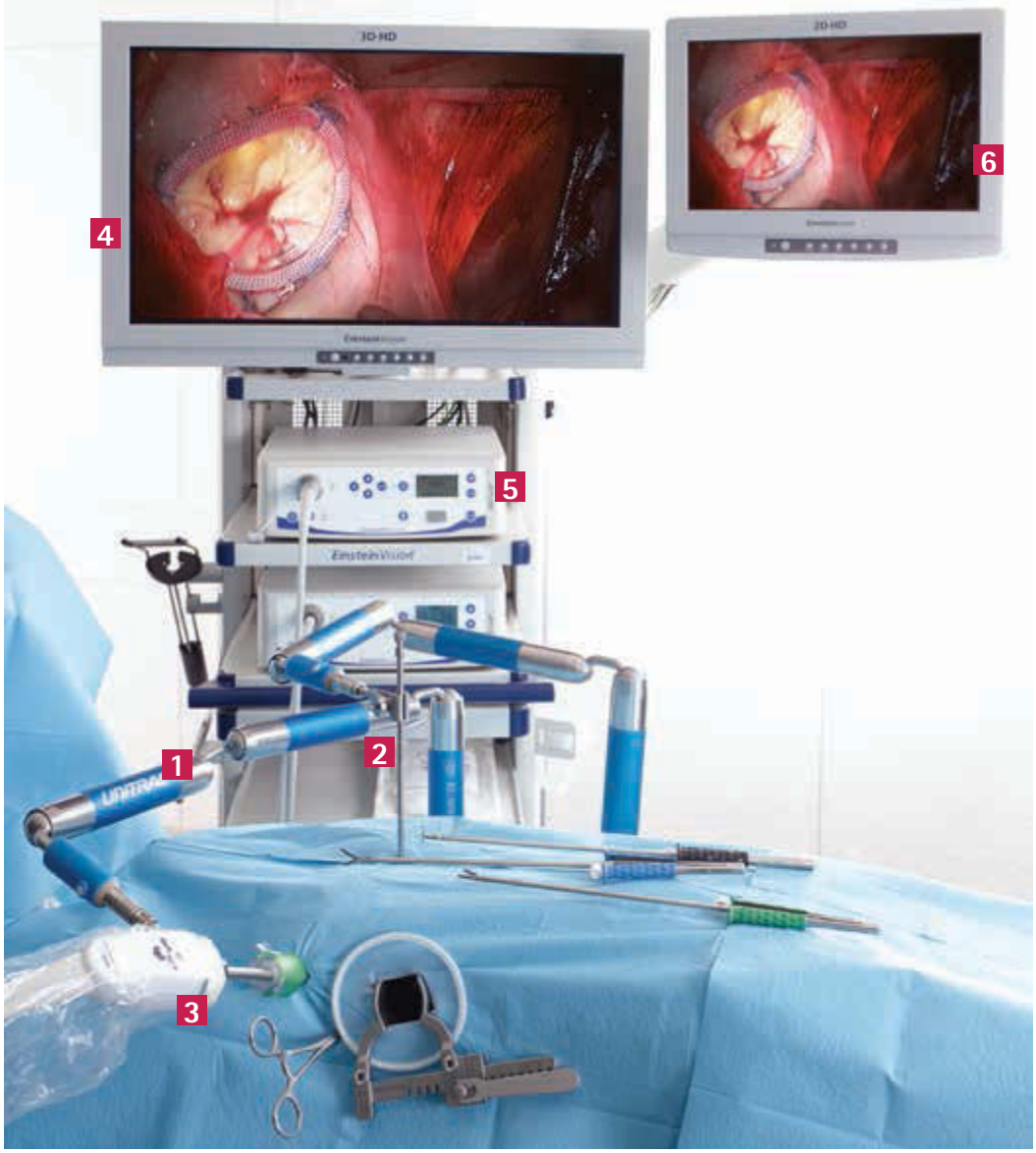
FC421R

Additional lateral Blade only for Retractor Blades for Mitral Valve (Single use Product)

Art. No.	Height	Width
FC434R	50 mm	25 mm
FC435R	25 mm	40 mm
FC436R	25 mm	50 mm

Aesculap® Valve XS

Peripheral Equipment and Holding Devices



1 UNITRAC® Universal retraction and holding arm

2 Universal holder for Valve XS atrium lift retractor

3 Full HD 3 chip camera

4 3D Full HD monitor

5 *Einstein*Vision® light source

6 2D Full HD digital documentation system

RT040R

UNITRAC® Universal retraction and holding arm

- Pneumatically supported system for
  - connection with the Aesculap Unitrac® CO_2 compressed air cartridge, or direct connection with the compressed air supply in the operating room
- Total length: 74 cm
- Holding force: 4 kg
- One-hand-use

RT043R

CO_2 cartrigde adapter
For use of Unitrac independent from central compressed air sources

RT044SU

Unitrac CO_2 cartridge pack of 10 pcs. Single use product. To be used with RT043R.

FF168R

Holding Device

Flexible holding device with mechanic arm

Aesculap® Valve XS

UNITRAC® pneumatic holding arm

RT090R

UNITRAC® Connection clamp suitable for RTo40R and FF168R

FF280R

Flexible fixing element with ball joint suitable for RT040R and FF168R

RT072R

Universal holder for Valve XS atrium lift retractor

RT046P

Universal holder for endoscopes diam. 3.0-7.5 mm

RT020R

UNITRAC® Quick connect adapter for use with sterile drape JG901

RT079R

Endoscope holder for fixation at the endoscope body or at the ocular, diam. 21 mm

GA466

Air hose, 5.0 m

RT035

Y-compressed air distributor, for connecting two UNITRAC® arms to one compressed air source

JG901

Sterile drape for UNITRAC® holding arm

Optional Accessories

RT093R Endofreeze endoscope holder with ball hinge, diam. 5/110 mm

FULL HD

Endoscopes

Art. No.	Direction of view	Diameter	Working length
PE590A	0°	5 mm	310 mm
PE610A	30°	5 mm	310 mm

- Autoclavable up to 134°C , 2 bar
- Integrated rod lens system
- Compatible with full HD camera system

FULL HD

3 Chip Camera
Full HD camera with 1080px technology (1920 x 1080 pixel),
consisting of:

PV460 **camera control unit**

PV462 **camera head with Full HD zoom coupler**

Alternative:

PV470 **camera control unit**

PV472 **camera head with Full HD zoom coupler**

Accessories to order separately
JG904 Sterile camera drape, ring design, pack of 25 pcs.

FULL HD

LCD Monitor

PV959 **26" Full HD flat screen monitor**, 1920 x 1080 pixel resolution

Accessories to order separately
PV909 Monitor stand

Aesculap® Valve XS

Endo Units

FULL HD

Xenon light source

OP932 **AXEL xenon light source,** 300 W

Alternative:

OP940 **LED light source**

Accessories to order separately
OP923 Full HD light cable, diam. 4.8 mm, length 2.5 m
OP933 Xenon spare lamp for OP932, 300 W
OP942 Communication- and BUS-Cable (only for OP940)

Documentation

PV840 **EDDY Full HD digital documentation system**

Accessories: including all cables required for operation

PV908 **15 " touchscreen Monitor**

Accessories to order separately
PV909 Monitor stand

PV986 **A4 USB color printer Sony** UP-DR80MD

Accessories to order separately
PV987 Sony print media packet UPC-R80MD

consisting of:
2x Paper roll for 50 prints each and 2x ink ribbon

Endoscopic trolley

PV880 **Endoscopic trolley** „Metro Junior"
Dimensions: 835 x 1580 x 750 mm (W x H x D)

Accessories to order separately

PV893	**Mains cord orange**, Euro-plug, 5 m
PV884	**Camera holding device**
PV875	**Extension arm** short
PV865	**Central monitor mounting for narrow trolley**
TE676	**IEC320 Power plug and cord**, 1 m
TA008205	**Potential equalization cable,** 0.8 m

Insufflation

PG080 **Flow 40 – CO_2 High Flow Insufflator**

High-flow insufflator with central info display

- Maximum gas flow 40 l/min
- Maximum pressure 30 mm Hg
- Integrated gas preheating

Accessories to be ordered separately

PG083 **NIST Connector for central gas supply (only Flow 40)**

PG085 High pressure tube for central gas supply, 5 m (only Flow 40)

PG086 High pressure tube, 1 m; Unit side US Connector, Bottle side DIN Connector

PG087 High pressure tube, 1 m; Unit side US Connector, Bottle side ISO Connector

PG088 High pressure tube, 1 m; Unit side US Connector, Bottle side PIN Connector

PG012 Disposable insufflation tube set incl. CO_2 filter, package of 10 pieces

Optional

PG082 Reusable insufflation tube with gas warming

PG019 Disposable CO_2 filter, package of 25 pieces

Aesculap® Valve XS

Trocars

Single-use trocars for 2D camera

PAK = Sterile package of
6 single packed pieces

EK110SU

Trocar sleeve with stopcock,
smooth, incl. sealing unit
60 mm

EK148SU

Tilating trocar pin, conical sharp,
60 mm

Distribution worldwide except Spain, USA, Canada
also in reusable available

*Einstein*Vision® 3D trocar

EK086P

Reusable sealing unit for trocars with diam. 10 -12 mm

EK002SU

Single use universal seal for trocars with diam. 10 -12 mm, (pack of 20)

EK043R

Trocar sleeve with stopcock, smooth, 60 mm

EK058R

Tilating trocar pin, conical sharp, 60 mm

Aesculap® Valve XS

*Einstein*Vision® **2.0** | Benchmark in 3D cardiac surgery

Item no.	Description
EV2-000017	3D camera control unit
EV2-000053	***Einstein****Vision*® 2.0 camera head, 0°, 10 mm
EV2-000054	***Einstein****Vision*® 2.0 camera head, 30°, 10 mm
EV2-000055	Sterile drape for 0° camera head
EV2-000056	Sterile drape for 30° camera head
EV2-000021	Xenon light source, 300 W
EV-000020	USB keyboard (QWERTY)
EV-000023	3D polarization glasses, standard (pack of 15)
EV-000024	3D polarization glasses, deluxe (pack of 5)
EV2-000027	3D polarization glasses, clip-on (pack of 1)
EV2-000083	Camera holder for trolley
EV-000047	3D Full HD monitor 32"
EV2-000018	2D/3D adapter plate
PV904	2D Full HD touch monitor 21"
EV2-000016	Trolley
EV2-000016A	Extension arm for 2D monitor

Trolley for 3D units

- Endoscopic trolley with 5 shelves
- Dimensions 720 x 720 x 1610 mm (w x h x d)
- Central on/off power switch
- Rear trolley columns for high stability
- Two integrated drawers for smart storage of keyboard and accessories
- Two lockable doors on trolley backside
- Integrated multiple power socket strip with isolation transformer (max. 1600 VA)

Einstein*Vision*® 2.0 camera head, 0°, 10 mm

- All-in-one system (endoscope, camera head and cable fixed to each other)
- Image sensors provide native Full HD resolution (1920 x 1080 pixel) without upscaling
- Full HD image display in progressive scan technology
- Integrated heating elements to prevent fogging of distal laparoscope tip

Aesculap® Valve XS

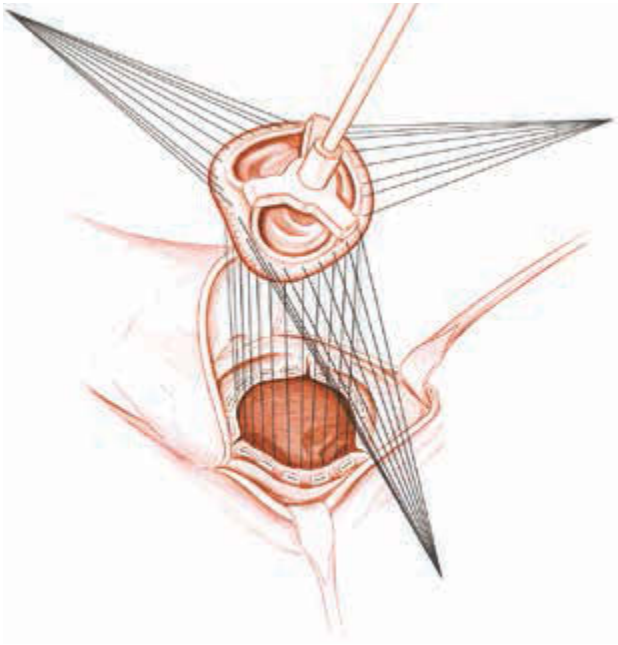
Suture Material

PremiCron® – The Polyester Generation for Heart Valve Replacement

Braided and coated, non-absorbable suture made of polyester

Central core covered by several small compact braids and an outermost silicone coating, conferring PremiCron® with all required features for heart valve prosthetic ring implantation.

- Smooth surface and knot run down
- Improved knot adjustability and lockdown
- Tight seal at the prosthetic ring



The ultimate needle generation for CV surgery, available with:

HRC ⋎
Short cutting tip

HR ●
Taper point

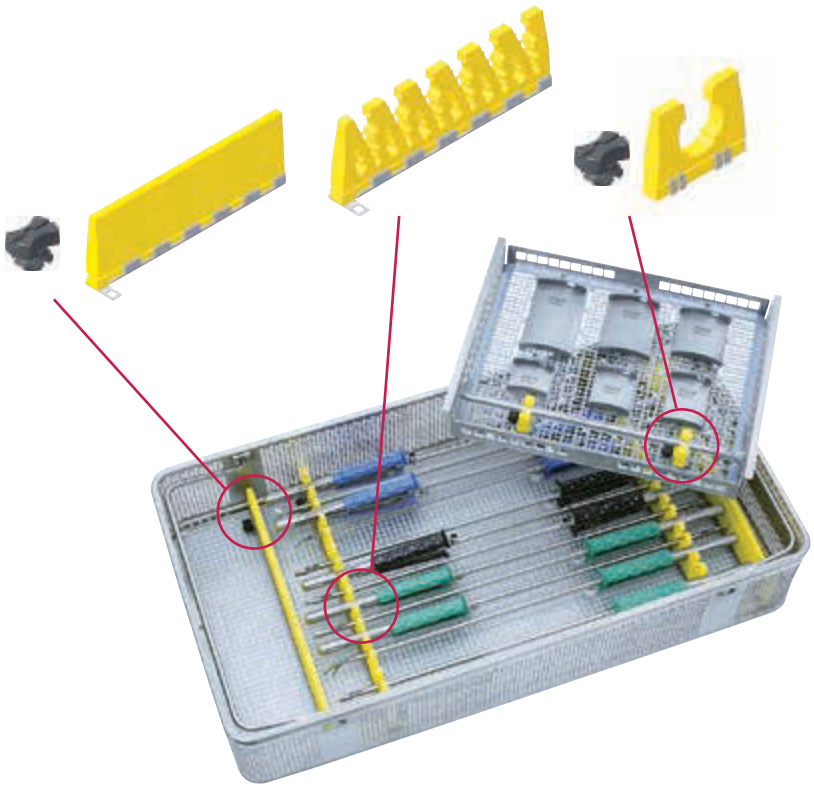
For more information please also ask for our brochure
B21602 Premicron®

Storage Sample Product List

Container
1 x JK441 Bottom for 1/1 container, height: 120 mm
1 x JP007 Primeline clear lid 1/1 size
1 x JB214R Aesculap tray DIN 1/1, 485 x 253 x 94 mm
1 x JF110R Tray insert 1/2 size

Aesculap Instrument Organization System (InOS)
2 x JG306 Instrument rack type 1, 240 x 40 mm
2 x JG360 Silicone divider, 240 x 40 mm
1 x JG300 Fixation pins for storage devices
2 x JG340 Silicone clamp

Accessories
2 x JG786B Identification label up to 13 letters, blue
2 x JG785B Identification label up to 13 letters, red
2 x JG617U Barcode identification label, 89 x 30 x 10 mm



For more information please also ask for our brochure **C81902** Aesculap InOS and C40402 Sterile Container

Set recommendation

Article	Article number standard	Article number long version	Article number short version
Forceps	**FC285R** **FC288R** **FC289R**	FC385R FC388R FC389R	FC485R FC488R FC489R
Scissors	**FC265R** **FC266R** **FC268R**	FC370R FC371R FC373R	FC470R FC471R FC473R
Needle holders with ratchet	**FC275R** (2 x) **FC276R** (1 x) **FC279R** (1 x)	FC378R (2 x) FC379R (1 x) FC382R (1 x)	FC478R (2 x) FC479R (1 x) FC482R (1 x)
Knot pusher	**FC292R**	FC392R	FC492R
Mini thoracotomy retractor	**FC145R**		
Nerve and vessel hook	**FC351R** (2 x) **FC352R** (2 x)		
Suture ruler	**FC357R**		
Magnetic retriever	**FC356R**		
Suture catcher	**FC358R**		
Aortic clamp	**FC295R** **FC296R** **FC297R**		
Aortic valve rongeur	**FC299R**		
Atrium retraction set Additional lateral blade Blades for Tricuspid valve	**FC420R** **FC421R** **FC431R – FC436R**		
Scalpel blade holder Micro scalpel blades (Package of 10 pieces)	**BB060R** **BB365R**		
AESCULAP Micro Instrument Set for 5/0 Premilene Sutures	**FM566R** **FM591R**		
AESCULAP Wound retractor	**BV085R**		
Abdominal Retractor	**BT751R** **BT752R** **BT755R**		

UNITRAC®	Item number
UNITRAC® Universal retraction and holding arm	**RT040R** (2 x)
Connection clamp to the OR table rail	**RT090R** (2 x)
Universal holder	**RT072R**
Universal endoscope holder	**RT046P**
Air hose	**GA466**
Y-compressed air distributor	**RT035**
Sterile drape for UNITRAC®	**JG901**
Connect adapter for use with sterile drape	**RT020R** (2x)
CO_2 cartridge adapter	**RT043R**
Unitrac® CO_2 cartridge	**RT044SU**
Endoscope holder	**RT079R**

VISUAL SYSTEM 2D	Item number
Full HD endoscope, 5 mm, 0°	**PE590A**
Endoscope tray	**JF431R**
Full HD 3 chip camera	**PV460**
Full HD zoom coupler	**PV462**
Sterile camera drape	**JG904**
Full HD 26" flat screen monitor	**PV959**
Monitor stand	**PV909**
Xenon light source	**OP932** **OP940**
Full HD light cable	**OP923**

Set recommendation

DOCUMENTATION	Item number
EDDY DVD digital documentation system	**PV840**
Remote control cable	**PV968**
Serial connecting cable	**PV428**
15" touchscreen monitor	**PV908**
USB color printer	**PV986**
Sony print media packet	**PV987**

ENDOSCOPIC TROLLEY	Item number
Endoscopic trolley	**PV880**
Mains cord orange	**PV893**
Camera holding device	**PV884**
Extension arm	**PV875**
Power plug	**TE676** (6x)

VISUAL SYSTEM 3D	Item number
3D camera control unit	**EV2-000017**
Einstein*Vision*® 2.0 camera head, 0°, 10 mm	**EV2-000053**
Einstein*Vision*® 2.0 camera head, 30°, 10 mm	**EV2-000054**
Sterile drape for 0° camera head	**EV2-000055**
Sterile drape for 30° camera head	**EV2-000056**
Xenon light source, 300 W	**EV2-000021**
USB keyboard (QWERTY)	**EV-000020**
3D polarization glasses, standard (pack of 15)	**EV-000023**
3D polarization glasses, deluxe (pack of 5)	**EV-000024**
3D polarization glasses, clip-on (pack of 1)	**EV2-000027**
Camera holder for trolley	**EV2-000083**
3D Full HD monitor 32"	**EV-000047**
2D/3D adapter plate	**EV2-000018**
2D Full HD touch monitor 21"	**PV904**
Trolley	**EV2-000016**
Extension arm for 2D monitor	**EV2-000016A**

VISUAL SYSTEM 3D APPROACH	Item number
Einstein*Vision*® 2.0 reusable trocar sleeve with stopcock, smooth, 60 mm	**EK043R**
Reusable trocar pin, conical sharp, 60 mm	**EK058R**
Reusable sealing unit for trocars with diam. 10 -12 mm	**EK086P**

BASIC INSTRUMENTATION	Item number
AESCULAP basic heart set	**10400 195 100 S**

STERILE CONTAINERS AND INSTRUMENT ORGANISATION SYSTEM	Item number
Instrument Set:	
Bottom for 1/1 size Container	**JK444**
Primeline 1/1 Lid red	**JP001**
1/1 size perforated basket	**JF212R** (2 x)
Silicone instrument rack	**JG318** (4 x)
Fixation pin for storage devices	**JG300**
1/1 size perforated basket	**JF213R**
Silicone basket liner	**JF939**
Identification label	**JG785B** (4 x)
Silicone clamp	**JG340**

Unitrac® Set:	Item number
Bottom for 1/1 size Container	**JK446**
Primeline 1/1 Lid red	**JP001**
1/1 size perforated basket	**JF224R** (2 x)
Silicone basket liner	**JF941** (2 x)
Identification label	**JG785B** (4 x)

VARIOUS	Item number
Tourniquet	**79006**, Medtronic
Sump	**12010**, Medtronic
Cardioplegia needle	**11012L 12 GA (9 Fr)**, Medtronic

Aesculap Academy
Horizons of Knowledge – Competence to Master the Future



Innovative developments in the field of medical technology, sophisticated new treatment methods, increasingly more stringent requirements for hospital and quality management and, last but not least, a healthy interest in acquiring new knowledge have given rise to an enormous and ever-increasing demand for further and advanced training.

The Aesculap Academy enjoys a world-wide reputation as a leading forum for medical training and answers the demands of physicians and medical staff in OR, anesthesia, ward, outpatient care and hospital management. The course program comprises a wide range of hands-on workshops, management seminars and international symposia.

Aesculap Academy courses are of premium quality and are accredited by the respective medical societies and international medical organizations. A scientific advisory board guarantees the perfect selection of speakers and topics.

Our state-of-the-art training facilities in Tuttlingen (Aesculapium), Berlin (Langenbeck-Virchow-Haus) and Bochum, offer up to 10 workstations for a maximum of 20 participants. Different training modules have been developed for "dry" and "wet" lab training in laparoscopic procedures.

Intensive hands-on sessions on animal models prepare for the real case and small working teams are the ideal set-up for an intensive exchange of knowledge.

"I prefer the friendly spirit and the practice with the specimen."

"The lab is brilliant!"

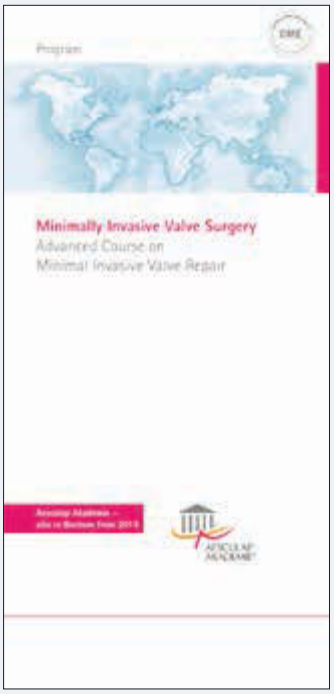
"Very professional, pleasure to take part in."

"Personal instructions from faculty during wet lab session – excellent guidance!"

AESCULAP ACADEMY®



Tuttlingen | Berlin | Bochum



The program of our valve surgery courses at one glance:

Minimally Invasive Valve Surgery

The detailed program is available upon request or at www.aesculap-academy.com.

AESCULAP ACADEMY

Further information of the courses is available from:

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Notice

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