

Video-atlas of transapical aortic valve implantation

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Transapical and transfemoral aortic valve implantation procedures will probably be performed in an ever increasing number of patients with aortic stenosis over the next decades. The following video is an intraoperative film of a transapical aortic valve implantation procedure performed in June 2012 at the Leipzig Heart Center in Germany (*Video 1*). We have a very large clinical experience with transapical aortic valve procedures at our center, dating back to the first ever performed worldwide at the end of 2004. We have subsequently carried out over 500 transapical and more than 1,000 transfemoral aortic valve implantation procedures. Hopefully the viewer will be able to benefit from our clinical experience and be able to appreciate that such procedures can be performed in a very time-efficient and almost routine manner. Having said this, unexpected complications with rapid and grave consequences can occur at almost any stage of a transcatheter aortic valve procedure. We therefore strongly advise that the operators be aware

of such complications before embarking on a transcatheter aortic valve program, and to have planned beforehand what the appropriate response will be for each such complication.

In the following video, a Sapien XT valve (Edwards Lifesciences; Irvine, CA) was implanted using an Ascendra 2 transapical delivery system. The patient is an 81 year-old male with symptomatic severe aortic stenosis, normal left ventricular function, and previous coronary bypass surgery with patent bypass grafts. The operation is performed by Drs. David Holzhey and Joerg Seeburger. Drs. Thilo Noack and Dennis Merk are filming the procedure, and commentary is supplied by Dr. Michael Borger. We sincerely hope that you find the following video instructive and informative.

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Appendix 1 Narration of operative steps

Time stamp	Commentary
0:30	81 year old male patient with severe AS, normal EF, and previous coronary bypass surgery. Indication for surgery and choice of TAVI approach was previously discussed by the Heart Team (not shown).
1:20	TEE revealing severe AS with fairly symmetrical cusp calcification and absence of severe septal hypertrophy, which can be problematic for TAVI.
2:20	Preoperative CT can be used to approximate the plane of apical access to the AV.
3:15	Aortic annular measurement performed by CT. Note the oval-shaped annulus, making the CT measurement of the effective diameter (23 mm in this patient) more reliable than a TEE-based measurement.
4:00	Based on the CT-measured diameter, a 26 mm Edwards Sapien XT valve will be implanted in order to achieve at least 10% oversizing.

Appendix 1 (continued)

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Time stamp	Commentary
4:30	Distance from the annulus to the left and right main coronary arteries (i.e. 19 and 16 mm) are well above the “worry threshold” of 8 to 10 mm. In addition, the existence of patent bypass grafts makes the risk of coronary complications exceedingly low for this patient.
5:00	A 6 French sheath is inserted into the right femoral artery and a guidewire is advanced through the right femoral vein. The tip of the venous wire is advanced into the right atrium under fluoroscopic or echocardiographic guidance. A pigtail catheter is advanced through the arterial sheath for root angiography and injection of adrenaline, if required. This so-called “safety net” enables the patient to be rapidly placed on CPB in case of hemodynamic instability.
6:30	The LV apex is located by palpation of an apical impulse, or by the use of transthoracic echo probe in obese patients.
6:50	Ventilation is temporarily stopped and the location of the LV apex is confirmed by digital palpation. If deciding between two different intercostal spaces, then the lower space should be chosen and the apex displaced inferiorly with the pericardial stay sutures.
7:30	Small thoracotomy retractor is inserted and double lung ventilation is resumed.
8:00	Excess pre-pericardial fat needs to be removed. Adhesions in this area are usually not severe in patients with previous cardiac surgery.
9:30	The apex of the LV is located two to three centimeters lateral to the LAD. TEE can be used to confirm the position of the apex while applying digital pressure.
9:45	Four pericardial stay sutures are inserted.
11:30	Two Prolene 2-0 sutures with multiple pledgets are used to create two purse-string sutures with a diameter of 1.5-2 cm. The needle must pass through healthy myocardium, and not simply through epicardial fat, with each bite.
12:30	Heparin is given in order to achieve an ACT of 300 seconds, starting with a dose equivalent to half of what is used for CPB.
13:30	Separate scrub table required for valve crimping, which is performed at our center by the perfusionist. The inflation device is de-aired and checked for proper functioning.
15:00	A bipolar epicardial pacemaker lead is placed at the inner edge of the pursestring and checked for proper function. A sufficient heart frequency to reduce the pulse pressure and induce mild-to-moderate hypotension is chosen, usually 160 to 180 bpm, but sometimes as high as 220 bpm.
15:45	The C-arm is rotated around the patient's bed to ensure there is no conflict with surrounding equipment prior to performing rotational imaging.
16:30	Diluted contrast dye is administered via the pigtail catheter into the aortic root during rapid pacing and C-arm rotation. 3D reconstruction of root anatomy is performed by DynaCT (Siemens) or by HeartNavigator (Philips) software.
17:15	DynaCT results are used to determine optimal angulation of fluoroscopy equipment (RAO 8° and caudal 5° in this case) for the rest of the procedure.
17:30	Apical puncture in the middle of the pursestring. A guidewire is inserted into the ascending aorta using fluoroscopic guidance. TEE is used to ensure that guidewire does not pass through the subvalvular apparatus of the mitral valve.
18:30	A soft-tipped sheath is inserted over the guidewire and through the aortic valve, and the obturator and guidewire are removed.
19:30	A right Judkins pigtail catheter is inserted through the sheath and positioned in the descending aorta. An Amplatz Super Stiff guidewire is inserted through the Judkins catheter.
21:00	The Judkins catheter is removed and a valvuloplasty balloon is inserted over the super stiff guidewire. AV leaflet calcification is confirmed to lie halfway between the two radiopaque markers on the valvuloplasty device. The balloon must be deaired prior to positioning.
Appendix 1 (continued)	

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Time stamp	Commentary
21:20	Balloon valvuloplasty is performed during rapid pacing using a volume-controlled balloon. Final sizing of the aortic annulus may be performed at this time.
21:50	Removal of the balloon valvuloplasty device and sheath. The guidewire stays in place and the small hole at the insertion site is sealed with a finger until the next step.
22:45	The Ascendra2 transapical delivery sheath (24 French) is inserted over the guidewire to a depth of 4 cm (markers on sheath exterior). The dilator is removed and the sheath is secured by the operator's hand for the remainder of the procedure.
23:15	The correct position and orientation of the Sapien valve is confirmed prior to insertion of the valve introducer.
23:45	The valve introducer is inserted into the sheath and is deaired by squeezing both deairing buttons. This maneuver is repeated once the Sapien valve is inside of the LV.
24:15	The Sapien valve is inserted through the native AV.
24:30	The valve pusher is withdrawn. Tension or slack should be introduced into the super stiff guidewire in order to remove any oblique positioning of the Sapien valve.
24:45	Root angiography is performed to confirm proper valve positioning, aiming for 40-50% of the Sapien valve lying above the plane of the native annulus.
25:20	Ventilation is stopped and rapid pacing is induced. The Sapien valve is partially deployed. Root angiography is repeated in order to confirm proper valve position. Fine adjustments of valve positioning can still be performed at this stage. The pigtail catheter is then withdrawn and the balloon is completely inflated.
25:30	The balloon is fully deflated prior to cessation of rapid pacing.
25:45	All equipment is removed, with the exception of the super stiff guidewire, and the pursestring sutures are tightened while the assistant applies digital pressure to the apex. Mild hypotension at this point is helpful in avoiding apical tearing.
27:00	TEE is used to confirm proper position and functioning of the Sapien valve, and to rule out perivalvular leaks or new regional wall motion abnormalities.
29:15	The guidewire is removed and a final angiography is performed.
30:00	The pursestring sutures are tied. Rapid pacing may be used again at this point to induce hypotension in patients with fragile apical tissue.
30:45	Protamine is given. ASA is administered after extubation.
31:00	Proper functioning of the temporary pacing wire is confirmed. Telemetry should be continued for 5 days prior to removal of the temporary pacing wire, because of the risk of late AV block.
31:45	An Angio-Seal device is used to seal the femoral arterial puncture site.
33:00	The pericardium is closed, a single chest-tube is inserted into the left pleural space, and the intercostal space is closed with a PDS suture.
34:15	The muscular fascia is completely closed to lower the risk of lung herniation. Skin closure is performed in the usual technique.
Abbreviations: AS, aortic stenosis; EF, ejection fraction; TAVI, transcatheter aortic valve implantation; TEE, transesophageal echocardiography; AV, aortic valve; CPB, cardiopulmonary bypass; LV, left ventricle; LAD, left anterior descending coronary artery; ACT, activated clotting time; bpm, beats per minute; RAO, right anterior oblique; AV, atrioventricular	

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