Totally endoscopic aortic valve replacement (TEAVR)

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Clinical vignette

We present the case of a 69-year-old male with a symptomatic aortic valve stenosis (dyspnea, NYHA III). This is an intermediate risk patient (STS score 6.6%) with an ejection fraction of 65% (*Video 1*). The only known cardiovascular risk factor was hypertension. Mean and peak transvalvular gradient were 48 and 70 mmHg, respectively, and the patient had a surface area of 0.8 cm^2. Specific informed consent was approved by the Internal Ethical Committee and was obtained for a totally endoscopic aortic valve replacement (TEAVR).

Surgical techniques

Patient preparation

Surgery is performed in a supine position. Beyond a selective ventilation, positioning of a transeosophageal echocardiography (TEE) probe and a temporary transvenous pacemaker wire into the right ventricle (right jugular vein) is necessary.

Exposition

The main operative working trocar is positioned into the second right intercostal space (Flexipath, Ethicon, Inc, Somerville, NJ, USA), between the midclavicular and anterior axillary line. The second working port (15 mm) is located in the third intercostal space. A 7 mm trocar, destined to the venting line purse-string and to the carbon dioxide line, is inserted in the 5th intercostal space. Optics (5 mm and 30°) are inserted laterally to the main working trocar, in the second intercostal space. Fat tissues adherent to the lateral pericardium are ablated, the pericardium opened, and margins suspended using four stitches that are extracted transcutaneously. Femoro-femoral cardiopulmonary bypass (CPB) is instituted using an active venous drainage (positioning of aortic and venous cannulas is performed under TEE guidance), and an aortic vent is inserted into the aortic root.

Operation

Under CPB, a purse string is prepared (right inferior pulmonary vein) for insertion of a vent, and the tourniquet extracted throughout the fifth intercostal space 7 mm trocar. The aorta is cross-clamped using a Chitwood clamp inserted into the first intercostal space, and cardioplegia delivered (histidine-tryptophan ketoglutarate cardioplegic solution; Kohler Chemie, Alsbach-Hahnlein, Germany). The aortic vent is ablated, and the aortotomy performed. Margins of the aorta are suspended with stay stitches (prolene 4/0) that are extracted again transcutaneously or around the working trocars. Aortic valve decalcification is performed. Minimal valvular tissue is allowed to adhere to the aortic annulus in order to optimize the grip of the sutureless valve. The size of the sutureless bioprosthesis (3f Enable, Medtronic, Inc, Minneapolis, Minn, USA) has been previously established with an accurate computed tomography (CT) scan study, and verified with TEE. The 3f Enable valve is then folded and inserted, kept compressed by two prolene stitches. The valve is positioned into the main working trocar and subsequently descended into the aortic root, sliding it down a guiding stitch placed in the non-coronary sinus. The stitch is knotted, the left side of the sutureless prosthesis is kept in contact with the native annulus, and the compression stitches

are cut and removed. The upper part of the stent can then be expanded using a grasper with closed jaws and the camera is introduced in the space that is now present between the upper part of the stent and the leaflets. The landing level of the valve can be controlled step-by-step, focusing on the right coronary annulus. The right side of the cuff is gently pushed to the right native annulus. The position level of the sutureless valve can be further tuned, partially re-collapsing the valve and fixing it upper or lower, while the stent is still cool and thus malleable.

Completion

Presence of paravalvular leakages is excluded with a nerve hook control around the sewing ring before activation of the full radial force of the nitinol stent with injection of warm saline into the aortic root. The aorta is closed and de-aired with table tilting via the aortic vent that has been re-inserted. Once CPB is dismissed, absence of paravalvular leakages is verified with TEE.

Comments

Advantages

The present case should be interpreted in the context of the actual process of feasibility confirmation and technical refinement of the TEAVR procedure. Since clinical results of the initial cohort will be published after a case series is performed, the potential clinical advantages discussed here require further validation in the future.

TEAVR aims to avoid any sternal fracture or costal spreading by reducing iatrogenic chest wall trauma during aortic valve replacement, advantages seen in other minimally invasive endoscopic approaches (1-3). However, TEVAR also aims to maintain the advantages of the surgical approach over TAVI, given the possibility of providing ablation of valvular tissues prior to implantation of a bioprosthesis as well as visual quality control of the valve landing position. TEAVR is actually addressed to intermediate-risk patients, who can better tolerate, rather than high risk patients, since the cross clamp and CPB durations are still relatively long during this early development stage of this approach. TEVAR may also be indicated in patients who usually have an active life style, and may need a quicker restitution to the everyday physical activities.

Caveats

Since the achievement of the first TEAVR (4), this is the only complete video documenting surgical aortic valve replacement performed with exclusive use of thoracoscopic trocars, and more generally, of human totally endoscopic valve replacement. Sutureless bioprostheses are essential for achieving valve replacement using trocars, however sutureless technology does not yet exist for the other cardiac valves. Reproduction of this technique is reserved for centers with confirmed experience in minimally invasive video-assisted surgery or expertise in the use of sutureless valves.

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