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Review Article

Video-assisted Thoracoscopic Redo Sternotomy for Primary Dysfunction of the Aortic Root Homograft: A Case Report

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Abstract

Adhesion in the anterior mediastinum following previous heart surgeries is a predictor of fatal trauma of the heart chambers, large vessels and lungs during redo cardiac procedures. The approaches used to prevent such complications have evolved over the past decades, but the need for their improvement remains. Annual increase in heart surgeries, coupled with the phenomenon of "aging population" in economically developed countries, predetermines the growth of redo cardiac surgical procedures. An important role in this process is also played by the recent more active use of various biological implants (for example, bioprosthetic heart valves), which makes the search for new technologies for safe redo sternotomy even more urgent.

The publication presents a case of redo surgery in a patient with primary degeneration of the homograft in the aortic root position implanted 13 years ago for aortic stenosis using the Full Root technique. The original technique applied (Method for endoscopic prevention of traumatisation of cardiac, lung and major vessels of anterior mediastinum accompanying repeated cardiosurgical operations. Patent No. RU 2726605 C1) provides for a combination of minimally invasive and classic surgical approaches. Total adhesiolysis of the anterior mediastinum was performed thoracoscopically: the posterior surface of the sternum and the cartilaginous part of the ribs were completely freed from adhesions with the right ventricle, the aorta, lungs and innominate vein. The redo sternotomy was made using a standard electric saw under direct visual control and protection of the right ventricle and the ascending aorta with endoscopic retractors. The risk of surgical trauma of the anterior mediastinum organs was fully eliminated and the intraoperative blood loss was comparable to a traditional sternotomy approach.

Keywords: Allografts; Aortic Valve Stenosis; Bioprosthesis; Case Reports; Heart Valves; Mediastinum; Sternotomy; Thoracic Surgery; Video-Assisted

Background

Cardiac reoperation involving safe resternotomy remains an issue of concern [1,2]. Despite a few absolute number of prior cardiopulmonary bypass (CPB) cardiothoracic operations [3-5] and the annual increase in the rate of prosthetic valve endocarditis and heart valve surgeries (including heart valve repair and replacement) [6-9], the need for repeated CPB surgery is still growing [10,11]. Global aging of the population along with increased life expectancy project a constant increase in the rate of

repeated on-pump cardiac reoperations. Resternotomy remains challenging due to adhesions between the epicardial surface, the great vessels, and the posterior surface of the sternum [12]. Fatal bleeding during resternotomy is commonly caused by the rupture of the right ventricle (39%), coronary artery bypass grafts (20%), the aorta (15%), and the great vessels (12%) [13]. Diagnostic cardiac radiology allows assessing the risk of complications and planning a safe surgical strategy to ensure adequate organ protection during repeat sternotomy [14-16]. The development and improvement of surgical approaches that are able to reduce the risk of perioperative trauma are of high relevance. We report a case of redo aortic root surgery for failure of the aortic root homograft and the prevention of surgical complications associated with resternotomy.

Case Report

A 56-year-old patient (the height of 175 cm, the weight of 90 kg, and the body mass index of 29 kg/cm^2) admitted to the Department of Cardiac Surgery at the A.V. Vishnevsky National Medical Research Center of Surgery, with complaint of shortness of breath, decreased exercise tolerance, weakness, and fatigue. In 1983 the patient was diagnosed with bicuspid aortic valve. In 2008 the patient underwent elective root replacemrnt procedure using a full root technique (a 26 mm homograft) due to the progression of aortic valve dysfunction and an increased aortic root diameter. The patient refused the heart valve replacement with a mechanical heart valve.

Transthoracic echocardiography reported marked calcification of the tubular part of the homograft, including the cusps, grade 4 aortic regurgitation, and moderate stenosis of the homograft. The peak pressure gradient was 52 mm Hg, and the mean pressure gradient was 30 mm Hg. The left ventricular end diastolic volume was 263 mL, the left ventricular end systolic volume was 134 mL, and the stroke volume was 126 mL. The left ventricular ejection fraction measured by Simpson's method was 42%, and the cardiac output was 7.3 l/min. Coronary angiography reported uneven contours of the coronary arteries, and a balanced type of coronary circulation. Contrast-enhanced multislice computed tomography reported massive calcification of the homograft and the presence of excess adhesions between the right ventricle and the retrosternal surface (Figure 1).

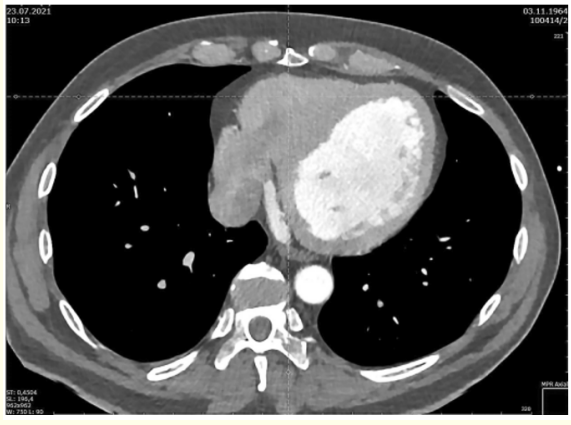

Figure 1: Multislice computed tomography of the thorax. Dense adhesions of the right heart chambers with the sternum and the costal cartilages.

Surgery protocol

The patient was placed supine on the operating table. After the trachea was intubated and single left lung ventilation was achieved, the access was formed through the right pleural cavity to the anterior mediastinum. An optical endoscopic port with a diameter of 5 mm was placed in the 4th intercostal space along the anterior axillary line, and the pleural cavity was examined using an endoscopic camera (a diameter of 5 mm, 0°). Two 5 mm ports were placed in the 3rd and 5th intercostal spaces between the midclavicular and anterior axillary lines. Retrosternal tissue was visualized. All anatomical structures of the anterior mediastinum were soldered to the retrosternal surface. There were adhesions between the right ventricle and the posterior surface of the sternum. Adhesiolysis was performed starting at the tip of xiphoid process to the jugular notch using a spatula for electrocoagulation, an endoscopic retractor, and an irrigation suction set. The anterior surface of the right ventricle and the great vessels were separated. Prior stainless steel ligatures were visualized (Figure 2).

Figure 2: Two steel wires used as sutures are visualized. Green arrows indicate stainless steel ligatures.

The skin incision was made with the excision of the scar. The wire sutures were removed. A median sternotomy was performed under direct visual endoscopic control (Figure 3).

Figure 3: Sternotomy under direct visual control: the thoracic aorta and right ventricle are pushed back by endoscopic retractors during operation of the electric sternotome (A); general view of the operating room and operating field: the surgeon performs resternotomy, the assistant pushes back the ascending aorta freed from adhesions using endoscopic retractors under the control of the endoscopic camera (B).

The pericardial cavity was not sutured after prior surgical interventions. Redo aortic root surgery with a 25 mm homograft was perfromed (modified Cabrol procedure).

Intraoperative blood loss was 580 mL. CPB duration was 170 mins. The aortic cross-clamping time was 110 mins. Drainage output at days 1 and 2 was 250 mL and 80 mL, respectively. The duration of mechanical ventilation was 720 mins. The length of stay in the ICU was 68 hours.

Control transthoracic echocardiography reported the peak pressure gradient of 15 mm Hg and the mean pressure gradient of 8 mm Hg. The left ventricular end diastolic volume was 221 mL. The left ventricular end systolic volume was 117 mL. The stroke volume was 104 mL. The left ventricular ejection fraction measured by Simpson's method was 47%.

At day 3 the patient was transferred from the intensive care unit to the Department of cardiac surgery. The patient was successfully discharged at day 12.

Discussion

Safe resternotomy remains the issue of concern since the dawn of cardiac surgery. The first attempts to perform redo heart valve replacement without any specific approaches to resternotomy were associated with high intraoperative mortality and morbidity. The first approach to overcome this problem was the use of oscillatory sternotomes, that allowed reducing the rate of the right ventricle rupture by 40%. However, the rate of perioperative complications was unacceptably high. A number of tertiary centers have revised the concept of surgical protection of the heart and the great vessels during redo CPB cardiac surgery [17]. The induction of a heart-lung machine immediately before resternotomy allows unloading the heart chambers (especially the right ventricle) and reducing the risk of fatal bleeding in case of any trauma [13,18]. However, this approach is associated with significant drawbacks, including the necessity to perform adhesiolysis after the heparin administration, significantly increased CPB duration accompanied by adverse systemic effects, and the peripheral cannulation that is associated with the risk of specific complications and is not always feasible in patients with multivessel disease.

The original approach to safe resternotomy (patent of the Russian Federation 2726605 C1: "A method of endoscopic prevention of the heart injury, lungs and the large vessels of the anterior mediastinum during redo CPB cardiac surgery") developed at the A.V. Vishnevsky National Medical Research Center of Surgery does not exclude the peripheral cannulation of artificial circulation. We did not experience any difficulties while performing adhesiolysis of the anterior mediastinum. Both protective strategies have all the prerequisites for convergence. The described cardio endoscopic approach is suggested to be used for preventing perioperative morbidity while performing redo CPB cardiac surgery.

Conclusion

The described endoscopic strategy ensures safe surgical access that reduces the risk of the right ventricle rupture and the great vessels. This approach is of potential interest for tertiary cardiac centers performing a wide range of cardiac surgeries, including redo CPB operation with median resternotomy.

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