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Simultaneous Correction of Aortic Coarctation and Bicuspid Aortic Valve in an Adult Patient (Case Report)

Varbanets S. V., PukasA. Y., Furman M. M.
Ukrainian Children's Cardiac Center, Kyiv, Ukraine

Abstract. Aortic coarctation is one of the most frequent congenital heart defects; the frequency is in the range of 6-7%. Aortic coarctation is often associated with other heart defects, namely: a bicuspid aortic valve, an interventricular septal defect, and others. Purpose: to highlight our first experience of one-stage surgical correction of aortic coarctation and aortic valve pathology. Material and method. A 56-year-old man was hospitalized in the department in a planned manner with symptoms of chronic heart failure. Upon admission, the main complaints were shortness of breath with minimal physical stress and increased blood pressure. Aortic coarctation was diagnosed accidentally during coronary angiography in another medical institution. The thoracic aortic CT angiography with intravenous contrast diagnosed: sharp narrowing of the aorta in a typical place. Results and discussion. Despite a large number of publications in foreign sources, the literature review showed no cases of extra-anatomic bypass surgery of aortic coarctation with correction of a cardiac pathology in adult patients in the territory of Ukraine. The main indications for surgical correction of aortic coarctation using the technique of extra-anatomic bypass surgery include: aortic coarctation or re-coarctation in combination with a cardiac pathology requiring correction via median sternotomy; complex aortic coarctation or re-coarctation associated with technical difficulties upon choosing the method of direct anatomical correction. Based on the experience of foreign institutions, our patient had contraindications to extra-anatomic anastomosis via median sternotomy due to a constitutional peculiarity, namely a barrel chest. However, the minimally invasive surgical instruments made it possible to perform the operation successfully with reduced time required for distal anastomosis. Conclusion. Extra-anatomic creation of anastomosis in aortic coarctation in combination with a cardiac pathology is a good alternative of treatment for an adult cohort of patients.
Keywords: *aortic coarctation, extra-anatomic graft, methods of surgical correction.*

Aortic coarctation is one of the most frequent congenital heart defects; the frequency is in the range of 6-7%. Aortic coarctation is often associated with other heart defects, namely a bicuspid aortic valve, an interventricular septal defect, etc. [1]. This pathology may not manifest for a prolonged period and may be

an accidental finding when diagnosed for other reasons. The consequence of the disease is the development of severe hypertension, heart failure.

The purpose of the work is to highlight our first experience of one-stage surgical correction of aortic coarctation and aortic valve pathology.

Material and methods

A 56-year-old man was hospitalized in the department in a planned manner with the symptoms of chronic heart failure. Upon admission, the main complaints were shortness of breath with minimal physical stress and increased blood pressure. In the past history, the patient suffered ischemic stroke in 2012 and 2015. The patient also had a constitutional peculiarity in the form of a barrel chest. Aortic coarctation was diagnosed accidentally during coronary angiography in another medical institution. The echocardiogram showed a combined aortic defect with predominant critical stenosis (mean gradient of 49 mmHg, aortic valve opening area of 0.4 cm^2) in the presence of mild deficiency. There was concentric hypertrophy of the left ventricular wall, the thickness of the diastolic posterior left ventricular wall was 15 mm. The ejection fraction was 43%. Coronary angiography showed no hemodynamically significant lesions of the coronary arteries. The thoracic aortic CT angiography with intravenous contrast diagnosed: sharp narrowing of the aorta in a typical place (hemodynamic break, Fig. 2, 3). There were multiple collateral vessels flowing into the descending aorta, with the maximum diameter of up to 0.9 cm (Fig. 1). There were multiple collateral arteries in the mediastinum, on the anterior thoracic wall, inguinal area and on the back (Fig. 1). Severe aortic valve calcification was present.

Fig. 1. CT scan with intravenous contrast clearly indicates aortic coarctation in a typical place (indicated by a red arrow)

Fig. 2. CT scan with intravenous contrast shows a large number of collaterals (indicated by red arrows)

Fig. 3. CT scan with intravenous contrast clearly indicates aortic coarctation in a typical place (indicated by a red arrow)

The artificial circulation apparatus was connected after median sternotomy and incision of the pericardium. Aortic cannulation was more proximal to the point of origin of the brachiocephalic artery, the vena cava cannulation was typical. Total body hypothermia was up to 26 °C. Retropericardial access was made laterally from the esophagus with parallel perfusion and an end-to-side anastomosis was formed between the vascular graft (Dacron 20 mm) and the descending aorta using a mini-invasive tool – a long needle holder and forceps (Azemus). This allowed us to perform a distal anastomosis, despite the patient's anatomical peculiarities, and to reduce the duration of surgery. The conduit was formed behind the inferior vena cava, along the lateral edge of the heart (Fig. 4, 6). After performing transverse aortotomy, antegrade and later antero-retrograde cold blood cardioplegia was performed. Aortic valve anatomy: bicuspid, type I (R/N). The aortic valve was replaced with a mechanical prosthesis (SJM Master 23). The aorta was closed with a double row continuous suture. Prevention of air embolism was performed, an aortic clamp was removed. Proximal anastomosis was formed between the vascular graft and the ascending aorta upon parallel perfusion using a lateral clamp (Fig. 5). Intraoperative control of direct blood pressure was evaluated using two arterial lines in the left radial artery and the left dorsal artery of the foot. Nasogastric tube No. 20 was also preoperatively placed to facilitate verification and avoidance of esophageal injury during surgery. The duration of artificial circulation was 306 minutes, the duration of aortic clamping was 115 minutes. The patient was extubated 33 hours after surgery. The ankle-shoulder pressure gradient improved significantly (preoperatively 54.5 ± 12.3 mmHg, postoperatively 21.2 ± 5.1 mmHg). Upon discharge from the hospital, the patient feels well, shortness of breath occurs with moderate or heavy exercise.

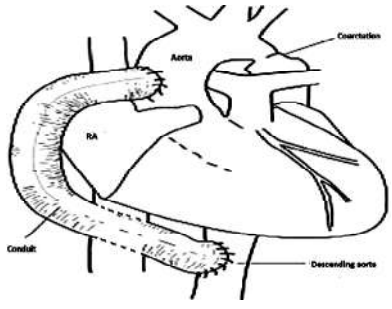

Fig. 4. Scheme of operation

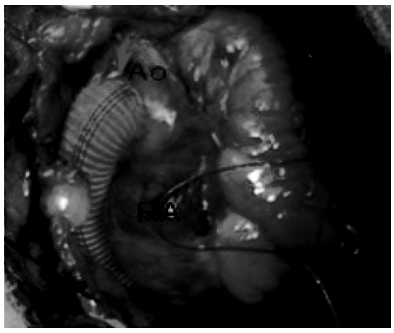

Fig. 5. Intraoperative photo of proximal anastomosis (indicated by an arrow)

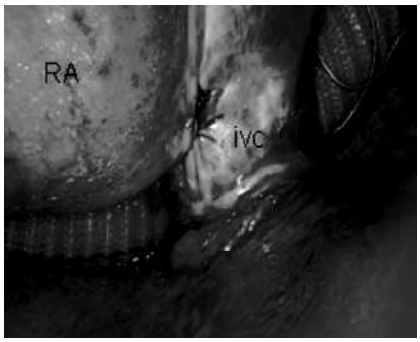

Fig. 6. Location of the conduit behind the inferior vena cava

In the postoperative period, control CT-angiography with intravenous contrast (Fig. 7) and shuntography (Fig. 8) was performed.

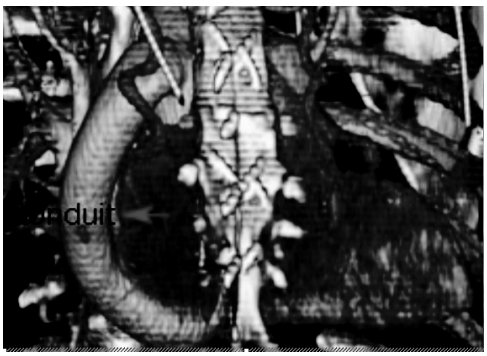

Fig. 7. CT angiogram of the chest cavity with intravenous contrast shows the anatomical position of the conduit (indicated by a red arrow)

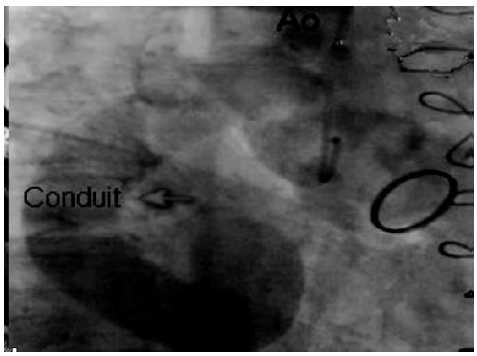

Fig. 8. Shuntogram shows the bypass patency with good blood flow (indicated by a red arrow)

Results and discussion

Despite a large number of publications in foreign sources, the literature review showed no cases of extra-anatomic bypass surgery of aortic coarctation with correction of a cardiac pathology in adult patients in the territory of Ukraine. The first extra-anatomical correction of aortic coarctation was performed in 1975 by Dr. Edie [1]. He formed an extra-anatomical shunt with access via median sternotomy and left-sided thoracotomy in one stage. The graft was anterior to the left lung hilum and anastomosed from the left lateral edge of the ascending aorta. In 1977, Dr. Wukasch and Cooley first described the method of aortic coarctation correction, an extra-anatomic shunt between the ascending and abdominal aorta [1]. In 1980, Dr. Vijayanagar first described the process of forming a shunt between the ascending and descending aorta only from median sternotomy; the graft was placed along the left edge of the heart [2, 3]. And in 1983, Dr. Powell modified the Vijayanagar technique, where the graft was directed behind the inferior vena cava and anterior to the right inferior pulmonary vein [1]. The graft was anastomosed with the ascending aorta on the lateral surface to the right. One of the benefits of extra-anatomical anastomosis is the avoidance of manipulation of aortic coarctation and collateral vessels, which significantly reduces the likelihood of ischemic spinal cord injury and reduces the risk of fatal bleeding [2].

According to foreign literature, aortic coarctation without timely correction results in a fatal outcome for 50% of patients under 32 years of age and 90% of patients under 58 years of age [7]. Anatomical correction is most favourable for newborns and children. Potential complications of surgery include bleeding, damage to the parenchyma of the lungs, diaphragmatic and vagus nerve, chylothorax, ischemia of the spinal cord [3]. The risk of spinal cord ischemia after aortic coarctation correction is from 0.5% to 5% [3]. The main indications for surgical correction of aortic coarctation using the technique of extra-anatomic bypass surgery include: aortic coarctation or re-coarctation in combination with a cardiac pathology requiring correction via median sternotomy; complex aortic coarctation or re-

coarctation associated with technical difficulties upon choosing the method of direct anatomical correction [4].

Therefore, the extra-anatomical approach is most appropriate for adult patients in combination with pathology of the intracardiac structures and/or coronary arteries. But there is the question about the most optimal approach. Two-stage correction involves two different surgical procedures: correction of left coronary artery coarctation followed by correction of cardiac pathology via median sternotomy. This technique facilitates the technical performance of each procedure, however, the risk of surgery and mortality is significantly increased in the event of hemodynamic instability during aortic coarctation correction [2]. A two-step approach also extends the hospital stay and increases the cost of treatment. One-stage correction of aortic coarctation and cardiac pathology eliminates the disadvantages of the two-stage procedure, but it is technically more complicated and prolongs the working time of the artificial circulation apparatus [5].

What is the right tactic to choose to position the extra-anatomical graft? There are two possible options for the distal anastomosis formation: descending thoracic or abdominal aorta [6, 7]. Each option has disadvantages and advantages, indications and contraindications. Consider the first option. A distal anastomosis between the descending aorta and the vascular graft is a good alternative, since all manipulations are performed from one access, which is less traumatic. However, the technical implementation is more complex and has the disadvantages, namely: visualization of the descending aorta and formation of anastomosis, especially in patients with barrel chest and obesity, longer period of operation of the artificial circulation apparatus, control of hemostasis and potential risk of esophageal injury with subsequent severe infectious complications [1]. If you consider the option of forming a distal anastomosis with the abdominal aorta, then following comment can be given. Visualization and formation of an anastomosis do not cause technical problems, there is no need to connect the artificial circulation apparatus, does not pose special difficulties to achieve stable hemostasis [1]. However, there are also disadvantages to this technique: graft kinking, infectious complications, intestinal obstruction, longer stay in hospital and prolonged rehabilitation [4].

Taking into account the literature data, it can be stated that anastomosis between the ascending and abdominal aorta is the best alternative for barrel chest, repeated heart surgery, pericardial adhesion process [6]. However, anastomosis between the ascending and descending thoracic aorta has advantages in patients with the pre-laparotomy and adhesion process in the abdominal cavity. Based the experience of foreign institutions, our patient had contraindications to extra-anatomic anastomosis via median sternotomy due to a constitutional peculiarity, namely a barrel chest [1]. However, the minimally invasive surgical instruments made it possible to perform the operation successfully with reduced time required for distal anastomosis. In our opinion, the chosen tactic was more optimal for the patient. The results of a retrospective review indicate that extra-anatomical bypass grafting of aortic coarctation provides satisfactory clinical results [1, 2, 5]. However,

there is a universal method of treatment, since each individual patient is an individual with their own history, constitution and anatomy; in addition, the described method should be avoided in young patients due to body growth.

Conclusions

1. Extra-anatomic creation of anastomosis in aortic coarctation in combination with a cardiac pathology is a good alternative of treatment for an adult cohort of patients.

2. Concomitant correction of aortic coarctation and cardiac pathology is technically more complex than the two-stage one, but it provides less treatment costs and shortens the rehabilitation period.

3. Although there are some algorithms in the treatment of this group of patients, each case requires an individual approach.

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