

# Total Aortic Arch Endoprosthesis Repair using the “Outside” and “In-Situ” Fenestration Techniques: First Results in Russia

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## ABSTRACT

Over the past 20 years, there has been a clear shift towards endovascular repair of the thoracic aorta in its various pathologies. However, complete endovascular repair of the aortic arch remains technically sophisticated. Currently, there are several methods of endovascular arch treatment: A hybrid approach, total endovascular debranching using parallel grafts (like a chimney or snorkeling) and fenestration (factory-made, hand-made (physician modified graft (PMG)) *in-situ* or outside (on-a-table)). The first results of the application of the aortic arch repair technology are promising, especially the complete replacement of the

aortic arch by means of non-standard fenestrated or branched stent grafts. Use of fenestrated or branched grafts factory FTEVAR and Chimney is an attractive method for treating of aortic arch diseases but they have a higher cost and longer waiting time.

**Keywords:** Aortic dissection, Outside and *in-situ*, Fenestration, Aortic arch, Total arch, Stent-graft, FTEVAR, TEVAR

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## INTRODUCTION

A dissecting thoracic aortic aneurysm is urgent situation that requires close attention to surgical tactics aimed at preventing such serious complications as cardiac tamponade due to rupture of the intrapericardial part of the aorta and acute heart failure in severe aortic regurgitation. The incidence of aortic dissection is 5-10 cases per 100,000 population in the Russian Federation, from 0.2 to 0.8 per 100,000 population in the USA and from 0.5 to 2.95 cases per 100,000 population worldwide. Acute aortic dissection of type A (ORAA) is characterized by high mortality, which in the absence of treatment reaches up to 35% during the first 24 hours, 50% in 48 hours, from 80% to 94% in the 1st week. The mortality rate after aortic dissection is estimated at 1%-2% in 1 h.

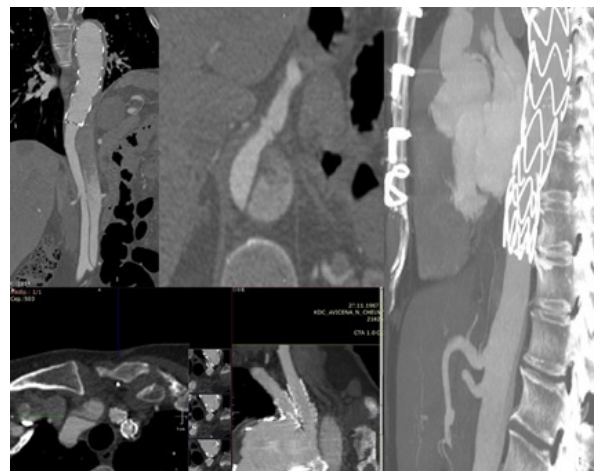
Surgical treatment for the elimination of cardiac tamponade by eliminating the primary rupture and preventing further fatal complications. The choice of surgical method of correction of the proximal segment of the aorta depends on the experience of the surgeon and the technical capabilities of the clinic. Despite the limited data presented in the publication, several methods of performing graft fenestration with satisfactory short-term results have been described (Charchian ÉR, *et al.*, 2014; Shket AP, *et al.*, 2013; Mokashi SA and Svensson LG, 2019). We would like to present an example of several clinical cases of endovascular correction in acute pathology of the aortic arch and their results in an emergency medical clinic.

## CASE PRESENTATION

### First case (Gender: Female, 52 years old)

In March 2018, she was admitted to the Regional Emergency Center in Naberezhnye Chelny through the EMS channel with complaints of chest pain arising not directly connected with physical activity. It is known that in 2017, a supracoronary open ascending aorta repair was performed aortic dissection, type A (according to the Stanford classification). In 2018, due to the spread of dissection into the Left Common Carotid (LCC) and Left Subclavian Artery (LSA) and development of transitory ischemic attacks, we

performed their stenting and subsequent Thoracic Endovascular Aortic Repair (TEVAR) of the descending aorta in Z3. Since October 2018 the patient began to have complaints of food-borne epigastric pains. In March 2019, control CT angiography revealed: Retrograde dissection of the thoracoabdominal aorta and aortic growth up to 6 mm and development of visceral artery malperfusion with spreading of dissection to the right common carotid artery (Figure 1).



**Figure 1:** Retrograde dissection and spread to the innominate artery

In this connection, we performed staged stenting of the right common carotid artery (RCCA) and TEVAR (first stage) using an *in-situ* fenestration technique for the celiac trunk (by NBC-Technique) and stenting of the superior mesenteric artery. At the second stage, taking into account the aortic arch dissection and spread to the brachycephalic trunk (Figure 1), in June 2020, TEVAR was performed using “outside (on-a-table)” Fenestration Thoracic Endovascular Aortic Repair (FTEVAR) of the aortic

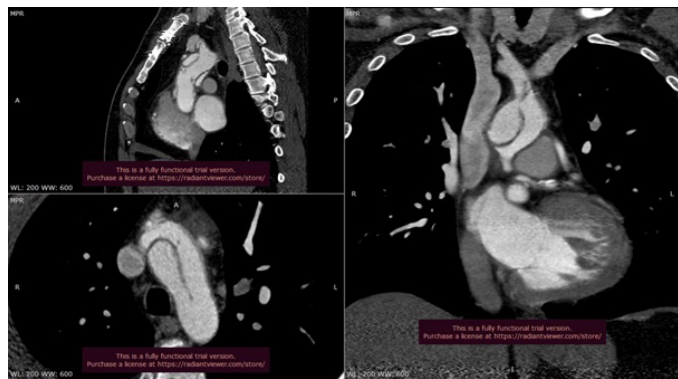
arch with stenting of the right common carotid and right subclavian arteries (Figure 2).



**Figure 2: The result of a successful total endovascular debranching stent graft of the thoracoabdominal aorta**

#### **Second case (Gender: Male, 37 years old)**

In December 2020 patient was admitted to the Regional Emergency Center in Naberezhnye Chelny on an emergency call with pain syndrome of the interscapular region and a Syncopal episode. According to the clinic and CT angiography, the diagnosis was: Type A dissection (according to Stanford classification) with dissection spread to the brachiocephalic (Innominate artery, LCCA, LSA) arteries complicated by cerebral malperfusion syndrome (Figure 3). According to echocardiogram, the aortic valve insufficiency of 2-3 grade was revealed.



**Figure 3: Aortic dissection with extension to the orifices of the left subclavian artery and occlusion of the left common carotid artery**

## **RESULTS AND DISCUSSION**

A life-saving supracoronary prosthetics with simultaneous CABG to obtuse marginal artery was performed under hypothermia (28°C). At the second stage stenting of the left ICA was performed. The patient was discharged from the hospital in satisfactory condition 10 day after without

neurological deficits. 8 months later, control CT angiography: Dissection remains at the level of the aortic arch branches (Figure 3). Therefore, we performed FTEVAR using wide fenestration under the aortic arch arteries, the “outside on-a-table” technique, followed by their stenting. Thus, a “landing zone” was created for the subsequent graft into the descending thoracic aorta from the mouth of the left CCA, as well as this “in-situ” graft fenestration was performed under the left common carotid artery followed insertion of a stent (Figure 4). Thus, in two cases presented a total endovascular repair of the aortic arch (total arch) was performed using the new “outside” (on-a-table) and “in-situ” fenestration technology. Longer studies are needed to assess the durability and effectiveness this innovative endovascular procedure.



**Figure 4: Final result of a stent graft in the thoracic aorta, a stent in the left CCA, left ICA, and left accessory artery**

Our experience in the use of aortic arch endoprosthetics with use of “outside” and “in-situ” fenestration techniques for pathologies has shown encouraging results with low mortality and frequency of complications, which indicates that these methods of minimally invasive treatment are safe and feasible (Zhang J, *et al.*, 2020; Moulakakis KG, *et al.*, 2013; Glorion M, *et al.*, 2016). Due to low trauma, there was a reduction in the length of stay in the hospital. F-TAVAR is a promising and more reasonable method used to repair the aorta without changing anatomical structures. In our practice, we took advantage of the characteristics of various stent graft, which made the planning, modification and orientation procedures much more efficient and effective. In our experience with endoprosthetics of the aortic arch using the “outside” and “in-situ” fenestration technique, only two out of 48 (4.16%) patients developed endoleak, which is consistent with recent publications that reported the frequency of endoleak 0%-4.2% (Shu C, *et al.*, 2020).

Thus, based on the individual advantages and limitations, as well as the encouraging results of these methods in the early and medium term, each of the methods can be applied in endovascular surgery (Makaloski V, *et al.*, 2018). Given the significant limitation of the study in the form of a small number of patients and follow-up time, we consider it necessary to conduct further long-term follow-up in a large cohort of patients (Canaud L, *et al.*, 2017; Zhu J, *et al.*, 2018).

## **CONCLUSION**

Surgical treatment with circulatory arrest and hypothermia remains the gold standard in the treatment of aortic arch pathology, but it is a tech-

nically more sophisticated and traumatic operation associated with a high risk of complications and mortality. For this reason, we have proposed a new method hand-made (physician modified graft (PMG)) FTEVAR in case of type. An aortic dissection with graft fenestration using “outside” and “*in-situ*” techniques. Our Regional Emergency Center was the first in the Russian Federation to use this type of treatment in 13 patients with follow-up for more than 52 months. We have also developed an optimal drug therapy management.

#### **AUTHORS CONTRIBUTION**

Akhmedov U and Sharafutdinov M-Concept and design of the article, literature review; Sharafutdinov M, Yakubov R-Correction of the article; Akhmedov U, Khairutdinov A, Tarasov Yu, Sadykov R-Review and analysis of data.

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