PHYSICIAN MODIFIED ENDOVASCULAR STENT-GRAFT IN PATIENT WITH DISSECTING THORACIC AORTIC ANEURYSM. CASE REPORT

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Abstract

Increasement in the diameter of the thoracic aorta ≥ 50% of the norm of 40 mm in men and 34 mm in women (99 percentile) is considered to be an aneurysmal expansion. The risk of rupture is proportional to the size of the aneurysm and is associated with the development of fatal complications. Diagnosis is usually verified by computed tomographic angiography (CTA), magnetic resonance angiography (MRA), or transesophageal echocardiogram. Treatment consists of endovascular stent graft placement or open surgery in combination with optimal medical therapy. The article presents the experience of treating a patient with a dissecting aneurysm of the thoracic aorta type IIIB according to DeBakey using a stent graft modified by a doctor "on table" by forming a fenestration modeled after the anatomy of the left subclavian artery orifice. The aim of the work was to evaluate the short-term and medium-term results and prognosis of treatment using the technique of endovascular prosthesis with a modified graft. Such modifications on the table or in situ make it possible to model the prosthesis according to the variant of the anatomy of a particular patient, which allows optimizing the apposition of the prosthesis, eliminating additional stages of complex surgical treatment, reducing the undesirable effects of standard approaches, including preliminary endovascular occlusion of the left subclavian artery and/or the formation of a carotid-subclavian shunt, reduce the time of stationary observation. The use of the described technique will reduce the radicalness of surgical treatment of patients with dissecting aneurysms and increase economic efficiency. This technique is a promising direction in the development of endovascular and surgery and requires further study to assess long-term results and prognosis in a large number of patients.

Thoracic aortic aneurysm (TAA) is an abnormal enlargement of the aorta above the diaphragm. TAA account for 1/4 of all aortic aneurysms, occurring in 40 people per 100,000 population. Men and women get sick equally.

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Keywords:
thoracic aorta, aneurysm, TEVAR, Stent-graft, endovascular surgery, PMEG

Кеуде аортасының диссекциялық аневризмасы бар науқастағы модификацияланған эндоваскулярлық стент-графт. Клиникалық жағдай

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Аңдатпа

Кеуде аорта аневризмасы аортаның диаметрінің еркектерде 40 мм нормадан ≥ 50%, әйелдерде 34 мм (99 процентиль) ұлғаюы болып саналады. Жарылу қаупі аневризма өлшеміне пропорционалды және өлімге әкелетін асқынулардың дамуымен байланысты. Диагноз компьютерлік томографиялық ангиография (КТА), магнитті-резонанстық ангиография (МРА) немесе трансөңештік эхокардиограмма арқылы қойылады. Емдеу оңтайлы медициналық терапиямен біріктірілген эндоваскулярлық стент салудан немесе ашық операциядан тұрады.

Мақалада DeBakey бойынша IIIB типті кеуде аортасының диссекциялық аневризмасы бар науқасты сол жақ бұғана асты артериясының анатомиясынан кейін үлгіленген фенестра қалыптастыру арқылы «үстел үстінде» дәрігер модификацияланған стент-графтың көмегімен емдеу тәжірибесі берілген. Жұмыстың мақсаты модификацияланған стент-графтпен эндоваскулярлық протездеу техникасын қолдану арқылы қысқа мерзімді және орта мерзімді нәтижелерді және емдеу болжамын бағалау болды. Үстелдегі немесе in situ-дағы мұндай модификациялар протезді нақты науқастың анатомиясының нұсқасына сәйкес модельдеуге мүмкіндік береді, бұл протездің орналасуын оңтайландыруға, күрделі хирургиялық емдеудің қосымша кезеңдерін жоюға, стандарттың жағымсыз әсерлерін азайтуға мүмкіндік береді, соның ішінде сол жақ бұғана асты артериясының алдын ала эндоваскулярлық окклюзиясы және/немесе каротид-субклавиялық шунттың қалыптасуы, стационарлық бақылау уақытын қысқартады. Сипатталған әдістемені қолдану диссекциялық аневризмасы бар науқастарды хирургиялық емдеудің радикалдылығын төмендетеді және экономикалық тиімділікті арттырады. Бұл әдіс эндоваскулярлық және хирургиялық дамудың перспективті бағыты болып табылады және науқастардың үлкен үлгісінде ұзақ мерзімді нәтижелер мен болжамды бағалау үшін қосымша зерттеуді талап етеді.

Түйін сөздер:
кеуде аортасы, аневризма, стент-графт, эндоваскулярлық хирургия, модификацияланған, фенестрленген

Модифицированный эндоваскулярный стент-графт у пациента с расслаивающей аневризмой грудной аорты. Клинический случай

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Аннотация

Аневризматическим расширением грудной аорты принято считать увеличение диаметра грудной аорты ≥ 50% от нормы в 40 мм у мужчин и 34 мм у женщин (99 процентиль). Риск разрыва пропорционален размеру аневризмы и сопряжен с развитием фатальных осложнений. Диагноз ставят с помощью компьютерной томографической ангиографии (КТА), магнитно-резонансной ангиографии (МРА) или трансэзофагеальной эхокардиограммы. Лечение заключается в эндоваскулярной установке стент-графта или открытом хирургическом вмешательстве в комбинации с оптимальной медикаментозной терапией.

В статье представлен опыт лечения пациента с расслаивающей аневризмой грудной аорты IIIB типа по DeBakey с использованием модифицированного врачом «на столе» стент-графта путём формирования фенестры смоделированной под анатомию устья левой подключичной артерии. Целью работы было оценить краткосрочные и среднесрочные результаты и прогноз лечения с использованием техники эндоваскулярного протезирования модифицированным графтом. Подобные модификации на столе или in situ позволяют моделировать протез под вариант анатомии конкретного пациента, что позволяет оптимизировать аппозицию протеза, исключить дополнительные этапы комплексного оперативного лечения, снизить нежелательные эффекты стандартных подходов, включающих предварительную эндоваскулярную окклюзию левой подключичной артерии и/или формирование сонно-подключичного шунта, сократить время стационарного наблюдения. Использование описанной методики позволит снизить радикальность оперативного лечения пациентов с расслаивающей аневризмой и повысить экономическую эффективность. Данная техника является перспективным направлением развития эндоваскулярной и хирургии и требует дальнейшего изучения для оценки долгосрочных результатов и прогноза в большой выборке пациентов.

Ключевые слова:
грудная аорта, аневризма, стент-графт, эндоваскулярная хирургия, модифицированный, фенестрированный

Increasement in the diameter of the thoracic aorta ≥ 50% of the norm of 40 mm in men and 34 mm in women (99 percentile) is considered to be an aneurysmal expansion [1]. The risk of rupture is proportional to the size of the aneurysm and is associated with the development of fatal complications. Diagnosis is usually verified by computed tomographic angiography (CTA), magnetic resonance angiography (MRA), or transesophageal echocardiogram. Treatment consists of endovascular stent graft placement or open surgery in combination with optimal medical therapy.

The article presents the experience of treating a patient with a dissecting aneurysm of the thoracic aorta type IIIB according to DeBakey using a stent graft modified by a doctor “on table” by forming a fenestration modeled after the anatomy of the left subclavian artery orifice. The aim of the work was to evaluate the short-term and medium-term results and prognosis of treatment using the technique of endovascular prosthesis with a modified graft. Such modifications on the table or in situ make it possible to model the prosthesis according to the variant of the anatomy of a particular patient, which allows optimizing the apposition of the prosthesis, eliminating additional stages of complex surgical treatment, reducing the undesirable effects of standard approaches, including preliminary endovascular occlusion of the left subclavian artery and/or the formation of a carotid-subclavian shunt, reduce the time of stationary observation. The use of the described technique will reduce the radicalness of surgical treatment of patients with dissecting aneurysms and increase economic efficiency. This technique is a promising direction in the development of endovascular and surgery and requires further study to assess long-term results and prognosis in a large number of patients.

Thoracic aortic aneurysm (TAA) is an abnormal enlargement of the aorta above the diaphragm. TAA account for 1/4 of all aortic aneurysms, occurring in 40 people per 100,000. population. Men and women get sick equally [2].

TAA localizations include:

• Ascending thoracic aorta (between aortic root and brachiocephalic trunk) - 40%;

• Aortic arch (including brachiocephalic trunk, carotid and left subclavian arteries) - 10%;

• Descending thoracic aorta (distal to the left subclavian artery) - 35%;

• The upper part of the abdominal cavity - thoracoabdominal aortic aneurysms (TAAA) - 15%.

Thoracoabdominal aneurysms increase on average from 3 to 5 mm per year. The risk factors for rapid enlargement are the large size of the aneurysm, its localization in the descending aorta, and the presence of parietal thrombi [4].

The risk of rupture (per year) is:

• 2% for aneurysms < 5 cm

• 3% for aneurysms from 5 to 5.9 cm

• 8-10% for aneurysms > 6 cm

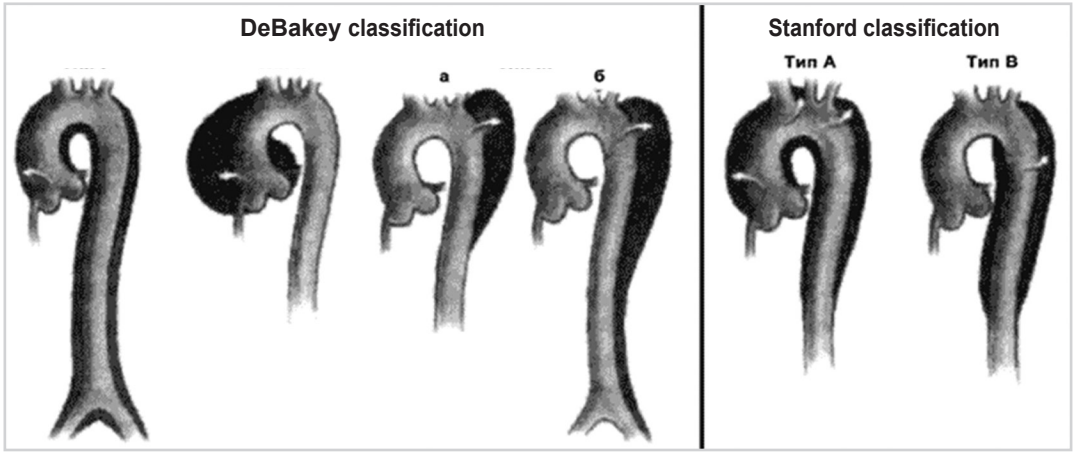

Figure 1.
Classification of dissecting aortic aneurysm [3]

The median diameter at rupture is 6 cm for ascending aortic aneurysms and 7 cm for descending aortic aneurysms; smaller aneurysms may also rupture, especially in patients with connective tissue disease or saccular aneurysms. The survival rate for patients with untreated major TAA is 65% at 1 year and 20% at 5 years. When TAA is ruptured, the mortality rate is 97% [5].

Risk factors for both thoracic aortic aneurysm and complications of aortic aneurysm include long-term hypertension, dyslipidemia, and smoking. Additional risk factors for TAA include the presence of aneurysms at other sites, infection, aortitis, and older age (peak incidence at age 65–70 years). Also, the reasons for the development of TAA can be:

• hereditary connective tissue diseases (Marfan syndrome, Ehlers-Danlos syndrome, Lois-Dietz syndrome);

• infectious and mycotic TAA (sepsis, pneumonia, tuberculosis, osteomyelitis, pericarditis);

• a number of inflammatory diseases (giant cell arteritis, Takayasu's arteritis, granulomatosis with polyangiitis).

Blunt chest trauma can cause the development of a pseudoaneurysm (false aneurysm) as a result of damage to the aortic wall - as a result, connections are formed between the arterial lumen and the connective tissue surrounding the aorta, and blood flows outside the aorta; a cavity filled with blood is formed outside the vessel wall and the existing defect closes by a thrombus formation.

Thoracic aortic aneurysm is diagnosed by CT angiography (the gold standard), MR angiography, or transesophageal echocardiography. Contrast angiography has traditionally been the standard imaging modality. It provides the best visualization of the arterial lumen, but does not provide information about extraluminal structures, which is inferior to CT and MR angiography [4].

Most thoracic aortic aneurysms are asymptomatic before complications such as thromboembolism, dissection, aortic regurgitation, rupture develop [6]. However, compression of adjacent structures can cause back pain due to vertebral compression, cough due to tracheal compression, wheezing, dysphagia due to esophageal compression, hoarseness due to left recurrent laryngeal or vagus nerve compression, chest pain due to for compression of the coronary arteries and superior vena cava syndrome. Dissection of the aneurysm manifests as a pain syndrome in the chest area of a tearing nature, often with irradiation to the back, between the shoulder blades. A non-fatal TAA rupture presents with severe chest or back pain, as well as hypotension or shock.

When correcting aortic dissection, the main problem is to optimize the ratio between the volume of surgical intervention and the physiological reserve of the patient [7].

In order to increase the radicalness of the intervention, staged and combined techniques are used.

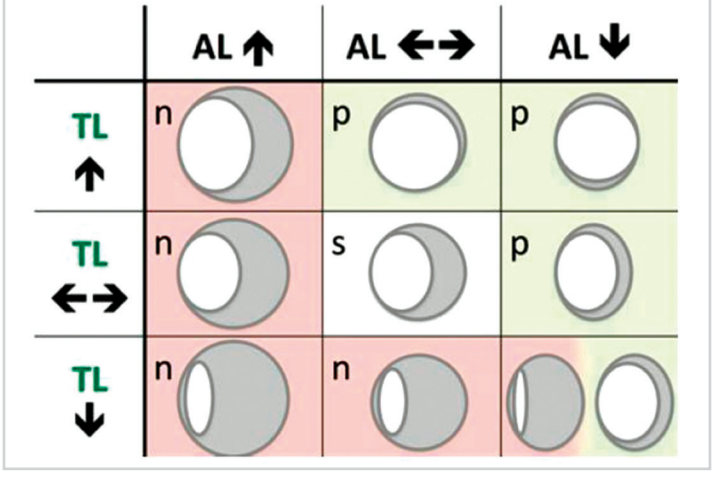

Figure 2.
Classification of remodeling of the thoracoabdominal aorta according to Dohle D-S.et al.: TL, true aortic lumen; AL is the total lumen of the aorta; N, negative aortic remodeling; S, stable remodeling of the aorta; P - positive aortic remodeling

Complex aortic pathology consisting of aortic aneurysm and dissection with involvement of the aortic arch presents a technical challenge for remodeling due to involvement of the left subclavian artery. Traditionally, open surgery has been the gold standard for surgical treatment. However, open surgery for this pathology is associated with high perioperative risks and mortality. Thus, for patients with significant comorbidities or complex surgical/anatomical features, the risk of open surgery may be prohibitive.

With the development of endovascular methods, options for endovascular treatment of complex pathology of the aorta involving the arch are being developed. A promising approach is fenestrated or branched endovascular aortic plasty (F/B-EVAR) using fenestrated or branched endovascular prostheses.

One of the options for definitive repair of complex aortic pathology in patients who are contraindicated or impossible to install factory-produced stent grafts is endovascular repair with a physician-modified endovascular graft (PMEG). For this procedure, the operating surgeon modifies the endovascular graft to create fenestrations based on the patient's anatomy. Numerous reports have been published demonstrating that this procedure can be performed with high technical success and acceptable perioperative and mid-term outcomes in high-risk patients [8,9,10].

Case report

An 80-year-old man underwent a routine examination at the place of residence in November 2019, where an increase in the contours of the aortic arch was found on chest X-ray. The patient was consulted by an angiosurgeon at the place of residence, received recommendations for optimal drug therapy and was sent for outpatient follow-up.

In May 2021 he began to notice the appearance of blood streaks in the sputum when coughing, in connection with which he was repeatedly consulted by an angiosurgeon, and CT angiography was performed. Based on the results of the examination, a picture of a fusiform aneurysm of the descending aorta with dissection of the walls in the transversely descending and distal sections, type IIIb according to DeBakey, was revealed.

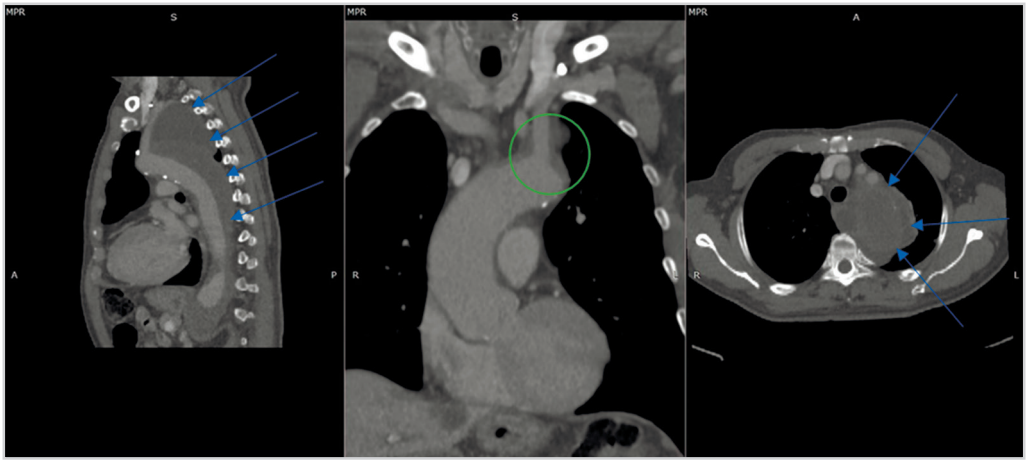

Figure 3. CT angiography at the outpatient stage.The arrows indicate the false lumen of the aorta. Circle highlights the involvement of the left subclavian artery in the pathological process

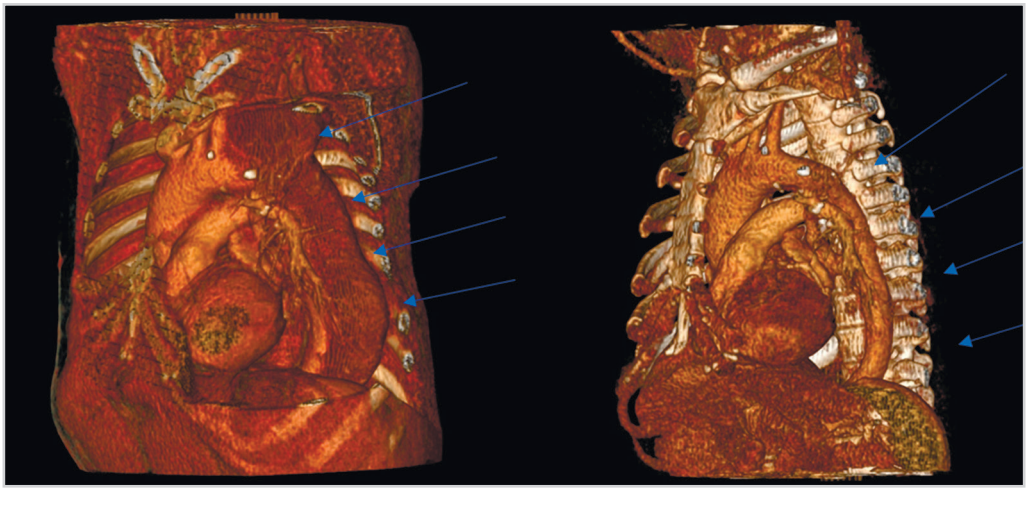

Figure 4. 3D reconstruction of CTA data. An aneurysmal sac with a false passage and an encapsulated hematoma in the region of the left subclavianartery

Figure 5. 3D reconstruction of CTA data. True lumen of the thoracic aorta

Further, the patient was consulted by an endovascular surgeon, and TEVAR was recommended.

During hospitalization: a patient with a height of 158 cm, weight - 56 kg, BMI - 22.3. An experienced smoker, registered with a cardiologist since 2007 about coronary artery disease, hypertension with pressure rises up to 170/110 mm Hg, periodically adhered to antihypertensive therapy. Heredity and allergic anamnesis are not burdened. Hb - 138.9 g/l; RBC - 4.56x1012/l; HCT - 41.57%; PLT - 286.8x109/l; WBC - 6.51x109/l; Creatinine - 117.0μmol/l; Ureinase - 7.70 mmol/l; Cholesterol - 4.72 mmol/l.

07.12.2021, the patient underwent endovascular implantation of an “on table” fenestrated stent graft into the descending thoracic aorta.

After preparing and dressing of the surgical field of the upper third of the left thigh, under spinal anesthesia, in the projection of the common femoral arteries, an incision was made in the skin and subcutaneous fat. After opening the femoral fascia, by blunt and sharp way, access was made to the common femoral artery (CFA) on the left. After processing the surgical field under the infiltrative anesthesia, CFA was punctured and catheterized on the right according to Seldinger. Performed thoracic aortography, which reveals an aneurysm of the descending part of the thoracic aorta. The stent graft was removed by 1/4 length of the delivery catheter, in the projection of the landing zone at the orifices of the internal carotid artery (ICA) and left subclavian artery (LSA), the proximal end of the stent graft was fenestrated in the form of a wedge in “on table” fashion. Further, the selected CFA is punctured on the left. On the diagnostic catheter, a super-stiff guidewire was inserted into the aortic arch and installed with its distal end in the ascending aorta. The catheter was removed, and a partial arteriotomy was performed. After expanding the vascular access through a super-stiff guidewire, a modified thoracic stent graft Valiant Thoracic StentGraft 36.0x36x200.0 mm, mounted on the Captivia delivery system, was delivered to the aortic arch. Then, under the control of angiography and fluoroscopy, the stent-graft was positioned in the descending part of the thoracic aorta, capturing the site of the dissecting aortic defect, proximal to the celiac trunk. After exposure of the stent graft, the “crown” of the proximal section of the device was opened immediately after the departure of the brachiocephalic trunk so that the fenestrated area was at the level of the left common carotid and at the ostium of the left subclavian artery. During intermediate angiography, the crown of the stent graft was completely opened, the arteries of the aortic arch were patent. The stent graft is fully deployed and implanted. The delivery system has been removed. At the control aortography, the stent-graft and arteries of the aortic arch are completely passable, the false lumen is not contrasted. The defect of the CFA on the left was repaired with an interrupted vascular suture with a 6/0 prolene suture. Hemostasis was achieved. The wound was sutured by layers, drainage was installed, and an aseptic dressing was applied. Introducer from CFA on the right, the puncture site was removed, closed with an Angioseal 6F device, an aseptic dressing was applied.

The patient was transferred for a day to the intensive care unit for dynamic observation.

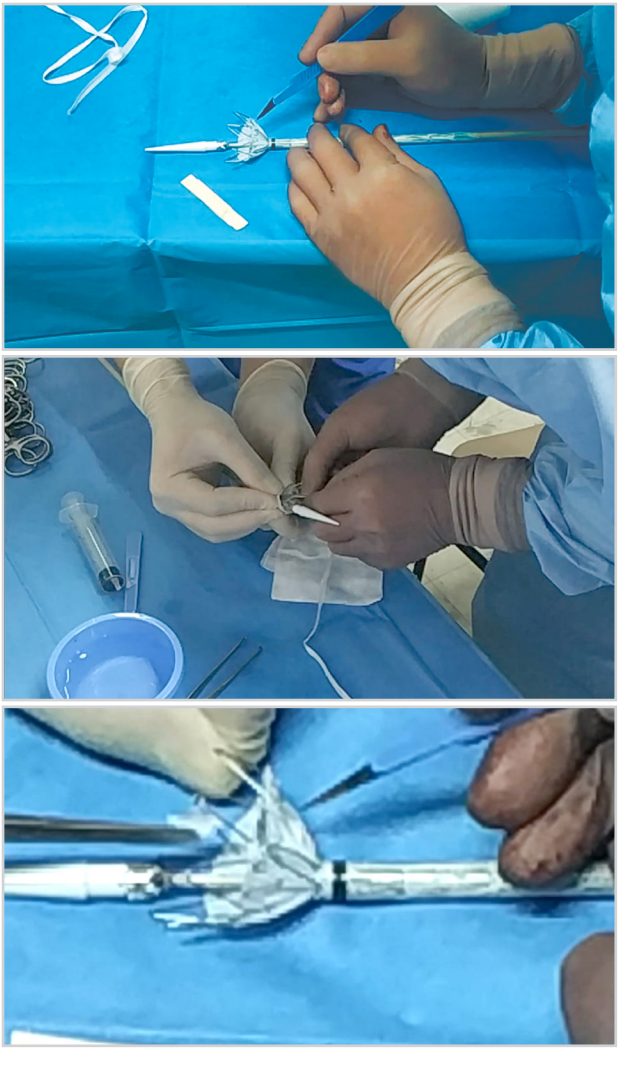

Figure 6,7,8,9,10,11.
Stages of the operation

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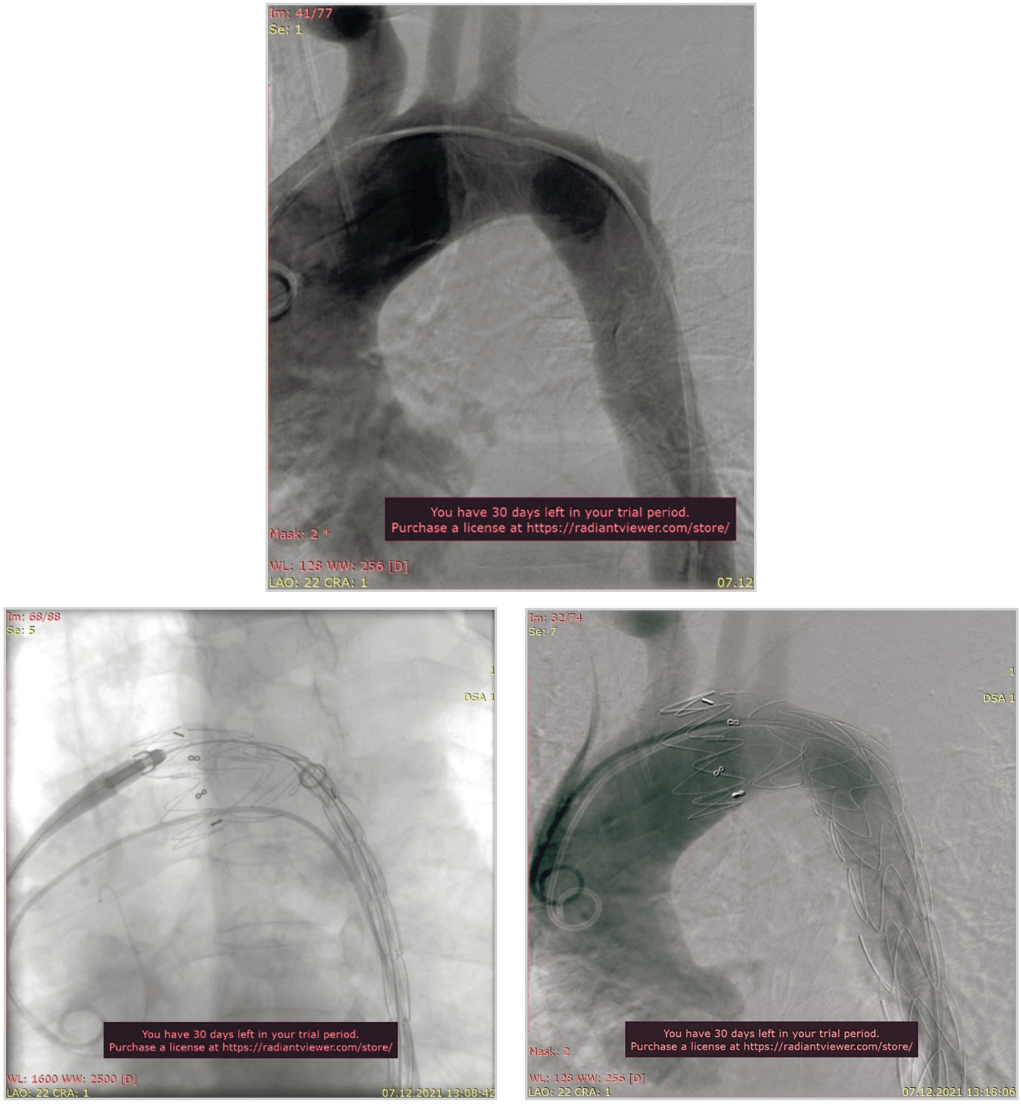
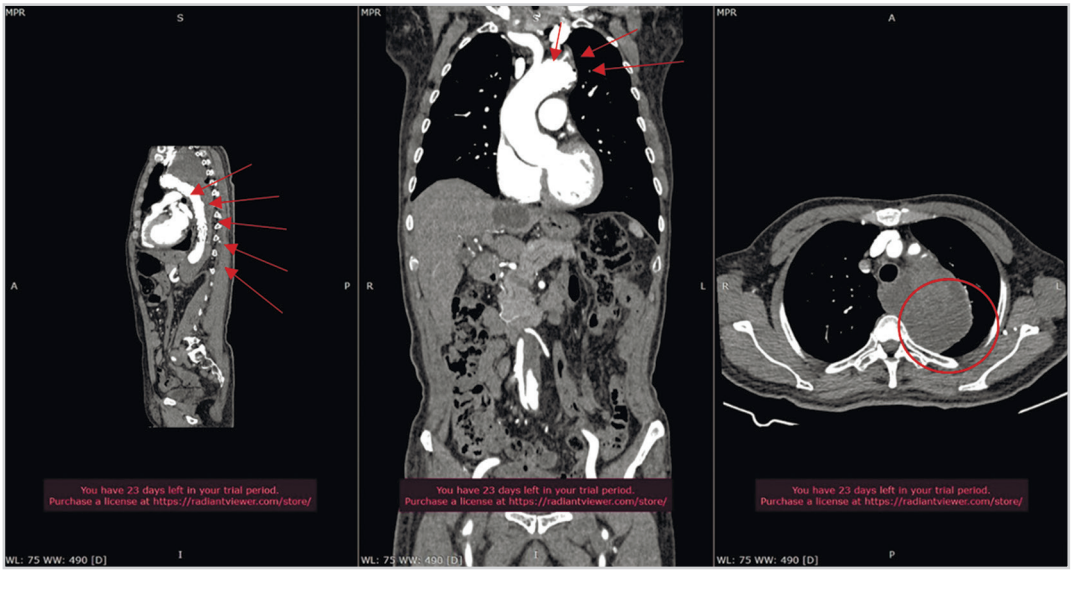


Analysis after the operation:

Hb - 121.0g/l; RBC - 4.11 1012/l; HCT - 35.70%; PLT - 209.0x109/l; WBC - 9.80x109/l; Creatinine - 119.0 µmol/l; Urea - 6.10 mmol/l.

CTA CONTROL

Figure 12.
CTA control after surgery.
On the left is the apposition of the stent graft.
In the center - the patency of the arteries of the aortic arch is preserved.
On the right - the residual cavity of the aneurysm with thrombus masses, without signs of blood flow



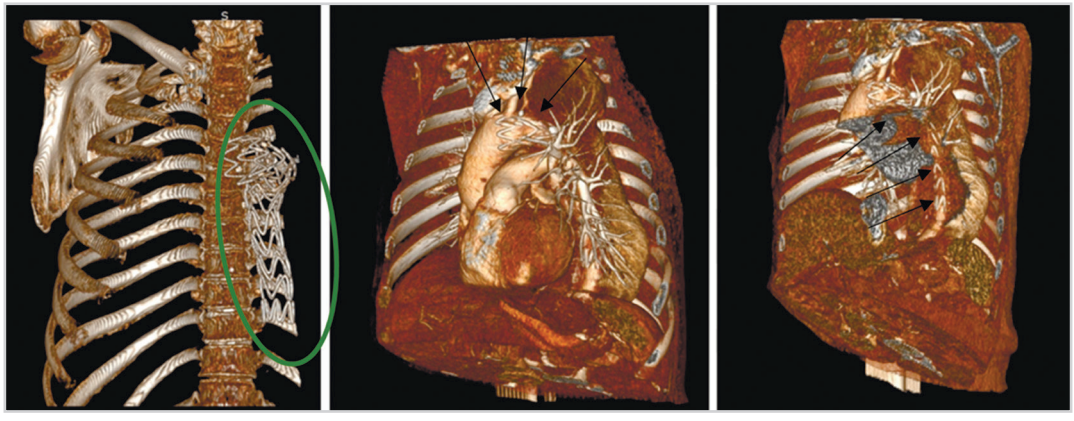


Figure 13.
3D reconstruction of CTA after surgery.
Skeleton prosthesis.
Topography of the prosthesis (arteries of the aortic arch are patent).
Topography of the prosthesis (heart dissected)

Conclusion

Intraoperative fenestration as wedge of the stent-graft in "on table" fashion allowed maintaining the patency of the LSA without forced occlusion by a plug and the formation of subsequent ischemia of the left upper limb with symptoms of still syndrome from vertebral artery with inevitable neurological deficit.

This technique allows TEVAR to be carried out in one stage without the development of undesirable consequences.

Such modifications on the table or in situ make it possible to model the prosthesis according to the variant of the anatomy of a particular patient, which allows optimizing the apposition of the prosthesis, eliminating additional stages of complex surgical treatment, reducing the undesirable effects of standard approaches, including preliminary endovascular occlusion of the left subclavian artery and/or the formation of a carotid-subclavian shunt, reduce the time of stationary observation. The use of the described technique will reduce the radicalness of surgical treatment of patients with dissecting aneurysms and increase economic efficiency. This technique is a promising direction in the development of endovascular and surgery and requires further study to assess long-term results and prognosis in a large sample of patients.

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