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Торакобедренное бифуркационное шунтирование с использованием робототехники

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АННОТАЦИЯ

Введение. Торакобифеморальное шунтирование при окклюзии аортофеморального сегмента является вариантом выбора метода лечения пациентов при невозможности проведения традиционного аортофеморального шунтирования. Использование робот-ассистированных технологий при формировании проксимального анастомоза позволяет уменьшить травматичность операционного доступа и улучшить результаты оперативного вмешательства. В статье приводится клиническое наблюдение пациента с окклюзией аорто-подвздошного сегмента и тотальным кальцинозом инфраренального отдела аорты, которому выполнено торакобедренное бифуркационное шунтирование с применением робототехники.

Заключение. Использование в сосудистой хирургии современных технологий позволяет уменьшить травматизацию, минимизировать влияние человеческого фактора, улучшить визуализацию и свободу движений, при этом сократить восстановительный период пациента и время его нахождения в стационаре.

Ключевые слова: *сосудистая хирургия; торакофеморальное шунтирование; робот-ассистированная операция; хирургический робот da Vinci; аортобедренное бифуркационное шунтирование; лапароскопическая сосудистая хирургия; миниинвазивная хирургия*

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Robot-Assisted Thoracofemoral Bifurcation Bypass

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ABSTRACT

INTRODUCTION: Thoracofemoral bypass surgery for occlusion of aortofemoral segment is a variant of choice for treatment of patients with impossibility of performing traditional aortofemoral bypass. The use of robot-assisted technologies in the formation of a proximal anastomosis permits to reduce the trauma of surgical access and to improve the results of surgical intervention. The article reports a case of a patient with occlusion of the aorto-iliac segment and total calcification of the infrarenal aorta, who underwent robot-assisted thoracofemoral bifurcation bypass surgery.

CONCLUSION: Use of modern technologies in the vascular surgery permits to reduce traumatization, minimize the effect of the human factor, improve visualization and freedom of movement and shorten the recovery period and the period of hospital stay.

Keywords: *vascular surgery; thoracofemoral bypass; robot-assisted surgery; da Vinci surgical robot; aortofemoral bifurcation bypass; laparoscopic vascular surgery; minimally invasive surgery*

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LIST OF ABBREVIATIONS

FA — femoral artery
LE — lower extremity
MSCT — multispiral computed tomography

INTRODUCTION

Atherosclerotic lesions of the abdominal aorta and peripheral arteries are the most common pathology of the cardiovascular system. Epidemiological multicenter studies conducted at the end of the XXth and beginning of the XXIst century, show a high prevalence of peripheral atherosclerosis in the general population of economically developed countries where it varies from 3% to 10%, and reaches 15%–20% among individuals above 70 years [1].

Aortobifemoral bypass remains a 'gold standard' for the treatment of patients with a severe atherosclerotic diseases or complete occlusion of the infrarenal aorta and iliac arteries. In cases of total calcification of the abdominal aorta, adhesions in the abdominal cavity, thrombosis and infection of the previous reconstruction of the infrarenal aorta and in other intraabdominal pathologies that do not permit standard revascularization of the lower extremities (LEs), a method of choice may be a thoracofemoral bypass [2]. Open surgical interventions are associated with a high risk of perioperative complications and a long rehabilitation period.

The active introduction of robot-assisted endovideosurgery improves the results of surgical intervention, since it minimizes tissue injury and reduces the operation time and permits rehabilitation of patients in shorter periods.

Case report

A patient Z., 68 years old, was admitted to the vascular surgery department of Scientific and Research Institute Ochapovsky Krasnodar Regional Hospital No. 1 in June 2022 with *complaints* of pain in the calf muscles at rest, dry necrosis of the 1st toe of the left foot, pain in the calf muscles of the right LE in walking 10 m distance. The patient considers himself ill for 5 years. In the previous month he noted impairment of the condition, sleep disorders due to a pronounced pain syndrome.

From life history: the patient had been observed by an endocrinologist for type 2 diabetes mellitus for more than 20 years, receives insulin therapy.

Instrumental methods of examination: on ultrasonic dopplerography, collateral blood flow was determined from the level of the external iliac artery on both sides and further along the entire length in all projections of the major arteries, the ankle pressure index 0.18 on the right and 0.22 on the left.

Multispiral computed tomography (MSCT) with intravenous contrast, revealed atherosclerotic lesion of the aorta and its branches, total calcification of the infrarenal aorta, occlusion of the terminal aorta, of both common iliac arteries, external iliac arteries, occlusion of the superficial femoral arteries (FAs) of both LE.

Angiography data confirmed the level of occlusion: the deep femoral, popliteal and tibial arteries were determined patent. Based on the data, the following clinical diagnosis was established: *Atherosclerosis. Leriche's syndrome. Occlusion of the terminal aorta, of both common external iliac arteries, occlusion of the superficial femoral arteries of both lower extremities. Third degree chronic arterial insufficiency of both lower extremities*.

Taking into account the clinical presentation, the data of instrumental examinations, to minimize traumatization of the surgical wound and to reduce the rehabilitation period, it was decided to perform a surgical intervention in the volume of thoracofemoral bifurcation bypass with prosthesis using robot-assisted technology.

Operation technique. After the general anesthesia and the installation of a double-lumen endotracheal tube, the patient was placed on his right side with the left arm abducted to the right. At the first stage, a lateral incision was performed in the projection of FA bypassing femoral lymph nodes. The common, superficial and deep FAs of both LEs were sequentially isolated and taken on holders. The superficial FAs of both LEs were incompressible, calcified, deep FAs soft, compressible. Next, a lumbotomic approach was performed on the left. The abdominal sac was displaced upward and medially. Revision of the retroperitoneal space and the diaphragm. A bifurcation prosthesis made of polyester was conducted retroperitoneally along the route of the iliac arteries distally on the left and right, branches of the prosthesis were drawn to the FA under the inguinal ligament.

At the next stage, trocars were installed in the thoracic region. An 8 mm video-optical trocar was installed in the left thoracic region in the sixth interspace at the level of the posterior axillary line. A laparoscope was inserted into the trocar. In the revision, the lobes of the lung were airy, did not participate in breathing due to single-lung ventilation, parietal and visceral pleura without pathology. There was a single adhesive process in the upper part of the lung lobe. Further, an 8 mm trocar for the 2nd robot manipulator was installed medial to the video-optical trocar at the level of the midaxillary line in the sixth interspace. An 8 mm trocar for the 1st robot manipulator was installed along the anterior axillary line in the fifth interspace. An 8 mm trocar for the 4th robot manipulator was installed along the scapular line in the fifth interspace. Next, a mini-thoracotomy up to 3 cm long was performed in the eighth interspace between the video-optical trocar and the 4th robot manipulator for aortic clamping. A mini-thoracotomy up to 3 cm long was performed in the seventh interspace between the video-optical trocar and the 2nd robot manipulator for the aspirator. A mini-thoracotomy up to 4 cm long was performed along the posterior axillary line between the video-optical trocar and the 4th robot manipulator in the forth interspace for the aortic clamp (Figure 1).

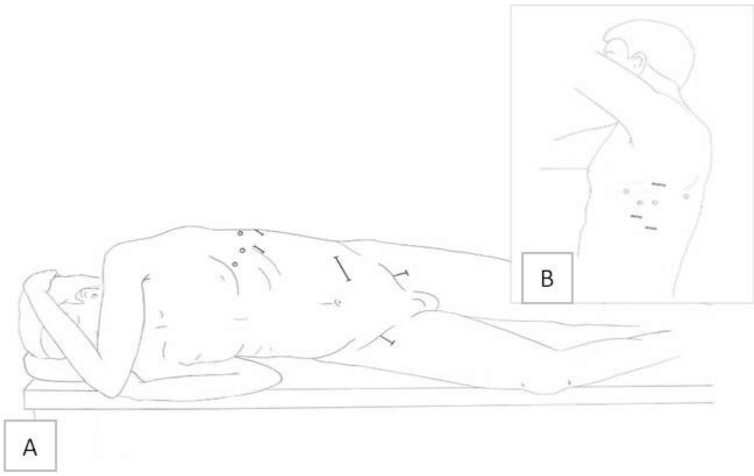

Fig. 1. Position of the patient on the operating table (A). The layout of trocars and open surgical approaches (B).

The Da Vinci Xi robot manipulators were fixed; with the help of robot arms, a single adhesive process in the upper lobe of the lung was excised. The distal part of the descending thoracic aorta was isolated. In the tendon part of the diaphragm, a hole was formed for drawing a synthetic prosthesis. The prosthesis was conducted along the left lateral canal and further into the left pleural cavity through the formed hole in the diaphragm. Two thousand five hundred activity units of sodium heparin were administered intravenously. For side-biting clamping of the thoracic aorta descending into the pleural cavity, 2 curved Satinsky aortic clamps were introduced through mini-thoracotomy wounds, with the help of the 1st and 3rd assistant arms. The clamps were applied towards each other. Aortic side-biting clamping was performed. A longitudinal aortotomy was carried out. An end-to-side proximal anastomosis was formed between the synthetic prosthesis and the aorta with continuous suturing with prolene 4.0 thread. The clamps were sequentially removed from the aorta, followed by adaptation of the anastomosis (Figure 2).

Pleural drainage was drawn through the 2nd robotic port under laparoscopic control. Robot manipulators were removed together with thoracic ports. At the next stage, end-to-side distal anastomoses were formed between prosthetic branches and common FAs with transition to deep FAs with continuous suturing with prolene 5.0 thread. Anastomoses was adapted, arteries pulsating in the wound. Redon draining of wounds on hips. Connection of pleural drainage. Suturing of the wounds.

The duration of the surgical intervention was 310 minutes. The time of aortic side-biting clamping was 36 minutes, the time of robot-assisted formation of the proximal anastomosis was 31 minutes. The volume of blood loss was about 350 ml. The patient was extubated 20 minutes after the operation on the operating table, and transferred to the intensive care unit.

The postoperative period of the patient ran without peculiarities and complications. LE ischemia was corrected. On the 2nd day after the operation, the patient was transferred to the general ward. One day after the operation, the patients had an independent stool. For the postoperative control, drains were removed on the 3rd day (Figure 3), and MSCT with intravenous contrast with 1 mm increments was performed. The structure was patent, without obstacles to the blood flow (Figure 4).

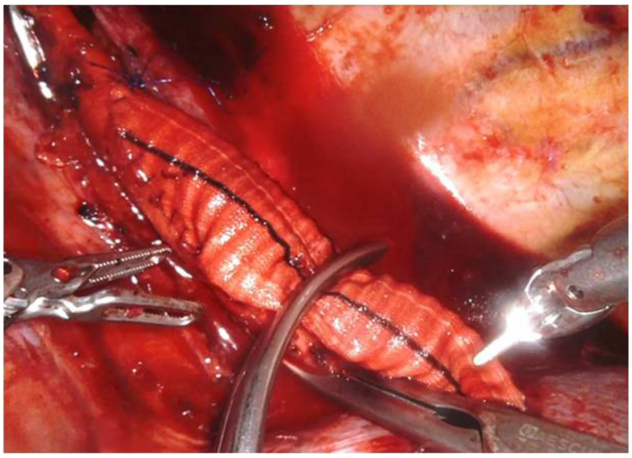

Fig. 2. View of the formed proximal anastomosis between the synthetic prosthesis and the aorta. Adaptation of the proximal anastomosis between the descending thoracic aorta and the synthetic prosthesis.

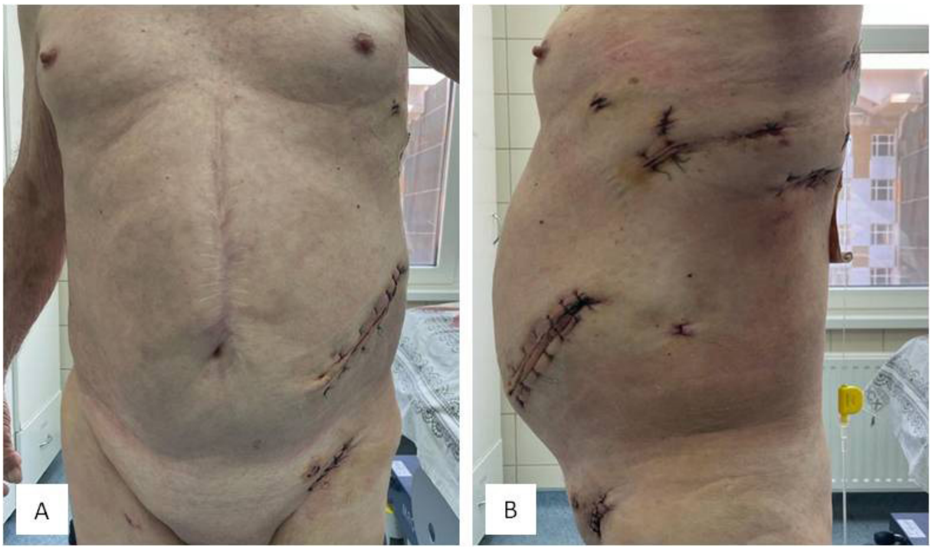

Fig. 3. Postoperative wounds after removal of drainages (after 3 days): front view (A), side view (B).

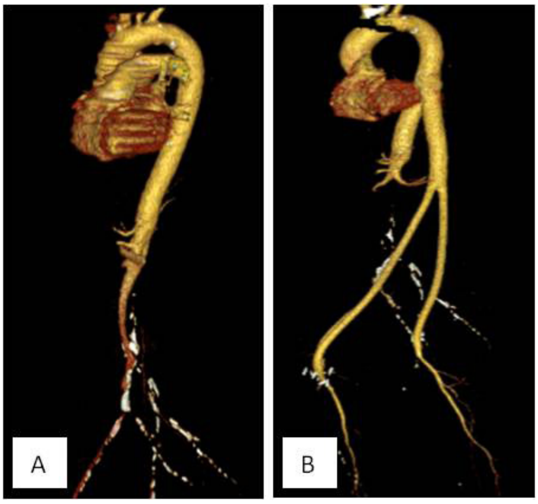

Fig. 4. Three-dimensional reconstruction of multispiral computed tomography with intravenous contrast: before surgical intervention (A), after surgical intervention (B).

DISCUSSION

Robot-assisted surgery is one of the most advanced techniques of minimally invasive endovideosurgery to date. A high accuracy and freedom of movements, 3D image, minimization of intervention and of blood loss, shortened period of rehabilitation of patients are factors that promote active introduction of robot-assisted operations in different spheres. A short learning curve facilitates the application of robotized surgical systems in vascular surgery for interventions on large vessels with minimal injury of surgical approach, and makes them promising instruments for complex reconstructions on the aortofemoral segment [4–7].

In modern practice, in case of occlusion of the aorto-iliac segment, traditional reconstructive surgery is aortobifemoral bypass surgery, which is characterized by the longest long-term patency. In patients of high-risk group and patients in whom conventional reconstructive surgery is impossible, an alternative option is thoracobifemoral bypass surgery.

The technique of performing thoracobifemoral bypass surgery differs from author to author. In most cases, an anterolateral thoracotomy is used with a posterior tunnel under the left diaphragmatic peduncle. A graft is brought to the left inguinal region, and then one branch of the bypass is tunneled into the right femoral region [8].

A standard anterolateral thoracotomy for isolating the descending part of the thoracic aorta and forming a proximal anastomosis is a very traumatic approach associated with a high risk of damage to the rib cage and long periods of postoperative rehabilitation. Standard open surgical treatment in obese patients with a barrel chest may be associated with great technical difficulties. The use of robot-assisted technologies for the formation of a proximal anastomosis permits to reduce the trauma of an operation wound, blood loss, and to improve the rehabilitation period of patients.

One of the disadvantages is the probability of collision of the robot manipulators with laparoscopic instruments, which can lead to the removal of the aortic clamp. The success of surgical intervention is based on the cooperation between the surgeon's assistant at the table and the surgeon at the console. One should avoid quick, abrupt movements of instruments. Besides, of importance is correct installation of the trocar with sufficient space between robotic and laparoscopic instruments. The robotic system does not possess tactile feedback, so caution is required in the interaction with body tissues, sutures and prosthetic material. To help in robot-assisted surgery in case of necessity of a rapid conversion, experienced surgeons must be present in the operating room. In addition, it is important to take into account the costs of the use of a robotized system, its maintenance and tools [9].

CONCLUSION

The use of modern technologies in vascular surgery permits to reduce traumatization, minimize the effect of the human factor, improve visualization and freedom of movement, while reducing the patient's recovery period and hospital stay.

The use of robotic technologies improves the rehabilitation of patients and reduces the risk of postoperative complications without increasing the volume of surgery and vascular compression time, which makes them promising in performing complex reconstructive interventions.

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