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Case Report

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Intraoperative Axillary Artery Injury as a Complication of Reverse Total Shoulder Arthroplasty

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ABSTRACT Axillary artery injury as a result of total shoulder artroplasty is a fairly rare complication. Isolated clinical observations are described in foreign articles, there are no reports of domestic authors about this problem. There is a need for more extensive coverage of this problem in order to prevent similar situations in the future.

THE AIM of this publication is to present a clinical case of intraoperative axillary artery injury in the process of reverse shoulder arthroplasty, and the medium-term result of surgical treatment after replacement of the artery defect with a synthetic graft.

MATERIAL AND METHODS We present a rare clinical case of intraoperative axillary artery injury in the process of reverse shoulder arthroplasty. After the replacement of the artery defect by a team of vascular surgeons, it was decided to continue the shoulder joint replacement surgery. In the postoperative period, computed tomography angiography revealed occlusion of the restored section of the axillary artery, but the presence of collateral blood flow distal to the injury zone, the preservation of active movements in the joints of the right upper limb, and the absence of sensitivity disorders in the right hand made it possible to refrain from repeated surgical intervention. When evaluating the medium-term results 15 months after surgical treatment, a significant limitation of the function of the right upper limb was noted in the complete absence of pain syndrome.

CONCLUSION The presented clinical case demonstrates the experience of managing a patient with simultaneous reverse shoulder arthroplasty and an intraoperatively damaged section of the axillary artery with the achievement of complete absence of pain syndrome with significant restriction of function in the remote period. Bearing in mind the possible damage to the main arteries, particularly in age-related patients, and the amount of medical care required in the event of this complication, it is recommended that medical care be provided in a multidisciplinary hospital with a team of vascular surgeons.

Keywords: axillary artery, total reverse shoulder arthroplasty, case report

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ASES — American Shoulder and Elbow Surgeons Score
CSS — Constant Shoulder Score
CT — computed tomography
DASH — the Disabilities of the Arm, Shoulder and Hand questionnaire
NSAIDs — nonsteroidal anti-inflammatory drugs
RSA — reverse shoulder arthroplasty
SST — Simple Shoulder Test

INTRODUCTION

Trauma of the musculoskeletal system and its consequences remain one of the most acute medical and social problems of our time [1]. Total shoulder arthroplasty is a relatively safe procedure with an in-hospital mortality rate of 0.09% [2]. The most common complications of total shoulder arthroplasty include dislocations and aseptic instability of the endoprosthesis components, periprosthetic fractures, scapular notching, periprosthetic infection, brachial plexus nerve injury, acromial process and/or scapular spine fractures, hematoma, deltoid muscle injury, rotator cuff tear, and venous thromboembolism [3–5]. The literature also describes relatively rare complications associated with axillary artery injury [6–10], which may ultimately lead to death [11]. We present a clinical observation of a patient who sustained an injury to the axillary artery during reverse shoulder arthroplasty (RSA), which was interrupted to replace a portion of the axillary artery, and was successfully continued after the vascular surgical team had completed their work.

Clinical observation

An 89-year-old female patient was admitted to our Clinic with a closed four-part (according to the Neer classification) fracture of the proximal metaphysis of the right humerus after falling on her right shoulder from her own height (Fig. 1, 2).

Fig. 1. 3D CT scan of the right shoulder joint, anterior view

Fig. 2. 3D CT scan of the right shoulder joint, side view

Osteosynthesis of the humerus seemed futile. An attempt was made to conservatively treat the fracture; however, the patient was bothered by intense pain. The need for daily nonsteroidal anti-inflammatory drugs (NSAIDs) remained. Surgical treatment was performed 1.5 months after the injury, after compensation for concomitant pathology. During the operation, fragments of the humeral head were removed. While careful and consistent peeling of soft tissues from the diaphysis of the humerus with a raspatory (aggressive surgical tactics were not used), massive arterial bleeding opened from the scar tissue. In order to temporarily stop the bleeding, the damaged artery was pressed to the humerus with a finger, and a team of vascular surgeons was urgently called to the operating room. Twenty minutes after their arrival, they extended the surgical wound proximally to the sternal end of the clavicle. With the aim to gain access to the subclavian artery, partial dissection of the anterior portion of the deltoid muscle and the clavicular portion of the pectoralis major muscle was performed. During the revision of the neurovascular bundle, traumatic damage to the axillary artery over 95% of its circumference with an extensive defect of the arterial wall up to 2 cm was revealed. The latter was mobilized along the length with technical difficulties, taken on holders; clamps were applied to the proximal and distal ends of the axillary artery (Fig. 3).

A resection of this section of the arterial wall was performed, followed by its prosthetic replacement with a reinforced synthetic vascular graft of 6mm in diameter (Vascutek Ltd., UK) with end-to-end anastomoses (Fig. 4).

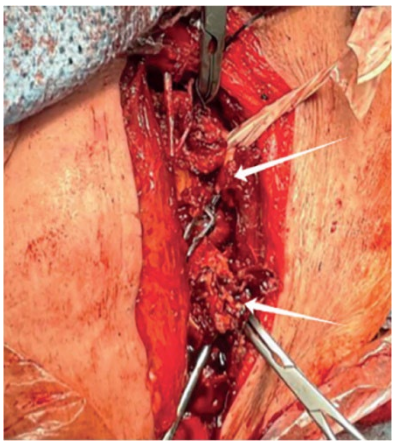

Fig. 3. Axillary artery after resection of the damaged area. The proximal and distal ends of the artery are indicated by arrows

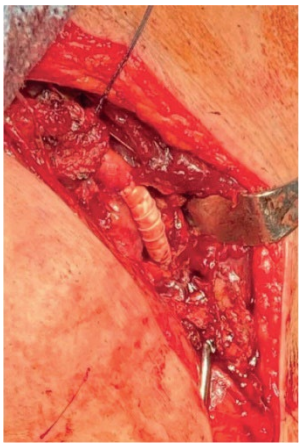

Fig. 4. Axillary artery after the repair of the damaged area

The interval between the application of clamps to the axillary artery and their removal was 1 hour and 30 minutes. During this time, blood circulation in the upper limb was carried out through vascular collaterals. After removing the clamps, blood flow was restored. Clinically, a distinct pulsation of the artery in the wound was determined. A medical consultation was held, and on the recommendation of vascular

surgeons, a decision was made to continue reverse shoulder arthroplasty in order to reduce the risk of re-injury to the axillary artery and the installed synthetic prosthesis by a humeral bone fragment. A UNIC shoulder prosthesis (Evolutis, France) was installed, and refixation of the pectoralis major and deltoid muscles was performed (Fig. 5, 6).

Fig. 5. Postoperative scar (15 months after the surgery)

Fig. 6. Postoperative X-ray of the right shoulder joint

The operated limb was immobilized in a Desault-type bandage. The patient spent the first day of the postoperative period in the intensive care unit. After her condition stabilized, she was transferred to the trauma unit.

The right upper limb was clinically assessed daily in collaboration with vascular surgeons for critical ischemia and sensation disorders. The hand was warm to the touch, pulsation in the radial and ulnar arteries was not determined, but filling of the nail bed after compression was active. No sensation disorders were noted, active movements in the elbow joint and hand joints were preserved. According to Doppler ultrasonography of the vessels of the upper and lower extremities, the right axillary artery was not visualized, the blood flow was not clearly recorded in the upper third of the right brachial artery, but distally along the entire length, collateral blood flow was recorded. Non-occlusive thrombosis of the right axillary vein and occlusive thrombosis of the deep veins of both lower extremities were also detected. The patient received anticoagulant therapy with calcium nadroparin at a dosage of 8550 anti-XA IU. In order to assess the blood flow in the right upper limb, computed tomography (CT) angiography was performed. The following changes were revealed: at the level of the distal third of the right subclavian artery, an acute-angle bend of the artery with a narrowing of its lumen, occlusion of the lumen of the proximal part of the right axillary artery over a length of 4.3 cm were determined; the proximal part of the right brachial artery was stenotic for 5 cm up to 70% (Fig. 7, 8).

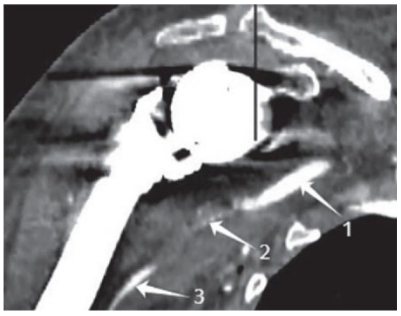

Fig. 7. CT-angiogram of the right upper limb: 1 — axillary artery, 2 — synthetic prosthesis, 3 — brachial artery

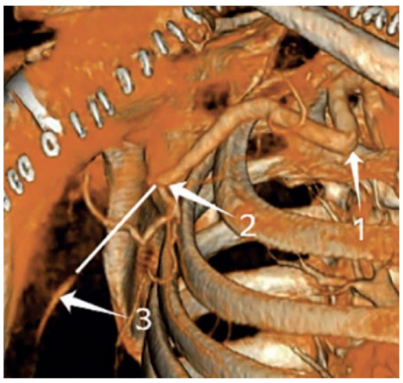

Fig. 8. 3D modeling of CT-angiography of the right upper limb. 1 — inflection of the subclavian artery, 2 — axillary artery, 3 — brachial artery. The line represents the restored section of the artery

Considering the presence of collateral blood flow, preservation of active movements in the joints of the right upper limb, and the absence of sensation disorders in the right wrist, the vascular surgeon did not identify any clear indications for repeated reconstructive interventions on the axillary artery. Despite all of the above, the patient was bothered by severe pain, not typical for RSA. Analgesic therapy included daily intravenous infusions of paracetamol (up to 4 g per day) and tramadol injections.

Also, due to the low efficiency of the previous analgesia, a transdermal patch with fentanyl was used. During a control Doppler ultrasound of the vessels of the right upper limb, along the anterointernal surface of the right shoulder, an echo-heterogeneous fluid formation with fuzzy uneven contours measuring 9×3.4×10 cm without signs of blood flow was detected. Due to severe pain in the surgical site, probably associated with the pressure of the resulting hematoma on the surrounding soft tissues, its puncture was performed, 215 ml of lysed blood was evacuated. After this, the patient noted a significant reduction in pain. Given the positive dynamics in her condition, the absence of signs of critical ischemia of the operated limb, and relief of severe pain syndrome, on the 15th day after surgery, the patient was discharged from the hospital for outpatient follow-up care. It was recommended to continue immobilization in a Desault-type bandage for 1 month after surgery, as well as anticoagulant therapy with rivaroxaban at a dosage of 20 mg per day for at least 3 months with dynamic ultrasound examination of the vessels of the extremities.

When assessing the mid-term results 15 months after surgery, a complete absence of pain syndrome in the area of the right upper limb was noted with a significant limitation of function: ASES 65, DASH 62.9%, CSS 38%, SST 16.7%. When examining the pulse on the main arteries of the right upper limb, pulsation was determined only on the brachial artery, pulsation on the radial and ulnar arteries was not reliably detected. The limb was warm to the touch, no neurological disorders or atrophy were detected, muscle strength was similar to the left upper limb.

One year after the RSA, the patient fell and fractured the neck of the right femur. A right hip replacement was performed. After this operation, the patient's activity decreased sharply. She complained of loss of the weight-bearing ability of her right lower limb. The function of the right upper limb was also affected. After the RSA and before the fracture of the right femoral neck, the patient cooked her own food, did small household chores (sweeping the floor, washing dishes), and fully looked after herself. Subjectively, after the rehabilitation course and independent development of movements, the patient believed that the function of the right upper limb had restored by 75%. After the right femoral neck fracture and hemiprosthesis, she lost the ability to walk independently, and began to move only in a wheelchair with assistance (the hip replacement surgery was performed in a regional clinic, the patient was not provided with control X-rays). Now she constantly requires help from others to solve most of her everyday needs due to the inability to walk independently. The range of active movements currently available to the patient is shown in the photographs (Fig. 9).

Fig. 9. Range of motions in the right shoulder joint 15 months after surgery

DISCUSSION

The axillary artery, vein, and brachial plexus are located in close proximity to the shoulder joint. They originate in the posterior triangle of the neck, limited by the clavicle, trapezius and sternocleidomastoid muscles, enter the axillary region under the pectoralis minor muscle, and pass 5–20 mm medial to the anterior edge of the glenoid process of the scapula. This arrangement of the components of the neurovascular bundle makes them vulnerable to damage during shoulder injuries, as well as during surgical interventions on the shoulder joint [12–14].

Damage to the axillary artery should be considered as one of the possible serious complications of shoulder arthroplasty with a possible fatal outcome [11]. During surgical treatment several weeks or months after fractures/dislocations of the proximal humerus, the risks of damage to the vascular-nerve structures and muscles increase due to changes in the soft tissues surrounding the fracture area [15–17].

Bleeding from the axillary artery is an extremely complex clinical situation. This is explained by the limited access to it and to the subclavian artery due to the clavicle and surrounding muscle mass that prevent their visualization. To temporarily stop bleeding from the axillary artery, it is pressed with a finger to the head or diaphysis of the humerus (depending on the level of damage), or the limb is flexed as much as possible at the shoulder joint with the arm extended and pressed to the back. There are two main accesses to the axillary artery for open hemostasis: projection (along the border between the anterior and middle thirds of the axillary fossa), and non-projection (from the middle of the clavicle along the sulcus deltoideopectoralis) with dissection of the pectoralis major and minor muscles. In case of unsuccessful attempts to visualize the axillary artery, there is the possibility of clamping the subclavian artery through supra-, sub- and transclavicular approaches (with partial resection of the clavicle).

With age, a decrease in bone density is observed, especially in women, largely associated with postmenopausal osteoporosis [18–20]. The multi-fragmentary nature of the fracture indirectly reflected the condition of the patient's bone tissue. Osteosynthesis of the humerus seemed unpromising. In the case of an unsuccessful attempt at conservative treatment to improve the quality of life of the elderly patient, the most appropriate treatment option was chosen – RSA. It is also necessary to take into account degenerative age-related changes in the vascular wall, which ultimately leads to a decrease in its elasticity and compliance [21, 22]. This increases the risk of vascular trauma without direct damaging effects during work with soft tissues.

There are two main causes of vascular damage in RSA that are not associated with direct injury during surgical manipulations. The first is constructive medialization and distalization of the humeral component of the endoprosthesis, which leads to the transformation of the force vector, increase and tension of the deltoid muscle lever arm. Lengthening of the upper limb causes traction deformation of the brachial plexus and axillary artery [4, 9, 23]. The second is a rupture of the axillary artery wall during

the release of fused cicatricial soft tissues. The main solution to this problem is autografting or replacement of the damaged vessel with a synthetic graft [6, 9, 10]. O'Neill et al. reviewed 6 case reports of axillary artery injury during shoulder arthroplasty [6]. In 4 of them, the probable cause was torsional and traction forces associated with the position of the limb during surgery [6, 7, 9, 24]. In 2 cases, the integrity of the vessel was disrupted during direct damaging impact [6, 8]. In all the described cases, the intervention of a team of vascular surgeons was required. In the case described by O'Neil et al., after prosthetic replacement of the damaged axillary artery section with a synthetic graft, teams of orthopedic and vascular surgeons decided to interrupt the shoulder replacement surgery at the stage of humeral head filing in order to exclude damage to the axillary artery during humeral retraction in glenoid treatment. Repeated reverse shoulder arthroplasty was successfully performed 6.5 months after the first attempt. In the case described by us, reverse shoulder joint arthroplasty and prosthetic replacement of the damaged axillary artery were performed simultaneously. Despite the fact that the vessel reconstruction did not lead to complete restoration of blood flow, the blood supply to the limb was preserved due to the collateral vascular network. After 15 months from the date of surgery, with significant limitation of limb function, a complete absence of pain syndrome was noted: ASES 65, DASH 62.9%, CSS 38, SST 16.7%.

CONCLUSION

Shoulder joint arthroplasty should be performed by experienced trained surgical teams. Due to possible damage to the main arteries, particularly in older patients, this type of medical care is recommended to be provided in a multidisciplinary hospital with a team of vascular surgeons. The presented clinical observation confirms the possibility of one-stage endoprosthesis of the shoulder joint and replacement of the damaged section of the axillary artery with a reinforced synthetic prosthesis.

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