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Evaluation of the effectiveness of the use of low-traumatic surgical access in the reverse shoulder arthroplasty

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ABSTRACT

BACKGROUND: The number of reversible shoulder joint endoprotheses installed in the world at the present stage is several times greater than the number of hemiarthroplasty performed. Nevertheless shoulder arthroplasty is considered a traumatic operation and can be accompanied by a number of complications, both from the side of implants and due to the traumatic nature of the surgical technique. During surgical interventions on the shoulder joint with a wide dissection of the skin and subcutaneous tissue, iatrogenic damage to structures such as the axillary nerve, posterior and anterior arteries and veins surrounding the humerus can often be detected, which triggers a whole cascade of pathophysiological and regulatory processes in which Interventions immediately release inflammatory mediators. Therefore, orthopedic traumatologists strive to reduce the risk of intra- and postoperative complications, and it is necessary to improve the surgical technique of surgical interventions towards their less traumatic performance.

AIM: Development and evaluation of the effectiveness of the use of low-traumatic surgical access when performing reverse shoulder arthroplasty.

MATERIALS AND METHODS: In the period 2017–2020, 169 patients with various diseases, injuries of the shoulder joint and their consequences were operated on in the Department of Adult Orthopedics of the N.N. Priorov National Research Medical Center of the Russian Federation, who underwent reverse shoulder arthroplasty according to generally accepted indications. In the main group (84 patients), surgical treatment was performed using a low-traumatic surgical approach, while the control group (85 patients) underwent standard procedures. Functional, clinical and radiological results of surgical treatment of patients of the main and control groups were evaluated and compared after 3, 6 and 12 months.

RESULTS: In the main group, excellent results (<25 points on DASH) were observed in 73 patients, good results (26–50 points) — in 10 patients. In 1 patient, the results were assessed as satisfactory (51–75 points). In the control group of observation, the clinical result was worse (68 excellent, 16 good and 1 satisfactory result).

CONCLUSION: On the basis of the performed study, taking into account the better results in the main group of patients, the technique of low-traumatic surgical access for reverse shoulder arthroplasty can be recommended for wide use in clinical practice.

Keywords: reverse arthroplasty; shoulder arthroplasty; surgical aggression; a minimally invasive method.

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INTRODUCTION

According to the early literature on shoulder arthroplasty, patients with rotator cuff failure, who underwent humerus head arthroplasty, had poor functional treatment results [1]. This negative experience was the main reason for the development of reverse endoprostheses for the treatment of patients with functional failure of the rotator cuff [1].

Over time, with the development of new implants and surgical techniques, the reverse philosophy of endoprosthesis replacement has become the driving force behind the development of contemporary design of shoulder joint endoprostheses [2]. At present, the number of reverse shoulder joint endoprostheses installed globally is several times higher than the number of hemiarthroplasty surgeries [2]. Statistical data from open registries of shoulder arthroplasty in Germany (2006–2019) and Great Britain (2012–2019) revealed that the prevalent use of reverse total shoulder endoprostheses over total anatomical and unipolar prostheses (Tables 1 and 2) [3, 4]. This tendency can be comparable with the historical development of hip arthroplasty [5].

Shoulder arthroplasty is considered a traumatic surgery and can be accompanied by several complications [2]. Some complications are related to the material, design, and correct placement of the orthopedic prosthetic systems. Some complications not associated with implants are caused by the traumatic nature of the surgical technique. During surgical interventions on the shoulder joint, iatrogenic damage to structures such as the axillary nerve and posterior and anterior arteries and veins that surround the humerus led to disorders in the innervation and blood supply to the shoulder joint structures, which manifest as muscle hypotrophy and poor functional outcomes [6]. The surgical approach, accompanied by a wide dissection of the skin and subcutaneous tissue, dissection and stratification of contracted and scarred muscle fibers, removal of pathological tissues, resection of the proximal humerus, implantation of prosthesis components, and manipulations near the main neurovascular bundles, launched a whole cascade of pathophysiological and

regulatory processes in which inflammatory mediators are immediately released in the intervention zone [2].

This study aimed to develop and evaluate the efficiency of using a low-traumatic surgical approach when performing reverse shoulder arthroplasty. Owing to the desire of trauma orthopedists to reduce the risk of intra- and postoperative complications, developing methods for improving the technique of surgical interventions toward their less traumatic performance are necessary [7].

MATERIALS AND METHODS

From 2017 to 2020 in the Department of Orthopedics for Adults of the Priorov National Medical Research Center of Traumatology and Orthopedics, 169 patients with various diseases, injuries of the shoulder joint, and their consequences were surgically treated, according to generally accepted indications, underwent reverse arthroplasty. The main group (84 patients) underwent surgery using a low-traumatic surgical approach, while the control group (85 patients) received surgical treatment using standard techniques. The patients were comparable by gender, age, nosology, and degree of degenerative dystrophic changes in the shoulder joint. The deviations in these groups were not significant.

Clinical, radiological, and instrumental examinations of the patients were performed before the surgery. A clinical examination, including assessment of the pain syndrome, range of joint motion, and functional state of the deltoid muscle, was performed. With severe hypotrophy of the deltoid muscle, which often results from injuries, especially preceding surgical treatment, ultrasound examination of the deltoid muscle and electroneuromyography of the upper limb nerves were performed. With total atrophy of the deltoid muscle bundles, even reverse arthroplasty is functionally unpromising. Radiography of the shoulder joint in two projections and multispiral computed tomography of the shoulder joint with visualization of the glenoid were performed to assess its dysplasia and defects (Fig.

Table 1. Types and number of installed shoulder joint endoprostheses in the period from 2006 to 2019 according to the German Shoulder Arthroplasty Registry.

Endoprosthesis type	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Total	70	69	96	157	120	137	167	177	230	228	288	203	299	250
Hemiendoprosthesis	76	58	95	134	76	44	55	52	73	72	68	45	29	37
Reverse	72	113	130	200	169	179	171	308	446	478	583	691	933	1018

Table 2. Types and number of installed shoulder joint replacements in the period from 2012 to 2019 according to the UK National Joint Registry

Endoprosthesis type	2012	2013	2014	2015	2016	2017	2018	2019
Total	627	1177	1526	1764	1891	1971	1870	1850
Hemiendoprosthesis	880	1296	1283	1055	1010	830	694	647
Reverse	678	1344	1853	2125	2742	3268	3485	3805

1). These diagnostic methods are required for planning the preferred types of endoprosthesis components and their spatial orientation during implantation.

Based on the literature, well-known surgical techniques, and authors' own practical experience, several surgical approaches are used in reverse shoulder arthroplasty, as detailed below [6].

(1). Forty-three patients of the control group underwent reverse arthroplasty through the anterior deltoid–pectoral surgical approach. A skin incision of at least 8 cm was made in the middle of the line between the coracoid process and the anterior angle of the acromion and in the caudal direction on the tendon of the biceps brachii long head. After the skin and subcutaneous tissue were dissected, dissection was performed along the fascia of the deltoid muscle medially to the deltoid–pectoral sulcus. Then, a blunt instrument was passed through the deltoid sulcus to the clavicular–thoracic fascia medially from the cephalic vein. The deltoid muscle was retracted to the side. Despite the use of modern prosthetic systems of special instruments for installing components through this access, the technical implementation of their implantation can have several difficulties. Adequate visualization of the articular surface of the scapula with this approach is complicated, and for the correct installation of the metaglene, a widened incision may be required, thereby increasing the injury rate of the surgery. However, there are risks of iatrogenic damage to the anterior artery and vein bending around the humerus. Damage to the axillary nerve and branches of the musculocutaneous nerve is also possible.

The use of this surgical approach can be justified if there was a history of hypotrophy of the anterior bundle and functionally good condition of the middle and posterior bundles of the deltoid muscle. This is substantiated by the desire to preserve the healthy muscle tissue as much as possible, since after surgical treatment, local hypotrophy of the deltoid muscle is noted in the area of surgical access in majority of the cases.

(2) Forty-two patients of the control group underwent surgery using an external transdeltoid surgical approach to the shoulder joint. During the access, a skin incision of at least 8 cm along the outer surface of the shoulder joint was started from the outer edge of the acromial process of the scapula and was made laterally to the level of the surgical neck of the humerus. After the dissection of the skin and subcutaneous tissue, the deltoid muscle fascia was dissected. The anterior and middle bundles of the deltoid muscle were bluntly separated.

This surgical approach provided good visualization of the shoulder joint structures, namely, the proximal humerus with the supraspinatus muscle and full visualization of the scapular articular surface after resection of the humeral head. Despite the advantages of this approach over the deltoid–thoracic approach, the risks of trauma with a surgical instrument to the neurovascular formations (axillary nerve and anterior and posterior veins and arteries surrounding the humerus) persist after surgery, when they are compressed or tensioned with retractors.

(3) The main follow-up group consisted of 84 patients who underwent surgery with a minimally invasive modified transdeltoid approach. With the patient sitting on the operating table, a skin incision was made up to 6 cm from the edge of the acromion and linearly along the outer surface of the shoulder distally to the level of the greater tubercle projection (Fig. 2).

The deltoid muscle was accessed using a cutting tool; the anterior and middle muscle bundles were bluntly separated. Then, the scar tissue was excised, the humerus head was mobilized, and preliminary suturing of the tendons of the rotator muscles was performed. Then, the shoulder was rotated moderately; by applying pressure along the humeral axis in the proximal direction with the forearm bent by 90°, the proximal metaepiphysis of the humerus was dislocated and removed from the wound (Fig. 3).



Fig. 1. Computed tomography was performed to measure anatomical parameters of the articular process of the scapula

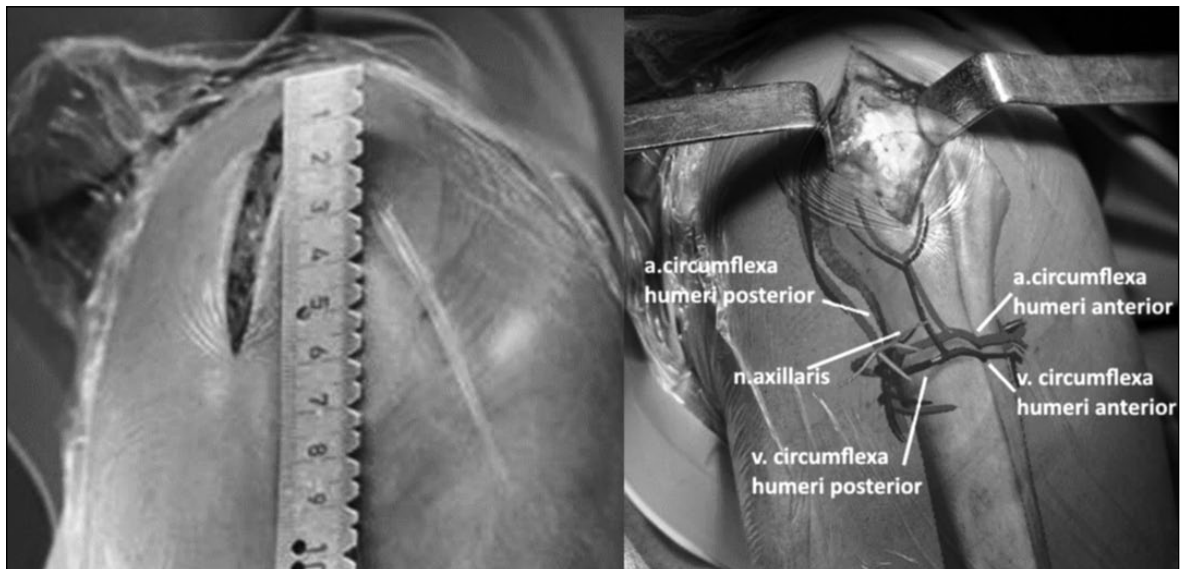


Fig. 2. Dissection of soft tissues with minimally invasive access to the shoulder joint and topography of neurovascular formations of the deltoid region in relation to the surgical access

According to the preoperative planning, the humeral head was resected, the humerus was brought down using special tools, and the wound edges were separated, thereby visualizing completely the articular surface of the scapula. Further, after sequential processing of the articular surface of the scapula with special cutters, the metaglene and glenosphere were installed, taking into consideration the inclination angle of the articular process of the scapula. The rest of the endoprosthesis components were installed according to the standard technique (Fig. 4).

If the tendons of the rotator cuff were intact, they were re-fixed, and the wound was sutured in layers. Given the economical dissection of soft tissues and the removal of the proximal shoulder into the wound, the injury rate of the surgery and risks of postoperative hypotrophy of the deltoid muscle bundles are reduced, and there are no risks of trauma to the

nerve trunks and vascular formations. Moreover, the approach enables full visualization and allows work with the articular surface of the scapula and proximal humerus.

RESULTS

Initiation of early rehabilitation in the postoperative period, which included electrical stimulation of the deltoid muscle, mechanotherapy, and physiotherapy exercises, was fundamental. In the early postoperative period, none of the patients had marginal wound necrosis, hematomas, and wounds healed by primary intention. No purulent and inflammatory complications were also registered in the study patients.

The functional, clinical, and radiological results of the surgical treatment of patients in the main and control groups

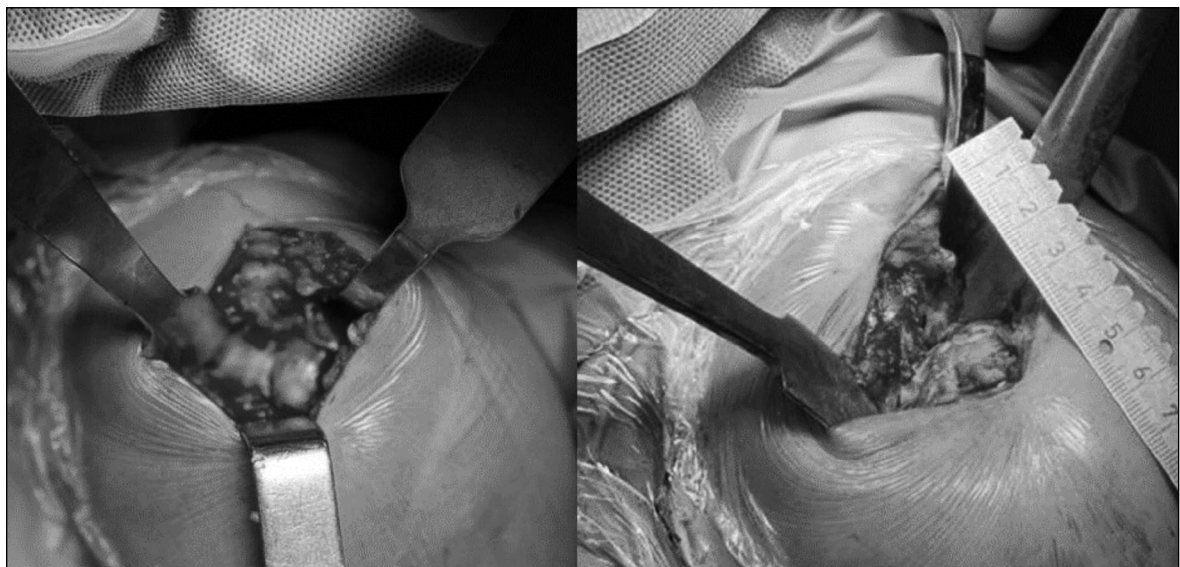


Fig. 3. Mobilization of the humerus head

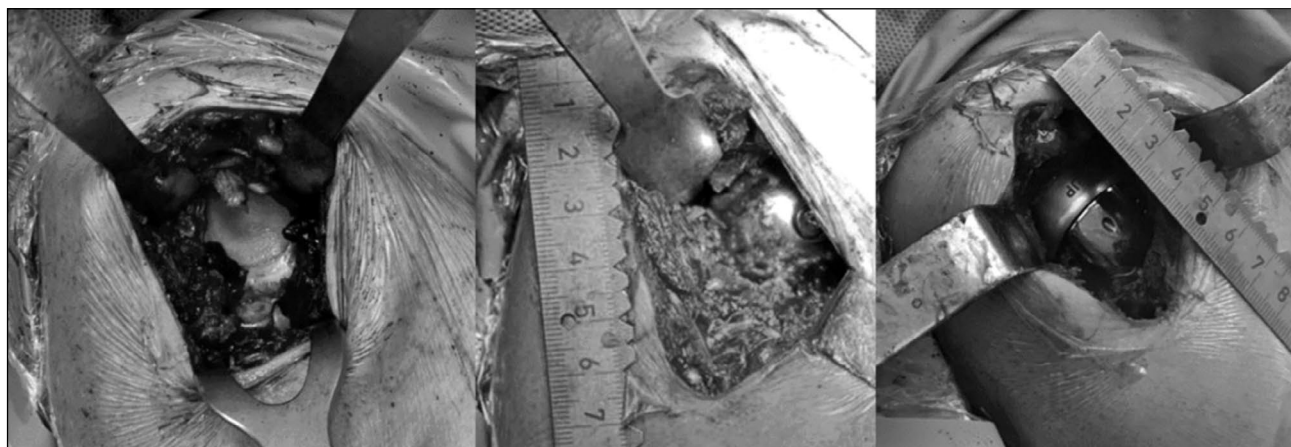


Fig. 4. Visualization of the articular surface of the scapula and installation of endoprosthesis components

were assessed after 3, 6, and 12 months. After the follow-up period, X-ray patterns revealed no dislocation, migration, or instability of the endoprosthesis components.

Functional results were assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire. In the main group, 73 patients had excellent (<25 DASH points), 10 patients had good (26–50 points), and one patient had satisfactory results (51–75 points). In the control group, the clinical result was worse, and it was excellent in 68 patients, good in 16, and satisfactory in one. Considering the absence of significant differences between patients in the groups monitored and correct installation of reverse endoprostheses according to standard techniques, the treatment outcomes were directly dependent on the surgical approach used. In the group using the minimally invasive approach, almost no hypotrophy of the muscle tissue of the deltoid region was registered; clinically and according to electroneuromyography data, the functional state of the deltoid muscle was the same compared with the healthy limb. In the control group of patients who received surgical treatment using external transdeltoid and deltopectoral surgical approaches, local hypotrophy of the deltoid muscle bundles were noted, as a result of its trauma with wide tissue separation during surgical access to the shoulder joint. With standard approaches to the shoulder joint, a comparatively large intraoperative blood loss was revealed compared with the use of a low-traumatic approach.

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CONCLUSION

Given the tendency in current surgery to reduce surgical aggression and the scientific and practical development of the subject of reverse arthroplasty, the availability of modern implants enables development and selection of low-traumatic treatment approaches. The improvement of treatment results of the shoulder joint pathology depends directly on the use of methods for correcting surgical aggression. Based on the study performed, given the best results in the main group of patients, the low-traumatic surgical approach technique for reverse shoulder arthroplasty can be recommended for widespread use in clinical practice.

ADDITIONAL INFO

Author contribution. Thereby, all authors made a substantial contribution to the conception of the work, acquisition, analysis, interpretation of data for the work, drafting and revising the work, final approval of the version to be published and agree to be accountable for all aspects of the work.

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