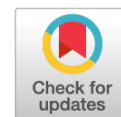


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Reverse shoulder arthroplasty in cases of glenoid defects using primary-revision metaglene

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ABSTRACT

BACKGROUND: Reverse shoulder arthroplasty is one of the surgical treatment methods of the shoulder joint injuries and diseases accompanied by pronounced changes in the anatomy of the articular structures. Considering the positive aspects of reverse shoulder arthroplasty, the indications for this operation are expanding over time. However, during this operation, errors are possible that lead to early dislocation of the endoprosthesis, compression of the metaglene to the scapula, screw instability and migration of the scapular component. Given the lack of a generally recognized clear algorithm of actions in these complex cases, the problem of reversible shoulder arthroplasty in case of defects in the articular surface of the scapula are relevant.

AIM: To develop and evaluate the effectiveness of the method of compensating for the lack of bone tissue of the scapula in the reverse shoulder arthroplasty

MATERIALS AND METHODS: In the Department of Adult Orthopaedics of the N.N. Priorov National Research Medical Center, reverse shoulder arthroplasty was performed in patients with scapular bone mass deficiency, who needed to fill in both marginal defects for the installation of metaglene with the correct angle of inclination, and the replacement of extensive defects with the necessary level of glenosphere lateralization.

RESULTS: Follow-up of patients who underwent glenoid remodeling using bone autoplasty and subsequent shoulder reverse arthroplasty within a period of 6 to 24 months. Remodeling and osseointegration of the grafts were determined, without signs of metaglene instability by the end of the 3rd month after the operation. The complex of rehabilitation measures and the time of recovery of movements in the operated joint did not differ from those of conventional reverse arthroplasty.

CONCLUSION: Given the high efficiency of the proposed algorithm, the method used to compensate for the lack of bone tissue of the scapula in shoulder reverse arthroplasty can be recommended for implementation in a wide clinical practice.

Keywords: reverse arthroplasty; shoulder arthroplasty; glenoid; bone grafting.

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INTRODUCTION

Reverse arthroplasty is one of the methods of surgical treatment of injuries and diseases of the shoulder joint, accompanied by pronounced anatomical changes in articular structures [1]. Given the positive aspects of reverse arthroplasty such as displacement of the center of rotation of the joint and improvement of the tension and tone of the deltoid muscle, the indications of this surgery expand over time [2]. In the literature, traumatologists encounter deficits in the bone mass of the articular process of the scapula in 38% of the cases of reverse shoulder arthroplasty with deforming or post-traumatic osteoarthritis (Fig. 1) [3, 4]. These subtotal or total defects of the glenoid are particularly problematic for the correct installation of the scapular components of the endoprosthesis because of the difficulties of the intraoperative differentiation of the true and false planes of the articular surface.

According to the literature, special guiding instruments have been created for such cases, which are used to install the metaglene in the correct position in relation to the scapula neck [5]. In these cases, the medialization of the glenosphere is unacceptable, and it is also undesirable to conduct the metaglene stem and fixing screws through the defect area outside the bone tissue. This mistake leads to early dislocation of the endoprosthesis. The disrupted compression of the metaglene to the scapula, screw instability, and migration of the scapular component are also possible.

Methods for leveling the deformity of the scapular articular surface using bone autoplasty from the resected shoulder head or alloplasty use augments and modify the scapular

components of the endoprosthesis [6]. Many authors indicate that spongy autografts are the most optimal osteoplastic material, since spongy bone has a high potential for synostosis and, accordingly, more pronounced osteogenic, osteoinductive, and osteoconductive properties [7, 8]. Given the lack of a generally recognized clear algorithm of actions in these complex cases, the problem of reverse shoulder arthroplasty in case of defects in the articular surface of the scapula can be considered relevant.

MATERIALS AND METHODS

In the Department of Orthopedics for Adults of the Priorov National Medical Research Center of Traumatology and Orthopedics, a reverse shoulder arthroplasty was performed in six patients with scapula bone mass deficiency, who needed replacement of both marginal ($n = 4$) and extensive bone defects ($n = 2$) to install the metaglene with correct inclination angle and to create the required level of glenosphere lateralization.

Preoperatively, clinical, radiological, and instrumental examinations of the patient were performed. Pain syndrome, joint range of motion, and functional state of the deltoid muscle were assessed. Radiographs of the shoulder joint in two projections were obtained, as well as data from multispiral computed tomography (CT) of the shoulder joint with visualization of the scapular articular process and three-dimensional modeling. This was based on CT in which the volume of the proposed reconstruction of the articular process of the scapula, which could be in several versions, was assessed.

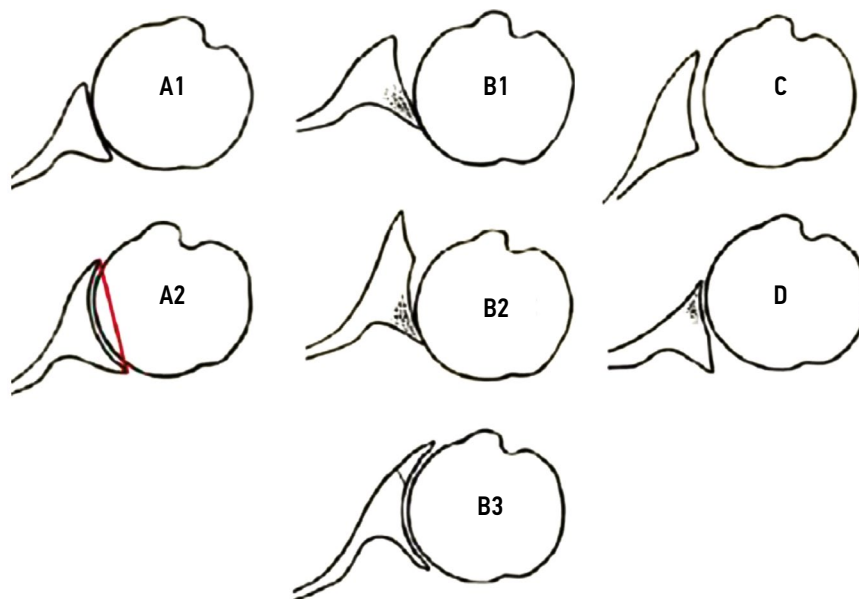


Fig. 1. Walch modified classification of glenoid defects in primary shoulder arthritis. Type A — central erosion of the glenoid (A1 — minimal erosion,; A2 — more significant bone loss); type B — posterior subluxation of the humerus head (B1 — narrowing of the articular gap, subchondral sclerosis and osteophytes; B2 — biconcave form of the glenoid as a result of erosion of the posterior edge; B3 — erosion of the posterior edge with pathological retroversion); type C — pathological retroversion of the articular surface of the scapula; type D — erosion of the anterior edge of the glenoid with subluxation of the humerus head anteriorly

In case of the marginal defects of the articular surface of the scapula without medialization of its entire surface, bone autoplasty and graft fixation were performed, followed by endoprosthesis. Plastic repair of glenoid marginal defects was performed as follows. After surgical access to the shoulder joint, skeletonization of the glenoid articular surface was performed, and scar tissues and articular cartilage were removed. In addition to preoperative planning based on CT with three-dimensional modeling, visual, manual, and instrumental assessments of the defect parameters and the amount of bone loss in the articular surface of the scapula were performed. Then, an incision was made on the skin and subcutaneous tissue in the projection of the iliac crest. The muscle fibers were bluntly separated, the ilium surface was visualized, and the bone autograft of the required size was collected using an osteotome. Hemostasis with a layer-by-layer wound closure was performed. The graft was modeled with special instruments. After reconstruction of the graft shape corresponding to the defect, the graft was implanted into the defect area. Osteosynthesis of the graft was performed with cannulated metal or bioresorbable screws. The metaglene was installed, taking into account the inclination angle of the formed articular process of the scapula and patient's biomechanical data (such as the presence of thoracic kyphosis). Compression and tight fit of the surfaces of all elements of the scapula-graft-metaglene system were achieved, without gaps and empty spaces. The metaglene was then fixed with screws; it was essential to place screws of the required length into the scapular body to ensure autograft compression, stability, reconstruction, and subsequent consolidation with the scapular bone tissue. Even in the absence of pronounced medialization of the metaglene and replacement of minor defects, it is advisable to choose revision metaglene with an elongated stem for a more stable fixation (Fig. 2). Fundamentally, the long stem of the metaglene should enter the body of the scapula.

Autoplasty with a graft of a significant size is required if there is a massive deficit of bone mass of the glenoid and medialization of the bone site for metaglene implantation. In this case, the elongated metaglene stem was brought into the scapula through the graft center. After surgical access to the shoulder joint, the scar tissue was removed, and the articular surface of the scapula was treated with a cutter. According to the preoperative planning and intraoperative presentation, the graft thickness was calculated for the required lateralization of the articular surface of the scapula. An incision was made on the skin and subcutaneous tissue in the projection of the iliac crest. The muscle fibers were bluntly separated, the surface of the ilium was visualized, and the bone autograft was collected with an osteotome. Hemostasis and wound closure were performed. The graft was designed, and autoplasty was performed using a graft of considerable size to lateralize the metaglene. Moreover, the graft was installed along



Fig. 2. Standard metaglene and revision metaglene with a long peg

the guide wire, along which the canal of the metaglene stem was drilled through the graft. The metaglene was placed through the autograft center into the scapula neck and body, considering the inclination angle of the articular process and patient's biomechanical data. Compression and tight fit of the surfaces of all elements of the scapula-graft-metaglene system were achieved in relation to each other on the elongated metaglene stem without gaps and empty spaces. The metaglene was then fixed with screws, and it was essential to pass the screws of the required length through the bone graft into the body of the scapula to ensure its compression, stability, remodeling, and subsequent consolidation with bone tissue.

Clinical case

Patient S, 75 years old, applied to the department of orthopedics for adults of the Priorov National Medical Research Center of Traumatology and Orthopedics with complaints of pain and dysfunction of the right shoulder joint. Clinically, severe limitation of the range of motion, pain syndrome, and moderate hypotrophy of the deltoid muscle were noted (Fig. 3).

The patient had a history of gunshot injury in the right shoulder joint more than 15 years ago and had repeated reconstructive surgery on the shoulder joint. X-ray imaging and CT revealed post-traumatic arthrosis of the right shoulder joint with pronounced "wear" and medialization of the glenoid and a defect in the proximal humerus (Fig. 4).

Reverse shoulder arthroplasty was performed with replacement of a significant bone defect in the glenoid using a graft from the iliac crest, according to the method described above (Figs. 5 and 6).

All stages of surgery must take place under the control of an electro-optical converter (Fig. 7). Postoperatively, an



Fig. 3. Appearance of patient S., hypertrophy of the deltoid muscle, limited range of motion in the shoulder joint.

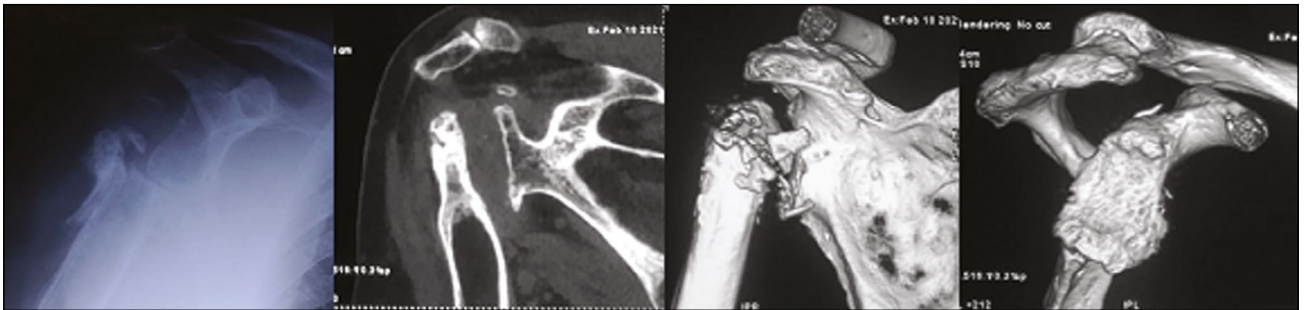


Fig. 4. Patient S., 75 years old. X-ray picture

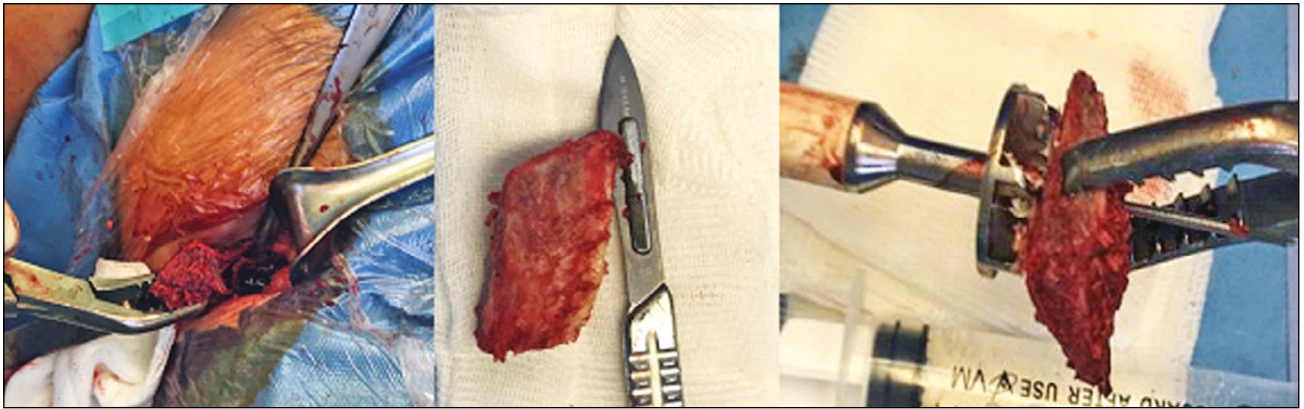


Fig. 5. Autograft sampling, modeling, and processing

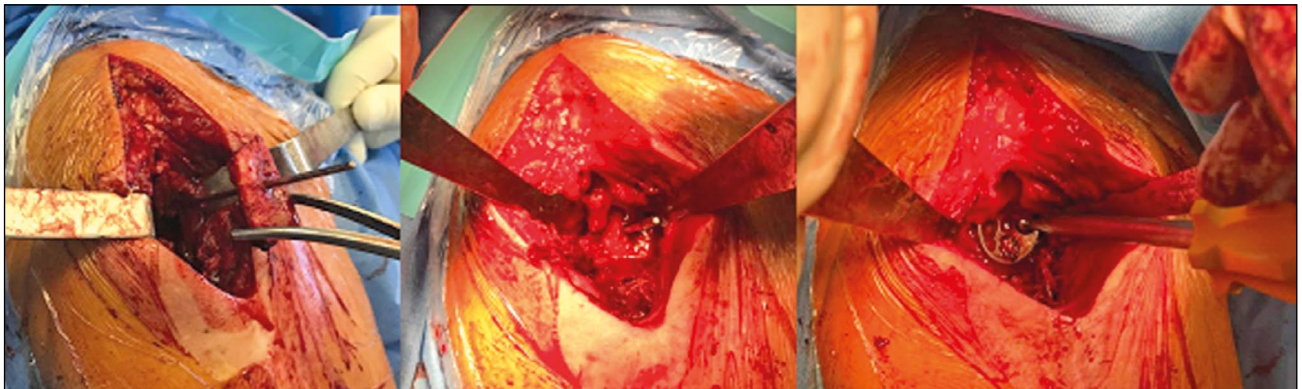


Fig. 6. Needle graft implantation, metaglene insertion

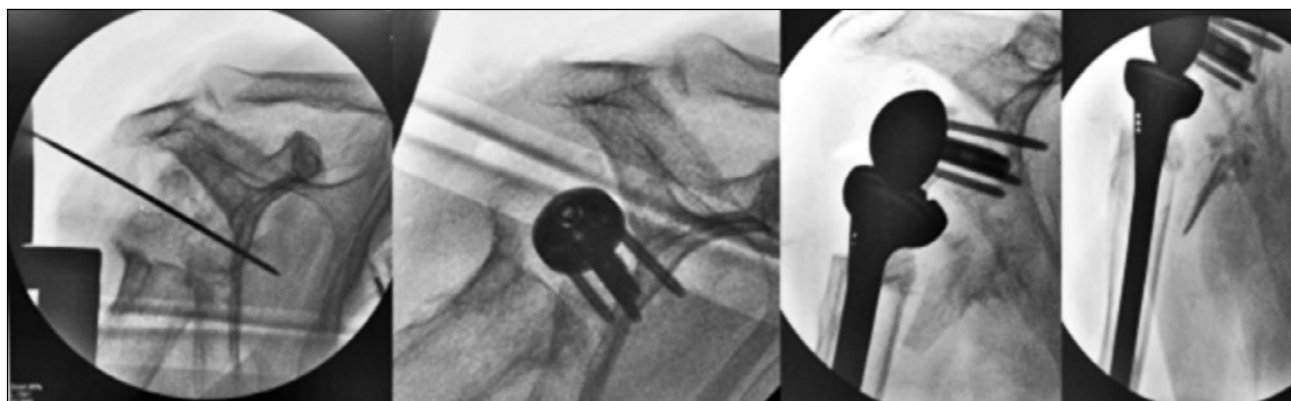


Fig. 7. Step-by-step intraoperative X-ray control

external immobilization of the operated limb with an orthosis, removable for rehabilitation measures, was performed. The patient followed a rehabilitation course, which included mechanotherapy and electrical stimulation of the deltoid muscle in the early stages after surgery.

RESULTS

Patients who underwent bone autoplasty of the glenoid and subsequent reverse arthroplasty were monitored in 6–24 months. Good clinical, radiological, and functional results were obtained. The surgical wounds healed by primary intention, and no postoperative hematomas or proinflammatory complications were recorded. The main criterion was the absence of dislocation of the endoprosthesis in all six patients during the follow-up period. According to CT data, remodeling and osseointegration of the grafts were determined, without signs of instability of the metaglene and screws fixing the graft by the end of month 3 postoperatively. The rehabilitation measures and timing of movement recovery in the operated joint did not differ from those of conventional (without bone grafting) reverse arthroplasty.

DISCUSSION

When the revision scapular component of the reverse shoulder joint endoprosthesis is installed on the medialized articular surface of the scapula, the glenosphere is medialized and the center of the joint rotation changes. This leads to complications associated with impaired centering of the graft stem in relation to the glenosphere and the absence of the necessary tension and tone of the deltoid muscle. These impairments of biomechanics during reverse arthroplasty result in dislocations of the shoulder component.

In our practice, we choose the ridge of the iliac wing as the graft collection area since the cortical–spongy graft possesses the necessary mechanical properties and is optimal in the reparative regeneration and restoration of

bone mass. Replacement of significant defects, medializing the glenoid, made it possible to perform stable fixation of the cortical–spongy graft on the metaglene stem with sufficient compression using screws. Under similar conditions, a spongy graft from a resected humerus head has a more pliable structure and does not require the necessary mechanical strength for the glenoid lateralization. Moreover, the head can often be completely absent in case of hypovascular and degenerative dystrophic changes. In some conditions and post-traumatic changes in the proximal humerus, it is also not possible to collect bone tissues from this zone.

The development of a clear algorithm of actions depending on the shape and volume of the defect is important in solving the problem of glenoid bone mass deficiency during reconstructive interventions and shoulder arthroplasty. In our experience, in most cases, the metaglene instability and dislocations of the endoprosthesis were caused by the incorrect installation of the scapular component with an improper angle of installation and offset of the glenosphere. Given the high efficiency of the proposed algorithm, the method used to compensate for the deficit of the scapula bone tissue during reverse shoulder arthroplasty can be implemented in broad 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.

Competing interests. The authors declare that they have no competing interests.

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