SHORT REPORTS AND NOTES FROM PRACTIC

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Using 3D printing for open reduction of chronic posterior shoulder dislocation (case from practice)

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Objective. An example of the treatment of a patient with chronic posterior dislocation of the shoulder, previously operated on by the Latarge technique due to recurrence of anterior instability, is given. Methods. The patient presented with an old fixed posterior dislocation of the left shoulder joint, large bone defect of the front part of the head (reverse Hill-Sachs). The patient has already undergone 2 operations on the left shoulder due to chronic anterior dislocation of the humeral head: 2018 — arthroscopy and capsuloplasty according to Bankart; 2020 — arthrotomy with Latarje transposition (due to recurrence of anterior instability). The peculiarity of this case is a bone block with screws located on the front surface of the glenoid made a massive defect front part of the humeral head. Planning performed on the basis of a CT scan of the shoulder joint in the FreeformPlus program. Assessment of functioning performed on the QuickDASH and Constant scales. The results. To improve the performance of intraoperative osteoplasty of the defect, a plastic model of the humeral head was printed for simulating bone graft and osteosynthesis. According to the QuickDASH scale before the operation, the patient had 45 points, that is, a significant decrease in the function of the upper limb — constant discomfort, pain. After surgery for 2 days — 35 points, 6 weeks — 12, and 3 months. — 12 points, that is, the patient's quality of life has improved significantly. According to the Constant scale before the operation, there were 16 points, of which: pain — 6, household activity — 2, range of motion — 8. After surgery on the 2nd day, a total of 33 points: pain — 10, household activity — 7, range of motion (passive) — 16, after 6 weeks — 80 points, this result remained after 3 months. Conclusion. The use of three-dimensional planning and an individual tool greatly facilitated the main stages of surgical intervention in the case of chronic posterior dislocation of the humeral head and made it possible to quickly and conveniently prepare a bone graft and install it in the defect. The printed navigation made it possible to perform a stabilizing osteosynthesis, ensure high patient satisfaction and a good functional result.

Мета. Наведено приклад лікування пацієнта з застарілим заднім вивихом плеча, прооперованого раніше за методикою Латарже через рецидив передньої нестабільності. Методи. Хворий звернувся з діагнозом застарілий задній фіксований вивих лівого плечового суглоба, великий кістковий дефект переднього відділу головки (зворотний Хілл-Сакс). Пацієнту вже було виконано 2 операції на лівому плечовому суглобі з приводу звичного переднього вивиху головки плеча: 2018 — артроскопія та капсулопластика за Банкартом; 2020 — артротомія транспозицій дзьобоподібного відростка за Латарже (через рецидив передньої нестабільності). Особливість цього випадку — кістковий блок із гвинтами на передній поверхні гленоїду утворив масивний дефект передньої частини головки плечової кістки. Планування проведено на основі комп'ютерної томограми плечового суглоба в програмі FreeformPlus. Оцінювання функціонування здійснено за шкалами QuickDASH та Constant. Результати. Для зручності виконання інтраопераційної кісткової пластики дефекту виконано друк пластикової моделі головки плечової кістки для моделювання кісткового трансплантата й остеосинтезу. За шкалою QuickDASH до операції в пацієнта було 45 балів, тобто значне порушення функції верхньої кінцівки — постійний дискомфорт, біль. Після операції на 2 добу — 35 балів, 6 тижнів — 12 та 3 міс. — 12 балів, тобто якість життя хворого значно покращилася. За шкалою Constant до операції було 16 балів з яких: біль — 6, побутова активність — 2, обсяг рухів — 8. Після операції на 2 добу загальна сума 33 бали: біль — 10, побутова активність — 7, обсяг рухів (пасивних) — 16, через 6 тижнів — 80 балів, цей результат зберігся й через 3 міс. Висновок. Використання тривимірного планування й індивідуального інструмента значно полегшило основні етапи оперативного втручання в разі застарілого заднього вивиху головки плечової кістки. Дозволило швидко та зручно підготовити кістковий трансплантат, встановити його в дефект, а надрукована навігація дала змогу виконати стабілізований остеосинтез, забезпечити високу задоволеність пацієнта й добрий функціональний результат. Ключові слова. Плечовий суглоб, задній вивих, імпресійний перелом Хілл-Сакс, 3D-моделювання.

Keywords. Shoulder joint, posterior dislocation, Hill-Sachs impression fracture, 3D-modeling

Introduction

The shoulder joint is most prone to dislocation, primarily due to its anatomy. One of the main causes of dislocation of the head is the disproportion of the sizes of the articular surfaces of the shoulder joint [1]. Front dislocations of the shoulder are diagnosed in 95–97 % [2], posterior dislocations in 3–5 % of cases [3, 4].

Posterior dislocations are not common, so their diagnosis and treatment are much more difficult. As a result of secondary pathological changes after the primary dislocation, relapses are usually detected [5]. Repeated dislocations increase the risks of additional damage to anatomical structures (reverse impression defect of the head of the Hill-Sachs type; progressive defect of the posterior edge of the glenoid) — this causes a decrease in the overall stability of the joint [6]. It is necessary to pay special attention to the posterior dislocations of the shoulder, because they are rare and often untimely detected. As a result, late diagnosis and treatment have serious consequences for the function of the upper limb [7, 8]. All cases of posterior dislocations of the shoulder require increased attention and appropriate diagnosis. Detection of accompanying injuries, such as fractures and tears of the rotator cuff of the shoulder, is essential for determining treatment tactics [9, 10]. In an acute case of posterior dislocation, closed reposition with immobilization in the position of neutral rotation of the shoulder gives good functional results, in case of an old one, open reposition taking into account the impression fracture of the anterior part of the humeral head. With a significant defect of the head of the shoulder, in some cases, even endoprosthesis of the shoulder joint is used [11].

Purpose: to provide a clinical example of a rare case of chronic posterior dislocation of the humeral head, previously operated on by the Latarjet technique due to recurrence of anterior instability.

Material and methods

The study was approved by the local bioethics committee (Bioethics Committee of Zaporizhzhya State Medical University, Protocol No. 7 dated 26.10.2016).

A 39-year-old patient P., first sought medical attention in the clinic in 2022 due to pain and significant limitation of movements in the left shoulder joint, difficulties in everyday life. It is known from the history that in 2006, as a result of an injury, he suffered a front dislocation of the head of the left shoulder, a closed reposition, immobilization for 3 weeks with a course of restorative treatment was performed. The relapse occurred in 2012, after which dislocations occurred 3 times a year. In 2018, arthroscopy and capsuloplasty according to Bankart were performed. The recurrence of the dislocation in 2020 occurred during an epileptic attack. The patient underwent arthrotomy of the left shoulder joint and transposition of the beak-like process according to Latarjet, after which, according to the patient, the function of the left shoulder was fully restored. However, in 2022, he developed pain in the shoulder, impaired function. Radiography revealed posterior dislocation of the head of the left humerus and postoperative changes after transposition of the beak-like process according to Latarjet. According to the patient, he was injured during an epileptic attack. A timely visit to an orthopedist was prevented by the development of acute kidney failure, so the head of the left shoulder was in the position of posterior dislocation for at least 2 months. He sufferred from epilepsy with infrequent generalized epileptic seizures and is registered with a psychiatrist and takes all prescribed medications.

In this particular case, we chose an open reduction technique for the treatment of a chronic posterior shoulder dislocation using 3D printing, rather than shoulder arthroplasty or McLaughlin surgery. This is due to several key factors: firstly, the patient's history is complicated by epileptic seizures, which significantly increases the risk of dislocation of the endoprosthesis after endoprosthetic repair. Second, preservation of the natural joint (natural biomechanics) always prevails over prosthetic repair or muscle transposition operations. The shoulder joint does not have significant axial loads, which allows the use of a wider replacement of head defects compared to the joints of the lower extremities. An individualized approach to treatment provided by a 3D model helps to adapt open repositioning to the specific characteristics of each patient. The choice of this technique is motivated not only by technical efficiency, but also by maintaining the natural functional mechanism of the shoulder joint, which is important in the long term [12, 13].

For preoperative planning, a computed tomography (CT) was performed (slice thickness 1.3 mm), a 3D model of the humerus was constructed (Fig. 1, a); a satisfactory position of the bone block of the beak-like process on the front surface of the glenoid and its fixing screws was determined (Fig. 1, b).

The peculiarity of the case was that the articular surface of the head was significantly reduced due to the Hill-Sachs defect typical for anterior instability and the reverse Hill-Sachs defect due to the old posterior dislocation (Fig. 1, c), the articular surface defect was about 70 % in cross-section. The operation according to McLaughlin, both in its classical

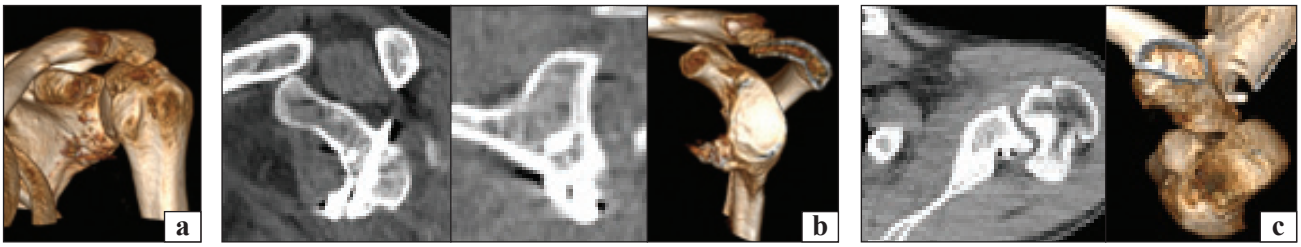

Fig. 1. Computed tomogram of the shoulder joint for preoperative planning: a) model of the shoulder joint; b) reconstruction of the articular cavity of the scapula; c) illustration of the dimensions of the anterior and posterior defects of the humeral head

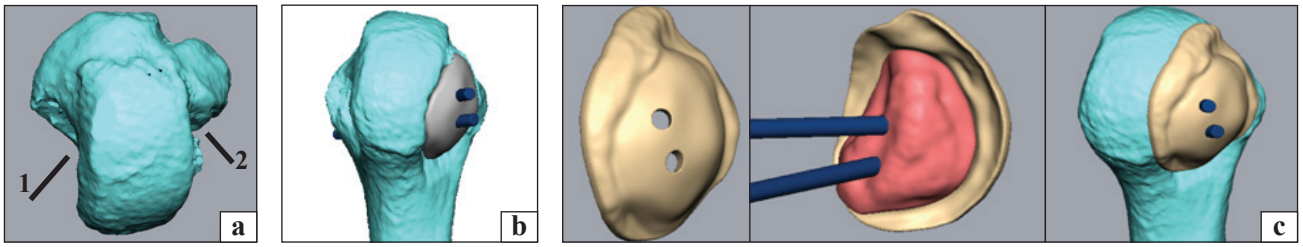

Fig. 2. Preoperative planning: a) anatomy of the humerus: 1 — reverse Hill-Sachs, 2 — classic Hill-Sachs; b) preoperative planning; c) conductor for drilling channels for screws in the augmentation and humerus

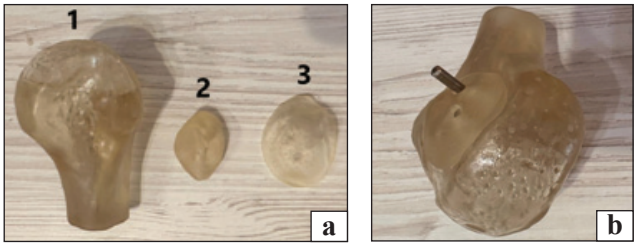

Fig. 3. Model of the head of the humerus with a conductor for drilling channels in a bone graft: a) 1 — humerus, 2 — graft, 3 — navigation, b) view of a fixed bone graft on the humerus

Fig. 4. Intraoperative comparison of the printed anatomy with the humerus

form and modified (with transposition of the small tubercle), would not be effective. During the modeling of the articular surface of the scapula, no posterior edge defect was detected (Fig. 1, c).

Preoperative planning. The 3D model was built in STL format in the RadiAnt DICOM Viewer Version 2021.2 and imported into the FreeformPlus software environment. After segmentation, a model of the head of the humerus was obtained (Fig. 2, a). On the bone defect area of the back of the head, an augmentation was virtually installed (Fig. 2, b), in which two screws (3.5 mm) were planned for osteosynthesis, drilling channels for the screws, a conductor was built, which was then printed, sterilized for use during surgery (Fig. 2, c). The obtained models of the shoulder head and augmentation, the conductor were sent for 3D printing from ViolaDent surgical resin (Fig. 3), then sterilized by the gas method.

Peculiarities of surgical technique. Under general anesthesia, an arthrotomy of the left shoulder joint was performed through a deltopectoral approach through the existing scar. The front surface of the head of the shoulder was isolated, subpectoral tenodesis of the tendon of the long head of the biceps muscle was performed. The subscapularis muscle was cut and sutured subperiosteally, its release was performed medially to the level of the base of the beak-like process, and the scars in the rotator interval and inside the shoulder joint were removed. The humeral head was repositioned by means of a partial lower capsulotomy. Revision of the subacromial space with myolysis of supraspinatus and subspinatus muscles was performed.

After cleaning the front surface of the head from scars, the shape of the reverse Hill-Sachs defect was compared with the printed model (Fig. 4).

The autobone graft from the iliac crest was gradually adapted to the shape of the defect on the model. Then it was placed in the defect area, then with the help of printed navigation (Fig. 5), which was superimposed on top of the humerus with the graft, channels were drilled for the screws in the planned

direction. Osteosynthesis was performed with cannulated screws with a diameter of 4 mm. The tendon of the subscapularis muscle was sutured transaxially to the lesser tubercle. The position of the bone graft and screws was checked by X-ray. Tubular drainage was installed, the wound was closed in layers.

Immobilization with a bandage in the position of neutral rotation and abduction of the shoulder by 10°. In the postoperative period, the patients was prescribed flenox 0.4 subcutaneously once a day, analgin 500 mg IV twice a day, dexketoprofen 100 mg IV twice a day, pregabalin 75 mg at bedtime, paracetamol 1 000 mg IV twice a day, nefopam 20 mg IV 2 injections during the first day. The postoperative period passed without complications.

Results

On the first day after the operation, a control CT scan was performed, activation and a set of exercises were started, which he performed 2–3 times a day for 5–10 min or until the onset of pain. Time course of indicators of complete blood count for 1, 2 days; 6 weeks, 3 months indicated their complete restoration by the 6th week after operations (Table).

Reconstruction of the shoulder joint according to CT is shown in Fig. 6. CT after surgery with the planned position of the bone graft during planning was analyzed (Fig. 7). Accurate positioning of the bone block was noted. Control X-ray after 1.5 months (Fig. 8).

The patient had a score of 45 on the QuickDASH scale before surgery. That is, significant impairment of limb function — constant discomfort, sometimes pain. 35 points on the 2nd day after surgery, 12 pints in 6 weeks, and 12 points in 3 months, that is, the patient's quality of life has improved significantly. According to the Constant scale before the operation,

Table

Restoration of complete blood count indicators

Indicator	Before surgery	Period after surgery	
		1 day	6 weeks
Leucocytes, ×109/l	8.2	6.2	4.2
Erythrocytes, ×106/mcl	4.61	3.41	4.44
Hemoglobin, g/l	135	123	137
ESR, mm/h	3	15	5
Thrombocytes, ×109/l	310	270	313

Fig. 5. Passing the needles through the navigation into the bone block and the humerus

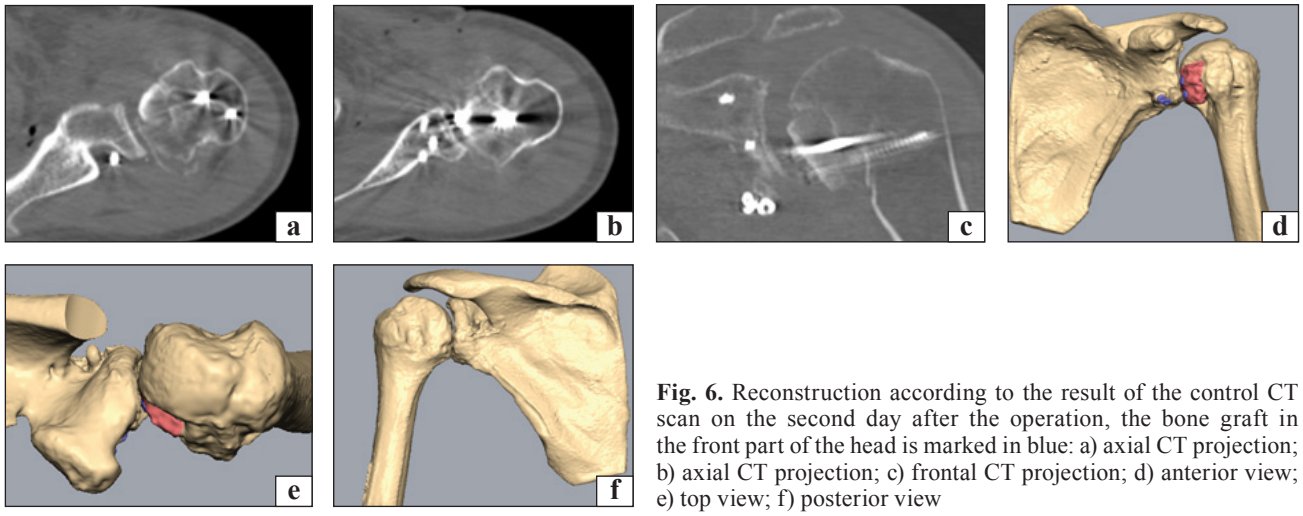

Fig. 6. Reconstruction according to the result of the control CT scan on the second day after the operation, the bone graft in the front part of the head is marked in blue: a) axial CT projection; b) axial CT projection; c) frontal CT projection; d) anterior view; e) top view; f) posterior view

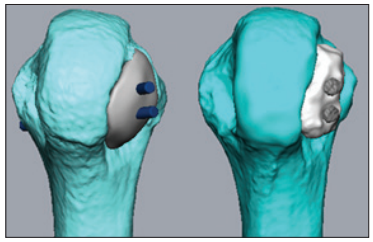

Fig. 7. Analysis of postoperative CT (right) and comparison of the result with the preoperative plan (left)

Fig. 8. Control X-ray 6 weeks after surgery

there were 16 points, of which: pain — 6, household activity — 2, range of motion — 8. After the operation on the 2nd day, the total number of points was 33: pain — 10, household activity — 7, range of motion (passive) — 16. 6 weeks after surgical intervention on the Constant scale — 80 points, as well as 3 months later.

The patient was "very satisfied" with the result 3 months after surgery.

Discussion

Preoperative planning in the 3D modeling software was used to determine the volume of the defect, assess humeral deformity and choose rational screw directions. The printed model and navigation made it possible to accurately process and prepare the bone autograft and perform the appropriate screw placement. Manually fitting it to the model of the head on the table, and not in the wound, made it possible to better adapt it. The use of planning reduced the risks of their incorrect placement and allowed a better understanding of the shape of the glenoid and the humeral head, and the printed plastic model greatly improved the accuracy of graft adaptation. Planning the direction of the screws helps guide them precisely through the dense bone tissue of the humeral head, which ensures the stability of the osteosynthesis.

The presented clinical case is a rare variant of the combination of the result of the treatment of recurrent anterior instability and chronic posterior dislocation of the humeral head. The possibilities of 3D modeling open the further perspective of manufacturing individual implants to replace massive defects of the head due to impression fractures of the Hill-Sachs type.

Conclusions

The use of individual three-dimensional planning greatly facilitated the main stages of intervention for chronic posterior dislocation of the humeral head. It made it possible to prepare a bone graft, install it in the defect, and the printed navigation made it possible to perform stabilized osteosynthesis, which ensured high patient satisfaction and a good functional result quickly and conveniently.

Conflict of interest. The authors declare no conflict of interest.

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USING 3D PRINTING FOR OPEN REDUCTION OF CHRONIC POSTERIOR SHOULDER DISLOCATION (CASE FROM PRACTICE)

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