Ethiopian Medical Journal 2023, 61(4) *ISSN 0014-1755* *eISSN 2415-2420* *Yergali et al.*

Original Article

Clinical observation of patients with fractures of the proximal humerus bone in Kazakhstan

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Abstract

Background: *Treatment of patients with fractures of the proximal humerus remains an urgent problem of modern traumatology and orthopedics. The aim of this work was to study the results of surgical treatment of patients with proximal humerus fractures in which plates with angular stability of screws were used for osteosynthesis.*

Materials and methods: *Thirty six patients aged 18 to 75 years with fractures of the proximal humerus, ,were observed after treated in the polytrauma department of the City Clinical Hospital No. 4 in Almaty, Kazakhstan during the period from August 2019 to December 2021. There were12 men (33.4%) and 24 women (66.6%). According to the C.S., Neer patients were distributed as follows: two-part patients - 17 (47.2%), three-part patients - 11 (30.6%), four-partpatients-5(13.9%), fracture-dislocations of the humerus head-3 (8.3%). Most of the patients applied before 3 days after injury (53.0%).*

Results: *Positive treatment results were achieved in most cases with two and three fragmentary fractures and in those operated early (from 3 to 7 days) after injury. Plates with angular stability of the screws provided excellent and good treatment results in 69.5%, and a satisfactory result in 16.7%. The unsatisfactory results of treatment were 13.8%, and the incidence of postoperative complications was 19.4%.*

Conclusions: *Performing stable osteosynthesis in three- to four-fragment fractures and fracture-dislocations of the humerus head is technically a difficult operation. A study of our material and literature has shown that the incidence of complications after extra-cortical osteosynthesis of the humerus is associated not only with the surgical technique of implant placement, but also with the nature of the damage, including osteoporosis, osteonecrosis, and pathology of bone tissue regeneration.*

Keywords*: fractures of the humerus, proximal humerus, internal osteosynthesis, lockable plates.*
Citation : *Yergali N, Kanat T, Saruarbek A . Clinical observation of patients with fractures of the proximal humer us bone in kazakhstan .Ethiop Med J 61 (4) 335 –342*
Submission date : *28 May 2022* ***Accepted:*** *09 September 2023* ***Published:*** *24 September 2023*

Introduction

Treatment of patients with fractures of the proximal humerus remains an urgent problem of modern traumatology and orthopedics [1,2]. According to the literature, such fractures account for 4-6% of the structure of all skeletal bone fractures [3,4,1], and according to some data, up to 12% [5,6], and among humerus fractures, 45 to 80% of cases [7,8].

The method of choice in the treatment of displaced fractures is repositioning and osteosynthesis [9,10]. Many constructions are used for fixation of such fractures: T-or L-shaped plates, plates with angular screw stability, interlocking intramedullary nails, external fixation devices, Kirschner spokes, titanium nickelise fixators with memory, suture materials, bone grafts and endoprostheses of shoulder joint [11,12,13,14,15,16,17].

Currently, LSP and LPHP - angularly stable screw plates [18,19,20].

G.J. Haidukewych (2004) [18] believes, that when screws are blocked in the plate, the angle between the screw and the plate will be rigidly fixed. Thus, plates with angular stability of screws have a mechanical advantage in the case of fractures with a

comminuted metaphysis, especially in cases where there is insufficient contact between the fractures [19,20].

Despite the aforementioned advantages of the plate with the angular stability of the screws, the percentage of postoperative complications doesn`t decrease. According to different authors, the complication rate after shoulder osteosynthesis with an angular screw stability plate ranges from 3.7 to 33.5% [21,22,23,24]. Thus, during the treatment of fractures, impingement syndrome, aseptic necrosis of the humeral head, adhesive capsulitis, metal structure migration, vascular and nerve damage, infection, nonunion of the fracture and pseudarthrosis may develop, which may subsequently require repeated operations [25,26,27,12,15,19].

According to researchers, the development of such complications can be not only the result of a violation of surgical technique of implant placement, and selection of metal structures, but also the nature of the damage, including osteonecrosis, osteoporosis, pathology of bone tissue regeneration [27,25,12].
To reduce complications, a number of researchers used bone cement in patients with severe osteoporosis [28,29,30,31].

Some authors, when fixing a fracture with a plate, simultaneously used a fibular graft (6-8 cm long), which was placed intramedullary and proximal to the neck of the shoulder, thereby providing support along the inner surface of the humerus, taking into account the weakness of the bone plate on the medial side [32,33].

Thus, the improvement of both the means of osteosynthesis and the methods of restorative treatment for near- and intra-articular fractures of the humerus is an urgent problem of modern traumatology, and therefore often attracts the attention of researchers.
The purpose of this work was to study the results of surgical treatment of patients with proximal humerus fractures in which plates with angular stability of screws were used for osteosynthesis.

Materials and methods

We observed 36 patients aged from 18 to 75 years with fractures of the proximal humerus who were treated at the polytrauma department of State Clinical Hospital No. 4 in Almaty, Kazakhstan during the pandemic "Covid - 19" period from August 2019 to December 2021.

There were 12 (33.4%) male patients and 24 (66.6%) female patients. The ratio of women to men was 1:1.7. This trend is explained by hormonal changes in the female body, beginning in the post-menopausal period. Among the victims under the age of 44, males predominated (27.9%) due to the number of injuries sustained as a result of road accidents, and men are known to be more susceptible to this type of injury.

The study included patients aged 18 to 75 years with closed fractures of the proximal humerus, which required surgical treatment, and the minimum follow-up period was 1 year.

The study did not include patients under the age of 18 and over 75 years, patients who received conservative treatment, endoprosthetics, as well as patients with pathological shoulder fractures and without displacement of bone fragments.

All patients underwent osteosynthesis of the humerus using a plate with angular stability of screws and standard anterior deltoid-thoracic (pectoral) access was used.

Surgical technique

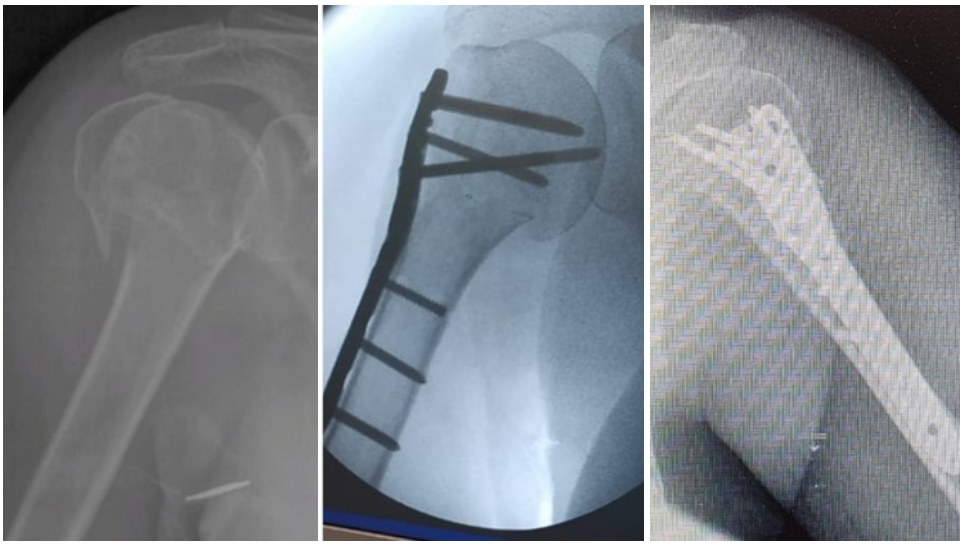
The patient was lying on his back or with the head end raised by 30°. Standard deltoid-thoracic access was performed. The deltoid muscle was diverted laterally, the pectoralis major muscle — medially.

The tendon of the long head of the biceps muscle of the shoulder is identified. It is located in the intertubercular furrow. The fracture was repositioned and temporarily fixed with spokes, the reposition was controlled by an electron-optical converter (EOC). The plate was located approximately 8 mm distal from the tip of the large tubercle.

The more proximally the plate is located, the higher the risk of developing subacromial impingement syndrome. In order to block the screws in the plate, the direction of insertion of the screws must exactly correspond to the direction of the thread in the hole.

For stable fixation, the proximal part of the plate must be fixed with at least 4-6 lockable screws, especially with poor bone quality; at least 3 bicortical lockable or 4 bicortical standard screws must be inserted into the distal fragment.

Clinical case



A B C

Picture 1. a – X-ray picture of the patient on admission; b – direct X-ray picture of the shoulder after osteosynthesis with a locking plate; c – axial X-ray picture after osteosynthesis.

X-ray picture of patient K., 37 years old with a diagnosis of "Close oblique fracture of the surgical neck of the right humerus with displacement (fracture B3.1 according to the AO/ASIF classification, two-fragment fractures according to Nir)"
In the postoperative period, immobilization was 2-3 weeks. After the immobilization was removed, the patients were prescribed physiotherapy procedures, physical therapy, and massage of the shoulder girdle muscles.

Complications were observed in 7 (19.4%) patients during treatment. The frequency of patients with fractures of the proximal humerus, who had complications during treatment is shown in Table 2. It should be noted that out of 7 (19.4%) patients, 2 (5.5%) had a satisfactory result, 5 (13.9%) had an unsatisfactory result.

Table 1 - Frequency of patients with fractures of the proximal humerus, who had complications during treat ment.

Types of complications	**Numberofpatients**	
	Absolutenumber	%
Impingement syndrome with shoulder joint contracture	3	8,4
Varus deformity of the humerus with Contracture of the shoulder joint	2	5,5
Avascular necrosis with shoulder joint contracture and migration of screws into the joint	2	5,5
Total	7	19,4

According to Table 1, impingement syndrome was observed in 3 (8.4%) patients with type B3, C2 fractures (three- and four-fragment fractures), and the complication was combined with varus collapse of the head and persistent contracture of the shoulder joint in all cases.

In 2 (5.5%) patients with a type C2 fracture (four-fragment fracture and fracture dislocation) on the background of an improperly fused fracture due to varus deformation, a contracture of the shoulder joint of the 2 nd degree was formed.

Avascular necrosis of the head of the humerus developed in 2 (5.5%) patients (four-fragment fractures and fracture-dislocation), caused by a malpositioned fracture with varus deformation of the shoulder head and with adductor contracture of the shoulder joint. The analysis of complications developed during treatment is presented in Table 2. Out of 7 (19.4%) patients, only 12 (33.3%) complications were observed.

Table 2 – Types of complications in patients, taking in to account the type of fracture.

Typesofcomplications	**Numberofcases**	
	absolute number	%
Impingement syndrome with shoulder joint contracture	3	8,4
Varus deformity of the humerus with contracture of the shoulder joint	6	16,7
Avascular necrosis with shoulder joint contracture and migration of screws into the joint	2	5,5
Migration of screws to the joint	1	2,7
Total	12	33,3

The average age of the operated patients was 48.0±2.4 years. Fractures of the right humerus were registered in 21 (58.3%), and 15 (41.7%) of the left humerus.

Among the patients, pensioners prevailed - 26.0%, workers – 23.0% in second place, and temporarily unemployed - 22.6% in third place. The cause of fractures was a domestic injury (37.5%) and road accidents (27.9%). The vast majority of pensioners was injured at home and rarely - as a result of road accidents and does not get injured at all at work.

According to C.S. Neer's classification, the patients were distributed as follows: two-fragmentary - 17 (47.2%), three-fragmentary - 11 (30.6%), four-fragmentary – 5 (13.9%), fractures-dislocations of the humerus head – 3 (8.3%). Most patients applied up to 3 days after the injury (53.0%).

According to the Swiss AO/ASIF classification [34], type A fractures were the most common, which occurred in 20 (55.5%) patients, including A 3 types. The second place was occupied by fractures of type B in 11 cases (30.5%), including fractures of type B1 and B2 were observed with the same frequency. Type C fractures were observed only in 5 (14.0%) patients.

According to the timing of patients seeking specialized care, it is known that the absolute majority of patients applied to 3 days after injury (53.0%). Out of 36 patients, 15 (41.6%) had concomitant diseases – mainly elderly and senile people. The remaining part of the patients - young and middle-aged persons turned out to be somatically healthy.

Basically, X-ray was more usable, we used CT in 45% of cases, because the CT machine is the only one in the clinic, and was constantly loaded during the pandemic period.

All patients underwent a clinical assessment of the general condition, and the state of the local status to diagnose the damage, and determine indications and contraindications for surgical treatment. It was mandatory to examine the distal parts of the upper limb, because the literature describes damage to the neurovascular bundle in patients with fractures of the proximal humerus, especially in elderly and senile people, against the background of atherosclerotic vascular lesions.

To confirm the diagnosis, when the patient with fractures of the proximal humerus was admitted to the hospital, X-rays of the shoulder joint were performed with indirect and axial projections. Performing an axial radiograph of the shoulder joint with such fractures is impossible due to the pro-

nounced pain syndrome and sharp restriction of movements in the shoulder joint. In this case, radiography of the proximal shoulder was performed in a transthoracic projection. X-ray method of investigation was also used after osteosynthesis to assess the reparative regeneration of bone tissue in dynamic observations.

The analysis of the clinical material considered gender, age, type of injury, the nature of the fracture, the method of surgical intervention, the timing from the moment of injury, the volume of intervention, complications, the timing of in-patient and outpatient treatment, the timing of the restoration of the ability to support and function of the damaged limb.

The protocol of the study was approved by the Local Ethics Commission of the Kazakh National Medical University named after S.D. Asfendiyarov, registration No. 1047 dated 02/24/2020, developed in accordance with the ethical principles of the Helsinki Declaration. Informed consent was obtained from all participants of the study.

Results

The results of surgical treatment were evaluated according to the scheme of E.R. Mattis [35], this scheme is universal and can be used to study the outcomes of treatment of the proximal humerus. The system includes16 indicators evaluated on a5-point scale, the last indicator (restoration of limb function) is evaluated on a 25-pointscale. A comparative analysis of the outcome of treatment of patients of both clinical groups is presented in Table 3.

Table 3 –Results of surgical treatment of patients with fractures of the proximal humerus.

Treatmentoutcomes	Numberof patients
Excellent	
Number of patients	14
Frequency in %	38,9
Good	
Number of patients	11
Frequency in%	30,6
Satisfactory:	
Number of patients	6
Frequency in%	16,7
Unsatisfactory:	
Number of patients	5
Frequency in%	13,8
Total	36 (100,0%)

The frequency of excellent treatment results was 38.9%, while that of good was - 30.6% of cases. Such high results were achieved due to the properties of locking plates with angular stability of screws, providing stable synthesis and early rehabilitation of patients. The frequency of satisfactory treatment results in 6 patients was 16.7%, which was statistically significant.

Cases complicated by shoulder joint contracture also led to an increase in the number of patients with satisfactory results. It should be noted that in one patient (2.7%) with a type B3 fracture, grade 2 adductor contracture of the shoulder joint developed as a result of impingement syndrome due to the high position of the plate, in another patient (2.7%) - due to varus displacement of the head of the humerus. Unsatisfactory treatment was recognized in 5 (13.8%) patients. Moreover, in 2 (5.5%) patients with fractures of type B3, C2, impingement syndrome was observed, combined with varus collapse of the head and persistent contracture of the shoulder joint. 2 (5.5%) patients developed avascular necrosis of the head of the humerus, an improperly fused fracture with adduction contracture of the shoulder joint with the migration of screws into the joint. In 1 (2.7%) patient with a type C2 fracture, on the background of an improperly fused fracture due to varus deformation, a contracture of the shoulder joint of the 2nd degree was formed. Thus, the treatment of patients with the proximal humeral bone using locking plates with angular stability of screws provided excellent and good treatment results in 69.5%, and satisfactory results in 16.7%. Unsatisfactory treatment results were 13.8%.

Discussion

According to various authors, the frequency of complications after osteosynthesis of fractures of the proximal humerus having a plate with angular stability of screws ranges from 13.7 to 33.5% [21,22,23,24,25,12]. The authors refer to the following complications: impingement syndrome, screw migration, avascular necrosis, varus displacement, neurological lesions, plate fractures, inadequate fixation, and infection [22,23,24,25]. According to Fankhauser F., *et al*., and [12] Duralde X., *et al*., [25] such complications may not only be the result of a violation of surgical technique of implant placement and improper selection of metal structures but also the nature of damage, including osteonecrosis, osteoporosis, pathology of bone regeneration.

Impingement syndrome

Among our patients, impingement syndrome was observed in 3 (8.4%) cases, and in 2(5.5%) cases due to the high location of the plates (while the distance to the tip of the large tubercle was less than 3 mm) and in 1 (2.6%) case due to varus collapse of the head.

Varus deformity of the humerus

In our observation, varus deformity of the proximal humerus was observed in 6 (16.7%) cases. Moreoer,

the cause of such a complication was irregularly grown fractures of type C2 (four-fragment fracture and fracture-dislocation) in 4 (11.0%) cases. Incomplete reposition of B3, C2 fractures (three- and four-fragment fractures) with impingement syndrome, avascular necrosis in 2 (5.5%).

In 2 (5.5%) clinical observations, avvascular necrosis of the head of the humerus with the fragmentation of bone structures, and varus deformation, with the migration of screws into the joint in one case was revealed in patients with a four-fragment fracture and fracture-dislocation older than 65 years in the long-term period of injury.

Penetration of screws into the shoulder joint

According to researchers, the penetration of screws into the shoulder joint is observed from 14 to 16%, as a result of damage to the subchondar plate, and the migration of screws [34,35,49]. According to Sproul *et al*., [37] the frequency of this complication is 7.5%, and other authors - up to 23% [49]. In our studies, such a complication was observed in one 1 (2.7%) case in a patient with a shoulder fracture-dislocation. This complication still affected the long-term result of treatment. Despite the fusion of the fracture, the patient developed avascular necrosis of the caput of the humerus in the long-term period after osteosynthesis. As a rule, such errors are eliminated by surgery intraoperatively. Primary and secondary penetration into the shoulder joint is known. Primary penetration is observed with intraoperative insertion of screws. Secondary penetration is considered when the screw is lobbed due to the varus displacement of the shoulder head, migration of the metal structure [38]. According to the researchers, secondary screw ingestion was more often observed in the elderly as a result of osteoporosis [39]. According to Thanasas *et al*., [40] incorrect selection of the size of the fixing screw is the most common intraoperative error. The proportion of such a complication ranges from 2 to 17.9% [20]. To prevent such a complication, some researchers recommended installing screws at a distance of 2-3 mm from the subchondral plate [41,3,37], others at a distance of 5- 10 millimeters from the joint surface [25]. According to Spross *et al*., [25], when installing screws at a distance of 4-5 mm from the subchondral bone, complications associated with intra-articular penetration of screws significantly decreased. A decrease in this complication was observed with the use of bone cement [42]. According to Voigt et al., [43] the polyaxial arrangement of interlocked screws with blunted ends may be useful if their twisting occurs.

Conclusions

The treatment of our patients with fractures of the proximal humerus using locking plates with angular stability of screws provided excellent and good treatment results in 69.5% with full restoration of the volume of movements of the shoulder joint, in 16.7% - a satisfactory result. Unsatisfactory treatment results were 13.8%, the frequency of postoperative complications was 19.4%. Performing stable osteosynthesis of fractures of three-four-segment fractures and fractures-dislocations of the shoulder with the help of locking plates with angular stability of screws is a technically complex operation. The study of our material and our brief review of the literature showed that the frequency of complications after osteosynthesis of the shoulder with a blocked plate is associated not only with the complexity of the surgical technique of implant placement but also with the nature of the damage, including osteoporosis, osteonecrosis, pathology of bone regeneration.

Conflict of interest

The authors declared no sources of financial support or conflict of interest.

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