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EVALUATION OF SURGICAL TREATMENT RESULTS OF DISTAL HUMERAL FRACTURES

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Summary

In spite of the fact that distal humeral fractures constitute only 2% of all fractures, they are often the cause of significant elbow joint mobility restrictions, which may disturb proper functioning of the upper limb to a considerable extent. The aim of the study was to evaluate the results of distal humeral fractures treatment with particular focus on type-C fractures according to the AO/ASIF classification.

The material of the study was composed of 60 patients between 25 and 82 years of age, treated in the Clinical Department of Orthopaedics and Traumatology of the University Hospital No. 1 in Bydgoszcz in the years 2009-2011. The patients were subject to operative treatment with the use of four techniques (ORIF – LCP-type plate, ORIF – AO-type plate, ORIF – AO screw(s), CRIF – K-wires). The average patient observation period was 18.7 months (±5.9). Patients under the study were subject to observation and functioning of the elbow joint was evaluated after surgery according to the MEPI score.

Patients suffering from type-B fractures recorded better treatment results than those suffering from type-C fractures: $p = 0.046$. The differences between type A and types B and C have been statistically insignificant: $p > 0.05$. No impact of any type of fixation on the results of treatment has been recorded. In type-C group of fractures according to AO/ASIF, statistical analysis has shown advantage to the benefit of fixation with dedicated anatomical LCP plates and AO plates ($p = 0.046$). In this group, operative treatment using the aforesaid methods achieved good and excellent results (MEPI $\geq$ 75 points) in 81% of cases.

Good treatment results depend on proper patient qualification for a particular surgical procedure and may be achieved also for type-C intra-articular fractures, provided that anatomical reduction of articular surface and stable plate osteosynthesis are obtained. In other types of distal humeral fractures (types A and B) similar treatment results may be obtained using different operative treatment techniques.

Streszczenie

Pomimo że złamania nasady dalszej kości ramiennej stanowią jedynie 2% wszystkich złamań, to są one często powodem znacznego ograniczenia ruchomości stawu łokciowego, które może zakłócać prawidłowe funkcjonowanie górnej kończyny do znacznym stopniu.

Celem pracy była ocena wyników leczenia złamań nasady dalszej kości ramiennej, ze szczególnym uwzględnieniem złamań typu C według klasyfikacji AO/ASIF.

Materiał badania stanowiło 60 chorych pomiędzy 25 a 82 rokiem życia, leczonych w Klinice Ortopedii i Traumatologii Narządu Ruchu szpitala Uniwersyteckiego Nr 1 w Bydgoszczy w latach 2009-2011. Chorzy byli leczeni operacyjnie z użyciem jednego z czterech sposobów (ORIF – płyta LCP, ORIF – płyta AO, ORIF – śruby, CRIF – druty K). Średni okres obserwacji chorych wyniósł 18,7 miesięcy (±5.9). Funkcja stawu łokciowego leczonych chirurgicznie chorych została poddana badaniu kontrolnemu przy użyciu skali MEPI.

Pacjenci leczeni z powodu złamania typu B wykazywali lepsze wyniki leczenia niż chorzy ze złamaniem typ C: p =

0.046. Różnica pomiędzy typem A a typem B i C nie wykazywała istotności statystycznej: p > 0,05. Nie stwierdzono wpływu typu zespolenia na wynik leczenia. W grupie złamań typu C analiza statystyczna wykazała przewagę zespolenia z użyciem dedykowanych anatomicznych płyt LCP i płyt AO (p = 0.046). W tej grupie leczenie operacyjne z użyciem powyższych metod osiągnęło bardzo dobre i dobre wyniki (MEPI ≥ 75 punktów) u 81 chorych.

Dobre wyniki leczenia złamań nasady dalszej kości ramiennej zależą od właściwej kwalifikacji chorego do odpowiedniej procedury i można je również osiągać w złamaniu śródstawowym typu C poprzez anatomiczne nastawienie złamania powierzchni stawowej i stabilne zespolenie z użyciem płytki LCP. W innych typach tego złamania (typie A i B) podobne wyniki leczenia można uzyskać różnymi sposobami leczenia operacyjnego.

Key words: humerus, fracture, surgery, osteosynthesis
Słowa kluczowe: kość ramienna, złamanie, chirurgia, osteosynthesis

INTRODUCTION

Distal humeral fractures constitute a diverse group of injuries, including both extracapsular juxta-articular fractures and intra-articular fractures of various complexity. The frequency of distal humeral fractures has been estimated at 5.7 cases per 100,000 persons per annum [1] after publication of the study conducted in 2003, analyzing 320 subsequent patients between 1988 and 1997 in Great Britain [2]. These fractures constitute circa 2% of all fractures [3] and according to Angelen they represent 30% of fractures within the elbow joint area, which in turn constitute circa 7% of all fractures. It has been observed that distal humeral fractures reach their peak in two groups of patients: young males between 12 and 19 years of age, who sustained high-energy trauma [1] and patients 60 years of age or older, suffering from osteoporosis, mainly women [1, 5], with low-energy trauma [1], usually a fall [1-2], history. Probably, the number of distal humeral fractures increases with the ageing of population [6]. Between 1970 and 1998, Finland recorded a five-time increase in the number of distal humeral fractures in the population of women older than 60 years of age [7]. However, in the following years, the number of fractures became stable and such a dynamic growth in this type of injuries with regard to the Finnish population was no longer observed.

In spite of the fact that distal humeral fractures constitute only 2% of all fractures, they are often the cause of significant elbow joint mobility restrictions, which may disturb proper functioning of the upper limb to a considerable extent. It is connected with the disruption of elbow joint complex anatomical structure and common occurrence of contractions as a result of trauma in this area. Difficulties in treating these fractures also result from their very nature. These are often multifragmentary fractures [3] with numerous bone fragments translated far from the place of their anatomical occurrence, often observed in osteoporotic bone in elderly patients [3]. The complex bone and vascular and neural anatomy of the elbow joint area results in limited number of places where fixing hardware may be entered safely and in a stable manner. Therefore, treating most of these complex fractures is a challenge for surgical treatment with a hard-to-predict final outcome.

The aim of this study was to evaluate the results of distal humeral fractures treatment, depending on the type of fracture and applied method of treatment. Additionally, the correlation between treatment results and internal fixators applied for multifragmentary intra-articular distal humeral fractures (type C) was examined.

MATERIAL AND METHODS

The subject of the study was a group of 61 patients who were treated surgically in the Clinical Department of Orthopaedic Surgery and Traumatology of the University Hospital No. 1 in Bydgoszcz in the years 2009-2011 due to distal humeral fractures. The group was composed of 38 women and 23 men between 25 and 82 years of age. The average patient's age was 47.9 (±18.1). Distal humeral fractures were categorized according to the AO/ASIF classification based on X-ray examination performed prior to surgery in conjunction with intraoperative view and CT scan, if performed. There were 4 cases of elbow joint injury resulting from multifocal injury. In one case, open distal humeral fracture was accompanied by brachial artery damage. The patient was excluded from the studied group due to post-operative complications, i.e. pseudarthrosis and need of subsequent surgical interventions. The patients were operated on as urgent within 48 hours from the injury. Operative approach depended on the nature of fracture (type A, B or C) and type of fixator. In the most complex type-C fractures,

operative approach with olecranon osteotomy, fixed with Weber's tension band, was used for open reduction and internal fixation. The following were used in internal fracture fixation: anatomical plates dedicated for distal humerus perpendicular plating and fixed-angle screws (locked in the plate), AO plates and cortical screws, internal fixation with cortical screws according to AO, percutaneous stabilization with K-wires. Table 1 presents patients included in the study depending on the method of surgical treatment and type of fracture.

Table I. *Distribution of used method of surgical treatment depending on the type of fracture*
Tabela I. *Rozkład użytych sposobów leczenia operacyjnego w zależności od typu złamania*

	Type A	Type B	Type C
Dedicated LCP[1] plate	1 (10%)	0 (0%)	18 (56.3%)
AO[2] plate	4 (40%)	1 (5.6%)	8 (25%)
Screws[3]	0 (0%)	14 (77.8%)	2 (6.3%)
K-wires[4]	5 (50%)	3 (16.7%)	4 (12.5%)

1 ORIF with a dedicated plate using fixed-angle screws.
2 ORIF with AO plate.
3 ORIF using screws according to AO.
4 CRIF using K-wires.

There were no instances of ulnar nerve transposition. No intraoperative complications such as damage to vascular and neural structures were recorded. No short-term or long-term postoperative complications such as nonunion, heterotopic ossification or ulnar nerve neuropathy were observed. No infections such as surgical wound infection or surgical area infection were noted. The average hospitalization period was 7 days. During their stay in the Clinic, the patients were rehabilitated in accordance with the same binding protocol, including passive and active movement exercises of the elbow joint following stable osteosynthesis. The average patient observation period was 18.7 months (± 5.9). Patients under the study were subject to observation and functioning of the elbow joint was evaluated after surgery according to the MEPI score (*Mayo Elbow Performance Index*) [8]. The study data were subject to statistical analysis using the Kruskal-Wallis test.

RESULTS

The treatment results by type of fracture and by type of fixation are presented in Table II and Table III.

Table II. *Distribution of treatment results according to type of fracture in MEPI scale*
Tabela II. *Rozkład wyników leczenia w zależności od typu złamania w skali MEPI*

		Type A (n=10)	Type B (n=18)	Type C (n=32)
Treatment result	poor (MEPI < 60pts)	1 (10%)	0 (0%)	4 (12.5%)
	fair (MEPI 60-74pts)	2 (20%)	1 (5.6%)	6 (18.8%)
	good (MEPI75-89pts)	1 (10%)	5 (27.8%)	12 (37.5%)
	excellent (MEPI ≥90pts)	6 (60%)	12 (66.7%)	10 (31.3%)

Table III. *Distribution of treatment results according to type of fixation in MEPI scale*
Tabela III. *Rozkład wyników leczenia w zależności od typu zespolenia w skali MEPI*

		LCP plate (n=19)	AO plate (n=13)	screws (n=16)	K-wires (n=12)
Treatment result	poor (MEPI < 60pts)	2 (10.5%)	0 (0%)	1 (6.3%)	2 (16.7%)
	fair (MEPI 60-74pts)	3 (15.8%)	1 (7.7%)	2 (12.5%)	3 (25%)
	good (MEPI 75-89pts)	5 (26.3%)	6 (46.2%)	3 (18.8%)	4 (33.3%)
	excellent (MEPI ≥ 90 pts)	9 (47.4%)	6 (46.2%)	10 (62.5%)	3 (25%)

The statistical analysis has shown statistically significant differences in treatment results $chi^2(2) = 6.98$; $p = 0.030$. Multiple comparisons have demonstrated that the patients suffering from type-B fractures recorded better treatment results than those suffering from type-C fractures: $p = 0.046$. The differences between type A and types B and C have been statistically insignificant: $p > 0.05$. As far as statistical evaluation of treatment results by type of fixation is concerned, the analysis has shown no statistically significant differences: $chi^2(3) = 4.44$; $p = 0.217$. No advantage to the benefit of any type of fixation, including stable osteosynthesis with dedicated plates and fixed-angle screws, has been recorded.

Another analysis concerned the results of type-C distal humeral fractures treatment. In this group, surgical treatment using internal fixation with LCP plates as well as AO plates was applied in 26 patients (~81% of the group), obtaining 21 (~66%) good and excellent results (MEPI ≥ 75 points). The results of treatment using other methods in this group were poor and fair (MEPI < 75 points), except for one patient who obtained a good result. Treatment results for stable osteosynthesis with dedicated plates using fixed-angle screws and AO plate were statistically evaluated. The analysis has shown statistically significant

differences: $chi^2(3) = 8.02$; $p = 0.046$, indicating better results of treatment with these methods in type-C group of fractures. However, multiple comparisons have shown no statistically significant differences between particular types of fixation, including no advantage to the benefit of stable osteosynthesis with a dedicated plate using fixed-angle screws and AO plate.

DISCUSSION

The above treatment results indicate that in the case of type-C distal humeral fractures according to AO/ASIF open reduction and internal fixation with dedicated plates using fixed-angle screws and AO plates is a method of treatment achieving good and excellent results in circa 81% of cases. This is confirmed by scientific reports discussing the need to perform anatomical reduction of articular surface and its stable osteosynthesis and to initiate early movements in the operated joint in order to obtain satisfactory treatment results [1]. However, relatively few authors have studied the results of this kind of treatment with the application of LCP plates, whereby all existing studies on the topic show very good results [9-10]. Most studies are based on the use of AO plates in either perpendicular [11-12] or parallel [13-16] configuration, whereby no difference in treatment results depending on plate fixation technique has been recorded. Some biomechanical studies have demonstrated that better stability is achieved when LCP plates are used for osteoporotic bone fractures and/or comminuted fractures with fragments translated far apart [1].

In the studied group, operative approach with the Chevron osteotomy of the olecranon was used for all open reduction procedures, ensuring very good visualization of the surgical field [19]. A disadvantage of this approach may be the need to remove fixing hardware from the olecranon, ranging from 6% to 30% of cases as well as nonunion of the osteotomy site, present in up to 9% [1, 18, 20-21]. During the postoperative period, no intraoperative complications such as damage to vital vascular and neural structures or ulnar nerve neuropathy have been recorded in the studied group. The available literature does not discuss the optimum management of the ulnar nerve following implant placement [1]. Usually, studies on the topic do not recommend routine transposition of the ulnar nerve [22]. Chen et al. reported much more frequent symptoms of ulnar nerve dysfunction following its transposition such as paresthesias on the ulnar side, numbness and poorer functioning of intrinsic muscles of the hand [23]. Numerous studies discuss ulnar neuropathy reaching 12% after routine anterior subfascial transposition [1, 13, 16-18, 23]. Some authors recommend subfascial transposition and ulnar nerve neurolysis during surgery but only if symptoms of injury to the ulnar nerve, accompanying a distal humeral fracture, are present [24]. No other distant postoperative complications such as heterotopic ossification or nonunion have been recorded in the studied material. The literature on the topic describes cases of heterotopic ossification following open reduction and internal fixation of distal humeral fractures ranging from 0% to 21% [1, 13-14, 16, 21]. Common risk factors for the development of heterotopic ossification include injury to the central nervous system, a delay in operative treatment or operative intervention preceding final operative treatment [16]. Routine pharmacologic prophylaxis for heterotopic ossification is not recommended [1]. It may be considered if risk factors are present [1]. In the case of open reduction and internal fixation of distal humeral fractures, nonunion is very rare [14].

Treating distal humeral fractures may be very demanding from the technical point of view. Good treatment results depend on proper patient qualification for a particular surgical procedure and may be achieved also for type-C intra-articular fractures, provided that anatomical reduction of articular surface and stable plate osteosynthesis are obtained. In consideration of a vast group of patients over 60 years old suffering from osteoporosis, it is reasonable to use anatomical plates with fixed-angle screws. In other types of distal humeral fractures (types A and B) similar treatment results may be obtained using different operative treatment techniques, including minimally invasive ones with less interference with the elbow joint area, of shorter duration, more economical and enabling patients to facilitate restoration of upper limb functions.

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