Review article
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Role of olecranon osteosynthesis types and approaches in surgical treatment of patients with distal humerus fractures: a systematic review

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Abstract

Introduction Distal humerus fractures account for about 2 % of all fractures, with annual fracture incidence up to 5.7–8.3 cases per 100,000 population. In this regard, optimal surgical treatment methods continue to be sought. Despite the widespread use of olecranon osteotomy to approach the humerus, the choice of an osteotomy type and fixator for an artificial fracture consolidation remains with the surgeon. This paper systematizes the available literature related to types of osteotomies, types of fixators, and characteristics of complications.

Purpose To evaluate the results of performing olecranon osteotomy to approach the humeral trochlea in the treatment of distal humerus fractures, to determine the optimal type of approach, type of osteotomy and type of fixators for an artificial olecranon fracture in the surgical treatment of distal humerus fractures.

Material and methods The search for publications was carried out in the PubMed, Google Scholar, eLibrary databases for the period from 2020 to 2025. Studies that described olecranon osteotomy in the surgical treatment of distal humerus fractures (DHFs) were selected. After evaluating 595 articles, 18 studies with a total sample size of 640 patients were included in the systematic review according to the PRISMA criteria.

Results and discussion The results of the review are: the overall incidence of delayed consolidation was 5 out of 112 cases (4.46 %), pseudarthrosis developed in 24 out of 416 (5.76 %), and metal implant broke in 10 out of 150 (6.6 %). Development of surgical site infection in the early postoperative period was described in 37 out of 473 (7.82 %). Metal implants were removed in the postoperative period in 55 out of 297 cases (18.51 %). The incidence was calculated based on the available data for each described complication.

Conclusion The results of olecranon osteotomy used to approach to the humeral trochlea in distal humerus fracture treatment have been evaluated. Based on the results of this systematic review, it is impossible to indicate the optimal approach, type of osteotomy and type of fixation due to the limited data. However, given the available statistics, it is possible to assume the advantage of the Tension Band Wiring (TBW) method. Therefore, the issue of conducting experimental and prospective studies remains open.

Keywords: elbow joint, olecranon, olecranon osteotomy, distal humerus intra-articular fractures, humerus fracture

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INTRODUCTION

Distal humeral fractures (DHFs) account for approximately 2 % of all fractures, with a high incidence rate of up to 5.7–8.3 cases per 100,000 population per year [1, 2]. DHFs typically have a bimodal distribution: they occur either in young males due to high-energy injuries or in older women due to low-energy injuries [1].

Successful surgical fixation of DHFs is challenging. Numerous factors must be considered in selecting the best surgical strategy for open reduction and internal fixation (ORIF). Over the past 25 years, surgical outcomes in the management of DHFs have improved significantly. The principles formulated by the AO-ASIF (Arbeitsgemeinschaft für Osteosynthesefragen — Association for the Study of Internal Osteosynthesis) group include anatomical reduction of the articular surface and rigid internal fixation, ensuring rapid healing and early rehabilitation [3]. Furthermore, over the past two decades, a better understanding of elbow anatomy has emerged and surgical approaches have been refined [4–11]; innovative fixation devices have become available, and the rehabilitation protocols developed by the AO have evolved. Precontoured locking plates for the posterior and medial columns, as well as for fixation of artificial olecranon fractures, are new and effective means of fixation, especially if fractures are associated with osteoporosis [12].

However, olecranon osteotomy may result in damage to articular cartilage, thus increasing the risk of complications such as postoperative osteoarthritis [13–16]. To minimize its impact on the articular surface of the elbow, it is recommended to perform the osteotomy within the permissible zone, the proximal ulna fossa. The authors describe this area as a bare area [17, 18], which serves as a suitable site for olecranon osteotomy. However, its anatomical narrowness creates difficulties in performing the osteotomy correctly. Wang et al in their study on cadavers described 39 elbow joints. The bare area was measured, and the following data were obtained: the average width was 0.53 cm (range: 0.13–0.97 cm), and the average distance from the insertion of the distal triceps tendon to the area was 2.1 cm (range: 1.4–2.5 cm) [19]. Hakl et al obtained the height of the bare area equal to (4.92 ± 0.81) mm. Moreover, the insertion site of the distal triceps tendon was found to be wide and allowed for different attachment options to the olecranon, which could lead to inaccurate positioning of the osteotomy instrument when used as a landmark [20]. This led to the search for a method to improve the accuracy of osteotomies in this area.

For olecranon osteotomy, the standard approach is to perform a chevron osteotomy and fixation of the artificial fracture with Kirschner wires and a tensioned wire or tape, or an intramedullary screw with or without a washer. Transverse osteotomy is easier to perform and causes minimal bone damage compared to chevron osteotomy. Biomechanical studies demonstrated comparable stability of transverse and chevron osteotomies [21], but the effect of osteotomies on the area to reduce cartilage damage remains unknown. Anatomical and biomechanical studies focusing on the morphological characteristics of the bare area are currently not sufficient and lack a reliable description of the precise anatomical landmarks for the initiation and termination of olecranon osteotomy. However, there are numerous variants of olecranon osteotomy with a wide range of fixation types: chevron osteotomy, transverse or oblique osteotomy, L-shaped osteotomy, SCOOT osteotomy (step-cut olecranon osteotomy) [22]. Moreover, there is still interest among researchers in structuring the complication profile.

Purpose To evaluate the results of performing olecranon osteotomy to approach the humeral trochleain the distal humerus.

MATERIAL AND METHODS

Data sources

A search for relevant publications was conducted in the electronic databases eLIBRARY, PubMed, and Google Scholar for the period from 2020 to 2025. A total of 595 full-text publications were identified based on the keywords after removing duplicates. After screening according to PRISMA criteria, 36 publications were selected, 18 of which did not contain the required quantitative data. A systematic review and quantitative analysis included 18 publications [23].

Selection of studies and data extraction

Inclusion criteria:

— age 18 years or older;
— olecranon osteotomy for a distal humerus fracture;
— fixation of the artificial fracture with various types of fixators.

Exclusion criteria:

— case reports;
— biomechanical studies;
— pediatric studies and patients under 18 years of age;
— isolated olecranon fractures;
— studies conducted on cadaveric material.

The exclusion criterion was the lack of data on treated patients.

The sampling algorithm according to the PRISMA criteria for the subsequent systematic review is presented in Figure 1. The data were analyzed and presented descriptively.

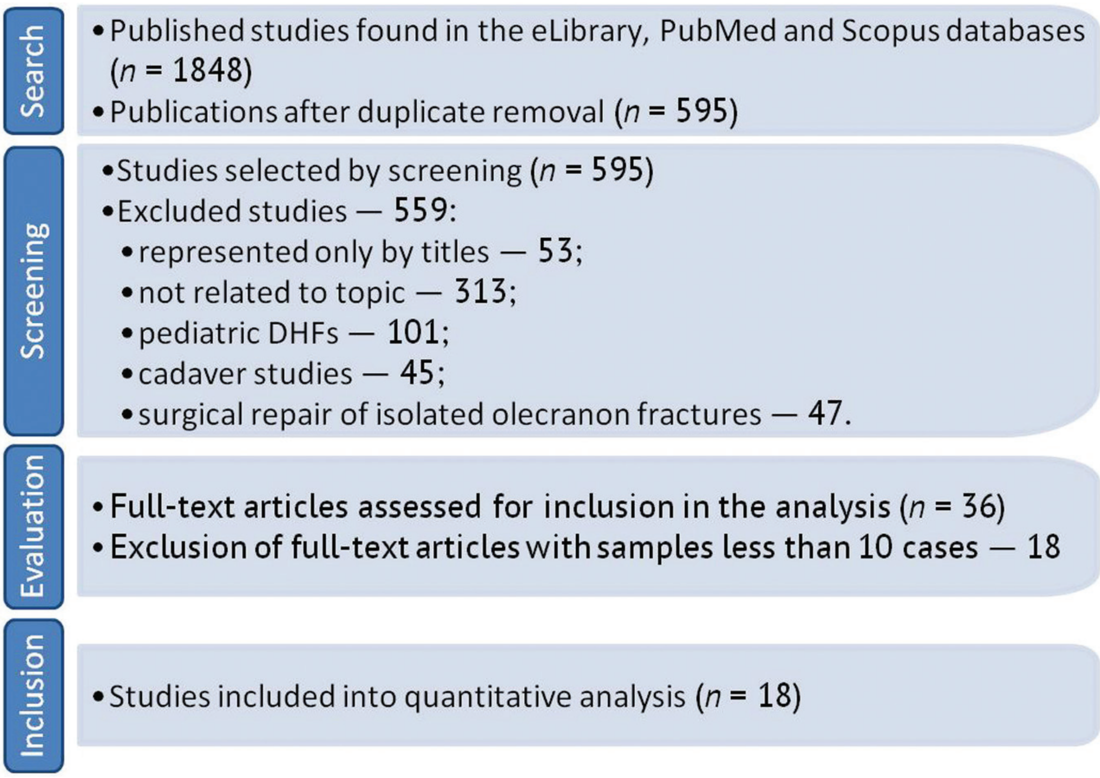

Fig. 1 Flowchart of the search and staged selection of publications for a systematic review

RESULTS AND DISCUSSION

Based on the data from all studies included in the systematic review, 640 clinical cases were reported in which the authors performed olecranon osteotomy (Table 1). The mean age of patients was (46.18 ± 8.5) years. One study did not specify the age of the study population [24]. Patient gender was reported in 14 studies, with men accounting for (51.4 ± 12.2) %.

Tabl 1

Distribution of data obtained by literature analysis for the period from 2020 to 2025

Source	LE	Number of patients (n)	OT	Fixation type	DC		PS		Break or migration		MI removal		SSI		MA, лет	M, %	F, %	FP, mo
					n	%	*n*	%	*n*	%	*n*	%	*n*	%				
Haglin JM et al, 2021 [24]	IV	48	Ш	TBW — 27, plate — 21	2	4.17	2	4.17	N/A		3	6.25	1	2.08	N/A	N/A	N/A	21
Zhou M et al, 2024 [25]	IV	73	П	TBW	N/A		N/A		N/A		N/A		N/A		40	60	40	37
Somerson JS et al, 2022 [26]	III	43	Ш — 41, П — 2	TBW, plate, screw & TBW, screw	N/A		2	4.65	N/A		N/A		9	20.93	59	61	39	17
Weber M.B. et al, 2022 [27]	III	14	Ш — 13, П — 2	TBW — 2, plate — 5, screw & TBW — 7	N/A		5	35.71	N/A		N/A		0	0.00	58	47	53	10
Cañete San Pastor P. et al, 2021 [28]	IV	26	Ш	screw	2	7.69	1	3.85	N/A		8	30.77	1	3.85	54.8	N/A	N/A	12
Phadnis J.S. et al, 2020 [29]	IV	30	Ш	TBW — 8, plate — 5, suture — 17	N/A		1/17 (suture)	3.33	N/A		1 (plate), 3 (TBW)	13.33	N/A		55	N/A	N/A	12
Kellam P.J. et al, 2024 [30]	IV	38	Ш	mini plate	N/A		0	0.00	N/A		3	7.89	N/A		50	42	58	10
Sinkler M.A. et al, 2025 [31]	III	36	Ш	TBW, plate, screw & TBW, screw	N/A		7	19.44	3	8.33	N/A		1	2.78	58	44	56	12
Wilson E.S. et al, 2021 [32]	III	64	Ш	N/A	N/A		0	0.00	N/A		3	4.69	9	14.06	45	41	59	13
Ailani R. et al, 2024 [33]	IV	20	Ш	TBW	N/A		N/A		5	25,00	N/A		2	10.00	37.5	55	45	12
Meldrum A. et al, 2021 [34]	IV	91	Ш	TBW — 63, plate — 18, screw & TBW — 1, screw — 9	N/A		2/63 (TBW), 1/18 (plate)	8.73	N/A		34	37.36	3	3.30	55.1	41	59	74
Jamoh K. et al, 2022 [35]	IV	30	Ш	TBW	N/A		N/A		1	3.33	N/A		8/	26.67	38.1	N/A	N/A	12
Ding J. et al, 2022 [37]	IV	27	Ш, П	screw & TBW	N/A		N/A		0	0.00	N/A		0	0.00	51.4	41	59	16
Ansari M.F. et al, 2020 [38]	IV	28	Ш	TBW	1	3.57	1	3.57	N/A		N/A		3	10.71	37.5	64	36	46
Yıldız V. et al, 2021 [39]	III	37	Ш	screw & TBW — 20, plate — 8, nail — 9	N/A		2	5.41	1	2.70	N/A		1	2.70	37	51	49	44
Butala R.R. et al, 2022 [40]	IV	15	Ш	TBW	N/A		N/A		N/A		N/A		N/A		44.6	53	47	6
Kumar D. et al, 2024 [41]	IV	10	Ш	TBW	0	0.00	0	0.00	N/A		N/A		N/A		36	60	40	13
Song Z.F. et al, 2025 [42]	IV	10	Ш	TBW	N/A		N/A		N/A		N/A		N/A		51.4	60	40	40

Notes: LE — level of evidence; OT — type of osteotomy; DC — delayed consolidation; PS — pseudoarthrosis; MI — metal implant; SSI — surgical site infection; MA — mean age; FP — follow-up period; TBW — tension band wiring; plate; screw; screw and TBW — screw with tension band wiring method; nail; suture; MP — mini plates; M — male; F — female; CO- chevron osteotomy; TO - transverse osteotomy; N/A — no data.

The follow-up period was 22.56 ± 17.7 months (range 1.5–74.4). Seventeen studies included 536 patients who underwent chevron osteotomy, and one study described 73 cases of transverse osteotomy [25]. Two studies reported transverse or chevron osteotomies in 57 patients, but did not specify the number of osteotomies [26, 27].

The most commonly used fixation method was tension band fixation using Kirschner wires and metal loop wiring: 286 patients in 11 articles. The next most frequently used method was fixation of the artificial fracture with a plate and screws: 95 patients in five articles. A cancellous screw along with the tension band wire method was used in 55 patients in four articles. Cañete San Pastor et al. used olecranon fixation with a 6.5 mm screw [28].

Over the past five years, only one study described successful fixation of an artificial fracture with a bone suture in 17 cases [29]. In one study, the authors reported 38 successful cases using 2.7 mm miniplates [30]. In the remaining articles, the authors included groups of patients with several types of fixation. In three studies, 143 patients were not distributed by type and method of fixation [26, 31, 32]. The incidence of complications after olecranon osteotomy for distal humerus fractures is shown in Figure 2.

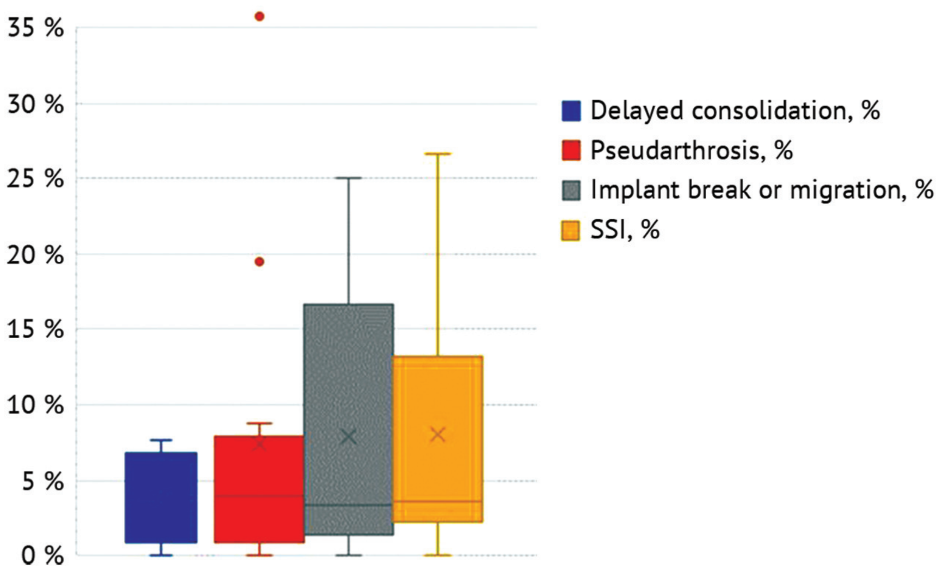

Fig. 2 Incidence of complications after olecranon osteotomy In DHFs (SSI — surgical site infection)

In 112 patients from four studies analyzed, there were five (4.46 %) cases of delayed olecranon consolidation after its osteotomy. The highest rate was described in the article by Cañete San Pastor et al.: two cases out of 26 patients (7.69 %) [28]. In 24 (5.76 %) cases out of 416, pseudarthrosis of an artificial olecranon fracture developed. Weber et al. reported pseudarthrosis in five (35.71 %) out of 15 patients [27], and Sinkler et al. [31] found pseudarthrosis in seven cases (19.44 %) out of 36.

In 10 out of 150 cases (6.6 %), fractures of the fixing metal or its migration into soft tissues occurred. Ailani et al. described repeated interventions due to implant failure in five patients (25.0 %) out of 20 [33].

In the late postoperative period, after complete consolidation of the artificial olecranon fracture, metal implants were removed in 55 (18.51 %) of 297 cases. Meldrum et al. removed metal structures in more than a third of cases, i.e., 34 (37.36 %) of 91 cases [34].

Wound infection in the early postoperative period developed in 37 (7.82 %) out of 473 cases; Jamoh et al. identified eight cases (26.67 %) out of 30 in their study [35], and a similarly high rate was reported by Somerson et al., i.e., 20.93 % (9 out of 43 cases) [26].

According to the literature, chevron osteotomy of the olecranon was used much more frequently, with better clinical outcomes than transverse osteotomy. Most studies used an oscillating saw to perform chevron osteotomy, cutting the bone only to three-quarters of its depth. An osteotome was used to complete the osteotomy, thereby avoiding damage to the articular cartilage and creating a relief surface for improved consolidation of the artificial fracture. The increased surface area of the cut bone ends in chevron osteotomy promotes effective apposition of the fragments, thus enhancing the rotational and translational stability of the artificial fracture.

Somerson et al. reported on the performance of two transverse osteotomies with delayed consolidation of fragments [26]. Weber et al. recorded five cases of pseudarthrosis after performing chevron and transverse osteotomies, but did not indicate which type of osteotomy they were obtained with [27]. In each study with mixed osteotomy techniques, it was concluded that chevron osteotomy is more reliable and yields better results [36].

Among the types and methods of fixation, the tension band wiring method alone and in combination with a single cancellous screw (with or without a washer) was used more frequently than other fixation devices.

The results of fixation of the artificial fracture site with plates and screws showed differences between studies. Five different types of plates or methods of their use were presented in 92 patients. Kellam et al. used 2.7 mm miniplates, resulting in implant removal in three (7.89 %) of 38 patients [30]. Phadnis et al. performed fixation of an artificial fracture with a bone suture; in a study of 30 patients, only one case of pseudarthrosis and four cases of subsequent implant removal were noted [29]. Cañete San Pastor et al. used a cancellous screw to fix the artificial fracture in 26 patients. It resulted in two cases of delayed consolidation and one case nonunion; the fixator was removed in the late postoperative period on a planned basis in eight patients [28].

The postoperative rehabilitation protocol in all analyzed studies included a short (up to 14 days) period of immobilization of the upper limb using a splint or cast. The range of motion exercises were initiated between the first and seventh days after surgery. Most studies prescribed wearing an orthosis after cast removal, while others did not use supportive means.

Limitation of the study

This systematic review has several limitations. As the study was designed as a descriptive one, we pooled similar groups to calculate incidence rates to demonstrate the trends. These results should be interpreted with caution (Fig. 3). A larger sample size would likely have yielded more reliable estimates.

We excluded biomechanical studies and studies involving patients diagnosed with an isolated olecranon fracture who did not undergo osteotomy to access the humeral trochlea for a olecranon fracture. Biomechanical studies provide valuable information unavailable in patient cohort studies, but our goal in this review was to evaluate clinical outcomes. We also observed heterogeneity between the groups. Thus, when using the tension band wiring technique (wiring loop and Kirschner wires), different plate types were grouped together.

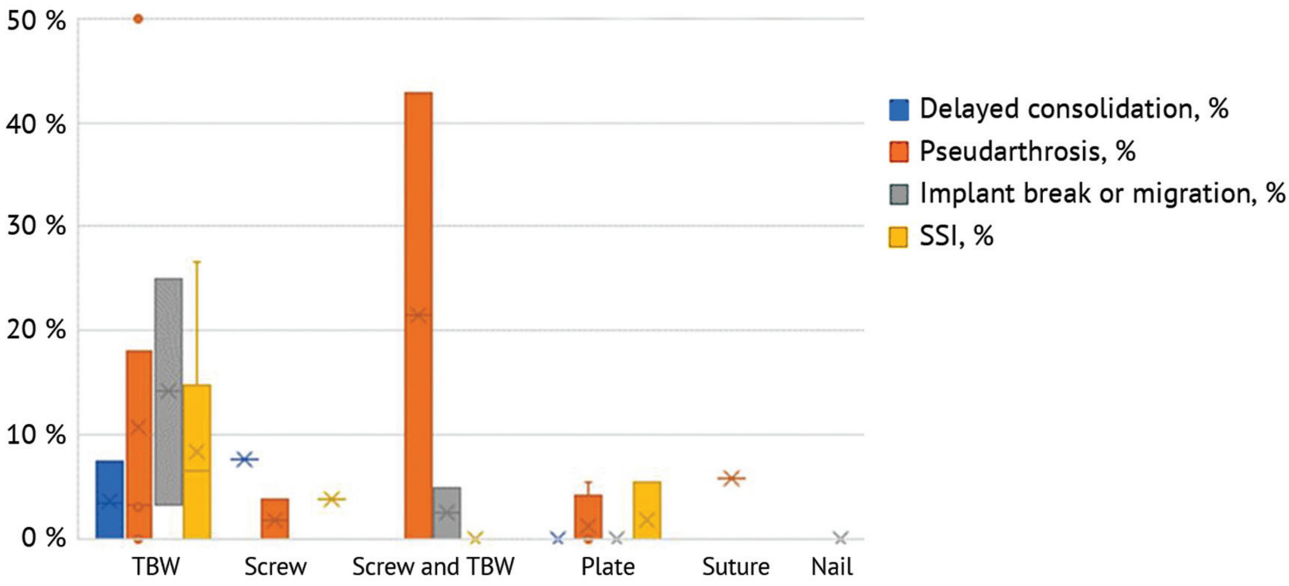

Fig. 3 Comparative diagram of complications based on the use of various techniques according to literature data for 2020–2025 (SSI — surgical site infection)

We were limited by the calculation information provided in each study. Patients were excluded from the review if it was unclear how to classify them.

CONCLUSION

Despite the frequent use and reproducibility of the general fixation methods in artificial fractures, the results of olecranon osteotomy used to approach to the humeral trochlea in distal humeral fractures remain poor. Based on the results of this systematic review, it is impossible to indicate the optimal approach, type of osteotomy and type of fixation due to the limited data. Therefore, the issue of conducting experimental and prospective studies remains open.

Conflict of interests *The authors report no obvious or potential conflicts of interest related to the publication of the materials.*

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