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Total wrist arthrodesis efficiency in various upper limb orthopedic pathologies

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Wrist arthrodesis for different pathologies has important specific features and yields varying functional outcomes. Objective. Based on the analysis of functional parameters dynamics to assess the total wrist arthrodesis efficacy for different upper limb pathologies. Methods. An analysis was performed on the dynamics of cylindrical grip strength and upper limb disability (qDASH score) before and one year after total wrist arthrodesis in 49 patients with various conditions, including wrist osteoarthritis, chronic brachial plexus injuries, distal radius giant cell tumor, rheumatoid arthritis, and wartime wrist joint injuries. Results.Wrist arthrodesis improved cylindrical grip strength in patients with degenerative wrist osteoarthritis by a median of 14 kg (range: 7–15 kg; IQR: 1 kg), in tumors by a median of 10 kg (range: 8–11 kg; IQR: 1,5 kg), and in consequences of wartime injuries involving joint surface defects by a median of 4 kg (range: 2–39 kg; IQR: 3 kg). In cases of rheumatoid arthritis, the median improvement was 3,4 kg (range: 2–9 kg; IQR: 2 kg). Effectiveness was minimal in patients with chronic brachial plexus injuries. The greatest reduction in upper limb disability (qDASH score) was observed in patients with of wartime wrist trauma consequences, with a median improvement of 40 points (range: 0–68 points; IQR: 27 points). In wrist osteoarthritis, the median improvement was 20 points (range: 9–39 points; IQR: 9 points), while relatively minor improvements were noted in patients with tumors, rheumatoid arthritis, and brachial plexus injuries. Total wrist arthrodesis is an effective surgical procedure; however, depending on the pathology, the indications, surgical conditions, techniques, and outcomes differ significantly and are notably varied.

Артродез кистьового суглоба за різних патологій має важливі особливості та різниться за функціональними результатами. Мета. На підставі оцінювання динаміки функціональних показників визначити ефективність операції повного (тотального) артродезу кистьового суглоба за умов патологій верхньої кінцівки. Методи. Аналіз динаміки показників сили циліндричного захвату кисті та ступеня недієздатності верхньої кінцівки (qDASH) до і через рік після тотального артродезу кистьового суглоба в 49 пацієнтів із різними (деформуючий артроз кистьового суглоба, застаріле ушкодження плечового сплетення, гігантоклітинна пухлина дистального метаепіфіза променевої кістки, ревматоїдний артрит суглоба, наслідки вогнепальних поранень зап'ястка) патологіями. Результати. Артродез кистьового суглоба покращує силу циліндричного захвату під час лікування деформуючого артрозу кистьового суглоба на — 14 кг (медіана) (діапазон: 7–15 кг; IQR: 1 кг); під час лікування пухлин — медіана 10,0 кг (діапазон: 8–11 кг; IQR: 1,5 кг); наслідків вогнепальних поранень із дефектом суглобових поверхонь — медіана 4 кг (діапазон: 2–39 кг; IQR: 3 кг), ревматоідного артриту — медіана 3,4 кг (діапазон: 2–9 кг; IQR: 2 кг), а за ушкоджень плечового сплетення його ефективність мінімальна. Найкраще артродез знижує недієздатність верхньої кінцівки за шкалою qDASH у пацієнтів із наслідками вогнепальної травми — медіана 40 (діапазон: 0–68; IQR: 27) балів; помітно менше під час лікування артрозу кистьового суглоба — медіана 20 (діапазон: 9–39; IQR: 9) балів та відносно невелику динаміку зменшення недієздатності за наслідків пухлин, артритів та уражень плечового сплетення. Артродез кистьового суглоба — дієва хірургічна процедура, проте залежно від патології покази, умови та техніка виконання, як і результати, достовірно відрізняються поміж собою, але в значному ступені неоднорідні. Ключові слова. Артродез, кистьовий суглоб, артроз, артрит, вогнепальні ушкодження, плечове сплетення.

Keywords. Arthrodesis, wrist joint, osteoarthritis, arthritis, wartime injuries, brachial plexus

Introduction

The issue of studying the effectiveness of wrist arthrodesis currently requires additional attention due to the high percentage of combat injuries. The first scientific publications on wrist arthrodesis and ankylosis date back to the beginning of the 20th century. Thus, in 1911, R. Eden [1] described this ccondition in the case of tuberculosis, and already in 1923, E. Hey-Groves [2] studied in detail the operation of wrist arthrodesis as a surgical treatment option for various diseases, including post-traumatic conditions.

In recent decades, surgical interventions that preserve movement in the wrist joint have become widely developed: removal of a number of wrist bones; partial intercarpal arthrodesis [3, 4]; endoprosthetic repair of the wrist joint [5]. However, firstly, some of them lose their effectiveness after a certain time and eventually lead to the performance of total arthrodesis as the final treatment procedure [4]. Secondly, due to pronounced structural and functional disorders of both the wrist and the entire limb, it is mostly impossible to preserve movements in the wrist joint, which requires its primary arthrodesis [6]. Information from literary sources on the use of wrist arthrodesis differs significantly [6, 7]. Therefore, we consider it advisable to clarify the results of wrist arthrodesis, especially taking into account various disorders of the upper limb, because there is a significant specificity of the intervention in these conditions, both in terms of indications and in terms of the technique of execution. It is also important to study the degree of restoration of the cylindrical grip strength of the hand and changes in the disability of the upper limb according to qDASH, and to outline important technical features of the procedure.

Purpose: based on the assessment of the dynamics of functional indicators, to determine the effectiveness of the operation of complete (total) wrist arthrodesis in conditions of upper limb disorders.

Material and Methods

Study Design: Retrospective, single-center, case series. Inclusion criteria: adult patients (≥ 18 years) who underwent total wrist arthrodesis for the following five types of lesions and injuries: degenerative changes (deforming arthrosis of the wrist due to post-traumatic or degenerative lesions); rheumatoid arthritis; giant cell tumor of the distal metaepiphysis of the radius; old injuries of the brachial plexus; gunshot wounds of the wrist with defects of the bones and articular surfaces.

The Bioethics Commission of the State Institution "Institute of Traumatology and Orthopedics of the National Academy of Medical Sciences of Ukraine" reviewed the materials of the article and concluded that the research was carried out in compliance with bioethical requirements in accordance with the Helsinki Convention of the Council of Europe on Human Rights and Biomedicine, relevant laws of Ukraine (No. 3 of 26.04.2025).

Table 1 shows the population distribution of patients by pathologies that necessitated arthrodesis.

In order to determine the effectiveness of arthrodesis, the strength of the cylindrical grip was determined using a certified hand dynamometer and the indicators of upper limb disability up to 12 months and more after surgery using the standard qDASH scale [8].

Surgical treatment. All patients underwent the intervention via a standard posterior approach using metal plates and screws. Before arthrodesis, the future position of the wrist joint was agreed with the patient, and where possible, it was modeled using a plaster cast, orthosis, or simple manual fixation. In most cases, either a neutral position or 10° extension, a neutral position relative to the elbow/radial deviation was chosen. For degenerative and inflammatory diseases, standard specialized metal structures for wrist arthrodesis were used, for other disorders, straight plates (as for forearm bone synthesis), which are thicker and longer than specialized ones.

The position of the plate is traditional: the distal-dorsal surface of the third metacarpal, proximal to the back of the radius. The articular surfaces of the radiocarpal, mid-carpal and third carpal-metacarpal joints were resected. For local structural needs

Table 1

Patient demographics and time since onset of illness/injury

Characteristics	Rheumatoid arthritis (n = 10)	Brachial plexus injury (n = 7)	Carpal tumors (n = 11)	Carpal osteoarthritis (n = 9)	Gunshot injury (n = 12)
Age, years, M ± SD	31 ± 7	22 ± 4	37 ± 7	54 ± 11	39 ± 7
Male	3 (30 %)	6 (86 %)	6 (55 %)	7 (78 %)	12 (100 %)
Female	7 (70 %)	1 (14 %)	5 (45 %)	2 (22 %)	0
Disease duration (M ± SD), months	93 ± 58	22 ± 4	7 ± 3	106 ± 57	6 ± 5

(after gunshot wounds in 7 of 12 patients, and always in the case of giant cell tumors), bone grafting was performed. In the case of ulnar-carpal conflict, marginal resection of the trihedral and part of the lunate bones was performed, and in the case of radioulnar conflict, tangential resection of the ulnar head was performed. Wrist immobilization lasted 2 months.

The peculiarities of arthrodesis for giant cell tumors of the distal metaepiphysis of the radius were the need for complete resection of the entire metaepiphysis in a single block, often with soft tissue components of the tumor extending beyond the metaepiphysis. After such a resection, it is easy to lose anatomical landmarks, disrupting the axis, rotation, and length of the segment during arthrodesis. Therefore, before removing the tumor, we used a temporary imposition of the future fixation plate on the unaffected segments of the radius and third metacarpal bones on 4–5 screws. Then, the plate was removed before the resection stage, and the holes remained as a reliable landmark for completing arthrodesis with bone grafting.

Results and Discussion

In all cases considered for quantitative analysis, wrist ankylosis developed within 2–3 months after arthrodesis.

Preoperative average indicators of the strength of the cylindrical grip, disability of the upper limb and their final values one year after the intervention due to the achievement of ankylosis of the wrist are shown in the histograms in the Figure.

The effectiveness of arthrodesis was characterized by the indicators of the dynamics of strength and disability of the upper limb, presented in Table 2.

Both according to the initial data and according to the results and dynamics of changes, the calculated parameters fundamentally and reliably differed in different groups (significance level from 0.02 to 0.001).

Summing up the results of arthrodesis, we note that the minimum increase in the strength of the cylindrical grip and the decrease in disability were recorded in patients with the consequences of brachial plexus damage. This can be explained from the standpoint of the principles of orthopedic correc-

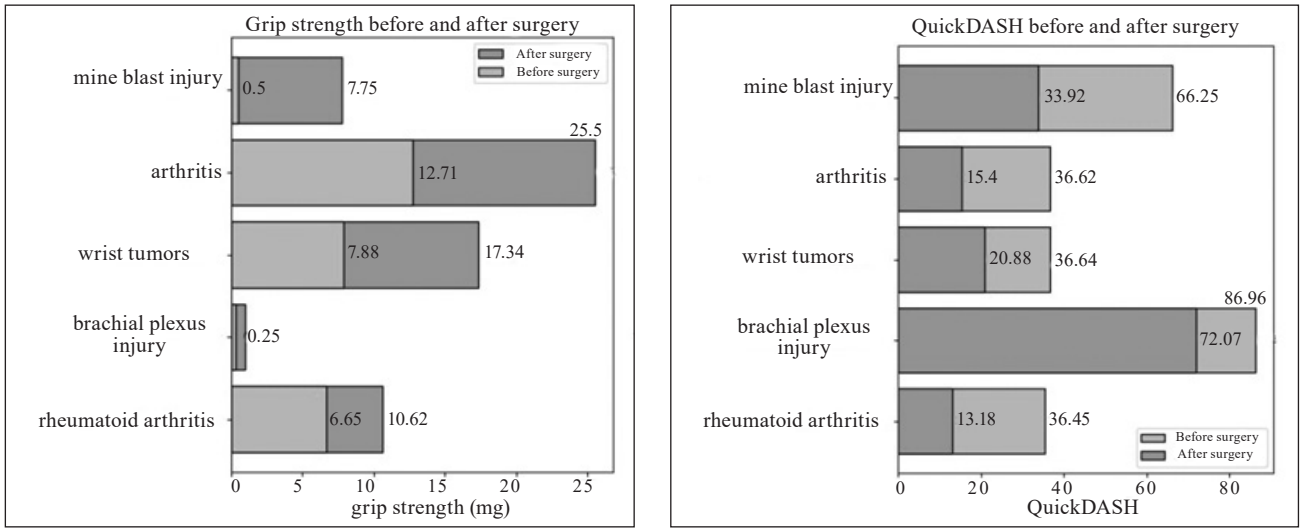

Figure. Average values of cylindrical grip strength and upper limb disability before and one year after carpal arthrodesis for various disorders

Table 2

Dynamics of hand grip strength and functional disability of the upper limb according to the qDASH scale

Lesion	Median grip strength, kg (IQR)	Grip strength range, kg	Median qDASH, points (IQR)	qDASH range, points
Gunshot wound	4.0 (3.0)	2–39	39.7 (27.4)	0.0–68.1
Arthritis deformans	14.0 (1.0)	7–15	20.4 (9.0)	9.1–38.6
Tumor	10.0 (1.5)	8–11	15.9 (10.2)	4.6–34.1
Brachial plexus injury	0.0 (1.0)	0–3	15.9 (6.8)	6.8–22.7
Rheumatoid arthritis	3.4 (2.0)	2–9	15.9 (26.1)	4.5–50.0

Notes: IQR — interquartile range, qDASH — abbreviated Disabilities of the Arm, Shoulder and Hand questionnaire

tion of this disorder [9], when arthrodesis of the wrist joint is only the first, largely preparatory operation, which precedes a complex of function-forming interventions (tendon-muscular transpositions, arthrodesis of the shoulder joint, etc.) and does not independently change the integral functions of the limb. It does not improve arthrodesis and grip strength but only creates conditions for further reconstructions.

The best increase in grip strength dynamics and qDASH scores is demonstrated by the limb against the background of its severe polystructural injury, which from the point of view of structural and functional losses of the wrist and hand often looks catastrophic. The increase in strength and ability may be associated with the restoration of both direct and indirect consequences of the injury. After arthrodesis, immobilization is removed, healing occurs, pain syndrome is reduced, the frequency of neuropathies and trophic disorders is reduced, finger contractures and the consequences of ischemic and other concomitant injuries of both the affected limb and polytrauma are eliminated.

Wrist arthrodesis in case of deforming arthrosis of the wrist joint is performed quite regularly. According to recent publications by L. Adey [10], the limits of effectiveness of arthrodesis in this condition were: for restoration of grip strength of the hand — up to 79 % of the healthy hand, and residual functional disability of the upper limb — an average of 25 points on the DASH scale. According to our results, arthrodesis in case of arthrosis provided restoration of grip strength on average up to Me 27.0 kg (range: 17–30 kg; IQR: 4.0 kg), which generally corresponds to the known data. Restoration of the level of functional disability was less significant — up to Me 16 points (range: 6.8–20.5; IQR: 3.5) on the qDASH. This discrepancy may be due to our small sample size and requires further clarification.

The effectiveness of arthrodesis and the dynamics of disability data in the conditions of the consequences of arthritis and tumors are generally similar. However, the indicators of grip strength in rheumatoid arthritis were restored noticeably worse — Me 11 kg (range: 4–18 kg; IQR: 7.5 kg), versus Me 17.5 kg (range: 14–20 kg; IQR: 2.5 kg) after arthrodesis for tumors, presumably due to systemic damage to other small joints of the hand and fingers in the case of arthritis.

Therefore, this study presents the results of arthrodesis of the wrist joint in patients with five fundamentally different ddisorders of the upper limb. This operation is infrequently required for the specified conditions, but further research is necessary. Given that movements in the wrist are important for manipulating the hand in tight spaces, as well as for hygiene, their value is obvious. It should be noted that arthrodesis fundamentally solves the problem of joint instability, significantly reduces pain, improves the appearance and indicators of grip strength, and the integral function of the upper limb. Therefore, despite the disappearance of movements in the joint, patients decide to perform this procedure.

Despite the obvious limitations of this study (retrospectiveness, single-center, low representativeness of groups), certain conclusions about the effectiveness of carpal arthrodesis for these patients can be made, but the obtained indicators should be considered approximate.

Conclusions

Among the five disorders of the upper limb, carpal arthrodesis best increases the cylindrical grip strength during the treatment of deforming arthrosis of this localization, namely by Me 14 kg (range: 7–15 kg; IQR: 1 kg).

Arthrodesis demonstrates a somewhat lower rate of strength recovery in the treatment of tumors — Me 10 kg (range: 8–11 kg; IQR: 1.5 kg); gunshot wounds with a defect in the articular surfaces — Me 4 kg (range: 2–39 kg; IQR: 3 kg); rheumatoid arthritis Me 3.4 kg (range: 2–9 kg; IQR: 2 kg). Its effectiveness is minimal in cases of brachial plexus injuries.

Arthrodesis best reduces upper limb disability according to the qDASH scale in case of gunshot injury — Me 40 (range: 0–68; IQR: 28) points, noticeably less than in case of carpal joint arthrosis — Me 20 (range: 9–39; IQR: 9) points, and demonstrates even less dynamics during the treatment of tumors, arthritis, and brachial plexus lesions.

Conflict of interest. The authors declare the absence of a conflict of interest.

Prospects for further research. Further study of the effectiveness of arthrodesis in prospective studies is relevant. Comparison of multicenter studies and increasing the representativeness of groups will allow to improve the results.

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Authors' contribution. Tymoshenko S. V. — idea, concept of the study, drafting the article, data calculations; Kotova M. V. — participation in surgical interventions, filling in primary documentation and registration of remote results.

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