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Functional Results of Surgical Elbow Arthrolysis based on Stiffness Severity: Assessment of the Results of a Series of 21 Cases

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Abstract **Original Research Article**

Our work is a retrospective study over 6 years period on the results obtained from the surgical arthrolysis of post-traumatic stiffness in 21 patients, operated in Department of Traumatology in the Ibn Sina University Hospital in Rabat. The aim of the study consisted to study the functional results of surgical elbow arthrolysis and highlight the prognostic factors which influence the overall results of this therapy. The average age of our patients is 35 years. The predominantly affected side was the right. All the patients had a traumatic history where 57.1% were joint fractures due to falls in 57.1% of cases. On these injuries, 23.8% were neglected and received orthopedic treatment. The type of stiffness was mixed in 76.2% of cases and severe to very severe in 80.9% of cases. Capsulectomy was the most performed surgical procedure. Our immediate results were very good in 42.9% and 52.4% of cases according to the relative gain of MERLE d´AUBIGNE. The functional sector was obtained in 52.4% of the patients. With an average follow-up of 34 months, our results were successful in 81% of cases according to the relative gain of MERLE d´AUBIGNE and 47.6% of patients kept a functional area according to the sectorization of ALLIEU and ANJOU. In total, there is an improvement in the performance of the member according to the MAYO score with an excellent result in 33% and a good result in 33% of cases. Thus, elbow arthrolysis is a useful technique for treating stiff elbow and demonstrates the importance of rehabilitation to maintain the operative results.

Keywords: Elbow, post traumatic, stiffness, arthrolysis.

INTRODUCTION

The elbow is an intermediate joint of the upper limb that connects the arm to the forearm. It is formed by three articulations: the humeroradial joint, the humeroulnar joint, and the proximal radioulnar joint. To ensure stability during movements in all three planes of space, this joint is reinforced by the articular capsule, surrounding muscles, and ligaments. The primary movements of the elbow are flexion, extension, and pronosupination. As an extensively used joint in daily activities, the elbow can be affected by various pathologies that result in stiffness. Elbow stiffness is characterized by a limited range of motion, in contrast to ankylosis, which represents a complete loss of mobility. The severity of stiffness can vary. Trauma, particularly post-traumatic injuries due to the superficial location of the elbow, is the main cause of elbow stiffness. Traumatic injuries to the elbow can range from minor incidents to severe accidents such as road accidents, falls, or sports injuries. Elbow stiffness significantly impacts patients' quality of life, highlighting the therapeutic importance of restoring joint mobility and preventing this condition. Elbow arthrolysis is a mobilizing intervention that aims to release contractures in the soft tissues surrounding the elbow, including the capsule, ligaments, muscles, and fascia. In some cases, additional surgical procedures may be performed alongside arthrolysis, such as removing osteophytes, bony blocks, or resecting the upper end of the radius or coronoid or olecranon processes. Our study focuses on 21 cases of post-traumatic elbow stiffness treated with arthrolysis at the Ibn Sina University Hospital in Rabat between 2014 and 2019. The objective of our research is to analyze the functional outcomes of this case series, compare them with existing literature data, and identify prognostic factors that influence the overall results of this therapeutic approach.

MATERIALS AND METHODS

This retrospective study was conducted at the Department of Traumatology in the Ibn Sina University

Hospital in Rabat, focusing on patients with post-traumatic elbow stiffness. The study covered a six-year period from 2014 to 2019, and various epidemiological, clinical, radiological, and therapeutic aspects of post-traumatic elbow stiffness were gathered from the patients' medical records.

Inclusion criteria comprised patients who underwent surgical treatment by the department's team, with admissions occurring between January 2014 and April 2019, and complete medical records containing comprehensive clinical, radiological, and anatomopathological information. Exclusion criteria included elbow stiffness not resulting from trauma, cases involving children below the age of 15, elbow stiffness managed through arthroscopic arthrolysis, patients with elbow stiffness due to polytrauma accompanied by a head injury, as well as incomplete records and patients lost to follow-up.

Arthrolysis is based on fundamental principles, such as achieving the most comprehensive possible joint range of motion intraoperatively without destabilizing the elbow.

- **Surgical Technique**

The surgical technique is standardized and aims to release the capsuloligamentous and bony constraints. Additional procedures are performed based on the etiology of the stiffness to optimize the range of motion, including muscle lengthening, ulnar nerve neurolysis, ulnar nerve transposition, removal of osteosynthesis material, and removal of foreign bodies.

The choice of surgical approach depends on various factors, including the nature of the lesion and the surgeon's expertise. The approach is carefully selected to minimize trauma during the procedure.

- **Outcome Measures**

In the field of functional mobility, we have adopted Morrey [1] mobility sector to assess the range of motion of the elbow. This functional sector is characterized by an extension ranging from -30° to a flexion of 130°, totaling 100°, as well as a pronation of 50° and a supination of 50°, also totaling 100°. The stiffness of the elbow is divided into four sectors [2].

Firstly, stiffness in elbow extension is defined by a lack of extension greater than 30° and a flexion equal to or greater than 120°.

Secondly, stiffness in elbow flexion is characterized by a flexion less than 120° and a lack of extension less than or equal to 30°.

Thirdly, mixed stiffness manifests as a lack of extension greater than 30° and a flexion less than 120°.

Regarding the severity of stiffness, we used a four-level classification established by the French Society of Orthopedic Surgery and Traumatology (S.O.F.C.O.T) in 1970. The levels are defined as follows: very severe for a range of motion from 0° to 30°, severe for a range of motion from 31° to 60°, moderate for a range of motion from 61° to 90°, and minimal for a range of motion greater than 90°.

To evaluate elbow function, we used the Mayo Clinic Elbow Performance Score (MEPS) (figure 1). This score assesses pain, stability, range of motion, and daily functional tasks of the elbow. Each domain is evaluated on a total point scale. The final score is then classified as follows: excellent for a score of 90 to 100, good for a score of 75 to 89, fair for a score of 60 to 74, and poor for a score of 0 to 59.

The radiological assessment criteria in this study focused on the use of conventional radiology to analyze joint surfaces, the presence of bony impingements, ossifications, and malunions. These elements were integrated into the Katz's classification system, which includes the following types of stiffness [3]: Type I stiffness with normal joint surfaces, no impingements, and no ossifications; Type II stiffness with normal joint surfaces, impingements present, and no ossifications; Type III stiffness with altered joint surfaces, impingements present, and no ossification; Type IV stiffness complicated by significant periarticular ossifications, with or without joint space narrowing (figure 2, 3, 4, 5).

Variable	Definition	No. of points
Pain (max. 45 points)	None	45
	Mild	30
	Moderate	15
	Severe	0
Range of motion (max. 20 points)	Arc >100°	20
	Arc 50–100°	15
	Arc <50°	5
Stability (max. 10 points)	Stable	10
	Moderately unstable	5
	Grossly unstable	0
Function (max. 25 points)	Able to comb hair	5
	Able to feed oneself	5
	Able to perform personal hygiene tasks	5
	Able to put on shirt	5
	Able to put on shoes	5

Figure 1: Mayo elbow performance score (MEPS)

Figure 2: X-ray of the elbow of patient no. 7 classified as type I according to the Katz classification

Figure 3: X-ray of the elbow of patient n1 classified as type II according to the Katz classification

Figure 4: X-ray of the elbow of patient no. 19 classified as type III according to the classification of Katz

Figure 5: X-ray of the elbow of patient no. 17 classified as type VI according to the classification of Katz

The main criterion for evaluating the outcomes of arthrolysis is the improvement in flexion-extension mobility. In this study, we used the scoring principles of DeBurge, as recommended by Kerboull and Valentin, which advocate for the use of relative mobility gain instead of absolute mobility gain. The relative gain (RG%) was calculated using the formula: Relative Gain (RG%) = Absolute Gain / Possible Gain * 100. Absolute gain represents postoperative mobility minus preoperative mobility, while possible gain represents normal mobility minus preoperative mobility. The results were classified according to the Merle d'Aubigné criteria into five categories: Excellent (> 70%), Good (40 - 70%), Fair (30 - 40%), Poor (20 - 30%), and Bad (< 20% or mobility loss).

The sectorization of the results was performed using the classification established by Allieu and d'Anjou [2]. The results were grouped into four categories: Group 1, elbows with extension deficit ≤ 30° and flexion ≥ 130°; Group 2, stiffness in the flexion sector with extension deficit ≤ 30° and flexion < 130°; Group 3, stiffness in the extension sector with extension deficit > 30° and flexion ≥ 130°; Group 4, mixed stiffness with extension deficit > 30° and flexion < 130°.

Statistical analysis of the data was conducted using SPSS version 20 software. Qualitative variables were expressed as percentages, while quantitative variables were presented as mean/standard deviation for Gaussian variables and median/interquartile range for non-Gaussian variables. Certain correlations were calculated, and the threshold for statistical significance was set at $p < 0.05$ for all statistical tests.

RESULTS

❖ Preoperative Data

The preoperative data of our study included epidemiological information and clinical characteristics of the patients. In our series, the median age of the patients was 35 years, with a majority (57.2%) falling within the age range of 20 to 40 years. There was no significant difference in the severity of stiffness among different age groups. Regarding gender, there was a clear male predominance, with 15 males (71.4%) and 6 females (28.6%) in the series. Most patients (85.7%) had stiffness on the right side, and stiffness predominantly occurred in the right elbow (57%). In terms of occupation, the series mainly consisted of manual laborers (9 males), students (2 females and 4 males), and unemployed individuals (4 females and 2 males). Among the medical history, 14% of the patients had diabetes and 19% were hypertensive.

Regarding the etiology of stiffness, all elbow stiffness cases in our series were traumatic in origin. Falls onto the elbow were the most common cause (57.1%), followed by road traffic accidents (29%) and assaults (13.9%). The traumatic injuries were primarily articular fractures (57.1%), followed by extra-articular fractures (28.6%) and fracture-dislocations (9.5%). The initial treatment of the injuries included surgical osteosynthesis in 52.4% of the patients, neglected treatment in 23.8%, and orthopedic treatment with a cast in 23.8%.

The average time between initial treatment and referral to our service for arthrolysis was 17 months, with a range of 2 months to 3 years. Regarding clinical characteristics, stiffness in extension was present in 23.8% of the patients, while mixed stiffness was present in 76.2%. Prono-supination limitation was observed in 9.5% of the patients. The severity of stiffness was evaluated based on the range of flexion-extension, with 23.8% of cases classified as very severe, 57.1% as severe, and 19% as moderate. The skin condition was satisfactory in all patients, and no vascular injuries were reported. According to the Mayo Clinic score, the performance of the affected limb was considered poor in 38.1% of cases, fair in 33.3%, and good in 28.6%.

The radiological study revealed the following findings in our series:

- Altered articular surface was observed in 4 cases, accounting for 19%.
- Bone spurs were present in 66.6% of cases, with 10 cases (47.6%) located posteriorly and the remaining cases (19%) showing dual localization.
- Periarticular ossifications were identified in 4 cases, representing 19%.
- Malunion was observed in 2 cases, accounting for 9.5%.

The radiographic lesions were classified using the KATZS classification system [3]. Type 3 stiffness was the most prevalent, with 13 cases (61.9%), followed by type 4 stiffness with 7 cases (33.3%). In our study, only one case (4.8%) presented with type 2 stiffness.

❖ Operating Data

In our series, various surgical approaches were utilized. The posterior approach was employed in 9 patients (42.9%), the external approach in 4 patients (19%), the combined approach in 4 patients (19%), the postero-external approach in 2 patients (10%), and the internal approach in 2 patients (10%). In all cases, capsulectomy was performed, along with other surgical procedures such as ligament sectioning in 1 patient (4.8%), bone resection in 12 patients (57.1%), and radial head resection in 4 patients (19%). Removal of osteosynthesis material was conducted in 9 cases (42.9%) to enhance range of motion. Neurolysis and cubital nerve transposition were carried out in 1 patient (4.8%). No patients required foreign body removal or muscle lengthening.

Regarding the results, a significant improvement in elbow mobility was observed. The average flexion increased from 84° preoperatively to 126° intraoperatively, with a statistically significant difference. The mean extension deficit decreased from -37° to -12° intraoperatively, also with a statistically significant difference. The flexion-extension range of motion increased from 46° to 113° intraoperatively, with a statistically significant difference. In the pronosupination range of motion, the average pronation increased from 59° to 90° intraoperatively, while the average supination increased from 52° to 80° intraoperatively.

In terms of relative gain, the peroperative gain was assessed among patients. It was classified as "very good" in 9 patients (42.9%), "good" in 11 patients (52.4%), and "fairly good" in 1 patient (4.8%). Regarding sectorization, 11 patients (52.4%) achieved a functional sector, while 10 patients (47.6%) retained a flexion deficit.

In conclusion, different surgical approaches were utilized in our series, resulting in significant improvements in elbow mobility postoperatively. The peroperative results demonstrated a positive relative gain in the majority of patients, with a majority achieving a functional sector.

❖ Postoperative Data

After the surgery, patients in our series followed a postoperative treatment protocol. All patients received medical treatment with anti-staphylococcal antibiotic therapy, starting during anesthesia induction and continued for 48 hours, followed by oral medication. An analgesic component

was implemented, including non-steroidal anti-inflammatory drugs (NSAIDs) for all patients and the placement of peripheral venous catheters in 7 patients (33.3%). An aspirative drain was placed at the end of the procedure in all patients for two to three days to prevent hematoma formation. Dressings were changed every two days, with wound surveillance for signs of inflammation or hematomas. Sutures were removed on the 15th postoperative day. Gentle passive mobilization was initiated in the hospital, with one session per day, using dynamic postural splints for flexion and extension, and patients were encouraged to practice gentle self-mobilization. This rehabilitation was continued as an outpatient to maintain the achieved functional outcomes.

Regarding postoperative complications, we observed different cases in our series. One case of nerve complication (4.8%) was noted during immediate postoperative follow-up, as well as one case of septic complication (4.8%) that was successfully treated. In the long term, one patient (4.8%) experienced ossification recurrence, which had a negative impact on postoperative mobility, and another case (4.8%) developed arthritis. The majority of patients (76.2%) progressed favorably without complications.

Regarding the results, all patients were reviewed after an average follow-up of 34 months (24 to 44 months). Patient satisfaction was assessed, as well as the presence of residual pain. Clinical examination evaluated elbow mobility in different ranges. Functional gains in flexion-extension were evaluated according to the Merle and Aubigne scoring criteria, as well as sectorization based on the classification by Allieu and Anjou. Control radiographs were taken at each visit to detect potential recurrence of ossifications.

Improvement in flexion-extension mobility was the major criterion for evaluating the outcomes of arthrolysis. On average, flexion increased from 84° +/- 14 preoperatively to 119° +/- 14 postoperatively, and extension increased from -37° +/- 10 to -17° +/- 7. The range of motion in flexion-extension increased from 46° +/- 16 to 100° +/- 16. Postoperative results showed a significant improvement in elbow mobility.

DISCUSSION

Elbow stiffness can be observed at any age, but it primarily affects young active individuals, which can be explained by the predominance of traumatic causes in the majority of published studies. In our study, the mean age was 35 years with a range of 28 to 58 years, which is consistent with the majority of studies.

Male predominance is highlighted in all literature series, with a sex ratio ranging from 1.1 to 4. In our study, we observed a male predominance with a male-to-female ratio of 2.5, which is consistent with the literature data.

The epidemiological data from our study on elbow stiffness can be summarized as follows. Regarding age, although elbow stiffness can be observed at any age, it is primarily seen in young active individuals due to traumatic causes. In our study, the average age of patients was 35 years, which aligns with the results of most previous studies [4-8]. In terms of gender, men are predominant in all literature series, with a male-to-female ratio ranging from 1.1 to 4. Our study also demonstrated a male predominance, with a male-to-female ratio of 2.5, which is consistent with previous data [4, 6-8]. Regarding the affected side, we observed a slight predominance of right-sided involvement, confirming the findings of other studies, with a percentage of 57% in our series [4, 6, 8, 9]. As for the initial trauma, our results differ from other studies, which showed a predominance of articular fractures, while in our series, extra-articular fractures were more frequent [5, 6, 8-10].

Finally, concerning the type of stiffness, we found a predominance of mixed stiffness in the literature, which was confirmed by our series with a percentage of 76.2% [6, 8, 9].

In our series, the majority of patients received an initial treatment, whether orthopedic or surgical, with a percentage of 76.2%. Only 23.8% of patients neglected their initial trauma, which can be a predictive factor for the development of stiffness. This correlation was confirmed by comparing our results with other publications [4, 8, 9].

The time interval between symptom onset and surgical intervention is also an important factor. According to some studies, it is preferable to intervene within the first year following symptom onset [11]. In our series, the average time to intervention was 17 months, which is similar to data from other studies, However, other authors did not find a significant correlation between the time of intervention and clinical outcomes [4, 6, 8, 9].

The anesthesia used can be general or locoregional, with the performance of a pure sensory axillary block. In our series, general anesthesia was used more frequently (17 times), but other studies have used both types of anesthesia [12, 13].

The choice of surgical approach depends on the location of the main lesions and the surgeon's preferences. In our series, the posterior approach was the most commonly used (42.9%), which allowed access to the posterior and medial compartments and facilitated extensive joint exploration [8]. Other studies have also shown a preference for the posterior approach [4, 6-10].

The most frequently performed surgical procedures were capsulectomy and bone resection. This is consistent with literature data [4, 7-9].

Immediate postoperative care includes hemostasis management, the placement of Redon drains, trans osseous reinsertion of the anconeus tendon in lateral approaches, and the application of compressive dressings.

Postoperative pain management is ensured through various techniques, such as iterative bolus injections, continuous infusion, or patient-controlled analgesia. The average length of hospital stay varies from one study to another.

Postoperative rehabilitation is essential to restore elbow range of motion and improve muscle function. It includes assisted exercises, active mobilization, and possibly the use of continuous passive motion (CPM). Postural splints are often used to maintain positions of maximum flexion and extension. Rehabilitation should be early, active, continuous, and painless, in order to avoid recurrence of ossification and achieve good long-term functional outcomes.

Functional Results

In our case series focusing on the functional sector, we observed a perioperative gain of 52.4%. According to Merle and d'Aubigne's criteria, 42.9% of cases were classified as very good and 52.4% as good. These results are similar to those of other studies [8, 9].

The analysis of our study demonstrated that neither the severity of stiffness, nor the nature or timing of intervention had an impact on the outcomes. This contradicts the findings of the study by Judet and Trillat [11, 14], who observed that the best results were achieved between the 4th month and 1 year. Our data analysis revealed that the immediate postoperative results were better than those observed after an average follow-up of 34 months. The mean range of motion in flexion-extension decreased from 113° perioperatively to 100° during follow-up, resulting in a loss of 13°. This observation is consistent with other studies, such as CHANTELOT. C series [5], which experienced a 40% loss in perioperative amplitude, the C.H.R.U de Lille series, which noted a 15% loss, and the AYADI.A series [4], which showed an average degradation of 17°.

We also observed an alteration in the relative gain and sectorization in our study, as well as in other case series [4, 6, 9].

The patient follow-up in our series was influenced by several factors, including the lack of rehabilitation resources and the discontinuity of rehabilitation, especially among patients with a lower level of education. This led to ossification recurrence.

In conclusion, open arthrolysis of the elbow is a highly beneficial intervention for treating elbow stiffness, particularly when performed under optimal conditions. This is especially true for young and motivated individuals, before stiffness significantly impairs elbow functionality. Early and continuous postoperative rehabilitation is crucial for maintaining the achieved joint range of motion and should be conducted under the best possible conditions for as long as necessary.

Finally, primary prevention remains the best approach to address this condition, primarily through improved management of elbow injuries.

CONCLUSION

We studied 21 cases of post-traumatic elbow stiffness that underwent open arthrolysis over a period of 4 years. At the end of our study, we found that the results obtained were similar to those reported in the specialized literature. The technique of arthrolysis has been well standardized since 1971 and has benefited from new approaches and techniques. It remains an effective and safe solution when performed by an experienced surgeon who can improve elbow mobility, relieve pain, and preserve muscle strength and tone. It should be considered for any stiffness that limits elbow functionality, given the high percentage of satisfied patients reported in the literature.

This study led to the following conclusions:

- Elbow stiffness is a common condition that can occur at any age, with a slight predominance in young and active individuals.
- A thorough clinical examination is essential to identify the type of stiffness and classify it from severe to mild.
- The diagnosis relies primarily on standard radiographs.
- Arthrolysis is indicated when the mobility deficit exceeds the functional range of 30 to 120° of elbow motion.
- The main goal of surgery is to restore functional range while preserving elbow stability and minimizing trauma.
- The choice of surgical technique depends on the etiology, origin, and location of the responsible lesions.

The duration of stiffness does not affect functional outcomes, nor does the nature or timing of intervention. Postoperative rehabilitation remains a crucial component of treatment, especially with the introduction of continuous passive mobilization, which helps maintain the joint range of motion achieved during surgery. All of this leads us to address the issue of prevention. It is better to prevent than to cure these stiffness conditions by ensuring early diagnosis of any elbow trauma, raising patient awareness—particularly in rural areas—to eliminate traditional treatments (such

as "jbira"), and providing tailored, early, and active rehabilitation to promote recovery.

Ethics Approval and Consent to Participate

Ethical approval was not sought. Written consent was obtained from the patients.

Availability of Data and Materials

The datasets used and analysed during the study are available from the corresponding author.

DECLARATION OF CONFLICTING INTEREST

The authors declare that there is no conflict of interest.

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Authors Contributions

All authors have read and approved the final manuscript.

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