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Open elbow arthrolysis for posttraumatic elbow stiffness

THESE

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DOCTEUR EN MEDECINE

par

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Résumé

Introduction et objectif : l'articulation du coude est vulnérable à l'enraidissement, en particulier après un traumatisme. Le but de cette étude est d'évaluer les résultats du traitement chirurgical des raideurs post-traumatiques du coude.

Type d'étude : étude rétrospective de cohorte.

Les patients : dix-huit patients ont été évalués cliniquement par un observateur indépendant dans un intervalle moyen de 16 mois (6 à 43) après avoir subi une arthrolyse ouverte du coude, avec comme indication opératoire une raideur post-traumatique du coude. Les traumatismes subis étaient : 11 fractures isolées, 1 luxation isolée, 6 fracture-luxations complexes. Les prises en charge initiales étaient : non-chirurgicales pour 3 patients, résection de la tête radiale pour 1 patient, réduction ouverte et ostéosynthèse pour 14 patients. Les patients ont présenté des types de raideurs mixtes pour la plupart d'entre eux.

Type d'intervention : arthrolyse ouverte du coude.

Evaluation : la fonction du coude et la satisfaction des patients furent les principales données récoltées. Lors de l'évaluation, les scores de SECEC (Société Européenne de Chirurgie d'Epaule et du Coude) ont été calculés. Une analyse radiologique a aussi été effectuée.

Résultats : trois patients ont présenté des complications postopératoires mineures : 1 déhiscence de plaie, 1 infection sous-cutanée, 1 sérome. Aucune de ces complications n'a eu de répercussion sur le résultat final. Le gain d'amplitude articulaire moyen était de 40°, avec un gain moyen en flexion du coude de 14° (0°–45°), et de 26° en extension (5°–67°). Aucun patient n'a présenté d'instabilité du coude. Il n'y a pas eu de signe de progression d'arthrose sur les clichés radiographiques à la revue. Nous n'avons pas mis en évidence de rapport entre le type de raideur et la voie d'abord sur les résultats. Les patients ayant présentés les raideurs les plus importantes ont bénéficiés des meilleurs résultats en terme de mobilité ($p<0.001$). Les meilleurs résultats ont été obtenus pour les patients opérés dans la première année après le traumatisme initial ($p=0.008$). Le score SECEC moyen était de 88 points pour les coudes opérés (52–100), et de 96 points pour les coudes sains (88–100).

Conclusion : l'arthrolyse ouverte confère de bons résultats pour les patients présentant une raideur post-traumatique du coude. Les meilleurs résultats sont obtenus pour les patients présentant une raideur sévère, prise en charge dans l'année qui suit le traumatisme initial.

Open Elbow Arthrolysis for Posttraumatic Elbow Stiffness

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Objectives: The elbow joint is vulnerable to stiffness, especially after trauma. The aim of this study was to evaluate the results of open arthrolysis for posttraumatic elbow stiffness.

Design: Cohort retrospective study.

Patients: Eighteen consecutive patients were evaluated by an independent observer at an average of 16 months (6 to 43) after open elbow arthrolysis was performed for posttraumatic stiffness. Initial traumas were: isolated fractures (11) or dislocation (1) and complex fracture-dislocations (6). Initial treatments were: nonoperative (3), radial head resection (1), and ORIF (14). Patients presented predominantly with mixed contractures (combined extrinsic and intrinsic contractures).

Intervention: Open elbow arthrolysis.

Main Outcome Measurements: Elbow function and patient satisfaction were the principal outcome measures. At follow-up European Society for Shoulder and Elbow Surgery (SECEC) elbow scores were calculated.

Results and Conclusions: Three patients had minor postoperative complications: 1 partial wound dehiscence, 1 subcutaneous infection, and one seroma. None of these complications influenced the final result clinically. The mean total increase in range of motion was 40 degrees (13 to 112 degrees), with a mean gain in flexion of 14 degrees (0 to 45 degrees) and 26 degrees in extension (5 to 67 degrees). No patient showed signs of elbow instability. There was no radiographic evidence of osteoarthritis progression at follow-up. We did not find any correlations between the type of stiffness, the approaches used, and the results. However, patients with the greatest preoperative stiffness had significantly better improvement of mobility ($P < 0.001$). The best results were obtained in patients who had arthrolysis done within 1 year after the initial trauma ($P = 0.008$). The mean SECEC scores were 88 (52 to 100) for the injured elbows, and 96 (88 to 100) for the contralateral elbows.

Conclusion: Open elbow arthrolysis for patients with posttraumatic stiffness improves joint function and provides patient satisfaction. The best results, in terms of gain of motion and patient satisfaction, were obtained in patients with severe stiffness who had operations within the first year after initial trauma.

Key Words: elbow arthrolysis, elbow stiffness

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The elbow joint has long been recognized to be vulnerable to stiffness from trauma, burns, and arthritis.[1] Trauma constitutes the most frequent cause of elbow contracture.[2] The development of posttraumatic elbow stiffness is a result of the high degree of congruency of the joint, the close continuity of the muscle to the capsule, the propensity for comminuted fractures, and the somewhat unique response of the joint capsule to trauma.[3]

According to Morrey,[3] elbow stiffness can be classified as extrinsic (periarticular) contracture: soft tissues (capsuloligamentous or muscular tissue) or osseus ankylosis (ectopic bone forming a bridge across the joint, in the capsule or muscle crossing the joint). Conversely, intrinsic (intraarticular) contracture involves intraarticular adhesions, loss of cartilage due to avascular changes of the comminuted segments, gross joint distortion due to the initial trauma, or inadequate or failed reduction. Mixed contracture, with elements of both extrinsic and intrinsic contractures, can also be observed. Most of these pathologic states are accessible to open arthrolysis. The decrease in elbow motion is a result of the filling in of the different joint spaces with scar tissue (bone and fibrous tissue), loose bodies or implanted material and capsule retraction or hypertrophy.[4]

The purpose of our study was to present the results of an open elbow arthrolysis procedure, in terms of joint function and patient satisfaction, for patients who had posttraumatic stiffness resulting in elbow contracture. We also evaluated the final results based on the severity of the contracture and its type, and the time between initial trauma and the arthrolysis procedure. Our hypothesis was that the procedure is suitable for patients presenting with posttraumatic elbow stiffness, and that the presence of a severe elbow contracture should not be a contraindication for the surgery.

PATIENTS AND METHODS

Between October 1998 and October 2002, 21 patients underwent open elbow arthrolysis for posttraumatic elbow stiffness. Eighteen patients were available for

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follow-up evaluation at an average of 15.8 months from surgery (6 to 43). Three patients were excluded from the study; 1 patient had left the country, another patient was not available for follow-up due to psychiatric reasons, and 1 patient had an elbow contracture as a consequence of burn lesions.

Patients Selection

All the patients related a history of elbow trauma. The 5 males and 13 females had a mean age of 35.7 years (19 to 67) with the dominant elbow involved in 9 patients. The time interval between injury and arthrolysis was 12 months (4 to 27). Patients' sports activity before arthrolysis was 1 x /week for 2, 2.5 x /week for 15, and none for 1. Patients' work activity before arthrolysis was sedentary in 13, semisedentary in 1, heavy in 2, and no work activity in 2. The type of trauma, the initial treatment, the type of elbow contracture, and the interval between initial trauma and arthrolysis for each patient were recorded (Table 1). The indications for arthrolysis were decided upon individually for each patient; generally when all nonoperative means had failed. The arthrolysis were performed only if the initial fractures were healed according to clinical and plain x-rays.

Surgical Procedure

Surgical Approach

The initial skin incisions were used whenever possible (for 14 patients in this study). The skin incisions, approaches, and compartments released are detailed in Table 2. The approaches were carried out according to Morrey's description.[5]

Surgical Technique

Implanted material was removed in 11 elbows as part of the arthrolysis procedure. Ulnar nerve transpositions were performed in 3 elbows. Intraarticular inspections revealed only minor cartilage damages in all cases (grade 1 and 2 chondrolysis). Olecranon osteophytes were resected in 2 elbows. The olecranon fossa was cleaned of fibrous scar tissue in 6 elbows. Capsule resections were performed in 15 elbows (13 anterior capsules, 1 anterior and posterior capsule, 1 anterior and internal capsule). Anterior capsules were only incised 3 times. The olecranon was partially resected in 4 elbows (to a maximum of its third proximal portion). Periarticular soft tissue adhesions were removed in 7 elbows. Heterotopic ossifications were removed in 2 elbows. No further external elbow manipulations were performed.

Postsurgical Treatment

Early mobilization on a continuous passive motion device (Kinetec, Smith & Nephew Inc, Memphis, TN) was used for all patients starting on the first postoperative day, during the whole hospital stay, and for an average of 12 h/d. After arthrolysis, 13 patients had a night extension splint for 5.1 weeks (2 to 12). Interscalene nerve blocks were used for all patients preoperatively to facilitate the rehabilitation process. All patients underwent rehabilitation therapy for 12 weeks (1 to 32), with an average of 32 therapy sessions (6 to 72). Average duration of hospital stay was 4.6 days (3 to 6). No specific treatment was given to prevent heterotopic ossifications.

Follow-up Evaluation

The mean duration of follow-up was 16 months (6 to 43). An independent observer who was not involved

TABLE 1. Patient Data, Preoperative Information, n=18

Patient	Initial Trauma	Initial Treatment	Type of Contracture	Interval Trauma-Arthrolysis (mo)	Postoperative F/E
1	Radial head fracture	ORIF	Mixed	10	140/5
2	Open supracondylar fracture	ORIF	Mixed	15	125/15
3	Comminuted supracondylar fracture	ORIF	Mixed	27	140/18
4	Olecranon fracture	ORIF	Intrinsic	9	140/15
5	Radial head fracture	Conservative	Extrinsic	6	120/5
6	Radial head fracture	ORIF	Extrinsic	7	130/0
7	Comminuted radial head fracture	Radial head resection	Extrinsic	10	140/10
8	Monteggia fracture	ORIF	Mixed	16	140/5
9	Supracondylar fracture-dislocation	ORIF	Mixed	14	120/15
10	External elbow dislocation	Conservative	Extrinsic	10	140/0
11	Olecranon fracture+radial head fracture+elbow dislocation	ORIF	Extrinsic	13	130/7
12	Supracondylar fracture+elbow dislocation+humeral shaft fracture+ulnar shaft fracture	ORIF	Mixed	19	125/18
13	Radial head fracture+coronoid fracture+elbow dislocation	ORIF+external fixator	Mixed	10	140/0
14	Radial head fracture	Conservative	Mixed	4	145/5
15	Comminuted olecranon fracture	ORIF	Mixed	16	130/5
16	Comminuted supracondylar fracture	ORIF	Mixed	9	135/5
17	Supracondylar fracture	ORIF	Mixed	10	120/10
18	Radial head fracture +posterior elbow dislocation	ORIF	Mixed	14	140/5

TABLE 2. Surgical Approaches, n=18

Patient	Skin Incision	Approach	Compartment Released
1	Lateral*	Lateral	Anterior
2	Posterior†	Posterior	Posterior
		Lateral	Anterior
3	Posterior†	Posterior	Posterior
		Lateral	Anterior
4	Posterior‡	Posterior	Posterior
5	Lateral§	Lateral	Anterior + Posterior
6	Lateral*	Lateral	Anterior
7	Lateral*	Lateral	Anterior
8	Lateral*	Lateral	Anterior
9	Posterior‡	Posterior	Posterior
10	Lateral*	Lateral	Anterior
11	Lateral*	Lateral	Anterior
12	Posterior†	Posterior	Posterior
		Lateral	Anterior
13	Lateral*	Lateral	Anterior
14	Lateral*	Lateral	Anterior
15	Posterior†	Posterior	Posterior
		Lateral	Anterior
16	Posterior + Lateral‖	Posterior	Posterior
		Lateral	Anterior
17	Posterior†	Posterior	Posterior
		Lateral	Anterior
18	Lateral*	Lateral	Anterior

The approaches were carried out according to Morrey's description.[5]

*Lateral incision with a lateral approach to release the anterior compartment.

†Posterior incision with a posterior approach to release the posterior compartment, and a lateral approach to release the anterior compartment.

‡Posterior incision with a posterior approach to release the posterior compartment.

§Lateral incision with a lateral approach to release the anterior and the posterior compartment.

‖Posterior incision with a posterior approach to release the posterior compartment combined with a lateral incision with a lateral approach to release the anterior compartment.

in the surgical procedure and who was seeing the patients for the first time evaluated all the patients and the x-rays. Follow-up evaluation consisted of our own questionnaire, a thorough physical examination, and an isokinetic strength-testing (Isobex, Cursor AG, Bern, Switzerland). Strength in flexion and extension on the injured and contralateral elbow was tested. The SECEC elbow score[6] was used to evaluate pain, activity, to calculate ROM deficit and to assess strength in flexion and extension. Strength was measured using an Isobex machine, and scored according to European Society for Shoulder and Elbow Surgery (SECEC) elbow score system (1 point/kg, maximum 15 points in elbow flexion, maximum 10 points in elbow extension). Additional questions addressed the level of patient satisfaction with respect to the results of surgery and return to sporting and work activities.

Plain radiographs (anteroposterior and lateral elbow views) were obtained for all patients. Preoperative radiographs were analyzed, graded, and then compared with the radiographs made at follow-up evaluation. We graded all the radiographs using our own point system, with scores ranging from 0 (normal) to 8 (severe lesions).

TABLE 3. Patients' Subjective Results at Follow-up, n=18

Satisfaction	
Very satisfied	12 (66.66%)
Satisfied	5 (27.77%)
Not satisfied	1 (5.55%)
Return to sporting activity (to level before trauma)	
Same level	13 (72.22%)
Inferior level	5 (27.77%)
Return to professional activity (to level before trauma)	
Same level	16 (88.88%)
Inferior level	2 (11.11%)
Time from surgery to return to work	
1 month or less	12 (66.66%)
1 to 2 months	3 (16.66%)
2 to 3 months	2 (11.11%)
No professional activity	1 (5.55%)
Would recommend the arthrolysis procedure	18 (100%)

Points were allocated as follows:

Humeral ulnar and humeral radial joint spaces: normal, 0 point; narrowed, 1 point; not visible, 2 points.

Osteophyte (the largest osteophyte was measured): none, 0 point, 0 to 2 mm; 1 point; 2 to 3 mm, 2 points; > 3 mm, 3 points.

Presence of one or more loose body: 1 point.

Presence of one or more heterotopic ossifications: 1 point.

Presence of excessive callus formation: 1 point.

A test-retest procedure was made on 20 radiographs and showed excellent correlation coefficients: 0.99 for the global score and for each items: 0.76 for joint space, 1 for loose body, heterotopic ossification and excessive callus formation.

Statistical Analysis

The statistical analysis was performed using Wilcoxon signed rank tests at the $\alpha = 0.05$ level of significance (a nonparametric test because of the small number of patients). Spearman rank correlation coefficients were calculated and robust regression was carried out to determine the influence of the delay between the initial elbow trauma and the arthrolysis procedure, and the values of preoperative elbow flexion and extension on the gain in ROM. The same robust regression was also performed for each subtype of contracture (extrinsic/intrinsic/mixed). The software STATA 8.0 (Stata Corporation, College Station, TX) was used for data analysis.

RESULTS

Tables 3 and 4 summarize the patients' subjective and objective results at follow-up.

Subjective Results

On the basis of our own questionnaire, 17 patients (94.4%) were satisfied or very satisfied regarding the results of surgery. Patients with the worst preoperative contractures had the best subjective results; all the patients with less than 80 degrees of elbow ROM

preoperatively were very satisfied with the results of surgery, the only unsatisfied patient had a 110 degrees preoperative ROM. All the patients would recommend the procedure.

Objective Results

Table 4 summarizes SECEC elbow scores, and flexion/extension ROM gains for all the patients. There was a significant difference ($P = 0.0012$) in SECEC scores between the injured and contralateral side. Excellent significant Spearman rank correlation was found between the gain in ROM and the preoperative ROM ($\rho = -0.90$, $P < 0.001$); the smaller the preoperative ROM, the higher the postoperative ROM gain. More precisely, the robust regression analysis revealed that 84% of the gain in ROM could be explained by the value of the preoperative flexion, the preoperative extension, and the delay between trauma and arthrolysis ($R^2 = 0.84$). With longer delay to perform the arthrolysis, the ROM gain is significantly reduced ($\beta = -1.26$, $P = 0.008$); the decrease being clinically significant after 1 year. Patients with preoperative flexion contractures also had a smaller gain in ROM ($\beta = -0.52$, $P < 0.001$), and also patients with extension contractures ($\beta = 0.57$, $P = 0.001$). We did not find any clinical nor statistical association between the type of elbow contracture and the results at follow-up in terms of elbow function and patients satisfaction (only 1 patient was not satisfied). The effect of length of follow-up was not statistically significant ($\beta = 0.07$, $P = 0.75$).

Eleven patients (61.1%) had their radiographic scores unchanged, with the same score at follow-up and before the arthrolysis procedure. Four patients lowered their score by 1 point. Two patients lowered their score by more than 2 points, respectively, 3 and 4 points. One patient had a 1 point gain at follow-up.

Complications

Three patients had minor postoperative complications: one had a partial wound dehiscence which healed in 4 weeks with no specific treatment, another patient had a local infection of the subcutaneous sutures which healed in 2 weeks with local wound care, the third patient presented with a subcutaneous seroma which resolved spontaneously in 2 weeks. None of these complications influenced the results of arthrolysis clinically. No patient showed signs of elbow laxity at follow-up. One patient was dissatisfied regarding the results of the procedure, but would still recommend the procedure. This particular patient sustained an olecranon fracture, and the arthrolysis was carried out 9 months after the initial trauma. The flexion gain was 40 degrees (140 degrees flexion at follow-up), the extension gain was 5 degrees (15 degrees extension deficit at follow-up). The patient had expected more improvement in range of motion from the arthrolysis.

DISCUSSION

This study was conducted to evaluate the outcome of open elbow arthrolysis performed for posttraumatic stiffness. The factors that may influence the results were also analyzed. The mean increase in flexion/extension and the complication rate obtained were comparable to those of other studies.[7–14] Our results did not show any clinical or statistical correlation between the type of elbow contracture and the outcome of the arthrolysis procedure. Our patients showed better results in extension, because

TABLE 4. Patients' Objective Results at Follow-up, n = 18

Mean flexion	
Preoperative mean [range]	116.7° [80–145°, SD 21.1°]
At follow-up mean [range]	130.6° [90–145°]
	$P = 0.0008$
Gain mean [range]	13.9° [0–45°, SD 15.3°]
Mean extension	
Preoperative mean [range]	35.0° [15–85°, SD 18.0°]
At follow-up mean [range]	8.8° [0–20°, SD 6.6°]
	$P = 0.0002$
Gain mean [range]	26.2° [5–67°, SD 16.0°]
Mean total ROM* gain in flexion/extension mean [range]: 40.1° [13–112°, SD 23.6°], $P = 0.0001$	
Mean SECEC scores (points)	
Pain (0–15 points [range]), injured/contralateral: 13.4 [6–15, SD 3.2]/15 [15–15, SD 0.0]	
Activity (4–20 points [range]), injured/contralateral: 18.6 [14–20, SD 1.9]/19.9 [19–20, SD 0.2]	
ROM deficit (0–40 points [range]), injured/contralateral: 35.6 [21–40, SD 5.0]/40 [40–40, SD 0.0]	
Strength	
Extension (max. 10 points) injured/contralateral: 8.8 [5–10, SD 8.8]/9.0 [6–10, SD 1.3]	
Flexion (max. 15 points) injured/contralateral: 11.6 [4–15, SD 3.3]/12.7 [7–15, SD 2.5]	
Total (max. 25 points) injured/contralateral: 20.4 [11–25, SD 4.7]/21.7 [13–25, SD 3.5]	
Total SECEC score (max. 100 [range])	
Injured	88.0 [52–100, SD 11.6]
Contralateral	96.6 [88–100, SD 3.6]
	$P = 0.0012$†

*Each ROM gain was computed for each patient and then the mean of ROM gain done.
†P value for the difference between the injured and contralateral side.

they presented preoperatively with more severe extension than flexion contractures. Mansat and Morrey[12] reported a mean ROM gain of 43 degrees in their series involving patients with extrinsic contractures, when arthrolysis was carried out using a lateral approach. Although our results are comparable, we had 12 patients with mixed contractures, and only 5 with isolated extrinsic elbow contractures (1 patient had an isolated intrinsic contracture in our series).

Like Heirweg and De Smet[14] we found a decrease between the immediate postoperative ROM and the ROM measured at follow-up. In our study, the patients decreased their ROM in flexion-extension by 7.77 degrees (−35 to 0 degrees).

The timing of the arthrolysis is controversial. Chantelot et al[7] did not find any correlation between the interval trauma-arthrolysis and the results. However, like Lahoda et al,[15] we observed that patients who underwent the arthrolysis procedure within the first year of initial trauma had statistically significant clinical improvement. We assume that in chronic contractures, the changes in the soft tissues, especially the muscles, are less reversible. Blauth et al[16] stated that the exact course of an open arthrolysis cannot be standardized. We believe that the procedure must be individually adapted to each patient. In our study, the surgical exposures were carried out according to Morrey's description. We chose the approaches according to the initial incisions (if any), and to the type of contracture encountered and the surgical techniques were adapted accordingly. The limitations of our study are the small number of patients and a mean follow-up time of only 16 months (6 to 43). However, we think that time frame is sufficient to evaluate the primary outcome of the surgical procedure, as we did not find any significant change of mobility after 6 months from the surgery. It is likely, however, that the follow-up time is insufficient to analyze the effect of the procedure on posttraumatic elbow osteoarthritis.

CONCLUSIONS

We found that elbow arthrolysis is an efficient procedure, with a mean increase in ROM of 40 degrees. The preoperative ROM and the delay between trauma and arthrolysis influenced the outcome: the more severe the preoperative ROM and the shorter delay to arthrolysis, the better the gain in mobility. The best results, in terms of elbow motion and patient satisfaction, were obtained for patients with severe stiffness operated on within the first year after initial trauma. We therefore try to perform the procedure as soon as the local conditions are stable (healed fracture and no increase in ROM with physiotherapy); usually between 6 and 12 months postsurgery. The type of elbow contracture does not influence the results of the surgery nor should a severe elbow contracture be considered as a contraindication for the surgery. In summary, open elbow arthrolysis provides encouraging objective and subjective results for patients with posttraumatic elbow contractures.

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