Arthroscopic Wrist Arthrolysis After Wrist Fracture

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Purpose: To evaluate the results of this surgical procedure in patients affected by wrist stiffness after wrist fracture. Criteria for patient inclusion in our preoperative and postoperative study were wrist stiffness with or without pain, decreased grip strength, and unsuccessful results 3 to 6 months after following a rehabilitation program. **Methods:** From 1988 to 2003, surgery was performed in 22 patients (16 men and 6 women) with a mean age of 37 years. Radiocarpal, midcarpal, and distal radioulnar joint portals were used in relation to the site of rigidity. Statistical evaluation was performed in all cases. **Results:** At a mean follow-up of 28 months (range, 9 to 144 months), no complications were documented. One case that was operated on bilaterally successively required an additional right wrist arthroscopic arthrolysis to reach the same level of improvement as that of the contralateral side. Pain was almost absent in all cases ($P < .0001$), and mean flexion/extension range of motion increased from 84° preoperatively to 99° postoperatively, mean pronation/supination increased from 144° to 159°, and mean grip strength increased from 22 to 28 kg ($P < .0001$). The mean modified Mayo wrist score improved from 28 to 79 postoperatively ($P < .0001$), and the mean postoperative score on the Disabilities of the Arm, Shoulder and Hand questionnaire was 21 points. **Conclusions:** Arthroscopic wrist arthrolysis is a suitable and promising surgical option for the treatment of wrist rigidity after trauma or surgery. In our series pain and wrist flexion-extension and grip strength significantly improved. The procedure is safe and required a minimal amount of invasive surgery while also permitting the surgeon to identify the precise cause of the intra-articular rigidity and pain. **Level of Evidence:** Level IV, therapeutic case series. **Key Words:** Wrist arthroscopy—Wrist stiffness—Arthrolysis.

Wrist stiffness is the most common complication from either trauma with or without extra-articular or intra-articular fractures (or both) or surgery (Table 1).[1] Rehabilitation of the wrist is the treatment of choice when a patient presents with persistant wrist stiffness for more than 3 to 6 months. Wrist manipulation under anesthesia may be used in cases in which a rehabilitation regimen has failed to produce increased wrist range of motion (ROM). However, this procedure can also be dangerous by provoking further damage, such as ligament lesions or bone fractures (ulnar head fractures).

Surgical arthrolysis is an alternative option that can be performed via open surgery or arthroscopy. Open surgical arthrolysis is rarely performed in cases of flexion-extension rigidity but is frequently used for distal radioulnar joint wrist rigidity, in which pronation-supination ROM is affected.[2]

Arthroscopic arthrolysis[3] is a new procedure that allows the surgeon to treat all of the wrist joints, without running the risk of causing secondary damage to the articulations involved and, at the same time, permitting immediate postoperative mobilization.[3-8] The purpose of our study was to show the efficacy of wrist arthrolysis in the treatment of wrist

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TABLE 1. *Possible Causes of Secondary Wrist Rigidity (Extra-articular or Intra-articular)*

After trauma
Fracture
Fracture-dislocation
Dislocation
Ligament lesion
After surgery
Dorsal wrist ganglia recurrence
Treatment of scaphoid fracture/nonunion
Intercarpal arthrodesis (4-bone fusion and so on)
Ligament reconstruction (SL ligament and so on)
Proximal row carpectomy
Prolonged immobilization
Erroneous wrist immobilization

Abbreviation: SL, scapholunate.

stiffness as a result of a distal radius fracture in terms of increased wrist ROM and function.

METHODS

This study was performed from 1988 to 2003 and includes 22 patients (16 men and 6 women) with a mean age of 37 years, all of whom are right hand–dominant. The right hand was affected in 11 cases. One of our cases was operated on bilaterally and successively required an additional right wrist arthroscopic arthrolysis to reach the same level of improvement as that of the contralateral side. All of the cases had incurred wrist rigidity as a result of prolonged immobilization after wrist fracture.

The patients were accepted into the study according to the following inclusion and exclusion criteria. Our primary indication for selecting surgical candidates was based on the subject's level of wrist rigidity associated with or without pain, considering that wrist rigidity alone was not important enough to require arthroscopic arthrolysis, but when associated with pain, this surgical technique is strongly indicated. The second indication for surgery was the presence of decreased grip strength and unsuccessful results after 3 to 6 months of rehabilitation. Patients with incomplete preoperative and postoperative evaluations were excluded from this study.

Ligament lesions, such as complete scapholunate, lunotriquetral, or type 1B triangular fibrocartilage complex (TFCC) tears, can be associated with wrist rigidity. When ligament injuries were present, they were considered conditions in which arthroscopic arthrolysis was not indicated. Those injuries must be treated first, followed by a waiting period of 3 or more months until wrist stability has been achieved, before an arthroscopic arthrolysis procedure should be performed. Patients with bony anchylosis verified by radiographs or wrist rigidity resulting from reflex sympathetic dystrophy were also excluded from this study.

Surgical Technique

The radiocarpal, midcarpal, and distal radioulnar joint portals are the arthroscopic surgical approaches of choice. Wrist arthrolysis may be performed by use of both traditional and more elaborate instruments (Table 2).

Although arthroscopy starts at the level of the radiocarpal joint, the midcarpal joint should always be thoroughly evaluated. When there is a loss of articular ROM in pronation/supination, arthrolysis of the distal radioulnar joint may also be performed.

Radiocarpal joint: With regard to the radiocarpal joint, all of the portals (1-2, 3-4, 4-5, 6R, and 6U) can be used, including the volar portal, when needed. However, in our experience 1-2, 3-4, and 6R are the most common portals and are most frequently used.

Fibrotic adhesions are initially removed with the appropriate instruments (laser and radiofrequency instruments). This procedure is frequently sufficient to improve wrist ROM. When needed, the volar or dorsal radiocarpal ligaments may be resected from the border of the radius to improve wrist ROM. Miniblade, laser, or radiofrequency instruments are used to resect the ligament. Complete dorsal capsulotomy sometimes may require a volar approach.[9] It is very important to remember that the volar and dorsal ulnar ligaments should not be resected.[4] Ulnar translation of the carpal bones has not been reported after resection of the radial ligaments.[4]

Limited articular steps (Fig 1) of the radius (<1 mm) may be leveled, when possible. TFCC central tears are also treated: the flap is removed, and the borders are cleaned. When the patient presents with an ulnar-carpal impingement, the ulnar head may be treated with a wafer arthroscopic resection. However, when the ulnar-plus variance is up to 4 mm, the correct

TABLE 2. *Instruments for Arthroscopic Arthrolysis*

Motor-powered	Suction punch
Full radius blade	Mini-scalpel (banana blade)
Cutter blade	Laser
Razor cut blade	Radiofrequency
Barrel abrader	Dissector and scalpel

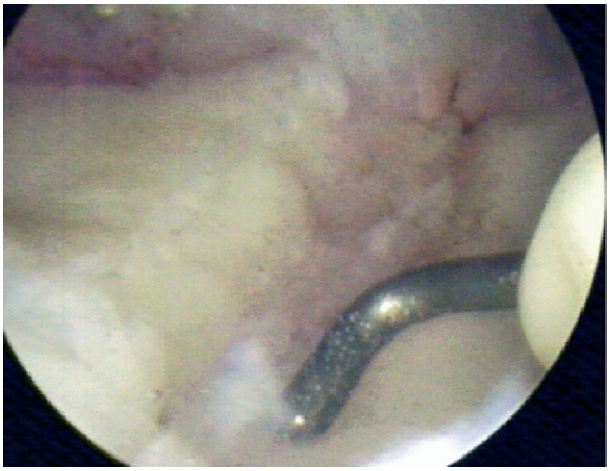

FIGURE 1. Evidence of articular step-off after fracture after joint debridement.

indication is ulnar shortening. Chondritis should also be treated by chondroplasty. The loose bodies should be removed if they are found inside the articulation.

At the end of surgery, wrist manipulation is performed to evaluate its ROM and whether there has been an improvement in articular excursion (Fig 2A-2E).

Midcarpal joint: The inspection of the midcarpal joint should be done via the 2 common portals (radial and ulnar) only to determine the cause of wrist pain that has been addressed by a preoperative clinical examination.

Distal radioulnar joint: It is very unusual to have good visibility of the distal radioulnar joint even under normal conditions. Stiffness of this joint results from synovitis and fibrosis, which in turn increases the difficulty of performing arthroscopy. With regard to the radiocarpal joint, manipulation of this joint with the patient under anesthesia is performed first. Only when pronation/supination does not improve is it indicated for the arthroscope to be placed in the joint to evaluate the extent of adhesions present. Then, by use of appropriate instruments, these adhesions are gently detached from the articular surfaces of the ulnar head and the sigmoid facet of the radius, as well as between the ulnar head and the proximal part of the TFCC ligament.

In cases in which joint arthroscopy begins to take a prolonged amount of time and becomes quite tedious, it is convenient to introduce a dissector into the proximal portal and to detach the adhesions between the ulnar head and the sigmoid fossa or to resect the volar capsule from the bone. The dissector can also be introduced through the distal portal, and then one should perform resection of the adhesions between the ulnar head and the ulnar surface of the TFCC. These maneuvers usually result in a good improvement in wrist pronation/supination ROM.

The duration of each arthroscopic surgery was accurately measured and recorded. Additional surgery for carpal tunnel syndrome and wrist denervation was permitted in 5 cases because it did not interfere with the postoperative rehabilitation program.

Postoperative Treatment

Rehabilitation is started immediately after surgery. Pain control may sometimes require the use of a pain-reducing pharmaceutical. Pronation-supination and flexion-extension exercises are performed for almost 3 months, gradually increasing the number of repetitions and amount of resistance applied. Hydrotherapy is the initial treatment of choice, and the patient can gradually progress to exercising in antigravity postures out of the water. Passive, active, and active-assisted exercises are performed by the patient, with the guidance of a physical therapist.

Return to work is limited until 3 months or in relation to the job requirements of the subject. A palmar wrist splint is used to protect the articulation when the subject must perform heavy labor activities. Work-specific training and endurance-strengthening exercises via isokinetic and isotonic rehabilitation equipment can be initiated 1 month after surgery under the strict supervision of a physical therapist. The patient protocol is individualized depending on the strength requirements that he or she needs to obtain to perform his or her job. It is advisable that the physical therapist perform ergonomic evaluation at the patient's work site to establish a specific rehabilitation program and to quantify the forces required of the patient's entire upper extremity to perform his or her work duties.[10]

Method of Evaluation

A protocol for evaluation was established prospectively. All of the patients had preoperative and postoperative x-ray films. Preoperative and postoperative clinical evaluation quantified pain, wrist ROM, and grip strength. Pain was evaluated by use of a visual analog scale ranging from 0 to 10 points. Wrist ROM included flexion-extension, pronation-supination, and radioulnar deviation and was evaluated goniometrically. Grip strength was evaluated in kilograms by use of a dynamometer (Jamar; Preston, Jackson, MI). Each patient was evaluated clinically by use of the

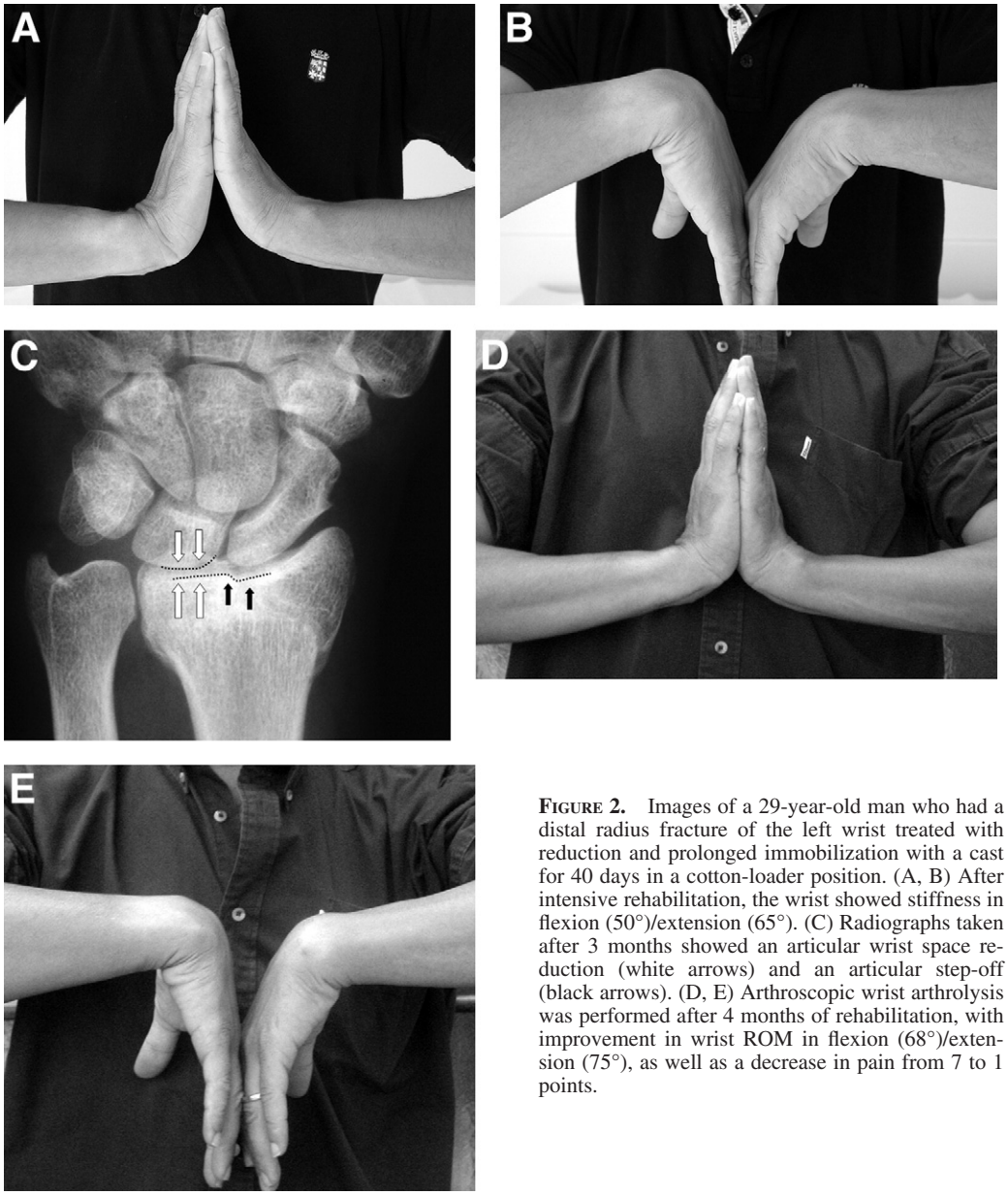

Figure 2. Images of a 29-year-old man who had a distal radius fracture of the left wrist treated with reduction and prolonged immobilization with a cast for 40 days in a cotton-loader position. (A, B) After intensive rehabilitation, the wrist showed stiffness in flexion (50°)/extension (65°). (C) Radiographs taken after 3 months showed an articular wrist space reduction (white arrows) and an articular step-off (black arrows). (D, E) Arthroscopic wrist arthrolysis was performed after 4 months of rehabilitation, with improvement in wrist ROM in flexion (68°)/extension (75°), as well as a decrease in pain from 7 to 1 points.

Mayo wrist score (0 to 100 points) as modified by Cooney and Bussey.[11] The best values were considered those that almost reached 100 points. The Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire was included in the postoperative checkup (Table 3).

Statistical Analysis

Preoperative and postoperative data for pain, wrist ROM, grip strength, and Mayo score were compared statistically in 22 cases by use of the 2-tailed matched-pair Student *t* test.

RESULTS

The duration of arthroscopic surgery ranged from 1 to 1.5 hours in almost all operative cases. The 3-4 and 6R portals were used for the radiocarpal joint. The 1-2 portal was used 3 times to obtain a better arthrolysis from the scaphoid and radial styloid, whereas the 6U

TABLE 3. *Preoperative and Postoperative Evaluation*

Mayo wrist score
Pain (visual analog scale)
Wrist ROM (°)
Grip strength (kg or %)
Work status
DASH questionnaire (postoperatively)

portal was used only once. The midcarpal joint was evaluated in 5 cases and the distal radioulnar joint in 2 to improve pronation-supination.

Intraoperative findings showed the presence of fibrotic bands between the radius and carpal bones (scaphoid or lunate bones, scapholunate ligament) in all cases. The intra-articular position of the fibrotic bands depended on the type of previous damage. In 3 cases fibrotic bands were also located in the ulnocarpal joint. Loose bodies were found in 9 cases. Osteochondral injuries and articular step-off were frequently recorded on the articular surface of the radius, and these were also shown to be correlated with those cases with the least improvement in ROM and residual pain after surgery. Scapholunate ligament partial tears (proximal portion) were found in 5 cases and treated by debridement. TFCC central tears were found in 4 cases; 2 of them had an ulnar-plus variance with carpal abutment that required a wafer resection.

All cases were clinically re-evaluated at a mean follow-up of 28 months (range, 9 to 144 months). No complications were documented.

In all 22 cases pain was significantly diminished or completely absent, and wrist ROM and grip strength were improved (Table 4). The mean modified Mayo wrist score improved from 28 preoperatively to 79 postoperatively, and the mean score on the DASH questionnaire was 21 points.

Analysis of the results showed that all of the parameters (pain, wrist ROM, and grip strength) yielded statistically significant results ($P < .0001$) (Table 4). In addition, the Mayo score yielded statistically significant results ($P < .0001$).

DISCUSSION

Various authors have reported that wrist stiffness that is a residual complication due to a traumatic capsular wrist contracture can improve with wrist athroscopy because it permits selective resection of the volar and dorsal radiocarpal joint.[4-6,12]

Verhellen and Bain[5] reported that arthroscopic arthrolysis cannot harm the medial nerve and radial artery because these important anatomic structures are at a safe distance from the site of the ligament resection (from 5 to 6 mm). Our results in fact did not demonstrate this complication.

A comparison among previous publications regarding the improvement of wrist ROM after arthroscopic wrist arthrolysis is reported in Table 5.

Compared with the reports of Verhellen and Bain[5] and Osterman et al.,[6] our cases had greater preoperative wrist ROM but the final results regarding wrist motion were almost the same. We believe that these results are due to the fact that we were extremely selective in choosing appropriate participants for this study. However, the final results of this series showed that the best recovery parameters were achieved.

Our experience consists of only 22 cases studied from 1988 to 2003. The small number of cases resulted from our selective inclusion and exclusion criteria based on the patients' condition after fracture. The arthroscopic surgical procedure was not altered from the start of the study, and all patients underwent a complete review for this study both clinically and radiographically. Although

TABLE 4. *Results*

	Preoperatively		Postoperatively		Difference		95% Confidence Interval				
	Mean	SD	Mean	SD	Mean	SD	Upper	Lower	*t*	*df*	*P* Value (2-Tailed)
Pain	7.73	1.86	2.09	2.64	5.64	3.02	4.30	6.97	8.7640	21	< .001
Flexion-extension (°)	83.64	28.86	98.68	19.53	−15.05	18.16	−23.10	−6.99	−3.8861	21	< .001
Radial-ulnar (°)	42.82	10.88	47.18	10.93	−4.36	12.86	−10.07	1.34	−1.5910	21	.127 (not significant)
Pronation-supination (°)	143.95	34.44	159.09	18.23	−15.14	22.21	−24.98	−5.29	−3.1970	21	< .01
Grip (kg)	22.36	10.36	28.36	9.65	−6.00	6.44	−8.86	−3.14	−4.3673	21	< .001
Mayo wrist score	28.18	14.76	79.09	12.31	−50.91	12.50	−56.45	−45.37	−19.1011	21	< .001

NOTE. All data were obtained in 22 patients.

TABLE 5. *Comparison Among Previous Studies in Literature*

Authors	No. of Cases	Follow-up (mos)	Flexion/Extension (°) (Mean)	
			Preoperatively	Postoperatively
Pederzini et al.,[3] 1991	5	10	44/40	54/60
Verhellen and Bain,[5] 2000	5	6	17/10	47/50
Osterman et al.,[6] 2000	20	32	9/15	42/58
Luchetti et al.,[8] 2001	19	32	46/38	54/53
Hattori et al.,[12] 2004	11	Not reported	29/47	42/56

not all patients obtained complete wrist ROM, they all confirmed that they were satisfied with the obtained results, as shown by the Mayo wrist score ($P < .0001$) and DASH questionnaire results.

Arthroscopic wrist arthrolysis has been shown to be a difficult and time-consuming technical procedure because of the presence of thick and tenacious radiocarpal joint fibrotic bands that are very difficult to remove and release.

Arthroscopy can reveal associated pathologies that are considered to be the cause of the wrist pain. In our cases we frequently found arthrofibrosis of the radiocarpal septum, loose bodies, chondritis, osteochondritis, TFCC central tears associated with an ulnar-plus variance, partial tears of the intercarpal ligaments (scapholunate, lunotriquetral), or a minimal articular step, which was not evident from the radiographic or magnetic resonance imaging studies. This confirms the validity of arthroscopy in comparison to other methods of investigation.[13,14] Moreover, during the operation, it was possible to treat all of these conditions, thus improving both wrist pain and rigidity at the same time while obtaining efficient wrist function. The scarce results were correlated to a patient who presented with a radial articular step-off of 2 mm associated with lunate bone and lunate fossa chondritis.

CONCLUSIONS

Arthroscopic wrist arthrolysis is a suitable and promising surgical option for the treatment of wrist rigidity after trauma or surgery. In our series wrist flexion-extension improved from a mean of 84° to 99°. Pain also significantly decreased from 8 to 2 points (visual analog scale). The procedure is safe and required a minimal amount of invasive surgery while also permitting the surgeon to identify the precise cause of the intra-articular rigidity and pain.

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