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Arthroscopic treatment of chronic wrist pain after distal radius fractures

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Abstract

We report the arthroscopic and clinical findings of patients with chronic wrist pain following distal radius fracture (DRF) who underwent diagnostic arthroscopy and arthroscopically-assisted tailored treatment.

We retrospectively analyzed the records of 15 patients with chronic wrist pain following DRF, who underwent diagnostic arthroscopy and arthroscopically-assisted tailored treatment from 2010 to 2017. The average patient age was 44 years (range, 20–68 years), average time from injury to treatment 21 ± 23.46 months (range, 3–96 months) and average follow up period 20.13 ± 8.71 months (range, 12–39 months). The functional outcome was evaluated by comparing the preoperative and final follow up values of the range of motion, grip strength, pinch strength, visual analogue scale for pain and quick disabilities of the arm, shoulder and hand score.

Based on the arthroscopic findings, synovitis was found in all cases and the pathologic intra-articular lesions were classified into 4 patterns. Triangular fibrocartilage complex rupture was seen in 14 cases, intercarpal and radiocarpal ligament ruptures in 9 cases, ulnar impaction syndrome in 5 cases, and cartilage lesion in 9 cases. In terms of surgical treatment, 15 patients underwent arthroscopic synovectomy, 7 foveal or capsular repair of TFCC, 7 intercarpal Kirschner wires fixation or intercarpal thermal shrinkage, 1 intercarpal ligament reconstruction, 2 Sauve-Kapandji procedure, and 2 unlar shortening osteotomy. Postoperatively, the average range of motion, grip strength, and pinch strength increased significantly. From preoperative to final follow up values, the average visual analogue scale and quick disabilities of the arm score decreased from 5.93 ± 1.58 (range, 3–8) to 1.33 ± 1.29 (range, 0–3) ($P = .001$) and from 49.38 ± 19.09 to 12.63 ± 7.63 ($P = .001$), respectively.

Diagnostic arthroscopy and arthroscopically-assisted tailored treatment of chronic wrist pain following DRF can provide an accurate diagnosis, significant pain relief, and functional improvement.

Abbreviations: CT = computerized tomography, DASH = disabilities of the arm, DRF = distal radius fracture, DRUJ = distal radioulnar joint, K = Kirschner, MCU = mid-carpal ulna, MRI = magnetic resonance imaging, RC = radio-carpal, ROM = range of motion, shoulder and hand, SL = scapho-lunate, TFCC = triangular fibrocartilage complex, VAS = visual analogue scale.

Keywords: chronic pain, distal radius fracture, wrist arthroscopy

1. Introduction

It is observed that, distal radius fractures (DRFs) account for approximately 15% of all fractures in adults. Therefore, the management of these fractures is associated with a myriad of complications with complication rates as high as 31%.[1,2] Among these complications, residual chronic pain is common. Consequently, wrist and forearm motion are impaired by stiffness, thereby leading to dysfunction of the entire upper limb.

In order to overcome the aforementioned problem, an accurate delineation of the cause of pain is crucial for effective treatment. Arthroscopy has been used in treating intra-articular DRFs; however, the process is the associated soft tissue injuries requiring prompt treatment for better functional results.[3–6]

Nonetheless, few physicians generally accept this because it may result from the fracture or incompletely understood conditions such as associated soft tissue injuries.[7]

Moreover, previous publications were limited to the discussion of operative treatment for certain specific problems such as the correction of radius malunion or the treatment of TFCC injury or ulnar impaction.[8–11] However, in our opinion, the chronic pain arises from many complex causes. Thus, it is essential to treat the complex pathoanatomy in order to overcome the chronic wrist pain following DRF.

We performed wrist arthroscopy for patients with chronic wrist pain following DRFs, and conducted surgical treatment based on arthroscopic findings. In this report, we reveal the arthroscopic findings and the results of surgical treatment.

1.1. Consent

This study received approval from our institutional review board at Jeonbuk National University Hospital (2018-07-008-002).

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2. Material and methods

We reviewed a consecutive series of 15 patients with chronic wrist pain following DRF healing previously treated with diagnostic wrist arthroscopy and arthroscopically-assisted tailored treatment between 2010 and 2017. We excluded patients with DRF-associated nerve injuries; complications such as infection, compartment syndrome, and complex regional pain syndrome; and severe malunion that required corrective osteotomy during the DRF treatment. There were 9 males and 6 females with a mean age of 44 years (range, 20–68 years). All had unilateral involvement with 8 involving the right side. The injuries were caused by a simple slip in 12 cases, fall in 2 cases, and traffic-accident in 1 case. Initial treatment was administered in other hospitals in all cases. Ten (66.7%) cases were treated with conservatively, 3 with open reduction and internal fixation with locking plate, and 2 with closed reduction and percutaneous Kirschner (K)-wires fixation. Wrist arthroscopy was not performed as the initial treatment.

On initial examination, the mean radial length of all healed fractures was 12.13 ± 2.29 mm (range, 8–17 mm), mean radial inclination 23.20 ± 4.87° (range, 12–31°), mean volar tilt 2.33 ± 8.46° (range, –15–16°), and mean ulnar variance 1.53 ± 1.88 mm (range, −1–5) (Table 1).

The presenting symptoms included ulnar side pain in 8 cases, 2 of them with concomitant dorsal wrist pain. Generalized wrist pain was shown in 5 cases, 2 of them with aggravated pain during the wrist motion. The mean time interval from injury to surgery was 21 ± 23.46 months (range, 3–96 months). Computerized tomography or magnetic resonance imaging (MRI) scans were not done routinely. Diagnostic wrist arthroscopy with arthroscopic synovectomy was performed in all cases. The Palmer[12] and Geissler[13] classification were used for assessment of the TFCC and midcarpal space intercarpal ligaments, respectively. Additional treatment was administered based on the arthroscopic findings.

2.1. Surgical technique

The operation was performed under general anesthesia and the patient is positioned supine The operated arm was placed in a wrist traction tower and a vertical traction of 4 to 6 kg force was applied through plastic finger trap devices to the middle 3 fingers for joint distraction on a hand table. An arm tourniquet was not applied and a C-arm image intensifier was prepared for the percutaneous scaphoid fracture reduction and K-wires fixation.

We used a 2.5 or 1.9 mm video arthroscope (Linvatec, CONMED Linvatec, Utica, NY), 2.0 and 2.9 mm shavers, a 3.0 mm burr, and a radiofrequency probe as surgical instruments. A 3 liter bag of normal saline was used to instill continuous saline irrigation with the aid of gravity. We made 3/4 and 4/5 portals for the radio-carpal (RC) joint, and mid-carpal radial, mid-carpal ulna portal for the mid-carpal joint.

Initially, we inspected the RC joint. During arthroscopy, we keenly observed the status of the interosseous ligament, articular cartilage, the presence of synovitis, and other un-suspected pathologies. Thereafter, synovectomy was performed. The arthroscope was then transferred to the mid-carpal joint to examine the status of the articular cartilage and interosseous ligament. Thenceforth, we performed additional operation based on the arthroscopic findings.

Additional treatment was included in TFCC rupture, capsular TFCC repair (2), transosseous TFCC repair (5) (Fig. 1).[14,15] Debridement of TFCC was performed for traumatic rupture (2) and degenerative tears (5).[14] In intercarpal ligament rupture, we performed K-wires fixation after thermal shrinkage for Geissler grade II injury (3), only thermal shrinkage for Geissler grade II or III injury (4), scapho-lunate (SL) ligament reconstruction with palmaris longus tendon graft for Geissler grade IV injury (one) (Fig.e 2).[16,17] In ulnar impaction syndrome, we performed ulnar shortening osteotomy (2), arthroscopic debridement (1), Sauve-Kapandji procedure associated with distal radioulnar joint (DRUJ) osteoarthritis (2).[18,19] In chondral lesion, we conducted arthroscopic debridement (8) (Table 2).[20] We did not conduct corrective osteotomy for the radial malunion. Average follow up was 20.13 ± 8.71 months (range 12–39 months).

At the final follow up, patients were evaluated for wrist ROM, grip strength, pinch strength and these were compared with preoperative values. The functional outcome was evaluated from a comparison between preoperative and final follow up values of the quick DASH score and the VAS score for pain (0 = no pain, 10 = worst pain).[21]

Table 1

Demography of the patients.

Patients No.	Age	Sex	Injury site	Injury mechanism	Initial treatment*	Radial deformity†
1	31	M	Right	Slip down	Conservative	RL: 13, RI: 22, VT: –6, UV: 0
2	52	M	Right	Slip down	Conservative	RL: 10, RI: 20, VT: 0, UV: 2
3	51	M	Left	Fall down	ORIF with plate	RL: 10, RI: 20, VT: –5, UV: 0
4	31	M	Right	Fall down	ORIF with plate	RL: 14, RI: 24, VT: 10, UV: 0
5	34	M	Right	Traffic accident	Conservative	RL: 12, RI: 22, VT: 16, UV: 2
6	56	F	Right	Slip down	CRPP with K-wires	RL: 12, RI: 22, VT: 10, UV: 3
7	59	F	Left	Slip down	Conservative	RL: 8, RI: 12, VT: –5, UV: 5
8	52	F	Right	Slip down	Conservative	RL: 13, RI: 28, VT: 0, UV: 1
9	46	M	Right	Slip down	CRPP with K-wires	RL: 17, RI: 31, VT: 5, UV: 3
10	68	F	Right	Slip down	Conservative	RL: 10, RI: 21, VT: –15, UV: 0
11	58	F	Left	Slip down	Conservative	RL: 10, RI: 18, VT: –5, UV: 4
12	20	M	Left	Slip down	Conservative	RL: 13, RI: 27, VT: 8, UV: 0
13	22	M	Left	Slip down	Conservative	RL: 12, RI: 25, VT: 7, UV: -1
14	35	M	Left	Slip down	Conservative	RL: 15, RI: 29, VT: 0, UV: 0
15	48	F	Left	Slip down	ORIF c Plate	RL: 13, RI: 27, VT: 15, UV: 4

* CRPP = closed reduction and percutaneous pinning, ORIF = open reduction and internal fixation.

† RI = radial inclination(°), RL = radial length(mm), VT = volar tilt(°), UV = ulnar variance(mm).

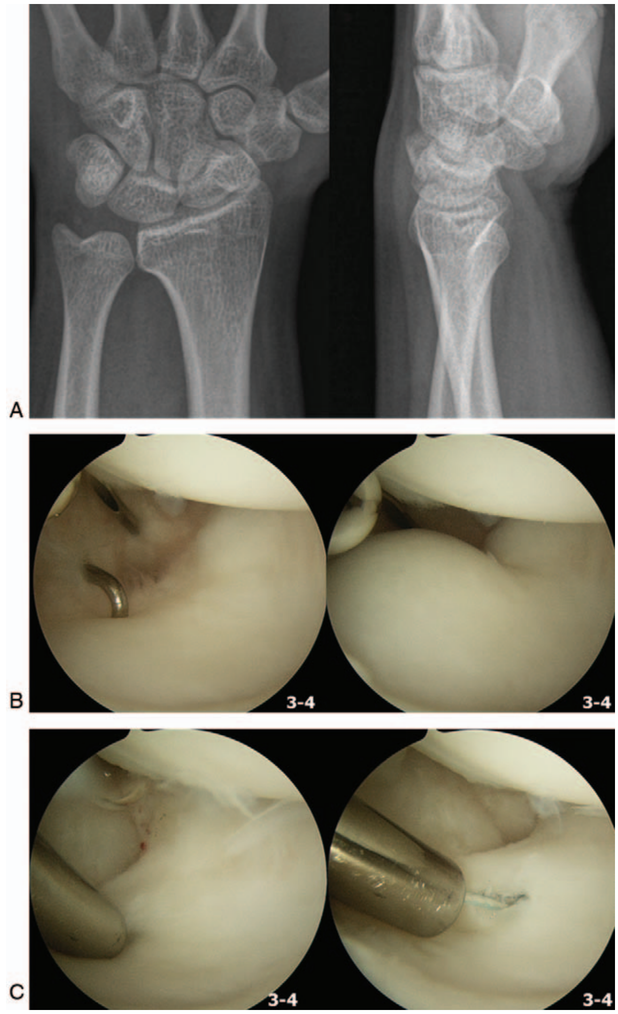

Figure 1. Case 13, (A) Preoperative plain radiograph of the left wrist shows mild distal radius malunion; radial length 12 mm, radial inclination 25°, volar tilt 7°, and ulnar variance -1 mm. (B) Intraoperative arthroscopic views show the positive hook test. (Left) The probe is inserted through the 6R portal, (Right) The triangular fibrocartilage complex (TFCC) is folded and pulled upward and radially by the probe when traction is applied to the ulnar prestyloid recess. (C) Intraoperative arthroscopic view showing the TFCC repairing using the single-lumen curved guide and 2 to 0 fiberwire (Arthres, Naples, FL). (D) Intraoperative arthroscopic view showing the TFCC is pushed forcefully against the fovea of the distal ulna. (E) Intraoperative photograph showing transosseous pull-put suture repairing. Both suture ends are pulled out through the bone tunnel to reduce the TFCC to the fovea and fixed tightly by knotting over the distal ulnar cortex. (F) Postoperative views 26 months later, showing improved functional results.

2.2. Statistical analysis

IBM SPSS version 20.0 (IBM Corp., Armonk, NY) software was used for the statistical analysis. The Wilcoxon signed rank test was used to compare the preoperative and follow up ROM, grip strength, pinch strength, VAS for pain and quick DASH score changes. *P* values < .05 were considered statically significant.[22]

3. Results

On physical examination, a positive axial compression test and foveal sign were main findings observed in 12 (80%) patients. Definitive DRUJ instability was seen in 4 patients; however, in 2 of them, it was associated to ulnar styloid process fractures. We found 4 patterns of pathoanatomy in the wrist based on radiographic and arthroscopic assessment: TFCC rupture in 14 patients, intercarpal and RC ligament rupture in 9 (60%) patients, ulnar impaction syndrome caused by radial malunion and shorteing in 5 (33.3%) patients, and chondral lesion in 9 (60%) patients. Traumatic synovitis was seen in all 15 patients (Table 3). Of 14 TFCC tears, 9 were traumatic (2 Palmar type Ia, 5 Ib fovea, 2 Ib capsular), 5 were degenerative tear (1 Palamr type IIb, 4 IIc). Eight (88.9%) of 9 intercarpal and RC ligament tear were SL ligament tears; among them, 3 patients combined with luno-triquetral ligament tear and 1 patient combined with RC ligament tear. The other 1 patient had only a long radio-lunate ligament tear. In the 5 ulnar impaction syndromes, the mean radial length was 12.6 mm, mean radial inclination was 24°, mean volar tilt was 5°, and mean ulnar variance was 3.2 mm. In 9 chondral lesions, 6 were lunate chondral lesions while 3 involved the radial articular surface (Table 2). There were 6 patients (40%) with multiple combined injuries including TFCC tear, intercarpal, and RC ligament rupture and chondral lesions without traumatic synovitis. Seven patients were treated with 2 more operative measures except arthroscopic synovectomy.

The mean final follow up and preoperative wrist ROMs were, respectively, improved to 88.06 ± 11.46% and 76.09 ± 12.36% of those of the normal side (*P* = .001). The average percentage improvement of the mean grip strength with respect to the normal

Figure 1. (Continued).

moved from 65.27±21.95% preoperatively to 82.77±13.67% at the final follow up (P=.002). The average VAS score decreased from 5.93±1.58 preoperatively to 1.33±1.29 at the final follow up (P=.001). Clinically, the patients were evaluated using the quick DASH score whose average decreased from 49.38±19.09 preoperatively to 12.63±7.63 at the final follow up (P=.001). No complications occurred (Table 2).

4. Discussion

Chronic pain is defined as the pain lasting beyond the anticipated point of tissue healing, typically over a 3-months duration. Approximately 16% those with DRFs continue to report wrist and hand pain even 1 year following the injury.[23] Personal factors, such as age, female sex, education level, job type, compensation status, and pathoanatomical factors could be considered as the causes of chronic wrist pain. The exact pathoanatomical factors remain unknown; however, Cheng et al[24] reported that the etiologies of pain were multifactorial. For example, ulnar impaction was caused by radial malunion and shortening, ulnar styloid nonunion, TFCC tear with or without DRUJ instability, intercarpal ligament injuries, and chondral lesions. Geissler described that partial or complete ligament tears of the wrist not detected on plain radiographs may be a possible explanation.[25] Of the 143 and 283 patients with DRF who received conservative and surgical treatment, respectively, during 2010 to 2017 at our department and were followed up for a minimum of 1 year, none had chronic wrist pain that required further surgical treatment.

Careful clinical assessment should be done based on the possible causes of pain such as intercarpal ligament and DRUJ instabilities and ulnar impaction syndrome. Plain radiographic assessment is done essentially to demonstrate the radial malunion, ulnar variance and the SL distance.[26] MRI may not be accurate because of the post-traumatic change and is especially unhelpful in the investigation of suspected carpal instability especially.[24,27] Wrist arthroscopy is the gold-standard diagnostic tool and should be carried out as early as possible to get an accurate diagnosis.[24,25,28] It is advantageous in the treatment of DRF in that it provides an excellent view of the articular surface with minimal soft-tissue disruption, it can restore the anatomy of the articular surface, it removes fracture debris and small cartilage loose bodies, and it may detect and simultaneously treat associated important carpal ligament and TFCC tears not apparent on plain radiographs.[25,29] However, recently, a number of studies have reported better results with the use of a volar locking plate system,

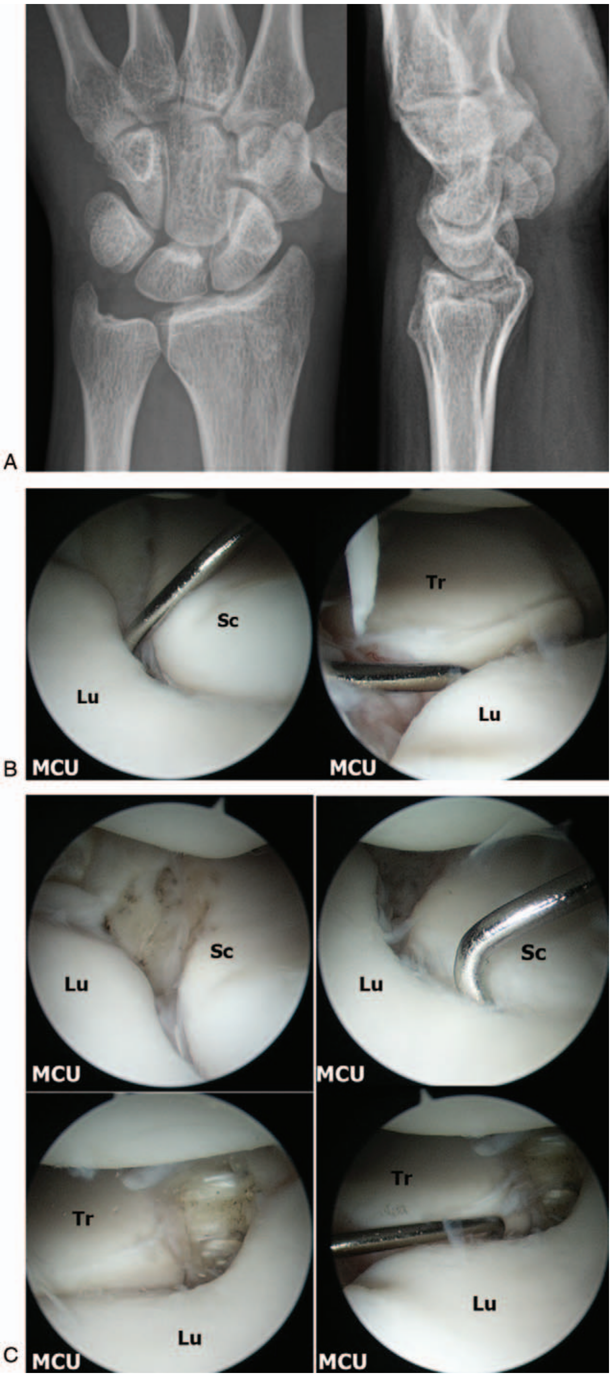

Figure 2. Case 14, (A) Preoperative plain radiographs of the left wrist show mild distal radius malunion; radial length 15 mm, radial inclination 29°, volar tilt 0°, ulnar variance 0 mm, and scapho-lunate angle about 74°. (B) Intraoperative arthroscopic views showing Geissler grade II instability of the scapho-lunate (SL) and luno-triquetral (LT) ligament (Lu = lunate, MCU = midcarpal ulnar, Sc = scaphoid, Tr = triquetrum). (C) Intraoperative arthroscopic views showing thermal shrinkage performed on the SL and LT ligament (left) and the SL and LT joints fixed by Kirschner-wires to the SL joint after thermal shrinkage (right). (D) Postoperative plain radiographs showing SL and radio-lunate joints Kirschner-wires fixation and about 45° SL angle. (E) Postoperative views 30 months later, showing clinically improved findings while the SL angle increased from 45° to 60° after surgery.

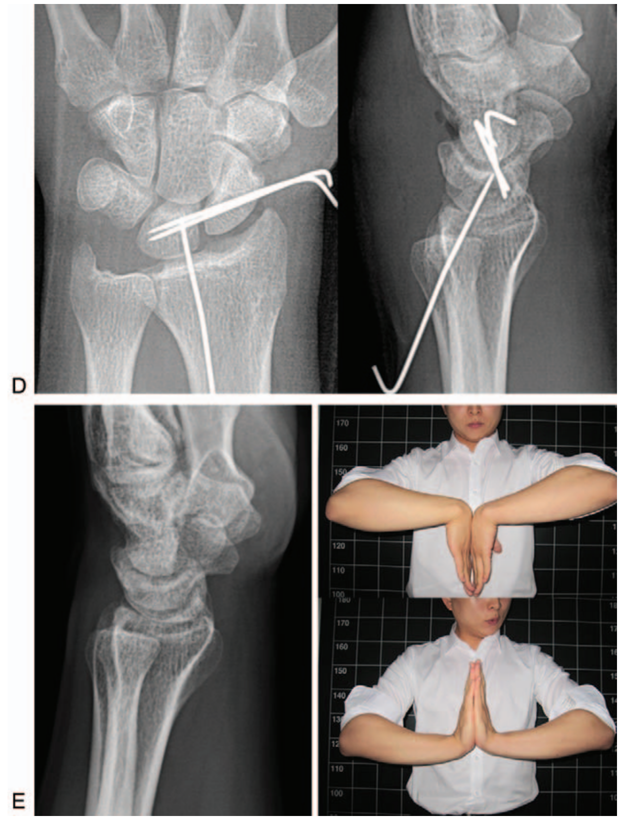

Figure 2. (Continued).

rather than external fixator, for the treatment of unstable DRF.[30,31] Yamazaki et al[32] reported that arthroscopic reduction conferred no advantage over conventional fluoroscopic guidance in achieving anatomical reduction of intra-articular DRF when using a volar locking plate. Nonetheless, their study was limited as much as they did not assess soft-tissue injuries. Yoshida et al[33] reported that residual chronic pain that is related to intercarpal ligament injury could occur even with the successful restoration of the skeletal and articular anatomy in high-energy DRFs with open reduction and internal fixation. Therefore they restressed the advantages of wrist arthroscopy in the simultaneous diagnosis and treatment of soft tissue injury. The authors of this study also concomitantly perform wrist arthroscopic examination with open reduction and internal fixation in young adults with DRFs by high-energy injuries. The slip-down mechanism of injury ranked the highest in frequency, occurring in 12 patients. Of these patients, 9 received conservative treatment; 2 closed reduction and percutaneous K-wires fixation; and 1 open reduction and internal fixation with volar locking plates. The causes of pain in these patients were thought to be bony subsidence and joint movement before sufficient immobilization during conservative treatment and post-operative treatment, which alters the recovery of intercarpal ligaments and TFCC. Therefore, it is difficult to conclude whether DRF comminution and pain are related.

We did not routinely perform MRI examination as we did wrist arthroscopy in all patients. Abnormal arthroscopic findings were traumatic synovitis, TFCC rupture, intercarpal ligament rupture, RC ligament rupture, ulnar impaction syndrome, and chondral injury. The causes of chronic pain were complicated. As many as 6 patients (40%) had multiple combined causes of pain such as TFCC tear, intercarpal and RC ligament rupture and chondral lesions. Chen et al[24] outlined that 31.3% of patients

Table 2

Surgical procedures and outcomes.

Patients No	Procedures*	Follow up (m)	VAS† (Pre/last f/u)	Grip strength (% of normal) (Pre/last f/u)	ROM‡ (% of normal side) (Pre/ Last f/u)	Quick DASH§ (Pre/ Last f/u)
1	TFCC transosseous repair	13	4/1	44.44/75.55	88.88/97.77	25/9.1
2	Synovectomy	12	8/3	40/83.33	91.17/94.11	54.5/15.3
3	TFCC capsular repair, S-L pinning	16	7/3	43.33/66.66	61.11/69.44	62.5/22.5
4	L-T pinning	39	5/1	75/90	66.66/75	52.2/13.5
5	TFCC transosseous repair, S-L thermal shrinkage	15	6/0	25/75	61.9/85.71	90.75/22.7
6	Sauve-Kapandji procedure	23	6/0	47.61/57.14	76.47/82.35	66.71/18.75
7	S-L reconstruction, Sauve-Kapandji procedure	12	7/0	43.47/91.30	52.94/70.58	52.2/0
8	Synovectomy	24	7/3	60.86/65.21	80.55/86.11	50/11.2
9	USO	12	6/0	76.92/92.30	61.76/85.29	43.3/15.3
10	TFCC capsular repair, S-L thermal shrinkage	15	7/2	54.54/71.72	80.55/80.55	50/20.2
11	TFCC foveal repair, S-L, L-T thermal shrinkage	12	8/2	90.9/100	89.65/110.34	56.8/13.6
12	TFCC foveal transosseous repair	20	7/3	83.33/83.33	84.82/100	45.5/6.8
13	TFCC foveal transosseous repair	26	3/0	78.26/100	80.95/107.1	27.3/2.3
14	S-L, L-T thermal shrinkage, K-wires fixation	33	4/0	112.5/100	94.5/99.1	18.2/0
15	S-L thermal shrinkage, USO	30	4/2	60/90	69.5/87.5	56.8 / 18.2

* K = Kirschner, L-T = luno-triquetral, S-L = scapho-lunate, TFCC = triangular fibrocartilage complex, USO = ulnar shortening osteotomy.
† Last f/u = last follow up, Pre = preoperation, VAS = visual analogue scale.,
‡ ROM = range of motion.
§ DASH = disabilities of the arm.

had pain due to ulnar styloid nonunion; however, they made no mention of RC ligament rupture. We did not experience styloid nonunion as a cause of pain; nonetheless, we experienced partial RC ligament rupture in 2 patients.

We performed additional surgery based on the arthroscopic findings. As many as 7 patients (46.7%) received 2 more surgical methods. Corrective osteotomy was not performed for radial malunion because there were no included cases according to the criteria of Haase and Chung.[34]

This study had several limitations. First, the sample size was small and each patient had several pathology; therefore, we did not evaluate the results of each treatment. Second, all patients were diagnosed with only wrist arthroscopy; therefore, we could not estimate the correlations between the radiological parameter

Table 3

Clinical and arthroscopic findings.

Patients No	Symptoms	Symptoms Duration (min)	Positive signs	DRUJ/ulnar styloid Fx	TFCC* (palmar classification)12	Ligaments† (Geissler classification)13)	Others‡
1	Ulnar side pain	19	Fovea	Instability/−	Ib foveal rupture		Ulnar synovitis
2	Wrist pain	12	Axial compression Swelling	/−	Ia	Long RL partial	Lunate CD, AF
3	Wrist pain	3	Volar tenderness Fovea	/−	Ib capsular rupture	S-L (II)	Lunate & lunate fossa CD
4	Wrist pain, aggravation during motion	9	Radial, dorsal tenderness during flexion	/−	Ia	S-L, L-T (II)	Scaphoid & lunate fossa CD, AF
5	Wrist pain, aggravation during motion	6	Axial compression, dorsal pain during extension	/−	Ib foveal rupture	S-L (II)	Synovitis, lunate fossa CD, AF
6	Ulnar side pain	12	Axial compression	/+	IIC		Synovitis, lunate CD
7	Dorsal and ulnar side pain	36	Dorsal & ulnar tenderness	/−	IIC	S-L (IV), long RL partial	Synovitis, lunate & ulnar head CD
8	Ulnar side pain	3	Axial compression	/+	IIB		Ulnar synovitis, lunate chondromalacia
9	Ulnar side pain	12	Axial compression	/−	IIC		Synovitis, lunate CD
10	Wrist pain	29	Fovea	/−	Ib capsular rupture	S-L (II)	Ulnar synovitis
11	Ulnar side pain	11	Axial compression, fovea	Instability/−	Ib foveal rupture	S-L, L-T (III)	Ulnar synovitis
12	Ulnar side pain	7	Fovea	Instability/+	Ib foveal rupture		Ulnar synovitis
13	Ulnar side pain	96	Fovea	Instability/+	Ib foveal rupture		Ulnar synovitis
14	Dorsal pain	24	S-L shift	/−		S-L, L-T(II)	Dorso-radial synovitis
15	Dorsal and ulnar side pain	36	Fovea, S-L shift	/−	IIC	S-L(II)	AF, lunate & ulnar head chondromalacia

* TFCC = triangular fibrocartilage complex.
† L-T = lunotriquetral ligament, RL = radiolunate ligament, S-L = scapholunate ligament.
‡ AF = arthrofibrosis, CD = chondral defect.

and pathoanatomical structures. Third, the follow up was relatively short. Thus, studies with a longer follow up are required to identify the disease progression in patients with chondral injury treated with only arthroscopic debridement.

5. Conclusion

The use of arthroscopy and open reduction with plate fixation can decrease the incidence of chronic wrist pain following DRF healing. However, conservative treatment is accepted as a main treatment modality for DRFs. Moreover, wrist arthroscopy is not performed in all patients with DRFs because of variable factors such as invasiveness, high cost, and lack of expertise. We stress that early accurate diagnosis using wrist arthroscopy and proper surgical treatment based on arthroscopic findings without radial corrective osteotomy will yield good results in patients with chronic wrist pain following DRF healing with minimal radial malunion.

Author contributions

Conceptualization: Young keun Lee.
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Formal analysis: Young keun Lee, Tae-Young Kwon.
Funding acquisition: Young keun Lee.
Methodology: Young keun Lee, Ha-Song Lee.
Writing – original draft: Young keun Lee.
Writing – review & editing: Young keun Lee.

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