Outcomes Following Temporary Kapandji Pinning Technique and Distal Radial LCP Fixation for Intra-Articular Fractures of the Displaced Distal Radius

Puripun Jirangkul, MD, Surasak Jitprapaikulsarn, MD,† and Thawee Songpatanaslip, MD, PhD**

Abstract: In partially or completely displaced intra-articular fracture of the distal radius , achieving satisfactory reduction and maintenance of good reduction before applying the plate may be difficult. Especially to accomplish the anatomic volar tilt remains a problem. Typically, the Kapandji technique has been described to reduce and stabilize a large displaced and extra-articular fracture of the distal radius. We present the results of a prospective series using the temporary Kapandji technique for K-wire intrafocal fixation followed by rigid fixation with distal radial locking compression plate. The mean follow-up period totaled 12 months. A total of 57 patients were evaluated by radiographic and clinical review. The modified Mayo wrist score was used for postoperative patient evaluation. The clinical results on follow-up were good to excellent. Minimal joint stiffness and functional outcomes of the wrist and elbow were satisfactory. Statically significant differences were found between the preoperative and postoperative radiologic parameters. No skin infection due to K-wire insertion was noted, and the fracture healed completely in every case. This paper reports the results of 57 cases of intra-articular fractures of the distal radius treated by Kapandji wires as a reduction tool and definitive fixation by the application of a locked volar plate. It could be performed easily and reliably. K-wires were used to temporarily maintain reduction throughout the rigid fixation without further displacement in the follow-up clinic. The results proved appropriate, and the technique has merit, as it obviates the need for dorsal exposure in most cases.

Key Words: temporary Kapandji intrafocal technique, displaced intra-articular distal radius fracture, distal radial LCP fixation

(*Tech Hand Surg* 2019;23: 38–43)

The distal radius fracture is one of the most common fractures especially among the elderly. They are reported at a rate of >100,000 fractures annually in the United Kingdom and >600,000 annually in the United States.[1,2]

The majority of these fractures (57% to 66%) are extra-articular (AO type A). From 9% to 16% are reported as partial-articular fractures (AO type B) and from 25% to 35% are reported as complete-articular fractures (AO type C).[3,4]

The patient outcomes rely on the metaphyseal alignments after reduction including radial height, radial inclination, ulnar variance, and dorsal/palmar tilt. In an attempt to predict functional outcomes, poorer functional outcome could be predicted by age, residual dorsal angulation, positive ulnar variance, and carpal malalignment.[5,6] Hence, good quality reduction is the main factor of a satisfactory outcome.

The reduction K-wire technique was firstly described by Adalbert Kapandji in 1976.[7] The Kapandji pinning technique is typically used and maintained throughout the fracture-healing period. Most authors apply a short arm casting after percutaneous pinning up to 6 weeks.[8–11] The Kapandji technique is typically indicated for displaced 2-part Colles' fracture without involving the articular surface and no or minimal comminution of the dorsal cortex, and extra-articular and intra-articular fractures with only one fracture line. In general, the Kapandji technique is not recommended for intra-articular fractures involving the radiocarpal joint and severe osteoporotic bone.[7,11]

A number of cohort studies, examining the outcome of percutaneous K-wire pinning for distal radius fractures, have reported a significant loss of position at the final radiologic result.[10,12] This is especially true among elderly patients and patients with poor bone stock and comminuted fractures.[8,12–14] Furthermore, 2 randomized control trials reported improved radiologic results, patient outcomes, and fewer complications and reoperations in the plated group compared with the use of closed reduction and percutaneous pinning.[15,16]

Meanwhile, volar locked plating using the volar approach has some limitation with regard to the dorsal fragments' reduction. Typically, the volar tilt restoration can be performed by manual traction and wrist volar flexion or using double approaches. Brachioradialis tendon release may be needed in some cases. This allows visualization of the dorsal surface. Consequently, the reduction alignment, especially volar tilt restoration, may become troublesome using the single volar approach. One recent publication described the "lift technique," which is a reduction technique with the plate allowing volar tilt restoration.[17] This usually reduces the distal fragment in a similar manner to the joystick effect. However, the lift technique cannot achieve satisfactory volar tilt alignment in the case of multicomminuted dorsal fragments at different levels. Thus, this fracture pattern may require the dorsal approach or brachioradialis tendon sacrifice.

Although likely popular and used by several orthopedic surgeons, the Kapandji technique in partial or intra-articular fractures of the distal radius has not been reported. We used the combination of temporary intrafocal K-wire pinning as a reduction tool to reduce each fragment individually followed by volar locked plate fixation. This study was approved by the Ethics National Committee.

From the *Department of Orthopaedics Phramongkutklao Hospital and College of Medicine, Bangkok; and †Orthopedic Department, Buddhashinnaraj Hospital, Pisanulok, Thailand.

P.J.: comes up with the combined technique, collects the data, analyzes all data statistically and writes the manuscript. S.J.: reviews the article, analyzes the data. T.S.: reviews and rechecks all manuscript.

Conflicts of Interest and Source of Funding: The authors report no conflicts of interest and no source of funding.

Address correspondence and reprint requests to Puripun Jirangkul, MD, Department of Orthopaedics, Phramongkutklao Hospital and College of Medicine, Bangkok, Thailand. E-mail: dr.puripun@gmail.com.

FIGURE1. A 61-year-old woman incurred a multifragmentary intra-articular fracture of the displaced distal radius.

PATIENTS AND METHODS

Between January 2016 and January 2017, 57 consecutive patients who sustained intra-articular displaced fractures of the distal radius and underwent an operation by an orthopedic trauma surgeon were enrolled in this study. The operation involved temporary intrafocal pinning reduction followed by stable osteosynthesis using a locked plate system. The operations were performed within 10 days after injury. Standard posteroanterior and lateral radiographs were assessed (Fig. 1). According to the AO/OTA classification, the fractures were classified on the basis of the preoperative radiographs as AO23-B2, B3, C1, and C2. We excluded elderly patients who presented severe medical comorbidity, severe comminuted osteoporotic fracture (AO23-C3), and cases of patients delayed > 10 days. Informed consent was obtained. The postoperative radiographs were obtained one day after surgery, then at 2 weeks, 4 weeks, 6 weeks, and 3 months, consecutively. Early finger and wrist motion as tolerated was convinced. Wrist supports were applied in the first 2 weeks. The patients attended the follow-up clinic for a minimum of 6 months, postoperatively. The radiographic parameters were measured, and clinical outcomes were evaluated according to the modified Mayo wrist score.

Surgical Techniques

Position

The patient was placed in the supine position and the arm abducted to 90 degrees and supinated on a radiolucent arm table. A tourniquet was applied to the upper arm, and the C-arm was placed at the opposite side of the radiolucent arm table.

Approach

The modified volar Henry's approach or trans-flexor carpi radialis (FCR) were generally used for volar locked plate fixation. A longitudinal skin incision was used in line with the FCR tendon. The fracture sites were identified after the pronator quadrates were elevated subperiosteally.

Kapandji K-wire Technique

After the fracture site was identified using the volar approach, the styloid wire was applied percutaneously in the fracture site. It was levered to reduce the radial styloid fragment, then fixed to the radius to correct the radial height and inclination. This is usually placed first from the fracture to the medial cortex of the radius.[17,18] The radial height, radial inclination, and ulnar variant were checked under the C-arm. After these parameters were achieved, the next wires were applied percutaneously at the dorsal aspect of the radius. To restore volar tilt, the dorsal cortex was levered out with the handheld K-wire. Once the volar tilt was corrected, the K-wire was pushed through the fracture just to touch the volar cortex of the proximal fragment. The orthopedic surgeons need to beware of over drilling the dorsal pins to the volar cortex because of the obstruction of the volar locked plate's placement. In the case of intra-articular comminution, > 2 pins may be applied. These wires were then angled at 45 degrees and advanced in a proximal direction to the fracture site; thereafter, the fragments are levered and drilled through to the opposite cortex. They supported the distal fragments and levered them similar to a buttress effect (Fig. 2).

Fluoroscopic control was used to confirm the correct placement of the K-wires and to achieve the acceptable alignment.

Plate Application

Our technique did not require further approaches or tendon sacrifice because all fragments had been reduced by percutaneous pinning already. After the satisfactorily reduced alignment was checked under fluoroscopic control, the K-wires were cut 3 to 4 cm above the skin for easier wrist control on the arm board, and then the locked volar plate was

FIGURE 2. After intrafocal pinning reduction and temporary K-wire fixation.

applied on the volar surface of the radius. The appropriate position of the plate was then confirmed under the C-arm. The plate should not be placed distal to the watershed line, as this risks flexor pollicis longus tendon rupture.[18] The diaphyseal screws were inserted into the proximal fragment through the oval hole of the plate, allowing fine adjustment of the plate position. The distal screws were then inserted using rotational fluoroscopy consecutively.[19] After the position of the plate and screws was confirmed on an image intensifier, the percutaneous K-wires were then removed. Finally, the wrist motion was evaluated (Fig. 3).

Postoperative Management

Typically, after rigid and stable fixation by the volar locked plate, no need exists to immobilize the wrist. In our practice, we used the wrist splint in the first 2 weeks.[20,21] Early finger and wrist motion and rehabilitation were encouraged, as could be tolerated.

Outcome Parameters

We evaluated patients at 2-week intervals until evidence was observed of fracture union and at 3-month intervals thereafter. Fracture healing was clinically defined as no pain on movement over the fracture zone and radiographically defined as haziness of the fracture line with consolidation or solid callus connecting the fracture fragment.[22]

Clinical Assessment

Patient wrist motion, pain, and functional outcomes were evaluated according to the modified Mayo wrist scoring system during the follow-up period, and complications were recorded.

Radiographic Assessment

Quality of the reduction was evaluated 3 months postoperatively. The 4 parameters consisted of radial inclination, radial height, dorsal/volar tilt, and ulnar plus. Their preoperative and postoperative comparisons were evaluated using mean ± SD and then analyzed using the paired *t* test. For comparison, the parameters of the contralateral side were also measured and were evaluated by their mean ± SD and analyzed by the paired *t* test. More than 10 degrees deviation, > 10 mm of radial height loss, dorsal tilt, and > 2 mm deviation of the ulnar were defined as cases of unsatisfactory reduction.

RESULTS

Among the 57 patients, 28 (49.12%) were male individuals and 29 (50.88%) female individuals. Patient age averaged 56.16 years. All patients attended the follow-up clinic for a minimum of 6 months. The median follow-up period was 12 months (range, 10 to 16 mo). The operations were performed under axillary block in 31 cases and under general anesthesia in 26 cases. Timing to surgery averaged 4.77 days. The operation time averaged 61.32 minutes, and blood loss averaged 20 mL (10 to 50 mL). The median incision

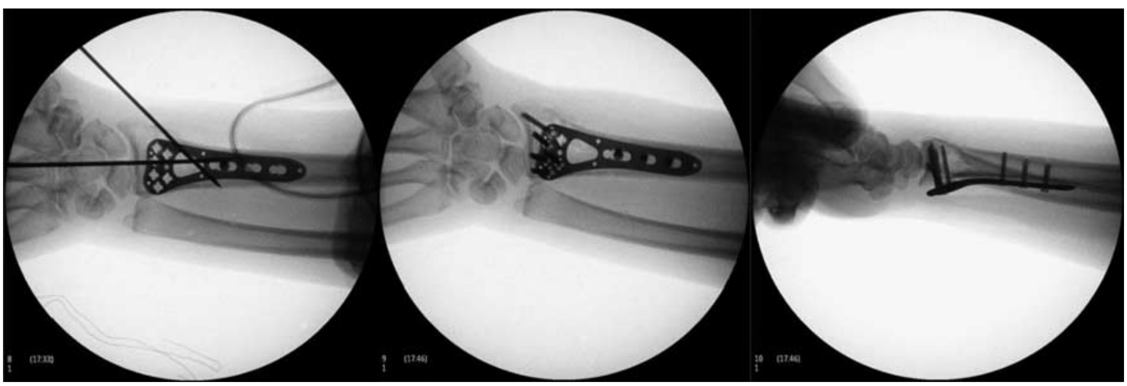

FIGURE 3. Rigid and stable fixation with a volar locked plate; K-wires were removed thereafter.

TABLE 1. Demographic Data of 57 Patients

	N (%)
Age (y)	
Mean ± SD	56.16 ± 21.11
Median (min, max)	60 (16, 88)
Sex	
Male	28 (49.12)
Female	29 (50.88)
AO classification	
B2	3 (5.26)
B3	10 (17.54)
C1	32 (56.14)
C2	12 (21.05)
Time to surgery (d)	
Mean ± SD	4.77 ± 2.22
Median (min, max)	4 (2, 9)
No. K-wire	
Mean ± SD	2.40 ± 0.78
Median (min, max)	2 (1, 4)
Wound length (cm)	
Mean ± SD	5.24 ± 0.61
Median (min, max)	5.01 (3.80, 6.30)
Operative time (min)	
Mean ± SD	61.32 ± 17.15
Median (min, max)	55 (40, 110)

length was 5.10 cm. while the median number of K-wire was 2. Patient demographics are presented in Table 1.

Clinical Outcomes

The range of motion was evaluated three months postoperatively compared with the contralateral wrist (Table 2). Even though statistically significant differences were observed between the postoperative range of motion and contralateral wrist motion, all patients were able to achieve the functional range of motion for activities of daily living[23] without pain.

Moreover, the clinical outcomes were evaluated using the modified Mayo wrist scoring system[24] including pain, motion, grip strength, and the ability to return to regular employment or activities every 2 weeks postoperatively until 10 weeks, as depicted in Table 3. Good to excellent outcomes could be achieved in most cases. An excellent result was defined as 90 to 100 points, good was 80 to 89, fair was 65 to 79 points, and poor was <65 points (Table 4).

TABLE 2. Comparison of 3-Month Postoperative Injured Wrist Motion and the Contralateral Side

Motion	3 mo Postoperative (Mean ± SD)	Contralateral (Mean ± SD)	*P*
Supination (deg.)	81.16 ± 6.10	86.07 ± 4.23	< 0.01
Pronation (deg.)	80.09 ± 6.29	81.16 ± 6.47	0.05
Flexion (deg.)	72.95 ± 8.19	80.45 ± 5.66	< 0.01
Extension (deg.)	60.36 ± 7.97	68.75 ± 5.97	< 0.01

Paired *t* test.

TABLE 3. MMW Score Concerning the Follow-up Period

Follow-up Period (wk)	MMW Score (Mean ± SD)	Mean Difference (95% CI)	*P**
2	55.71 ± 9.56	—	—
4	71.25 ± 7.58	15.54 (14.18-16.98)	0.05
6	81.96 ± 7.30	26.25 (24.89-27.61)	< 0.01
8	86.16 ± 7.38	30.45 (29.09-31.80)	< 0.01
10	88.30 ± 6.20	32.59 (31.23-33.95)	< 0.01
Repeated measures analysis of variance	—	—	< 0.001†

*Paired *t* test comparison with baseline (2 wk).
†One-way repeated measures analysis of variance.
CI indicates confidence interval; MMW, modified mayo wrist score.

Radiographic Outcomes

The average immediate postoperative radial length was 10.89 mm, the radial inclination was 21.15 degrees, and volar tilt was 10.23 degrees. Statistically significant differences were found between the preoperative and postoperative parameters, as depicted in Table 5. In contrast, all parameters exhibited no statistically significant differences between the postoperative injured side and the contralateral side (Table 6). All patients achieved complete fracture union and maintained good reduction after locking compression plate (LCP) fixation.

Complications

No major medical complications were recorded during surgery. No patient had an infection, delayed union, or nonunion. Only one 57-year-old woman could not achieve satisfactory reduction by intrafocal K-wire technique due to bone fragility and long-term use of bisphosphonate. Iatrogenic metaphyseal comminuted fracture occurred during the the process of the fragments being levered by K-wires. We had to perform dorsal incision for adequate approach and satisfactory reduction. Double plates were applied thereafter.

DISCUSSION

Currently, many treatment methods are available for distal radius fracture. The goal of treatment is to achieve good functional outcomes requiring good reduction. Many orthopedic surgeons agree that the alignments are crucial to predicting functional outcomes.[25,26] One recent study reported a dorsal tilt of 12 degrees or more, and > 2 mm of the radial shift was clearly associated with significant functional limitation.[27] In addition, the volar tilt correction was the most important radiologic parameter related to outcomes[5,6] and may become troublesome when the reduction is performed through the volar

TABLE 4. Clinical Outcomes by MMW Score

MMW Score	N	Percentage (95% CI)
Fair (65-79)	3	3.56 (1.12-14.87)
Good (80-89)	21	37.50 (24.92-51.45)
Excellent (90-100)	32	57.14 (43.22-70.29)

CI indicates confidence interval; MMW, modified Mayo wrist score.

TABLE 5. Comparison of Preoperative and Postoperative Parameters

Measurement	Preoperative (Mean ± SD)	Postoperative (Mean ± SD)	*P*
Radial inclination (deg.)	10.86 ± 3.66	21.15 ± 2.27	< 0.01
Radial length (mm)	5.07 ± 1.72	10.89 ± 1.26	< 0.01
Volar tilt (deg.)	−1.58 ± 6.50	10.23 ± 3.52	< 0.01

Paired *t* test.

approach. Consequently, the brachioradialis tendon sacrifice or additional dorsal approach might be needed.

The temporary K-wires' use in recent publications are mostly extrafocal or interfragmental pins that could be typically performed only after achieving satisfactory reduction. In addition, Kapandji intrafocal pinning could reduce the fragments like a buttress against a displaced fragment.[27] In general, this is designed to treat extra-articular or noncomminuted distal radius fracture.

In this study, we combined temporary intrafocal pinning to provide a good reduction followed by rigid fixation with the distal radial LCP. The radiologic parameter outcomes were comparable to other studies elsewhere.[27,28–30] The advantages of this technique are that it is simple, reproducible, and provides only single volar approach without brachioradialis sacrifice. No risk of pin tract infection occurred because of temporary K-wire use. No further fracture displacement was found after rigid LCP fixation. The patients were able to encourage the postoperative rehabilitation protocol. Thus, no finger or wrist stiffness occurred. According to the modified Mayo wrist scoring system, the functional assessment revealed good to excellent results in most cases (Table 4).

Our study possessed some limitations. First, our technique was not compared with other reduction techniques. A further comparison study may be required. Second, our population size was modest compared with large national studies. Third, the follow-up period was relatively short. Long-term results and complications including osteoarthritis of the wrist should be observed. Fourth, this study used C-arm imaging to evaluate the quality of fracture reduction. Direct visualization such as wrist arthroscopy was not performed. However, it would be feasible to use the intrafocal pinning reduction technique with arthroscopic-assisted reduction.[31] Further comparison studies should be advocated in terms of functional outcomes, risks, and benefits; complications would include those occurring during the learning curve.

TABLE 6. Comparison of Postoperative Radiographic Parameters and Contralateral Distal Radius

Measurement	Postoperative (Mean ± SD)	Uninjured Side (Mean ± SD)	*P*
Radial inclination (deg.)	21.15 ± 2.27	24.14 ± 2.12	0.272
Radial length (mm)	10.89 ± 1.26	11.35 ± 0.72	0.003
Volar tilt (deg.)	10.23 ± 3.52	11.36 ± 1.02	0.006
Ulnar variance (mm)	−0.05 ± 0.95	0.08 ± 0.68	0.367

Paired *t* test.

CONCLUSIONS

Applying the intrafocal Kapandji pinning technique was feasible as a reduction tool for unstable intra-articular fracture of the distal radius. This reduction technique not only could be easily performed but is also reproducible. The satisfactory reduction alignment could be accomplished with minimal leverage force. The rigid and stable fixation occurs with the locked plate system thereafter. The outcomes are good to excellent, and the technique has merit, as it obviates the need for dorsal exposure in most cases. The authors recommend this surgical technique with regard to intra-articular fracture of the distal radius concerning reduction and fixation. To apply this surgical technique in the treatment of cases with poor bone stock, severe comminuted fracture, late presentation, and pathologic fracture should be avoided.

REFERENCES

1. Chung KC, Shauver MJ, Yin H, et al. Variations in the use of internal fixation for distal radial fracture in the United States medicare population. *J Bone Joint Surg Am*. 2011;93:2154–2162.
2. Court-Brown CM, Caesar B. Epidemiology of adult fractures: a review. *Injury*. 2006;37:691–697.
3. Court-Brown CM, Aitken S, Hamilton TW, et al. Nonoperative fracture treatment in the modern era. *J Trauma*. 2010;69:699–707.
4. Orce CH, Martinez FJ. Epidemiology of fall related forearm and wrist fractures among adults treated in US hospital emergency departments. *Inj Prev*. 2011;17:33–36.
5. Kihara H, Plamer AK, Werner FW, et al. The effect of dorsally angulated distal radius fractures on distal radioulnar joint congruency and forearm rotation. *J Hand Surg Am*. 1996;21:40–47.
6. Karnezis IA, Panagiotopoulos E, Tyllianakis M, et al. Correlation between radiological parameters and patient-rated wrist dysfunction following fractures of the distal radius. *Injury*. 2005;36:1435–1439.
7. Kapandji A. Intra-focal pinning of fractures of the distal end of the radius 10 years later. *Ann Chir Main*. 1987;6:57–63.
8. Allain J, Ie GP, Le MS, et al. Trans-styloid fixation of fractures of the distal radius. A prospective randomized comparison between 6- and 1-week postoperative immobilization in 60 fractures. *Acta Orthop Scand*. 1999;70:119–123.
9. Azzopardi T, Ehrendorfer S, Coulton T, et al. Unstable extra-articular fractures of the distal radius: a prospective, randomized study of immobilization in a cast versus supplementary percutaneous pinning. *J Bone Joint Surg Br*. 2005;87:837–840.
10. Kennedy C, Kennedy MT, Niall D, et al. Radiological outcomes of distal radius extra-articular fragility fractures treated with extra-focal Kirschner wires. *Injury*. 2010;41:639–642.
11. Stoffelen DV, Broos PL. Kapandji pinning or closed reduction for extra-articular distal radius fractures. *J Trauma*. 1998;45:753–757.
12. Brady O, Rice J, Nicholson P, et al. The unstable distal radial fracture one year post Kapanji intrafocal pinning. *Injury*. 1999;30:251–255.
13. Dowling JJ, Sawyer B Jr. Comminuted Colles' fractures. Evaluation of a method of treatment. *J Bone Surg Am*. 1961;43-A:657–668.
14. Oskam J, Kingma J, Bart J, et al. K-wire fixation for redislocated Colles' fractures. Malunion in 8/21 cases. *Acta Orthop Scand*. 1997;68:259–261.
15. McFadyen I, Field J, McCann P, et al. Should unstable extra-articular distal radial fractures be treated with fixed-angle volar-locked plates or percutaneous Kirschner wires? A prospective randomized controlled trial. *Injury*. 2011;42:162–166.
16. Rozental TD, Blazar PE, Franko OI, et al. Functional outcomes for unstable distal radial fractures treated with open reduction and internal

fixation or closed reduction and percutaneous fixation. A prospective randomized trial. *J Bone Surg Am*. 2009;91:1837–1846.

17. Smith DW, Henry MH. Volar fixed-angle plating of the distal radius. *J Am Acad Orthop Surg*. 2005;13:28–36.
18. Asadollahi S, Keith PPA. Flexor tendon injuries following plate fixation of distal radius fractures: a systematic review of the literature. *J Orthop Traumatol*. 2013;14:227–234.
19. Soong M, Got C, Katarincic J, et al. Fluoroscopic evaluation of intra-articular screw placement during locked volar plating of the distal radius: a cadaveric study. *J Hand Surg Am*. 2008;33:1720–1723.
20. Chung KC, Watt AJ, Kotsis SV, et al. Treatment of unstable distal radial fractures with the volar locking plating system. *J Bone Joint Surg Am*. 2006;88:2687–2694.
21. Figl M, Weninger P, Liska M, et al. Volar fixed-angle plate osteosynthesis of unstable distal radius fractures: 12 months results. *Arch Orthop Trauma Surg*. 2009;129:661–669.
22. Corrales LA, Morshed S, Bhandari M, et al. Variability in the assessment of fracture-healing in orthopaedic trauma studies. *J Bone Joint Surg Am*. 2008;90:1862–1868.
23. Ryu JY, Cooney WP III, Askew LJ, et al. Functional ranges of motion of the wrist joint. *J Hand Surg Am*. 1991;16:409–419.
24. Cooney WP, Bussey R, Dobyns JH, et al. Difficult wrist fractures. Perilunate fracture-dislocations of the wrist. *Clin Orthop Relat Res*. 1987;214:136–147.
25. van der Linden W, Ericson R. Colles' fracture. How should its displacement be measured and how should it be immobilized? *J Bone Joint Surg Am*. 1981;63:1285–1288.
26. Porter M, Stockley I. Fractures of the distal radius. Intermediate and end results in relation to radiologic parameters. *Clin Orthop Relat Res*. 1987;220:241–252.
27. McQueen M, Caspers J. Colles fracture: does the anatomical result affect the final function? *J Bone Joint Surg Br*. 1988;70:649–651.
28. Benoit LA, Freeland AE. Buttress pinning in the unstable distal radius fracture. A modification of Kapandji technique. *J Hand Surg Br*. 1995;20:82–96.
29. Fuji K, Hemi T, Kanematsu Y, et al. Fracture of the distal end of the radius in elderly patients: a comparative study of anatomical and functional results. *J Orthop Surg*. 2002;10:9–15.
30. Rosenthal AH, Chung KC. Intrafocal pinning of distal radius fracture. *Ann Plastic Surg*. 2002;48:593–599.
31. Abe Y, Fujii K. Arthroscopic-assisted reduction of intraarticular distal radius fracture. *Hand Clin*. 2017;33:659–668.