Article

Wrist Arthroscopy-Assisted Reduction for Distal Radius Fracture and its Associated Injuries: Clinical Observation of Triangular Fibrocartilage Complex Injuries

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Fengwei Yu[1,†], Botao Pang[1,†], Yongtao Liu[1], Chengnian Zhang[1], Zhiyang Deng[1], Daijie Zhang[1], Xiaozhi Liu[1], Weiqiang Yang[2]

[1]Hand Microsurgery, Binzhou Medical University Hospital, 256600 Binzhou, Shandong, China
[2]Binzhou Medical University, 256600 Binzhou, Shandong, China

Background: To compare the clinical effects between wrist arthroscopy-assisted open reduction plus internal fixation, using the triangular fibrocartilage complex (TFCC) as an example, and simple open reduction plus internal fixation in the treatment of distal radius fractures (DRFs). The study aims to assess the efficacy of arthroscopic-assisted open reduction and internal fixation in treating distal radius fractures.
Methods: The study utilized a retrospective cohort research approach, involving 60 patients treated at Binzhou Medical University Hospital between August 2021 and October 2022. These patients met the specified criteria and underwent two distinct surgical procedures for DRFs. Prior to surgery, thorough communication was established with the patients to elucidate the advantages, risks, and associated costs of wrist arthroscopy, and informed consent was obtained. Subsequent to the surgeries, postoperative follow-up was conducted to evaluate the variances between the two treatment modalities. Postoperative analysis and assessment encompassed the patients' Visual Analogue Scale (VAS) scores, Cooney wrist scores, grip strength of the affected limb (in comparison with the healthy side), wrist range of motion, and the frequency of intraoperative fluoroscopy usage.
Results: No surgical complications were observed among all patients. They were followed up for an average duration of (12.1 $\pm$ 1.3) months postoperatively, during which all fractures healed successfully. Within the treatment group, arthroscopy detected 14 cases of TFCC tears during the operation, all of which were repaired under a microscope. Conversely, physical examination identified three cases of TFCC injury in the control group, which were treated via incision and suture. At the 3-month postoperative mark, the treatment group exhibited significantly superior comprehensive scores for wrist pain, grip strength, and wrist range of motion compared to the control group ($p < 0.05$). Cooney's comprehensive wrist joint scoring yielded the following results: treatment group — excellent in 21 cases, good in five cases, and moderate in four cases; control group — excellent in 16 cases, good in nine cases, and moderate in five cases.
Conclusion: Wrist arthroscopy-assisted surgery facilitates precise reduction of the articular surface and alleviation of intraarticular congestion. Moreover, it enables evaluation and repair of concurrent intra-articular injuries such as TFCC tears and other tissue injuries, thereby reducing the likelihood of chronic wrist pain. Consequently, this technique should be deemed valuable in clinical practice owing to its outstanding clinical efficacy.

Keywords: arthroscope; distal radius fracture; TFCC; open reduction and internal fixation; efficacy observation

Introduction

The fractured end of a complex distal radius fracture (DRF) often presents instability, necessitating surgical intervention to address both the fracture and displacement of the articular surface. Traditional open reduction and internal fixation methods may fall short in accurately assessing articular surface recovery, thereby hindering the evaluation and treatment of accompanying wrist soft tissue injuries. Wrist arthroscopy has demonstrated utility in identifying associated ligamentous and cartilaginous lesions subsequent to distal radial fractures [1]. Detection of triangular fibrocartilage complex (TFCC) injuries primarily relies on physical examination techniques such as the ulnar wrist stress test, in addition to imaging modalities [2]. In a study conducted by Caroline A. Selles, all patients who underwent arthroscopic examination were found to have soft tissue injuries, with 90% exhibiting varying degrees of TFCC injuries, 50% showing scapholunate (SL) ligament injuries, and 50% demonstrating lunotriquetral (LT) ligament injuries [3]. The advent of wrist arthroscopy offers an opportunity to address related soft tissue injuries early on, particularly those involving the scaphoid-lunate interosseous ligament (SLIL), lunate-triangular interosseous ligament (LTIL), and TFCC, which are common intra-articular in-

Correspondence to: Yongtao Liu, Hand Microsurgery, Binzhou Medical University Hospital, 256600 Binzhou, Shandong, China (e-mail: 1752703560@qq.com).
[†] *These authors contributed equally.*

juries associated with distal radius fractures [4]. Anatomically, the distal radius serves as a pivotal platform for the wrist joint and marks the origin of the radial ligament. The distal articular surface is formed by the radiolunate, radioscaphoid, and inferior radioulnar joints. Notably, the irregular shape of the distal radius is characterized by numerous longitudinal depressions through which the flexor and extensor tendons traverse. In a normal distal radius, the articular surface typically exhibits a radial inclination ranging from 22° to 24° and a palmar inclination ranging from 13° to 14° [5].

The combination of TFCC and the distal end of the interosseous membrane represents the most crucial stabilizing structure of the distal radioulnar joint (DRUJ). This combination facilitates unrestricted movement of the forearm, with the TFCC transmitting approximately 16% of the axial load between the carpal bones and forearm [6–8]. The interaction between the TFCC and the distal end of the interosseous membrane is pivotal for DRUJ stability. The radioulnar ligament of the DRUJ is attached to both the palmar and dorsal aspects of the sigmoid notch, enveloping the articular disc. Comprising superficial and deep components, the TFCC consists of a hammock-like structure, termed the superficial or distal component, which is affixed to the ulnar collateral ligament. The deep or proximal component, known as the triangular ligament or ligamentum subcruentum, attaches to the ulnar fovea via palmar and dorsal limbs, forming the volar and dorsal distal radioulnar ligaments. Consequently, the tension between these structures plays a pivotal role in facilitating smooth forearm pronation [9,10]. These kinematic characteristics ensure uninhibited forearm rotation and uphold DRUJ stability [9]. Prompt identification of any damage to these structures is crucial, especially following DRF treatment, necessitating corresponding postoperative measures.

Indications and contraindications of wrist arthroscopy: In 2017, The Institute of Plastic Surgery of Shimonoseki General Hospital, Shimonoseki Prefecture, Japan, recommended that the incidence of intra-articular soft tissue injuries in extra-articular and intra-articular DRF is almost similar. Any type of DRF should be considered for wrist arthroscopy. In the same year, a second conservative view was generally accepted by clinicians. The indications were as follows: (1) B and C fractures of AO/ASIF classification, fractures of the distal radius with a step on the articular surface or a displacement of more than 2 mm; (2) DRF complicated with injuries of carpal interosseous ligament such as TFCC and SLIL [11, 12].

Current contraindications for wrist arthroscopy in examining distal radius fractures (DRFs) include extra-articular fractures in elderly patients with low activity levels, open fractures, joint space narrowing, intra-articular infection, joint stiffness, and coagulation dysfunction.

Epidemiology

DRF accounts for approximately 15% of all fractures in adults. Conducting epidemiological investigations into this type of injury is essential for hand surgeons to devise treatment and rehabilitation strategies. It is noteworthy that DRF exhibits two incidence peaks: one among young individuals, typically around the age of 10 years, often associated with high-energy trauma, and another peak among young adults [1]. Moreover, DRF stands as the most prevalent fracture in every age group except for individuals aged 18–34 (ranking third) and 35–49 (ranking second) years, respectively. Notably, there's a gradual increase in the incidence of DRF within the older population. A research involving 208,094 American patients of working age with fractures identified the radius as the most commonly affected site. Consequently, DRF emerges as the most frequent fracture occurrence across an individual's lifespan.

Materials and methods

Inclusion and Exclusion Criteria

The inclusion criteria for this study were as follows: (1) Patients meeting the diagnostic criteria for DRF; (2) Patients within 7 days post-injury; (3) Patients without any other serious complications; (4) Patients who voluntarily signed the informed consent form to undergo relevant surgical treatments.

The exclusion criteria for this study were as follows: (1) Patients with distal radial fractures caused by pathological diseases; (2) Patients with old fractures; (3) Patients with severe osteoporosis and concomitant fractures; (4) Patients with systemic infections, neurological deficits, or coagulation disorders; (5) Patients with significant organ dysfunction; (6) Patients with psychiatric disorders.

In the traditional group (control group), there were 30 patients, comprising 16 males and 14 females. Among them, 25 patients sustained distal radial fractures due to falls, while 5 patients sustained injuries due to vehicle accidents and machinery-related incidents. The age range of these patients was between 30 and 72 years.

In the modified group (experimental group), there were 30 patients, with 12 males and 18 females. Among them, 27 patients had distal radial fractures resulting from falls, while 3 patients were involved in vehicle accidents, with 1 case presenting an open fracture. The age range of these patients varied from 27 to 80 years.

To analyze the gender distribution, a chi-square test was employed, while a t-test was conducted for age comparison. The general characteristics (age, gender) of the two patient groups exhibited no statistical differences ($p > 0.05$, as shown in Table 1).

Surgical Method

The surgical procedure commenced with patients placed in the supine position following anesthesia administration via a brachial plexus block. An upper arm pneumatic tourniquet was applied to the affected limb, with pressure adjusted based on blood pressure, allowing for a 10-minute relaxation period every hour. The surgical approach involved a volar Henry incision at the wrist, approximately 5 cm in length, through the skin, subcutaneous tissue, and deep fascia. Subsequent steps included making an incision between the flexor carpi radialis tendon and radial arteries and veins, exposing the pronator quadratus, and performing a longitudinal incision in the pronator quadratus to reveal the distal radial bone surface.

The poking reduction technique was utilized to restore radial height and articular surface collapse, while palmar tipping was reduced using the Kapandji technique, followed by temporary fixation with Kirschner wires. Intraoperative X-ray confirmed the relatively accurate reduction before final fixation with a volar locked compression plat.

The arthroscopic procedure involved assembling the arthroscope and installing an arthroscopic traction tower weighing 15 lbs. A 3-4, 6-r approach was performed dorsally, with the 3-4 gap serving as the observation channel and the 6-r approach as the working channel. A 2.5-mm arthroscope was used to access the wrist joint, which was irrigated with normal saline for optimal visualization.

Synovial hyperplasia and small cartilage fragments were removed, followed by exploration of the articular surface and soft tissue injuries under microscopic guidance. Reduction was achieved with Kirschner wires, ensuring a flat articular surface with a step of less than 2.0 mm. Further exploration through arthroscopy addressed intra-articular cartilage, ligament, and TFCC injuries.

Patients with TFCC injuries underwent various interventions, including arthroplasty, resection of the ulnar head, suture repair, or reconstruction using Smith nephew anchor and anchored tail lines. Microscopic exploration and wire tension fixation were performed for patients with ulnar styloid fractures and DRUJ instability.

In the treatment group, patients underwent wrist arthroscopy-assisted open reduction plus internal fixation, while the control group received simple open reduction plus internal fixation. Additionally, patients with combined TFCC injury underwent suture repair.

In this study, the wrist arthroscope used was produced by Stryker (Beijing) Medical Equipment Co., Ltd. on July 19, 2019, with the batch number SN: 17a530264.

Postoperative Management

Following surgery, patients received routine antibiotics for 24 hours and were administered appropriate medications to promote blood circulation, alleviate stagnation, and reduce swelling and pain during the postoperative period. Subsequent to postoperative radiographs and CT scans, patients commenced joint exercises of the metacarpophalangeal, interphalangeal, and wrist joints of the affected limb, involving active/passive flexion/extension, ulnar and radial deviation, and rotational movements, starting 24 hours postoperatively. Patients with combined TFCC injuries who underwent simultaneous repair were immobilized with plaster splints and forearm supination for 4 weeks. Following splint removal at the 4-week mark, patients gradually initiated forearm rotatory function training.

Table 1. The comparison of preoperative general information between the two groups.

	Experiment group	Control group	T or χ^2	p
Age	54.9 ± 16.0	54.3 ± 13.8	0.138 (T)	0.891
Gender (man/woman)	12/18	16/14	1.071 (χ^2)	0.301

Evaluation Methods

All patients in both the treatment and control groups underwent evaluations for subjective pain, functional status, and mobility using visual analog scale scores and the Cooney wrist score scale at 3, 6, and 12 months postoperatively.

Statistical Analysis

Data analysis was conducted using SPSS 26.0 (IBM Corp., Armonk, NY, USA). For data following a composite normal distribution, use the mean ± standard deviation to represent it. For data that does not conform to a normal distribution, use the mean (interquartile range) to represent it. An independent samples *t*-test was employed for data conforming to a normal distribution. For data not conforming to a normal distribution, a non-parametric test was conducted, as indicated by the Z values in Table 2. A significance level of $p < 0.05$ was deemed statistically significant.

Results

No surgical complications were observed in any of the patients, who were followed up at 3, 6, and 12 months postoperatively (mean: 12.1 ± 1.3 months). At 3 months postoperatively, the treatment group demonstrated significantly better comprehensive scores for wrist pain, grip strength, and wrist range of motion compared to the control group ($p < 0.05$). However, there were no significant differences in these scores between the treatment and control groups at 6 months postoperatively ($p > 0.05$). By the 12-month mark, the treatment group's scores surpassed those of the control group, with the difference being statistically significant ($p < 0.05$, as shown in Table 2).

Regarding wrist pain scores, no significant statistical differences were observed between the treatment and control groups at 3- and 6-months post-surgery ($p > 0.05$). However, at 12 months postoperatively, the treatment group exhibited significantly better comprehensive scores for wrist pain compared to the control group ($p < 0.05$).

Cooney's comprehensive wrist joint scoring indicated excellent outcomes for 21 cases in the treatment group, with five cases rated as good and four cases as moderate. In the control group, 16 cases were rated as excellent, nine cases as good, and five cases as moderate.

Table 2. Postoperative Follow-Up Results.

Groups	n	Visual analog scale score			Cooney wrist score scale			Grip strength (healthy side, %)	Wrist range of motion (3 month postoperatively)		Intraoperative perspective time
		3 months postopera-tively	6 months postopera-tively	12 months postopera-tively	3 months postopera-tively	6 months postopera-tively	12 months postopera-tively		Wrist flexion and extension	Wrist rotation	
Control group	30	2.0 (1.00)	1.3 (1.00)	2.1 (2.00)	62.5 (55.00)	80.7 (75.00)	86.2 (80.00)	80.9 ± 6.6	135.0 (128.00)	1602 (152.75)	4.5 (3.00)
Treatment group	30	2.9 (2.00)	1.3 (0.00)	1.0 (0.75)	73.8 (70.00)	80.3 (75.00)	90.5 (85.00)	85.4 ± 6.4	148.3 (142.75)	167.7 (164.50)	2.0 (1.00)
T value or Z value		−2.915(Z)	–0.0581 (Z)	–4.297 (Z)	−4.105 (Z)	–0.425 (Z)	−2.159 (Z)	−2.683	−3.771(Z)	−2.303 (Z)	–4.844 (Z)
p value		0.996	0.561	0.00	0.00	0.671	0.031	0.009	0.000	0.021	0.000

Fig. 1. Preoperative appearance of the patient.

Fig. 2. Preoperative X-ray.

Typical case I (Figs.1–17):

Fig. 1: Left wrist injury from a fall injury.

Figs. 2,3: Preoperative X-ray showing ulnar styloid fracture with DRF involving the articular surface where the distal folded end is displaced toward the dorsal radius.

Figs. 4–6: Preoperative CT suggesting a comminuted fracture of the radiocarpal articular surface and a sagittal directional split, resulting in a coronal split and generation of a free bone block at the center.

Fig. 7: The fracture of the articular surface is temporarily fixed with Kirschner wire, and the complex fracture is converted into a simple fracture as much as possible.

Fig. 8: The steel plate is placed after temporary fixation with Kirschner wire. The fluoroscopy shows that the steel plate is in a good position.

Figs. 9,10: Placement of palmar steel plate.

Fig. 11: The steel plate is placed at the back to strengthen the fixation due to the broken joint and poor stability. At this time, no obvious TFCC injury was found on fluoroscopy and preoperative physical examination (due to preoperative wrist pain, the error of physical examination was large and the compliance was poor).

Figs. 12,13. Arthroscope was placed through the 3-4 approach, and operation opening was established through the 6R approach. TFCC tear could be seen after the removal of the synovial membrane.

Figs. 14–17. The outpatient follow-up at 12 months postoperatively showed that the wrist rotation, flexion, and extension function of the patient was almost the same as that of the healthy side.

Typical case II (Figs. 18–20): The steel plate was inserted into the wrist arthroscope through a 3-4 approach during the operation, and the screw was found to enter the joint cavity.

Discussion

The primary challenge in treating comminuted fractures of the distal radius, particularly those affecting the articular surface, lies in restoring the radius height, palm angle, ulnar deviation angle, and the flatness of the articular surface through poking reduction. Failure to effectively address DRFs may result in persistent pain, limited joint mobility, or post-traumatic arthritis [13]. Consequently, surgical intervention is often recommended for comminuted and

Fig. 3. **Preoperative X-ray.**

Fig. 4. Preoperative CT.

Fig. 5. Preoperative CT.

unstable DRFs, with arthroscopic-assisted reduction being particularly advocated for cases involving the articular surface.

At the 3-month postoperative follow-up, the experimental group exhibited a higher Visual Analog Scale (VAS) score compared to the control group. The author suggests that this discrepancy may stem from the increased detection rate of concomitant injuries, such as TFCC (Triangular Fibrocartilage Complex) injuries, during wrist arthroscopy. All identified injuries were repaired in a single stage, followed by external fixation with a plaster cast. Consequently, the commencement of early functional exercises was delayed relative to the control group. Additionally, patients in the experimental group encountered a heightened psychological burden following arthroscopy, often exhibiting fear of wrist movement and displaying poor compliance, leading to early postoperative joint stiffness and swelling. The delayed onset of functional exercises and resultant joint stiffness contributed to more pronounced postoperative wrist pain in the early stages compared to the control group.

At the 6-month postoperative follow-up, no significant improvements were observed in the Visual Analog Scale scores and Cooney Wrist Score Scale results of the experimental group compared to those of the control group ($p > 0.05$). The author's analysis suggests that although the patients with distal radial fractures in this study were pre-

Fig. 6. Preoperative CT.

Fig. 7. Intraoperative X-ray.

Fig. 8. Intraoperative X-ray.

dominantly elderly, the average age was relatively young (around 50 years old, as indicated in Table 2), indicating a better natural healing capacity among the patients. Furthermore, previous literature, particularly Chinese domestic statistics, suggests that complications such as post-traumatic arthritis and chronic pain from distal radial fractures often result from untimely treatment. This issue is especially prevalent in rural areas, where historical levels of economic development have led to delays in hospital treatment following injuries. These delays can result in deformity healing of Colles' fractures accompanied by wrist swelling, pain, deformity, and functional limitations. However, in this study, all patients were treated at the affiliated hospital of Binzhou Medical University (admissions from 2021 to 2022).

With China's economic and transportation development, patients were able to seek timely medical attention, and all patients underwent surgical treatment within four days of admission. Regardless of the use of arthroscopy, all treatments adhered to the latest medical standards (e.g., ensuring joint surface step-off <2 mm). Post-traumatic arthritis and chronic pain typically begin to develop gradually after 6 months postoperatively. Since the follow-up in this study was conducted at 6 months post-surgery, the patients received treatment of high standards in a timely manner, resulting in a lower risk of arthritis. Additionally, even

Fig. 9. Intraoperative X-ray.

Fig. 10. Intraoperative X-ray.

if post-traumatic arthritis and chronic pain were to occur, they had not yet reached a stage where symptoms were pronounced.

The remaining indicators all suggest that the application of wrist arthroscopy leads to significant postoperative benefits for patients. Wrist arthroscopy offers the benefits of less trauma and more intuitive observation of the joint surface. It allows the assessment and treatment of soft tissue injuries such as TFCC, SLIL, and LTIL under direct vision. According to the traditional DRF reduction standard, patients with distal radius articular surface displacement of more than 2 mm can develop traumatic arthritis, whereas those with a displacement of less than 1 mm are considered safe. According to Knirk JL *et al*. [14], the incidence of traumatic osteoarthritis in patients with an articular surface displacement of less than 1 mm after reduction is only 11%; otherwise, the incidence reaches 91%.

Currently, the restoration of the flatness of the articular surface of the distal radius is considered even more significant than the height and angle of the radius [11]. However, in traditional open reduction and internal fixation with a steel plate, the surgeon cannot directly observe the reduction of the articular surface during the operation due to the failure to open the capsule. The determination of the reduction mainly relies on anterolateral and tangential fluoroscopy of the wrist by X-ray during the operation, which has certain limitations. Moreover, the evaluation of the joint surface using traditional techniques mentioned above is coarse, leading to significant errors. Therefore, ensuring strict anatomical reduction of the articular surface during the operation is challenging. It is difficult to assess residual joint surface steps within 2 mm by fluoroscopy during the operation. In the present study, intraoperative X-ray fluoroscopy revealed good fracture alignment and a flat joint surface without any steps. Arthroscopic exploration revealed a large number of findings including synovial hyperplasia, hemorrhage and edema, cartilage fragments, and even ruptured TFCC and carpal interosseous ligaments (Fig. 21).

For wrist fractures, the flatness of the joint surface is closely associated with the occurrence of wrist arthritis in the future, leading to joint stiffness and limited forearm rotation function [12,15]. The extent of postoperative steps and gaps has also been demonstrated to correlate with functional outcomes [16]. According to Rikli's three-column theory of the distal radius, the radial column involves the radial styloid process and navicular fossa, the middle column includes the lunate fossa and sigmoid notch (lower radioulnar joint), and the ulnar column comprises the distal ulna and TFCC; of these, the radial column bears approximately 40% of the axial load. Due to the presence of the ulnar deflection angle, lateral shear fractures are easily caused when the scaphoid is affected. Furthermore, the intermediate column bears approximately 40% of the axial load and is the

Fig. 11. Postoperative X-ray.

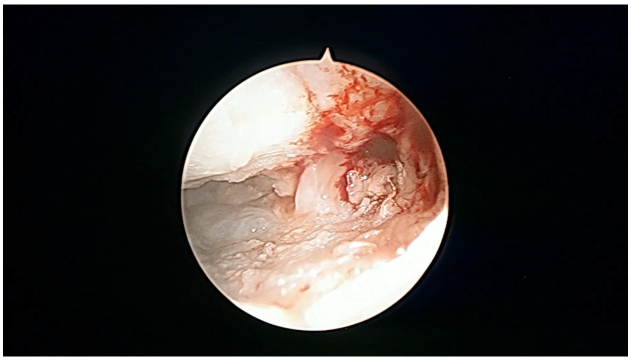

Fig. 12. Intraoperative arthroscopy (triangular fibrocartilage complex (TFCC)).

most important part of the distal radius. A direct impact on the lunate bone can simultaneously produce shear fractures at the dorsal and volar sides or lead to free bone blocks at the joint surface, specifically die-punch injuries; therefore, the ulnar column bears approximately 20% of the axial load and represents the distal end of this stable structure [17,18].

Among these columns, the TFCC is the main structure for maintaining the stability of the wrist joint and forearm, facilitating independent flexion and extension of the wrist joint, radial ulnar deviation, and pronation and supination movements. If the joint surface step of the fracture involving the joint surface is greater than 2 mm postoperatively, the stress on the radiocarpal joint will increase by 27%–51%. Moreover, transferring the stress center to the ulna will cause changes in the position and movement of the wrist joint [19]. Therefore, approximately 100% of patients develop traumatic arthritis after surgery. With the continuous deepening of clinical research and further improvement of patients' treatment requirements, the persis-

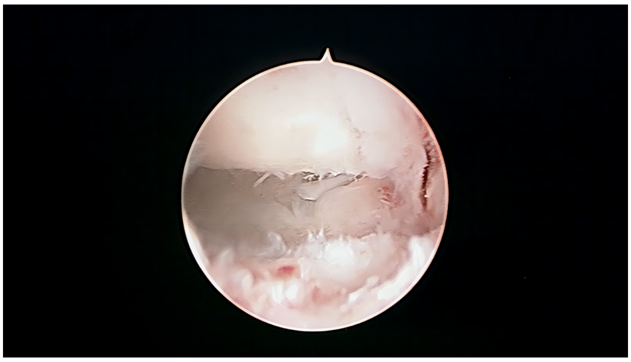

Fig. 13. Intraoperative arthroscopy.

Fig. 14. Postoperative follow-up.

Fig. 15. Postoperative follow-up.

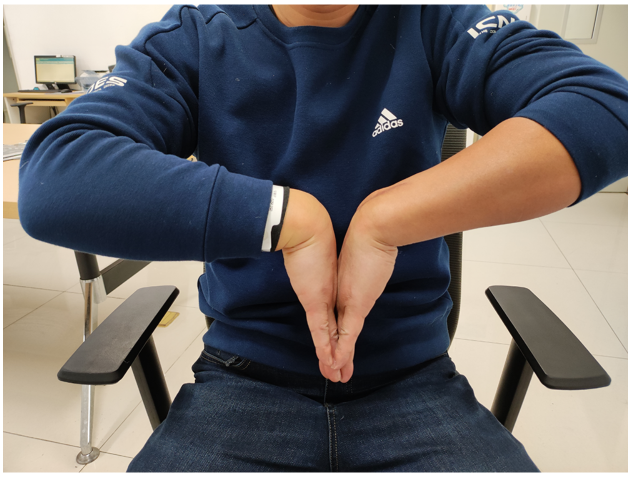

Fig. 16. Postoperative follow-up.

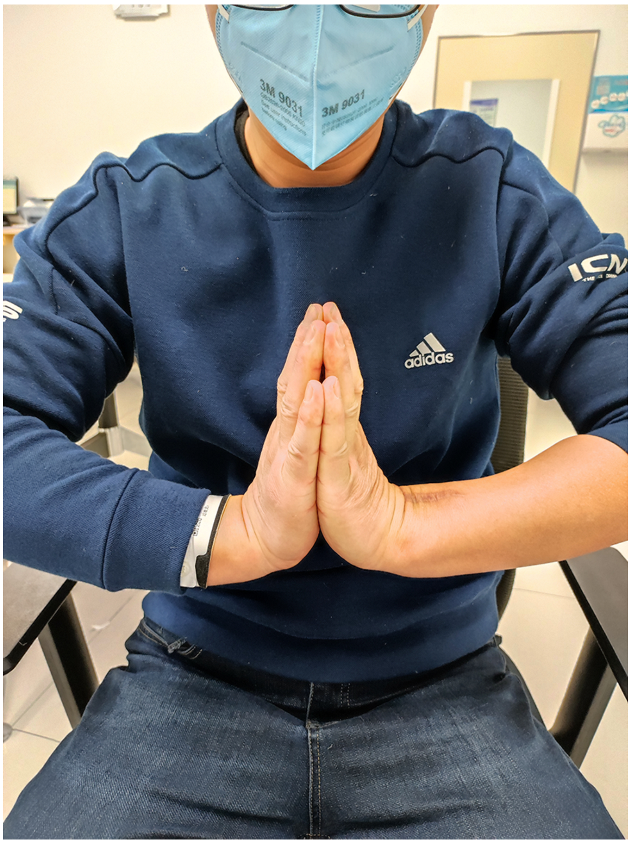

Fig. 17. Intraoperative follow-up.

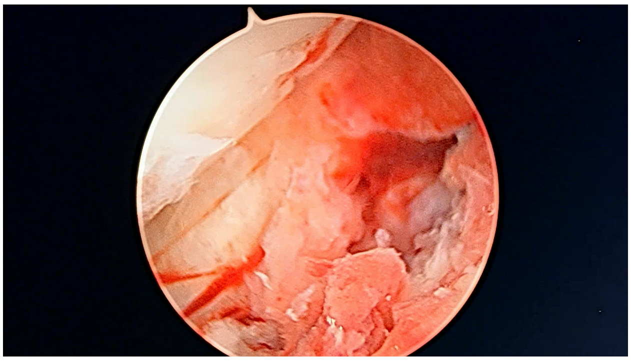

Fig. 18. A large number of synovial hyperplasia and hyperemia are seen under arthroscopy.

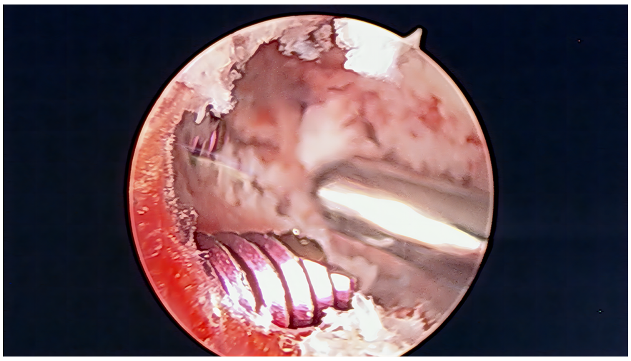

Fig. 19. The screw enters the joint cavity after cleaning the synovial membrane.

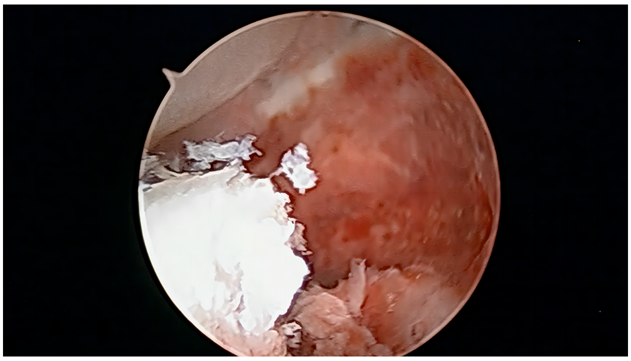

Fig. 20. Joint surface step is detected during operation.

tent joint surface gap and the step greater than 1 mm after DRF may lead to traumatic radiocarpal arthritis. Doi *et al.* [20] recommended that the intra-articular displacement after internal fixation of DRF should be within 1 mm. Residual steps of more than 1 mm on the articular surface are significantly associated with postoperative joint pain. Wrist arthroscopy-assisted reduction can ensure the accuracy of reduction, help understand the direct-view minimally invasive reduction, and assess the fixation of the fracture end [21]. It can also help in checking the joint clearance and steps. Therefore, restoring the flatness of the joint surface to the maximum extent, with the step less than 1 mm, is the main difficulty in the treatment of DRF. With the advancement of wrist arthroscopy technology, it is possible to check and calculate the reduction effect after fracture reduction under direct vision to avoid the screw from entering the joint and achieve the conditions of accurate reduction. In the typical case II of the present study, arthroscopy helped in accurately viewing the screw entering the joint cavity. The screws should be replaced with shorter-length ones to avoid pain during joint movement postoperatively. Comminuted fractures of the distal radius, particularly type C fractures,

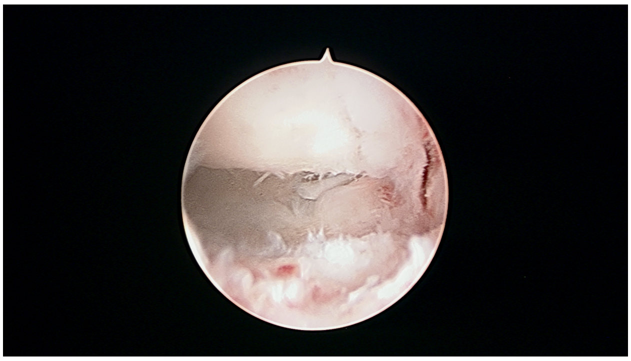

Fig. 21. Fractured TFCC found under a microscope.

are high-energy injuries. Therefore, cartilage fragments and hyperplastic and hyperemic synovium are often found in the articular cavity in such cases, along with different degrees of intraarticular cartilage, ligaments, TFCC, and other tissue injuries.

The TFCC comprises the articular disc, meniscus homolog, volar and dorsal distal radioulnar ligaments, deep layer of the tendon sheath of the extensor carpi ulnaris muscle, ulnar joint capsule, ulnar lunate ligament, and ulnar triangle ligament. Triangular fibrocartilage disc injury is common in the clinical field. If the injury mechanism of the patient involves a fall and the injury mode is a forearm pronation sprain, the patient's main complaint is typically ulnar wrist pain. Furthermore, if physical examination reveals tenderness in the distal region of the ulna, it can be diagnosed as a TFCC injury. Patients with DRF, particularly those with ulnar styloid process fractures, usually have TFCC injuries (84%). Fok *et al*. [22] suggested that most patients with DRFs combined with TFCC injuries would not heal naturally. Among such patients, the rate of TFCC injuries associated with DRFs is high, and some may develop symptoms of TFCC injuries [22]. Although there are debates about whether TFCC injury combined with DRF requires primary repair, TFCC injury can cause instability and long-term pain in the wrist joint. Therefore, it is crucial to detect combined TFCC injuries during the operation and perform initial repair to promote wrist function recovery and prevent long-term pain [23].

However, the clinical diagnosis of TFCC is primarily based on conventional wrist X-rays and physical examination methods such as Sharpey's Test and TFCC load test. Magnetic resonance imaging can also aid in diagnosis, but its usage is limited due to its expense. In patients with TFCC injury, such as in typical case I, the false positive result of physical examination may be due to wrist joint pain following a fracture. Therefore, it can be challenging to accurately determine TFCC damage. Additionally, patients often exhibit poor compliance with examinations due to pain. Wrist arthroscopy has recently emerged as the gold standard for TFCC diagnosis [24]. The fixation of the ulnar styloid process primarily relies on the relationship between the fracture block and TFCC and surrounding ligaments. In cases where the fracture block is associated with the surrounding ligament and TFCC, open reduction and tension fixation of the ulnar styloid process should be actively performed during the operation. Other types of patients with ulnar styloid fractures may not require treatment.

The results of our study still hold positive significance for the repair of wrist joint ligaments and TFCC. This advantage will gradually manifest in the medium and long-term follow-up. The assessment and repair of soft tissue are also crucial factors in evaluating wrist pain and functional recovery in the future. Furthermore, the removal of hyperplastic hyperemia synovium and fractured cartilage in the joint cavity during the operation can help reduce the incidence of traumatic arthritis and joint stiffness in the future. Wrist arthroscopy technology itself offers the advantages of minimal trauma, rapid postoperative recovery, direct observation of joint surface reduction and fixation, and better examination of relevant ligaments and TFCC structures. Clinical studies indicate that wrist joint activity and grip strength of the affected limb are superior in mid- and long-term patients who undergo wrist arthroscopy-assisted reduction and fixation for DRFs compared to those who undergo conventional open surgery. Additionally, the detection rate of combined TFCC injury is higher with wrist arthroscopy than with traditional imaging and physical examination methods.

Therefore, wrist arthroscopy technology, including traditional plate internal fixation with minimally invasive endoscopic technology, holds positive significance for fracture reduction and soft tissue repair. This approach aligns with the concept of prioritizing soft tissues in traditional fracture treatment and can reduce the incidence of traumatic arthritis in the future. Hence, it stands as one of the ideal methods for treating such fractures. However, there are some limitations to our study. Firstly, the number of cases is small, and there is a lack of prospective cohort studies. Secondly, in the operation process, the steel plate was initially placed under traditional fluoroscopy, and then the arthroscope was used for examination, rather than the entire process of reduction and fixation being conducted under the arthroscope.

Conclusion

In summary, the treatment of distal radius fractures involving the articular surface with wrist arthroscopy combined with volar locking plate technology significantly improves postoperative wrist joint mobility and function. It effectively alleviates long-term pain and provides better fracture reduction outcomes. Additionally, it is associated with a lower incidence of postoperative complications, demonstrating good effectiveness and safety in fracture reduction.

Availability of Data and Materials

The author will supply the relevant data in response to reasonable requests. Author's mail: 1752703560@qq.com.

Author Contributions

YL, FY designed the research study. FY and BP performed the research. CZ and ZD provided help and advice on the operation. FY, BP and DZ analyzed the data. YL, XL and WY participate in image collection. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The ethical committee in Binzhou Medical University Hospital approved this study. Ethics Code: KYLL-2022-17. This study is a clinical retrospective observational study, and all participants signed informed consent forms. The study complies with the Declaration of Helsinki.

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Conflict of Interest

The authors declare no conflict of interest.

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