

Ulnar impaction syndrome: Managed by wrist arthroscopy

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ABSTRACT

Background: The development of handicraft industry and increase of various such works that need a large amount of repeated wrist ulnar deviation strength, the incidence of ulnar impaction syndrome (UIS) is increasing, but the traditional simple ulnar shortening osteotomy has more complications. This study aimed to explore the early diagnostic criteria of UIS and its wrist arthroscopic treatment experience.

Materials and Methods: 9 UIS patients were enrolled in this study. According to magnetic resonance imaging, X-ray and endoscopic features, the diagnostic criteria of UIS were summarized and the individualized treatment schedule was made. If the ulnar positive variance was less than 4 mm, the arthroscopic wafer resection was performed. If the ulnar positive variance was more than 4 mm, the arthroscopic resection of injury and degenerative triangular fibrocartilage complex and ulnar osteotomy were conducted.

Results: In all patients, the wound healed without any complications. All patients returned to normal life and work, with no ulnar wrist pain again. One patient had wrist weakness. There was a significant difference of the wrist activity between the last followup and before operation ($P < 0.05$). According to the modified wrist function scoring system of Green and O'Brien, there were 6 cases of excellent, 2 cases of good and 1 case of appropriate and the overall excellent and good rate was 92.3%.

Conclusion: In the treatment of UIS, the arthroscopy can improve the diagnosis rate, optimize the treatment plan, shorten the treatment cycle, with good treatment results.

Key words: Arthroscopy, diagnostic criteria, function, treatment, ulnar impaction syndrome

MeSH terms: Arthroscopy, surgical procedure, arthroscopy, ulna, wrist joint

INTRODUCTION

Ulnar impaction syndrome (UIS) was first presented by Milch in 1941, which was directed at the wrist ulnar sided pain caused by Colles fracture-induced radial shortening and wrist ulnar impaction induced lunate necrosis.¹ It is found by research and clinical experience that the wrist trauma is not the only risk factor of UIS. Other factors such as chronic wrist fatigue and occupation disease can also cause UIS. The pathogenesis is mainly the wrist ulnar overload, which causes chronic impact

of ulnar head, triangular fibrocartilage complex (TFCC) and lunate and triangular bone. This leads to nutrition disorder of the blood supply and synovial fluid of ulnar wrist structure, resulting in ulnar wrist joint degeneration. Ultimately, a group of syndrome such as ulnar wrist pain and functional limitation occur.² With the development of handicraft industry and increase of various works that need a large amount of repeated wrist ulnar deviation strength, the incidence of UIS is increasing, but the traditional simple ulnar shortening osteotomy has more complications.³ In the Western countries, UIS is one of the main causes of carpal instability.⁴ In this study, the early diagnostic criteria of UIS and its wrist arthroscopic treatment experience were explored. The objective is to provide a basis for further application of wrist arthroscopy to treatment of UIS.

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MATERIALS AND METHODS

9 UIS patients were enrolled in this study, including 7 males and 2 females. Their ages were 16–55 years old, with average age of 29 ± 3.6 years. 4 patients were with traumatic tumble or sprain, and other 5 patients had long term repeated work with strength for grabbing or rotating with hand. The diagnosis criteria⁵ for UIS were as follows: (1) Wrist trauma history and long term repeated hand work history; (2) the history of wrist ulnar-side rotation, compression and ulnar wrist pain, with or without clicking; (3) X ray: Most of the ulnar positive variance (ulna is over 2 mm greater than radius) is associated with osteosclerosis or/and cystic degeneration under proximal articular surface of ulna head, lunate bone and triangular bone, which may also be associated with Kienböck's disease,⁶ while minority of ulnar neutral variation only need fist wrist pronation X-ray (dynamic ulnar positive variance);⁷ (4) magnetic resonance imaging (MRI) performance: The signal changes of the lunate bone, triangular bone, as well as TFCC; (5) wrist arthroscopic changes: Chondromalacia of lunate bone, triangular bone and various types of TFCC injury.

All 9 patients were associated with different degree of TFCC injury. They had wrist chronic pain and wrist weakness symptoms, which seriously affected the daily life and work. The conservative treatments such as the use of nonsteroidal anti-inflammatory drugs, wrist immobilization, and cold compression could not obtain a good result. Physical examination showed that 9 patients had positive wrist ulnar stress test result. X-ray examination revealed that, 8 cases had ulnar positive variance including 1 case with positive variance more than 4 mm [Figure 1], with 1 case of negative variance. MR joint imaging showed different degree of signal change in the wrist bone in 9 patients [Table 1].

Operative procedure

Under brachial plexus anesthesia or general anesthesia, the patient was in the supine position and the tourniquet was used. The patient was fixed at shoulder abduction 90° , elbow flexion 90° and wrist flexion 15° , with finger implementing the traction. 3–4 portals were established at the dorsal carpal,

and the arthroscopy sheath was inserted as the water inlet. The normal saline was injected for expansion of the joint capsule. The 2.7 mm angle 30° arthroscopy was inserted into the sheath. After checking the radiocarpal joint (RCJ), the pinhead was inserted through the 6-R approach as a water outlet, and a cannula was inserted. A 2.9 mm full radius shaver was inserted to remove degenerative joint capsule tissue and synovial tissue, making the vision more clear.⁸ After confirming the scapholunate ligament, the carpometacarpal ligaments including radial head ligament, the radioscapulohumeral ligament and radial triangular ligament were in turn confirmed. After full inspection on dorsal lunate bone and TFCC, the arthroscopy was transformed to the 6-R approach to examine the RCJ ulnar part. The degree of TFCC damage was detected by the probe to determine the injury condition of each ligament. The stability degree of lunotriquetral joints (LTJ) was observed.

In 9 patients, 8 cases with positive variance had TFCC II C damage that is, central damage (TFCC central perforation), and 5 cases were complicated with lunar and ulna osteomalacia. For patients with ulnar positive variance less than 4 mm, the arthroscopy was placed in the 3–4 approach (if necessary, arthroscopy was placed on the 4–5 or 6-R approach to expand the observation scope). After resection of tear or degeneration of the TFCC central part and reserve of the intact peripheral part, the arthroscopic



Figure 1: Ulnar impaction syndrome with positive variance >4 mm

Table 1: Demographics and surgical methods for 9 cases

Case	1	2	3	4	5	6	7	8	9
Dominant side	Right	Right	Right	Right	Left	Left	Left	Right	Right
Side of injury	Left	Right	Right	Right	Right	Left	Right	Left	Right
Ulnar variance	≤4 mm	>4 mm	≤4 mm	≤4 mm	≤4 mm	≤4 mm	≤4 mm	≤4 mm	≤4 mm
TFCC injury type	II C	II D	II C	II D	II D	II C	II C	II C	II C
Surgical method	Wafer resection with TFCC debridement	Ulnar shortening with TFCC debridement	Wafer resection with TFCC debridement	Wafer resection with TFCC debridement	Wafer resection with TFCC debridement	Wafer resection with TFCC debridement	Wafer resection with TFCC debridement	Wafer resection with TFCC debridement	Wafer resection with TFCC debridement

TFCC=Triangular fibrocartilage complex

wafer resection was performed through the TFCC central perforation area. A 1/2 or 1/3 of the radial side was firstly removed, using the shaver as contrast. The shaver device with a diameter was about 3 mm and the resection distal ulna depth did not exceed 4 mm. If the LTJ stability was poor, or the ulnar positive variance was greater than 4 mm, the routine ulnar shortening osteotomy was conducted. At the same time, the ligament reconstruction was performed to restore the stability of LTJ. Almost, 1 patient with ulnar positive variance greater than 4 mm was treated with ulnar shortening osteotomy and arthroscopic ligament reconstruction, with TFCC exploration and removal of the wear. The junction of distal and middle 1/3 ulna were chosen for the ulnar shortening osteotomy, as this site was the intersection of the diaphysis nutrient artery and the epiphysis-metaphysis arteries. The amputation end was rich in blood supply and was good for healing, which could be performed with plate fixation, laying a good foundation for early functional exercise.⁹

Postoperative treatment

After operation, Cefmetazole sodium (2 g) was intravenously injected for preventing infection (once per day, 7 days). The patients with the ulna osteotomy were treated with using plaster for 2 months and the patients with only the arthroscopic treatment were treated with plaster external fixation for 1-week. Then the plaster was removed, and the positive functions exercise was performed.

All the patients were evaluated clinically for pain, functional status, range of motion and grip strength after a followup. The wrist function scoring system of Green and O'Brien¹⁰ modified by Cooney *et al.*¹¹ [Table 2] was used for the final clinical assessment of patients.

Statistical analysis

Data were expressed as mean \pm standard deviation. Statistical analysis was performed using SPSS 13.0 statistical software (SPSS Inc., IL, USA). A *t*-test was used to analyze the differences between two groups, and $P < 0.05$ was considered as statistically significant.

RESULTS

The indications for surgery were shown in Table 3. 9 patients obtained stage-I healing of incision, with no joint infection, vascular or nerve damage, or other complication. They were followed up for 2-18 months, with average 13 ± 2.6 months. 9 patients recovered normal life and work, with no ulnar wrist pain again. Almost, 1 patient remained wrist weakness. There was a significant difference of the wrist activity between the last followup and before operation ($P < 0.05$) [Table 4]. For one case (female) with left wrist pain and myasthenia, X-ray and MRI examination

Table 2: Clinical scoring system of Green and O'Brien modified by Cooney

Items	Findings	Score (points)
Pain	None	25
	Mild, occasional	20
	Moderate, tolerable	15
	Severe or intolerable	0
Functional status	Returned to regular employment	25
	Restricted employment	20
	Able to work but unemployed	15
	Unable to work because of pain	0
Range of motion	Full	25
	75-99% of normal	15
	50-74% of normal	10
	25-49% of normal	5
Grip strength	Less than 25% of normal	0
	Normal	25
	75-99% of normal	15
	50-74% of normal	10
	25-49% of normal	5
	0-24% of normal	0

Results=90–100, Excellent=80–89, Good=65–79, Fair=<65, Poor

Table 3: Indications for surgery

TFCC injury type*	Indication
II C	TFCC perforation, lunate bone or ulnar cartilage lesion
II D	TFCC perforation, lunate bone or ulnar cartilage lesion, lunar triangular bone ligament perforation
II E	TFCC perforation, lunate bone or ulnar cartilage lesion, lunar triangular bone ligament perforation, ulnar carpal arthritis
Other	Unable to change the occupation and personal habits

*The TFCC injury type included ulnar positive variance. TFCC=Triangular fibrocartilage complex

showed existence of free body in left wrist joint, positive ulnar variance and TFCC damage [Figure 2], which confirmed the UIS. Under brachial plexus anesthesia, the free body in left wrist joint was removed by wrist arthroscopy [Figure 3a]. The TFCC central damage was visible after resection of free body [Figure 3b]. The arthroscopic wafer resection was performed via TFCC central damaged zones, reserving the intact peripheral parts [Figure 4]. The patient was kept in plaster for 2 weeks and obtained good recovery through function exercise after removal of the plaster [Figure 5].

In 9 patients, the average scores of pain, functional status, range of motion and grip strength were 21.93 ± 0.80 , 23.80 ± 1.50 , 20.42 ± 0.60 and 18.60 ± 0.10 points respectively. According to Cooney's modification of Green and O'Brien's score for clinical outcome, 6 cases were graded excellent, with 2 cases of good and 1 case of fair. The overall excellent and good rate was 92.3%.

DISCUSSION

Normal wrist joint is composed of RCJ, distal radioulnar joint and radiolunate joint, which are not communicated.

Table 4: Comparison of wrist activity before operation and last followup

Time	Palmar flexion	Dorsal extension	Radial deviation	Ulna deviation	Anterior rotation	Posterior rotation
Before operation	45.58±5.18	41.22±3.83	17.82±2.48	21.35±4.61	69.85±8.36	70.13±6.34
Last followup	50.16±6.21	45.37±4.65	18.95±3.56	26.28±5.09	78.87±7.69	76.46±8.31
P	0.012	0.010	0.048	0.008	0.005	0.025



Figure 2: X-ray and magnetic resonance imaging (MRI) of wrist with forearm showing (a) The ulnar positive variance and free body in ulnar carpal joints; (b) Ulnar positive variance, triangular fibrocartilage complex central damage, lunate abnormal signals

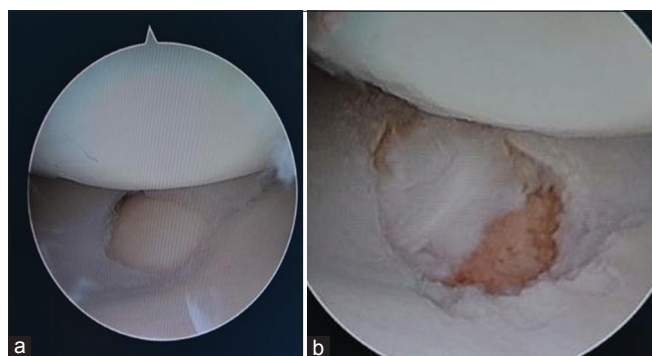


Figure 3: Arthroscopic views showing (a) The free body, visible during arthroscopic operation (b) triangular fibrocartilage complex central damage was visible after resection of free body

The triangular fibrocartilage locates in the ulnar-side of ulnar distal articular surface and originates from the ulnar margin of the distal radius articular surface and the ulnar notch, passing through distal radioulnar joint. The edge is divided into distal and the proximal ligaments, which respectively terminates at the tip and the basilar part of the styloid process of ulna. The lunate bone and triangular bone connect the distal ulnar joint through TFCC. When the positive ulnar variance occurs, the ulnar bone repeatedly impacts the lunate bone, triangular bone and TFCC, causing damage to them. The TFCC injury is very common and occurs earlier.^{12,13} Due to anatomical position, the lunate bone has higher morbidity than the triangular bone.

Ulnar impaction syndrome is a group of syndrome, including ulnar wrist pain and functional limitation. The ulnar wrist pain and activity limitation can occur in the TFCC damage and necrosis of lunate bone and triangular bone, which

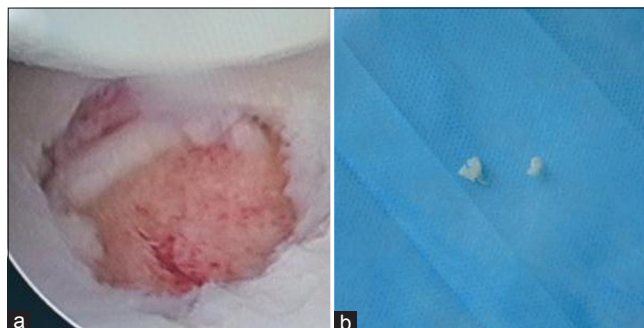


Figure 4: Arthroscopic view showing (a) After arthroscopic removal of free body, the arthroscopic wafer resection was performed via triangular fibrocartilage complex (TFCC) central damaged zones, reserving the intact peripheral parts (b) Free bodies from articular cavity

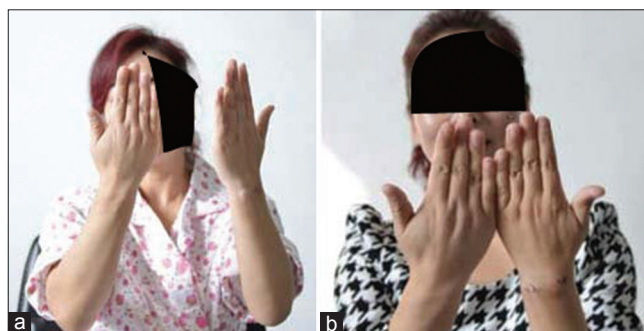


Figure 5: Clinical photographs showing (a) Physical examination before operation (b) Physical examination after operation

influence mutually. In this study, X-ray examination shows that, UIS is associated with osteosclerosis or/and cystic degeneration under proximal articular surface of ulnar head, lunate bone and triangular bone. At the same time, MRI more clearly displays the occurrence of positive variance, TFCC is irregular-shaped, thinner or even disappear, which shows the positive correlation.¹⁴ The proximal ulnar side of lunate bone and proximal radial side of triangle bone have different degree of chondromalacia. According to the five level classification method from Recht *et al.*,¹⁵ all of these can be reflected in MRI.

Ulnar impaction syndrome has low universal rate, low diagnosis rate and high rate of missed diagnosis. Although it is definitely diagnosed, the conservative treatment and simple ulnar shortening osteotomy are often applied. As the arthroscopic treatment has not been universalized, after UIS occurrence, the wrist joint TFCC injury, wrist joint instability, various types of ligament injury and other complications are not treated properly. So the overall treatment result of UIS is not ideal. Therefore, the wrist arthroscopy is the

only method for treatment of the complications. It has the advantages of less invasive, lower complication rate and rapid postoperative recovery. In view of the positive correlation between UIS and TFCC degeneration and chondromalacia of lunate bone and triangular bone, we believe that the wrist arthroscopy should be the dominant method in the treatment of UIS.

According to the damage degree of wrist injury, the operation modes are different, which are as follows: (1) If the ulnar positive variance is less than 4 mm and is associated with TFCC central damage, it is suitable for arthroscopic wafer resection via TFCC central damaged zones, reserving the intact peripheral part, with resection thickness less than 4 mm. (2) If the ulnar positive variance is greater than 4 mm, the osteotomy should be firstly performed, followed by wrist arthroscopic TFCC debridement. (3) If it is associated with chondromalacia of lunate bone and triangular bone and instability of wrist joint, which mostly belong to the Kienböck's disease, the debridement should be performed, with repair for ligament injury. However, the therapy of Kienböck's disease should be further explored, which looks forward to multidisciplinary treatment.⁸ (4) For TFCC damage and even the main UIS damage, the arthroscopy is the preferred treatment method, which has a good future.¹⁶⁻²⁰

CONCLUSION

Along with the popularization of MRI and gradually raised awareness of UIS among majority of clinicians, the diagnosis level of UIS has obtained a substantial progress than before. In the treatment of UIS, the wrist arthroscopy can improve the diagnosis rate, optimize the treatment plan, shorten the treatment cycle, with good treatment results. However, at present the wrist arthroscopy is mainly applied only for shortening osteotomy, and the operation is rough and unable to effectively deal with all complications. With the improvement in cognition and application of wrist arthroscopy, the treatment level of UIS will obtain further progress.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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