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HANDSURGERY

Persistent ulnar-sided wrist pain after treatment of triquetral dorsal chip fracture: six cases related to triangular fibrocartilage complex injury

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Abstract
Introduction Persistent ulnar-sided *wrist* pain after treatment of triquetral dorsal chip fracture even after union is a matter of concern. There could be various reasons for this persistent pain like *arthritis*, instability, fractures and nonunion. We correlate our findings of physical examination and wrist arthroscopy as triangular fibrocartilage complex injury to be one of the causes of this *persistent* pain.
Patients Six subjects who had persistent ulnocarpal joint pain and tenderness after triquetral dorsal chip fracture, despite 2 months of conservative treatment, were subjected to physical tests. If the physical examination yields positive results, then magnetic resonance imaging followed by arthroscopic treatment was performed. The six patients were then evaluated using the visual analogue scale, the Mayo modified wrist score, and the grip strength test.
Results Triangular fibrocartilage complex (TFCC) injury was observed in all six cases and partial TFCC resection and synovectomy were performed. Analysis of the visual analogue scale, Mayo modified wrist score, and grip strength test data revealed statistically significant improvements ($P < 0.05$).
Conclusion In addition to several causes reported in the published literature, TFCC injury can be a cause of persistent ulnar pain after treatment of triquetral dorsal chip fracture. Arthroscopic partial TFCC resection can be considered to be a suitable treatment for such cases.

Keywords Triquetral dorsal chip fracture · TFCC injury · Ulnar-sided pain · Physical tests · Arthroscopy

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Introduction

Ulnar-sided wrist pain is a common problem seen by hand surgeons. Indeed, in the past, it was called the "lower back pain" of the wrist. There are a multitude of lesions that can cause ulnar-sided wrist pain, including instability, arthritis and fractures [1]. The differential diagnosis of ulnar-sided wrist pain can be divided into six elements: osseous, ligamentous, tendinous, vascular, neurologic, and miscellaneous. Osseous injuries include the sequelae of fractures (nonunion or malunion) and degenerative processes. Fracture nonunions of the hamate, pisiform, triquetrum, base of the fifth metacarpal, ulnar styloid process, and distal part of the ulna or radius have all been reported to cause ulnar-sided wrist pain [2, 3].

Triquetral fractures are the second-most common group of carpal bone fractures. There are two types of triquetral fractures, namely dorsal chip fractures and body fractures [4–6]. Triquetral dorsal chip fractures are relatively common in patients who have wrist injuries and ulnar-sided pain, so they should be considered when making the differential diagnosis. If the suspicion of triquetral dorsal chip fracture is high but nothing can be seen on the radiographs, then the oblique radiograph should be inspected carefully, a repeat radiograph with the hand in slight pronation should be made, or a computed tomography (CT) scan should be considered to confirm the diagnosis. This is emphasized by reports in the published literature of cases where an

osteochondral fracture of the triquetrum and nonunion of a triquetral fracture were neglected because of initially negative radiographs [7, 8]. Physical examination or stress position also correlates with the TFCC injury; it has been reported that while hyperpronation and extension of wrist position evoked the most severe pain in patients with traumatic tears of TFCC [9]. It has been reported that in patients who do not respond to non-operative means of treatment, an arthroscopic evaluation is helpful for delineating ligamentous injuries and an *arthroscopic* debridement is also recommended [10]. In patients who still exhibit persistent ulnocarpal symptoms after arthroscopic treatment of Palmer type IB lesions, ulnar shortening is helpful to improve the symptoms of pain, range of motion and grip strength [11].

The aim of our study was to evaluate the cause of persistent ulnar-sided pain in patients treated for triquetral dorsal chip fracture, having pain even after 2 months of conservative treatment by detailed physical, radiological and arthroscopic evaluation.

Materials and methods

Eight patients were diagnosed with triquetral dorsal chip fracture between October 2005 and May 2007. All patients were treated according to the authors' algorithm (Fig. 1). Six patients, who obtained bony union but had persistent pain even after 2 months of conservative management and limited rotation of the wrist joint (pronation/supination), were included in the study. The period of conservative treatment of these patients ranged from 8 to 12 weeks, with an average of 10.2 weeks. The mean patient age was 45.4 (range 41–61) years and four were affected on the right side and two on the left. In four cases, the mechanism of injury was the hand hitting the ground while the carpometacarpal joint was extended. Fall from a bicycle was the cause in the remaining two cases.

The patients were clinically evaluated by the ulnar grind test, the ulnar stress test, the Kleinman shear test, the piano key test, the grip strength test, and the range of motion (ROM) measurement of the wrist joint rotation [2]. In the Kleinman shear test, the examiner holds the radial side stable with one hand while using the thumb of his or her other hand to apply a volar-to-dorsal force on the pisiform [2]. The test is positive if pain is felt. In the piano key test, ballottement of the ulna is performed by the examiner applying a dorsal-to-volar load with his or her hand 4 cm proximal to the distal radioulnar joint [2]. Anterior–posterior, lateral, and oblique views of the wrist joint were taken and both the initial radiographs and monthly radiographs were reviewed to identify any neglected osseous lesions. CT was performed to confirm the bony union and exclude other possible causes of per-

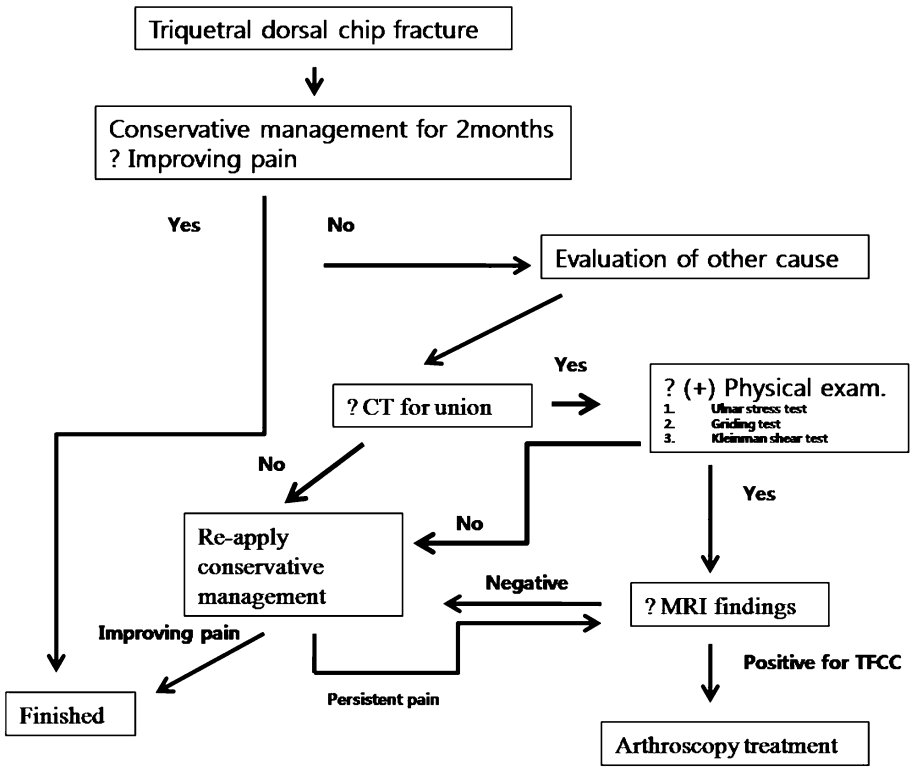

Fig. 1 Algorithm of triquetral dorsal chip fracture treatment

sistent pain like osteochondral lesions and neglected triquetral body lesions. Patients with positive physical findings were subjected to MRI. In four of the six cases, abnormal MRI findings were observed and arthroscopy was performed. Two patients refused for an MRI and hence were continued with the conservative treatment for another 1 month.

All six cases were then evaluated on the basis of the preoperative and postoperative physical examinations, the ROM, grip strength test, visual analogue pain scale (VAS), and Mayo modified wrist score [12].

Results

The patient data are summarized in Table 1. The radiographs revealed 3 mm positive variance in one case and an average of 1.4 mm neutral variance in the remaining five cases. Bony union in CT was observed in all six cases. In the four cases where MRI was performed, the MRI revealed a perforation of the radial aspect of the triangular fibrocartilage complex (TFCC) medial to its radial origin that looked like a type IA lesion according to Palmer classification. Carpal ligament injury was not detected. Arthroscopy of the wrist joint revealed a Palmer type IA lesion in five cases (Fig. 2a) and a Palmer type ID lesion in one case. Synovitis was also observed in all six cases (Fig. 2b). A Grade 1 scapholunate interosseous ligament injury (defined according to Geissler's scapholunate interosseous ligament injury classification [13]) was observed in one case (Fig. 2c).

The TFCC injury was subjected to repair, partial resection and debridement under an arthroscope (Fig. 2d). In the resection, more than 2 mm was left from the peripheral region of the TFCC. Synovectomy was performed at the same time. In addition, a radiofrequency thermal device (Arthrocare®) was used to treat the scapholunate interosseous ligament injury by partial thermocoagulation that only involved the membranous part.

Postoperatively, passive flexion, extension, and rotation of the wrist joint were resumed on the third day, but active motions were limited while wearing a brace for 4 weeks. Four weeks after surgery, normal daily activity without a brace was allowed but excessive weight loading on the wrist or active motions with excessive force were only permitted 3 months after surgery.

The mean VAS pain scores before surgery and 2, 4, and 12 weeks after surgery were 8.3 (range 8–9), 5.3 (4–8), 4.5 (4–6), and 1.8 points (0–4 points), respectively. This indicates that the degree of pain decreased significantly ($P < 0.005$) over time after surgery (Fig. 3).

In terms of the grip strength test, the mean average differences compared to the unaffected side before surgery

Table 1 Summarized data of patients

Case no.	Age (years)	Conservative treatment period (weeks)	Mayo wrist score		VAS pain scale		Physical examination												Arthroscopic finding			
							Grip power		UST		GT		KST		PT		Supination		Pronation		TFCC injury	Synovitis	Associated injury
			Preop	Final	Preop	Final	Preop	Postop	Preop	Postop	Preop	Postop	Preop	Postop	Preop	Postop	Preop	Postop	Preop	Postop			
1	56	8	40	70	8	4	30lb	10lb	P	N	P	P	N	N	N	N	60	80	60	80	IA	Yes	SLL injury
2	45	12	55	85	8	2	10lb	5lb	P	N	P	N	P	N	N	N	60	80	80	80	ID	Yes	No
3	41	8	50	80	9	2	20lb	5lb	P	N	P	N	P	N	N	N	60	80	80	80	IA	Yes	No
4	44	10	60	90	8	0	10lb	5lb	P	N	P	N	N	N	N	N	80	80	80	80	IA	Yes	No
5	61	12	60	85	8	2	10lb	5lb	P	N	P	N	N	N	N	N	60	80	80	80	IA	Yes	No
6	50	12	60	90	8	1	10lb	5lb	P	N	P	N	N	N	N	N	80	80	80	80	IA	Yes	No

UST ulnar stress test, *GT* grind test, *KST* Kleinman shear test, *PT* piano test, *N* negative, *P* positive, *lb* pound

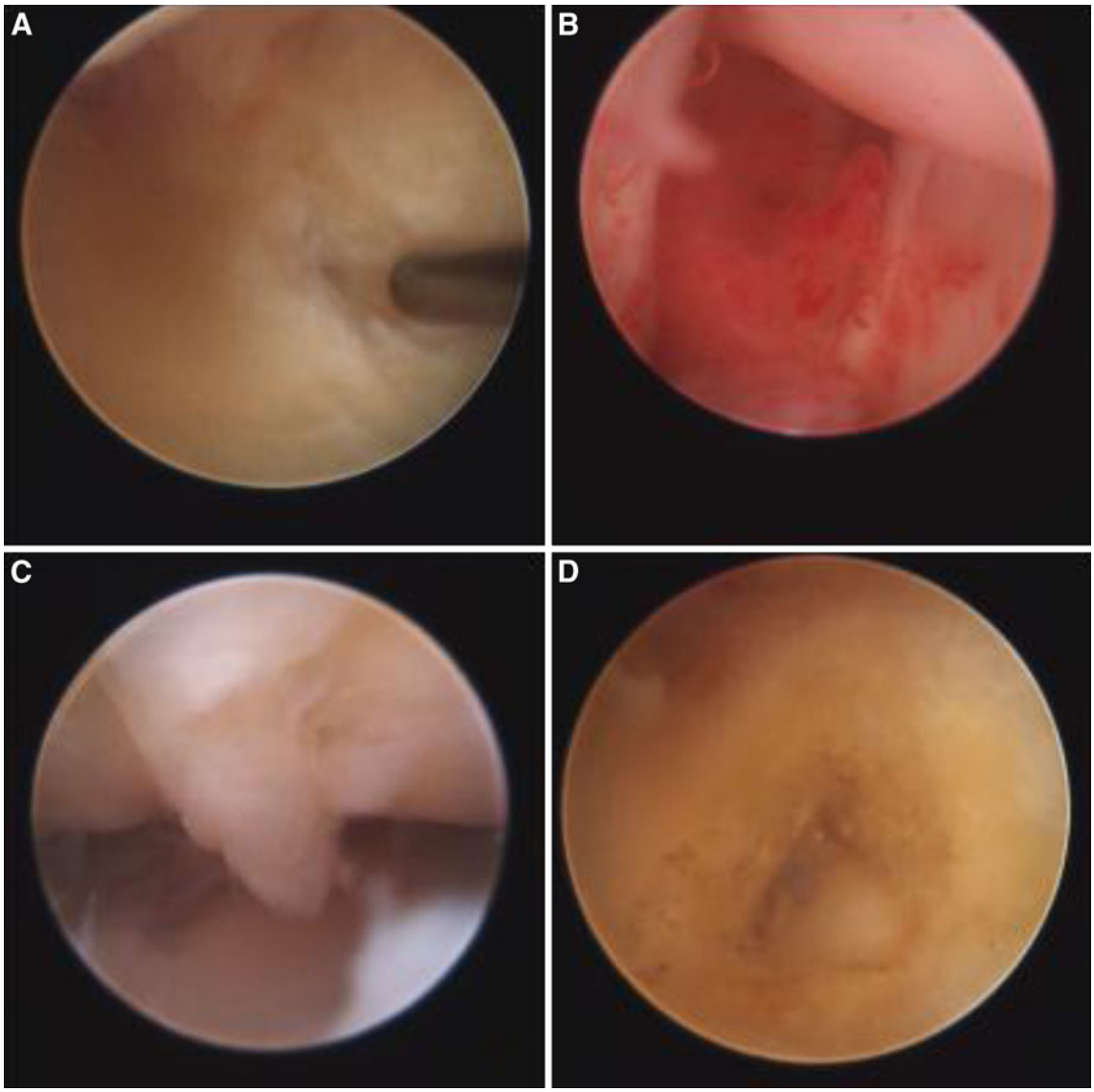

Fig. 2 Arthroscopy images. **a** A Palmer type Ia triangular fibrocartilage complex injury. **b** Synovitis can be observed. **c** A Grade 1 scapholunate interosseous ligament injury. **d** The triangular fibrocartilage complex after partial resection and debridement

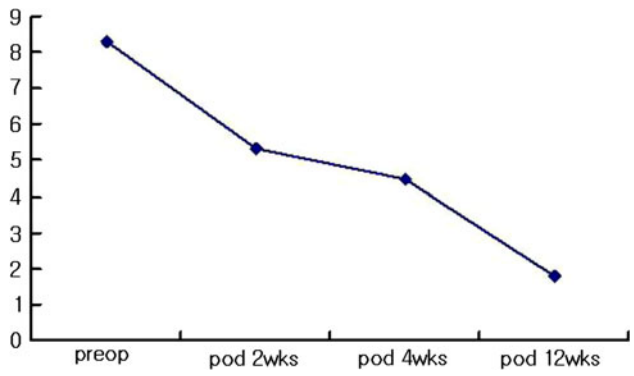

Fig. 3 The visual analogue pain scale (VAS) scores before and after surgery. The degree of pain decreased significantly over time after surgery. *Preop* preoperative, *Pod* postoperative day, *Wks* weeks

and 4 weeks after surgery were 15 (range 10–30) and 5.3 lb (5–10), respectively. This difference was statistically significant ($P < 0.005$).

Preoperatively all six cases responded positively to the ulnar grind and ulnar stress tests. Three cases also responded positively to the Kleinman shear test. Twelve weeks after surgery, all six cases responded negatively to the ulnar grind and Kleinman shearing tests, but one case was still positive to the ulnar stress test (Table 1). The ROM of the wrist joint measured before surgery showed an average of 66° (range 60°–80°) supination and 76.7° (60°–80°) pronation. Four weeks after surgery, all six cases showed full ROM and had recovered to normal.

Discussion

Triquetral fractures are second most common carpal bone fractures after scaphoid. Triquetral dorsal chip fractures are relatively common than the body fractures. They respond well to conservative treatment and lead to good long-term functional outcomes [14]. But if there is persistent ulnar-sided pain, other causes of pain should be considered.

It has been reported that triquetral fractures with avulsion of palmar aspect have high chances of associated ligamentous injuries such as ulnotriquetral and lunotriquetral interosseous ligamentous injuries [4, 5, 15].

Various causes have been reported for the persistent *ulnar-sided pain* of the dorsal chip fracture fragment, which resolves after simple excision of the fragment [4]. Another cause reported is carpal instability, although it is difficult to detect instability after triquetral fractures [15]. Abbound et al. [7] reported nonunion of the triquetral body to be one of the causes. Longitudinal split tears of ulnotriquetral ligament do not cause instability to the distal radioulnar joint or ulnocarpal articulation but lead to chronic pain and according to Palmer is a form of 1C injury which has not been described previously [16]. The ulnocarpal impaction syndrome is also a cause of ulnar-sided wrist pain with reactive cystic lesions of lunate on radiographs; however, such patients with large TFCC tears and negative ulnar variance usually require a wafer procedure [17].

In this paper, we propose that TFCC injury is another cause of persistent ulnar-sided pain after triquetral fracture. The mechanisms by which the TFCC can be injured include axial loading, ulnar deviation, and forced extremes of forearm rotation. Such mechanisms are similar to those involved in the development of triquetral fractures. Moritomo et al. [18] reported that the most common mechanism of foveal TFCC avulsion is forced wrist extension and forearm rotation. In our study the common lesion is Palmer IA; however, the number of cases is too small to correlate with the typical findings and conclude. However, the more common lesion Palmer IB can be either treated with a repair or an ulnar shortening osteotomy [19].

The suspicion that TFCC injury could be responsible for cases of persistent pain after triquetral fracture also arose because of several anatomical characteristics, namely the TFCC is located close to the triquetrum and the ulnotriquetral ligament is a part of the TFCC. We observed that in our patients with persistent pain on the ulnar side of the wrist joint after triquetral fracture indeed, TFCC injury and synovitis were the causes. We also found that the pain dissipated over time after partial TFCC resection and synovectomy. Moreover, the wrist joint motion was restored to its normal condition. In one case, Geissler's Grade I scapholunate interosseous ligament injury accompanied the TFCC injury [13]. This was treated by thermocoagulation of the scapholunate interosseous ligament. Since a scapholunate interosseous ligament injury was only observed in one case, it is difficult to predict the outcome of the thermocoagulation treatment.

In the present study, three cases responded positively to the preoperative Kleinman shear test but when they underwent an arthroscopic examination, lunotriquetral ligament injury was not observed. Moreover, the symptoms of three cases improved after arthroscopic partial TFCC resection and synovectomy. This suggests that lunotriquetral provocation tests may return positive results when there are abnormalities of the triquetrohamate joint or a TFCC injury [20].

Conservative treatment yields satisfactory outcomes for most triquetral dorsal chip fractures, and there are few cases with persistent pain. In such cases, the various causes of the pain that are listed above should be considered. In cases where the rotation of the wrist joint is limited, particularly in terms of supination, and there is physical examination evidence of TFCC injury (such as positive ulna stress and ulna grind test results), then the possibility that there is an accompanying TFCC injury should be considered. Arthroscopy of the wrist joint appears to be an effective method for diagnosing and treating such *injuries*. Moreover due to variability of TFCC tear type, different arthroscopic repair techniques and various post-operative immobilization protocols and series comprising of small number of patients make it difficult to compare the outcome of technique [21]. However, cadaveric studies have questioned the safety of all-inside arthroscopic repair of peripheral TFCC injury, because these techniques require additional incisions, risk injury to the DBUN [22] and ECU tendon, and sometimes require subcutaneous incisions. However, arthroscopic repair of TFCC is an effective means of treatment [23–26]. Lately Iwasaki et al. [27] have reported a new technique of arthroscopic attachment of avulsed TFCC into the ulnar fovea by creating an osseous tunnel which has yielded acceptable clinical and functional outcomes.

Conclusions

Conservative treatment of triquetral dorsal chip fracture generally produces a good outcome, but in cases with persistent ulnar-sided pain after union, TFCC injury should be considered a possible cause of the lack of response to treatment. In such cases, partial TFCC resection using arthroscopy is an effective treatment.

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