Chronic triangular fibrocartilage complex tears with distal radioulna joint instability: A new method of triangular fibrocartilage complex reconstruction

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ABSTRACT

From September 1996 to September 1997, 27 adult patients were diagnosed with chronic triangular fibrocartilage complex (TFCC) tears with distal radioulna joint (DRUJ) instability in our clinic. They all received the procedure of TFCC reconstruction with partial extensor carpi ulnaris (ECU) tendon combined with or without ulnar shortening. There were 26 males and one female in the study with a mean age of 22.4 years. The follow-up period ranged from 22 to 28 months with a mean of 26.2 months. 24 patients who had positive or zero ulnar variance received the procedure of ulnar shortening. Three patients who had minus ulnar variance only received TFCC reconstruction. After the operation, the DRUJ was fixed by a 2.0 mm K-wire for 4 weeks. All patients underwent a rehabilitation program and they were reexamined at our outpatient department (OPD). The results were graded according to the Mayo Modified Wrist Score. Five of the 27 patients rated their wrists ‘excellent’, 18 rated ‘good’, and 4 rated ‘fair’. Overall, a total of 23 patients (85%) rated satisfactorily and returned to work or sport activities. In the 4 patients rated ‘fair’, mild pain at work and/or exercise, and mildly limited supination were found; however their grip strength was improved at least by 65% compared to the opposite hand. Therefore, as suggested by this study, TFCC reconstruction with partial ECU tendon combined with the ulnar shortening procedure is an alternative method for chronic TFCC tears with DRUJ instability.

Key words: triangular fibrocartilage complex tears, ligament reconstruction, ulnar shortening

INTRODUCTION

Tears of the triangular fibrocartilage complex (TFCC) often show in ulnar wrist pain and limited wrist function in work or sports. The TFCC is the point that allows the carpus to rotate with the radius around the
ulna, which functions as the centre of forearm rotation.\textsuperscript{1,15,21} The TFCC is subjected to axial loads and shear forces. The TFCC is composed of the central fibrocartilage, the dorsal and palmar distal radioulnar ligaments, and the sheath of the extensor carpi ulnaris (ECU) tendon. It functions as an unit, and not just as separate ligaments. In acute peripheral TFCC tears, the vascularity allows surgeons to repair them with an excellent expectation of patient outcomes. However, in chronic TFCC tears, the treatment is controversial.

The TFCC has 3 important biomechanical functions.\textsuperscript{4} First, it allows loading or stress to be made on the forearm. Loading or stress passes from the forearm to the wrist by way of the TFCC. Second, it provides primary stability to the distal radioulnar joint (DRUJ). The TFCC is a major stabilizer of the DRUJ when distal radioulnar ligaments become taut. Third, it provides stability to the ulnar carpus through the ulnar carpal ligament complex. If the TFCC is disrupted or altered, the wrists become unstable. Thus, if the tears were missed, it would cause progressive instability in the DRUJ and arthritic changes in the TFCC, lunate, ulna and triquetrum, and furthermore, loss of motion and grip strength in the wrist. In chronic cases, tears with degenerative change of the TFCC combined with DRUJ instability make them difficult to treat. Therefore, we designed a new method of TFCC reconstruction with the partial ECU tendon with or without ulnar shortening to treat these patients.

\textbf{MATERIALS AND METHODS}

From September 1996 to September 1997, there were 27 adult patients with chronic TFCC tears in the study, 26 males and one female. Their ages ranged from 19 to 24 years, with a mean age of 22.4 years. All patients had experienced traumatic events, such as axial loading and hyperextensive injury in the past. The time from the accident to the operation ranged from 13 to 18 months with a mean of 15.6 months. After the operation, the follow-up period ranged from 22 to 28 months with a mean of 26.2 months.

\textbf{Patient evaluation}

\textbf{History and physical finding}

All patients had suffered from ulnar wrist pain, decreased grasp strength, and limited work or sport activities. They had tenderness over the ballottable area of the ulna bone. Passive ulnar deviation and ulna loading tests induced pain. The DRUJ stress test (Fig. 1) and piano key sign (Figs. 2a, b) were positive in all patients. They had all received previous treatment by other physicians, including oral NSAID drugs or herbal medicine.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{The DRUJ stress test. One hand holds the patient’s distal ulna and the other hand holds the distal radius and then applies stress by pushing one bone down while pushing the other bone up.}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure2.png}
\caption{The positive ‘piano key’ sign. (a) The protruding ulna is found when the forearm is in full pronation. (b) The positive ‘piano key’ sign is demonstrated by depressing the ulnar head. It springs back into position like a piano key.}
\end{figure}
Radiographic evaluation

All patients had plain radiography to assess any bony fracture and ulnar variance for the evaluation of possible degenerative changes. True lateral film can evaluate possible instability about the DRUJ. All patients had received bilateral wrist CT scan (Fig. 3) to evaluate the relationship between the distal radius and ulna, and any instability of the DRUJ. 24 of the 27 patients had received a triple injection wrist arthrogram. An arthrogram (Fig. 4) is used in our practice before the operation to identify the associated interosseous ligament injuries in the carpus and any TFCC tears. Three of the 27 patients had received MRI scans (Fig. 5) and the results were positive.

![Figure 3](image3.png) The wrist CT scan shows dorsal subluxation of ulna when the wrist is in full pronation.

![Figure 4](image4.png) The radiocarpal joint arthrogram. Contrast material placed within the radiocarpal joint enters through the radial rim of the triangular fibrocartilage into the distal radioulnar joint. The arrowhead points to the triangular fibrocartilage tear.

![Figure 5](image5.png) The wrist MRI scan revealed excessive joint fluid in the area of the TFCC tears.

Wrist arthroscopy

All patients underwent wrist arthroscopic examination and the lesions of TFCC tears were identified and classified according to Palmer (Table 1). We used a 1.9 mm small joint arthroscope and a 1.9 mm power shaver to evaluate and manage the wrist lesion. One week after the wrist arthroscopy, the operations of TFCC reconstruction and ulnar shortening were performed.
Table 1
Classification of TFCC lesions according to Palmer

<table>
<thead>
<tr>
<th>Traumatic lesions:</th>
<th>Degenerative lesions:</th>
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<tbody>
<tr>
<td>Class 1A: Central rupture</td>
<td>Class 2A: Superficial degenerative lesion</td>
</tr>
<tr>
<td>Class 1B: Ulnar avulsion with/without disruption of the ulnar styloid process</td>
<td>Class 2B: Degenerative tear with cartilage lesion of the lunate or the ulna</td>
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<tr>
<td>Class 1C: Distal avulsion</td>
<td>Class 2C: Degenerative disc perforation with cartilage lesion of the lunate or the ulna</td>
</tr>
<tr>
<td>Class 1D: Radial avulsion with/without osseous lesion of the radius</td>
<td>Class 2D: Degenerative disc perforation with cartilage lesion of the lunate or the ulna and lunotriquetral instability</td>
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<tr>
<td>Class 2E: Degenerative disc perforation with cartilage lesion of the lunate or the ulna, lunotriquetral instability and ulnocarpal arthrosis</td>
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Surgical procedure

The operations were performed under general or regional anaesthesia. An upper arm tourniquet was applied and the pressure was set between 200 and 250 mmHg. From the dorsal approach, the skin over ulnar border region of forearm was incised longitudinally and a zigzag-shaped incision was then made to the distal part (Fig. 6a). A partial ECU tendon graft about 3–4 mm in diameter and 12 cm in length was taken (Fig. 6b). A tunnel about 3 mm in diameter was made from the ulnar border of the ulna bone to the base region of the styloid process. The graft was passed through the tunnel to the pole of the ulna bone (Fig. 6c). The periosteum of the radius was dissected and elevated. The DRUJ was found and a tunnel over the radius near the DRUJ, about 3 mm in diameter, was made from the dorsal to the palmar region. The graft was then passed through the tunnel of the dorsal-to-palmar region (Fig. 6d). Finally, the graft was put back to the pole region of the ulnar bone and passed through the tunnel to the ulnar border of the ulna (Figs. 6e, 7).

Patients with positive ulnar variance received the ulnar shortening to neutralize the variance. Patients with zero ulnar variance received 2–3 mm of ulnar shortening, which has been shown to correspond with optimal unloading of the ulnar.2,5,9 From the same incision, a transverse osteotomy was made with a 2.0 mm saw blade, and then a 4 or 5-hole 3.5 mm dynamic compression plate (Synthes Ltd, Paoli, PA) was used to neutralize and fix the osteotomy (Fig. 6f). The DRUJ was fixed with mild supination (10–15°) via a 2.0 mm K-wire and the tendon graft was sutured together with 2-0 PDS. The operating time ranged from one hour 40 minutes to 2 hours 30 minutes with a mean time of 2 hours 10 minutes. Patients with negative ulnar variance did not receive the ulnar shortening procedure.

In all patients who received TFCC reconstructive procedures, the wrists were immobilized for 4 weeks with a 2.0 mm K-wire. After that, a rehabilitation program including wrist motion and occupational therapy was begun.

All operations were done by one surgeon (SJT) and the patients were evaluated and followed up at the OPD. We used the Mayo Modified Wrist Score (Table 2), including pain, work status, range of motion, and grip strength, to evaluate the wrist function. Grip strength was measured by a dynamometer at the injured and the contralateral sides. This allowed the results to be reported as a percentage of the contralateral data to normalize the data.

RESULTS

Plain X-ray film

None of the patients in our study showed degenerative changes in their X-ray films. The ulnar variance demonstrated an ulnar variance of 2.4 mm ± 0.5 mm. 23 patients had dorsal subluxation of the ulna from the true lateral X-ray. 24 patients had positive and zero ulnar variance; they had all received the ulnar shortening procedures. Three patients had minus ulnar variance, and they had received TFCC reconstruction only.

Arthrogram

24 patients had received the wrist arthrogram prior to the operation. 20 patients had positive arthrographic findings. Four patients had negative findings in their arthrogram but they all had Palmer type II lesions confirmed by the arthroscopy. None of the patients in our study had carpal interosseous ligament tears in arthrogram, and this was confirmed by the arthroscopy.
Figure 6  (a) This shows the incision wound over the dorsal aspect of forearm. (b) The partial ECU tendon graft, about 3 – 4 mm in diameter and 12 cm in length, was taken. (c) The graft was passed through the tunnel to the pole of ulna. (d) The graft was passed through the radius to palmar side. (e) The graft was put back and passed through the ulna to the ulnar border. (f) This demonstrates the ulnar shortening procedure. A transverse osteotomy was made, and then a 4-hole 3.5 mm dynamic compression plate was used to fix the osteotomy.
Figure 7  This demonstrates the TFCC reconstruction with a partial ECU tendon.

CT scan

All patients were examined by wrist CT scan to evaluate any subluxation or dislocation of the DRUJ. According to criteria from Mino et al., the ulnar head of a normal DRUJ lies between 2 tracing lines defining the dorsal and palmar borders of the radius (Fig. 3). All transverse computed tomographic scans showed subluxation of the DRUJ.

MRI scan

Three patients had received the wrist MRI scan examination. They all had torn TFCC which was confirmed by the wrist arthroscopy.

Arthroscopic findings

All the 27 patients had wrist arthroscopy and showed massive TFCC tears with degenerative change (Palmer type II). 11 of the 27 patients had Palmer type IIB tears (Fig. 8) and 16 patients had Palmer type IIC tears (Fig. 9). The tears and inflammatory synovium were debrided with a small joint power shaver. None of the patients had interosseous ligament lesions.

Table 2

<table>
<thead>
<tr>
<th>Pain</th>
<th>Point</th>
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<tr>
<td>No pain</td>
<td>25</td>
</tr>
<tr>
<td>Mild occasional</td>
<td>20</td>
</tr>
<tr>
<td>Moderate</td>
<td>15</td>
</tr>
<tr>
<td>Severe</td>
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<td>Regular job</td>
<td>25</td>
</tr>
<tr>
<td>Restricted job</td>
<td>20</td>
</tr>
<tr>
<td>Able to work but unemployed</td>
<td>15</td>
</tr>
<tr>
<td>Unable to work due to pain</td>
<td>0</td>
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<table>
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<th>Range of motion</th>
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<tr>
<td>&gt;120°</td>
<td>25</td>
</tr>
<tr>
<td>100 to 119°</td>
<td>25</td>
</tr>
<tr>
<td>90 to 99°</td>
<td>15</td>
</tr>
<tr>
<td>60 to 89°</td>
<td>10</td>
</tr>
<tr>
<td>30 to 59°</td>
<td>5</td>
</tr>
<tr>
<td>0 to 29°</td>
<td>0</td>
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<table>
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<th>Grip strength (% of normal)</th>
<th></th>
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<tbody>
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<td>90 to 100</td>
<td>25</td>
</tr>
<tr>
<td>75 to 89</td>
<td>15</td>
</tr>
<tr>
<td>50 to 74</td>
<td>10</td>
</tr>
<tr>
<td>25 to 49</td>
<td>5</td>
</tr>
<tr>
<td>0 to 24</td>
<td>0</td>
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</table>

* Total point scores: excellent (91 to 100), good (80 to 90), fair (65 to 79), and poor (<64).

Figure 8  A 21-year-old male patient had a Palmer type IIB lesion. Wrist arthroscopic examination demonstrates massive TFCC tears with TFC degenerative change.
Wrist function

Before the operation, we evaluated the function of the injured wrist. The majority of the patients had moderate ulnar wrist pain, were unable to work or tolerate the military training, and decreased grip strength (40% to 35% of the uninjured hand). Their scores ranged from 30 to 55 points according to the Mayo Modified Wrist Scores.

After the operations, all the 27 patients were followed up at our OPD for periods ranging from 22 to 28 months with a mean of 26.2 months. Five out of 27 patients (18%) had ‘excellent’ results. 18 of 27 patients (67%) had ‘good’ results. Four of 27 (15%) patients had ‘fair’ results.

Complications

One patient in the study had experienced superficial wound infection. He was treated with antibiotics and then discharged in a stable condition. Two patients suffered from numbness over the ulnar side of the dorsal hand region. The numbness was caused by damage to the dorsal branch of the ulnar nerve.

DISCUSSION

In 1991, Hermansdorfer and Kleinman first reported a series of the treatment of chronic tears of the TFCC, in which 8 of 11 patients had returned to painless normal activity. It is difficult to treat the patients with chronic TFCC tears with DRUJ instability. In the past, many procedures were suggested for TFCC reconstruction to stabilize the DRUJ. Unfortunately, these methods just tighten the joint and cause the DRUJ to lose the motion of pronation and supination. We designed a new method of TFCC reconstruction with a partial ECU tendon. This procedure not only stabilized the DRUJ but also kept the motion of pronation and supination. The method could dramatically improve the wrist function enabling the patient to tolerate the work and military training.

In 1985, Darrow et al. reported the results of ulnar shortening for patients with ulnar wrist pain in instability of the DRUJ, chronic TFCC tears, and Madelung’s deformity. They reported a rate of 77% good or excellent. Biomechanical studies had demonstrated that shortening the ulna even just by 2.0 mm could significantly decrease the force transmitted to the ulna from the carpus. In our study, most patients received the ulnar shortening procedure post TFCC reconstruction due to a positive or zero variance.

Wrist arthrography was shown to be a reliable procedure for diagnosis in 20 (83%) patients. It helps to identify the TFCC tears and their associated interosseous ligament tears, which greatly facilitates surgical planning. In our study, 3 patients had received MRI scan examination and showed TFCC tears. In one report, the accuracy of MRI has been demonstrated to be as high as 95% in detecting TFCC tears. MRI had a high sensitivity rate in the diagnosis of the TFCC tears. In our clinic, some patients had a positive finding in MRI scan but had a negative finding in arthroscopy. Our experience has shown that this noninvasive technique is not reliable enough to be used on a routine basis as other papers have suggested. Arthroscopy appears to be the most accurate means of diagnosing the TFCC tears.

In acute TFCC tears, many studies have reported satisfactory results after the immediate repair. In chronic cases, although short-term studies have demonstrated good results with partial TFCC excision, some long-term studies have reported a more than 30% failure rate when TFCC excision is performed without ulnar shortening. In 1991, Osterman reported that the debridement of the redundant cartilage remnant was a highly successful procedure, with an overall improvement rate ranging from 75% to 85%. For the remaining 15% to 25% of the patients who still had symptoms, ulnar surgery was an option. In our study, the debridement of the TFCC and inflammatory
synovium was proved to reduce the symptoms. Ulnar shortening can decrease the loading of the TFCC which prevents further degenerative change.

Four patients in our study had fair scores after TFCC reconstruction. Although their symptoms were improved, mild pain at work or sports, and mild limitation in supination of the wrist were reported in those patients. The causes might be the adhesion of the graft and more degenerative change in the wrist joint. Their grip strength was improved by at least 65% compared to the opposite hand. Their wrist scores were better than preoperation.

In our study, one patient experienced superficial wound infection and he was treated with antibiotics. That patient showed good results 2 years later. Two patients suffered from numbness over the ulnar region of the dorsal hand. The dorsal branch of the ulnar nerve was injured during the operation. These 2 patients received neurorrhaphy 4 months later. These complications can be avoided through careful dissection during the operation.

TFCC reconstruction with the partial ECU tendon combined with ulnar shortening is a good procedure. It provides a potentially satisfactory head-notch relationship, restores the TFCC integrity and stability, maintains the motion of supination and pronation of the DRUJ, and decreases the force transmitted to the ulna. These reduce the patients’ symptoms and improved their wrist functions enabling them to tolerate their work, sports, and military training. Therefore, as suggested by this study, TFCC reconstruction with partial ECU tendon combined with the ulnar shortening procedure is a alternative method for chronic TFCC tears with DRUJ instability.

REFERENCES