Arthroscopic Assisted Resection of Triangular Fibrocartilage Complex Lesions: A 19-Year Follow-up

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Abstract

Background: This study assesses long-term functional and subjective outcomes following arthroscopic assisted resection of lesions of the triangular fibrocartilage complex (TFCC). **Methods:** Functional and subjective outcomes were assessed based on review of patient charts for patient demographic characteristics, comprehensive clinical evaluation, obtained radiographs, and patient-reported questionnaires. **Results:** Fifteen patients, of whom 9 were female, and 10 dominant wrists, were included in this study. Median age was 60 (range, 37-73) years, and median duration of follow-up was 19 (range, 18-21) years. Median Mayo Wrist Score was 85 (range, 45-100). Four patients scored excellent, 7 good, 3 fair, and 1 poor result according to the Modified Mayo Wrist Score. Median Quick Disabilities of the Arm, Shoulder and Arm was 20 (range, 0-45) and Patient-Rated Wrist and Hand Evaluation was 8 (range, 0-61). Patients reported high rate for satisfaction and low rate for pain. All patients presented intact stability of the distal radioulnar joint. **Conclusions:** This study demonstrates persisting satisfactory subjective and functional outcomes for patients following arthroscopic assisted resection for lesions of the TFCC at 19 years of follow-up. Arthroscopically assisted resection of selected TFCC lesions seems to be both a safe and efficient procedure.

Keywords: triangular fibrocartilage complex, wrist arthroscopy, central lesions, radial lesions, clinical outcome, Palmer IA, Palmer ID

Introduction

The triangular fibrocartilage complex (TFCC) is recognized as the primary contributor to distal radioulnar joint (DRUJ) stability.^{2,4,7,10,11,27,30,31} In addition, the TFCC elongates the smooth joint surface from the distal radius to the ulnar side of the wrist, allowing for substantial transmission of forces over the ulnocarpal joint. Lesions of the TFCC, either acute or degenerative, commonly cause ulnar sided wrist pain and may benefit from treatment. In addition, stability of the DRUJ should be assessed, and addressed if present.^{26,34}

Palmer's classification of TFCC lesions was introduced in 1989, which is based on the etiology and the anatomic location of the lesion.²⁸ The distinction between the acute and degenerative lesions is important, as the acute tears (type1) may be treated with a higher rate of success,¹⁹ whereas degenerative lesions more commonly are associated with ulnar impaction syndrome (UIS). The latter draws attention toward the length of the ulna, in addition to the TFCC.^{14,19-21}

The limited vascularity of the central and radial regions of the TFCC reduces the healing potential following direct repair.^{24,25,35} Historically, these lesions were treated with

different distal ulnar resection techniques and ulnar shortening osteotomies.⁶ However, promising results following arthroscopic resection of these lesions lead to an establishment of this procedure as a treatment option to relieve patients' pain and discomfort.^{14,26}

This study assesses long-term functional and subjective outcomes following arthroscopic assisted resection of lesions of the TFCC.

Methods

The regional ethical committee approved the study, and all patients provided informed written consent. The midterm clinical outcomes for 35 consecutive cases treated with arthroscopic assisted resection of symptomatic lesions of

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the TFCC at our institution were previously published.¹⁴ Fifteen of these patients were available for an additional long-term follow-up.

The patients returned for a long-term clinical evaluation, including a targeted wrist examination with assessment of DRUJ stability by one of the authors. Measurements of range of motion (ROM) and grip strength (Jamar hydraulic dynamometer; Patterson Medical, Warrenville, Illinois) were taken by a hand therapist. All patients completed the patient-reported questionnaires: Quick Disabilities of the Arm, Shoulder and Arm (QuickDASH)^{3,12} and Patient-Rated Wrist and Hand Evaluation (PRWHE).^{17,18} Functional outcome was evaluated according to the Mayo Wrist Score (MWS) and the Modified Mayo Wrist Score (MMWS).^{7,9} Pain and satisfaction was assessed using a visual analog scale (VAS), where a score of 0 for pain indicated "pain free," whereas a score of 100 for satisfaction represented "perfectly satisfied." Anteroposterior (AP) and lateral view radiographs of the wrist were obtained and reviewed for degenerative osteoarthritis (OA) and ulnar variance.

Statistics

Continuous variables are presented as median and range and categorical variables as counts and fractions, due to limited data sample without expectation of normal distribution. The Mann-Whitney *U* test was used to compare continuous variables, whereas the Fisher exact test was used to compare categorical variables. Longitudinal data were analyzed using Wilcoxon signed-rank test for continuous variables and Fisher exact test for categorical variables. All statistical tests were 2-sided and statistical significance level set to .05. IBM SPSS Statistics for Mac version 24.0 (IBM Inc., Chicago, Illinois) was used for the statistical analysis.¹⁵

Results

Comparison of patient demographic characteristics and midterm outcomes did not reveal any statistically significant differences between the patients available and unavailable for the long-term follow-up (Table 1).

Median age at the time of surgery was 37 (range, 15-50) years and 60 (range, 37-73) years at the time of long-term follow-up for the patients available for this study. Median duration of follow-up was 19 (range, 18-21) years. Nine women and 6 men, and 10 dominant wrists were included. According to Palmer's classification, there were 11 type 1A, 2 type 1D, and 2 type 2C injuries, all arthroscopically verified. Neither patients with type 1D injuries had any bony avulsion or rupture of the distal radioulnar ligaments. We performed limited TFCC resections of these radial lesions as the stability of the DRUJ was unaffected.

The grip strength was reduced from the midterm to the long-term follow-up, however not significantly (Table 2).

Table 1. Patients Available for the Long-term Follow-up Compared With Those Who Were Unavailable, Based on Data From Midterm Follow-up.

Factor	Available for long-term follow-up (n = 15)	Unavailable for long-term follow-up (n = 20)	P value
Age, y	37 (15-50)	35 (11-52)	.236
Sex, female	9 of 15	10 of 20	1
Side, right	9 of 15	8 of 20	.296
Dominant wrist	10 of 15	10 of 20	.492
Mayo Wrist Score	95 (65-100)	90 (25-100)	.787
MMWS ≥ Good	11 of 15	16 of 20	.7
Flexion-extension, %	98 (74-107)	94 (50-104)	.547
Radial deviation, %	80 (33-150)	100 (60-175)	.054
Ulnar deviation, %	100 (75-125)	89 (45-137)	.063
Pronation/supination, %	100 (50-108)	100 (89-112)	.305
Grip strength, %	102 (4-167)	94 (4-150)	.855
Time injury to surgery, mo	15 (4-132)	27 (6-132)	.256
Satisfaction (VAS)	9 (4-10)	8 (0-10)	.434
Pain (VAS)	1 (0-6)	2 (0-9)	.327
Redone	14 of 15	19 of 20	1

Note. Continuous variables compared using Mann-Whitney *U* test, and categorical variables compared using Fisher exact test. Range of motion modalities presented as a percentage of contralateral uninjured extremity. MMWS ≥ Good: Fraction of patients with MMWS good or excellent. MMWS = Modified Mayo Wrist Score; VAS = visual analog scale.

Dominant wrist was affected in 5 of 9 women and 5 of 6 men ($P = .256$), and there was no difference in grip strength between patients with lesion in dominant compared with nondominant wrist ($P = .580$).

Overall, median MWS was 95 (range, 65-100) and 85 (range, 45-100) at midterm and long-term follow-ups, respectively ($P = .379$). Four patients scored excellent, 7 good, 3 satisfactory, and 1 poor according to the MMWS. Longitudinal comparison of the MMWS demonstrated that 9 of 15 patients improved or stayed at the same level, whereas 6 of 15 patients declined on the MMWS (Table 3). Median scores for QuickDASH and PRWHE were 20 (range, 0-45) and 8 (range, 0-61), respectively. Patients reported a median score of 17 (range, 0-60) for pain and 94 (range, 0-100) for satisfaction on the VAS. Preoperative pain was 70 (50-100) and 10 (0-60) at the midterm follow-up ($P = .001$). Three patients reported to be free of pain, 10 patients reported to be much better, and 2 patients claimed no change compared with preoperative pain. Knowing the clinical outcome, 13 patients stated they would have redone the procedure.

Ten patients presented normal radiographs without degenerative changes or other pathology. Degenerative OA of the wrist was present in 4 patients (DRUJ [$n = 2$],

Table 2. Comparison of Functional Outcomes, % of Uninjured Contralateral Side, Median (Range).

Modality	Midterm follow-up	Long-term follow-up	P value
Flexion-extension, %	98 (74-107)	93 (59-108)	.513
Pronation/supination, %	100 (50-108)	100 (56-104)	.972
Ulnar deviation, %	100 (75-125)	90 (33-108)	.005
Radial deviation, %	80 (33-150)	80 (42-120)	.552
Grip strength, %	102 (4-167)	85 (43-126)	.73
Mayo Wrist Score	95 (65-100)	85 (45-100)	.379

Note. Range of motion presented as percentage of contralateral uninjured extremity. The results of the 2 time points compared using Wilcoxon signed-rank test. Statistically significant results presented in bold.

radiocarpal joint [$n = 1$], and carpal [$n = 1$]). The patient with radiocarpal OA rated “excellent,” while both patients with DRUJ OA (one present already at midterm follow-up) were asymptomatic and rated “good,” while the patient with carpal OA rated “poor” on the MMWS. One patient had an asymptomatic lunate malacia, who was also present at the midterm follow-up.

Median ulnar variance was 0 mm (range, -3 to $+3$). Overall, the ulnar variance had increased from midterm to long-term follow-up ($P = .023$). Five patients presented with a positive ulnar variance, ranging $+1$ to $+3$ mm. However, the clinical assessment of these 5 patients demonstrated 3 excellent, 1 good, and 1 satisfactory result according to the MMWS.

All patients presented with a stable DRUJ at follow-up. No adverse events were unveiled, but 2 patients required additional resection of the TFCC and 1 patient underwent ulnar shortening osteotomy between midterm and long-term follow-up to achieve sufficient pain relief.

Discussion

The present study demonstrates satisfactory functional and subjective outcomes following arthroscopic assisted resection for central and radial lesions of the TFCC at approximately 19 years of follow-up.

Persisting ulnar sided wrist pain following a wrist trauma is in our opinion a good indication for arthroscopic evaluation, considered by many to be the “gold standard” for assessment of the TFCC, in addition to the radiocarpal and midcarpal joints. TFCC lesion is a common cause of ulnar sided wrist pain following a distal radius fractures^{14,16,36} in addition to other causes of ulnar sided wrist pain.³⁷ Treatment options for these lesions may include different conservative and operative procedures.²⁹

In our opinion, central and radial lesions without DRUJ instability of the TFCC may be treated with arthroscopically assisted resection of the unstable part of the disc. Yet,

it should be emphasized to limit the resection, leaving at least a 2-mm peripheral rim of the TFCC, to prevent instability and disruption of the load-bearing properties of the DRUJ.^{1,26}

The midterm follow-up revealed 27 of 35 patients with a good or excellent result according to the MMWS. Furthermore, 30 of 35 patients experienced pain reduction.¹⁴ Minami et al reported the results of 16 patients following arthroscopic debridement for a central lesion, presenting excellent results in the patients with traumatic lesions ($n = 11$), but inferior outcome for degenerative lesions.¹⁹ Westkaemper et al reported 21 good or excellent results in 28 patients at mean 15.4 months of follow-up.³⁷ The present study, with 19 years of follow-up, confirms the good long-term clinical outcomes of these studies.

Radial lesions have limited healing potential due to the poor vascularization.^{4,35} We consider arthroscopic resection to be an eligible treatment option for the radial lesions of the TFCC, provided an intact stability of the TFCC.

In an ulnar variance neutral wrist, 20% of the load is transmitted over the TFCC.³⁰ Removal of the TFCC reduced the ulnar sided load transmission to about 5%, while a 2.5-mm lengthening causing a positive ulnar variance altered the transmission of force on the ulnar side to more than 40%.³² A positive ulnar variance may cause a painful pathological compression of the TFCC with progressive degenerative changes, resulting in an ulnocarpal impaction syndrome. Patients with ulnocarpal impaction syndrome commonly present with ulnar sided wrist pain of increasing intensity with the forearm in a pronated and/or ulnar deviated position.³³ The treatment of ulnocarpal impaction syndrome aims to normalize the load transmission over the wrist by decompression of the ulnocarpal joint either by resection of the TFCC/distal ulna or by performing an ulnar shortening osteotomy.

Patients with TFCC lesions associated with a positive ulnar variance may have inferior outcome compared with patients with neutral ulnar variance after arthroscopic debridement alone.¹⁹ Hulsizer et al reported on 13 patients referred to ulnar shortening osteotomy due to persisting pain after arthroscopic resection for a central lesion of the TFCC.¹³ At mean 2 years following surgery, 12 of 13 patients were pain free. This was later confirmed by Minami and Kato, reporting good clinical outcome and no nonunions in 35 patients following arthroscopic TFCC resection and ulnar shortening osteotomy of average 3 mm.²⁰ In a comparative study, Bernstein et al concluded that arthroscopic debridement combined with the arthroscopic wafer procedure provided similar clinical outcome as arthroscopic debridement combined with ulnar shortening osteotomy, but with a lower complication rate in the arthroscopically assisted wafer group.⁵ In a newly published study presenting the outcome of 50 patients with Palmer 2C lesions, arthroscopic resection alone demonstrated to be a sufficient and reliable treatment

Table 3. Longitudinal Functional Outcome.

Case	Age at surgery, y	Sex	Dominant wrist	Midterm outcome				Long-term outcome							
				Duration of FU, y	MWS	MMWS	Redone	Additional surgery	Duration of FU, y	MWS	MMWS	PRWHE QuickDASH Redone	OA		
1	49	F	N	3.8	100	E	Y	Surgery to the thumb	20	70	F	61	45	Y	No
2	46	F	N	3.4	65	F	Y	No	19	45	P	40	39	N	Carpal
3	46	F	Y	2.7	70	F	Y	No	19	80	G	43	43	Y	DRUJ
4	42	F	Y	2.1	85	G	Y	No	19	85	G	17	29	Y	Lunate malacia
5	36	M	Y	3.0	95	E	Y	No	19	100	E	2	5	Y	No
6	24	F	N	3.1	100	E	Y	Re-resection	19	75	F	29	20	Y	No
7	40	F	Y	2.9	70	F	Y	No	19	80	G	15	29	Y	No
8	30	M	Y	1.5	70	F	Y	No	18	80	G	22	20	Y	No
9	44	M	Y	3.6	100	E	Y	No	20	100	E	0	0	Y	Radiocarpal
10	36	F	N	2.9	85	G	Y	No	19	90	G	0	0	Y	No
11	37	M	N	4.0	95	E	Y	No	21	85	G	8	5	Y	No
12	32	M	Y	2.8	95	E	Y	No	19	100	E	0	0	Y	No
13	15	F	Y	4.6	85	G	Y	Re-resection	21	100	E	0	5	Y	No
14	50	F	Y	3.7	95	E	Y	No	20	85	G	4	20	Y	DRUJ
15	34	M	Y	3.4	95	E	N	USO	20	75	F	4	2	N	No
Median	37			3.1	95				19	85		8	20		
Range	15-50			1.5-4.6	65-100				18-21	45-100		0-61	0-45		

Note. FU = follow-up; MWS = Mayo Wrist Score; MMWS = Modified Mayo Wrist Score; PRWHE = Patient-Rated Wrist and Hand Evaluation; QuickDASH = Quick Disabilities of the Arm, Shoulder and Arm; OA = osteoarthritis; DRUJ = distal radioulnar joint; Re-resection = additional arthroscopic resection of the TFCC; USO = ulnar shortening osteotomy; TFCC = triangular fibrocartilage complex; E = excellent; F = fair; P = poor; G = good.

option for the majority of the patients.²² Nine patients had persisting ulnar sided wrist pain (mean ulnar variance, 2.5 [SD, 0.5]) after 6 months and were referred to an ulnar shortening osteotomy, concluding that central TFCC lesions can be treated initially by arthroscopic resection alone, and restrict the ulnar shortening osteotomy for patients with persisting symptoms. This confirms the findings in our study and supports our clinical practice.

Mrkonjic et al found increased DRUJ laxity in 17 out of 38 patients with distal radius fractures and arthroscopically verified TFCC lesions.²³ In addition, they had reduced grip strength and reduced functional outcome. The distal radius fracture was treated according to the surgeon's preference.

Like other available studies on this topic, it is a retrospective study on a single treatment modality without control groups or comparison with other treatment options, and should for this reason be interpreted with some caution. The study sample is limited due to low incidence of these lesions and loss of years follow-up. However, we noted no differences based on demographic characteristics and results from the midterm follow-up for patients available versus unavailable for the long-term follow-up. Thus, we consider the presented results to be representative for the clinical condition. Furthermore, change in occupation, adjustment of activity level, and increased age of the patients should be considered when interpreting the results. Grip strength was not adjusted for dominant side, right/left side, sex, or age, all factors known to affect grip strength.⁸ However, presenting grip strength as the ratio of contralateral side at both time points, they act as their own control. Therefore, in our opinion, this is a reliable evaluation of the grip strength.

The present study supports the findings in the currently available literature. For central and radial lesions of the TFCC without compromised stability of the DRUJ, arthroscopically assisted resection seems to be a safe and efficient procedure, providing satisfactory subjective and functional long-term outcomes. To improve our ability to provide reliable clinical guidance and adjust patients' expectations, there is a need for further investigations to enlighten unanswered questions currently existing regarding management of TFCC lesions.

Authors' Note

The investigation was performed at Oslo University Hospital, Ullevål.

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Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

All procedures followed were in accordance with the regional ethical committee of the Norwegian Health Authorities and with the Helsinki Declaration of 1975, as revised in 2008.

Statement of Informed Consent

Informed consent was obtained from all individual participants included in the study.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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