Biomechanical Comparison of Two Different Arthroscopic Transosseous Foveal Repair Techniques in Triangular Fibrocartilage Complex Foveal tears: A Cadaveric Study

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ABSTRACT

Biomechanical Comparison of Two Different Arthroscopic Transosseous Foveal Repair Techniques in Triangular Fibrocartilage Complex Foveal tears: A Cadaveric Study

Background: Arthroscopic transosseous foveal repair of the triangular fibrocartilage complex (TFCC) is an option for the treatment of symptomatic TFCC foveal tear. This technique has two main variations—the one-tunnel and two-tunnel methods—but comparative studies are limited. This study aimed to assess the initial biomechanical stability of one-tunnel versus two-tunnel arthroscopic transosseous foveal repair.

Methods: Nine matched pairs of human cadaveric arm specimens were randomized into two groups of arthroscopic transosseous TFCC foveal repair: one-tunnel technique (Group I) and two-tunnel technique (Group II). A foveal tear was made from its origin at the ulnar styloid base in each wrist under arthroscopic guidance. In group I, a single tunnel was created, and PushLock anchors were used to reattach the TFCC to its anatomic origin. In group II, two tunnels were created, and a simple suture knot was used. Biomechanical tests included load at 2-mm gap formation and single load to failure. The load was applied to the ulna with respect to the fixed radius. The load at 2-mm gap formation was measured in each of the three forearm positions (neutral alignment, 60°of pronation, and 60°of supination), and the load to failure was measured in the pronation forearm position. Failure modes were compared between two groups.

Results: There were no significant differences between the two groups in the load at 2-mm gap formation at all positions and in the load to failure. In Group I, suture anchor pull-out occurred in three specimens, while in Group II, fractures through the bone tunnels were observed in two specimens. All other failures occurred at the suture–soft tissue junction.

Conclusions: Our study revealed that the arthroscopic-assisted one-tunnel and two-tunnel transosseous techniques for TFCC foveal repair demonstrated comparable biomechanical stability. Therefore, the choice of technique may be based on the surgeon's preference and experience.

Clinical Relevance: Both one-tunnel and two-tunnel techniques offer similar biomechanical strength, supporting surgeon preference in clinical decision-making.

Key words : Triangular Fibrocartilage Complex Foveal repair; transosseous technique; biomechanics

1. Introduction

Palmer type 1B lesions of the triangular fibrocartilage complex (TFCC) can lead to distal radioulnar joint (DRUJ) instability, resulting in ulnar-sided wrist pain, reduced grip strength, and functional limitations.[1,2] When symptoms persist and DRUJ instability does not resolve with conservative treatment, surgical intervention may be considered. If the TFCC is amenable to repair, reattachment is preferred due to the healing potential of the well-vascularized peripheral region.[3]

Various reattachment techniques have been described, but no single method has demonstrated clear superiority. Recent systematic reviews have shown similar outcomes in terms of pain relief, functional recovery, range of motion, and complication rates between arthroscopic and open techniques.[4,5] However, arthroscopic approaches, being minimally invasive, are associated with faster recovery times.[6,7]

Among arthroscopic assisted foveal repair techniques for the TFCC, anchor-based and transosseous methods are the most commonly employed.[1,8,9] Both techniques have shown good short- and medium-term results in symptom relief by restoring DRUJ stability. While prior biomechanical study suggested a potential advantage of the transosseous technique in resisting forearm rotational forces, a recent randomized clinical trial reported comparable clinical and functional outcomes between transosseous and suture anchor repairs.[10,11]

Arthroscopic transosseous repair has gained popularity following its introduction by Iwasaki and Minami.[8] The transosseous repair technique has been modified in various ways, including two-tunnel and one-tunnel techniques.[9,12] However, no studies have directly compared these arthroscopic transosseous foveal repair techniques, either biomechanically or clinically.

This study aimed to evaluate the initial biomechanical stability of one-tunnel versus two-tunnel arthroscopic transosseous foveal repair. We hypothesized that both techniques would provide comparable biomechanical stability.

2. MATERIALS AND METHODS

2.1. Specimen

In total, 22 matched fresh-frozen human cadaveric upper extremities from 11 donors were obtained through the university's cadaveric donation program, following institutional review board approval. Each matched pair was randomly assigned using a random number generator to either the one-tunnel or two-tunnel transosseous repair group. Specimens were screened visually and radiographically to exclude deformities, prior injuries, or surgical history. Specimens were stored at −20°C and thawed at room temperature for 24 h before testing. DRUJ stability was assessed using ballottement testing in pronated, neutral, and supinated positions. One matched pair was excluded owing to DRUJ instability in one limb. The remaining 10 pairs underwent diagnostic wrist arthroscopy to confirm TFCC integrity. One additional specimen was excluded because of a severe degenerative TFCC tear, and its contralateral limb was also excluded to maintain pair matching. Ultimately, 18 specimens from 9 matched pairs were included in the final analysis. All included specimens had intact TFCC without cartilage or ligament damage and negative hook tests.

2.2. Surgical procedures

All procedures were arthroscopically performed with the specimens mounted on a traction tower. A complete tear of the ulnar foveal insertion of the TFCC was created. The TFCC was released from its proximal insertion into the ulnar fovea using a #11 scalpel through the 6U portal, under arthroscopic visualization from the 3-4 portal. In all specimens, the complete foveal tears were confirmed with a probe (Fig. 1A) and the DRUJ Ballottement test. For the one-tunnel transosseous technique, a 2 cm incision was made along the lateral ulna, and a 1.1-mm K-wire was used to guide a 2.7-mm drill, which was then enlarged to 4 mm. A #2 FiberWire (Arthrex, Naples, FL) was passed through the transosseous tunnel and stabilized using a 2.5-mm PushLock anchor (Arthrex, Naples, FL) approximately 5–10 mm apart.[13] For the two-tunnel transosseous technique, a 1-cm longitudinal incision was made on the ulnar shaft about 2-cm proximal from the 6R portal. With periosteal elevation, two separate small holes were made from the ulnar cortex of the ulnar with 1.5-mm K-wires. A #2 FiberWire (Arthrex, Naples, FL) was passed through in one bone tunnel and the TFCC using an 18-gauge spinal needle.[14] A looped #3 polydioxanone suture was introduced through the other bone tunnel to retrieve the core suture in the radiocarpal joint. The core suture ran through the TFCC and out of the ulnar cortex of the distal ulna. After finger traps and traction were removed, the elbow was flexed 90° with the forearm in neutral position, and the suture was tied securely. All cadavers that underwent TFCC foveal repair demonstrated normal findings on the arthroscopic hook test (Fig. 1B) and the physical examination DRUJ ballottement test following the repair. A schematic illustrating both the one-tunnel and two-tunnel transosseous techniques is shown in Figure 2.

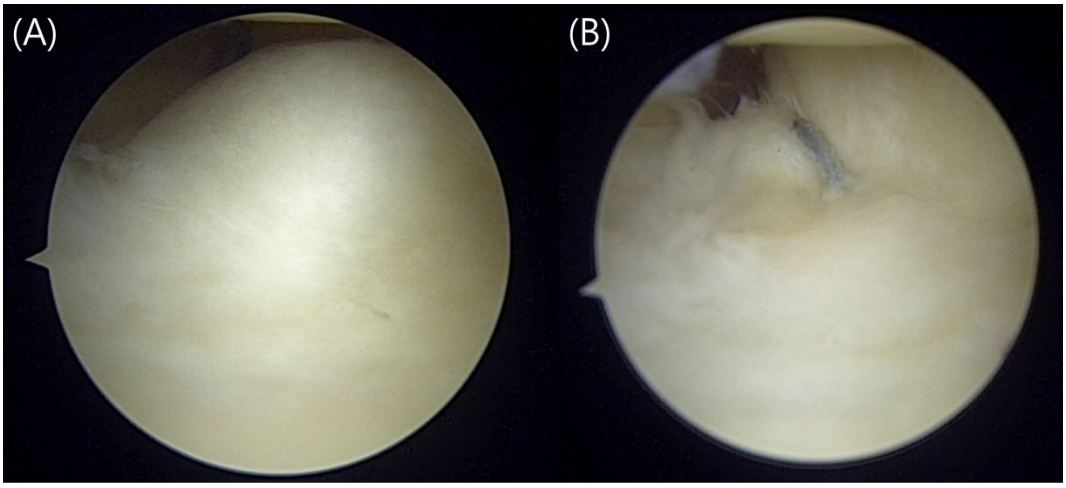

Figure 1. (A-B) Arthroscopic images of the triangular fibrocartilage complex as seen through the 3-4 portal. (A) A foveal tear demonstrated by a positive hook test. (B) Restoration of stability after foveal repair, showing a negative hook test.

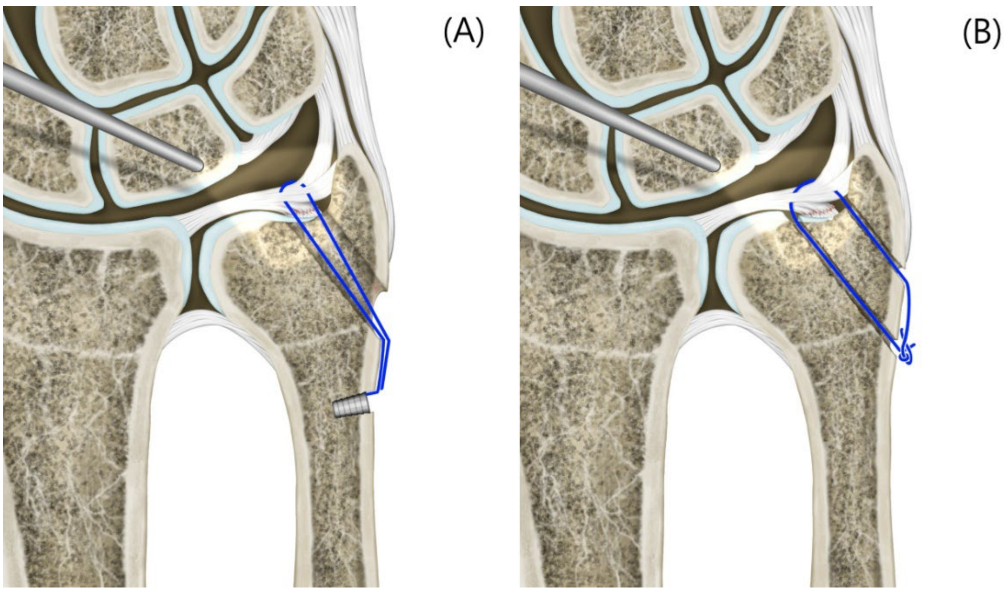

Figure 2. Schematic of arthroscopic assisted transosseous foveal repair techniques. (A) One tunnel technique, (B) Two tunnel technique.

2.3. Biomechanical testing

Specimens were dissected to expose the distal radius and ulna, and biomechanical testing was performed with the bones fully exposed. The mid-humerus was amputated and mounted in the custom-designed jig, which allowed controlled pronation–supination movement. The forearm was rigidly secured to the jig in supinated, pronated, and neutral positions using compressive screws. The distal radius and carpal bones were fixed together to ensure that the applied force would be transmitted solely to the distal ulna. We then evaluated the strength of the repair by applying a load to the distal ulna, 2 cm proximal to the ulnar styloid (Figure 2). The vector of pull was perpendicular to the repair site. Each specimen was loaded until a 2-mm gap formed across the repair site, and the corresponding load was recorded in forearm neutral, 60° supinated, and 60° pronated positions. Subsequently, specimens were loaded to failure in the pronated position, and the failure load was recorded. Failures were classified by location, based on visual and arthroscopic evaluation: TFCC tissue (suture cut-out), suture failure, or bone failure. Bone failure included suture anchor pullout or fracture at the bone tunnel. Thus, for each repair, we obtained the load at 2-mm gap formation, load to failure, and failure mode using an Instron device (model 3366; Instron Co., Norwood, MA).

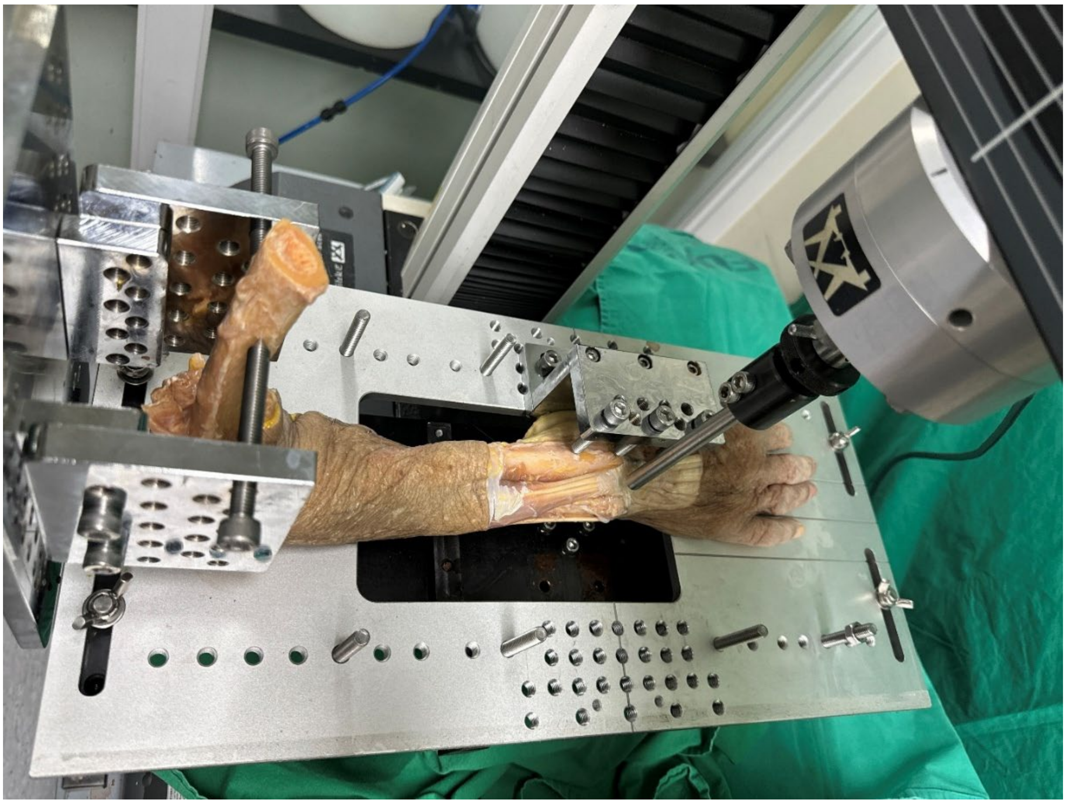

Figure 3. Biomechanical testing setup of the humerus, radius, and carpus fixed on a custom-made jig.

2.4. Statistical Analysis

Due to the limited literature, the sample size was calculated based on the load to 2-mm gap formation, measured in a pilot study involving four paired upper extremities (eight specimens). Based on the mean and standard deviation from this pilot data, a sample size of 16 specimens (eight per group) was required to achieve 80% statistical power ($\alpha = 0.05$). To minimize potential bias and account for variability, 11 specimens were ultimately included in the study.

The data were analyzed using descriptive statistics, including the calculation of mean values and standard deviations. To evaluate the normality of distribution for all variables, the Shapiro–Wilk test was employed. Depending on the normality of variables, paired t-tests or Wilcoxon signed-rank test were used to compare biomechanical metrics between the two groups. Statistical analyses were performed using SAS version 9.4 (SAS Institute, Inc., Cary, NC), with statistical significance set at $p < 0.05$.

3. RESULTS

The average donor age was 66 ± 6 years; 7 were men, and 2 women. In forearm pronated position, the mean load at 2-mm gap formation was 21.89 ± 12.65 N in Group I and 25.06 ± 11.28 N in Group II (p = 0.582). In the neutral position, the mean load at 2-mm gap formation was 16.68 ± 5.01 N in Group I and 17.60 ± 4.99 N in Group II (p = 0.703). In the supinated position, the mean load at 2-mm gap formation was 15.63 ± 4.09 N in Group I and 20.88 ± 8.08 N in Group II (p = 0.108). The mean single load to failure was 206.21 ± 70.56 N in Group I and 239.72 ± 62.41 N in Group II (p = 0.302). No significant differences were observed between the two groups in any of the biomechanical parameters (Table 1).

In Group I, suture anchor pullout was observed in three cases, while in Group II, fractures near the distal ulna bone tunnel were observed in two cases. In the remaining cadavers, failure occurred at the junction between the TFCC and the suture (Table 2).

Table 1. Comparative results of load to 2mm gap formation and load to failure between the two groups

	Group I (n=9)	Group II (n=9)	p-value
Load to 2mm gap formation (N) (Forearm in pronation position)	21.89 ± 12.65	25.07 ± 11.29	0.484
Load to 2mm gap formation (N) (Forearm in neutral position)	16.68 ± 5.01	17.60 ± 4.99	0.485
Load to 2mm gap formation (N) (Forearm in supination position)	14.58 ± 3.24	20.88 ± 8.08	0.054
Single load to failure (N)	206.21 ± 70.56	239.72 ± 62.41	0.163

Note: Group I: Arthroscopic one tunnel transosseous foveal repair. Group II: Arthroscopic two tunnel transosseous foveal repair. Values are expressed as mean ± standard deviation.

In Group I, suture anchor pullout was observed in three cases, while in Group II, fractures near the distal ulna bone tunnel were observed in two cases. In the remaining cadavers, failure occurred at the junction between the TFCC and the suture (Table 2).

Table 2. Sites of Repair Failure.

	Group I	Group II
TFCC-suture junction failure, n	6	7
Suture failure, n	0	0
Bone failure, n	3	2

Note: Group I: Arthroscopic one tunnel transosseous foveal repair. Group II: Arthroscopic two tunnel transosseous foveal repair.

4. DISCUSSION

This study aimed to compare the biomechanical stability of the one-tunnel and two-tunnel techniques in arthroscopic assisted transosseous foveal TFCC repair and investigate whether both methods provide biomechanical stability of DRUJ. There were no significant differences between the two groups in the tested metrics, including load at 2mm gap formation and single load to failure.

TFCC foveal tears can lead to instability of the distal radioulnar joint (DRUJ). To address this, arthroscopic-assisted foveal repair is increasingly being used as a minimally invasive technique to restore joint stability. Arthroscopic foveal repair of the TFCC not only preserves the normal structures around the ulnar side of the wrist but also maintains the innervation of the capsule and its proprioceptive function.[15] Theoretically, arthroscopic techniques for repairing the foveal TFCC offer the advantage of direct visualization, leading to superior biomechanical stability compared to open procedures.[16] Additionally, they involve a smaller incision, cause less disruption to surrounding structures, and allow for faster functional recovery.[6] To our knowledge, most previous cadaveric studies on TFCC foveal repair have focused on stability following open procedures.[16,17] However, in our study, we created a foveal injury model in cadavers and tested the stability of sutures using a transosseous foveal repair technique with arthroscopy, closely simulating actual clinical conditions.

An optimal foveal TFCC repair should provide strong fixation, minimize gap formation, and ensure sufficient mechanical stability to support ligament-to-bone healing. Previous studies have demonstrated that transosseous foveal repair technique has equivalent or superior biomechanical properties relative to suture anchor foveal repair technique.[10,16] Most recently, a cadaveric investigation by Gutie´rrez-Monclus et al., demonstrate arthroscopic transosseous foveal repair technique is superior biomechanical resistance to pronosupination movement of forearm in comparison to the arthroscopic assisted suture anchor fixation technique. One possible explanation for these results is that the oblique direction of the suture in the transosseous tunnel technique provides a more secure reattachment of the TFCC due to the oblique traction forces, in contrast to the transverse traction forces in the suture anchor technique. Another explanation is that tunneling the suture through to the opposite side of the ulna may result in a stronger grip on the TFCC, thereby reducing the likelihood of loosening of the reinserted TFCC.[18]

The one-tunnel and two-tunnel techniques did not show a statistically significant difference in biomechanical strength. This finding further supports the positive outcomes observed in patients who underwent surgery with either technique.[3,14,19-21] Theoretically, the two-tunnel technique provides fixation near the TFCC foveal footprint, allowing the repaired TFCC to maintain consistent tension during forearm rotation. This can help prevent the repaired tissue from overstretching or loosening, thereby enhancing the stability of the repair. While the results showed a trend toward requiring a higher load to produce a 2mm gap formation and eventual failure in the two-tunnel technique compared to the one-tunnel technique, the difference was not statistically significant. Therefore, further studies with larger cadaveric samples are needed to confirm these findings.

The most common mode of failure after TFCC foveal repair has been reported to occur at the TFCC–suture junction[10,18,22]. Similarly, in our study, suture pullout was the most frequent cause of failure in both surgical techniques. This finding highlights the importance of distributing the suture across a broad area of the TFCC, rather than concentrating it in a narrow region, to prevent pullout from the tissue due to localized stress. In this regard, the two tunnel transosseous technique offers the advantage of greater flexibility in adjusting the spacing between tunnels. However, in the two-tunnel technique, failure due to fractures at the distal ulnar metaphysis bone tunnel was observed, indicating that it is crucial to maintain adequate spacing between the bone tunnels to prevent such complications. Furthermore, the fact that failure predominantly occurred at the TFCC–soft tissue junction in both techniques implies that these procedures may be operator-dependent. The surgeon’s level of experience and technical proficiency can significantly influence the outcome of the repair, highlighting the importance of standardized surgical techniques and adequate training to ensure consistent results.

The choice between the one-tunnel and two-tunnel transosseous techniques for foveal TFCC repair depends on the surgeon's experience and preference. This study confirmed similar strength and efficacy between the one-tunnel and two-tunnel techniques using an arthroscopic transosseous approach in a biomechanical setting. An arthroscopic transosseous technique can be safely considered for DRUJ stabilization in patients with DRUJ instability.

This study has several limitations. First, the comparable outcomes of the TFCC foveal repair shown in the current study represent the initial strength and not the healing potential, as in time zero cadaver studies. Second, we included a small sample size. This might have increased the chance of type II statistical error. Third, the failure that occurred as the result of suture anchor pullout and distal ulnar metaphyseal fracture may have been due to poor-quality bone. However, the bone density was not measured prior to testing. Lastly, we did not conduct cyclic testing to assess the viscoelastic properties of the TFCC under repetitive stress conditions. The focus of our study was to determine the maximum strength of the ligament following different TFCC foveal repair techniques.

5. Conclusion

Arthroscopic-assisted one-tunnel and two-tunnel transosseous foveal repair techniques provide comparable biomechanical stability. Either method may be safely used for restoring DRUJ stability in patients with TFCC foveal tears, allowing technique selection based on surgeon preference and experience.

References

1. Atzei A. New trends in arthroscopic management of type 1-B TFCC injuries with DRUJ instability. The Journal of hand surgery, European volume. 2009;34(5):582-591.
2. McAdams TR, Swan J, Yao J. Arthroscopic treatment of triangular fibrocartilage wrist injuries in the athlete. The American journal of sports medicine. 2009;37(2):291-297.
3. Atzei A, Luchetti R, Braidotti F. Arthroscopic foveal repair of the triangular fibrocartilage complex. Journal of wrist surgery. 2015;4(1):22-30.
4. Robba V, Fowler A, Karantana A, Grindlay D, Lindau T. Open Versus Arthroscopic Repair of 1B Ulnar-Sided Triangular Fibrocartilage Complex Tears: A Systematic Review. Hand (New York, NY). 2020;15(4):456-464.
5. Andersson JK, Åhlén M, Andernord D. Open versus arthroscopic repair of the triangular fibrocartilage complex: a systematic review. Journal of experimental orthopaedics. 2018;5(1):6.
6. Lee SW, Hong JJ, Sung SY, Park TH, Kim JS. Clinical Outcomes and Failure Rate of Triangular Fibrocartilage Complex Foveal Repair Were Comparable between Arthroscopic and Open Techniques. Journal of clinical medicine. 2024;13(10).
7. Luchetti R, Atzei A, Cozzolino R, Fairplay T, Badur N. Comparison between open and arthroscopic-assisted foveal triangular fibrocartilage complex repair for post-traumatic distal radio-ulnar joint instability. The Journal of hand surgery, European volume. 2014;39(8):845-855.
8. Iwasaki N, Minami A. Arthroscopically assisted reattachment of avulsed triangular fibrocartilage complex to the fovea of the ulnar head. The Journal of hand surgery. 2009;34(7):1323-1326.
9. Shinohara T, Tatebe M, Okui N, Yamamoto M, Kurimoto S, Hirata H. Arthroscopically assisted repair of triangular fibrocartilage complex foveal tears. The Journal of hand surgery. 2013;38(2):271-277.
10. Gutiérrez-Monclus R, Ferreres A, Rodríguez-Baeza A, Gutiérrez-Espinoza H. Arthroscopic triangular fibrocartilage complex repair: A biomechanical comparison of anchor and pull-out techniques in Atzei type II lesions. Science progress. 2021;104(1):368504211000888.

11. Afifi A, Abdel-Ati EA, Abdel-Wahed M, Moharram AN. Arthroscopic-Assisted Foveal Reattachment of Triangular Fibrocartilage Complex Tears With Distal Radioulnar Joint Instability: A Comparison of Suture Anchors and Transosseous Sutures. The Journal of hand surgery. 2022;47(6):507-516.
12. Park JH, Kim D, Park JW. Arthroscopic one-tunnel transosseous foveal repair for triangular fibrocartilage complex (TFCC) peripheral tear. Archives of orthopaedic and trauma surgery. 2018;138(1):131-138.
13. Kwon YW, Park JH, Choi IC, Lee JS, Park JW. Revisional triangular fibrocartilage complex (TFCC) repair using arthroscopic one-tunnel transosseous suture: preliminary results. Archives of orthopaedic and trauma surgery. 2022;142(2):197-203.
14. Park YC, Shin SC, Kang HJ, Jeon SY, Song JH, Kim JS. Arthroscopic Foveal Repair of the Triangular Fibrocartilage Complex Improved the Clinical Outcomes in Patients With Persistent Symptomatic Distal Radio-Ulnar Joint Instability After Plate Fixation of Distal Radius Fractures: Minimum 2-Year Follow-Up. Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association. 2022;38(4):1146-1153.e1141.
15. Garcia-Elias M, Hagert E. Surgical approaches to the distal radioulnar joint. Hand clinics. 2010;26(4):477-483.
16. Ma CH, Lin TS, Wu CH, Li DY, Yang SC, Tu YK. Biomechanical Comparison of Open and Arthroscopic Transosseous Repair of Triangular Fibrocartilage Complex Foveal Tears: A Cadaveric Study. Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association. 2017;33(2):297-304.
17. Spies CK, Niehoff A, Unglaub F, et al. Biomechanical comparison of transosseous re-fixation of the deep fibres of the distal radioulnar ligaments versus deep and superficial fibres: a cadaver study. International orthopaedics. 2016;40(2):315-321.
18. Koeyvoets CEA, Teunissen JS, Feitz R, Hovius S, Hagert E, van der Heijden EPA. Biomechanical Outcomes of Surgically Repaired TFCC Palmer Type 1B Tears: A Systematic Review of Cadaver Studies. Hand (New York, NY). 2023;18(8):1258-1266.
19. Liu B, Arianni M, Wu F. Arthroscopic ligament-specific repair for triangular fibrocartilage

complex foveal avulsions: a minimum 2-year follow-up study. The Journal of hand surgery, European volume. 2021;46(3):270-277.

20. Iwasaki N, Nishida K, Motomiya M, Funakoshi T, Minami A. Arthroscopic-assisted repair of avulsed triangular fibrocartilage complex to the fovea of the ulnar head: a 2- to 4-year follow-up study. Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association. 2011;27(10):1371-1378.
21. Park JH, Lim JW, Kwon YW, Kang JW, Choi IC, Park JW. Functional Outcomes Are Similar After Early and Late Arthroscopic One-Tunnel Transosseous Repair of Triangular Fibrocartilage Complex Foveal Tears. Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association. 2020;36(7):1845-1852.
22. Desai MJ, Hutton WC, Jarrett CD. Arthroscopic repair of triangular fibrocartilage tears: a biomechanical comparison of a knotless suture anchor and the traditional outside-in repairs. The Journal of hand surgery. 2013;38(11):2193-2197.

Abstract in Korean

삼각섬유연골복합체 척골두 와 부착부 파열의 두가지 관절경하 경골 봉합술의 생체역학적 비교 분석

배경: 삼각섬유연골복합체(TFCC) 척골두 와 부착부 파열에 대해 관절경적 경골(transosseous) 봉합술은 증상이 있는 환자에서 사용할 수 있는 치료 방법 중 하나이다. 이 술식에는 단일 터널법과 이중 터널법의 두 가지 주요 변형이 있으나, 이들 간의 비교 연구는 제한적이다. 본 연구의 목적은 단일 터널법과 이중 터널법을 이용한 관절경적 경골 봉합술의 초기 생역학적 안정성을 비교하는 것이었다.

방법: TFCC 결절부 봉합술의 생역학적 비교를 위해 총 아홉 쌍(우측 및 좌측)으로 구성된 인체 사체 상지 표본에 대해 블록 무작위 배정을 시행하였다. 모든 표본에는 관절경 유도 하에 척골두 와 부착부 파열을 인위적으로 생성하였다. 이후, 단일 터널 기법(Group I)과 이중 터널 기법(Group II)으로 나누어 관절경 보조하 경골 봉합술을 시행하였다. Group I 에서는 단일 터널을 형성하고 PushLock 앵커를 사용하여 고정하였다. Group II 에서는 두 개의 터널을 만들고 단순 봉합 매듭을 이용하여 고정하였다. 생역학적 평가는 2mm 간격 형성 시 하중(load at 2-mm gap formation)과 최대 파열 하중(load to failure)을 측정하였으며, 하중은 고정된 요골에 대해 척골에 가해졌다. 2mm 간격 하중은 전완의 중립 자세, 60도 회내, 60도 회외의 세 가지 자세에서 측정하였고, 파열 하중은 전완 회내 자세에서 측정하였다. 두 군 간의 실패 양상도 비교하였다.

결과: 두 군 간 생역학적 지표에서는 유의한 차이가 관찰되지 않았다. Group I 에서는 세 예에서 봉합 앵커의 이탈이 발생하였고, Group II 에서는 두 예에서 골 터널을 통한 골절이 관찰되었다. 이외의 모든 실패는 봉합사–연부조직 접합부에서 발생하였다.

결론: 본 연구에서는 관절경을 이용한 one tunnel 술식과 two tunnel 술식 모두 TFCC foveal 부위의 생역학적 안정성에 있어 유사한 결과를 보였다. 따라서 술식의 선택은 술자의 선호도와 경험에 따라 결정될 수 있다.

핵심되는 말 : 삼각섬유연골복합체 척골두 와 부착부 파열, 관절경하 봉합술; 경골 기법; 생역학