Technical Note

# Elbow Ulnar Collateral Ligament Shoelace Repair with Internal Bracing for Treating Throwing Athletes Who Have Ulnar Collateral Ligament Instability

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**Abstract:** This Technical Note aimed to present a surgical technique of ulnar collateral ligament (UCL) shoelace repair using suture anchors and double suture tapes in combination with internal bracing to correct UCL instability along with epiphyseal avulsion of the medial epicondyle in throwing athletes Skeletally immature throwing athletes playing baseball and softball are at a risk of sustaining medial epicondyle epiphyseal separation that can result in UCL instability, predisposing to elbow UCL disruption later. There are several surgical techniques that can restore elbow UCL function and stability. In cases where large fragments of the medial epicondyle are present in skeletally immature athletes, the residual bony fragment and the shortened, chronically injured UCL make surgical treatment quite challenging. Recent studies have shown that UCL repair with internal bracing can effectively treat acute UCL injury. However, this procedure is not ideal for restoring large disruption of the UCL such as fragmentation. Here, we present a surgical technique of UCL shoelace repair using suture anchors with double suture tapes in combination with internal bracing for correcting UCL instability concurrent with epiphyseal fragmentation of medial epicondyle in throwing athletes.

Injuries of the ulnar collateral ligament (UCL) of the elbow have become the most common cause of elbow pain and dysfunction among overhead-throwing athletes.[1] The prevalence of UCL surgery currently ranges from 15%-25% among baseball players.[2] In addition, skeletally immature overhead throwers are at a greater risk of fragmentation and separation of the medial epicondyle apophysis.[3,4]

Several radiographic studies have demonstrated a high incidence of fragmentation and separation of the medial epicondyle in preadolescent and adolescent throwing athletes.[5,6] These injuries, including fragmentation and separation, can result from repeated valgus forces due to throwing activity, which can create an excessive tensile load on the medial aspect of the elbow joint.[7] In addition, epiphyseal fragmentation or separation of the medial epicondyle can also cause scarring and shortening of the UCL, resulting in instability of the UCL of the elbow joint.[8]

Several surgical techniques have been used to repair such injuries, including open reduction and internal fixation, tension band wiring and fragment excision with ligament repair. However, these procedures have not focused on restoring the stability of the UCL. Reconstruction surgery of the UCL includes the Docking procedure or Tommy John surgery and is the gold standard for correcting elbow instability due to UCL injuries in throwing athletes. Despite the fact that the clinical outcomes of UCL reconstruction are generally favorable, with 83% athletes returning to play at the preinjury level, recent studies have reported that that revision rates for failed UCL reconstruction range from 3.9%-13.2%. In response to this evidence concerning UCL reconstruction, UCL repair with internal bracing (IB) has become popular over

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*The authors report the following potential conflicts of interest or sources of funding: S.U. is a consultant for Smith & Nephew, ConMed and Sigmax and receives research funding from Smith & Nephew and Stryker. Full ICMJE author disclosure forms are available for this article online, as supplementary material.*

*Received February 7, 2021; accepted April 2, 2021.*

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*2212-6287/21244*

*https://doi.org/10.1016/j.eats.2021.04.008*

the past decade.[7] However, these reconstruction surgeries appear to be too invasive for skeletally immature throwing athletes.

Recent studies have shown that UCL repair using the IB technique and using a collagen-coated suture tape can provide stability by reducing the mechanical stress required during the repair or reconstruction of various ligaments. Some biomechanical studies have demonstrated that augmented UCL repair with IB is as robust as UCL reconstruction and can restore the UCL to its native state.[9,10]

Some reports have suggested that the technique of excising the fragment, reconstructing the UCL and augmenting the IB can restore the stability of the UCL.[8] However, some throwing athletes still retain the native UCL fibers after medial epicondyle fragmentation surgery, even though the fibers are scarred and appear shortened. A recent report showed that 92% of overhead athletes undergoing UCL repair with IB returned to play.[11] However, we have experienced difficulties in performing traditional UCL repair with IB while treating some overhead active patients with UCL instability along with epiphyseal avulsion of the medial epicondyle. Moreover, UCL reconstruction is more invasive for these patients. Therefore, we devised a shoelace UCL repair technique with IB that uses suture anchors and double suture tapes (CorkScrew; Arthrex, Naples, FL) to treat patients with UCL instability and bony fragments. This Technical Note aims to present a surgical technique of UCL shoelace repair using suture anchors and double suture tapes in combination with IB to correct UCL instability along with epiphyseal avulsion of the medial epicondyle in throwing athletes.

Indications for UCL shoelace repair with IB include patients with UCL instability associated with medial epicondyle bony avulsion (Fig 1). Common UCL instability may be an indication for this technique.

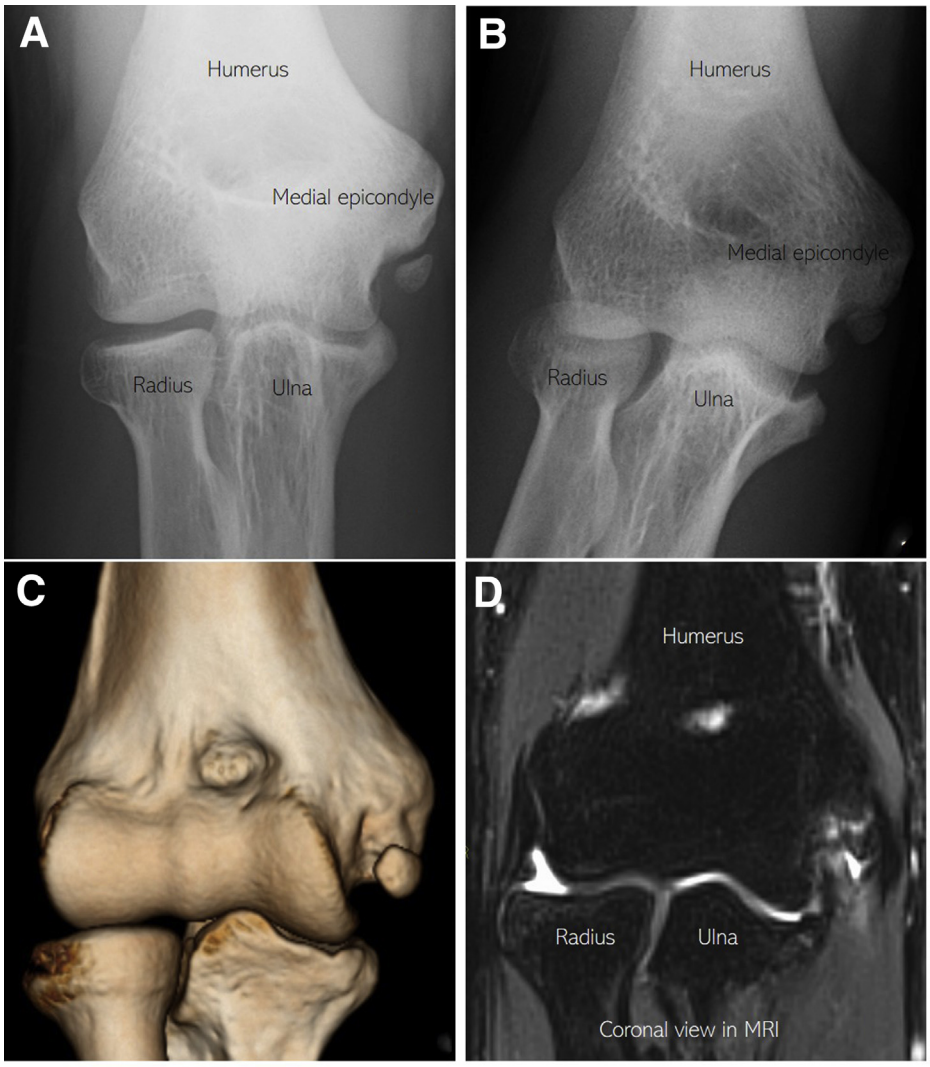


**Fig 1.** (A) A plain radiograph of the elbow (AP view) of a 20-year-old baseball player who presented to our hospital with complains of right elbow pain of 5 years' duration with chronic right elbow pain and valgus instability. It shows a bony fragment along with the medial epicondyle, suggesting Little League elbow. (B) Valgus stress AP view shows valgus instability of the elbow joint. (C) A 3-dimensional computed-tomography scan shows the fragment of the medial epicondyle of the humerus. (D) Magnetic resonance imaging T2 fat suppression coronal view shows a high-intensity area surrounding a round/circular area of low intensity suggestive of a bony fragment with the UCL detached from the medial epicondyle.

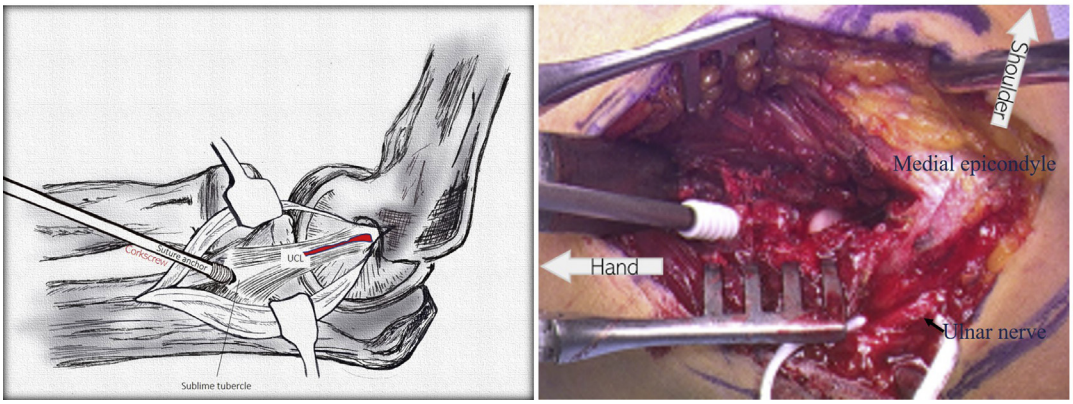


**Fig 2.** The muscle-splitting approach was adopted to expose the medial joint ligament capsule complexes associated with the UCL in his right elbow; the fragment is usually located at the inferior posterior portion of the medial epicondyle. The UCL was peeled off from the fragment and split longitudinally; the distal anchor (BioComposite CorkScrew FT Suture Anchor, 4.75 mm × 14 mm with 2 1.3 Suture Tapes) was placed at the apex of the sublime tubercle.

Contraindications for UCL shoelace repair with IB include asymptomatic patients who are capable of performing sports activities without dysfunction or pain and patients with active infection or neuropathic pain, including complex regional pain syndrome.

## Surgical Technique

The patient is placed in a supine position under general anesthesia. An Esmarch bandage is used to exsanguinate the surgical extremity, and the tourniquet is inflated. Patients with intra-articular pathologies, including loose bodies, osteophytes and osteochondritis dissecans, should undergo elbow arthroscopy prior to undergoing this technique.

The arm is placed on an arm board with the elbow extended. A 5 cm longitudinal skin incision is made over the medial epicondyle and the UCL. The medial antebrachial cutaneous nerve is identified and protected. Next, the ulnar nerve is identified and isolated with a vessel tape. The common flexor pronator muscle is split. The muscle-splitting approach is used to expose the medial part of the joint ligament capsule complexes associated with the UCL.

If a fragment is present at the medial epicondyle, the center of the UCL is incised from the attachment at the medial epicondyle and the sublime tubercle of the ulna. The fragment is usually located at the inferior posterior portion of the medial epicondyle. The UCL is peeled off from the fragment and split longitudinally. A distal anchor (BioComposite CorkScrew FT Suture Anchor, 4.75 mm × 14 mm w/2 1.3 Suture Tapes; Arthrex) is then placed at the apex of the sublime tubercle. A 2.7 mm drill is used to create a hole, which is taped with a 3.5 mm tape before placing a 4.75 mm BioComposite CorkScrew FT (Arthrex) suture anchor (Fig 2). This initial anchor is preloaded with collagen-coated double FiberTapes (Arthrex) prior to the final placement. One suture tape is passed through both ends of the UCL in a shoelace pattern using the shoelace technique (Fig 3). After making the shoelace UCL suture, the FiberTape

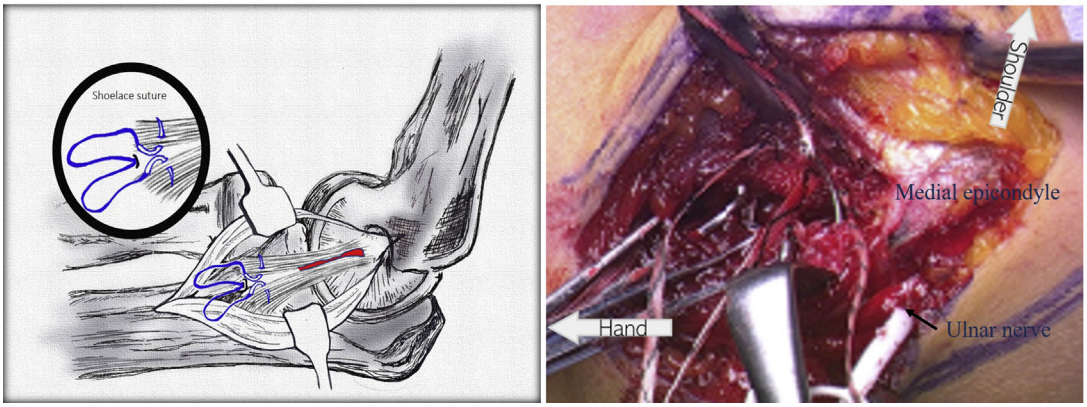


**Fig 3.** Two suture tapes anchored at the sublime tubercle using BioComposite CorkScrew FT Suture Anchor (4.75 mm × 14 mm with 2 1.3 Suture Tapes) were passed through both ends of the UCL in his right elbow in a shoelace pattern using the shoelace technique.

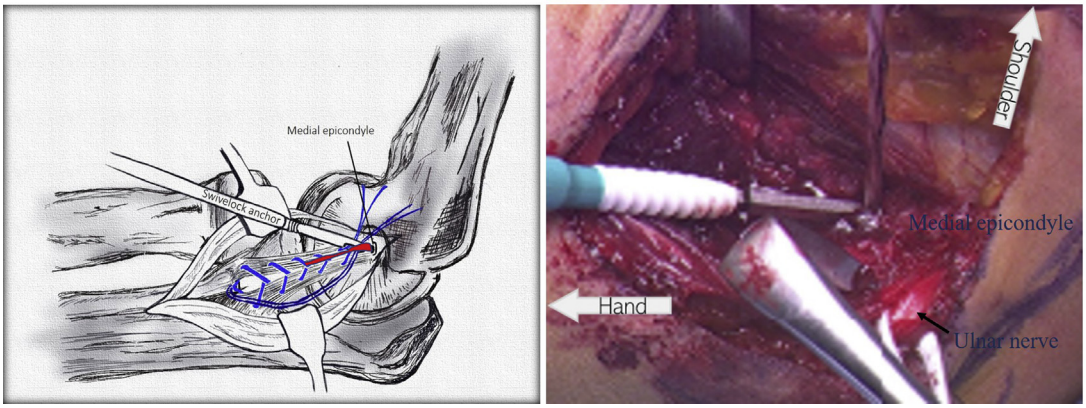


**Fig 4.** After performing the shoelace UCL suture in his right elbow, a FiberTape (Arthrex) sutured in the UCL as well as another FiberTape was passed through the hole of the tip of BioComposite SwiveLock, 4.75 mm × 14 mm (Arthrex); a SwiveLock with these FiberTapes was inserted into the pre-tapped hole in the medial epicondyle at 60° of elbow flexion.

that is sutured in the UCL along with another FiberTape are passed through the hole at the tip of a BioComposite SwiveLock 4.75 mm × 14 mm (Arthrex). A 2.7 mm drill is used to drill a hole at the origin of the UCL in the medial epicondyle, and the hole is taped with a 3.5 mm tape prior to the insertion of a SwiveLock anchor. The SwiveLock along with the FiberTapes is inserted into the pre-tapped hole in the medial epicondyle in an elbow flexion of 60 degrees (Fig 4). Finally, stability is confirmed using the valgus stress test after fixing the shoelace sutures (Fig 5), as shown in the online video (Video 1).

### Postoperative Rehabilitation

Postoperatively, the patient's arm is immobilized using a posterior 90° splint for 5 days until the first postoperative visit. The wrist is not immobilized so as to encourage early range-of-motion exercise. The splint is removed on postoperative day 6, and active and active-assisted range-of-motion exercises are initiated under the supervision of a physiotherapist. A hinged dynamic elbow brace is used after splint removal. The patient is expected to regain full range of motion 4 weeks postoperatively, and strengthening is initiated 6 weeks after surgery. In overhead throwers, an interval throwing program is started 4 months postoperatively, and this progresses over the next 6 weeks. Most throwers can return to professional sports within 6 to 8 months.

## Discussion

This article outlines the UCL shoelace repair technique with IB using StrongTape for treating UCL insufficiency with medial epicondyle fragmentation. Smith et al. described open reduction of the fragment with excision of the fibrous nonunion tissue and screw fixation with a 3.5 mm diameter screw. In cases of UCL injury or insufficiency, the modified Jobe and Docking techniques for UCL reconstruction remain the most commonly used techniques, and they have reproducible and reliable results. However, the complication and revision rates associated with these techniques have been on the increase. Recent evolving techniques

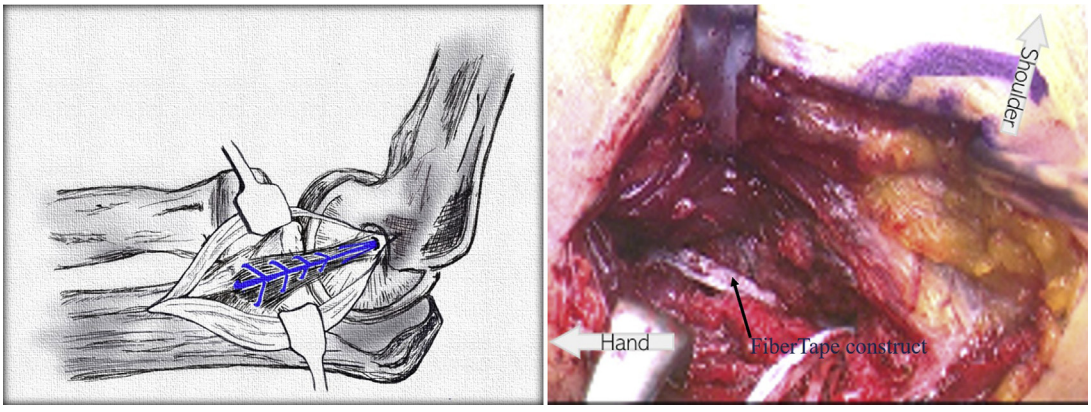


**Fig 5.** The shoelace UCL repair was completed in his right elbow. The stability should be confirmed by the valgus stress test after the fixation of the shoelace sutures.

**Table 1.** Comparison of Advantages and Disadvantages of Shoelace UCL Repair With IB and UCL Repair with IB

| | Advantages | Disadvantages |
|---|---|---|
| Shoelace UCL repair with IB | Two suture tapes are utilized, so the biomechanical strength may be stronger.<br>Shoelace suture enables suture repair of the defect of the ligament structure. | The process must be meticulous. |
| UCL repair with IB | It is easier and has a shorter surgical duration. | Only 1 suture tape is used. |

include primary repair with augmentation using anchored suture tape.[7]

The anterior bundle of the UCL is the primary restraint to the valgus load at the medial aspect of the elbow joint. A recent histologic study showed that this tendinous complex linked the humeroulnar joint and formed the UCL.[12] The tendinous complex consists of the brachialis tendon, the deep aponeurosis of the flexor digitorum superficialis muscle and the deep aponeurosis of the flexor carpi ulnaris muscle. Based on these findings, the study concluded that these muscles contribute to stabilizing the medial joint capsule dynamically by creating sufficient tension in the tendinous complex-UCL structure. Hoshika et al. supported this hypothesis and further suggested that valgus stability of the elbows was enhanced by contraction of the flexor digitorum superficialis, especially of the index and middle finger parts of this muscle as revealed by ultrasonography.[13] These findings suggest that the native UCL is an important structure for the dynamic stability of the medial elbow, and its stability should be restored. Further studies are needed to clarify whether this technique has any advantage over traditional UCL reconstruction procedures.

When the distal suture tapes pass through the distal part of the UCL, the tendinous complex that links the flexor muscles is gathered and fixed onto the medial epicondyle of the humerus. Theoretically, not only the static structure of the UCL but also the dynamic stability mechanism through the tendinous complex can be restored using this technique. Although further clinical trials are required, this technique could be adequate for restoring both the static and the dynamic stability of the UCL.

This procedure could be technically challenging because the bony fragment may not have the appropriate size for optimal fixation. Some reports have demonstrated other orthopedic surgical techniques, such as hip shoelace capsular plication or arthroscopic shoelace side-to-side rotator cuff repair.[14-16] However, we believe that the shoelace suture technique could offer a more secure and stable closure of the UCL and capsule complex after excision of the fragment of a Little League elbow.

The ulnar nerve should be dissected and moved out of the groove in order to allow the posteromedial capsule to be released.

In young athletes, the bony structure is sometimes too strong to insert biocomposite anchors. In such cases, repeated pre-tapping assists in anchor insertion. Intraoperative fluoroscopy is helpful in confirming the location of the bony fragment as well as ensuring proper placement of the drill hole and its orientation. This technique elongates the surgery period because it is technically demanding procedure, and this may, in turn, increase the risks of surgical-site infection. Considering that infection following UCL reconstruction is uncommon,[17] this surgical procedure is acceptable because it provides appropriate UCL instability correction. The advantages and the disadvantages of this technique are shown in Table 1. The pearls and the pitfalls of this technique are shown in Table 2.

This technique has its limitations, as follows. First, this is only a Technical Note that describes a surgical technique. Further biomechanical studies and clinical outcomes comparing this technique with other fixation or reconstruction procedures could prove beneficial in validating this technique.

In conclusion, we demonstrated the UCL shoelace repair technique with IB for the treatment of UCL insufficiency with fragmentation of the medial epicondyle. This technique maybe useful in the treatment of UCL instability along with a Little League elbow in throwing athletes.

## Acknowledgment

We thank Editage (www.editage.jp) for English language editing.

**Table 2.** The Pearls and Pitfalls Of UCL Shoelace Repair With IB

| Pearls | Pitfalls |
|---|---|
| A proper skin incision covering the sublime tubercle and medial epicondyle helps identification of the precise anatomic positioning. | Anatomic positioning of the sublime tubercle and medial epicondyle should be carefully identified. Otherwise, anatomic reduction cannot be completed. |
| Identification and protection of the ulnar nerve is essential. | |

## References


1. Dugas JR, Bilotta J, Watts CD, et al. Ulnar collateral ligament reconstruction with gracilis tendon in athletes with intraligamentous bony excision: technique and results. *Am J Sports Med* 2012;40:1578-1582.
2. Conte SA, Fleisig GS, Dines JS, et al. Prevalence of ulnar collateral ligament surgery in professional baseball players. *Am J Sports Med* 2015;43:1764-1769.
3. Lawrence JT, Patel NM, Macknin J, et al. Return to competitive sports after medial epicondyle fractures in adolescent athletes: Results of operative and nonoperative treatment. *Am J Sports Med* 2013;41:1152-1157.
4. Osbahr DC, Chalmers PN, Frank JS, Williams RJ 3rd, Widmann RF, Green DW. Acute, avulsion fractures of the medial epicondyle while throwing in youth baseball players: A variant of Little League elbow. *J Shoulder Elbow Surg* 2010;19:951-957.
5. Hang DW, Chao CM, Hang YS. A clinical and roentgenographic study of Little League elbow. *Am J Sports Med* 2004;32:79-84.
6. Schwartz ML, Thornton DD, Larrison MC, et al. Avulsion of the medial epicondyle after ulnar collateral ligament reconstruction: Imaging of a rare throwing injury. *Am J Roentgenol* 2008;190:595-598.
7. Cain L, Mathis T. Ulnar collateral ligament reconstruction: Current philosophy in 2016. *Am J Orthoped* 2016:E534-E540.
8. Mirzayan R, Cooper JD. Chronic medial epicondyle avulsion: Technique of fragment excision and ligament reconstruction with internal brace augmentation. *J Am Acad Orthop Surg* 2019;27:e64-e69.
9. Erickson BJ, Nwachukwu BU, Rosas S, et al. Trends in medial ulnar collateral ligament reconstruction in the United States: A retrospective review of a large private-payer database from 2007 to 2011. *Am J Sports Med* 2015;43:1770-1774.
10. Urch E, Limpisvasti O, ElAttrache NS, et al. Biomechanical evaluation of a modified internal brace construct for the treatment of ulnar collateral ligament injuries. *Orthopaed J Sports Med* 2019;7:1-9.
11. Dugas JR, Looze CA, Capogna B, et al. Ulnar collateral ligament repair with collagen-dipped fibertape augmentation in overhead-throwing athletes. *Am J Sports Med* 2019;47:1096-1102.
12. Hoshika S, Nimura A, Yamaguchi R, et al. Medial elbow anatomy: A paradigm shift for UCL injury prevention and management. *Clin Anat* 2019;32:379-389.
13. Hoshika S, Nimura A, Takahashi N, Sugaya H, Akita K. Valgus stability is enhanced by flexor digitorum superficialis muscle contraction of the index and middle fingers. *J Orthop Surg Res* 2020;15:121.
14. Kizaki K, Hatakeyama A, Utsunomiya H, Philippon MJ, Uchida S. Arthroscopic double shoelace capsular plication technique for the treatment of borderline hip dysplasia associated with capsular laxity. *Arthrosc Tech* 2019;8:923-927.
15. Suzuki H, Chang A, Kumagae H, Shimizu Y, Sakai A, Uchida S. Arthroscopic shoelace side-to-side repair technique using ultratape for the treatment of longitudinal midsubstance rotator cuff tears. *Arthrosc Tech* 2017;6:e1845-e1850.
16. Uchida S, Pascual-Garrido C, Ohnishi Y, et al. Arthroscopic shoelace capsular closure technique in the hip using ultratape. *Arthrosc Tech* 2017;6:e157-e161.
17. Smith JR, Bruce J, Andrews JR. Ulnar collateral ligament reconstruction: Complications and salvage. In: *Morrey's Elbow Disord*. 5th edition 2018;663-667.