



High variability among surgeons in evaluation, treatment, and rehabilitation of medial ulnar collateral ligament injuries



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Hypothesis and/or Background: The incidence of elbow medial ulnar collateral ligament (MUCL) injuries has been increasing, leading to advances in surgical treatments. However, it is not clear that there is consensus among surgeons regarding diagnostic imaging, the indications for acute surgery and postoperative rehabilitation. The purpose of this study is evaluate surgeon variability in the presurgical, surgical, and postsurgical treatment of MUCL injuries regarding the imaging modalities used for diagnosis, indications for acute surgical treatment, and postoperative treatment recommendations for rehabilitation and return to play (RTP). Our hypothesis is that indications for acute surgical treatment will be highly variable based on MUCL tear patterns and that agreement on the time to RTP will be consistent for throwing athletes and inconsistent for nonthrowing athletes.

Methods: A survey developed by 6 orthopedic surgeons with expertise in throwing athlete elbow injuries was distributed to 31 orthopedic surgeons who routinely treat MUCL injuries. The survey evaluated diagnostic and treatment topics related to MUCL injuries, and responses reaching 75% agreement were considered as high-level agreement.

Results: Twenty-four surgeons responded to the survey, resulting in a 77% response rate. There is 75% or better agreement among surveyed surgeons regarding acute surgical treatment for distal full thickness tears, ulnar nerve transposition in symptomatic patients or with ulnar nerve subluxation, postoperative splinting for 1–2 weeks with initiation of rehabilitation within 2 weeks, the use of bracing after surgery and the initiation of a throwing program at 3 months after MUCL repair with internal brace by surgeons performing 20 or more MUCL surgeries per year. There were a considerable number of survey topics without high-level agreement, particularly regarding the indications for acute surgical treatment, the time to return to throwing and time RTP in both throwing and nonthrowing athletes.

Discussion and/or Conclusion: The study reveals that there is agreement for the indication of acute surgical treatment of distal MUCL tears, duration of bracing after surgery, and the time to initiate physical therapy after surgery. There is not clear agreement on indications for surgical treatment for every MUCL tear pattern, RTP time for throwing, hitting and participation in nonthrowing sports.

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The incidence of elbow medial ulnar collateral ligament (MUCL) injuries has increased over the last 15 years.^{13,15} MUCL reconstruction has been the mainstay of surgical treatment since early studies suggested MUCL repair was not as effective as MUCL reconstruction.⁵ More recently, studies have shown that the use of MUCL repair, particularly with augmentation using strong braided suture (internal brace), can be effective at returning athletes to

sport at a high rate.⁸ Furthermore, MUCL repair with internal brace has the potential to shorten the recovery time back to unrestricted activities.⁸ With the increased incidence of MUCL injury and the advances in surgical treatment options, the indications for MUCL surgery need to be defined more clearly.

Ideally, surgeons should agree upon the indications for surgical management to better counsel patients on appropriate treatment for MUCL injuries. It is also important for surgeons to have consistency regarding postoperative rehabilitation and return to play (RTP) expectations to minimize confusion for athletes, parents, coaches, and athletic trainers when making treatment and RTP decisions. Furthermore, there is a paucity of literature outlining the optimal recovery time for nonthrowing athletes after MUCL reconstruction or MUCL repair with internal brace, therefore leading to surgeon variability in making RTP recommendations. To answer these questions more rigorously, a large prospective study is needed. Before such a study can be performed, it is critical to evaluate the variability in how surgeons currently manage patients with MUCL injuries with regards to indications for surgery, variability in postoperative recovery, and RTP to identify potential gaps in the knowledge of the current practices for treatment of MUCL injuries.

The purpose of this study is to evaluate surgeon variability in presurgical, surgical and postsurgical treatment of MUCL injuries. We aim to 1) identify the imaging modalities used to diagnose MUCL injuries with magnetic resonance imaging (MRI), magnetic resonance arthrogram (MRA), or ultrasound (US); 2) identify indications for acute operative treatment of MUCL injuries; 3) evaluate the indications for MUCL reconstruction or MUCL repair with suture augmentation and to determine the factors that influence that decision; and to 4) determine the postoperative treatment recommendations regarding immobilization, initiation of rehabilitation, and time before allowing RTP after MUCL reconstruction and MUCL repair with internal brace. Our hypothesis is that indications for acute surgical treatment will be highly variable based on MUCL tear patterns and that time to RTP will be consistent for throwing athletes but inconsistent for nonthrowing athletes.

Methods

A surgeon survey was created in Research Electronic Data Capture (REDCap; Vanderbilt University, Nashville, TN, USA) to evaluate the critical diagnostic and treatment topics based on the consensus of 6 orthopedic surgeons with fellowship training in sports medicine or shoulder/elbow surgery who consistently treat MUCL injuries (see [Supplementary Appendix S1](#)).¹² The survey was designed to assess surgeon indications for acute surgical repair, use of diagnostic imaging modalities, indications for MUCL reconstruction, and indications for MUCL repair with internal brace. Additionally, preferred postoperative rehabilitation protocols after MUCL reconstruction and MUCL repair with internal brace were surveyed. As splinting, bracing, restricting range of motion, and formal rehabilitation are common progressions in recovery, respondents were questioned on their preferences with regards to these specific rehabilitative measures. Lastly, respondents were asked to detail their return to throwing time and RTP time for throwing and nonthrowing athletes. Baseball-specific rehabilitation protocols were also assessed in the survey to gauge consensus among orthopedic surgeons with regards to RTP criteria following a MUCL injury. The RTP criteria surveyed were timing decisions for return to mound throwing, starting a formal interval throwing program, beginning unrestricted pitching, returning to a field position, and returning to hitting.

After institutional review board approval was obtained, the survey was sent to 31 hand/upper extremity, shoulder/elbow, or

Table 1
Surgeon respondent demographic summary: years in practice.

Years in practice	0-5	6-15	16-25	>25
Number of respondents	3	2	15	4

sports medicine–trained surgeons from across the United States who are known to treat MUCL injuries. Study participants were also selected based on their interest participating in a future prospective multicenter study evaluating medial elbow injuries. Willingness to complete the survey was considered implied consent to participate in this survey study. Any survey questions that reached 75% agreement among the survey respondents were considered to have a high level of agreement for the current standard care. Survey questions with less than 75% agreement among the respondents were considered a topic of interest for additional study.

Statistical methods

As the survey was developed in REDCap, the internal analytics functionality of REDCap was used to generate numerical reports on the frequency distribution of participant responses for survey questions. Using Microsoft Excel (Microsoft Corp., Redmond, WA, USA), the 3 measures of central tendency (mean, median, and mode) of participant responses were calculated. Again, using Excel’s data visualization functionality, the frequency distribution of participant responses for each question was depicted graphically. All of this information was synthesized to observe care management trends among practicing surgeons treating MUCL injuries.

Results

Surgeon demographics

Of the 31 surgeons who were sent a survey, 24 responded resulting in a 77% response rate. Relevant demographic information of the respondents of the survey is summarized in [Tables I and II](#).

Diagnostic imaging

In addition to plain radiographs, the 2 most preferred imaging techniques to diagnose a MUCL injury were an MRA (n = 9) and an MRI (n = 9). Regarding the use of stress US to diagnose MUCL injury, 13 (54%) answered they never use stress US for diagnosing a MUCL injury. Of the 11 respondents (46%) that use stress US to diagnose a MUCL injury, 9 (81%) indicated they only use stress US if the MRI and MRA are inconclusive in symptomatic patients.

Surgical technique

Among the survey respondents, 21 (87.5%) indicated they use the docking technique for MUCL reconstruction. For MUCL repair with internal brace, 18 of 22 (82%) use the technique described by Dugas et al.⁷ Furthermore, 21 of 24 (87.5%) indicated that they do not routinely transpose the ulnar nerve during MUCL surgery. When asked about the indications for ulnar nerve transposition, preoperative ulnar nerve symptoms (17 of 21, 80%) and ulnar nerve subluxation (15 of 21, 71%) were the most common responses. Nineteen percent indicated a positive Tinnel’s sign preop as another indication for ulnar nerve transposition (4 of 21), and there were 2 “Other” responses. The 2 “Other” responses were the following: “preop motor systems/persistent sensory systems” and “positive electrodiagnostic studies for ulnar neuropathy.”

Table II
Surgeon respondent demographic summary: yearly MUCL (reconstruction or repair with internal brace) operation cases.

MUCL cases per year	0-10	11-20	21-30	31-40	41-50	>50
Number of respondents	9	6	5	0	2	2

MUCL, medial ulnar collateral ligament.

Indications for acute surgical treatment

The most common indication for acute treatment of an isolated MUCL injury was the presence of a complete distal tear for 17 (85%) of the respondents. No other tear pattern resulted in an agreement greater than 50% agreement (Fig. 1). Other responses determining the need for acute surgical treatment other than MUCL tear characteristics included the level of the throwing athlete, the degree of laxity on exam, and the timing of the injury relative to the season.

Postoperative rehabilitation

Most respondents (consensus greater than 75%) splint for 1-2 weeks after surgery after both MUCL reconstruction and MUCL repair with internal brace. Also, most respondents (83%) start rehabilitation within 2 weeks of surgery after MUCL reconstruction. Similarly, most respondents (79%) start rehabilitation within 2 weeks of MUCL repair with internal brace. One respondent initiated rehabilitation immediately after MUCL reconstruction and 4 respondents initiated rehabilitation immediately after MUCL repair with internal brace (Fig. 2).

RTP

There was variability among respondents regarding the time to initiate a formal throwing program after MUCL reconstruction and after MUCL repair with internal brace (Fig. 3). After MUCL reconstruction, 11 of 24 (45%) respondents start a throwing program at 4 months and an additional 4 respondents start a throwing program at 4.5 months. After MUCL repair with internal brace, 13 of 24 (54%) start a throwing program at 3 months and 4 of 24 (17%) start at 4 months. Other criteria used by respondents were based more on the functional progression for both MUCL reconstruction and MUCL repair with internal brace.

After MUCL reconstruction, RTP at a field position in baseball and softball was allowed most commonly at 6 months (46%). After MUCL repair with internal brace, RTP at a field position was allowed between 3-7 months with the most common response being 6 months (42% for baseball and 45% for softball) (Fig. 4). There was no time point that reached greater than 75% agreement for RTP to a field position after MUCL reconstruction or MUCL repair with internal brace for either sport.

For baseball and softball athletes, return to throwing from the mound, return to unrestricted pitching, and return to hitting were variable among the respondents with no time point that reached greater than 75% agreement. Return to throwing off the mound was most commonly allowed at 6 or 7 months after MUCL reconstruction and was more variable after MUCL repair with internal brace. For baseball and softball, the most common return to unrestricted pitching criteria was completion of the throwing program regardless of the time since surgery (baseball: 58.3% for MUCL reconstruction and 50% for MUCL repair with internal brace; softball: 66.7% for MUCL reconstruction and 50% for MUCL repair with internal brace). While results indicated that surgeons using the internal brace had their patients begin a throwing program earlier, these same surgeons also allowed their reconstruction patients to get back to unrestricted pitching earlier.

Among the group of respondents completing greater than 20 MUCL operations per year, the only RTP milestone with 75% or greater consensus was 6 of 8 (75%) respondents to start a formal throwing program at 3 months after MUCL repair with internal brace. All other RTP (common as well as sport-specific) milestones (for both reconstruction and repair) exhibited less than 75% agreement among these respondents.

Recommended time to RTP after both MUCL reconstruction (2-8 months) and MUCL repair with internal brace varied substantially across the respondents. The range for MUCL reconstruction RTP was 2-8 months, and the range for MUCL repair with internal brace was 1-8 months. After MUCL reconstruction, 6 months was the most common time point recommended across all nonthrowing sports except tennis and track. There was no high-level agreement regarding time to RTP for any sport, including baseball and softball, regardless of the type of surgical technique. As summarized in Table III, after MUCL repair with internal brace, the time to RTP is more variable across sports than after reconstruction.

Discussion

Our study shows that there is 75% or better agreement among surveyed surgeons regarding acute surgical treatment for distal full thickness tears, ulnar nerve transposition in symptomatic patients or ulnar nerve subluxation, postoperative splinting for 1-2 weeks with initiation of rehabilitation within 2 weeks, the use of bracing after surgery and the initiation of a throwing program at 3 months after MUCL repair with internal brace by surgeons performing 20 or more MUCL surgeries per year. There were a considerable number of survey topics without high-level agreement, particularly regarding the indications for acute surgical treatment, the time to return to throwing and time RTP in both throwing and non-throwing athletes. While we would expect some variability in postoperative protocols, the clear variability in surgical indications and the time to RTP among surgeons identifies gaps in our knowledge of the optimum treatment of athletes with MUCL injuries.

The indications for surgical treatment of MUCL injuries are not fully defined. Currently, this decision is based on clinical symptoms, timing of the injury, the athlete's desire to continue playing their sport, and the appearance of the MUCL on imaging influence the decision to pursue surgical treatment for MUCL injury. Studies have noted variable RTP success with nonsurgical treatment of MUCL injuries. Rettig et al reported that 42% of overhead athletes with MUCL injury to get back to RTP at their previous level of competition after 3 months of rest and rehabilitation.¹⁸ A more recent systematic review by Cascia et al noted that the success rate of 42%-100% with a mean of 78% for nonsurgical treatment of MUCL injuries among overhead athletes who sustained a MUCL injury and had undergone a period of conservative treatment with RTP as the outcome measure.⁴ Additionally, Gopinath et al performed a systematic review outlining the results of nonoperative treatment for MUCL injuries in 15 studies that were mostly Level III and IV evidence.¹¹ Most of the MUCL injuries in the studies were partial tears with baseball being the most common sport. They noted that a 77.9% return to previous level of play with nonoperative treatment with an 80% RTP in patients with partial tears and 69% RTP in patients with complete tears. Additionally, they reported that RTP was only 41% in patients with distal tears with nonoperative treatment. Some authors have reported success with the use of platelet-rich plasma (PRP) for MUCL injuries.^{6,17} However, in their systematic review, Gopinath et al did a subgroup analysis comparing PRP use to no PRP and found no difference in RTP across the studies.¹¹ Based

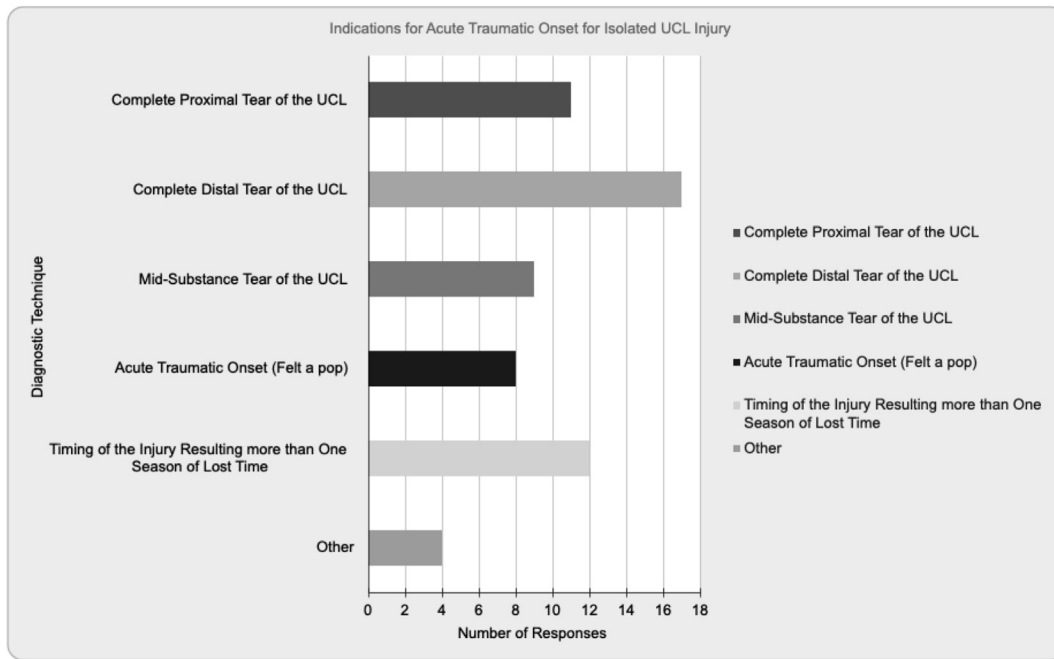


Figure 1 Summarizes the numerical distribution of various common indications surgeons utilize in determining the appropriate treatment for an acute MUCL injury. The responses in figure are to the question: “What are your indications for acute surgical treatment for isolated MUCL injury (Check all that apply)?” MUCL, medial ulnar collateral ligament; UCL, ulnar collateral ligament.

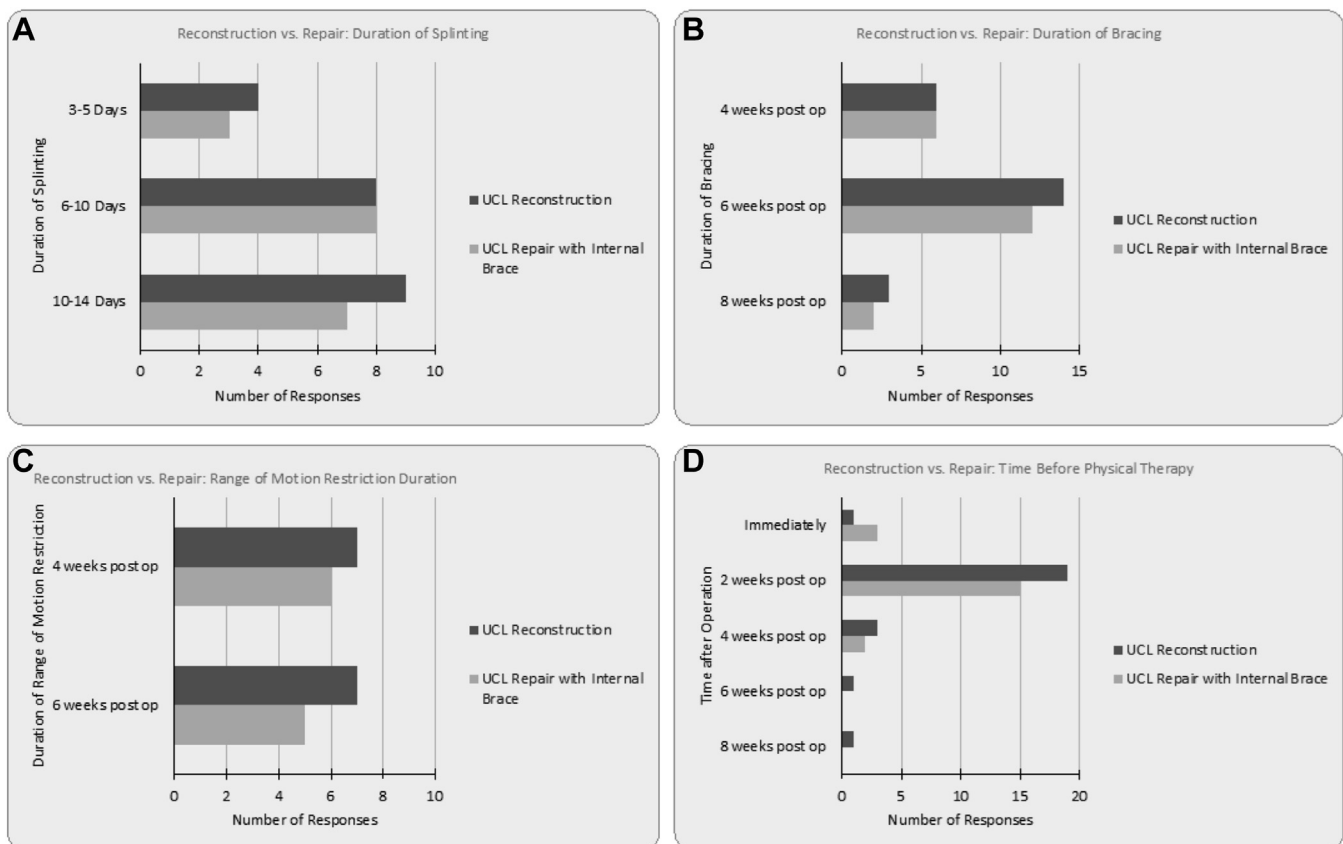


Figure 2 Rehabilitation Duration Comparison. (A) Comparison of preferred duration of postoperative splinting. (B) Comparison of preferred duration of postoperative bracing. (C) Comparison of preferred duration of postoperative restriction of range of motion. (D) Comparison of preferred time until commencing postoperative physical therapy. UCL, ulnar collateral ligament.

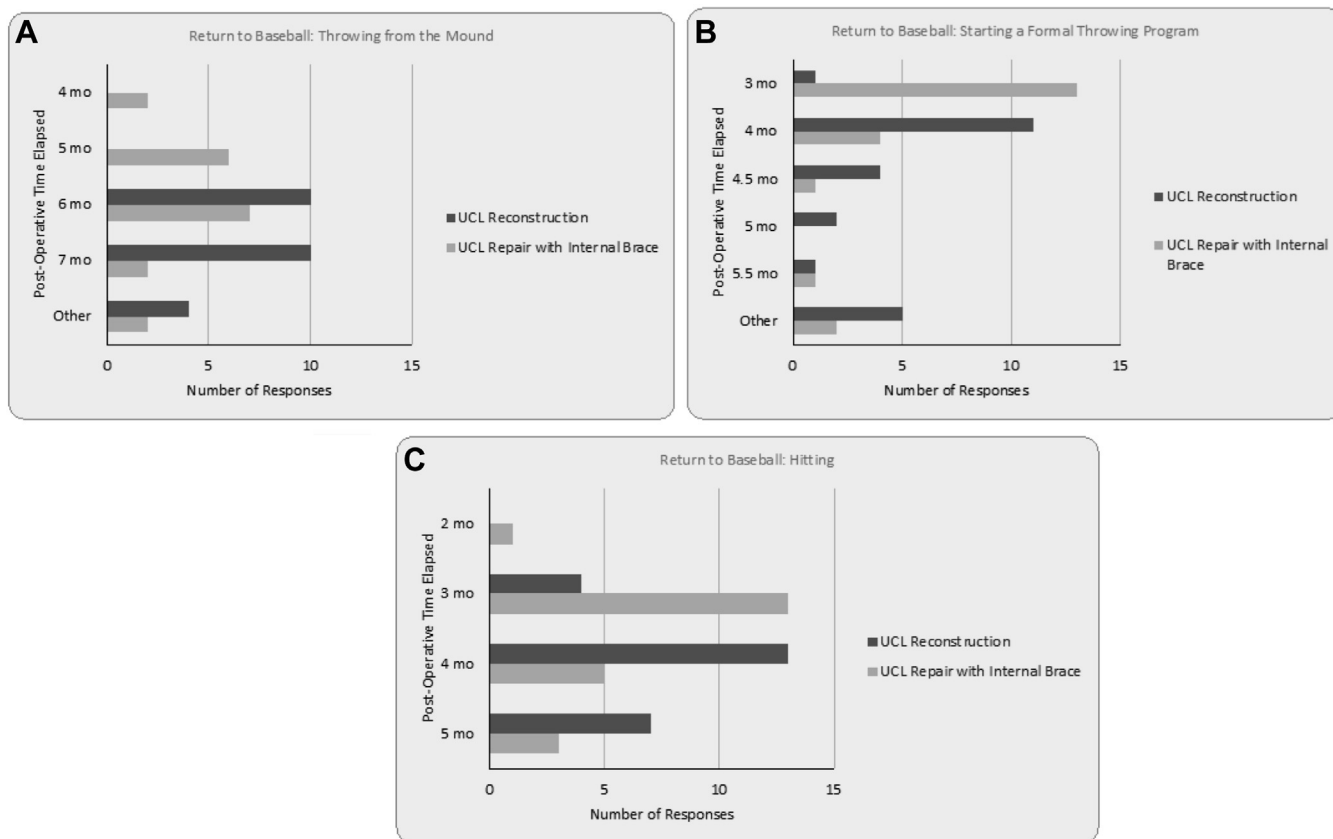


Figure 3 Summary of the surveyed results of duration and timing preferences for common return to play milestones after MUCL reconstruction and MUCL repair with internal brace. (A) Comparison of preferred postop time to begin throwing from the mound. (B) Comparison of preferred postop time to start a formal throwing program. (C) Comparison of preferred postop time to return to hitting. The ‘Other’ responses from all panels in figure are summarized in [Supplementary Table S1](#). MUCL, medial ulnar collateral ligament; UCL, ulnar collateral ligament.

on current literature, there is not a clear agreement on the benefits of PRP.

Our survey showed that the only clear agreement for acute surgical treatment is a complete distal tear seen on imaging. This indication is further supported by the data from Frangiamore et al that showed 82% of patients with distal tears failed nonsurgical treatment.¹⁰ In our study, no other tear pattern on MRI had a high level of agreement for acute surgical management. The varying success of nonsurgical treatment coupled with the potential for a long recovery after surgery makes the true indications for surgery difficult for surgeons and patients.

Often, the appearance of the MUCL on MRI or US can guide treatment decisions. Bowman et al found that the odds of recommending operative treatment was 5.1 times more likely for a complete distal full-thickness tear and 7.0 times more likely for a proximal full-thickness tear.¹ While MRI/MRA can assist with determining significant injury to the MUCL can be present, it is not a perfect tool for clinical decision-making. A systematic review of diagnostic imaging for MUCL injury showed that MRA sensitivity ranged from 81% to 100%, while MRA specificity ranged from 91% to 100%. MRI sensitivity and specificity ranged from 57% to 100% and 89% to 100%, respectively.³ This same paper reported that stress US is 96% sensitive (81% specific) compared to conventional US, which is 81% sensitive (91% specific). Current literature is conflicting as the value of MUCL laxity in the diagnosis of MUCL injury suggests a stress delta of 2.4 mm and stress delta difference of 1 mm from the uninjured elbow indicate MUCL injury.¹⁹ Interestingly, our

respondents were split on the use of MRI versus MRA. Approximately half of our respondents noted the stress US to add diagnostic value when the MRI/MRA is nondiagnostic.

A 2021 study by Lund et al examined the effectiveness of the flexed elbow valgus external rotation (FEVER) view during MRI evaluation of Major League Baseball pitchers indicated greater diagnostic confidence and greater ability to identify a ulnar collateral ligament as abnormal in the FEVER view during MRI, as increased joint space width confirmed elbow valgus stress in the FEVER view.¹⁴ Though, the value of US was called into question in a study by Molenaars et al who found that medial joint gapping was correlated to ulnar collateral ligament injury severity in throwing athletes with medial elbow pain, but the excess opening was not correlated injury severity. This result furthers questions about the utility of stress radiography in the clinical workup of throwing athletes.¹⁶ Furthermore, a study by Bruce et al including 273 baseball players with ulnar collateral ligament injuries suggested that large openings on stress radiography are more useful in differentiating complete from partial MUCL tears than determining who will require surgical treatment for a MUCL injury.²

Our study results also showed more aggressive rehabilitation and RTP for patients undergoing MUCL repair with internal brace compared to MUCL reconstruction. These results are consistent with research showing that MUCL repair with internal brace replicates time-zero failure strength of traditional MUCL graft reconstruction and is more resistant to gapping at low cyclic loads.⁸ There are clinical data to support that the accelerated rehabilitation after MUCL with

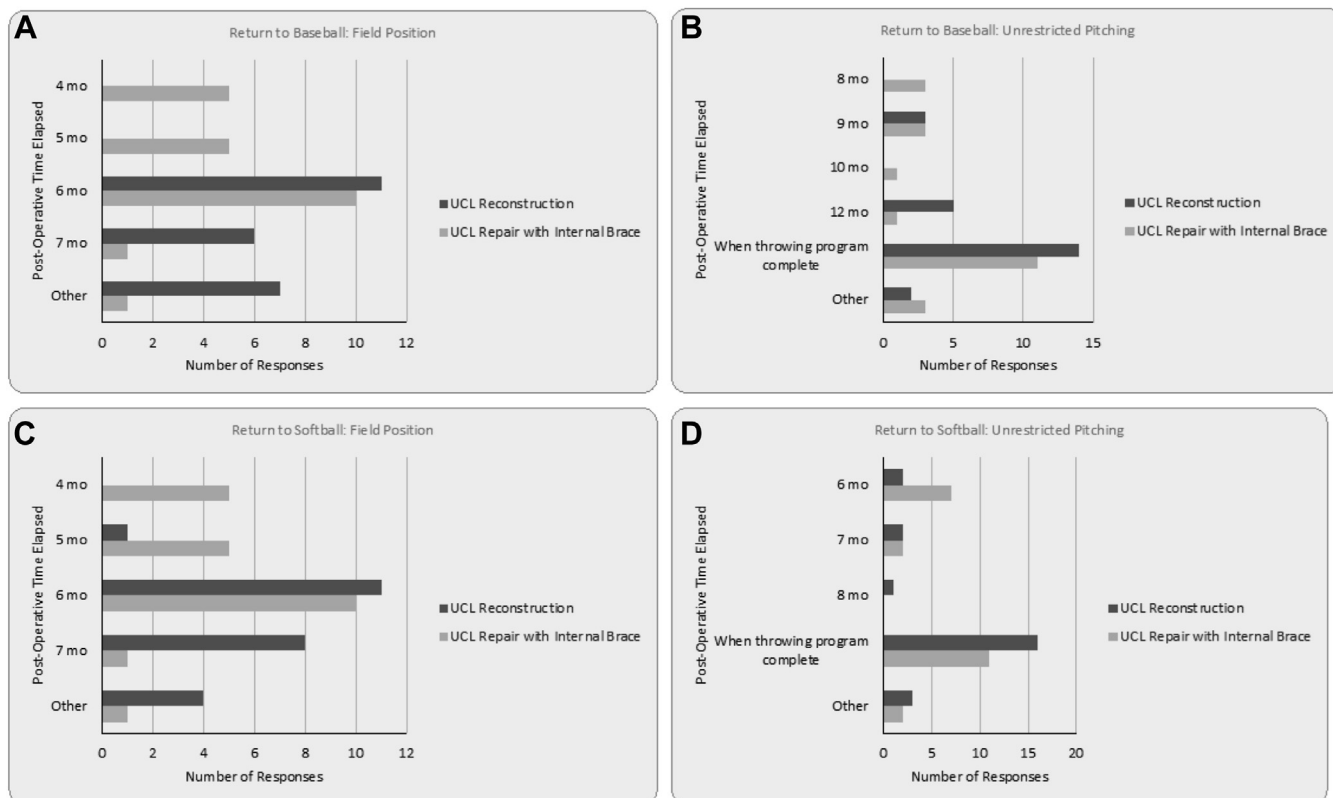


Figure 4 (A) Comparison of preferred postop time to return to a field position in baseball. (B) Comparison of preferred postop time to begin unrestricted pitching for baseball. (C) Comparison of preferred postop time to return to a field position in softball. (D) Comparison of preferred postop time to begin unrestricted pitching in softball. The ‘Other’ responses from all panels in figure are summarized in [Supplementary Table S2](#).

Table III

The number of respondents for all sports in Table under MUCL reconstruction was 24 respondents (100%), and the number of respondents for all sports in Table under MUCL repair with internal brace was 21 (87.5%).

	MUCL reconstruction								MUCL repair with internal brace							
Return to Play Time (Months Postop)	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Basketball	0	0	8	17	4	63	4	4	0	5	33	37	10	10	5	0
Soccer	0	0	17	25	8	42	4	4	5	0	52	28	5	5	5	0
Football	0	0	10	5	5	54	5	21	0	5	10	33	14	28	5	5
Ice hockey	0	0	13	8	8	63	4	4	0	0	19	43	14	19	5	0
Field hockey	0	0	13	8	8	63	4	4	0	0	0	33	14	33	10	10
Tennis	0	0	0	5	8	39	5	43	0	0	0	33	10	37	10	10
Volleyball	0	0	0	0	4	52	4	40	0	5	24	38	10	14	5	5
Swimming	0	0	13	13	4	54	3	13	0	5	24	38	10	14	5	5
Track	0	10	29	22	0	22	6	10	5	14	33	24	10	5	5	5
Golf	0	0	4	13	13	50	0	21	0	5	24	33	10	19	5	5
Gymnastics	0	0	0	0	9	48	0	43	0	0	5	14	5	48	10	19
Wrestling	0	0	0	8	0	46	0	33	0	0	0	25	10	45	0	20

MUCL, medial ulnar collateral ligament.

The numbers in each row labeled with a sport are percentages rounded to the nearest whole number. For each sport and for each procedure, the estimated return to play with the greatest percentage of surgeons is in bold.

internal brace can return throwing athletes to a high-level of play safely and with a shorter recovery time in patients with overhead throwing injuries to the MUCL.⁷ Given the improvements in recovery time with internal brace, there has been more interest in internal brace when possible versus MUCL reconstruction.

Lastly, our survey shows that recommended RTP time in non-throwing athletes is highly variable for most sports. While respondents generally agreed in a faster RTP after MUCL repair with internal brace than with MUCL reconstruction, there is a paucity of

literature to guide these treatment decisions. These findings were also seen in a recent study by Erickson et al where unanimous consensus among therapists and surgeons was rarely achieved when evaluating timing of RTP following MUCL surgery.⁹ Based on current available data, surgeons have to make an educated estimate regarding safe timing for RTP. While nonthrowing MUCL injuries are less common, further research in this area is needed to improve our knowledge for allowing safe return to sports after MUCL surgical treatment.

Limitations

There are limitations of this study. First, there was a small sample size of survey respondents ($n = 24$). As the sample size is small, the opinion and variable experiences of each surgeon may have an impact on the agreement within the survey. Second, the survey questions were created by a small group of experts that did not undergo a rigorous Delphi assessment. This could also allow for bias in the formulated questions based on the experiences of the surgeons in the group creating the questions. Furthermore, we did not include questions about MUCL reconstruction with internal brace since this is an emerging concept with little outcome data. Finally, the data are level 5 evidence generated from a cross sectional survey, which also detracts from the external validity of the study findings.

Conclusion

The study reveals that there is agreement for the indication of acute surgical treatment of distal MUCL tears, duration of bracing after surgery, and the time to initiate physical therapy after surgery. There is not clear agreement on indications for surgical treatment for every MUCL tear pattern, RTP time for throwing, hitting, and participation in nonthrowing sports.

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Supplementary Data

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