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Arthroscopic visualization of the medial collateral ligament of the elbow

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Background: This study aimed to determine the extent to which the medial collateral ligament (MCL) can be visualized during a standard posterior arthroscopic view of the elbow.
Methods: Eight fresh human cadaveric elbows were placed in a simulated lateral decubitus position. Standard elbow arthroscopy was performed on each specimen using a standard posterior portal for visualization with a 30° arthroscope. The most distal borders of the visible part of the MCL were marked using a spinal needle and tagged using nylon sutures. Subsequently, the elbow was dissected. The overall surface area of the entire MCL and that defined by the suture tags were calculated for each specimen.
Results: The mean area of the visible part of the MCL represented 48% of the mean overall area. The arthroscopically tagged part of the posterior band of the MCL represented <50% of the entire MCL. Arthroscopic visualization was not available for most of the posterior bands of the MCL.
Conclusions: Less than half of the MCL is visible with a 30° arthroscope from standard posterior portal. Thus, sole reliance on arthroscopic visualization with this manner is not enough to release of the MCL. The variable effort is required to improve the limited visualization during the procedure. Moreover, the individual attention is essential to protect the ulnar nerve because the ulnar nerve is very close to the MCL especially to the anterior band.
Level of evidence: Anatomy Study; Arthroscopy and Cadaver Dissection

Keywords: Elbow; arthroscopy; visualization; ulnar nerve; medial collateral ligament; stiff elbow

Elbow stiffness can occur owing to either extrinsic or intrinsic causes.[13] Although intrinsic stiffness is caused by intra-articular injuries, extrinsic stiffness is primarily associated with contracture of extra-articular soft tissue structures such as the capsule of the joint, triceps, and brachialis muscle. Surgical release of stiff elbow was originally designed as an open surgery.[1,2,4,12,13,19] However, arthroscopic osteocapsular arthroplasty has been extensively performed in recent years for treating stiff

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Ethical board review approval was obtained before this study was conducted (AMC IRB 2017 1221).

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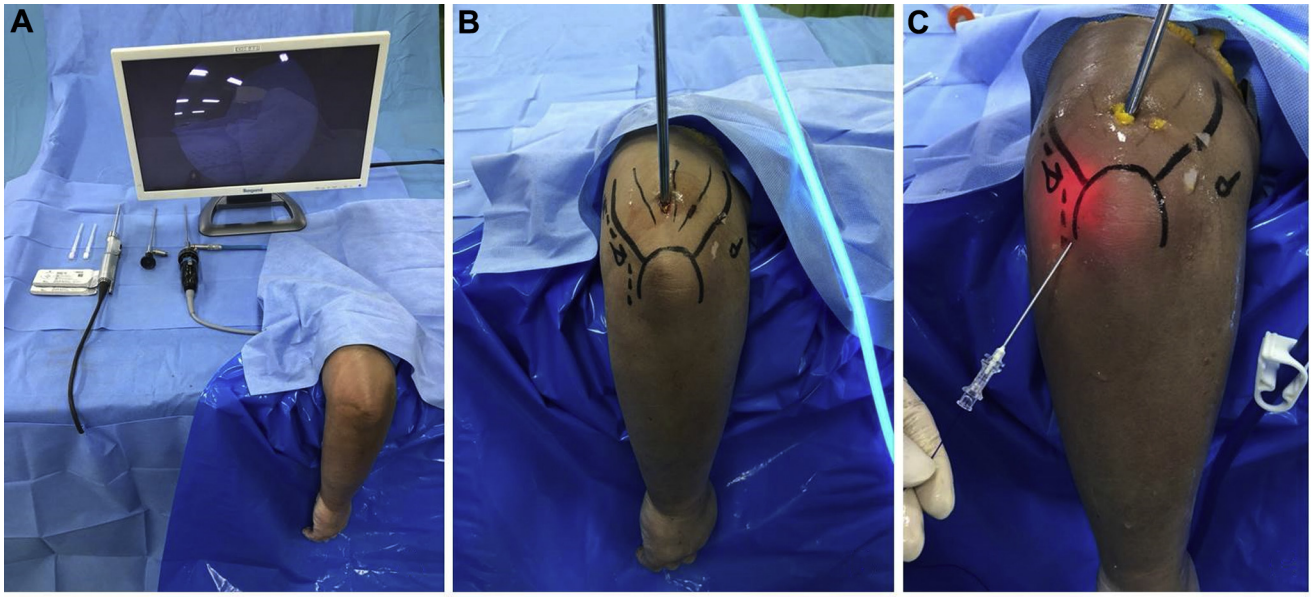

Figure 1 (**A**) Experimental setting. (**B**) Standard direct posterior viewing portal for insertion of a 4-mm 30° arthroscope in the elbow. (**C**) Nylon through a spinal needle with an outside-in technique.

elbow.[3,9,11,17] To achieve maximum flexion, release of the posterior band of the medial collateral ligament (MCL) has been accepted in open surgery.[10,16,18,19] However, the ability to visualize the MCL during elbow arthroscopy remains to be formally assessed. While visualizing the posteromedial gutter, the posterior band of the MCL can be detected on the medial aspect of the ulnohumeral joint between the anterior and transverse bands. To the best of our knowledge, no report has been published on the extent to which the posterior band of the MCL can be visualized during routine arthroscopy. The purpose of the present study was to define the percentage and part of the MCL that can be visualized during standard elbow arthroscopy.

Materials and methods

The study used 8 fresh-frozen cadaveric upper limbs (4 right and 4 left arms) from male donors whose mean age was 74 ± 6 years. The specimens were thawed overnight for 12 hours at room temperature before the experiment. The number of specimens was chosen on the basis of the availability of cadavers at our institution and the adequacy for this anatomical study. Each cadaveric elbow was mounted in a simulated lateral decubitus position with a vise attached to the humeral shaft (Fig. 1, *A*). A standard direct posterior viewing portal 2 cm above the tip of the olecranon was established in the setting of 90° flexion of the elbow, and a 4-mm 30° arthroscope (IM4000, IM4120; ConMed Linvatec, Utica, NY, USA) was inserted in the elbow (Fig. 1, *B*).

After the diagnostic examination of the elbow, the MCL was visualized through the posteromedial gutter. The MCL was best seen distally while viewing the anteromedial aspect toward the sublime tubercle in the posteromedial gutter. The most distal parts of the MCL that were visible were tagged by passing a suture through a spinal needle with an outside-in technique (Figs. 1, *C* and 2, *A*). The intra-articular end of the suture was passed to its opposite end outside the specimen (Fig. 2, *B*).

Next, each cadaveric elbow was dissected, and all the soft tissues were removed except the MCL, which was kept completely intact from its origin to its insertion. Care was taken to ensure that the tagging sutures were not disturbed during the layered dissection (Fig. 3, *A*). Considering the fan-shaped posterior band of the MCL, the following measurements were taken (Fig. 3, *B*): (1) total angle of the MCL (from the sublime tubercle to the posterior margin of the posterior band of the MCL), (2) invisible alpha angle (ie, angle from the sublime tubercle to the tagging sutures), and (3) beta angle, which involved the visible segment (ie, angle from the tagging suture to the posterior margin of the posterior band of the MCL; total angle−alpha angle = beta angle). The mean of the measurements was used for calculating the percentage of the angle for various segments of the MCL. The arthroscopy and tagging of the MCL were performed by 1 orthopedic senior surgeon; this ensured consistency in the technique. The distances were measured using a digital protractor.

Interobserver reliability

Three observers (orthopedic surgeons with fellowship training in upper extremity surgery) evaluated all of the measurements with the same method and device. Interobserver reliability was calculated using intraclass correlation coefficients with 95% confidence intervals.

Statistical assessment

Statistical analyses were performed using SPSS version 12 software (IBM, Armonk, NY, USA). The intraobserver reliability of each measurement was assessed using the intraclass correlation

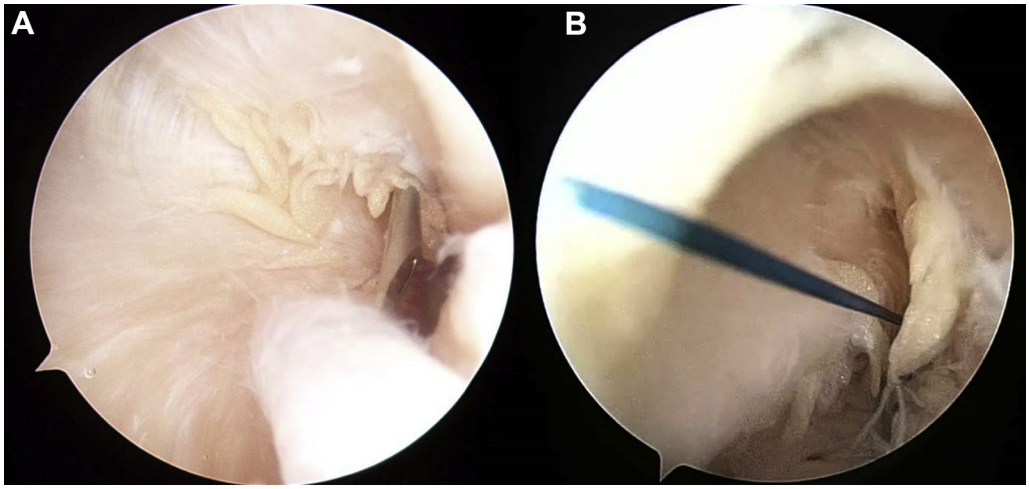

Figure 2 Posteromedial gutter under the arthroscopic view. (**A**) The most distal parts of the medial collateral ligament (MCL) marked by a spinal needle. (**B**) The visible MCL tagged by a nylon suture through a spinal needle.

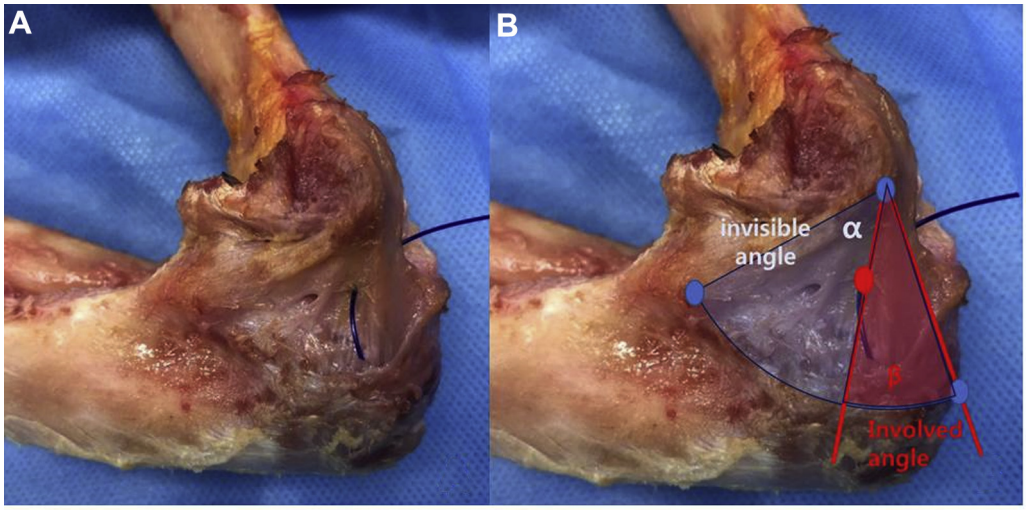

Figure 3 Dissected medial collateral ligament (MCL). (**A**) The nylon indicates the visible part of the MCL under arthroscopic visualization. (**B**) The nylon tagging indicates the alpha (invisible) and beta (involved) angles.

coefficient with the 95% confidence interval, and agreement was stratified as follows: 0.01 to 0.20, slight agreement; 0.21 to 0.40, fair; 0.41 to 0.60, moderate; 0.61 to 0.80, substantial; 0.81 to 0.99, almost perfect; and 1.00, perfect.

Results

All measurements are presented in Table I. The total mean angles for each measured segment were as follows: (1) total angle, 70°; (2) invisible angle (alpha), 36°; and (3) visible angle (beta), 34° (48% of the total angle of the MCL). The interobserver agreement among the 3 observers was almost perfect for all the measurements (visible angle, 0.86; invisible angle, 0.94; total angle, 0.83; involved MCL [%], 0.96).

Discussion

As arthroscopy has become popular for various joint diseases in the knee, hip, and shoulder, arthroscopic procedures for elbow joint diseases have also been suggested and performed. However, the main disadvantage of arthroscopy is limited visualization. Wright et al[20] reported that standard arthroscopic examination using a 30° arthroscope of the glenohumeral joint of the shoulder through a standard posterior portal permitted the visualization of only a small part of the subscapularis tendon. It was subsequently updated to show using a 70° arthroscope and an anterior superior viewing portal allowed visualization of more than 90% of the tendon intra-articularly; bursoscopy in the subcoracoid space allows 100% visualization along with

Table I Mean measurements for the 8 cadaveric elbows

Case	Visible angle (°)			Invisible angle (°)			Total angle (°)			Involved MCL (%)		
	Observer 1	Observer 2	Observer 3	Observer 1	Observer 2	Observer 3	Observer 1	Observer 2	Observer 3	Observer 1	Observer 2	Observer 3
1	30	29	31	41	40	42	71	69	73	42	42	42
2	31	30	29	41	39	40	72	69	69	43	43	42
3	32	33	31	38	37	40	71	70	71	45	46	43
4	23	25	22	45	46	44	68	71	67	34	34	34
5	31	29	29	34	35	32	65	65	62	47	45	46
6	30	30	31	49	52	51	79	83	83	38	37	38
7	32	34	30	35	37	34	67	71	64	48	47	46
8	35	33	32	36	37	35	71	71	67	49	47	47
Mean	31	30	29	40	40	40	71	71	69	43	43	42
Total mean	34			36			70			48		
ICC (95% CI)	0.86			0.94			0.83			0.96		

MCL, medial collateral ligament; *ICC*, interclass correlation coefficient; *CI*, confidence interval.

the axillary nerve.[5,15] Fineberg et al[7] concluded that less than one-half of a normal popliteus tendon is visible during standard knee arthroscopy, and the femoral insertion and musculotendinous junction could not be visualized. After that, Dilworth et al[6] reported that lateral tibiofemoral compartment portals could be safely created to enable improved visibility for complex arthroscopic procedures in the posterolateral viewing region. With a similar perspective, the present cadaveric study started from the notification of the limited visualization with a 30° scope through the standard posterior portal. Our findings suggest that this limitation can be overcome by using a 70° arthroscope, with accessory portals used for arthroscopic retractors as the previous literature of the shoulder and the knee. This study would be the baseline for future research regarding how to improve our visualization of elbow arthroscopy for the posteromedial gutter.

In the present study, less than half of the MCL (mean, 48%) was visualized from the standard posterior viewing portal using a 30° arthroscope. This study was performed on fresh cadaveric elbows using surgical simulation to replicate an actual surgical situation. Therefore, it is reasonable to conclude that arthroscopic visualization of the posteromedial gutter cannot identify the entire length of the MCL during an actual surgery. It is generally challenging to approach the posteromedial gutter using a standard posterior portal, as is normally done during surgery. The sublime tubercle of the ulna, the most anterior border of the anterior and posterior bands, was not detected in all the cases.

In our additional finding, around the elbow,[8,14] the ulnar nerve runs medial to the brachial artery and travels behind the medial epicondyle. The ulnar nerve was laid down on the posterior band of the MCL, coming along with the anterior band of the MCL with a 90° flexion of the elbow in all cases (Fig. 4). For this reason, if the surgeon tries to release the whole posterior band of the MCL from the anterior band of the MCL, there is a strong likelihood that the ulnar nerve can be injured. To reduce the ulnar nerve injury during the procedure, we recommend performing an ulnar nerve release with a mini-open incision before the procedure.

However, only 50% visualization as a conclusion never means that the surgeon can approach only 50% in real practice. It requires more action and attention from the surgeon to get more visualization such as using a 70° scope and arthroscopic retractor, creating another portal placement and changing the elbow position (more flexion gives us more visualization toward the anterior part from the posterior standard portal). The final goal of this study is to encourage the surgeon to attempt variable efforts to overcome the limited visualization after being aware of the possibility of ulnar nerve damage with only 30° scope and posterior standard portal. The authors of the present study emphasize that the sole visualization with only a 30° scope never guarantees the full view of the MCL from the

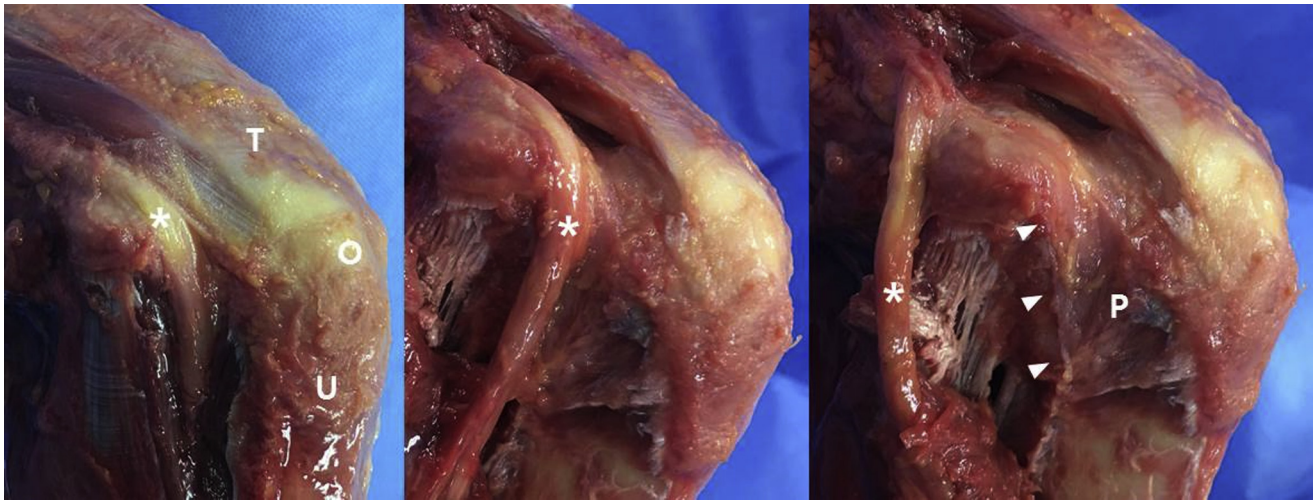

Figure 4 The relationship between the ulnar nerve and the medial collateral ligament (MCL). The white stars indicate the ulnar nerve, and the white arrowheads the anterior band of the MCL. *T*, triceps muscle; *O*, olecranon; *U*, posterior aspect of the ulnar bone; *P*, posterior band of the MCL.

posterior standard portal. On the basis of this, as a starting point, we expect future research on how we can achieve more visualization using a different strategy.

The main limitation of this study is that all the procedures were performed by 1 surgeon. Further anatomical studies are required to confirm the reliability of this arthroscopic technique. However, no other analysis has been conducted for cadaveric specimens regarding the visualization of the MCL during arthroscopy.

Conclusion

Less than half of the MCL is visible with a 30° arthroscope from the standard posterior portal. Thus, sole reliance on arthroscopic visualization with this manner is not enough to release of the MCL. The variable effort is required to improve the limited visualization during the procedure. Moreover, special attention is essential to protect the ulnar nerve because the ulnar nerve is very close to the MCL especially to the anterior band.

Disclaimer

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