CLINICAL ARTICLE

Arthroscopic Treatment of Posttraumatic Elbow Stiffness Due to Soft Tissue Problems

Junxi Dai, MD[1,2,3†], Guofeng Zhang, MD[4†], Shulin Li, MD[1,2,3], Jianguang Xu, MD, PhD[1,2,3,5], Jiuzhou Lu, MD, PhD[1,2,3]

[1]*Department of Hand Surgery, Huashan Hospital, Fudan University,* [2]*Key Laboratory of Hand Reconstruction, Ministry of Health,* [3]*Shanghai Key Laboratory of Peripheral Nerve and Microsurgery and* [5]*School of Rehabilitation Science, Shanghai University of Traditional Chinese Medicine, Shanghai and* [4]*Department of Hand Surgery, The Affiliated Hospital of Medical School of Ningbo University, Ningbo, China*

Objectives: To evaluate the effectiveness of arthroscopic management of posttraumatic elbow stiffness due to soft tissue problems.

Methods: A retrospective review of 30 consecutive arthroscopic elbow releases for posttraumatic stiff elbow from November 2011 to December 2019 was conducted. Stiff elbows with bony problems, such as heterotopic ossification, intraarticular nonunion or malunion, and cartilage lesions were excluded from this study. Contracture and adhesion of soft tissue around the elbow were identified. Surgical treatments included arthroscopic capsulectomy, ligaments and muscle release, and ulnar nerve release. The results were evaluated using the Mayo elbow performance score (MEPS) and range of motion of the elbow. Surgery-related complications were assessed.

Results: Patients who underwent arthroscopic release were followed up for between 6 and 35 months, with a mean follow-up time of 10.1 months. The postoperative elbow ROM was 123.2° ± 19°, which was significantly different compared to the preoperative value of 68° ± 32°. In addition, the MEPS score improved from 71.2 ± 10.3 preoperatively to 93.7 ± 6.6 at the final follow-up, a mean improvement of 22.5 (range, 0–55; $P < 0.05$). Postoperative complications included five cases of prolonged drainage from the portal site, three transient nerve palsies, and one hematoma in the medial elbow.

Conclusion: With full recognition by the surgeon of the pathologic changes of the soft tissue around the elbow, arthroscopic release is usually safe and effective for posttraumatic elbow stiffness without symptomatic bony problems.

Key words: Arthroscopic arthrolysis; Intra-articular adhesion; Posttraumatic elbow stiffness; Soft tissue contracture

Introduction

Elbow stiffness is a common complication after trauma[1–4]. It can be classified in different ways according to the time of the injury, the severity of the stiffness, the location of stiffness, or the structure involved[4–7]. Decision-making regarding treatment of a stiff elbow is usually based on these classifications. In Kay's classification, elbow stiffness is related to pathological change in soft tissue or osseous[6]. Although osseous changes are more conspicuous in preoperative evaluation, the predominant factor that impairs motion is usually the pathological change of the soft tissue around the elbow. Therefore, identifying and addressing the soft tissue problem in elbow stiffness is essential for good functional recovery.

Address for correspondence: Jiuzhou Lu, MD, PhD, Department of Hand Surgery, Huashan Hospital, Fudan University, Shanghai, China; 12 Wulumuqi Middle Road, Shanghai, China 200040; Tel: (86)21-52887092; E-mail: lujiuzhou@hotmail.com; Jianguang Xu, MD, PhD, Department of Hand Surgery, Huashan Hospital, Fudan University, Shanghai, China; School of Rehabilitation Science, Shanghai University of Traditional Chinese Medicine, Shanghai, China 12 Wulumuqi Middle Road Shanghai, China 200040; Tel: (86)21-52887092. E-mail: xjg@shutcm.edu.cn
†These authors contributed equally to this work.

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While capsule contracture is most common in posttraumatic stiffness of the elbow, there are different pathological changes that affect soft tissue around the elbow. Based on our experience, there are three main types of soft tissue that could be associated with elbow stiffness after trauma, including capsule, muscle and ligament. The pathologic changes of these soft tissue are contracture and adhesion. Misdiagnosis of each of those soft tissue problems may lead to poor postoperative results.

The treatment of elbow stiffness varies from nonsurgical rehabilitation to surgical managment. There are various techniques if surgical treatment is indicated, including arthroscopic and open release and different types of arthroplasty procedure[4–18]. Open procedures for treating posttraumatic elbow stiffness have been well described in the literature. The postoperative recovery is usually acceptable, and still the main surgical technique for treating a complex stiff elbow, especially when there is a bony problem. Bone problems that impair elbow motion include heterotopic ossification (HO), chronic intra-articular fractures and cartilage lesions. These situations are more complicated and usually require open surgery. Therefore, a common indication for arthroscopic release is elbow stiffness related to soft tissue problems.

The arthroscopic release approach for treating a stiff elbow has developed over the past few decades[16–18]. This technique has the advantages of less soft tissue trauma, better visualization, and more rapid functional recovery. However, the previous application is mainly focused on arthroscopic capsulectomy and ligament release. There is no published report introducing arthroscopic release for multiple pathological changes affect soft tissue around elbow. The purpose of this study is to: (i) classify soft tissue-related posttraumatic elbow stiffness; (ii) evaluate the effectiveness of arthroscopic release of a stiff elbow related to soft tissue problems; and (iii) describe the surgical steps and technique notes for arthroscopic release for this type of stiffness of the elbow.

Materials and Methods

Inclusion and Exclusion Criteria

Inclusion criteria: (i) patients hospitalized with posttraumatic elbow stiffness at the hand surgery department of Huashan Hospital from November 2011 to December 2019; (ii) patients whose elbow stiffness is related to the contracture and adhesion of soft tissue around the elbow; (iii) patients who underwent arthroscopic elbow release when there was no improvement in range of motion (ROM) after physical therapy; and (iv) ROM of the elbow, Mayo elbow performance score (MEPS), and complications were recorded and analyzed at follow-up.

Exclusion criteria: (i) elbow stiffness related to bony problems, such as heterotopic ossification, intraarticular nonunion or malunion, and cartilage lesions; and (ii) patients who have explicitly requested not to participate in the clinical research.

Surgical Technique

Anesthesia and Position

Under general anesthesia, the patient was positioned in lateral decubitus. The arm was supported by an arm holder. A tourniquet was placed on the upper arm. All bony landmarks and the ulnar nerve around the elbow were palpated and marked (Fig. 1).

Approach and Exposure

Following tourniquet inflation, the joint was insufflated with 10 to 25 mL of saline through the soft-spot portal site. For simple anterior capsule contracture, we started from the anterior compartment. More frequently, there was also extension stiffness; in which case, we would start from the posterior compartment. The ulnar nerve was decompressed and protected through a posterior medial incision. Posterior capsulectomy was performed arthroscopically (Fig. 2). If elbow flexion was still restricted, the posterior bundle (PB) of the medial collateral ligament (MCL) was identified and released (Fig. 3). This step can be performed arthroscopically or through an already existing posterior medial incision. After posterior compartment release, anterior capsulectomy was performed. Usually, obvious improvement of elbow motion can be achieved after this step. In case the passive ROM was still limited after capsulectomy

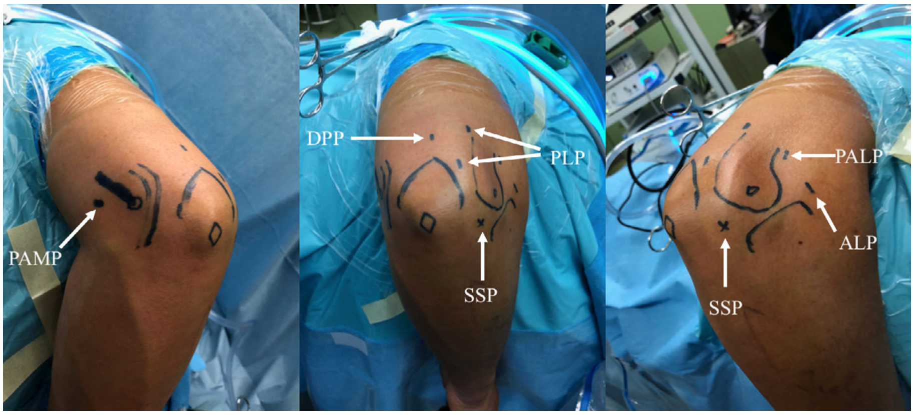

Fig. 1 The common surgical portal and markings of elbow arthroscopic arthrolysis. ALP, anterolateral portal; DPP, distal posterior portal; PALP: proximal anterolateral portal; PAMP, proximal anteromedial portal; PLP, posterolateral portal; SSP, soft spot portal.

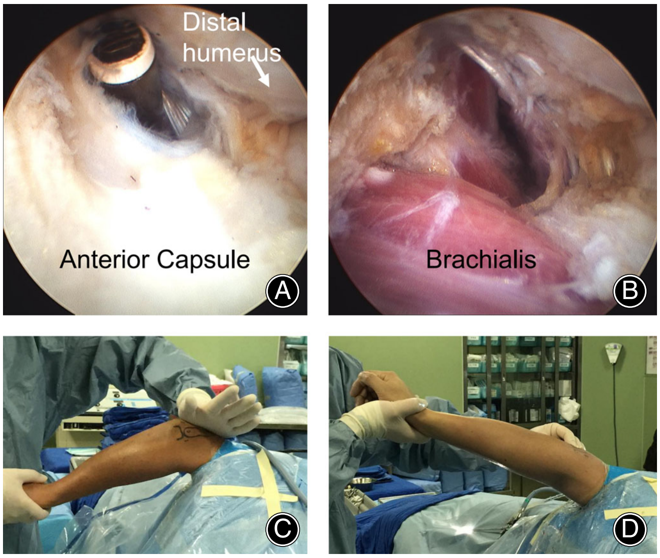

Fig. 2 A 35-year-old man before and after capsulectomy. (A) Arthroscopic view of the anterior compartment and capsule. (B) After capsulectomy, the brachialis muscle was exposed. (C) Intraoperative physical exam shows limited passive elbow extension. (D) Passive motion was improved after arthroscopic capsulectomy.

and PB release, adhesion between the muscle and the distal humerus needed to be evaluated. Both the brachialis in the front and triceps in the back could be released and elevated from the distal humerus (Fig. 4).

If there was extensive scar tissue or severe ischemic muscle contracture, open release or muscle lengthening was indicated. The final step was identification of adhesion between the ligaments and underneath the bone surface. Both annular ligaments and collateral ligaments were evaluated and addressed arthroscopically.

Postoperative Rehabilitation

All patients started physical therapy several hours after or on the day after surgery. We used continuous passive motion (CPM) and an ice compress while the patients remained in hospital (3–5 days). A hinged splinter and CPM were applied post-discharge. The therapy continued until the patient reached maximum improvement.

Clinical Outcome Evaluation

We assessed the following clinical data: age, gender, type of injury, injured elbow, interval between injury and the first arthroscopic treatment of the elbow, and length of follow-up. Preoperative and postoperative ROM of the elbow, the MEPS, and complications were also recorded and analyzed.

Mayo Elbow Performance Score

The Mayo elbow performance score (MEPS) is a rating system designed for evaluating both the objective function and subjective features (pain, stability, ROM, and the ability to perform daily activities).

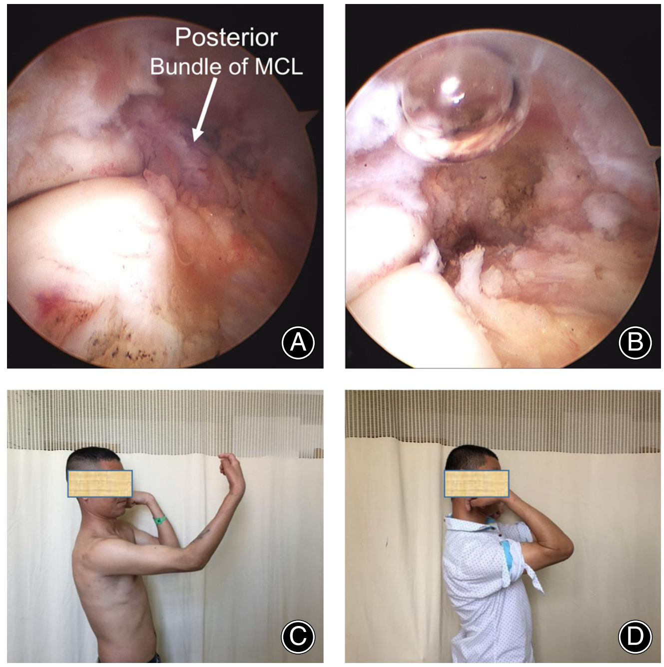

Fig. 3 Posttraumatic elbow stiffness with posterior bundle (PB) contracture in a 35-year-old man. (A) Arthroscopic view shows the contracture of PB of medial collateral ligament (MCL), which impairs elbow flexion. (B) The PB was released to improve elbow flexion. (C) Preoperative physical exam shows very limited elbow flexion. (D) Functional recovery at 1 month after arthroscopic elbow release. MCL, medial collateral ligament; PB, posterior bundle

Complications

The complications during or after surgery included prolonged drainage from the portal site, heterotopic ossification, nerve injury, and infection.

Statistical Analysis

All statistical analyses were performed using IBM SPSS statistics version 22.0 (SPSS, Chicago, IL, USA). The data were expressed as mean ± standard deviation. The motion of extension and flexion, the ROM, and the MEPS score preoperatively and at final follow-up were compared using the paired *t*-test. $P < 0.05$ was considered statistically significant.

Results

Patients' Characteristics

Thirty patients with posttraumatic elbow stiffness were enrolled in this study (Table 1). The average age at the time of surgery was 40 years (range, 17–72 years). The average time from the initial injury to arthroscopic surgery was 20.4 months (range, 2–180 m). The etiologies of the elbow

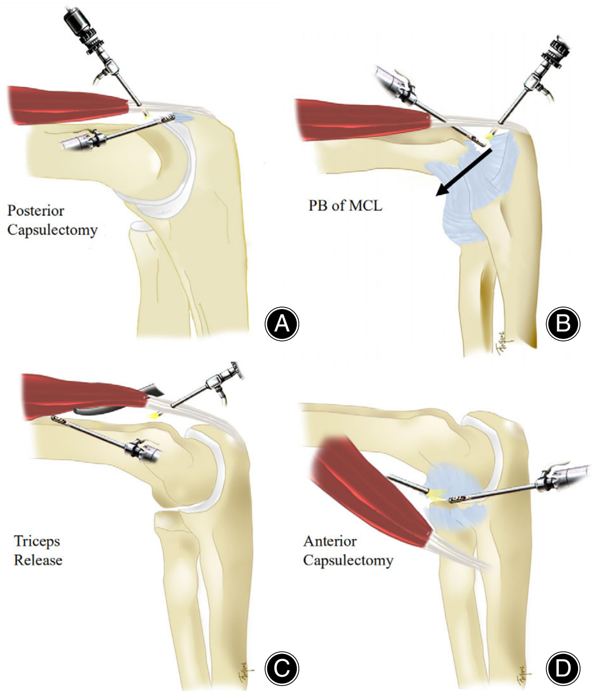

Fig. 4 Sequence of arthroscopic arthrolysis for soft tissue related stiff elbow. (A) Ulnar nerve decompression and posterior capsulectomy. Prophylactic open ulnar nerve decompression was indicated when there was a limitation on elbow flexion. Posterior capsulaectomy (including ulnar–humeral and radial–capitulum joint) was then performed arthroscpically. (B) Posterior bundle (PB) of medial collateral ligament (MCL) release. Passive elbow flexion was examined and PB of MCL was explored after posterior capsulectomy. Once PB contracture was confirmed, this ligament could be released from the origin. (C) Triceps release. If elbow flexion was still limited after posterior capsulectomy and PB release, triceps adhesion needed to be evaluated and released from the dorsal aspect of the distal humerus. (D) Anterior capsulectomy When there is no bone problem, contracture of the anterior capsule is the major restriction for elbow extension. Arthroscopic anterior capsulectomy is a well-established technique and can greatly improve elbow extension.

stiffness include four elbow dislocations, 10 isolated fractures, nine fractures with nerve injury, and seven cases of soft tissue injury around the elbow. Arthroscopic capsulectomy was performed for all cases. Additional procedures included 11 PB releases, five triceps releases, two brachialis releases, and 3 annular ligaments releases. Ulnar nerve decompression was performed in 19 cases.

Clinical Outcome Evaluation

Range of Motion

After a mean follow-up of 10.1 months (range, 6–35m), elbow flexion and extension were improved from 95.2° ± 29° to 131.8° ± 11.1° ($P < 0.05$) and 27.2° ± 22.5° to 8.7° ± 10.7° ($P < 0.001$), respectively. The active ROM at final follow up was significantly different compared to the preoperative value (preoperative 68° ± 32° *vs* postoperative 123.2° ± 19°), with a mean improvement of 55.2° (range 20°–110°; $P < 0.001$).

Mayo Elbow Performance Score

The MEPS score improved from 71.2 ± 10.3 preoperatively to 93.7 ± 6.6 at the final follow-up, with a mean improvement of 22.5 (range 0–55; $P < 0.05$) (Table 2). Thirty percent of patients reported good MEPS outcome (9/30), and the remaining patients reported excellent MEPS outcome. There was no significant difference between subgrouped patients (Table 3).

Complications

Postoperative complications included five cases pf prolonged drainage from the portal site, three transient nerve palsies, and one hematoma in the medial elbow. Two patients showed heterotopic calcification after surgery at postoperative follow-up. These ectopic bones have minor influences on elbow motion. In addition, two patients received repeat surgery because of persistent elbow stiffness.

Discussion

Effectiveness of Atrhroscopic Arthrolysis for Stiff Elbow Due to Soft Tissue Problems

This study showed that arthroscopic elbow release is effective in treating elbow stiffness without symptomatic bony problems. Soft tissue problems resulting in elbow stiffness include contracture and adhesion of the joint capsule, ligaments, and muscles. Most of these problems could be addressed arthroscopically, and functional recovery was satisfactory and complications were relatively rare.

Arthroscopic elbow release has the advantage of decreased soft tissue trauma, improved joint visualization, and more rapid functional recovery. Although there is potential risk of nerve injury, arthroscopic arthrolysis is generally safe and effective[15–18]. It is especially suitable for elbow stiffness without bony problems, which include intraarticular malunion or nonunion and HO formation around the elbow. This study was focused on surgical techniques for arthroscopic release of elbow stiffness with different types of soft tissue problems.

It was essential to identify the bony problem before surgery. Arthroscopic release can be performed even when there are bony problems such as HO formation or intraarticular malunion. The pathological change and surgical technique are different. These cases were not included in this study.

Recognition of the Soft Tissue Problems That Impair Elbow Motion

There are three major soft tissues that have a potential association with elbow stiffness, including capsule, muscle, and ligament. The soft tissue affects elbow motion through two different pathologic changes: contracture and adhesion.

TABLE 1 Patients characteristics

Case	Gender	Age (years)	Interval between injury and arthroscopic surgery (months)	Injured elbow	Injury type	Second elbow surgery
1	M	49	4	L	HF + OF	N
2	F	39	7	L	ED	N
3	M	16	4	R	HF	N
4	M	32	4	R	ED	N
5	M	38	17	L	ED	N
6	F	52	5	L	*CF*	N
7	M	31	24	L	ED	N
8	M	51	7	R	OF	N
9	M	32	5	R	RF+ nerve	N
10	M	15	19	R	CMHF	N
11	M	31	11	L	RF + UF	N
12	M	25	6	R	RF + HF + R nerve	N
13	M	30	180	L	Elbow contusions	N
14	M	46	5	L	R/U/M nerve	N
15	M	17	18	R	HF + BNI	Open arthrolysis
16	F	46	8	R	HF + RF + U nerve	N
17	F	63	30	R	HF	N
18	M	46	8	L	HF + U nerve	N
19	M	38	11	R	elbow contusions	N
20	M	34	120	R	U nerve	N
21	F	72	16	R	HF + Ulnar nerve	N
22	M	50	35	L	HF + U nerve	N
23	F	28	10	R	HF + U nerve	N
24	M	26	14	R	RF	N
25	M	29	10	R	RF + UF	Arthroscopic + R Head Resect
26	F	55	4	L	RF + UF + M/U/R nerve	N
27	M	31	15	L	elbow contusions	N
28	F	64	8	L	OF	N
29	F	60	2	R	elbow contusions	N
30	F	53	5	L	HF + U nerve	N

CMHF, condylus medialis humeri fracture; CF, coronoid fracture; ED, elbow dislocation; HF, humeral fracture; M, median; OF, olecranon fracture; R, radial; RF, radius fracture; U, ulnar; UF, ulna facture

TABLE 2 Preoperative and postoperative ROM and MEPS (mean ± SD)

Variable	Preoperative	Postoperative	*P*-value
MEPS	71.2 ± 10.3 (range, 65–85)	93.7 ± 6.6 (range, 85–100)*	0.005
Extension	27.2 ± 22.5 (range, 0°–90°)	8.7 ± 10.7 (range, 0°–45°)*	0.000
Flexion	95.2 ± 29 (range, 45°–150°)	131.8 ± 11.1 (range, 100°–150°)*	0.006
ROM	68 ± 32 (range, 0°–120°)	123.2 ± 19 (range, 75°–150°)*	0.000

MEPS, Mayo elbow performance score; ROM, range of motion; * Statistically improved at the final follow up compared with preoperative outcomes ($P < 0.05$).

The capsule contracture is most common in elbow stiffness. Anterior capsule contracture leads to flexion contracture, and posterior capsule contracture leads to elbow stiffness in extension. Open or arthroscopic capsulectomy have been well described for treating elbow stiffness[7–18]. It becomes very challenging when there is adhesion between the capsule and the joint. As there is no working space for arthroscopic exposure, visualizing and releasing the joint is very difficult and the risk of nerve injury is relatively high.

If the elbow flexion remains stiff after posterior capsulectomy, the PB of MCL needs to be explored and evaluated. Improvement in elbow flexion is usually achieved after releasing this ligament[19, 20]. Releasing this ligament can be performed arthroscopically or with a small incision in the posterior medial side of the elbow. The ulnar nerve is decompressed and protected spontaneously.

The ligaments can also adhere to the underneath bone surface. The adhesion can occur in the annular

TABLE 3 ROM and MEPS improvement in subgrouped patient (mean ± SD)

Group	ROM improvement	MEPS improvement
Age		
Age ≥50 years	51.9 ± 28.4	93.1 ± 6.5
<50 years	56.4 ± 24.8	93.9 ± 6.7
P-value	0.944	0.742
Gender		
Male	56.3 ± 25.7	94.7 ± 6.4
Female	53.0 ± 25.8	91.5 ± 6.7
P-value	0.439	0.71

MEPS, Mayo elbow performance score; ROM, range of motion

ligament to the radial head, which leads to limitation of the forearm rotation. It can also occur between the collateral ligaments and the side of joint, which will affect the elbow flexion and extension. Releasing the adhesion is technically demanding. Intraoperative injuries to these ligaments may lead to instability.

Adhesion between the muscle and the distal humerus is common after distal humeral fracture. There are two muscles that may affect the elbow motion after trauma. Brachialis limits extension in the front and triceps limits flexion in the back. Localized adhesion can be released effectively under arthroscope. When the adhesion is extensive, releasing the muscle from bone surface becomes more difficult. If the arthroscopic technique fails to release the adhesion, an open procedure was performed.

It becomes more challenging if the muscle has developed ischemic contracture after trauma. While mild contracture is usually concomitant with adhesion and can be released arthroscopically, moderate to severe muscle contracture usually requires open surgery[21].

For stiff elbows without bony problems, if soft tissue contracture or adhesion have been identified and resolved, near to normal passive motion should be achieved. Exceptional situations include nerve and vessel contracture or skin problems, which should be treated *via* open surgery.

Preoperative evaluation is essential to identify the major factors which impair joint motion. For stiff elbows without bony problems, contracture of the capsule and the posterior bundle of the MCL is most common. Adhesion of ligaments or muscle to the bone usually appears after intra-articular fractures or soft tissue injury. Releasing the adhesion is relatively challenging and a combined open approach may be necessary. Postoperative rehabilitation is essential for good functional recovery. Our preference is to use a CPM machine in the early stages after surgery. In addition, a hinged splinter was applied until full recovery.

Limitations

There are several limitations in this study. First, this study was performed using retrospective data that was not randomized. Second, there is no comparison group of other treatment options. Third, the postoperative follow-up was relatively short. Although the majority of patients in this study achieved good functional recovery, long-term outcomes are unknown. Fourth, there were only 30 cases in this group; the effectiveness of these procedures needs to be further investigated in large study series.

Conclusion

Generally, arthroscopic arthrolysis is relatively safe and effective for stiff elbows without bony problems. While contracture of the capsule and posterior bundle of the MCL are common pathologic changes in posttraumatic stiffness of the elbow, there are other soft tissue problems that may impair joint motion, including adhesions and contracture of the ligaments and muscles around the elbow. Full recognition of all these soft tissue problems is essential for a satisfactory outcome.

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