Arthroscopic debridement for primary elbow osteoarthritis with and without capsulectomy: a comparative cohort study

Ahaoiza D Isa, George S Athwal, Graham J W King,
Joy C MacDermid and Kenneth J Faber

Abstract

Background: Arthroscopic elbow debridement for primary osteoarthritis may be performed with or without a joint capsulectomy. The purpose of this comparative cohort study was to compare range of motion (ROM) and early complications between patients with and without anterior capsulectomy.

Methods: In total, 110 patients with primary osteoarthritis of the elbow who underwent an arthroscopic debridement for primary osteoarthritis were reviewed with a minimum of 3 months postoperative follow-up. The first group consisted of 51 patients who had a concomitant capsulectomy and the second group consisted of 59 patients who either had a capsulotomy or did not have the capsule addressed.

Results: There was significantly greater pre-operative stiffness in the group who had an anterior capsulectomy versus those who did not. A greater improvement in arc of ROM occurred in patients who had a concomitant capsulectomy compared to patients without (24° versus 12°) ($p < 0.003$); however, there were no significant differences in final ROM between groups. There were no statistically significant differences in the incidence of complications between the groups (16% capsulectomy versus 18% no capsulectomy).

Conclusions: Elbow arthroscopy and debridement for primary elbow osteoarthritis yields satisfactory motion at short-term follow-up with or without a capsulectomy. The incidence of early complications was low at this tertiary referral centre, with no significant differences between groups.

Keywords

elbow arthroscopy, capsulectomy, capsulotomy, osteocapsular arthroplasty, primary elbow osteoarthritis, arthroscopic debridement

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Introduction

Symptomatic primary osteoarthritis (OA) of the elbow most commonly affects the dominant arm of middle-aged men with a history of heavy manual labour or sport. This affects up to 2% of the population.^{1,2} Patients typically present with stiffness, impingement pain and/or locking. Elbow arthroscopy and debridement for primary OA reliably provides pain relief, improvement in range of motion (ROM) and good functional outcomes.^{3–10} In a systematic review examining indications for elbow arthroscopy, Yeoh et al.¹¹ reported that there was poor quality evidence favouring arthroscopic treatment over open treatment for primary elbow OA.

Arthroscopic elbow debridement may be conducted with or without joint capsulectomy. Although, conceptually, capsulectomy may be associated with better restoration of motion, it may also be associated with a higher risk of neurovascular injury as a result of the proximity of neurovascular structures to the capsule. In post-traumatic arthritis, capsulectomy is

Roth McFarlane Hand and Upper Limb Centre, St Joseph's Health Care, London, ON, Canada

Corresponding author:

Ahaoiza D. Isa, Roth McFarlane Hand & Upper Limb Centre, St Joseph's Health Care, 268 Grosvenor Street, London, ON N6A 4V2, Canada.
Email: ahaioza@gmail.com

recommended because the increased number of myofibroblasts within the capsule may be a significant contributor to elbow contracture.¹² However, the effect of capsulectomy on changes in ROM in primary elbow OA remains to be clarified. Significant gains in arc of motion up to 73° have been reported following arthroscopic debridement without a capsulectomy.^{5,13} This is comparable with improvements in arc of motion reported with capsulectomies.^{6,8} To our knowledge, no comparative studies examining outcomes and complication rates between patients with and without a capsulectomy for primary elbow OA have been reported.

The purpose of this study was to retrospectively review patients who had arthroscopic debridement for primary osteoarthritis of the elbow and to compare differences in early ROM and complication rates between patients with and without a capsulectomy. We hypothesized that there would be no difference in motion and complication rates with the addition of an anterior capsulectomy in patients undergoing arthroscopic debridement for primary elbow osteoarthritis.

Materials and methods

After approval by our hospital's institutional review board, we retrospectively reviewed a consecutive series of 205 patients with elbow OA who underwent arthroscopic debridement for stiffness, impingement pain and/or locking using the operating room database. All surgical procedures were performed by the senior authors (GSA, KJF and GJWK) between 2007 and 2014. Chart review was performed by an independent observer (ADI). Patients were considered candidates for inclusion in the study if they underwent arthroscopic debridement for primary elbow osteoarthritis. Patients had a minimum of 3 months of postoperative follow-up to be included in the study. Exclusion criteria included inflammatory arthritis, arthritis related to osteochondritis dissecans, history of elbow trauma and elbow instability. Hospital and outpatient records were analyzed for patient demographics and pertinent information as it related to our study (age, sex, hand dominance, elbow affected, workplace safety and insurance board status, presence of ulnar nerve symptoms pre-operatively, history of trauma without fracture, duration of symptoms and history of previous surgery), pre-operative and postoperative ROM at 6 weeks and 12 weeks using a standard long arm goniometer, reoperation and complication rates. The operative reports were reviewed to determine whether patients had an anterior capsulectomy as part of their procedure and to record patients who had secondary procedures (extensor carpi radialis brevis release, plica excision, excision of olecranon spur and reattachment of triceps

and ulnar nerve *in situ* release or anterior subcutaneous ulnar nerve transposition). The decision to perform an anterior capsulectomy was based on patient factors and surgeons' practices. For some surgeons, persistent flexion contracture $\geq 10^\circ$ to 15° in the absence of bony impingement was an indication for capsulectomy. For other surgeons, the decision to perform a capsulectomy was also tempered by patient preference for full ROM verses resolution of their locking and impingement pain symptoms. We identified 110 patients who satisfied the inclusion and exclusion criteria. Patients who had a complete excision of anterior capsule were grouped in the 'capsulectomy group' and patients in whom the capsule was not addressed or patients who had a capsulotomy or capsular reflection from the humerus were grouped in the 'no capsulectomy' group.

Surgical procedure

All patients underwent standard elbow arthroscopy and debridement. Regional brachial plexus blockade was followed by general anaesthesia, and the patient was placed in the lateral decubitus position on a beanbag. An axillary roll was placed under the thorax caudal to the axilla to support the patient's chest and to reduce the risk of brachial plexus compression injury. Pre-operative computed tomography (CT) scans were routinely used to assist the surgeon in ensuring a comprehensive debridement. A sterile tourniquet was applied to the upper arm and the affected elbow was flexed over a static limb positioner. Bony landmarks and the location of the ulnar nerve were outlined. Patients with symptoms of ulnar neuropathy were treated with an *in situ* release or anterior subcutaneous transposition prior to arthroscopy at the surgeon's discretion. The elbow was infiltrated with 20 mL of Ringer's lactate to attain adequate joint distention. After insertion of the arthroscope, irrigation fluid was delivered to the joint by gravity inflow through the arthroscope sheath.

A comprehensive diagnostic arthroscopic elbow evaluation was performed utilizing standard portals and was followed by a subtotal synovectomy and loose body removal. Osteophytes were systematically and sequentially removed from the coronoid tip, radial fossa and coronoid fossa in the anterior compartment and olecranon fossa, olecranon tip, posterior capitellum, medial and lateral gutters in the posterior compartment using a combination of burs, shavers, radiofrequency ablation devices, osteotomes and angled curettes.

The ROM was routinely assessed after completion of the bony debridement. For some surgeons, persistent flexion contracture $\geq 10^\circ$ to 15° in the absence of

bony impingement and subsequent capsulotomy was an indication for capsulectomy. For other surgeons, the decision to perform a capsulectomy was also tempered by patient preference for full ROM versus resolution of their locking and impingement pain symptoms. The use of gravity inflow usually precluded excessive swelling that would have otherwise impaired intra-operative assessment of motion. Capsulectomies were performed using a duckbill resector or shaver after bluntly developing a plane between the brachialis and the anterior capsule. When a capsulectomy was performed anteriorly, care was taken to protect the radial nerve by careful retraction when work was performed anterior to the radial head and distal excision of the capsule was avoided.

The use of suction with the arthroscopic burr/shaver was avoided in the posteromedial joint and debridement of the posteromedial gutter was performed with extreme caution as a result of the proximity of the ulnar nerve.

The elbow was then placed through a ROM. The tourniquet was deflated prior to closure of portals with non-absorbable sutures. The choice of the post-operative physiotherapy regimen was individualized in accordance with patient factors and the surgeon's discretion. Most patients were managed as outpatients with a soft dressing and encouraged to begin ROM exercises immediately postoperatively. If patients were admitted for continuous passive motion (CPM), this was initiated either on the day of surgery or the following morning. Provided that there were no contraindications, routine indomethacin (25 mg PO TID $\times$ 3 weeks) was given for heterotopic ossification prophylaxis, as well as a gastric cytoprotectant. Patients were discharged home with a routine referral for outpatient physiotherapy and static progressive flexion and extension splints as needed.

Patients were seen at 2 weeks for a wound assessment, measurement of ROM by a fellowship trained upper extremity surgeon, removal of sutures and standard postoperative radiographs. Patients who were treated as outpatients were referred for outpatient physiotherapy and static progressive flexion and extension splints as needed. Routine follow-up was performed at 6 weeks and 12 weeks. If patients had satisfactory pain relief and improvement in ROM, follow-up was then made on an as-needed basis.

Statistical analysis

Data were entered in SPSS, version 22.0 (SPSS Inc., Chicago, IL, USA) and descriptive statistics were used to assess data quality and distributions. Baseline characteristics were tested for differences using chi-squared tests for categorical variables and an

independent sample *t*-test for continuous variables. A Bonferroni correction was used. General linear models (GLM) were utilized to determine the effects of time at three different occasions (repeated measures) on capsulectomy (group differences) controlling for covariates (age, sex, hand dominance, occupation classification, history of trauma, previous surgery, workers' compensation status and presence of ulnar nerve symptoms). Where positive interactions were detected, separate analyses were undertaken to examine the effect of time and groups separately. A repeated measure analysis of variance was used to determine whether changes in ROM from pre-operative values at 6 weeks and 3 months were significant. Independent sample *t*-tests were used to determine whether there were differences in elbow extension and flexion between the two groups at each time point.

Results

Patient demographics

Patient baseline characteristics are shown in Table 1, stratified by the presence or absence of an anterior capsulectomy. The average age of our study population was 52 years (range 30 years to 74 years) and the mean duration of symptoms was 56 months (range 3 months to 300 months). Eighty-nine percent of the patients were male and 11% were female. Eight percent had previous surgery for primary OA and 20% of patients were involved in workplace safety and insurance board claims, 49% had associated symptoms relating to ulnar nerve compression, and 83% had labor intensive jobs. None of the demographic characteristics differed between the groups ($p > 0.05$), except for the pre-operative ROM. There was significantly less ($p < 0.001$) pre-operative motion in the group with a capsulectomy (36° to 123°) versus those without (28° to 127°). Workers' compensation claims were present in 12% of capsulectomy patients and 27% of patients without capsulectomies ($p = 0.05$).

Clinical assessment

Both groups demonstrated an improvement in the total arc of motion ($p < 0.001$) 3 months following surgery. In the capsulectomy group, mean (SD) extension improved from 36° (11°) pre-operatively to 23° (11°) at 6 weeks and 19° (10°) at 12 weeks. In the group without capsulectomies, extension improved from 28° (14°) pre-operatively to 27° (11°) at 6 weeks and 21° (10°) at 12 weeks ($p < 0.001$) (Table 2). Improvements in extension at 6 weeks were greater in the capsulectomy group ($p = 0.028$); however, there was no significant difference at 12 weeks following surgery (0.175)

Table 1. Patient demographics.

Population	Capsulectomy group		No capsulectomy group	
	<i>n</i> = 51		<i>n</i> = 59	
Mean age in years (range)	51 (36 to 74)		53 (30 to 66)	
Sex (%)	Male	47 (92.2%)	Male	51 (86.4%)
	Female	4 (7.8%)	Female	8 (13.6%)
Operative extremity (%)	Right	36 (70.6%)	Right	42 (71.2%)
	Left	15 (29.4%)	Left	17 (28.8%)
Operation on dominant extremity? (%)	Yes	33 (64.7%)	Yes	36 (61%)
	No	14 (27.5%)	No	14 (23.7%)
	Not recorded	4 (7.8%)	Not recorded	9 (15.3%)
Manual labour/labour intensive jobs (%)	Yes	42 (82.4%)	Yes	49 (83.1%)
	No	9 (17.6%)	No	10 (16.9%)
Workplace safety and insurance board (%)	Yes	6 (12%)	Yes	16 (27.1%)
	No	44 (88%)	No	43 (72.9%)
Ulnar nerve symptoms (%)	Yes	24 (47.1%)	Yes	29 (49.2%)
	No	27 (52.9%)	No	30 (50.8%)
Previous surgery (%)	Yes	6 (12%)	Yes	3 (5.1%)
	No	44 (88%)	No	56 (94.9%)
History of trauma (%)	Yes	16 (31.4%)	Yes	18 (30.5%)
	No	35 (68.6%)	No	41 (69.5%)
Mean duration of symptoms in months (range)	71.3 (3 to 300)		45.3 (3 to 192)	
Mean (SD) pre-operative extension	36° (11°)		28° (14°)	
Mean (SD) pre-operative flexion	123° (12°)		127° (13°)	

Table 2. Changes in extension at 6 and 12 weeks postoperatively.

	Extension			Repeated measures ANOVA <i>p</i> -value
	Pre-operative	6 weeks	12 weeks	
Capsulectomy, mean (SD)	36° (11°)	23° (11°)	19° (10°)	<0.001
No capsulectomy, mean (SD)	28° (14°)	27° (11°)	21° (10°)	<0.001
<i>p</i> -value (differences in extension between groups)	0.001	0.028	0.175	

ANOVA, analysis of variance.

Figure 1. Change in extension.

Table 3. Changes in flexion at 6 and 12 weeks postoperatively.

	Flexion			Repeated measures ANOVA <i>p</i> -value
	Pre-operative	6 weeks	12 weeks	
Capsulectomy, mean (SD)	123° (13°)	122° (12°)	130° (9°)	<0.001
No capsulectomy, mean (SD)	127° (13°)	125° (12°)	132° (9°)	<0.001
<i>p</i> -value (differences in flexion between groups)	0.001	0.456	0.124	

ANOVA, analysis of variance.

when compared using a Bonferroni corrected independent sample *t*-test (Fig. 1 and Table 2).

In the capsulectomy group, flexion changed from 123° (12°) pre-operatively to 122° (12°) at 6 weeks and 130° (9°) at 12 weeks. In the group without capsulectomy, flexion changed from 127° (13°) pre-operatively to 125° (12°) at 6 weeks and 132° (9°) at 12 weeks ($p < 0.001$) (Table 3). There were no differences in flexion between the groups at 6 weeks ($p = 0.46$) and 12 weeks postoperatively ($p = 0.12$) (Fig. 2 and Table 3).

Sex ($p = 0.144$), age ($p = 0.841$) and hand dominance ($p = 0.590$) had no effect on motion gains.

The GLM did not identify a significant relationship between extension and covariates/potential predictors of outcome, including age, sex, hand dominance, occupation, history of trauma, previous surgery, workers' compensation status or the presence of ulnar nerve symptoms. Most of the potential predictors evaluated were not statistically significant for extension, except for capsulectomy/no capsulectomy and procedures

that were associated with poorer ROM at 6 weeks, when other variables were controlled. A separate independent sample *t*-test analysis of the effect of procedures on elbow extension showed no differences at 6 weeks ($p = 0.65$) and 12 weeks ($p = 0.25$).

The majority of potential predictors evaluated were not statistically significant for flexion with the exception of a history of procedures and previous surgery, which were associated with poorer ROM at 6 weeks. A separate analysis showed a significant difference in flexion at 6 weeks postoperatively between patients who had associated procedures versus those who did not (119° versus 125°, respectively) ($p = 0.009$). There was no significant difference at 12 weeks ($p = 0.417$). There were no significant differences in flexion between patients who had previous surgery (nine patients) versus patients who had not undergone prior surgery at 6 weeks ($p = 0.917$) and 12 weeks ($p = 0.777$) postoperatively.

The complication rate was similar for both groups ($p = 0.270$). Eight capsulectomy patients and 11

Figure 2. Change in flexion.

noncapsulectomy patients experienced complications: four patients developed asymptomatic heterotopic ossification, three patients had painful seromas, two patients had superficial cellulitis, two loose bodies were retained within a portal, two patients developed a superficial sensory nerve neurapraxia, one patient developed olecranon bursitis, one patient had a full-thickness tourniquet burn, one patient had ulnar neuritis, one patient developed adhesive capsulitis of the shoulder and two patients developed recurrent stiffness requiring repeat surgery or manipulation in the operating room.

The re-operation rate was similar for both groups ($p=0.850$). There were four early re-operations in both groups during the study period, one repeat arthroscopy for stiffness, one symptomatic retained loose body in the subcutaneous tissue of a portal, one manipulation under brachial plexus block, one anterior subcutaneous transposition and one posterior capsular release for loss of flexion postoperatively at 6 weeks.

Discussion

Arthroscopic debridement is effective in the treatment of patients with elbow OA.^{3,5–11,14} This may be conducted with or without an anterior joint capsulectomy. Arthroscopy and debridement without a capsulectomy provides satisfactory outcomes in the literature.^{5,9,13,14} The theoretical advantages of a more complete excision of the capsule include a greater restoration of motion by releasing a tether to elbow extension and preventing recurrence of the contracture by hypertrophic scarring of the retained capsule.¹⁰ Capsulectomies may also provide pain relief by partial denervation of the articular branches of the median, ulnar and radial nerve.^{2,7,15} Studies have shown the close proximity of

neurovascular structures to the capsule.^{16–19} In theory, capsulectomy may be associated with a higher risk of neurovascular injury than capsulotomy or preservation of the capsule as a result of the proximity of neurovascular structures to the capsule. Caution should be exercised during anterior capsulectomy. Proximal to the joint line, the radial nerve is more medial than previously thought and is relatively protected by the brachialis muscle, whereas the posterior interosseous nerve is in close proximity and at risk at the level of the radial neck.¹⁷ This should be taken into consideration when the radial head is excised. The surgeon may choose to leave some of the capsule in this area as a result of the proximity of the posterior interosseous nerve; however, the effectiveness of this with respect to mitigating the risk of iatrogenic neurological injury is unknown. We did not have any major neurological complications in our cohort; however, this remains an important risk of elbow arthroscopy that must be communicated to patients as part of the informed consent process.

In the present study, at 12 weeks follow-up, there were no statistically significant differences in ROM, complications and re-operation rates in patients with or without anterior capsulectomy for the treatment of primary OA. The incidence of complications in our series is comparable to that described in the literature.^{4,20} Gundlach and Eygendaal²¹ demonstrated no significant additional gains in ROM at 3 months, 12 months and 24 months after contracture release. Based on this information, we consider that 12 weeks provided satisfactory follow-up for the purposes of our study. In the group with capsulectomies, mean flexion improved from 123° pre-operatively to 130° at 12 weeks and extension improved from 36° to 19° at 12 weeks. Overall gain in ROM was 24°. In the group without capsulectomies, mean flexion improved from 127° to

132° at 12 weeks and extension improved from 28° to 21° at 12 weeks postoperatively. Overall gain in ROM was 13°. Although the capsulectomy group had less motion pre-operatively, differences in flexion and extension at 6 weeks and 12 weeks were not statistically significant. Patients with less pre-operative motion have a greater capacity for motion gains and the inclusion of stiffer patients in the capsulectomy group likely influenced the improvement in motion.

Adams et al.³ reported results similar to ours in 42 elbows after arthroscopic elbow debridement with complete capsulectomy at a mean of 44 months postoperatively. The mean gain in flexion–extension arc was 27°. In a review of 31 patients following arthroscopic debridement with a capsulotomy, Galle et al.⁵ only demonstrated a mean gain in flexion–extension arc of 22°. In another retrospective review¹⁴ of 25 patients without a capsulectomy, the average flexion–extension arc improved by 21°. In the present study, we found a similar degree of improvement in the flexion–extension arc of 19° overall (24° in the capsulectomy group and 14° in the group without a capsulectomy). The choice of capsulectomy was based subjectively on the surgeon's opinion about the ability of the patient to restore motion in light of the severity of the pre-operative contracture. The decision to perform a capsulectomy or capsulotomy reflected a gradual change in surgeons' practice with this procedure in some cases. It is now our opinion that capsulectomies are not routinely required in the management of primary osteoarthritis of the elbow. Before proceeding, we now evaluate ROM following bony debridement. If the recovery of ROM is not sufficient, we favour a capsulotomy because, in our experience, satisfactory recovery of motion is typically possible without performing a complete capsulectomy. For others, the decision to perform a capsulectomy was based on pre-operative discussion about patient preference for full ROM verses resolution of their locking and impingement pain symptoms. Patients with less severe contractures and a functional arc of motion may have been less likely to undergo capsulectomies.

Persistent flexion contracture $\geq 10^\circ$ to 15° in the absence of bony impingement intra-operatively was a determining factor in performing a capsulectomy. This may explain the differences in ROM pre-operatively between those patients treated with a capsulectomy and those who were not. Another explanation may be the technique of ROM testing and the error within that testing system. There was a difference of 8° in extension and 4° in flexion between the groups pre-operatively. Although this is a statistically significant difference, it may not be clinically significant. As a result of variability in intratester ROM measurements taken with a universal standard goniometer,

meaningful changes in motion should be considered if there is a change of greater than 6° for flexion and 7° for extension.²²

In the present study, patients who underwent a capsulectomy had greater pre-operative motion limitations. However, the decision to perform a capsulectomy was not solely a result of pre-operative ROM. The decision to perform a capsulectomy was based on patient goals and the ability to achieve full ROM with bony debridement. Patients with less joint motion have a greater capacity for recovery in ROM than patients with greater ROM. This is a confounding factor for differences in arc of motion between both groups postoperatively and could possibly overestimate the effect of capsulectomies. Krishnan et al.¹³ achieved more improvement in flexion–extension arc of 73° at a mean of 26 months than that found in the present study and other series reported in the literature;^{3,5,21} however, the loss of motion pre-operatively was more profound than our current series with a mean pre-operative arc of motion of 60°.

The present study is unique within the literature because we focused on arthroscopic debridement as a treatment for primary elbow OA, comparing groups with and without capsulectomy. The findings of the present study may not be generalizable to the treatment of other causes of restricted elbow ROM such as post-traumatic contracture. Hildebrand et al.¹² have demonstrated an association between increased numbers of myofibroblasts in the elbow capsule and post-traumatic elbow contractures. The capsule may play a more important role in post-traumatic elbow contracture than in patients with primary OA where the formation of hypertrophic osteophytes is likely the most important factor limiting motion.

CPM was not routinely prescribed in our cohort; it was typically used for patients with more severe stiffness pre-operatively. In a retrospective review by Lindenhovius et al.,²³ at 6 months follow-up, there was no difference in improvement in arc of flexion and extension (59° improvement in arc of motion in both cohorts) and patient outcomes between patients who had CPM versus those without. The postoperative regimen in the present study was individualized according to each patient's unique circumstance. Static progressive or dynamic splints were used in patients where there was residual stiffness at 2 weeks postoperatively.

The shortcomings of the present study include its retrospective design, the lack of physician or patient-rated outcome measures and the short-term follow-up at 12 weeks. The ROM may have differed if a longer-term follow-up evaluation was performed. Patient outcome scores and pain scores may help detect functional differences between both groups. In this series, our outcome measure was ROM at 12 weeks; however, final

motion has been shown to be a predictor of scores on the physician-based rating systems but not of upper-extremity-specific health status.²⁴ Our primary purpose was to assess early ROM in patients who had a capsulectomy versus those without. The decision to perform capsulectomies in this study reflects a change in surgeons' practices with time. During the present study, surgeons transitioned from routine capsulectomies to capsulotomies in the presence of contracture despite bone debridement. However, in some patients, based on pre-operative discussion, if the primary goal of surgery was not full ROM restoration but resolution of locking and impingement pain, the capsule was left intact after bony debridement, thus making direct comparisons between both groups challenging. This change in trend over time is another explanation for the baseline differences in pre-operative ROM between groups. The difference in pre-operative arc of motion between both groups was a confounding factor.

One of the strengths of the present study is that we only included patients with primary OA, unlike most studies of elbow debridement that have included mixed aetiologies. We also compared differences in outcomes according to the status of capsule. Furthermore, the patient demographic factors of both groups were similar. To our knowledge, the present study is the first to compare differences between patients with capsulectomies versus patients without capsulectomies during arthroscopic elbow debridement for primary OA.

Conclusions

In conclusion, arthroscopic elbow debridement, with or without capsulectomy, is a safe and effective procedure that improves elbow ROM. Although patients with capsulectomies had less motion pre-operatively, at 12 weeks of follow-up, motion was comparable in both groups. The present study suggests that the decision to proceed with a capsulectomy can be made at surgery depending on the motion gained after removal of osteophytes alone and pre-operative discussion with patients regarding goals of surgery. Although we did not observe a significant increase in complications when capsulectomy was performed, routine capsulectomy may not be required when performing arthroscopic debridement for primary OA of the elbow. This adds time and complexity to the procedure; however, there may be considerable gains in ROM in particularly stiff elbows.

Declaration of Conflicting Interests

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Ethical Review and Patient Consent

Institutional Review Board: Western University Health Science Research Ethics Board (HSREB); HSREB File Number: 107302.

Level of evidence

Retrospective Level III

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