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Elbow arthroscopy: early complications and associated risk factors

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Background: Elbow arthroscopy is increasingly used to treat complex pathology. The purpose of this study was to investigate early complication rates after elbow arthroscopy and identify risk factors for adverse events.

Methods: Consecutive elbow arthroscopies performed during a 13-year period were reviewed, identifying early perioperative complications. Major complications included deep infection, permanent nerve injury, or complications requiring additional anesthesia. Minor complications included superficial wound complications and transient nerve palsies. Complications were compared with a surgical complexity scale based on the procedure performed, the number of arthroscopic portals, and tourniquet time.

Results: Of 417 procedures, there were 37 minor (8.9%) and 20 major (4.8%) complications. The rates of superficial and deep infections were 6.7% and 2.2%, respectively. Major complications included 9 deep infections, 6 cases of heterotopic ossification requiring further surgery, and 4 manipulations under anesthesia. There were 7 transient sensory nerve complications, and no motor deficits. No differences in complication rates were seen between low-, moderate-, and high-complexity (10.2%, 16.3% and 14.4%, respectively) cases. Intraoperative steroid injections were strongly associated with postoperative superficial (14.1% vs 2.0%) and deep infection (4.9% vs 0.4%) in elbows receiving vs those not receiving steroid ($P < .0001$).

Conclusions: Complications of elbow arthroscopy are seen in approximately 14% of cases. Most complications are minor, not affecting clinical outcome. Major complications occur in 5% of cases, often requiring repeat surgery. Intraoperative postsurgical steroid injections are associated with increased risk of perioperative infections. Case complexity does not appear to affect the rate of complications with modern surgical techniques.

Level of evidence: Level IV, Case Series, Treatment Study.

Keywords: Elbow; arthroscopy; complications; infection

Elbow arthroscopy has seen a rapid expansion in its indications and applications recently despite the technical demands of the procedure. Decreased postsurgical pain, reduced arthrofibrosis, minimized infection risk, and easier postoperative rehabilitation are the driving forces behind

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this expansion in elbow arthroscopy. Along with the increase in use, a concomitant increase in the complexity of procedures and pathologies treated arthroscopically has also been observed. Complex procedures, such as total synovectomy, radial head resection, osteocapsular arthroplasty, and medial epicondylectomy, have been performed with increasing frequency in recent years.

With the growth in both popularity and complexity of elbow arthroscopy, concern regarding maintaining patient safety remains paramount. Although catastrophic neurologic complications have been reported, several outcome studies have established that elbow arthroscopy is a generally safe procedure when appropriate precautions are taken.[1,3-5,7,8,10,12,13,15,18]

Several authors have reported their experience with elbow arthroscopy; however, not since 2001 has there been a comprehensive review of the complications of this surgery in a large series of consecutive patients across multiple diagnoses and procedures.[8] Given the expanded indications and use of this procedure, the purpose of this study was to report the early complications of modern elbow arthroscopy and to identify potential risk factors for these complications. Through a retrospective review of a large series of consecutive patients, we analyzed early complication rates as they related to pertinent risk factors such as preoperative diagnosis, the use of postoperative antibiotic prophylaxis, and procedural complexity.

Materials and methods

During a 13-year period between 1999 and 2012, 3 orthopedic surgeons who had completed subspecialty training in shoulder and elbow surgery performed 510 elbow arthroscopies. Patient records were retrospectively reviewed to determine preoperative diagnosis, procedural specifics, and perioperative complications. We excluded 93 surgeries for lacking adequate follow-up (at least 2 visits in the first 4 weeks or a single visit between 4 and 6 weeks postoperatively). This left 417 arthroscopic procedures performed in 404 patients.

The following information was obtained from the electronic record: pertinent past medical history, prior surgical procedures performed on the affected elbow, preoperative flexion contracture, preoperative diagnosis, tourniquet time, preoperative and postoperative antibiotic prophylaxis, length of follow-up, and perioperative complications. Complications were further categorized as minor or major.

Minor complications were considered to be (1) superficial infections (cellulitis or prolonged drainage lasting 7 days or longer), (2) any wound complication not requiring surgical intervention (drainage, ganglion cyst formation, etc), and (3) transient sensory paresthesias. Major complications were defined as (1) deep or intra-articular infection resulting in surgical treatment, (2) neurologic sequelae resulting in any motor deficit (transient or permanent) or permanent sensory deficit, (3) compartment syndrome, (4) vascular injury, (5) loss of motion in the immediate postoperative period treated by manipulation under anesthesia, or (6) any outcome necessitating repeat surgery other than the natural progression of the disease. Two independent observers who did not participate in the surgical procedures compiled all data. Categorization of complications was determined by consensus between 2 authors.

Table I Elbow arthroscopy complexity scale*

Procedure	Points
Limited debridement (single compartment)	1
Extensive debridement (2 or more compartments: anterior, posterior and posterolateral)	2
Capsular release without boney resection	3
Osteocapsular arthroplasty (arthroscopic bony resection with capsular release)	4
Release of posterior band of MCL or medial epicondylectomy	+1
Tourniquet time	
≤60 min	0
60-90 min	1
>90 min	2
Portals	
≤2	0
3-4	1
>4	2
Complexity category	
Low complexity	0-3
Moderate complexity	4-5
High complexity	>5

MCL, medial collateral ligament.

* Procedural complexity scale for elbow arthroscopy consisted of 3 parameters: nature of the procedure, tourniquet time, and number of portals.

To aid in the analysis of risk factors, a complexity scale was developed (Table I) to stratify the perceived risk associated with each procedure. The factors contributing to the complexity scale (ranging from 1 to 9) included procedural specifics (scored as 1-5 points), tourniquet time (scored as 0-2 points), and number of portals used (scored as 0-2 points).

Elbow arthroscopy was performed in a consistent fashion with the patient in the lateral decubitus position and under general anesthesia. The operative shoulder was flexed to 90° and internally rotated. A holster was used to support the operative arm, allowing free elbow motion. The elbow joint was insufflated with 15 to 30 mL normal saline before portal placement. Most often, the proximal anteromedial portal was created first, unless there had been a previous ulnar nerve transposition. In this instance, the medial portal was established initially after dissection and identification of the ulnar nerve, or more commonly, the proximal anterolateral was created initially. In all cases, anterior portals were established with the elbow flexed.

The number of portals was determined by the procedure and concomitant pathology. Accessory anterolateral portals were frequently used in more complicated cases for placement of intra-articular capsular retractors. Arthrotomy was performed to aid treatment if visualization deteriorated, the extent of disease precluded safe arthroscopic surgery, or tourniquet time was exceeded. Patients with contractures associated with loss of flexion motion (approximately 100°-110°) routinely underwent open decompression of the ulnar nerve and release of the posterior band of the medial collateral ligament. Portals were closed with nylon sutures, and sterile dressings were applied. Extension splints were used selectively in patients with advanced flexion contractures.

Statistical calculations were performed using SAS/STAT9.3 software (SAS Institute, Cary, NC, USA). For all comparisons, an α level of 0.05 was chosen to represent statistical significance. Proportional comparisons comprised all measures for this study and were performed with the χ^2 or Fisher exact tests.

Results

Of the 417 procedures, 281 (68%) were performed in males and 136 (32%) in females. One hundred and fifty seven (38%) of the procedures were performed in the left elbow. The study cohort had an average age of 43.4 years. The most common procedure was arthroscopic osteocapsular arthroplasty (186 [45%]) for primary or post-traumatic osteoarthritis. Simultaneous open procedures were performed in 68 elbows (16%). Most open procedures were performed in high-complexity arthroscopies (51%), with 36% in moderate-complexity and 12% in low-complexity cases. The most common simultaneous open procedures were posterior arthrotomy for bony resection or loose body removal (n = 16), in situ ulnar nerve decompression, transposition, or medial epicondylectomy (n = 23), and hardware removal (n = 9). The average tourniquet time was 71 minutes (range, 12-142 minutes).

Complications

The rates of major and minor complications in the early postoperative period were 4.8% and 8.9%, respectively. Deep infections requiring surgical irrigation and drainage were the most common major complications (2.2%), and prolonged wound drainage/superficial infection (6.7%) was the most frequent minor complication.

Despite frequent concerns regarding neurologic complications, nerve injuries were quite rare. Transient neurologic symptoms occurred in 7 elbows (1.7%), comprising 5 radial sensory, 1 median sensory, 1 sensory unspecified. No neurologic injuries leading to a motor deficit or permanent neurologic injury were seen (excluding 1 cutaneous neuroma). Ten elbows underwent arthroscopic medial epicondylectomy for the treatment of cubital tunnel symptoms. Although ulnar nerve symptoms were not completely resolved in the perioperative period, no new nerve injuries were seen, and no increase in ulnar nerve symptoms or objective worsening ulnar nerve motor deficits were seen.

The remaining isolated minor complications included 2 elbows with portal-site ganglion cysts. Ganglion cysts were seen in another 4 patients also having a minor complication of superficial wound infection; however, each elbow was only counted once as a minor complication. All 20 of the major complications necessitated repeat surgical intervention. Nine were secondary to deep infection, 6 for excision of symptomatic heterotopic ossification, 4 for manipulation under anesthesia, and 1 for excision of symptomatic ossification within the triceps tendon. The 4 elbows that underwent manipulation had early loss of elbow motion compared with intraoperative gains despite ongoing physical therapy or bracing techniques, or both.

Procedural complexity

As assessed by the elbow arthroscopy complexity scale, 127 procedures were considered low complexity, 117 were of moderate complexity, and 173 were graded as high complexity (Table II). Women were more likely to have a low-complexity procedure (54% low vs 16% high) compared with men (19% vs 54%, $P < .0001$). This was primarily due to the strong male predominance of elbow osteoarthritis. Patients with previous elbow surgery were more likely to have a higher complexity score than those without (42% vs 41% high, 41% vs 23% moderate, and 16% vs 36% low complexity, respectively; $P < .0001$).

The rate of minor complications associated with procedural complexity did not reach statistical significance ($P = .20$; Table III). There was no significant difference in rates between the 3 classes of complexity for major complications ($P = .94$). The rates of superficial and deep infections were, respectively, 3.2% and 3.9% for minor-complexity cases, 8.6% and 2.6% for moderate-complexity cases, and 8.7% and 0.6% for high-complexity cases. Surgical complexity classification was not associated with the risk of superficial or deep infection ($P = .14$).

Antibiotic prophylaxis

Patients routinely received preoperative antibiotic prophylaxis (1 or 2 g, >70 kg body weight) of intravenous cephazolin. Patients with relevant allergies received 1 g intravenous vancomycin preoperatively. Data on postoperative antibiotic prophylaxis was available in 374 of 417 patients (90%). Several oral antibiotic regimens were used postoperatively based on surgeon preference. These included oral cephalexin or clindamycin. Duration of oral antibiotic treatment also varied between 5 days and 2 weeks after surgery. For analysis, patients were divided into 3 groups: group 1, no prophylactic oral antibiotics; group 2, 5 to 10 days of antibiotics; and group 3, 12 to 14 days of antibiotics.

Postoperative oral antibiotics usage had no effect on the rate of postoperative infection ($P = .46$). Patients receiving no postoperative prophylaxis displayed a 5.0% rate of superficial and a 3.0% rate of deep infections. Oral antibiotics usage for 5 to 10 days also had a similar rate (7.1%) of minor infectious complications, and no deep infections were seen. Antibiotic prophylaxis for 12 to 14 days was associated with similar rates of superficial (8.6%) and deep infectious (3.5%) complications.

Intraoperative steroid injections

A total of 162 patients (39%) received an intra-articular steroid injection of triamcinolone (40 mg) at procedure completion. There was a significant association of intra-articular steroid

Table II Procedures by complexity category*

Category	ECRB release	Limited debridement	Extensive debridement	Capsular release	OCA	Other	Total (n = 417)
1 (low), No.	79	13	23	5	4	3	127
%	62.20	10.24	18.11	3.94	3.15	2.36	
2 (moderate), No.	13	1	36	25	36	6	117
%	11.11	0.85	30.77	21.37	30.77	5.13	
3 (high), No.	2	1	10	13	146	1	173
%	1.16	0.58	5.78	7.51	84.39	0.58	

ECRB, extensor carpi radialis brevis; *OCA*, arthroscopic osteocapsular arthroplasty.
* Breakdown of procedural complexity category vs nature of surgery.

Table III Complications vs complexity category*

Complexity category	Minor complications	Major complications	Total (n = 57)
1 (low), No.	7	6	13
%	5.5	4.7	
2 (moderate), No.	14	5	19
%	12.0	4.3	
3 (high), No.	16	9	25
%	9.2	5.2	
$P^{\dagger}$	.20	.94	

* Rates of minor and major complications compared with surgical complexity.
† *P* values determined by χ^2 analysis.

exposure to postoperative infectious complications ($P < .0001$). A superficial infection developed in 14% (23 of 162) of patients compared with 2.0% of those not receiving steroids. Deep infections were seen in 4.9% of elbows that received steroids vs 0.4% that did not. Of the 9 elbows that developed a deep infection, 8 had received a steroid injection.

When we looked at the effect of intraoperative steroid use on the development of symptomatic heterotopic bone formation after surgery, a significant relationship was seen. Of the 255 patients who did not receive a steroid injection, 7 (2.5%) developed symptomatic heterotopic ossification, whereas none of the 162 patients who received steroids developed this complication ($P = .046$).

Preoperative comorbidities

The following preoperative comorbidities were examined for associations with minor and major complications: preoperative contracture, prior elbow surgery, and a history of rheumatoid arthritis. Preoperative contracture was defined as total flexion-extension arc loss of 30° (normal arc, 0°-145°). Contracture was not associated with increased risk for minor (n = 15, 9.4% vs 8.6% without contracture; $P = .75$) or major complications (n = 10, 6.3% vs 3.5%; $P = .18$).

In our series, 121 patients (29%) had undergone prior surgery on the operative elbow. Prior surgery was not associated with an increased incidence of major complications (6.6% vs 3.7%, $P = .20$) or minor complications (12% vs 7.8%, $P = .22$). The rates of infection also were not significantly different between those with previous surgery (superficial rate, 9.1%; deep rate, 2.5%) compared with those without surgery (superficial rate, 5.8%; deep rate, 1.7%; $P = .40$).

Rheumatoid arthritis was examined as a potential risk factor in our series. We identified 13 patients with a medical history of rheumatoid arthritis. These patients had no perioperative complications.

Discussion

In the last decade, elbow arthroscopy has become increasingly popular for the management of a variety of elbow disorders. As the indications have expanded, the complexity of the cases has increased accordingly. Theoretically, this produces concern of a concurrent increase in the risks of complications. This retrospective study was performed to further delineate the risk of complications and to correlate the prevalence of complications to case complexity. There exists a need for continuous review of this and other surgical procedures as technology changes and surgical indications expand. Indeed, the most recent large series reviewing elbow arthroscopy complications was published more than a decade ago.[8]

This study demonstrates that complications of elbow arthroscopy are not infrequent; however, most are treatable. Overall, 8.9% of the patients sustained a minor complication, and 4.8% had a major complication in the immediate postoperative period. Our rate of minor complications compared favorably with the largest series of elbow arthroscopy complications to date, which was 11%.[8] Similar to that study, our most frequent minor complication was superficial wound infection/persistent drainage. In most cases, treatment consisting of oral antibiotics and immobilization of the elbow was successful. In 9 patients (2.2%), however, a deep infection was felt to be present as manifested by prolonged wound drainage after initial treatment or clinical signs of joint sepsis, or both. Our rate of deep infection was greater than the 0.8% reported by Kelly et al.[8] The reason for this is unclear and should be interpreted with caution given the

potential variances in the diagnosis of a deep infection between studies; this was not standardized in either study. We did not routinely rely on joint aspiration results or laboratory values; rather, we used an index of clinical suspicion, which was high in patients with persistent wound drainage. Like Kelly et al, we also found a strong association between the use of intraoperative steroid injections and infectious complications. However, surgical complexity and a history of prior surgery were not associated with postoperative infection. Interestingly, we did not find any protective value in the use of prophylactic oral antibiotics in the postoperative setting.

We defined major complications as an adverse event that required a repeat surgery or general anesthetic (manipulation). Our rate of major complications was greater than that in the Kelly series. In addition to a higher rate of presumed deep infection, we noted 6 elbows with pathologic periarticular ossification. In the Kelly series, heterotopic ossification was seen in only 2 elbows. These differences may be explained by the nature of the surgical procedures. In our series, all instances of heterotopic bone formation developed after osteocapsular arthroplasty. This procedure may predispose the elbow to heterotopic ossification given the extensive bone debris generated by removal of osteophytes (often with a burr) combined with the soft tissue trauma of capsular releases; however, this is uncertain. Although attempts were made to routinely remove all bone debris, this could not be evaluated objectively. Lastly, 4 patients underwent a postoperative manipulation for excessive stiffness early after surgery, a complication not reported in the Kelly series. Caution is warranted in interpreting differences in this complication, because the indications for postoperative manipulation were not standardized; however, the findings in our study do raise concern.

One of the clear differences in complications in the present study compared with previous research is the risk of operative nerve complications. Postoperative nerve injuries after elbow arthroscopy have ranged from 0% to 14% in previous reports.[2,6,9,11,14,17,19] Schneider et al[16] noted 7 temporary nerve injuries complicating 67 procedures. In our series, 7 patients (1.7%) sustained a neurologic injury, all of which resolved completely. We encountered no nerve injuries that resulted in a motor deficit or permanent sensory deficit. Our rate of neurologic injury was similar to the Kelly series (12 of 473 cases [2.5%]). Although the risk of nerve injury is higher in the elbow than in the shoulder and knee, most are transient problems with a good chance of full resolution.[1,5,8,18]

It should be noted that we had a number of patients with preoperative cubital tunnel syndrome. Most of these patients were treated with open surgical techniques (decompression or transposition) performed after the arthroscopic procedure. In some cases, persistent ulnar nerve symptoms were seen in patients who underwent a concomitant open nerve procedure. We believe we are justified in excluding these patients as nerve complications because no new nerve injuries were seen and the primary aim of this study was to examine risks of complications of elbow arthroscopy. We do recognize that this should be considered a limitation of the study, because one cannot clearly ascertain whether the persistent nerve symptoms were related to surgery (either an open or arthroscopic procedure). Importantly, we found no instances of new-onset or worsened ulnar nerve symptoms from an all-arthroscopic procedure, including contracture releases. Of note, patients with a severe loss of elbow flexion also underwent ulnar nerve decompression, which helps to explain the absence of ulnar nerve complications in individuals with advanced contractures.

We also examined complications of elbow arthroscopy with a procedural complexity scale. Interestingly, we found no significant correlation with case complexity and the risk of complications. This phenomenon was also seen in the Kelly series,[8] where more recent and more complex cases were not associated with an increased risk of nerve injuries. We believe that the use of contemporary surgical techniques in the hands of experienced surgeons helps to minimize the risk of complications with higher-complexity cases, but caution should be given in applying our data to less experienced surgeons.

Intra-articular steroid injections in this study were clearly related to a higher risk of infectious complications but seemed protective in preventing the formation of symptomatic ossification. On the basis of our findings, the routine use of intra-articular steroids cannot be recommended for patients undergoing elbow arthroscopy. However, selective use of steroids may be warranted in those deemed high risk for the development of heterotopic ossification. All cases of symptomatic postoperative heterotopic ossification in this series were seen in patients undergoing arthroscopic osteocapsular arthroplasty. In such cases, perioperative heterotopic ossification prophylaxis may be considered, such as oral anti-inflammatory medications, but must be weighed against associated risks for individual patients.

There are several study limitations that warrant discussion and are primarily related to the retrospective nature of the study. This study consisted of a record review of a large number of patients. We made all attempts to include only patients with reliable data. This resulted in a large number of potential patients who were excluded, mostly due to inadequate follow-up.

In addition, the length of follow-up for this study was short because the purpose of this study was to define the risks of perioperative complications. We recognize the potential to miss evolving complications that may not be present in the immediate perioperative period. We do believe, however, that the time frame chosen was adequate to define the major complications of infection and immediate nerve injuries commonly recognized to have higher risk with elbow arthroscopy. The patients who were discharged at 6 weeks were clinically improved and doing well.

We defined complications in a manner that made clinical sense; however, differing thresholds for intervention may have existed in this study compared with others, which

would have a direct reflection on our complication rates. We chose a low threshold for the diagnosis of a superficial infection and are confident that our numbers represent a worst-case scenario. The use of steroid injections and antibiotic prophylaxis was not controlled. Goniometric measures of range of motion were not routinely performed in the early postoperative setting. Therefore, the decision to intervene with manipulation under anesthesia was made subjectively. It is also likely that the rate of heterotopic ossification was underestimated, because routine postoperative elbow radiographs were not obtained. However, we do believe that we correctly captured clinically relevant heterotopic ossification because radiographs are routinely performed in patients with significant loss of motion after surgery.

We created a new classification system for surgical complexity; however, the validity of our scale has not been established.

Finally, the surgeons participating in this study had subspecialty training and extensive experience with elbow arthroscopy; therefore, the results of this study should be interpreted with caution and may not be applicable to less experienced surgeons.

Conclusions

In this retrospective review of early complications after elbow arthroscopy, our complication rates were comparable to previous reports, and complications were usually manageable. Most commonly, complications were related to wound healing and infections. The use of intraoperative steroid injections appears to increase the risk of these infectious complications and, therefore, should not be used routinely. Our findings did not demonstrate a significant relationship between procedural complexity and general or specific complications. Nerve injuries were relatively uncommon and transient in nature despite a high percentage of complex cases.

Disclaimer

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