First 50 Pediatric and Adolescent Elbow Arthroscopies: Analysis of Indications and Complications

Patrick Vavken, MD, MSc,† Andreas M. Müller, MD,* and Carlo Camathias, MD**

Background: Elbow arthroscopy is a challenging, yet extremely productive procedure in orthopaedic sports medicine. The severely confined anatomy of the pediatric and adolescent elbow is particularly prone for perioperative complications. This study focuses on the indications and complications of the first 50 elbow arthroscopies in skeletally immature patients done in a specialized pediatric orthopaedic department.

Purpose: To review analysis of indications and complications in pediatric and adolescent elbow arthroscopy. We hypothesized that the complication rate in these patients is similar to adults.

Methods: Data on 50 consecutive elbow arthroscopies were prospectively gathered in a dedicated database and retrospectively analyzed for indications and perioperative complications. All procedures were performed by a surgeon trained in orthopaedic sports medicine.

Results: A total of 26 boys and 24 girls with a mean age of 13.6 ± 3.3 years at the time of surgery and a minimum follow-up of 1 year were included. Fifty-eight percent were treated for osteochondritis dissecans, 24% for arthrofibrosis, 14% for a congenital disorder, and 4% for a posttraumatic problem other than arthrofibrosis. The complication rate was 8%, including 3 cases of transient neuropraxia and 1 superficial wound infection. There were no major complications such as septic arthritis, vascular injury, or permanent nerve damage. All complications resolved fully with conservative treatment, no revision were required.

Discussion: Although osteochondritis dissecans is still the leading reason for such surgery, fractures and posttraumatic conditions are becoming more important. With a rate of 5% to 8% of minor, fully resolving complications such an increase is not a reason for concerns.

Level of Evidence: Level IV—case series.

Key Words: elbow, arthroscopy, outcomes, complications, immature

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From the *Department of Orthopedic Surgery, University Children's Hospital Basel, Basel, Switzerland; and †Division of Sports Medicine, Boston Children's Hospital, Harvard Medical School, Boston, MA.

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Reprints: Patrick Vakven, MD, MSc, Division of Sports Medicine, Boston Children's Hospital, Harvard Medical School, 319 Longwood Ave, Boston, MA 02115. E-mail: patrick.vavken@childrens.harvard.edu.

The elbow has long been considered a joint that is not amenable to arthroscopic procedures. Burman was the first to visualize the anterior compartment in a cadaver study in 1932.[1] It took >50 years until the first in vivo elbow arthroscopy by Andrews and Carson in 1985.[2] The main reasons that deterred surgeons back then, and still dissuade many today, are the relatively small size of the joint and the absolutely high density of neurovascular structures.[3,4] This is particularly true in the pediatric and adolescent patient, where spatial relations are even closer and the growth plate poses another structure at risk.

However, pediatric and adolescent patients benefit in 2 ways from arthroscopic procedures.[5] First, with increased participations in organized and competitive sports, diagnoses amenable to arthroscopic repair are steadily increasing in patients younger than 18 years of age, in addition to the treatment of traumatic and posttraumatic conditions. Second, with arthroscopy, these problems can be treated effectively with reduced postoperative morbidity, decreased inflammatory response, and accelerated rehabilitation.

The aim of this study was to review the indications and complication rate in the first 50 elbow arthroscopies in pediatric and adolescent patients done consecutively at a specialized, tertiary-care center in Northern Switzerland.

PATIENTS AND METHODS

The operative database of the University Children's Hospital Basel was searched for the first consecutive elbow arthroscopies performed in patients 18 years of age and younger. Patient charts, as well as a dedicated research database that prospectively collects patient data for all orthopaedic procedures, were reviewed. IRB review for chart review was given.

Surgical Technique

All procedures were done in general anesthesia. Preoperative antibiotics were given at the discretion of the treating physician. Patients were treated in supine position with the arm held in flexion for anterior procedures and draped over the body for posterior scope, without suspension or arm holding devices. A sterile tourniquet was placed high on the upper arm for potential emergency use.

The procedure was started by distention of the joint through the soft spot[6] with 10 to 20 mL of saline solution and a backflow test. To access the anterior compartment, a proximal anteromedial portal was created as a viewing portal using a nick-and-spread technique. Depending on

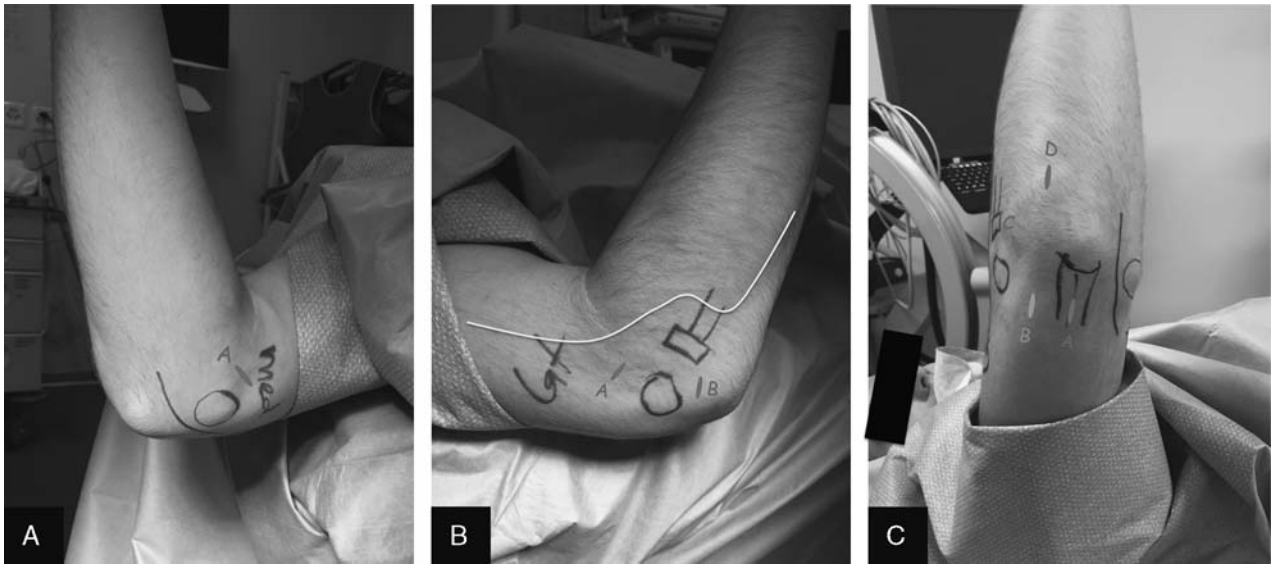

FIGURE 1. Shows the portals used. A, The anteromedial portal placed 1 cm proximal and 1 cm anterior of the medial epicondyle. The ulnar nerve is palpable and should be tested for subluxation and marked. If the nerve is mobile, the portal could be established closer to extension. B, The lateral portals. The radial nerve (white line) cannot be palpated, but its course should be memorized. The proximal anterolateral portal (A), 1 cm proximal and 1 cm anterior of the lateral epicondyle, allows access to the anterior compartment. It can be used as the initial portal instead of the anteromedial portal at a slight increase in risk for neurovascular injury.[8] The soft spot portal (B) allows access to the posterolateral joint. The posterior interosseus nerve crosses the radial neck on average 3 cm distal from the radiocapitellar joint line.[9] C, The posterior portals. A is the transtricipital portal that aims for the olcranon fossa. B is a posterolateral portal that can be established along the lateral edge of the triceps tendon. Care should be taken with this portal in skeletally immature patients as it can violate the radial recurrent artery leading to avascular necrosis of the lateral epicondyle and capitellum.[10] We have come to avoid this portal for this reason. C is the soft spot portal. D is the distal ulnar portal described by van den Ende et al,[7] which allows perpendicular access to the capitellum.

patient size a standard 4 mm or a smaller 2.8 mm, 30-degree scope was used with a pressure controlled pump (FMS duo; DePuy Mitek Inc., Raynham, MA) set to 40 mm Hg at a flow rate of 20 mL/min. The second, anterolateral portal was placed under direct vision with an 18-G needle. The skin and capsule were incised with a #11 blade under direct vision. A 3.5-mm shaver was used with passive backflow, avoiding direct suction. To access the posterior compartment, direct transtricipital and posterolateral portals were used, the lateral gutter/posterolateral plicae were approached via a soft spot portal. For microfracture or drilling of a capitellar osteochondritis dissecans (OCD) lesion, a distal ulnar portal was used.[7] All portals are depicted in Figure 1. All procedures started with a diagnostic arthroscopy of the whole elbow, followed by focused therapeutic arthroscopy of the affected anatomy.

Postoperatively, all portals were closed using absorbable sutures and a sterile dressing was applied. Postoperatively, immediate active and passive motion, as tolerated, was encouraged for all patients.

Analysis of Indications

Our first analysis pertains to indications for elbow arthroscopy. We defined 4 groups of indications: (1) osteochondritis dissecans; (2) reduced elbow motion or arthrofibrosis, defined as >15 degrees lack of extension or <100 degrees of flexion; (3) posttraumatic conditions other than arthrofibrosis; and (4) congenital or perinatally acquired problems, including cerebral palsy. The last group relates to the fact that our institution has a strong neuroorthopaedic group. Given the limited sample size of the population, we refrain from formal inferential statistics, but still compared age, sex, and affected side across the 4 groups with analysis of variance.

Analysis of Complications

All charts were reviewed independently and in duplicate to collect data on surgical indication, postoperative diagnosis, and complications. Complications were graded as minor (transient neuropraxia, delayed wound healing), major (persistent nerve damage, ligament injury, or infection).[11] We assessed the average loss of extension as well as range of motion postoperatively for all patients treated for arthrofibrosis. Length of stay was not collected as an endpoint as this is a multifactorial variable in pediatric patients in a socialized medicine system. Outpatient records were reviewed up to 1 year postoperatively to search for further documented complications related to the arthroscopic procedure of the elbow. Again, we did not pursue statistical analysis for this small population.

RESULTS

Patients

Fifty elbow arthroscopies were performed in 50 patients, 26 boys and 24 girls with a mean age of 13.6 ± 2.3 years (range, 9 to 18 y) at the time of surgery. Nineteen patients (38%) were treated for a problem of concerning the left elbow, 31 (62%) the right elbow. Twenty-five boys and 24 girls had hospital records for at least 1-year follow-up, for 1 patient only 11 months are recorded.

Analysis of Indications

Our first analysis pertains to indications for elbow arthroscopy. Twenty-nine (58%) of the 50 included patients were treated for osteochondritis dissecans. Twelve patients (24%) were treated for arthrofibrosis or reduced range of motion. Seven patients (14%) were treated for a congenital disorder, and 2 (4%) for a posttraumatic problem other than arthrofibrosis. Table 1 presents the data on age, sex, and side treated across the 4 groups. There was a borderline difference in age across groups at a *P*-value of 0.052, based on the substantially older age in the posttraumatic group, that is, 18 versus 13 years on average. There was no difference in sex ($P = 0.78$) or side treated ($P = 0.10$).

Analysis of Complications

We observed 4 perioperative complications, including 3 cases of transient neuropraxia and 1 superficial wound infection. Thus, the overall risk of a perioperative complication was 8% (95% confidence interval, 1% to 16%).

The neuropraxia cases involved the superficial branch of the radial nerve, the ulnar nerve, and 1 case of diffuse dysesthesia in the forearm.

The radial nerve neuropraxia occurred in a 15-year-old, male patient undergoing loose body removal due to OCD of the capitellum. A sizeable intra-articular fragment (approximately 6 × 8 mm) was found but required an extended anterolateral portal. Our estimate is that between manipulation and extension of the portal the radial nerve was offended.

The ulnar neuropraxia occurred in a 10-year-old female suffering from arthrofibrosis. Postoperatively, the flexion of the elbow increased from 80 to 120 degrees. Extension improved from 25 to 10 degrees lack of extension and might as well have been due to traction secondary to newly gained range of motion rather than through direct trauma.

The diffuse neuropraxia occurred in a 14-year-old female with arthrofibrosis after immobilization for OCD of the capitellum at an outside institution. The OCD healed well, but the prolonged immobilization caused a reduction in range of motion, which was treated with arthroscopic arthrolysis and mobilization under anesthesia. All nerve complications resolved with conservative treatment during the initial 24-week follow-up.

The wound infection was associated with a concomitant osteotomy of the distal humerus for a posttraumatic varus deformity, and did not spread to deeper tissue layers. Hence, we graded this event a minor complication. The patient had received preoperative antibiotics, and his wound infection resolved without further complications or revision surgery under a 2-week course of oral coamoxicillin. Those patients undergoing arthroscopy for arthrofibrosis had an average loss of extension of 7.1 ± 4.7 degrees and a mean flexion of 120.0 ± 14.1 degrees at the final follow-up.

DISCUSSION

Using standardized portals and technique, elbow arthroscopy has a low complication rate in a pediatric and adolescent population, and is no more risky than in adults. The most common indication by far for elbow arthroscopy in the studied population was osteochondritis dissecans.

Our study had some limitations. First, as a retrospective study without a control group, the inferential power of this study is limited. That is why we decided to use mostly descriptive statistics. Second, at our institution we treat an urban and suburban, central European population of children. Given regional differences in sports participation and types of sports played, the external validity of our study for other countries is limited. Finally, there are some differences in "surgical culture," with the local customs of these researchers being somewhat more aggressive than others. For example, our

TABLE 1. Indications and Complications

	Osteochondritis Dissecans	Range of Motion	Congenital Disorders	Posttraumatic Condition
N	29	12	7	2
Mean age (SD)	13.8 (2.1)	12.3 (4.8)	13.6 (2.9)	17.0 (1.4)
Male (%)	62	42	57	50
Female (%)	38	58	43	50
Right elbow (%)	66	58	57	50
Left elbow (%)	34	42	43	50
Complications [n (%)]	1 (3)	2 (17)	0 (0)	1 (50)
Description of complications	Transient radial nerve neuropraxia	Transient ulnar nerve neuropraxia, transient diffuse neuropraxia	—	Superficial wound infection after corrective osteotomy for posttraumatic cubitus varus

cutoff of 15 degrees of extension deficit for elbow arthrolysis is lower than those published elsewhere.[12,13] But if anything, this means that our complication rates should be higher, thus giving a more conservative estimate for others.

Two studies out of Boston Children's Hospital address the issue of indications for elbow arthroscopy in pediatric and adolescent patients. Micheli et al, in 2001,[14] report on the indications and outcomes for 49 elbow arthroscopies in patients younger than 17 years. Fifty-five percent of these patients were treated for osteochondritis dissecans, 18% for arthrofibrosis, results which are very comparable to our findings of 58% and 24%. They report good postoperative outcomes at 2-year follow-up as measured by a modified Andrews Elbow Scoring System, but—compared with our patients—no complications at all. This might be attributed to the somewhat higher number of arthrofibrosis cases in our population, which are more complication prone than OCDs. Siparsky and Kocher, in 2000,[5] reported that elbow arthroscopy is a valuable and productive tool in the diagnosis and treatment of cartilage injuries. Recently, trauma has gained a more prominent role in the list of indications for pediatric elbow arthroscopy.[5,15] Fractures of the lateral humeral condyle are of particular interest because of their relatively high incidence—being the second most common elbow injury in children—and the risks associated with formal open reduction internal fixation, such as avascular necrosis if one strays too posterior or posterolateral rotation instability if one strays to inferior. Both Hausman et al[15] and Perez Carro et al[16] suggest arthroscopic reduction and internal fixation, using the hematoma for joint capsule distension and anatomic reduction under direct vision.

Complication rates for elbow arthroscopy have been described for adult patients in earlier papers. Marti et al[11] described the perioperative complications in the first 100 elbow arthroscopies by a single surgeon and reported 6 minor complications in 5 patients, or a complication risk of 5%. This is very consistent with our findings of 8% minor complications. The study by Marti and colleagues is of particular interest for us as it was performed in very close geographical and cultural proximity to our institution. Elfeddali et al[17] offer data on a group of 200 elbow arthroscopies performed by a single surgeon with a rate of minor complications of 7.5%, which is virtually identical with our findings. The largest study on complications of elbow arthroscopy was published by Kelly et al[12] including 473 procedures in 449 patients done by 12 different surgeons. Minor complications occurred in 11%, but resolved without sequelae between 24 hours and 6 weeks. This paper is the only to report major complications, that is, 4 intra-articular infections at a complication risk of 0.8%. Only one of these 4 patients received prophylactic antibiotics before surgery, but all were treated successfully. More recently, Nelson et al[13] published a study of 417 elbow arthroscopies with a complication rate of 9% for minor complications, and 5% for major complications. The most frequent complication in those large series was persistent wound drainage.[12,13] To the best of our knowledge, our study is the first to specifically assess the perioperative complications of elbow arthroscopy in pediatric and adolescent patients, but our findings are very consistent with the adult literature.

What stands out from the literature is that a few guidelines, if followed rigorously, will help to avoid most complications. Intricate knowledge of the elbow anatomy as well as portal location is one crucial prerequisite.[3,4] Verhaar et al[8] were able to show that starting the procedure anteromedially reduces the risk of nerve injury compared with starting anterolaterally. Placing portals more proximal, be it lateral or medial, further reduces the risk of nerve damage.[18,19] Still, one should make sure to palpate and hold out of place the ulnar nerve when placing the incision for the anteromedial portal.[20] Many elbow surgeons in Switzerland have made it a habit to incise the skin only, then to palpate the medial intermuscular septum by swiping a straight clamp perpendicularly across at least twice before penetrating deeper through the flexors and brachialis (https://jomi.com/article/12/elbow-arthroscopy/). The radial nerve cannot be palpated, but its course is well described.[9] The importance of joint distension before portal placement is well recognized since the landmark paper by Miller and colleagues, but this can also be achieved by the intra-articular hematoma in fracture cases.[4,15] From the study by Kelly et al[12] we know that arthrolysis is associated with a higher risk of nerve injury, and facing the shaver blade away from the capsule is of paramount importance. Level V evidence also suggests to avoid pump pressures in excess of 50 mm Hg and to opt for passive outflow from the shaver rather than suction. From the group of Marti et al[11] we know that overzealous manipulation of the arthroscopic instruments can lead to nerve injury with direct compression across the soft-tissue envelope, such as median nerve neuropraxia from pushing an instrument in the medial portal too hard. Thus, maybe somewhat counterintuitively, the soft-tissue damage of an extra portal might be less risk prone than overreaching from a preexisting one. Finally, both Kelly et al[12] and Nelson et al,[13] looking back on almost 1000 elbow arthroscopies, have shown that intraoperative steroid injections are an important risk factor for intra-articular infections.

CONCLUSIONS

In summary, elbow arthroscopy can be done in pediatric and adolescent patients with a similar complication rate as in adults. At a rate of minor, fully resolving complications of 5% to 8% such an increase is not a reason for concerns, but strict adherence to the established techniques and portals will be essential in keeping major complications at bay.

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