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Anterior elbow release for post-traumatic flexion contractures in patients 21 years or younger

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Hypothesis and background: An elbow contracture in a young person can be a devastating problem. Significant contractures will lead to functional loss of the extremity. Appropriately performed contracture release can have profound implications on the overall well-being of the patient. The purpose of this study was to report improvements in sagittal-plane range of motion and the complication rate following an anterior elbow release for flexion contractures in patients 21 years or younger.
Methods: We performed a retrospective review of 27 patients with a median age of 16.8 years who were treated surgically for elbow flexion contracture with an anterior approach. Follow-up was possible in 18 of these patients at an average of 31 months. An anterior approach was performed in all 18 patients, with 4 patients undergoing an additional posterior incision to address posterior structures limiting extension.
Results: Elbow extension improved by an average of 35°, from –54° to –19°. The mean total arc of elbow motion improved by 37°, from 65° to 102°. Two complications occurred: traction-related neurapraxia of the lateral antebrachial cutaneous nerve and transient neurapraxia of the posterior interosseous nerve.
Discussion and conclusion: Elbow contracture release through an anterior approach is an acceptable surgical option. Significant improvement is obtained with a low risk of complications.
Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Elbow; flexion contracture; capsulotomy; continuous passive motion; pediatric; arthrofibrosis

There are many well-known causes of diminished elbow motion in the pediatric population, including local trauma, muscle imbalance, congenital dislocation, thermal burns, inflammatory arthropathies, hemophilia, and sepsis. The majority of these elbow contractures occur after a traumatic event. An elbow contracture can leave a child with a profound functional limitation. Initial nonoperative techniques such as supervised physical therapy and splinting can be effective for improving motion in cooperative patients.[6,11,13] Patients with persistent functional impairment after exhaustion of nonoperative measures are candidates for an operative intervention.

Several surgical approaches for release of flexion contractures have been reported for the adult population, with encouraging results.[1,3-5,7-10,12,14,16,20,22-24] Surgical correction through an anterior approach has proved effective in the adult population.[1,3,5,22] Only a few articles have discussed

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the surgical treatment of elbow contractures specifically within a pediatric subset. None of the studies used an anterior incision to surgically treat the elbow contracture. Therefore, the purpose of this study was to report a single surgeon's experience with an anterior elbow release for flexion contractures in patients 21 years or younger.

Materials and methods

We retrospectively reviewed the charts and records of all consecutive patients surgically treated for an elbow contracture during a 27-year period. Of the 106 patients reviewed, 27 were 21 years or younger at the time of surgery. Of these 27 patients, 9 were lost to follow-up and were therefore excluded from the study, leaving 18 patients for review. Of the 18 patients, 11 underwent a total of 13 prior procedures, either for initial treatment of their injury, for removal of hardware, or as an attempt to regain motion. None of these prior procedures were capsular releases. Etiologies, additional procedures performed at the time of the index operation, and preoperative and postoperative elbow range-of-motion data are outlined in Table I. Data regarding follow-up range of motion in these patients were included only when the measurements were performed at our institution, using a large goniometer (47 cm in length, 5.5 cm from center axis to increment markings), by the senior author. Our surgical indications included an elbow flexion contracture greater than 20° with a subjective assessment that the contracture impaired elbow function. Surgical indications included patients with functionally limiting contractures recalcitrant to nonoperative interventions, including physical therapy and splinting.

In 10 of the 18 cases, surgery was performed with patients under general anesthesia. The remaining 8 cases were performed with patients under regional anesthesia. An indwelling catheter placed adjacent to the brachial plexus was used in these 8 patients for 48 hours of postoperative pain management. The determination to use a specific type of anesthesia was based on increased use of regional blocks at our institution. Lasting regional anesthesia was requested for ease of postoperative continuous passive motion (CPM) therapy and was initiated late in the study.

Surgical technique

The senior author performed all surgical procedures over the 27-year period. The technique of anterior release has been described previously.[22] A curvilinear S-shaped incision spanning the antecubital skin crease was used to approach the anterior capsule (Fig. 1). The proximal extent of the incision was placed on the lateral aspect of the arm. The lateral antebrachial cutaneous, median, and radial nerves, as well as the brachial artery, were dissected and tagged. The brachialis muscle was lifted off the capsule, revealing a white capsular layer overlying the elbow joint. Early in the series, only a capsulotomy was performed. This was later changed to capsulectomy, in which approximately 8 mm of the capsule was resected (Figs. 2-4). This was done in an attempt to decrease the amount of scar recurrence. Except for the change from capsulotomy to capsulectomy, the procedure remained the same over the study period. After the capsulotomy or capsulectomy was performed, an attempt to fully extend the elbow was made using gentle force through a short lever arm. If full extension was not possible with this maneuver, sharp division of the anterior brachialis fascia was performed. This additional fascial release was necessary in 1 patient, whereas in another patient, both the brachialis and biceps tendon underwent Z-lengthening. Following this additional step, these 2 elbows showed improvements in extension by 30° and 65°. Hardware was removed in 2 patients. In addition, 3 patients underwent excision of osteophytes from the coronoid; 3 patients, from the olecranon; and 1 patient, from the radial head. The radial head was resected in 1 patient who presented with a chronic anteriorly dislocated radial head that was prohibiting full flexion.

A second, posterior incision was indicated if radiographs suggested a posterior bony block from an olecranon osteophyte, a posterior loose body, or retained posterior hardware, any of which could potentially cause impingement and loss of extension. An additional posterior incision was needed in 4 of 18 patients. The decision to perform an additional posterior incision in this subset of patients was made preoperatively in 3 and intraoperatively in 1, in whom full extension was not possible after release of the anterior capsule and brachialis muscle. The posterior releases were performed through a direct posterior incision approximately 6 cm in length with a triceps-splitting technique, with care taken to minimize local dissection. The ulnar nerve was identified and protected routinely.

Posterior procedures included lysis of adhesions and excision of olecranon osteophytes. Each of the 4 aforementioned elbows showed improvement in extension after the posterior procedure was completed compared with the degree of extension provided by the anterior release alone. Prophylaxis for heterotopic ossification was not prescribed.

Postoperative management

Following surgical release, the first 7 patients in the series were placed in an anterior splint in maximum extension. When a CPM machine became widely available, CPM became the choice for postoperative care and was used in the remaining 11 patients (Kinetic, Charleville-Mezieres, France). The typical postoperative course consisted of inpatient hospitalization for 2-3 days, during which time physical therapy was initiated. When it was used, CPM was introduced immediately in the recovery room following surgery, and the patient was educated about its operation on postoperative day 1. Patients remained in the CPM device for 2-4 weeks, with those patients having more severe contractures remaining in the device for the full 4 weeks. Patients used the CPM machine at least 12 hours a day, increasing the arc of motion by 10° each day until the preoperative goal had been achieved. When not using the CPM machine, patients wore an extension splint. At the time of hospital discharge, supervised physical therapy, lasting approximately 3-6 weeks, was arranged for all patients regardless of CPM use. Physical therapy included active-assisted and passive range-of-motion exercises, as well as application of static progressive splints for those patients not using CPM. Physical therapy was also useful for patients who began to show tendencies for contracture recurrence after completing the CPM treatment. An improvement in the total arc of motion (TAM) of at least 20° was considered a satisfactory result. This was deemed a substantial gain, justifying the risks of a large operation.

Results

The mean age of our patients was 16.8 years (range, 12-21 years). There were 12 male and 6 female patients. The

Table I Patient demographic characteristics and elbow range-of-motion data

Patient No.	Age, yr	Sex	Injury	Preop extension, °	Postop extension, °	Change in extension, °	Preop TAM, °	Postop TAM, °	Change in TAM, °	CPM	FU, mo	Additional procedures
1	15	M	Lateral condyle fracture	42	17	25	38	85	47	Yes	24	Excision of coronoid osteophyte
2	13	F	Elbow dislocation with radial neck fracture	70	60	10	38	40	2	Yes	12	None
3	13	M	Infection	65	35	30	85	98	13	No	18	Pronator and brachialis release, excision of olecranon osteophyte
4	14	M	Lateral condyle fracture	52	33	19	82	97	15	Yes	8	None
5	17	F	Olecranon open fracture-dislocation	90	0	90	0	130	130	Yes	12	Removal of hardware, resection of heterotopic bone
6	17	M	Intra-articular distal humeral fracture	47	7	40	63	105	42	Yes	35	Removal of hardware, excision of olecranon and coronoid spurs
7	17	F	Lateral condyle fracture	60	5	55	60	130	70	No	120	None
8	18	M	Intercondylar humeral fracture	20	10	10	110	110	0	No	41	None
9	18	F	Intercondylar humeral fracture	70	30	40	35	60	25	No	41	None
10	18	M	Radial head fracture	55	15	40	60	110	50	Yes	63	None
11	15	M	Supracondylar humeral fracture	45	20	25	75	95	20	Yes	27	None
12	18	M	Brachial plexopathy	80	15	65	68	125	57	Yes	16	Z-lengthening of brachialis and biceps
13	12	M	Osteochondritis radial head	80	18	62	28	97	69	Yes	6	Excision of olecranon spur, removal of anterior-posterior loose bodies, radial head débridement
14	18	M	Neglected radial head dislocation	47	20	27	85	102	17	No	6	Excision of osteochondroma and coronoid osteophyte, radial head resection
15	19	F	GSW to elbow	45	18	27	50	92	42	Yes	41	None
16	20	M	Elbow degloving	35	15	20	95	105	10	No	72	None
17	20	F	MCL tear	25	3	22	95	122	27	Yes	12	None
18	21	M	Open lateral condylar fracture	35	20	15	95	125	30	No	12	None

Preop, preoperative; *Postop*, postoperative; *TAM*, total arc of motion; *CPM*, continuous passive motion; *FU*, follow-up; *M*, male; *F*, female; *GSW*, gunshot wound; *MCL*, medial collateral ligament.

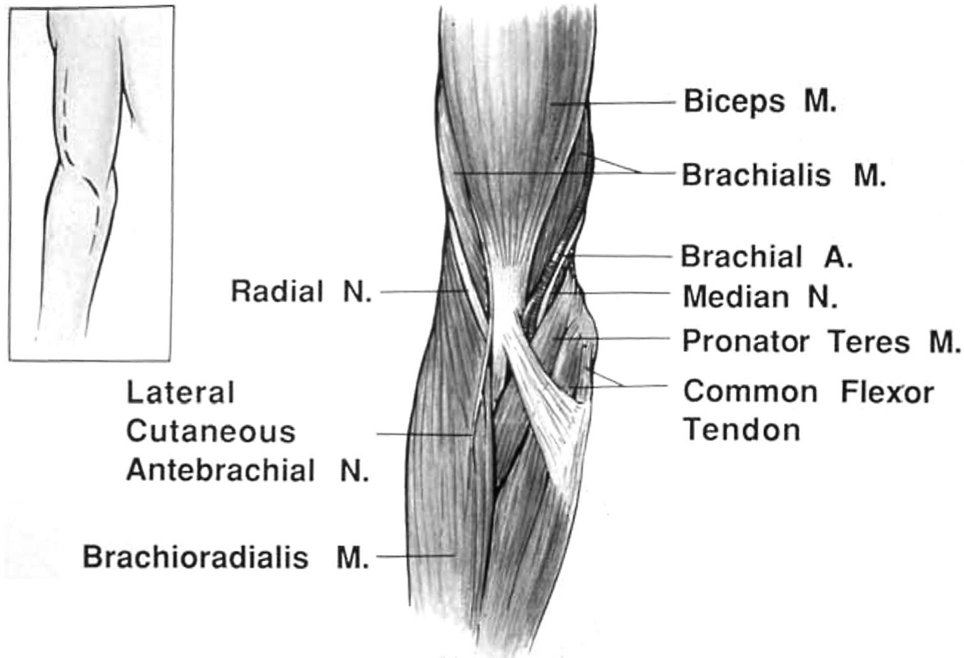

Figure 1 An S-shaped incision crosses the antecubital skin crease. The biceps tendon is identified early in the approach and serves as a landmark for the isolation and protection of the neurovascular structures. *M*, muscle; *A*, artery; *N*, nerve.

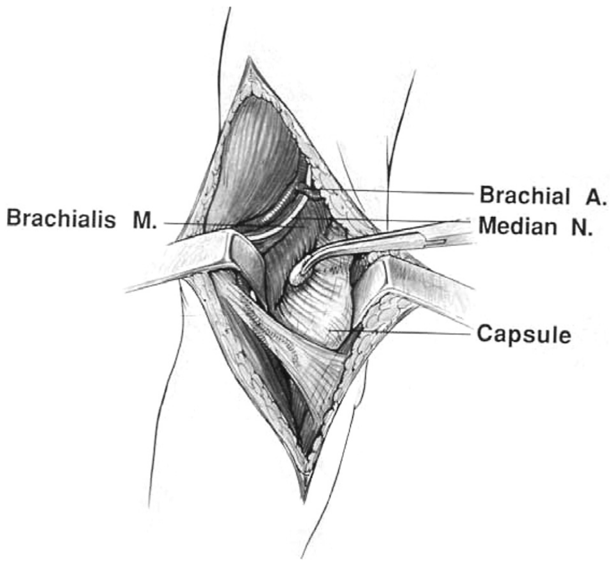

Figure 2 The medial side is approached first because the ulnohumeral joint is more readily identified on this side. The surgeon should be aware of neurovascular structures adherent to the thickened capsule. *A*, artery; *M*, muscle; *N*, nerve.

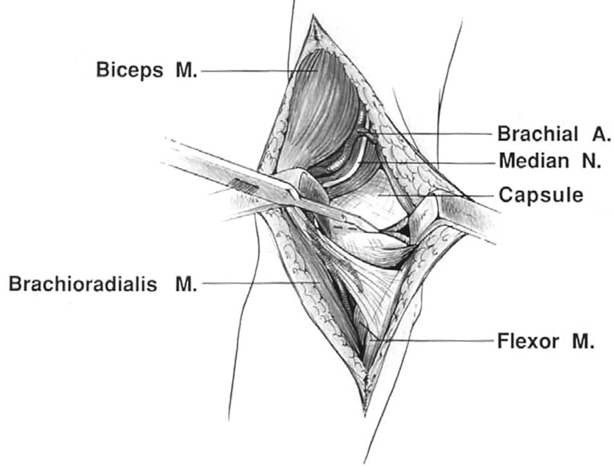

Figure 3 The medial aspect of the capsule is released sharply. An approximately 8-mm-long strip of capsule is excised. *M*, muscle; *A*, artery; *N*, nerve.

mean time from the initial injury to our surgery was 40 months (range, 6-221 months). Follow-up data were available at an average of 31.4 months (range, 6-120 months). Follow-up data at 1 year or more were available for 15 patients, whereas the remaining 3 patients were reviewed at between 6 and 12 months.

The mean flexion contracture of the group was 54° (range, 20°-90°) preoperatively, which improved to 19° (range, 0°-60°) postoperatively, an improvement of 35° (range, 10°-90°). The mean TAM of the group increased from 65° (range, 0°-110°) preoperatively to a mean of 102° (range, 40°-130°) postoperatively, an improvement of 37° (range, 0°-130°). A 20° or greater gain in TAM was found in 13 of 18 patients.

The first 7 patients were treated with extension splinting, whereas the subsequent 11 patients were treated with CPM during the immediate postoperative period. The mean TAM in the group treated with extension splinting alone was 81° preoperatively, which improved to 104°, an improvement of 24°. The mean arc of motion in the group treated with CPM

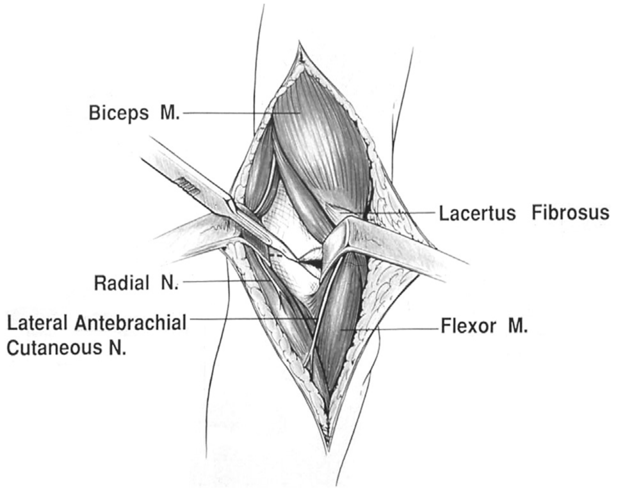

Figure 4 The lateral capsule is released in a similar fashion, with care taken to protect the radial nerve. An approximately 8mm long strip of capsule is excised. *M*, muscle; *N*, nerve.

was 54° preoperatively, which improved postoperatively to 100°, an increase of 46°. Despite the greater motion achieved in the CPM group, the difference was not statistically significant ($P = .15$). When the results were compared between patients with and without the use of a continuous axillary catheter, as well as based on the duration of contracture prior to the procedure, no difference regarding total motion was found. Two complications occurred in 2 patients. Both involved traction injuries to nerves crossing the elbow: One patient had posterior interosseous nerve palsy that improved after 6 months; the other patient had lateral antebrachial cutaneous nerve palsy that did not improve, although it was not functionally limiting. No cases of infection or heterotopic ossification developed.

Discussion

Loss of elbow range of motion can have serious consequences for normal function. Surgery is not recommended for an elbow flexion contracture until supervised nonoperative treatment has failed. The indications for surgical intervention vary with the functional demands and expectations of the patient. Until the report by Urbaniak et al[22] in 1985, there was little information in the literature relating to the correction of elbow contracture in patients of any age. Subsequent to this article, several authors reported on the successful surgical correction of elbow contractures using myriad techniques ranging from arthroscopic capsulectomy to the "column" approach to the elbow.[8,9,12,16,24]

The advantages of an anterior incision include the ability of the surgeon to clearly identify the neurovascular structures coursing through the anterior portion of the elbow. Once the structures are tagged and protected, the incidence of iatrogenic injury to important structures should significantly decrease. Scarring of nerves and vessels to the underlying anterior capsule is not uncommon, and these structures can be injured if not isolated and protected. No disruption of the collateral ligaments occurs with this incision.

The disadvantages of this incision include the fact that dissection is difficult. For surgeons uncomfortable with the elbow anatomy, the procedure can be very challenging. Even for accomplished upper-extremity surgeons, the exposure is very difficult with past trauma to the elbow and contracture. The incision made in a "lazy S" fashion courses directly over the anterior aspect of the elbow. There is a chance for an unsightly scar, which is clearly visible to the patient and could be a source of patient dissatisfaction.

This anterior incision only addresses anterior structures. It may somewhat improve flexion by removing extra anterior capsule scar tissue caught between the ulna and olecranon. However, if the patient complains about a lack of extension and flexion, other approaches are recommended.

In our study, 4 patients needed an additional posterior incision to remove osteophytes from the posterior ulnohumeral articulation. The second procedure was necessary as great gains were made when the procedure was performed. No areas of ischemic skin developed, but care needs to be taken, especially if old wounds are not used. In the study by Bae and Waters,[2] old incisions were the first to be used; then, if necessary, an extensile medial approach was undertaken.[20]

Our retrospective review comprised patients with a variety of etiologies causing the flexion contracture. We chose to include all patients irrespective of the etiology. The results seem to be similar. We believe the approach is applicable to all types of extension contractures. The surgeon performing a literature review should be able to see published cases outside of only trauma, showing successful outcomes with surgical intervention. The etiologies of the elbow contractures in our study were varied. Stans et al[21] reported the results of 37 patients aged 21 years or younger with elbow flexion contractures treated with capsular release through multiple different approaches. The TAM improved from a mean of 66° to 94° postoperatively. Only 46% of patients achieved a functional arc of motion of 100° or greater. Two patients lost motion after surgery. Our results are very similar. In 10 of our 18 patients, or 56%, an arc of 100° or better was obtained. However, 1 of these 10 patients started with a TAM of over 100° before surgery, and motion did not improve by an additional 20° or more.

In the summary by Mih and Wolf,[15] 9 patients were followed up at an average of 17 months after surgery. A lateral approach was used; an anterior capsulectomy as well as posterior procedures could be performed through a single incision. Extension improved to –15°, and the TAM improved to 108°. These results are in line with the improvements we saw. Initially, all extensor muscles were taken off their bony origin. Later, this changed to a muscle-sparing approach. A second medial incision was needed if the medial collateral ligament was believed to be limiting range of motion.

We extended the age inclusion criterion to 21 years to keep in line with 2 other recent reports. A review by Stans et al[21] included patients aged up to 21 years, and a review of post-traumatic elbow contracture by Bae and Waters[2] included patients younger than 21 years. Including patients in their late adolescent years increased our sample size without significantly changing the conclusions of the study.

Recently, Piper et al[17] reported on 26 patients younger than 21 years undergoing open surgical release of post-traumatic elbow contracture. The surgical procedure was performed through medial and/or lateral approaches as indicated by the pathology. Active flexion-extension and rotation arcs increased significantly by mean values of 49° and 70°, respectively. In addition, 85% of operative gains were maintained at final follow-up.

The issue of using CPM postoperatively has gained favor by many upper-extremity surgeons. This modality works best in conjunction with an indwelling catheter. Our results showed that more of a gain was made with the use of CPM, but the end TAMs were very similar. CPM was started in the middle of the collection period, and it was by chance that those patients started with a greater contracture. Even looking at the overall amount of improvement, because of the large ranges in TAM values, we found no statistical benefit in using CPM. This is a corollary to the results of Stans et al[21] and Piper et al,[17] who found no significant benefit with the use of CPM.

More information about the use of CPM can be gleaned from 2 reports dealing with T-condylar fractures in adolescents. In a study by Remia et al,[19] final range of motion was measured in a group of 9 patients in whom this fracture was treated. The 2 patients who did not use CPM had a statistically greater chance of having a flexion contracture. These 2 patients had the greatest flexion contractures in the study, at –23° and –25°. In a similar study by Re et al,[18] CPM was found to be helpful in improving flexion after a T-condylar fracture. There was no benefit in improving extension.

The 2 complications in our study were both traction-related nerve injuries. Both occurred in patients representing the extremes of either chronicity of contracture or gains in TAM. The patient with posterior interosseous nerve neurapraxia had the largest improvement in overall elbow motion, at 130° (from 90°-90° preoperatively to 0°-130° postoperatively). This patient's resultant wrist, thumb, and finger drop resolved completely by 6 months and was addressed in the interim with supportive splinting and physical therapy to maintain full motion of the wrist and fingers.

The patient with an injury to the lateral antebrachial cutaneous nerve presented after having had a contracture for 221 months. This patient was left with numbness over the lateral aspect of the forearm that was mildly symptomatic but did not interfere with his current level of functioning as a student.

One patient in this study made no improvement. This patient's range of motion was 20°-130° preoperatively, and he ended up with 10°-120°. He stated that he was bothered by the preoperative inability to fully extend his elbow. Although there are not sufficient numbers in this study to support a generalization, it would appear that patients with elbow range of motion closely approximating the functional arc of motion, found to be around –30° of extension, should consider accepting their limited range of motion.

There are limitations to this study. This is a retrospective study going back decades, and follow-up is difficult. Many patients traveled long distances to undergo surgery at a tertiary care facility. No long-term range-of-motion assessment was able to be obtained in 33% of patients. Techniques changed throughout the study regarding post-operative care. In addition, the population is not consistent regarding the cause of elbow contracture.

Conclusion

Flexion contracture of the elbow in the pediatric population can be a devastating problem. Surgical correction of elbow flexion contractures in pediatric patients through an anterior approach leads to a satisfactory result in the majority of cases, with a low incidence of complications. The anterior incision is technically demanding yet visually rewarding in the ability to protect the neurovascular structures. This approach is an additional option for well-qualified surgeons to manage elbow flexion contractures in pediatric patients.

Disclaimer

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