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Clinical presentation of posterolateral rotatory instability of the elbow in children

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Clinical Presentation of Posterolateral Rotatory Instability of the Elbow in Children

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Background: Posterolateral rotatory instability is a type of ulnohumeral instability seen following elbow trauma. It is caused by a deficiency in the lateral collateral ligament complex that allows the radius and ulna to subluxate as a single unit with respect to the distal part of the humerus. There are few studies on this type of instability in children. Our purpose was to evaluate cases of posterolateral rotatory instability in children to better understand its presentation and manifestation as compared with those in adults.

Methods: This was a retrospective chart review of patients from three academic centers. Eligible for inclusion were patients with a diagnosis of posterolateral rotatory instability who were treated with lateral ulnar collateral ligament reconstruction when they were less than nineteen years of age.

Results: Nine patients met the inclusion criteria. The mean age at the initial injury was ten years, and the average time from the initial injury to the final operation was 3.7 years. Six patients had prior elbow dislocation, and three had an isolated elbow fracture. Six of the nine patients had a forearm or elbow contracture. Only one patient had a positive pivot-shift test during the preoperative office examination, but all had a positive pivot-shift test when examined under anesthesia. Six had radiographic evidence of posterolateral rotatory instability. All patients underwent lateral ulnar collateral ligament reconstruction. At the time of follow-up, at a minimum of one year after the ligament reconstruction, there was no evidence of deformity secondary to early physeal closure and all elbows remained stable.

Conclusions: Although posterolateral rotatory instability of the elbow is rare, it does exist in children. The instability may not always be recognized because of masking by contracture but, as is the case with adult patients, radiographs may show evidence of the instability. In children with contracture, the clinician should consider the possibility of a masked posterolateral rotatory instability and plan accordingly at the time of contracture release. Surgical correction is technically difficult, and traditional ligament reconstruction in skeletally immature patients may pose a risk to the lateral humeral condylar and epicondylar physes.

Level of Evidence: Therapeutic Level IV. See Instructions for Authors for a complete description of levels of evidence.

Posterolateral rotatory instability of the elbow was first described by O'Driscoll et al. in 1991, and it has since been acknowledged as the most common type of symptomatic chronic instability of the elbow[1,2]. It is a kinematic disturbance of elbow motion whereby the radius and ulna subluxate with respect to the distal part of the humerus such that the forearm bones displace into a position of external rotation and valgus during elbow extension. The annular ligament and proximal radioulnar joint remain intact so that both forearm bones rotate as a single unit. The instability is secondary to deficiency in the lateral collateral ligament complex, particularly the lateral ulnar collateral ligament and radial collateral ligament[3-6]. The injury occurs when the elbow sustains a combination of axial force, supination, and valgus moments while being passively flexed, such as when a person falls on an outstretched hand[7]. Other causes, such as chronic

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TABLE I Preoperative Data on the Nine Children with Posterolateral Rotatory Instability of the Elbow

Case	Sex, Age* *(yr)*	Time to Operation†	Initial Injury; Initial Management‡
1	M, 11	3 yr	4 dislocations; cast
2	F, 11	3 mo	Fracture (olecranon and lateral epicondyle avulsion); cast
3	F, 12	4 yr	Fracture(radial neck); CRPP followed by ORIF
4	M, 12	3 yr	Dislocation; closed reduction, followed by LUCL reconstruction 2 yr after initial injury, which failed
5	M, 13	1 yr	Fracture (radial head); cast
6	M, 14	2 yr	Fracture (capitellum), dislocation; ORIF
7	M, 15	9 yr	Fracture (supracondylar humeral), dislocation; CRPP, followed by 4 dislocations
8	M, 15	8 mo	Dislocation and distal radial fracture; ORIF of wrist, closed reduction of elbow; LUCL repair 3 wk later, which soon became infected, debrided
9	F, 18	10 yr	Fracture (supracondylar humeral); ORIF, followed by dislocation at age 16

*Age at final operation for posterolateral rotatory instability of the elbow. †Time from initial injury to final operation. ‡CRPP = closed reduction with percutaneous pinning, ORIF = open reduction and internal fixation, and LUCL = lateral ulnar collateral ligament. §Full range of motion is defined as equal to that of the contralateral, uninjured extremity.

cubitus varus, iatrogenic injury (following radial head resection or tennis-elbow release), chronic overuse (such as from walking with crutches), or general ligamentous laxity, have been described[8].

Patients with posterolateral rotatory instability may exhibit a variety of symptoms, including lateral elbow pain, recurrent popping or snapping, or frank recurrent dislocation. On examination, there may be a positive lateral pivot-shift sign[9]. Radiographs made at the time of injury may show an avulsion fracture of the lateral ligament complex or an impression fracture of the radial head or capitellum. When there is a chronic injury, radiographs (of both adult and pediatric cases) show degenerative changes to the osseous structures secondary to repetitive subluxation. Radiographs may show an incongruent ulnohumeral joint and posterior subluxation of the radius on the capitellum, whereas, in other cases, these findings may be seen only under fluoroscopy with a dynamic pivot-shift maneuver[5]. Posterolateral rotatory instability does not respond to nonoperative management such as immobilization. It is treated surgically by repairing or reconstructing the lateral ligament complex, with correction of other osseous fractures or abnormalities of the joint at the same time[2].

The features of posterolateral rotatory instability are largely based on findings in adult patients. There are few detailed descriptions of posterolateral rotatory instability in children[10]. This may be because the condition is underdiagnosed in the pediatric population, much as adult posterolateral rotatory instability went unrecognized for many years. The purpose of this retrospective case review was to improve our understanding of the pediatric presentation of posterolateral rotatory instability and report our experiences with the surgical management of this instability in children.

Materials and Methods

We performed a retrospective chart review of children who had undergone lateral ulnar collateral ligament reconstruction for posterolateral rotatory instability of the elbow at three academic centers in the United States. Institutional review board approval for this study was obtained from Shriners Hospitals for Children of Northern California, Washington University at Barnes-Jewish Hospital in St. Louis, and the University of Utah Hospital and Primary Children's Medical Center in Salt Lake City.

We reviewed all elbow surgical procedures performed from 2000 to 2011. Patients were eligible for inclusion if they had undergone graft reconstruction of the lateral ulnar collateral ligament to treat posterolateral rotatory instability when they were under the age of nineteen years and if they had been followed for at least one year. The lateral ulnar collateral ligament was reconstructed either as previously described by one of us (L.L.L.)[11] or via a standard docking technique[12] (Figs. 1-A and 1-B). With use of the former (Lattanza) technique[11], both graft limbs are passed through an isometric hole distal to the lateral humeral condylar physis. This technique was used only in

TABLE I (*continued*)

Findings on Preop. Examination							
			Passive Range of Motion§ *(deg)*				
Subjective Instability	Pain	Apprehension	Extension-Flexion Arc	Pronation	Supination	Lateral Pivot-Shift Test Under Anesthesia	Radiograph: Posterior Subluxation of Radial Head
+	+	+	Full	Full	Full	+	−
+	−	−	5-35	65	5	+ (After contracture release)	+
−	+	−	Full	None	Fixed in 70	+	+
+	+	+	−20-135	50	80	+	+
−	+	−	25-145	50	50	+ (After contracture release)	+ (Also incongruent ulnohumeral joint)
−	+	+	30-120	60	45	+	−
+	−	−	Full	Full	Full	+	+
+	+	+	30-120	40-80	None	+ (Preoperative, without anesthesia)	+
+	+	+	Full	Full	Full	+	−

skeletally mature patients. All other patients underwent a docking technique, in which the graft is not passed all the way through the tunnel, allowing for smaller exit holes as only the suture is tied over the bone bridge. All surgical procedures were performed by fellowship-trained hand surgeons who subspecialize in adult and pediatric elbow surgery. For each patient, we recorded the sex, age at initial injury, mechanism of injury, time from the initial injury to the final surgery for the posterolateral rotatory instability, and any treatment received prior to the final ligament reconstruction. We also recorded the findings at the physical examination, including tenderness to palpation, the passive range of motion, and the response to special

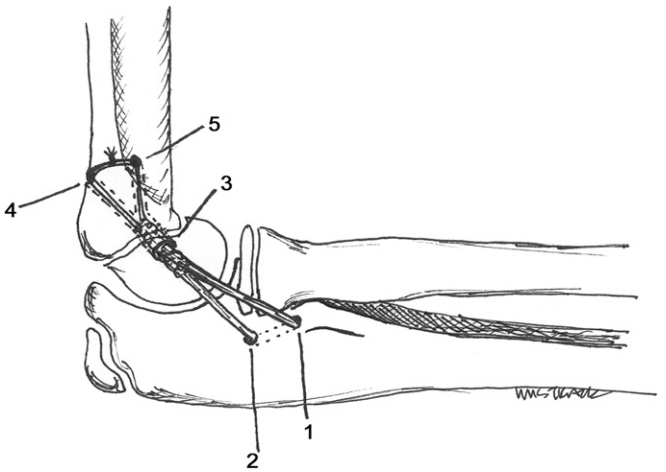

Fig. 1-A

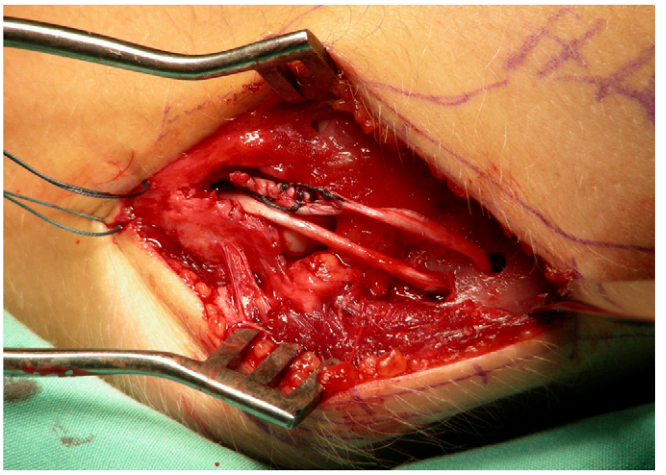

Fig. 1-B

Fig. 1-A A drawing showing the Lattanza technique for lateral ulnar collateral ligament reconstruction. The graft is first passed through the ulnar holes (1 and 2). Then both graft limbs are passed through the isometric hole, which is slightly distal to the lateral humeral condylar physis (3). The tendons are next passed through 4 and 5, and then tensioned and tied over the bone. (Reproduced, with permission, from: Lattanza LL. Surgical treatment of posterolateral rotatory instability of the elbow in children. Tech Hand Up Extrem Surg. 2010 Jun;14[2]:114-20.) **Fig. 1-B** Intraoperative photograph (Case 1) showing the docking procedure for lateral ulnar collateral ligament reconstruction Only the suture is passed through the bone, allowing for use of a shorter graft. This image was made prior to tightening and tying.

TABLE II Postoperative Data on the Nine Patients with Posterolateral Rotatory Instability of the Elbow

			Findings on Final Postop. Examination				
					Passive Range of Motion† *(deg)*		
Case*	Procedure†	Duration of Follow-up *(mo)*	Subjective Instability	Pain	Extension-Flexion Arc	Pronation	Supination
1	LUCL reconstruction	16	–	–	Full	Full	Full
2	Contracture release and LUCL reconstruction	40	–	–	0-130	Full	Full
3	Contracture release and LUCL and annular ligament reconstruction	36	–	–	Full	None	Fixed in 50
4	LUCL reconstruction and ulnar lengthening osteotomy	31	–	–	Full	Full	65
5	Contracture release, radial head replacement, and LUCL reconstruction	17	–	–	15-135	80	80
6	LUCL reconstruction	12	–	–	Full	80	50
7	LUCL reconstruction	36	–	–	Full	Full	Full
8	Contracture release and LUCL reconstruction	21	–	–	10-130	10-80	None
9	LUCL reconstruction	12	–	–	Full	Full	Full

*Case numbers correspond with those in Table I. †LUCL = lateral ulnar collateral ligament. ‡Full range of motion is defined as equal to that of the contralateral, uninjured extremity.

maneuvers such as the lateral pivot-shift test and intraoperative maneuvers performed with the patient under anesthesia. In addition, we documented preoperative radiographic findings. Clinical outcomes, including clinical examination findings at the time of the latest follow-up, were recorded. We defined a full range of motion as equal to that of the contralateral, uninjured extremity, and we performed the pivot-shift test as described by O'Driscoll et al. (see Appendix)[1].

Source of Funding
There was no external funding for this investigation.

Results

Nine patients (six male and three female) met the inclusion criteria (Table I). Their age at the time of the initial injury ranged from six to fourteen years (mean, ten years). The most common mechanism of initial injury was a fall. Three patients initially presented with an isolated elbow fracture; three, with isolated elbow dislocation(s) (one of these patients also had a distal radial fracture); and three, with a fracture and dislocation. The elbow injuries were initially managed nonoperatively in five patients, by closed reduction with percutaneous pinning in two, and by open reduction and internal fixation in two. Two patients had a failed repair or reconstruction of the lateral ulnar collateral ligament prior to the final reconstruction. The average time from the injury to the final reconstruction to treat the posterolateral rotatory instability was 3.7 years.

As shown in Table I, seven patients had preoperative lateral elbow pain and five had apprehension with manipulation of the elbow. Six patients had a loss of forearm rotation, and four had an elbow flexion contracture. Although six patients had symptoms consistent with instability, only one had a positive preoperative pivot-shift test. Three patients had a full range of motion of the elbow. Preoperative radiographs showed posterior subluxation of the radial head in six patients (Fig. 2-A) and an incongruent ulnohumeral joint in one (Case 5) (Fig. 2-B). Physes were open in three patients preoperatively (Case 1, all elbow physes open; Case 2, open radial head and olecranon physes; and Case 4, open lateral humeral condyle and radial head physes).

Intraoperatively, all patients had a positive pivot-shift sign under anesthesia (Table I). Of the six patients who had a contracture, four underwent a contracture release followed by the ligament reconstruction, and in two of those patients, the positive pivot-shift sign was not evident until after the contracture release. All patients underwent reconstruction of the lateral ulnar collateral ligament with use of either autograft (palmaris longus or plantaris tendon) or allograft (semitendinosus tendon), as chosen by the surgeon.

Postoperative data are shown in Table II. All patients were followed for a minimum of one year (mean, twenty-five months). All had a stable, painless, congruent elbow at the time of the latest follow-up, with an improved active range of motion. Two patients (Cases 5 and 8) had a persistent—but decreased—flexion contracture. In one patient (Case 3) the forearm was fixed in 50°of supination (improved from 70°),

Fig. 2-A

Fig. 2-B

Figs. 2-A and 2-B Lateral radiographs showing possible findings in patients with posterolateral rotatory instability. **Fig. 2-A** Posterior subluxation of the radial head (Case 2). **Fig. 2-B** Posterior subluxation of the radial head with an incongruent ulnohumeral joint (Case 5).

and in another patient (Case 8) pronation was limited to between 10° and 80° (improved from 40° to 80°). Postoperative radiographs of patients in this series (Cases 1 through 6, and 8) demonstrated closed lateral humeral condylar and epicondylar physes without any evidence of growth disturbance related to the reconstruction. We were unable to locate the postoperative radiographs for two of the older patients (Cases 7 and 9).

Discussion

Posterolateral rotatory instability is defined as a transient rotatory subluxation of the ulnohumeral joint together with subluxation of the radiocapitellar joint. The radial head, locked into the sigmoid notch by an intact annular ligament, subluxates posterior to the capitellum. Since posterolateral rotatory instability was described in 1991, its presentation, findings, and management in the adult elbow have been well detailed. However, there are few reports describing posterolateral rotatory instability in the pediatric elbow[10,13]. A report in 2000 by Clough et al. described posterolateral rotatory instability in a nine-year-old boy in whom traumatic dislocation of the elbow had caused an intra-articular fracture of the olecranon, which healed in a malunited position of 90° of rotation[14]. The resultant recurrent posterolateral rotatory instability was treated by open reduction, olecranon osteotomy, and fixation of the radial head with a transcapitellar Kirschner wire. The original paper on posterolateral rotatory instability by O'Driscoll et al. included the cases of two children (five and sixteen years old at the time of the final operation) who both had avulsion of the lateral collateral ligament complex and subsequently were treated by reattachment of the displaced fragment[1]. A later paper by Nestor et al. included the cases of three patients under the age of eighteen years who had posterolateral rotatory instability secondary to fracture or dislocation, treated by reconstruction or repair of the lateral ulnar collateral ligament[15]. None of these accounts emphasized elbow flexion contracture or mentioned contracture release in the ligament reconstruction, although Nestor et al. reported that two of three children had limited preoperative extension of 15° and 30°[15].

We present nine pediatric cases of posterolateral rotatory instability, from three centers, which had some similarities to adult cases with regard to presentation. All patients in our series had a remote history of trauma to the elbow resulting in fracture or dislocation, or both. Similar to what has been found in adult cases, considerable time had passed between the initial injury and the consultation for posterolateral rotatory instability (range, three months to ten years). In contrast to adult cases, one of the most frequent physical examination findings in our series was an elbow or forearm contracture, which may have been due to scarring from the initial trauma, or may have developed over time as a protective measure. We postulate that children avoid the elbow motions that provoke the pain related to the instability, particularly extension and supination, and this results in the development of an elbow or forearm contracture.

Only one patient in our series had a positive preoperative pivot-shift test during the clinic examination. The lateral pivot-shift test is difficult to interpret for adult patients without adjunctive use of dynamic fluoroscopy or arthroscopy, and it often is only positive when the patient is examined while under anesthesia[5,9]. The test seems to have a lower sensitivity in children because it is difficult to interpret maneuvers as a result of the child's pain or apprehension, or stiffness from contracture. This is supported by the finding that all patients had a positive pivot-shift examination under anesthesia, although only after contracture release for two of the six with a preoperative contracture. The lateral ulnar collateral ligament complex was specifically assessed at the time of surgery and was not released as part of the contracture release, although it was insufficient or torn in all cases. When full motion was restored to the elbow and forearm, the posterolateral rotatory instability became apparent.

The masking of instability by contracture is important to recognize. Spontaneous reduction of the elbow after dislocation is common in children because of the hypermobility of the pediatric joint[16,17]. The lack of confirmed dislocation on

radiographs after initial trauma may lead one away from the diagnosis of instability, especially if a child presents with a stiff elbow. The clinician must maintain a high index of suspicion for posterolateral rotatory instability in children, as the initial trauma may be vague or remote and the findings on physical examination may vary widely from instability to contracture. In our study, there was an average of 3.7 years from the injury to the repair, despite radiographic evidence of posterolateral rotatory instability in six patients, demonstrating that this condition can be easily missed and may be underdiagnosed and underreported. Careful assessment of radiographs for radiocapitellar and ulnohumeral malalignment may aid in diagnosis. If posterolateral rotatory instability is recognized, it is important to correct it because chronic instability leads to early degenerative changes in the elbow[18].

Lateral radiographs were diagnostic for only six of the patients. As is the case for adults, there is a spectrum of radiographic findings for posterolateral rotatory instability in children, ranging from a normal appearance to a slight posterior sag of the radial head on the capitellum to the most extreme case, which is complete posterior subluxation of the radial head with an incongruent ulnohumeral joint. In this study, most patients did not have preoperative magnetic resonance imaging (MRI). Although it may be possible to diagnose lateral ulnar collateral ligament injury with MRI, finding an abnormality in the ligament on MRI does not correlate with the presence of posterolateral rotatory instability as studies have shown asymptomatic elbows with high-intensity areas indicative of tearing[19]. Conversely, completely torn ligaments have been diagnosed with manipulation under anesthesia and surgical exploration in patients who have normal-appearing elbow ligaments on MRI[3,20].

All children in the present study had a stable elbow after lateral ulnar collateral ligament reconstruction. They experienced relief of pain and had a functional range (100° arc[21]) of elbow motion; two had a mild flexion contracture, and the two who did not have forearm contracture release at the time of the ligament reconstruction had a persistent forearm contracture. None of the three patients with open physes preoperatively had complications related to early physeal closure or angular deformity of the distal part of the humerus. Although our opinion is that this is a safe procedure in skeletally immature patients, none of the patients in our series were younger than eleven years of age. Due caution must therefore be exercised when making the decision to perform a standard lateral ulnar collateral ligament reconstruction in patients with open physes.

A limitation of this study is the small number of patients, a reflection of the fact that posterolateral rotatory instability in children has been rarely reported. A second limitation is our duration of follow-up. While all patients were followed for at least one year, we do not yet have data on long-term outcomes. However, our goal was to define posterolateral rotatory instability in the pediatric elbow and clarify how its presentation differs from that in the adult elbow, rather than to focus on its treatment. We present our follow-up data for completeness, and we recommend additional investigation of long-term outcomes following lateral ulnar collateral ligament reconstruction. The retrospective case study design also is a limitation because there may be selection bias.

In summary, our retrospective review shows that posterolateral rotatory instability of the elbow in children may not be recognized for months or years after an initial injury and often presents with elbow or forearm stiffness. Other clinical presentations include pain and instability. There are no perfect clinical signs or imaging studies for diagnosing posterolateral rotatory instability, although the lateral pivot-shift test with the patient under anesthesia was the most sensitive test in our series.

Appendix

(eA) Intraoperative photographs and fluoroscopic images of the pivot-shift test in two patients are available with the online version of this article as a data supplement at jbjs.org. ■

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