

Ligamentous repair and reconstruction for posterolateral rotatory instability of the elbow

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We describe the intermediate results of lateral ligamentous repair or reconstruction for posterolateral rotatory instability of the elbow. Between 1986 and 1999, we performed 12 direct repairs and 33 ligament reconstructions with a tendon autograft. One patient was lost to follow-up and 44 were retrospectively studied at a mean of six years (2 to 15).

Surgery restored stability in all except five patients. In two the elbow became stable after a second procedure. The mean post-operative Mayo elbow performance score was 85 points (60 to 100). The result was classified as excellent in 19, good in 13, fair in seven and poor in five patients. Thirty-eight patients (86%) were subjectively satisfied with the outcome of the operation. Better results were obtained in patients with a post-traumatic aetiology ($p = 0.03$), those with subjective symptoms of instability at presentation ($p = 0.006$) and those who had an augmented reconstruction using a tendon graft ($p = 0.04$).

Reconstruction using a tendon graft seems to provide better results than ligament repair and the results do not seem to deteriorate with time. The outcome of this procedure is less predictable in patients with no subjective instability.

Posterolateral rotatory instability of the elbow was first described as a clinical entity in 1991¹ and is caused by insufficiency of the lateral collateral ligament complex.¹⁻⁵ Most cases have a post-traumatic or iatrogenic origin.⁶ The ligamentous insufficiency results in multiple episodes of instability during which the ulna and radius rotate as a unit posterolaterally, losing congruency with the distal humerus. Symptoms range from catching or locking of the elbow to subjective instability or frank recurrent dislocation. Occasionally, pain over the lateral aspect of the elbow is the main symptom. Tests on physical examination which are useful for the diagnosis of this condition include varus stress of the elbow and the lateral pivot-shift, posterolateral drawer and apprehension manoeuvres. Radiological or arthroscopic evidence of posterolateral rotatory subluxation may help to confirm the diagnosis.^{1,7}

Reconstruction of the lateral collateral ligament complex has been recommended to restore stability of the elbow in patients with posterolateral rotatory instability.^{1,2,4} Nestor et al⁶ described 11 patients with this diagnosis who had been treated by lateral ligamentous reconstruction and followed for 2.0 to 5.5 years. Stability was obtained in ten of the patients and seven had an excellent result. Although the entity of posterolateral rotatory

instability and its treatment are now well recognised, no other studies on the outcome of this procedure have since been published. We describe the results of repair or reconstruction of the lateral ligamentous complex in a larger population of patients with posterolateral rotatory instability.

Patients and Methods

Between 1986 and 1999, 45 consecutive patients with posterolateral rotatory instability underwent surgical reconstruction of the lateral collateral ligament complex of the elbow at our institution. Eleven had been included in the preliminary study.⁶ Patients who had reconstruction of the lateral ligamentous complex for acute instability, or as an adjunct to other procedures such as reconstruction of the radial head or coronoid, interposition arthroplasty or repair of the medial collateral ligament, were not included.

One patient was lost to follow-up after his examination by an orthopaedic surgeon one year after surgery. At that time, he was satisfied with the result and had not experienced further instability. The remaining 44 patients were followed for a mean of six years (2 to 15). The most recent evaluation was by clinical examination in eight, by written questionnaire in 16 and by telephone questionnaire in 20.

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There were 28 males and 16 females with a mean age of 35 years (9 to 80) at the time of surgery. The left elbow was involved in 28 patients and the right in 16. The dominant elbow was affected in 18 of the patients (Table I).

In 32 patients, posterolateral rotatory instability developed after a documented injury to the elbow. Nine had a simple dislocation. Nine had a fracture-dislocation of which three were coronoid fracture-dislocations, two fracture-dislocations of the radial head, two combined fracture-dislocations of the radial head and coronoid and two osteochondral fracture-dislocations of the capitellum. An intra-articular fracture of the elbow without a complete dislocation was seen in five, three had fractures of the radial head, one a fracture of the coronoid and one fractures of both the radial head and the coronoid. An elbow strain was diagnosed in seven. Nine patients developed symptoms of instability after a surgical procedure; six had undergone release of the common extensor tendon for tennis elbow, with resection of the radial head in one; open removal of a loose body through a lateral approach had been carried out in two, and partial resection of the radial head with associated reconstruction of the annular ligament for a Monteggia lesion in one. Five patients could not identify a distinct injury which could have been responsible for their instability.

In addition to the nine patients who developed instability as a result of a surgical procedure, 13 others had previously undergone one or more operations on the affected elbow. Twelve had one previous operation, eight two, and two four operations. These procedures included repair of the lateral ligamentous structures in 12, release of the common extensor tendon in seven, reconstruction of the medial collateral ligament in four, removal of a loose body in four, open reduction and internal fixation of a fracture of the radial head in two, a Monteggia fracture in one, excision of the radial head in two, reconstruction of the annular ligament in two, arthroscopic debridement in one, and bone grafting of the coronoid in one.

For the 39 patients who could identify a distinct event which had been responsible for their instability, the mean interval from the injury to the time of presentation at our institution was 2.8 years (4 months to 12 years). Of these, 22 had experienced at least one dislocation or fracture-dislocation of the elbow and 14 had a history of two or more episodes of complete dislocation; the mean number of previous dislocations for these 14 patients was 5.5 (2 to 15). Seven of the 14 patients with a history of recurrent dislocation had also experienced multiple episodes of subluxation. Recurrent subluxation was the main complaint in all of the eight patients with only one documented episode of dislocation and in 22 of the 23 patients without a history of frank dislocation. Three patients presented with pain in the elbow with a sensation of catching or snapping and six complained of pain but had no mechanical symptoms.

Twenty-eight patients had limited extension (5° to 50°) of whom seven also had limited flexion (85° to 120°). Supina-

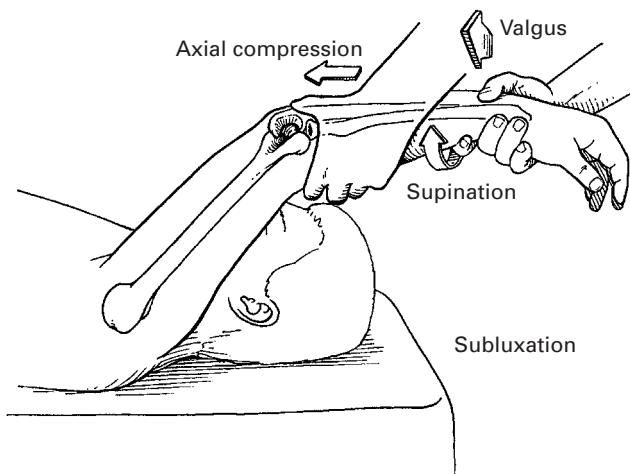


Fig. 1a

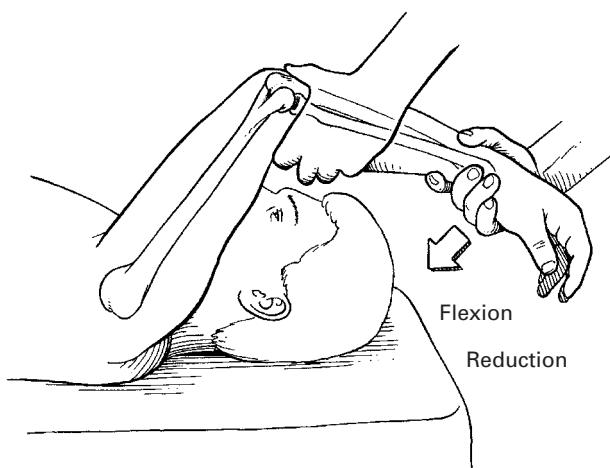


Fig. 1b

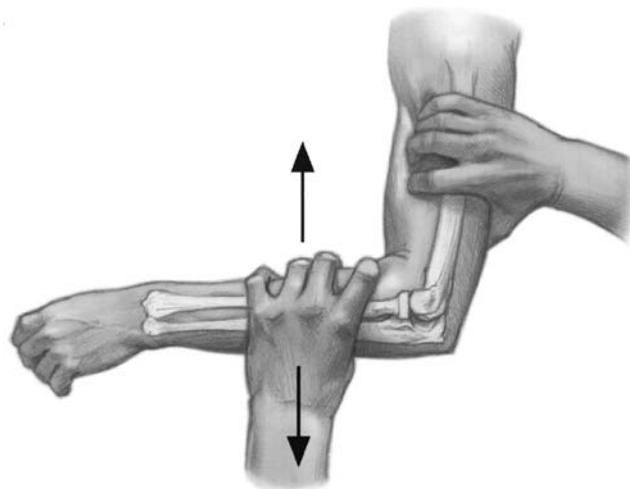


Fig. 1c

Tests used for the diagnosis of posterolateral rotatory instability. Figures 1a and 1b – Posterolateral rotatory pivot-shift test. Figure 1c – Postero-lateral drawer test.

Table I. Details of the 44 patients who were followed up for a mean of six years

Case	Gender	Age (yrs)	Mechanism	Previous surgery	Surgery	Follow-up (yrs)	Pre-operative review		Most recent review					Complications§	Re-operations§	
							Pain	ROM*	Pain	ROM	Recurrence	MEPST†	Rating‡	Result (Nestor)§		
1	M	9	Dislocation	No	Repair	12.1	Mild	15 to 150	Mild	10 to 150	Yes¶	85	G	E	Traumatic dislocation	LCL reconstr.
2	F	46	Fracture	Yes	Repair	14.5	Severe	20 to 120	Moderate	15 to 100	Yes¶	60	F	F	Recurrent instability	LCL reconstr.
3	M	60	Fracture	No	Repair	2.6	Moderate	40 to 120	Mild	10 to 145	No	100	E	E		
4	F	80	Fracture-dislocation	No	Repair	6.1	Moderate	0 to 135	Mild	20 to 145	No	85	G	G	HO-stiffness	HO resection
5	M	70	Not identified	No	Repair	4.6	Severe	5 to 140	Severe	0 to 140	No	65	F	F	Superficial infection	
6	F	10	Strain	No	Repair	3.1	Mild	45 to 140	Mild	0 to 145	No	80	G	G		
7	M	47	Surgery	Yes	Repair	2.4	Moderate	5 to 135	Severe	60 to 140	Yes	60	F	P	Recurrent instability	
8	M	19	Surgery	Yes	Repair	11.5	Moderate	30 to 150	Severe	10 to 140	No	65	F	P		
9	M	35	Surgery	Yes	Repair	6.4	Moderate	0 to 130	Severe	0 to 140	Yes	65	F	P	Recurrent instability	
10	M	47	Surgery	Yes	Repair	3.3	Moderate	30 to 138	Moderate	20 to 120	No	80	G	G	Superficial infection	
11	M	44	Surgery	Yes	Repair	5.0	Moderate	0 to 140	No	0 to 145	No	100	E	E		
12	M	31	Surgery (prior trauma)	Yes	Repair	5.4	Moderate	0 to 135	No	0 to 140	No	100	E	E		
13	M	15	Dislocation	No	Reconstruction	11.7	Mild	30 to 130	Moderate	0 to 137	No	70	F	G		
14	M	15	Dislocation	No	Reconstruction	7.8	No	50 to 135	Mild	0 to 150	Yes	85	G	G	Traumatic dislocation	
15	F	21	Dislocation	No	Reconstruction	6.5	No	0 to 130	Mild	0 to 135	No	85	G	E		
16	M	44	Dislocation	No	Reconstruction	4.5	Moderate	0 to 140	No	0 to 140	No	100	E	E		
17	F	22	Dislocation	No	Reconstruction	12.5	Mild	18 to 145	No	0 to 150	No	100	E	E		
18	F	12	Dislocation	No	Reconstruction	5.6	No	0 to 140	No	0 to 140	No	100	E	E		
19	F	38	Dislocation	No	Reconstruction	5.1	Mild	10 to 135	No	0 to 155	No	100	E	E		
20	M	68	Dislocation	No	Reconstruction	3.7	Moderate	15 to 130	No	0 to 140	No	100	E	E		
21	M	49	Fracture	No	Reconstruction	4.1	Moderate	10 to 135	Severe	15 to 130	No	65	F	F		
22	F	47	Fracture	Yes	Reconstruction	4.8	Moderate	15 to 120	No	0 to 130	No	100	E	E		
23	F	42	Fracture	Yes	Reconstruction	2.5	Moderate	15 to 160	No	0 to 155	No	100	E	E		
24	F	46	Fracture-dislocation	Yes	Reconstruction	4.1	No	0 to 135	Mild	0 to 140	No	75	G	F	DVT	
25	F	15	Fracture-dislocation	Yes	Reconstruction	11.6	No	0 to 145	Mild	20 to 150	No	80	G	F		
26	M	19	Fracture-dislocation	No	Reconstruction	8.3	Moderate	0 to 140	Mild	20 to 125	No	85	G	G		
27	F	60	Fracture-dislocation	Yes	Reconstruction	6.9	Moderate	0 to 140	Mild	0 to 140	No	85	G	E		
28	M	33	Fracture-dislocation	Yes	Reconstruction	3.2	No	5 to 135	Mild	20 to 140	No	85	G	G		
29	F	25	Fracture-dislocation	Yes	Reconstruction	3.1	Moderate	45 to 85	Mild	15 to 130	No	85	G	G	Ulnar neuropathy	Ulnar nerve transposition
30	M	42	Fracture-dislocation	Yes	Reconstruction	5.7	Moderate	30 to 110	No	20 to 140	No	95	E	G	DJD	Interpos. arthroplasty
31	M	25	Fracture dislocation	No	Reconstruction	6.3	No	0 to 150	No	20 to 130	No	100	E	E		
32	M	41	Not identified	Yes	Reconstruction	4.9	Mild	5 to 115	Severe	0 to 140	Yes	60	F	P	Recurrent instability	
33	F	36	Not identified	Yes	Reconstruction	6.2	Severe	5 to 155	Mild	10 to 155	No	80	G	G		
34	M	13	Not identified	No	Reconstruction	7.9	No	0 to 155	Mild	0 to 140	No	85	G	G		
35	F	27	Not identified	No	Reconstruction	3.9	Mild	5 to 145	No	0 to 150	No	100	E	E		
36	M	45	Strain	Yes	Reconstruction	8.9	Severe	25 to 118	Mild	20 to 130	No	80	G	F		

* range of movement from extension to flexion, in degrees

† Mayo elbow performance score

‡ E, excellent; G, good; F, fair; P, poor

§ DJD, degenerative joint disease; HO, heterotopic ossification; DVT, deep-venous thrombosis; LCL, lateral collateral ligament

¶ at final follow-up these elbows were stable after further surgery

** at final follow-up the elbow was stable with no additional surgery

Table I (cont.) Details of the 44 patients who were followed up for a mean of six years

Case	Gender	Age (yrs)	Mechanism	Previous surgery	Surgery	Follow-up (yrs)	Pre-operative review		Most recent review				Complications§	Re-operations§
							Pain	ROM*	Pain	ROM	Recurrence	MEPS†‡	Rating‡§	
37	M	16	Strain	No	Reconstruction	3.7	Moderate	0 to 140	Mild	0 to 140	No	85	G	G
38	F	37	Strain	No	Reconstruction	2.6	Moderate	0 to 150	No	0 to 150	No	100	E	E
39	M	27	Strain	No	Reconstruction	15.2	Moderate	10 to 135	No	0 to 140	No	100	E	E
40	M	19	Strain	Yes	Reconstruction	2.0	Moderate	0 to 140	No	0 to 140	No	100	E	E
41	M	40	Strain	No	Reconstruction	4.4	Mild	15 to 140	No	15 to 150	No	100	E	E
42	M	26	Surgery	Yes	Reconstruction	2.0	Moderate	10 to 130	Moderate	0 to 140	Yes**	60	F	P
43	M	42	Surgery	Yes	Reconstruction	4.8	Mild	10 to 140	Mild	0 to 140	No	80	G	G
44	M	36	Surgery (prior trauma)	Yes	Reconstruction	2.0	Moderate	5 to 140	Severe	0 to 140	No	70	F	DJD
														Radial head resection

* range of movement from extension to flexion, in degrees

† Mayo elbow performance score

‡ E, excellent; G, good; F, fair; P, poor

§ DJD, degenerative joint disease; HO, heterotopic ossification; DVT, deep-venous thrombosis; LCL, lateral collateral ligament

¶ at final follow-up these elbows were stable after further surgery

** at final follow-up the elbow was stable with no additional surgery

tion was limited to 0°, 45° and 60° in three patients, two of whom had only 30° and 40° of pronation, respectively. The remaining patients had a complete range of movement. The pivot-shift test showed subluxation and relocation in 19 patients (42%) and 39 (87%) had apprehension with this manoeuvre (Fig. 1). The ability to rise from a chair pushing with both arms was limited in 22 of the 33 patients of whom this question was asked and 26 of them were unable to do push-ups. Four patients had paraesthesiae in the distribution of the ulnar nerve. Under anaesthesia, all except three patients had a positive posterolateral rotatory pivot-shift test. Arthroscopic evaluation of the elbow was performed to confirm the diagnosis in the remaining three before ligamentous reconstruction. It showed excessive opening at the lateral side of the joint.

Operative treatment. The principles of the surgical technique for repair and reconstruction of the lateral collateral ligament complex have been described previously.⁶ The experience accumulated since the publication of the original report has resulted in the introduction of some modifications. Although no discernible differences in the outcome can be attributed to these, the perception is that the strength of the repair or reconstruction is such as to allow earlier active movement. A variety of surgical techniques has been used in this study.

Ligament avulsions, most commonly from the humeral attachment, were repaired by reinsertion at the isometric point through bone tunnels using heavy non-absorbable sutures as described by Krackow, Thomas and Jones.⁸ Ligamentous laxity was addressed by overlapping and advancement of the ligament and capsule. When the tissue of the lateral complex was of poor quality, the reconstruction was augmented with a tendon autograft or allograft.

The tendon of palmaris longus was the autograft of choice. When absent, autografts or allografts from the tendons of semitendinosus or the plantaris were used. Rarely, the reconstruction was performed with a strip from the triceps aponeurosis or tendo Achillis.

One of the authors (BFM) used a three or four-ply reconstruction and sutured the distal end of the tendon to itself at the entry of the isometric humeral hole creating a 'yoke'. This allowed simultaneous tensioning of the graft at both ends (Fig. 2). Another (SWO) used a two-ply reconstruction in a docking configuration and systematically reinforced the graft reconstruction with a No. 2 monofilament suture which followed the pathway of the tendon graft.

Avulsion from the humeral side was found in eight patients, distal avulsion in one, ligament laxity in 28 and absence of recognisable ligamentous structures in eight. The lateral ligament complex was repaired in 12: five had their complex reattached and seven had an imbrication of the ligamentous tissue. The remaining 32 had the lateral ligament complex augmented with the tendon of palmaris longus (20), the triceps fascia (four), tendo Achillis (three), the plantaris tendon (three) or tendon of semitendinosus (two).

Mersilene tape was used to augment two reconstructions with palmaris longus. Non-absorbable sutures were used to reinforce seven of these with palmaris longus and all with plantaris and semitendinous. Finally, a ligament augmentation device (LAD) was used to augment two of the reconstructions with triceps fascia and two with palmaris longus (3M, St Paul, Minnesota).

Nine patients had an associated procedure through the same approach with removal of a loose body from the elbow in five, a partial synovectomy and release of the com-

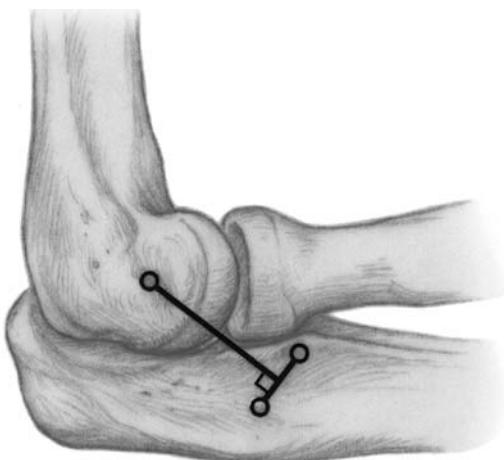


Fig. 2a

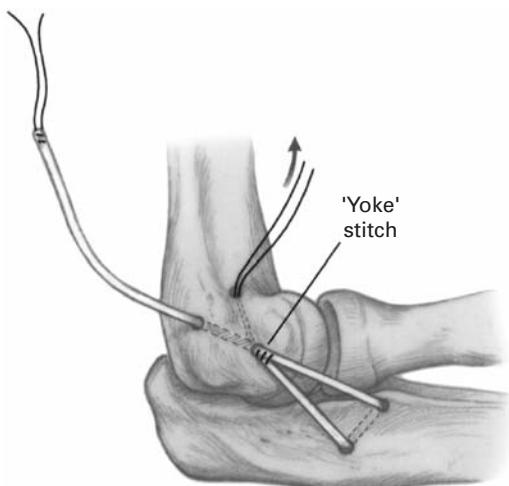


Fig. 2b

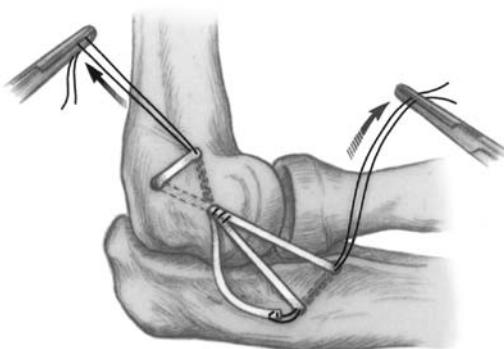


Fig. 2c

Surgical technique for reconstruction of the lateral collateral ligament complex with a tendon graft. Figure 2a – The ulnar tunnel placed in the crista supinatoris tubercle and orientated to have optimum alignment with isometric point. Figure 2b – Placement of the graft into the ulnar tunnel and creation of a "yoke" stitch. Figure 2c – Graft tensioning after introduction into the humeral tunnels.

mon extensor origin for tennis elbow in one, a radial headplasty in one, reconstruction of the annular ligament in one and reconstruction of the coronoid process in one. An elbow capsulectomy was also performed in one of the patients who had removal of a loose body and in the patient who required reconstruction of the annular ligament.

Post-operative management. Initially, the elbow was placed in 70° to 80° of flexion with the forearm in full pronation. The arm was held in this position for ten to 14 days. The patient was allowed protected movement in a hinged brace between two and six weeks after surgery. After six weeks, the patient could remove the hinged splint only for sedentary activities. At the end of an additional period of six weeks use of the splint was discontinued but the patient was encouraged to keep protecting the elbow from strenuous activities. Full activity was allowed at six months and contact sports at one year. During the healing process, the patient was advised to protect the reconstruction from the gravitational stresses placed through the elbow during activities of daily living, such as lifting weights with the shoulder abducted and the lateral aspect of the elbow facing up. It was recommended that patients lifted weights in the plane of elbow flexion and extension, keeping the shoulder adducted and the elbow close to the body.

Evaluation. The patients were assessed at three months and at least one year after surgery by two orthopaedic surgeons (BFM and SWO) to determine their pain, range of movement and stability. In addition, a questionnaire was sent to all the patients for their most recent follow-up. Those who did not return this were contacted by telephone. The questionnaire inquired about subjective satisfaction, pain, range of movement, subjective stability, the occurrence of further episodes of instability and the ability to perform various activities, including those required for calculation of the Mayo elbow performance score⁹ as well as rising from a chair pushing with the affected arm and doing push-ups onto a wall or the floor. All the patients were requested to draw and send tracings of their affected upper limb in maximum flexion and extension of the elbow and these were used to measure the range of movement of the elbow with a goniometer.

The results were graded according to the subjective satisfaction, the Mayo elbow performance score and the grading system described by Nestor et al.⁶ With regard to the performance, a score of 90 points was considered to be excellent, 75 to 89 good, 60 to 74 fair, and less than 60 poor.⁹ According to the system of Nestor et al.,⁶ an excellent result requires no objective or subjective instability, no pain and less than 10° of limitation of movement, a good result no objective or subjective instability, no increase in pain and no loss of range of movement, a fair result objective instability (the patient may have had subjective instability), mild pain and some loss of motion, and a poor result objective instability, including documented episodes of subluxation or dislocation or a positive instability test on physical examination.

Statistical analysis. Changes in continuous and ordinal measurements were assessed using the Wilcoxon sign-rank test. Associations of pairs of continuous or ordinal measures were assessed by Spearman's rank correlation coefficient. Associations between a continuous or ordinal variable and a categorical variable were assessed by the Wilcoxon rank-sum test for categorical variables with two levels or the Kruskal-Wallis test for categorical variables with more than two levels. Fisher's exact test was used to assess associations between pairs of categorical variables. A level of significance of 0.05 was used for all the statistical tests.

Results

Recurrences, re-operations and complications. Seven patients experienced one or more further episodes of instability after reconstruction. Two, whose initial injury had been an isolated dislocation, had another traumatic dislocation 2.6 and 2.9 years after operation. One of these elbows (case 14) had been initially reconstructed with a graft of palmaris longus reinforced with Mersilene tape. This patient was treated conservatively after his second dislocation and has not experienced further episodes of instability. The other patient (case 1) who had originally undergone an overlapping procedure of the ligament, continued to have episodes of subluxation after the second injury, and required a revision using an allograft of plantaris tendon, which has been successful up to the present.

Five more patients had persistent episodes of instability without a history of further injury. Three had originally had their ligamentous complex repaired (cases 2, 7 and 9) and the other two had had a reconstruction with a graft of plantaris reinforced with non-absorbable sutures (case 32) and a graft of palmaris longus reinforced with a LAD (case 42). Two of these patients underwent additional surgery which improved the stability of the elbow, but both complained of significant pain at the most recent follow-up. The other three patients declined further surgery.

In addition to the three patients detailed above who needed further operation because of recurrent instability, four others underwent revision. One developed heterotopic ossification which was treated six months after original ligament re-attachment by excision of the ectopic bone, capsulectomy and transposition of the ulnar nerve. The most recent range of movement is from 20° of extension to 145° of flexion and the elbow is stable. The three other further operations were an interposition arthroplasty for post-traumatic osteoarthritis in a patient whose original injury had been a fracture-dislocation of the radial head, resection of the radial head in a patient with previous degenerative changes in the radiohumeral joint, and transposition of the ulnar nerve performed at another institution 40 days after a palmaris tendon reconstruction in a patient with a previously normal neurological examination.

There were three other post-operative complications which did not require further surgery. One patient devel-

oped a deep-vein thrombosis which resolved after anti-coagulant treatment and two others a superficial post-operative infection which was treated with antibiotics.

Clinical results. Repair or reconstruction of the lateral collateral ligament complex initially improved or eliminated instability of the elbow in all but five of the 45 patients included in the study (89%). Stability was improved in two of the five failures following further surgery, but both complained of residual pain and poor elbow function at the most recent follow-up. The two patients who had suffered an additional episode of traumatic instability had a stable elbow when last seen, although one required a second ligamentous reconstruction. At the most recent review of the 44 patients followed for at least two years, 24 felt that their elbow was completely stable, 17 considered that stability had been improved to the point of not being a limiting factor in their daily activities, and three had intermittent episodes of instability which limited their activities. Fifteen of the 22 patients who had previously been unable to use the affected upper limb to rise from a chair, regained that ability. Similarly, 15 of the 26 patients who were unable to perform push-ups pre-operatively could do so at the most recent follow-up.

Surgery was significantly associated with relief from pain ($p = 0.01$). Pre-operatively, pain had been rated as absent in eight, mild in nine, moderate in 23 and severe in four patients. At the most recent follow-up, it was rated as absent in 16, mild in 17, moderate in four and severe in seven. Of the 11 patients with moderate or severe pain at the most recent follow-up, three had persistent instability, two had undergone further surgery for recurrence, two had had an infection, one had radiohumeral degenerative changes which had been treated by resection of the radial head, and in three there was no detectable explanation for the pain.

The range of movement was maintained or improved in most patients. The mean active elbow extension improved from 12° (0 to 50) before operation to 7° (0 to 60) at the most recent follow-up and the mean active elbow flexion from 136° (85 to 155) to 140° (100 to 155).

Before operation, six patients had a flexion-extension arc of less than 100° and, at the most recent follow-up, it was less than 100° in two patients.

The mean Mayo elbow performance score was 85 points (60 to 100). According to this score, the results were rated as excellent in 17, good in 17 and fair in ten patients. According to the rating system of Nestor et al,⁶ the result was excellent in 19, good in 13, fair in seven and poor in five patients. Subjectively, 23 patients felt that their elbow was much better than before the operation, 15 were better, four were the same, and two were worse. Thirty-eight patients (86%) were subjectively satisfied with the outcome.

Associations. According to the Mayo Elbow performance score, better overall results were obtained in patients with subjective instability at presentation than in those who complained mainly of pain (mean respective scores, 87.6 vs

Table II. Results obtained according to the MEPS⁹ in patients with previous surgery, repair or reconstruction, by number and percentage

	Satisfactory	Unsatisfactory
Previous surgery		
No	19 (86.4)	3 (13.6)
Yes	15 (68.2)	7 (31.8)
Surgical technique		
Repair	7 (58.0)	5 (42.0)
Reconstruction	27 (84.4)	5 (15.6)

71.9, $p = 0.006$). Augmented ligament reconstruction using a tendon graft provided better overall results than ligament repair (mean respective scores 87.3 vs 76.8, $p = 0.04$) (Table II). The results were also better in patients who developed posterolateral rotatory instability after an injury compared with those with an iatrogenic or unknown origin ($p = 0.03$). There was a trend towards better results when instability developed after injury to the elbow without associated fractures than when the elbow had also sustained a fracture or when the instability was not trauma-related, but the differences did not reach statistical significance ($p = 0.05$). With the numbers available, a statistically significant association could not be established between the final outcome and age, gender, dominance, pre-operative range of movement, the severity of pre-operative pain or the length of follow-up.

Discussion

Instability of the elbow is a rare consequence following dislocation.¹⁰⁻¹² The existence of specific patterns of instability has only been fully appreciated over the last two decades, and our understanding of the mechanisms continues to evolve. Evaluation and treatment of the unstable elbow require recognition of the pattern of instability, identification of the pathology responsible and reconstruction of the structures required to restore stability. Patients who have persistent or recurrent instability may have varied underlying pathology.⁷ Our study focused on the outcome of patients with a posterolateral rotatory pattern of instability which was treated by reconstruction of the lateral collateral ligament complex.

Although some authors have attributed the cause of posterolateral instability to separate components of the lateral complex, such as the lateral ulnar collateral ligament^{1,13} or the lateral collateral ligament and its insertion into the annular ligament,²⁻⁵ reconstruction of a ligamentous structure on the lateral side of the joint has been uniformly recommended for the treatment of this problem.^{1-7,14}

Injury to the lateral ligament complex is usually traumatic or iatrogenic.^{1,6} Most of the patients in our study developed the instability after an injury. It is important to recognise that although several had sustained a previous dislocation with or without associated fractures, posterolateral rotatory instability also resulted from an injury without an associated dislocation in a number of cases. Our

study does not specifically address the management of acute injuries and dislocations.

In eight cases the condition arose from iatrogenic damage to the lateral collateral ligament complex during surgery involving the lateral aspect of the elbow. The ligament complex can be inadvertently detached from the humeral side in extensive releases for tennis elbow, or transected during a Kocher approach which is commonly used for the surgical treatment of a fractured radial head.^{2,6,15} A more widespread awareness of the anatomy of the lateral ligament complex would hopefully reduce this complication.

The diagnosis of posterolateral rotatory instability may be missed if it is not suspected and investigated explicitly. Several patients in our study complained of pain, locking or catching but did not specifically recognise instability of the elbow. Assessment of stability with the varus stress, posterolateral drawer, posterolateral apprehension and posterolateral pivot-shift tests should be part of the evaluation of every elbow with mechanical symptoms, a previous injury, or surgery in the vicinity of the lateral ligament complex. It should be noted that some of these tests, such as the pivot-shift, may be difficult to demonstrate if the radial head has been resected or the patient does not relax adequately. When in doubt, the elbow should be examined under fluoroscopic control and occasionally under anaesthesia. Other imaging studies such as MRI are usually not needed.

Reconstruction of the lateral collateral complex eliminated instability in most patients. However, in complex cases, reconstruction of the medial collateral ligament, coronoid or radial head may be required. However, this study describes only patients who had been treated by isolated repair or reconstruction, and the results cannot be extrapolated to more complex problems or reconstructive procedures.

Our approach to this problem has been refined since the initial publication of Nestor et al.⁶ Although overlapping is still performed when the lateral collateral ligament complex is lax but of good quality, reconstruction with a tendon graft is also carried out if the strength of this repair is doubtful. At the present time, we tend to use tendon allografts to avoid the morbidity related to the harvesting of an autograft.

Our study has several weaknesses. The information was collected retrospectively, the length of follow-up by physical examination was limited, and different techniques of ligament reconstruction had been used. However, it has several strengths. Patients with additional reconstructive surgery were excluded to assess the isolated effect of lateral repair or reconstruction, only one patient was lost to follow-up and the mean time of follow-up was six years. It also included enough patients to allow identification of prognostic factors for the surgical treatment of this condition.

Reconstruction or repair of the lateral collateral ligament complex for patients with posterolateral rotatory instabil-

ity of the elbow was effective. Augmented ligamentous reconstruction using a tendon graft gave reliable results. Patients with objective but not subjective instability of the elbow had a less satisfactory outcome. Better results were obtained in patients with post-traumatic instability. Further studies are needed to determine if reconstruction of associated injuries to the radial head or coronoid will result in improved outcomes for that subset of patients.

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