Surgical treatment of Rockwood grade-V acromioclavicular joint dislocations

50 patients followed for 15–22 years

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Background and purpose Long-term outcome after surgery for grade-V acromioclavicular joint dislocation has not been reported. We performed a retrospective analysis of functional and radiographic outcome 15–22 years after surgery.

Patients and methods We examined 50 patients who were treated at our hospital between April 1985 and December 1993. Various methods of stabilization were used: K-wires (n = 36), 4.5-mm screw (n = 12), or biodegradable screw (n = 2). Osteosynthesis material was removed after 6–8 weeks. Mean follow-up time was 18 (15–22) years. Outcomes were assessed with the Constant shoulder (CS) score, Disabilities of the Arm, Shoulder, and Hand (DASH) score, the simple shoulder test (SST), the Copeland shoulder impingement test, the cross-arm test, pain, stability of the AC joint, and complications. From radiographs, we evaluated AC and glenohumeral (GH) arthrosis, osteolysis of the lateral clavicle, and alignment of the clavicle with the acromion.

Results Mean values were 90 (75–100) in CS score, 5.1 (0–41) in DASH score, and 11 (2–12) in SST. There was no statistically significant difference in CS score between the injured shoulder and the uninjured shoulder. The AC joint was clinically stable in 42 patients. In 38 patients, the clavicle alignment with the acromion was normal in radiographs. Lateral clavicle osteolysis (10 patients) appeared to be associated with permanent AC joint dislocation.

Interpretation Surgery with a temporary fixation for acute grade-V AC joint dislocation leads to successful long-term functional results. Only minor disability occurred in some patients.

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The acromioclavicular (AC) and the coracoclavicular (CC) ligaments stabilize the AC joint in both the horizontal and the vertical plane (Bontempo and Mazzocca 2010). AC joint dislocations are usually classified according to Rockwood, a classification based on degree of soft tissue injury and clavicle dislocation. In anteroposterior radiographs, grade-V denotes a 100–300% increase in the coracoclavicular distance (Galatz et al. 2009).

Several surgical methods have been reported for repair of ruptured AC and CC ligaments. Recent studies have focused on anatomical reconstruction of CC ligaments, arthroscopically assisted CC ligament reconstruction, and use of suture anchors (Basyoni et al. 2010, DeBerardino et al. 2010, Fraschini et al. 2010, Yoo et al. 2010).

To our knowledge, there have been no published studies on long-term results of surgery for grade-V AC joint dislocations. We retrospectively analyzed the long-term functional and radiographic outcome after surgery for acute grade-V AC joint dislocations.

Patients and methods

From April 1985 to December 1993, our hospital register showed that 390 patients had been treated surgically for acute AC joint dislocation. Most of the patients (n = 277) had the surgery for grade-I, -II, or -III dislocation. After exclusion of multiple-trauma patients and patients who had had surgery more than 2 weeks after injury, 113 patients with grade-V dislocation remained, 50 of whom were examined clinically and radiographically by the first author (KJV). The majority of the patients were male. Most of the patients had been injured by falling from a bicycle or by a simple fall. Mean age at the time of injury was 36 (20–57) years, and at the time of examination it was 54 (40–75). Mean follow-up time was 18 (15–22) years (Table 1).

Surgery had been performed under general anesthesia. The patient lay in a beach-chair position with the head turned away

Table 1. Characteristics of patients with Rockwood grade-V acromioclavicular joint dislocation. The 50 patients were examined after a mean of 18 years

Male	42	
Female	8	
Injured side		
left	27	
right	23	
Dominance		
left	4	
right	46	
Mechanism of trauma		
bicycling	20	
simple fall	20	
sport	6	
traffic accident	4	
Mean age at time of trauma, years	36	(20–57)
Mean age at time of examination, years	54	(40–75)
Mean follow-up time, months	215	(180–263)
Mean follow-up time, years	18	(15–22)

Table 2. Functional and clinical outcomes in 50 patients treated surgically for Rockwood grade-V acromioclavicular joint dislocation. The results are reported after a mean of 18 years of follow-up

Outcome	
CS, injured shoulder, mean (SD)	90 (6)
CS, uninjured shoulder, mean (SD)	90 (11)
DASH, mean (SD)	5.1 (8.4)
SST, mean (SD)	11 (1.6)
VAS at rest (0–100), mean (SD)	8 (17)
VAS at activity (0-100), mean (SD)	18 (25)
Instability of AC joint (n)	8
Cross-arm test positive (n)	1
Impingement test positive (n)	4

CS = Constant shoulder Score
DASH = Disabilities of the Arm, Shoulder, and Hand
SST = Simple Shoulder Test
VAS = Visual Analog Scale

from the side of the fracture. A transverse incision was made over the lateral clavicle and AC joint. The AC joint was reset manually, and the joint was stabilized with either 2 parallel non-threaded K-wires from the lateral edge of the acromion into the clavicle (36 patients), with 1 partially threaded 4.5-mm cancellous screw or 1 fully threaded 4.5-mm cortical screw through the acromion into the clavicle (12 patients), or with 1 biodegradable screw through the acromion into the clavicle (2 patients). The lateral ends of the K-wires were bent to prevent migration medially. Ruptured AC and CC ligaments were sutured. The position of the AC joint and osteosynthesis were ascertained with intraoperative radiographs. The deltoid and the trapezial aponeurosis were re-attached. The postoperative treatment protocol was uniform in all patients. The arm was immobilized in a sling for 3 weeks. Pendulum motion, abduction, and flexion up to the horizontal plane were started after 3 weeks. Fully active motion was allowed after osteosynthesis removal. K-wires and screws were removed 6–8 weeks after surgery under local anesthesia. Biodegradable screws were not removed.

Outcome measures included Constant shoulder (CS) score, Disabilities of the Arm, Shoulder, and Hand (DASH) score, the simple shoulder test (SST), the Copeland shoulder impingement test, the cross-arm test, pain (on a visual analog scale, VAS 0–100), clinical stability of the AC joint (independent of radiographic findings), and complications.

From postoperative radiographs, we evaluated the alignment of the AC joint, mechanical and methodological failures, and K-wire migration. Radiographs taken for the long-term follow-up included both clavicles. On these radiographs, we assessed AC and glenohumeral (GH) joint arthrosis, osteolysis of the lateral clavicle, distance between the coracoid process and the clavicle, AC joint space, and the alignment of the lateral clavicle with the acromion. We assessed the vertical translation of the clavicle at the AC joint in clavicle widths. The

study was approved by the local ethics committee (Helsinki University Central Hospital Ethics Committee, Department of Surgery: 2004-02-27, 66/E6/04).

Statistics

We used Kolmogorov-Smirnov test for normality. Nominal variables were analyzed by the McNemar test. Differences between continuous variables in relation to the injured shoulder and the uninjured shoulder were assessed with 95% confidence interval (CI) for means. Subgroup analyses comparing the results between patients with or without complications and with different grades of joint positions were analyzed with Fisher's exact test. For all tests, we considered a 2-sided level of 0.05 to be significant. Statistical analyses were performed with IBM SPSS statistical software version 20.0.

Results

The mean CS score was 90 (CI: 88–92) in the injured shoulder and 90 (CI: 87–93) in the uninjured shoulder. Subjective function, measured with DASH score and SST, was excellent. Pain at rest and on activity was mild (Table 2).

Radiographs were obtained from 49 patients (1 patient refused). AC joint arthrosis appeared in 27 patients and GH joint arthrosis in 4 patients. Osteolysis of the lateral clavicle affected 10 patients; 1 had bilateral osteolysis, 1 had osteolysis in the uninjured clavicle, and 8 had osteolysis in the injured clavicle (p = 0.04) (Table 3). Heterotopic ossification was evident in 20, appearing most in the region of the CC ligaments. In addition, ossification appeared in the AC joint, at the lateral end of the clavicle, and in the lateral border of the acromion. No interventions were necessary for heterotopic ossification. The AC joint stayed in good reduction in 38 patients. Surprisingly, half of the patients who had had a redislocation of the

Table 3. Radiographic results after a mean of 18 years of follow-up in 49 patients treated surgically for grade-V acromioclavicular joint dislocation

Radiographic findings	n	p-value
Acromioclavicular joint arthrosis	27	1.0
injured joint	11	
uninjured joint	11	
bilateral	5	
Glenohumeral joint arthrosis	4	0.5
injured side	1	
uninjured side	3	
bilateral	0	
Lateral clavicle osteolysis	10	0.04
injured side	8	
uninjured side	1	
bilateral	1	
Clavicle alignment with acromion in vertical plane [a]		
in place	38	
subluxation	5	
dislocation	6	

Radiological finding	mm	95% CI
Distance between coracoid process and clavicle		
injured side	13	11–14
uninjured side	9	8.0–9.3
Acromioclavicular joint space		
injured joint	6	4.8–7.4
uninjured joint	3	2.6–4.0

[a] In place: the reduction of the AC joint was anatomical in antero-
  posterior radiograph;
subluxation: the clavicle was in superior translation > half clavicle
  width, but < 1 clavicle width in anteroposterior radiograph;
dislocation: the clavicle was in superior translation ≥ 1 clavicle width
  in anteroposterior radiograph.

AC joint after the primary surgery had an anatomical reduction of the joint during the follow-up (for Figure, see supplementary data).

Early complications occurred in 18 patients. In 12 patients, the reduction was lost within 2 months after the operation. Of these patients, 9 joints had been stabilized initially with K-wires, 1 with a screw, and 2 with a biodegradable screw. Loss of reduction occurred in 11 joints before the osteosynthesis removal and in 1 after osteosynthesis removal. Only 2 patients had a reoperation due to reduction loss. 1 patient, initially stabilized with a biodegradable screw, had a wound infection and was therefore treated with oral antibiotics for 6 months. In 3 patients, the K-wires were broken in the line of the AC joint without a dislocation; in 2 of these, the medial ends of the K-wires were still visible in the clavicle. In 1 patient, a K-wire migrated into the supraclavicular fossa. It was removed 1 year after the primary operation.

We compared the functional, clinical, and radiographic outcome in patients with normal radiographic joint appearance with those whose joints were subluxated or permanently dislocated. Lateral clavicle osteolysis seemed to appear most often in patients with constant AC joint dislocation (Table 4, see

supplement data). We also compared outcome in patients with no complications (n = 14) to those in patients with early (n = 18) or late complications (n = 18). We found no statistically significant difference in CS score, DASH score, SST, or pain score between these subgroups (Table 5, see supplementary data).

Due to persistent pain, 1 patient underwent a resection of the lateral end of the clavicle 16 years after the primary AC joint dislocation. He managed well until a new fall injured the same AC joint. Another patient had a new traumatic grade-V AC joint dislocation on the previously injured side, which was treated nonoperatively.

Discussion

Despite several complications, we found good long-term function in patients who had undergone surgery for grade-V AC joint dislocation. In Rockwood grade-V injury, AC and CC ligaments and both the origin of the deltoid and insertion of the trapezius are torn, causing extreme instability of the AC joint (Galatz et al. 2009). The objective of surgery is to create an optimal environment for AC ligaments, CC ligaments, and muscle attachments to heal and thus achieve a stable clavicle. Urist (1946) found that the most important structures for clavicular stability are the superior AC ligament, the AC joint capsule, and both deltoid and trapezoidal attachments. Recently, the function of AC and CC ligaments and muscle aponeurosis in clavicular stability has been defined more precisely (Fukuda et al. 1986, Lee et al. 1997, Debski et al. 2000, 2001).

The literature provides a variety of methods for stabilization of the AC joint (Leidel et al. 2009, Salem and Schmelz 2009, Basyoni et al. 2010, DeBerardino et al. 2010, Petersen et al. 2010, Salzmann et al. 2010, Yoo et al. 2010). Temporary K-wire fixation has been criticized for failing to stabilize the AC joint sufficiently to achieve a stable joint. As in ankle syndesmosis separation, the goal in the treatment of dislocation of the AC joint is the healing of the short ligaments during the temporary fixation. Thornes et al. (2005) reported that healing of the ankle syndesmosis ligament does not necessary require rigid temporary fixation. Of our 36 patients who had stabilization with temporary K-wires, loss of reduction shortly after the primary surgery occurred in 9 patients. However, in long-term follow-up, loss of reduction was evident only in 2 patients. Thus, the ligament and muscle-attachment healing process can continue for years after the injury and the temporary stabilization. A possible mechanism for the improvement in joint position might be the tightening of the collagen fibers in the scar tissue during the ligament-healing process.

The optimal length of time for the temporary K-wire stabilization is not known. The stabilization should be long enough for the healed ligaments and muscle aponeurosis to be able to tolerate the mechanical load. We used a temporary 6- to

8-week AC joint stabilization. Occasionally, ligament healing failed during this period. A longer fixation period might have provided better ligament healing.

To date, there has been no explanation for the nature of CC ligament rupture and of AC ligament rupture in the literature. We do not know the possible difference in healing capability between ligament avulsion and midsubstance rupture. From clinical experience, we have noticed that AC ligament injury is often an avulsion from the clavicle. Because of the importance of the AC ligament in clavicular stability, we suggest that this lesion should always be repaired (Urist 1946).

Our patients had plenty of complications, but none of them were serious. Loss of reduction was common in the early phase. Despite permanent dislocation of the AC joint, it seems that with long-term follow-up, it had no influence on shoulder function, as also reported by Rawes and Diaz (1996). We found no relationship between constant AC joint dislocation or subluxation and AC joint arthrosis. Appearance of heterotopic ossification was common and was typical in the region of the CC ligaments. We found no relation between heterotopic ossification and the treatment method. This phenomenon is more likely a common biological consequence of ligament-rupture healing.

The etiology of lateral clavicle osteolysis is unknown (Gordon and Chew 2004). One cause could be a local bone-circulation disturbance. AC ligaments and muscle aponeurosis may be crucial for the lateral clavicle circulation (Knudsen et al. 1989). Posttraumatic lateral clavicle osteolysis may appear from weeks to several years after the primary injury (Levine et al. 1976). We found no association between the osteosynthesis method and the appearance of osteolysis. Instead, osteolysis was most common in the patients with permanent dislocation of the AC joint. A stable AC joint may enable revascularization of the lateral end of the clavicle.

Stabilization of the AC joint with K-wires is a technically demanding procedure. K-wire migration, which is relatively rare, can have serious sequelae (Regel et al. 2002, Hegemann et al. 2005). To prevent this undesirable complication, K-wires should be positioned through the acromion into the clavicle, and the medial ends should lie precisely in the cortical bone of the clavicle. Accurate positioning of K-wires must be verified using intraoperative radiographs. The thickness of K-wires should also be adequate: at least 1.8–2.0 mm.

The present study had some limitations. It was a retrospective cohort study, so there was evidence of level III. We were unable to examine all patients who were eligible, so there was a risk of selection bias.

To summarize, with long-term follow-up we found that temporary K-wire or screw stabilization of acute grade-V AC joint dislocation achieved good functional outcome, and that the sequelae were of minor importance and did not lead to any permanent insufficiency. We also found that early loss of reduction can improve to normal joint appearance during long-term follow-up.

Supplementary data

Figure and Tables 4 and 5 are available at Acta's website (www.actaorthop.org), identification number 5819.

KJV found the eligible patients from hospital registers, examined the patients, and wrote the manuscript. The other authors edited the manuscript and helped with the statistics.

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