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# Early and delayed acromioclavicular joint reconstruction provide equivalent outcomes

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**Background:** Some comparative studies have reported improved outcomes for early compared with delayed reconstruction for high-grade acromioclavicular (AC) joint dislocations. However, most are based on older techniques and did not specifically involve reconstruction of both the coracoclavicular (CC) and AC joint ligaments. The purpose of this study was to compare functional outcomes of early vs. delayed surgical intervention of AC joint dislocations managed with combined CC and AC ligament reconstruction.

**Methods:** A retrospective comparative study was performed of 53 patients who underwent early (<2 weeks after injury) or delayed (≥2 weeks after injury) open stabilization for AC joint dislocation. All patients were managed with the same surgical technique of combined CC reconstruction and stabilization of the AC joint, except for the addition of a gracilis allograft for biologic CC reconstruction in delayed intervention. Outcome was determined at a minimum follow-up of 12 months, using the Acromioclavicular Joint Instability (ACJI) score, Taft score, Subjective Shoulder Value (SSV), visual analog scale (VAS) for pain, and overall satisfaction (0-10). Multivariable regression analyses were performed to test associations of ACJI and Taft scores with 5 independent variables (early vs. delayed surgery, age, sex, manual worker, and Rockwood type).

**Results:** The cohort comprised 47 men (89%) and 6 women (11%) aged 40.1 ± 11.2 years (range, 22-63 years). The early group (n = 31) underwent surgery 1.1 ± 0.5 weeks after injury, whereas the delayed group (n = 22) underwent surgery 84.3 ± 99.1 weeks after injury. There were no significant differences in ACJI scores (87 ± 14 vs. 89 ± 14, $P = .267$), Taft scores (10.1 ± 1.3 vs. 10.7 ± 1.3, $P = .084$), pain on VAS (0.3 ± 0.7 vs. 0.6 ± 1.1, $P = .541$), SSV (95 ± 7 vs. 93 ± 9, $P = .427$), or overall satisfaction (9.6 ± 0.9 vs. 9.4 ± 1.1, $P = .491$). Multivariable analyses revealed no associations between any of the independent variables and ACJI or Taft score.

**Conclusions:** Early and delayed surgical interventions of high-grade AC joint dislocation provide equivalent clinical scores when combined CC and AC joint fixation is used for stabilization. Rapid surgical intervention for high-grade AC joint dislocation may not be necessary, as most patients can still benefit from surgery at a later stage.

**Level of evidence:** Level III; Retrospective Cohort Comparison; Treatment Study



**Keywords:** Shoulder; acromioclavicular joint dislocation; instability; coracoclavicular reconstruction; treatment; outcome

Institutional review board approval was obtained before the study (12-26).

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There are numerous techniques to treat acromioclavicular (AC) joint dislocations, including anatomic and nonanatomic repair or reconstruction.[9,21] Stabilization of the AC and coracoclavicular (CC) joints can be achieved using rigid fixation with sutures or wires,[5,19] or nonrigid fixation using synthetic materials or hook plates that require secondary surgery for hardware removal.[4,7] Although low-grade dislocations (Rockwood types I and II) can be managed conservatively, the treatment of high-grade dislocations (types III-VI) remains a matter of debate.[11]

Several comparative studies have reported improved outcomes for early surgical repair (<2 weeks from injury) compared with delayed surgical reconstruction (≥2 weeks from injury) for high-grade AC joint dislocations.[14,20,23] However, most of these studies used nonanatomic techniques with K-wires or hook plates. Therefore, these findings may not apply when using more modern anatomic techniques. Specifically, combined AC and CC fixation has demonstrated superior biomechanical strength compared with historical techniques as well as reliable clinical outcomes.[8] In addition, none of these studies used specific scores for AC joint dislocation, such as the AC Joint Instability (ACJI)[17] or Taft scores,[18] both of which demonstrated greater sensitivity to specific parameters of the AC joint compared with more commonly used scores such as the Constant score or Subjective Shoulder Value (SSV).[17]

The purpose of this study was to compare functional outcomes of early vs. delayed surgical intervention of high-grade AC joint dislocations managed with combined CC and AC ligament reconstruction. The hypothesis was that there would be no significant difference in outcomes of early vs. delayed surgical intervention.

## Materials and methods

### Study design and population

A retrospective review was performed of all patients who underwent open stabilization for AC joint dislocation between September 2011 and May 2018, by the same surgeon (AL) at a single center. During this period, open stabilization was the routine treatment for dislocations of Rockwood types IV and V, whereas conservative management was the routine treatment for dislocations of Rockwood type III, of which only 12% were treated by open stabilization. The indications for surgery in type III dislocations were young patients involved in heavy labor, athletes, patients with an unacceptable cosmetic deformity, and patients demanding surgical treatment. Inclusion criteria were (1) ≥16 years of age at the time of surgery, (2) AC joint dislocation Rockwood type ≥III, and (3) minimum follow-up of 12 months. Revision procedures and patients undergoing nonoperative treatment were excluded. The cohort was divided into 2 groups depending on the time from injury to surgery: early (<2 weeks after injury) and delayed (≥2 weeks after injury) according to current recommendations.[3]

The surgical technique was identical for early and delayed interventions, except for the addition of a gracilis allograft for biologic CC reconstruction in delayed intervention. Surgery was performed under general anesthesia in the beach-chair position by open reduction with AC and CC cerclage according to a previously described technique.[9] A longitudinal incision was made, permitting visualization of the clavicle, base of the coracoid process, AC joint, and acromion. Care was taken not to excise or damage the distal clavicle. The base of the coracoid process was then exposed, and a subcoracoid transfer with 4 nonabsorbable Ethibond No. 6 sutures (Ethibond; Ethicon, Hamburg, Germany) was then performed. The joint was reduced under direct visualization and the CC cerclage was tied tightly. AC joint stabilization was then performed with No. 6 sutures. Two 2.5-mm holes were drilled, 5 mm from the lateral end of the clavicle and 5 mm from the medial end of the acromion. The sutures were then passed through these holes and tied to limit anteroposterior translation.[2]

### Postoperative rehabilitation

Postoperative rehabilitation was the same in both groups. The arm was immobilized in a sling for the first 6 weeks. Passive shoulder motion was initiated 3 weeks postoperatively, and exercises against resistance were allowed at 6 weeks postoperatively. Sports and heavy labor were allowed at 12 weeks postoperatively.

### Clinical evaluation

Patients were evaluated at a minimum of 12 months after surgery using radiographic evaluation, the ACJI score,[17] Taft score,[18] pain on the visual analog scale (0-10), SSV,[6] and overall satisfaction (0-10). The primary outcome was the ACJI score that evaluates 5 items (100 points): pain (20 points), activities of daily living (10 points), cosmesis (10 points), function (25 points), and radiological assessment (35 points). This test adds specific parameters of the AC joint (tenderness, deformity or the presence of problems with surgical scar, radiological degenerative changes, degree of stability in the vertical and horizontal plane).

### Statistical analysis

A priori sample size calculation to ensure fulfillment of the principal goal of the study indicated that 20 patients per group were needed to determine the significance of a difference of 10 points in ACJI score between the 2 groups, assuming equal standard deviations of 12.3 points,[22] with a statistical power of 0.80. Normality of distribution was assessed using the Shapiro-Wilk test. For continuous data, differences between groups were evaluated using the unpaired t-test or Wilcoxon rank-sum test depending on data distribution. For categorical data, differences between groups were evaluated using Fisher's exact test. Multivariable linear regressions analyses were performed to test associations between 2 postoperative scores (ACJI and Taft) and 5 independent variables (early vs. delayed surgery, age, sex, manual worker, and Rockwood types of AC joint injury). With a sample

size of 53 patients at final follow-up, multivariable analyses were deemed sufficiently powered considering the recommendations of Austin and Steyerberg of 2 subjects per variable.[1] Statistical analyses were performed using R version 3.4.3 (R foundation for Statistical Computing, Vienna, Austria). $P$ values $<.05$ were considered statistically significant.

## Results

A total of 61 patients met the study criteria, of whom 53 patients (53 shoulders, 87%) were available for follow-up. Dislocations were of Rockwood type III in 14 patients (26%), type IV in 17 patients (32%), and type V in 22 patients (42%). The cohort comprised 47 men (89%) and 6 women (11%) aged 40.1 ± 11.2 years (range, 22-63 years) at index surgery (Table I). The early intervention group (n = 31) underwent surgery at 1.1 ± 0.5 weeks (range, 0.3-2.0 weeks) after injury, whereas the delayed intervention group (n = 22) underwent surgery at 84.3 ± 99.1 weeks (range, 10-338 weeks) after injury. The early and delayed intervention groups did not differ in preoperative demographics or AC joint dislocation Rockwood types. Four complications were noted in 3 patients in the delayed intervention group, including hyposensitivity in the hand, infection treated by lavage, and 2 clavicular osteolyses.

### Clinical outcomes

At a follow-up of 3.4 ± 1.6 years (range, 1.0-7.1 years) for the early intervention group and 3.6 ± 1.6 years (range, 1.4-6.0 years) for the delayed intervention group, there were 9 episodes of horizontal instability in each group (3 subluxations and 6 dislocations per group). Anteroposterior stress radiographs, according to Rockwood,[15] revealed a higher incidence of AC joint displacements in the early intervention group (24 of <10%; 1 of 10%-25%; 5 of 25%-100%; and 1 of 100%-300%) compared with the delayed intervention group (16 of <10%; 2 of 10%-25%; 3 of 25%-100%; and 1 of 100%-300%) (Table II).

No significant differences between the early and delayed groups were noted in ACJI scores (87 ± 14 vs. 89 ± 14, $P = .267$), Taft scores (10.1 ± 1.3 vs. 10.7 ± 1.3, $P = .084$), pain on VAS (0.3 ± 0.7 vs. 0.6 ± 1.1, $P = .541$), SSV (95 ± 7 vs. 93 ± 9, $P = .427$), or overall satisfaction (9.6 ± 0.9 vs. 9.4 ± 1.1, $P = .491$) (Table II). Side-to-side differences revealed a reduced external rotation of 10°-25° among both groups (4 vs. 3), whereas internal rotation increased in 1 (1 vs. 0). Univariable analyses revealed no associations between any of the variables and either ACJI or Taft score, further confirmed by multivariable analyses (Tables III and IV).

## Discussion

The most important finding of this study was that both early and delayed surgical interventions of AC joint dislocations provided equivalent clinical scores when both CC ligaments and AC joint are stabilized. This confirms the hypothesis that there is no significant difference in outcomes of early vs. delayed surgical intervention and suggests that attempting conservative treatment for high-grade AC joint dislocation would not compromise outcomes of subsequent surgical intervention, if required.

**Table I** Patient preoperative data for early and delayed surgical stabilization groups

| | Early (n = 31) | | Delayed (n = 22) | | $P$ value |
|---|---|---|---|---|---|
| | Mean ± SD or n (%) | Range | Mean ± SD or n (%) | Range | |
| Time from accident to surgery (weeks) | 1.1 ± 0.5 | (0.3-2.0) | 84.3 ± 99.1 | (10-338) | <.001 |
| Age at index surgery (yr) | 39.3 ± 10.3 | (22-63) | 41.1 ± 12.6 | (15-64) | .372 |
| Rockwood type | | | | | .531 |
| III | 7 (23) | | 7 (32) | | |
| IV | 9 (29) | | 8 (36) | | |
| V | 15 (48) | | 7 (32) | | |
| Sex | | | | | .683 |
| Male | 28 (90) | | 19 (86) | | |
| Female | 3 (10) | | 3 (14) | | |
| Smoking | 6 (19) | | 3 (14) | | .720 |
| Manual work | 6 (19) | | 10 (45) | | .068 |
| Hindrance during sport | | | | | .629 |
| None | 1 (3) | | 1 (5) | | |
| Minor | 17 (55) | | 9 (41) | | |
| Major | 13 (42) | | 12 (55) | | |
| Dominant arm | 23 (74) | | 13 (59) | | .371 |

*SD*, standard deviation.

**Table II** Patient postoperative data for early and delayed surgical stabilization groups

| | Early (n = 31) | | Delayed (n = 22) | | *P* value |
|---|---|---|---|---|---|
| | Mean ± SD or n (%) | Range | Mean ± SD or n (%) | Range | |
| Follow-up (yr) | 3.4 ± 1.6 | (1.0-7.1) | 3.6 ± 1.6 | (1.4-6.0) | .731 |
| ACJI score (0-100) | 86.8 ± 13.6 | (44-100) | 89.0 ± 13.9 | (55-100) | .267 |
| Taft score (0-12) | 10.1 ± 1.3 | (7-12) | 10.7 ± 1.3 | (8-12) | .084 |
| Pain on VAS (0-10) | 0.3 ± 0.7 | (0-2) | 0.6 ± 1.1 | (0-3) | .541 |
| SSV (0-100) | 95.2 ± 7.0 | (70-100) | 93.0 ± 8.7 | (70-100) | .427 |
| Satisfaction (0-10) | 9.6 ± 0.9 | (6-10) | 9.4 ± 1.0 | (6-10) | .491 |
| Horizontal stability | | | | | |
| Stable | 22 (71) | | 13 (59) | | |
| Subluxation | 3 (10) | | 3 (14) | | |
| Dislocation | 6 (19) | | 6 (27) | | |
| Vertical stability | | | | | |
| <10% | 24 (77) | | 16 (73) | | |
| 10%-25% | 1 (3) | | 2 (9) | | |
| 25%-100% | 5 (16) | | 3 (14) | | |
| 100%-300% | 1 (3) | | 1 (5) | | |

*ACJI*, Acromioclavicular Joint Instability; *VAS*, visual analog scale; *SSV*, Subjective Shoulder Value; *SD*, standard deviation.

**Table III** Uni- and multivariable regression analysis of the ACJI score

| | Univariable (n = 53) | | | Multivariable (n = 53) | | |
|---|---|---|---|---|---|---|
| | β (pts) | 95% CI | *P* value | β (pts) | 95% CI | *P* value |
| Age (yr) | 0.0 | (−0.3 to 0.4) | .905 | 0.0 | (−0.3 to 0.4) | .881 |
| Male sex | −3.7 | (−15.6 to 8.2) | .537 | −5.0 | (−18.0 to 8.0) | .439 |
| Manual worker | 3.4 | (−4.8 to 11.7) | .403 | 3.9 | (−5.6 to 13.4) | .411 |
| Delayed intervention | 2.2 | (−5.5 to 9.9) | .569 | 0.8 | (−7.7 to 9.3) | .846 |
| Rockwood type | | | | | | |
| Type III vs. IV | 0.1 | (−10.0 to 10.1) | .989 | 0.2 | (−10.2 to 10.6) | .971 |
| Type III vs. V | −1.4 | (−11.0 to 8.1) | .766 | −0.5 | (−10.8 to 9.8) | .924 |

*ACJI*, Acromioclavicular Joint Instability; *CI*, confidence interval.

Several studies have compared conservative with surgical treatment for high-grade AC joint dislocation, with a recent meta-analysis by Tang et al[20] that found lower incidences of CC ligament ossification and lateral clavicle osteolysis, but no significant differences in clinical outcomes. Likewise, Murray et al[14] found equivalent functional outcomes after both surgical and conservative treatments for high-grade AC joint dislocation, with only 16% requiring surgery after failed conservative treatment, which does not justify routine surgical intervention.

In the present study, clinical outcomes compared favorably with the literature. Tauber et al[22] found similar postoperative ACJI and Taft scores using a triple-bundle technique (84.7 and 10.9, respectively) that was performed 9 months after injury, but found significantly worse scores using a single-bundle technique (58.4 and 9.0, respectively) that was performed 23 months after injury. Metzlaff et al[12] found worse ACJI and Taft scores using minimally invasive AC joint repair (78.1 and 10.9, respectively) compared with a hook plate for AC joint reconstruction (80.8 and 10.5, respectively), both performed <2 weeks after injury.

In a systematic review published in 2013, Modi et al[13] identified 2 retrospective studies that compared early with delayed interventions of AC joint dislocation,[16,23] albeit using somewhat outdated techniques such as K-wires or hook plates. Rolf et al[16] found better outcomes in the early intervention group who received a modified Phemister procedure, also using K-wires, 10 days (range, 2-40 days) after injury compared with the delayed group who received a modified Weaver-Dunn procedure at 215 days (range, 68-900 days) after injury. Rolf et al[16] attributed the differences in outcomes to underestimation of the initial injury in patients who received delayed intervention, which compromises potential for healing. von Heideken et al[23] found significantly better SSV in patients who received surgery within 1 month (range, 0.1-0.4 months) after injury, especially in Rockwood type V, compared with those who

**Table IV** Uni- and multivariable regression analysis of the Taft score

| | Univariable (n = 53) | | | Multivariable (n = 53) | | |
|---|---|---|---|---|---|---|
| | β (pts) | 95% CI | *P* value | β (pts) | 95% CI | *P* value |
| Age (yr) | 0.0 | (−0.0 to 0.0) | .727 | 0.0 | (−0.0 to 0.0) | .616 |
| Male sex | 0.2 | (−1.0 to 1.3) | .766 | 0.1 | (−1.1 to 1.3) | .889 |
| Manual worker | 0.6 | (−0.2 to 1.4) | .122 | 0.6 | (−0.3 to 1.4) | .215 |
| Delayed intervention | 0.6 | (−0.1 to 1.3) | .095 | 0.5 | (−0.3 to 1.3) | .193 |
| Rockwood type | | | | | | |
| Type III vs. IV | 0.4 | (−0.6 to 1.4) | .414 | 0.5 | (−0.5 to 1.4) | .333 |
| Type III vs. V | 0.3 | (−0.6 to 1.2) | .528 | 0.6 | (−0.4 to 1.5) | .237 |

*CI*, confidence interval.

received surgery more than 16 months (range, 16-44 months) after injury with the same hook plate. Contrary to the literature, the present study showed equivalent SSV for early and delayed surgery (95.2 and 93.0, respectively), indicating that the techniques used are well suited for the type and timing of AC joint dislocation. It is important to note that contrary to older techniques that reconstruct the AC joint only, the techniques used in this study reconstructed both AC joint and CC ligaments, with allografts to augment healing potential in cases of delayed intervention. Combined AC and CC reconstruction mimics the native AC joint stiffness better than isolated CC reconstruction, leading to a more physiological stabilization.[10] We did not consider arthroscopic techniques for 2 reasons.[10] The first was that drilling through the coracoid process was a risk factor for coracoid fracture, the initial drill in the bone not being the problem, as there is subsequent hole enlargement due to micromotion of the suture within the bone. The second reason is that arthroscopic techniques do not allow effective stabilization of the AC joint.

The results of this study must be interpreted with the following limitations in mind. First, this was a small retrospective series, and although similar to cohort sizes of most published studies, it does not allow comparison of early vs. delayed interventions for each Rockwood type. Second, it was not possible to account for any conservative treatments that some of the patients may have received before delayed intervention, which may affect the outcomes. Nevertheless, the main strength of the present study is that it compared 2 modern techniques for repair or reconstruction of AC and CC joints, which have so far not been compared in the literature.

## Conclusions

Early and delayed surgical interventions of high-grade AC joint dislocation provide equivalent clinical scores when combined CC and AC joint fixation is used for stabilization. Rapid surgical intervention for high-grade AC joint dislocation may not be necessary, as most patients can still benefit from surgery at a later stage.

## Disclaimer

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