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Treatment of acute acromioclavicular joint  
dislocation  
: Kirschner's wire trans-acromial fixation versus  
AO locking hook plate fixation

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Treatment of acute acromioclavicular joint  
dislocation  
: Kirschner's wire trans-acromial fixation versus  
AO locking hook plate fixation

Directed by Professor Chun, Yong-Min

The Master's Thesis  
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in partial fulfillment of the requirements for the degree of Master of  
Medical Science

Kim, Young Jun

June 2016

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*Young Jun Kim*

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Abstract

Treatment of acute acromioclavicular joint dislocation  
: Kirschner's wire trans-acromial fixation versus AO locking hook plate fixation

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**Background:** The purpose of this study is to compare clinical and radiological outcomes between trans-acromial fixation with Kirschner's wire (K-wire) and AO locking hook plate fixation for acute acromioclavicular (AC) joint dislocation.

**Method:** This study included 61 patients who underwent either closed reduction and trans-acromial fixation with K-wire (Group A, 23 patients) or open reduction and internal fixation with AO locking hook plate (Group B, 38 patients). Pain on a visual analog scale (VAS) score, the University of California Los Angeles (UCLA) shoulder score, the American Shoulder and Elbow Surgeons (ASES) score, and active range of motion (ROM) were used in the functional evaluation. For radiological evaluation, coracoclavicular distance (CCD) was measured on both clavicular anteroposterior view and compared between groups.

**Results:** At one-year follow-up, no significant differences in VAS pain score, UCLA shoulder score, ASES score, and active ROM were observed between groups, despite five cases (23%, 5/23) of complication in Group A. The side-to-side difference between normal and affected CCD was  $2.4 \pm 2.2$  mm in Group A and  $0.2 \pm 0.7$  mm in Group B. This difference showed a statistical significance between groups ( $p < 0.001$ ).



Conclusion: For the treatment of acute AC joint dislocation, the K-wire trans-acromial fixation group showed a significantly greater coracoclavicular distance (CCD) than the AO locking hook plate group. In addition, during the follow-up period, incidence of complication related to implant was much higher in the trans-acromial fixation group. Although clinical outcomes between groups were not significantly different, these should be interpreted carefully.

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Key words: acromioclavicular joint, dislocation

Treatment of acute acromioclavicular joint dislocation  
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I. Introduction

Acromioclavicular (AC) joint injuries are common, accounting for approximately 9% of shoulder girdle injury<sup>1</sup>. Males showed much more involvement than females, representing five to ten times, during the first three decades of life, and often in contact sports activities<sup>2,3</sup>. While the AC joint and around structures appear to be simple, the precise biomechanics and associated function between acromion and clavicle are not fully understood. This may be a reason for the substantial debate and a lack of consensus on optimal treatment, despite numerous surgical techniques which have been introduced for surgical management of this injury<sup>4,5</sup>.

Among these surgical methods, trans-acromial fixation using Kirschner's wire (K-wire) and AO locking hook plate have been widely used to stabilize the AC joint in recent decades. Even though they are not anatomical repair or reconstruction of the

coracoclavicular (CC) ligament, they are relatively simple and easy to perform. Many studies have reported satisfactory outcomes of these methods<sup>6-14</sup>.

However, despite simplicity of the trans-acromial fixation using K-wires, several complications have been reported, including breakage, an unexpected migration, and a loss of reduction<sup>6,15,16</sup>: this may be related to recent decrease in use. On the contrary, the AO locking hook plate has recently been widely used and many studies have reported good clinical results<sup>10-12</sup>. However, there is a paucity of literature comparing these two non-anatomical stabilization methods.

The purpose of this study is to compare clinical and radiological outcomes between trans-acromial fixation with K-wires and locking hook plate fixation for acute AC joint dislocation. We hypothesize that the K-wire trans-acromial fixation would have comparable clinical and radiological outcomes to the AO locking hook plate fixation.

## II. Materials and Methods

We retrospectively reviewed 79 patients who underwent either the trans-acromial fixation using K-wires or AO locking hook plate fixation (3.5 mm LCP clavicle hook plate, Synthes, Paoli, PA) for acute (within two weeks after injury) AC joint dislocation from March 2009 to June 2014 in our institute. The patients assignments for each group were non-randomized; closed reduction and trans-acromial fixation (Group A) was used during the early period of this study (between March 2009 and May 2011), closed reduction and

the trans-acromial fixation (Group A) are used; open reduction and locking hook plate fixation (Group B) was used during the remaining period. Regardless of period, Rockwood type IV AC joint dislocation was addressed by open reduction and hook plate fixation. In case where a female patient was concerned about the postoperative scar, closed reduction and trans-acromial fixation was performed.

The inclusion criteria were (1) acute Rockwood type III, IV, or V AC joint dislocation; (2) available follow-up data available for a minimum of one-year after surgery. Exclusion criteria were (1) subacute (more than two weeks since injury) or chronic AC joint dislocation; (2) previous history of surgery on the affected shoulder; (3) concomitant fracture around the ipsilateral shoulder. Sixty-one patients (23 in Group A and 38 in Group B) met the inclusion and exclusion criteria. Our institutional review board approved this study and the requirement for informed consent was waived.

#### 1. Functional and radiological evaluation

For the functional evaluation, pain on a visual analog scale (VAS) score, the university of California Los Angeles (UCLA) Shoulder score, the American Shoulder and Elbow Surgeons (ASES) score, and active range of motion (ROM) were used. The active ROM included three movements: forward flexion in the scapular plane, external rotation with the arm at the side, and internal rotation. Internal rotation was estimated by determining how far the patients could reach their thumb up the spinal segments. For ease of statistical analysis, the spinal segment was converted into numbers: segments at T1 through T12

were designated as 1 through 12, segments at L1 through L5 were designated as 13 through 17, and the sacrum was designated as 18. Shoulder scores and active ROMs were measured by an independent examiner who was blinded to group assignment.

For the radiological evaluation, both clavicle anteroposterior (AP) views were taken regularly after surgery (two weeks, six weeks, 12 weeks, six months, and one year postoperatively), where the coracoclavicular distance (CCD) was measured by two independent examiners. The individual value was measured respectively and then, the individual mean value was calculated. The CCD was defined as the perpendicular distance from the top of the coracoid process to the lower border of the clavicle.

## 2. Operative procedures

All patients underwent surgery in 20° beach chair position on the ordinary operation table. For Group A, closed reduction was performed under fluoroscopic guidance. The K-wire was inserted percutaneously at the lateral edge of the acromion, parallel to the acromion as possible. Passing the acromion, the K-wire was introduced into the clavicle, engaging its superior cortex. Two or three additional K-wires were inserted in the same manner. Then, the ends of the K-wires were cut, bent into “J” shape, and placed underneath the skin (Figure 1).

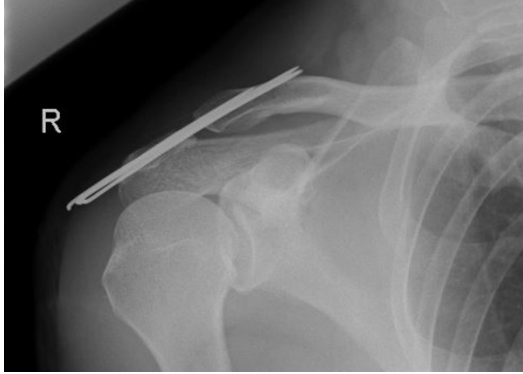


Figure 1. Trans-acromial fixation with Kirschner's wires, right shoulder.

For Group B, approximately 7-8 cm sized skin incision was made on the distal clavicle and acromion, one fourth of width, from the posterior border of the clavicle. The dislocated AC joint was identified after dissection, a hook plate was placed under the acromion as well as upon the distal clavicle. We checked the status of reduction, depth of the hook, and contour of the plate on the distal clavicle under fluoroscopic guidance. Adjustments of the plate contour with appropriate depth of the hook was made until the optimal reduction and contour of the plate were achieved. Then, locking screw fixation was performed (Figure 2). Even though an additional coracoclavicular ligament repair was not performed, the deltotrachezius fascial repair for reinforcement was done securely over the plate.



Figure 2. Locking hook plate fixation, right shoulder.

### 3. Postoperative rehabilitation and implant removal

Regardless of fixation methods, the affected arm was kept in a sling for six weeks after surgery. On the first day of surgery, pendulum exercise, self-assisted circumduction exercise, and gradual passive range of motion (ROM) as tolerable were begun. After six weeks postoperatively, active ROM exercise was begun as tolerated. After three months postoperatively, the implant (K-wires or hook plate) was removed. If the patient had shoulder stiffness at the time of the implant removal, brisement under general anesthesia and subsequent arthroscopic capsular release were performed concomitantly.

### 4. Statistical analysis

The SPSS program (IBM SPSS statistics version 20.0) was used for the statistical

analyses. The student's *t*-test was used for between group comparisons of continuous or continuous ranked data including the VAS pain score, ROM, and shoulder UCLA and ASES scores. The paired *t*-test was used for comparison of preoperative and postoperative values within each group and Fisher's exact test was used for comparison of categorical data including the presence of postoperative stiffness between groups. Statistical significance was set at  $p < 0.05$ .

### III. Results

#### 1. Patient demographics

Group A included 19 men and 4 women, and Group B included 36 men and 2 women. The mean age at the time of surgery was 34.9 years (ranging from 21 to 56 years) in Group A and 37.0 years (ranging from 19 to 63 years). In Group A, 14 patients injured on the right and remaining 9 patients injured on the left. In Group B, 22 patients injured on the right and 16 patients injured on the left. In Group A, six (26%, 6/23) were Rockwood type III and seventeen (74%, 17/23) were Rockwood type V; in Group B, nine (24%, 9/38) were type III, two (5%, 2/38), were type IV, and twenty-seven (71%, 27/38) type V (Table 1).



Table 1. Patients' demographics

	Group A (N=23)	Group B (N=38)	<i>p</i> value
Sex (M/F)	19/4	36/2	0.187
Age	34.9 ± 10.5	37.0 ± 10.9	0.416
Injured side (right/left)	14/9	22/16	0.819
Rockwood type III	6	9	0.532
Rockwood type IV	0	2	
Rockwood type V	17	27	

Group A, closed reduction and percutaneous trans-acromial fixation with K-wires; Group B, open reduction and internal fixation with AO locking hook plate. The values are given as the mean and standard deviation.

## 2. Clinical and radiological assessments

At one-year follow-up, the mean VAS pain score was  $1.2 \pm 1.1$  in Group A and  $0.9 \pm 1.0$  in Group B with no significant difference between groups. The mean UCLA shoulder score was  $31.8 \pm 3.2$  in Group A and  $32.3 \pm 2.4$  in Group B. However, the difference was not statistically significant. The mean ASES score was  $91.4 \pm 6.7$  in Group A and  $93.3 \pm 6.4$  in Group B, and there was no significant difference between groups. The active ROM measured in both groups at one-year follow-up showed no significant differences in forward flexion, external rotation with arm at side, and internal rotation (Table 2).

Table 2. Visual analog scale (VAS) score, University of California at Los Angeles (UCLA) shoulder score, American Shoulder and Elbow Surgeons (ASES) score, and active ranges of motion for both groups at final follow-up

	Group A	Group B	<i>p</i> value
VAS score	1.2 ± 1.1	0.9 ± 1.0	0.568
UCLA shoulder score	31.8 ± 3.2	32.3 ± 2.4	0.451
ASES score	91.4 ± 6.7	93.3 ± 6.4	0.362
Forward flexion	152.8° ± 9.1°	150.1° ± 9.9°	0.647
External rotation with arm at side	61.1° ± 10.3°	58.9° ± 11.4°	0.312
Internal rotation	9.3 ± 2.1	9.6 ± 2.5	0.514

Group A, closed reduction and percutaneous trans-acromial fixation with K-wires; Group B, open reduction and internal fixation with AO locking hook plate. The values are given as the mean and standard deviation. The internal rotation was estimated by determining how far the patients could reach their thumb up the spinal segments. For ease of statistical analysis, the spinal segment was converted into numbers: segments at T1 through T12 were designated as 1 through 12, segments at L1 through L5 were designated as 13 through 17, and the sacrum was designated as 18

The mean preoperative coracoclavicular distance (CCD) of the normal side was 7.4 ± 2.5 mm in Group A (Intraclass correlation coefficient of interobserver reliability (ICC) = 0.873) and 7.6 ± 2.3 mm in Group B (ICC = 0.792) ; the mean affected CCD was 17.9 ±

5.5 mm in Group A (ICC = 0.899) and  $17.3 \pm 5.1$  mm in Group B (ICC = 0.835). At the final follow-up, the mean affected CCD was  $9.8 \pm 3.1$  mm in Group A and  $7.8 \pm 2.3$  mm in Group B. A significant difference was observed between groups ( $p = 0.006$ ). The side-to-side difference between normal and affected CCD at final follow-up was  $2.4 \pm 2.2$  mm in Group A and  $0.2 \pm 0.7$  mm in Group B, showing difference showed a statistical significance between groups ( $p < 0.001$ ).

### 3. Complications

One patient in Group A had newly developed mild arthritis with heterotopic ossification around the AC joint, while there was no arthritis in Group B. In six patients (16%) in Group B, bony erosion under acromion was observed on plain x-ray. In Group A, there were five complications (22%, 5/23): one case of K-wire breakage, one case of superficial infection followed by skin irritation by a bent end of K-wire migration, and three cases of reduction loss after K-wire removal. These five complications occurred in all Rockwood type V. In the wire-breakage case, the remaining K-wires maintained the acceptable reduction of the AC joint until removal of the K-wire, even though the CCD increased compared to immediate postoperative CCD. In case of the superficial infection, the infection was identified at four weeks after surgery. All K-wires were removed immediately and reduction loss was followed. After resolving the infection, CC ligament reconstruction was recommended, but the patient did not want to undergo further surgery. In three patients of reduction loss, immediate postoperative plain x-ray just after removal

showed well maintained CCD. However, at three months follow-up after removal, six months follow-up from the initial fixation, reduction loss was observed. In Group B, there was no complication such as reduction loss or infection, etc. during the follow-up period. For the first postoperative three months before implant removal, shoulder stiffness was found in three patients (13%, 3/23) in Group A and seven patients (18%, 7/38) in Group B, who underwent both brisement under general anesthesia and subsequent arthroscopic capsular release at the time of implant removal. No significant difference in incidence of postoperative stiffness was observed between groups.

#### IV. Discussion

This study was designed to compare clinical and radiological outcomes between trans-acromial fixation using K-wires and AO locking hook plate fixation for acute AC joint dislocation. The K-wire trans-acromial fixation showed comparable clinical outcomes to AO locking hook plate fixation, which was consistent with part of our hypothesis. However, the remaining part of our hypothesis was not confirmed: the coracoclavicular distance (CCD) in radiological assessment was significantly different; the trans-acromial fixation group showed significantly greater CCD difference between normal and affected side at final follow-up, than the hook plate fixation group.

Among the methods for acute AC joint dislocation, trans-acromial fixation with pin or wire is a widely used method. Several investigators reported satisfactory outcomes after closed or open trans-acromial fixation with a pin or wire<sup>17,18</sup>. Nevertheless, the pin or wire

can migrate or be broken, and several complications can follow such as skin irritation or reduction loss of the AC joint. Rhee et al., who compared the trans-acromial fixation and AO hook plate, reported 8 cases (14%) of pin migration or breakage. In our study, five patients in the trans-acromial fixation group had a complication and, coincidentally, they were all Rockwood type V AC joint injury. We think that this result may be attributable to unrepaired and unhealed soft tissue around the AC joint in Rockwood type V injury in closed reduction despite a three-month fixation period. In particular, among 17 patients with Rockwood type V injury in the trans-acromial fixation group, these five-complication cases approach approximately 30%. In the difference of CCD between normal and affected side at final follow-up, the trans-acromial fixation group showed significantly inferior outcome, even though this was not directly related to clinical outcomes.

By contrast, there was no complication related to implant in the hook plate fixation group, although subacromial bony erosion was observed in some patients on the x-ray at the time of implant removal. While it appears that the trans-acromial fixation with wires has fallen out of favor, locking hook plate fixation seems to have become increasingly popular<sup>10-14</sup>. Many studies have indicated that subacromial bony erosion by hook plate and other complications such as impingement, rotator cuff lesion, and acromial fracture can be induced after hook plate fixation. Most cases of bony erosion, however, are asymptomatic and clinically insignificant<sup>13-15,19,20</sup>. In practice, if the depth of the hook is too deep, it can cause impingement and rotator cuff injury; by contrast, if the depth of the hook is too shallow, it can result in subacromial erosion. Sim et al. reported that early implant

removal can decrease this bony erosion<sup>15</sup>. Even though we tried to apply plates with an appropriate depth of hook and removed the implant after three months postoperatively, subacromial bony erosion occurred in 16% (6/38) of Group B. Rhee et al. bent the hook of the plate parallel to the acromion to prevent subacromial impingement or the hook encroaching the acromion<sup>13</sup>; they also removed the implant at three to four months after fixation. Only two cases (10%) of subacromial bony erosion with any functional deficiency may result from these efforts. Kim et al. reported 36% subacromial bony erosion at the time of hook plate removal; in their study, the hook plate was removed at about six months postoperatively<sup>14</sup>.

Kim et al. recently reported an interesting study regarding the AC joint motion after hook plate fixation<sup>21</sup>. In their study, the hook plate fixation of the AC joint can cause decreased motion of the distal clavicle with respect to the medial acromion. In addition, we know that hook plate fixation for the AC joint dislocation is indirect reduction of the AC joint by the lever arm of the hook. Considering these roles of the hook plate in AC joint fixation, a longer period of fixation can lead to higher incidence of subacromial bony erosion. Thus, as many investigators have indicated, removal of the implant should be removed after three to four months postoperatively would be appropriate<sup>13,14</sup>.

Among overall 61 patients included in this study, there were only six (10%) female patients, and as indicated in previous literature, its incidence was much lower in females, compared to males<sup>2</sup>. In determining the surgical method for AC joint fixation in the current study, a relatively large scar after open reduction was an issue for female patients; of three cases of reduction loss after pin removal, one case was a female patient. Even

though closed reduction and percutaneous pinning may have a cosmetic advantage in female patients, care is required in application of this method in Rockwood type V injury.

We kept the affected arm in a sling for first six weeks to relieve the load by arm weight on the AC joint regardless of the operation method. On the other hand, we were concerned about shoulder stiffness due to the relatively long period of wearing the sling. Despite immediate exercises to prevent the stiffness, the stiffness was observed in 16% (10/61) at the time of implant removal. They underwent both brisement under general anesthesia and subsequent arthroscopic capsular release at the time of implant removal.

This study has several limitations; first, this study is a retrospective comparative study and has an inherent weakness. In addition, the patient assignment was not randomized; in general, closed reduction and trans-acromial fixation with K-wires was used initially and open reduction and locking hook plate fixation was used later. Second, even though our study showed no significant difference in clinical outcomes between the two groups, we cannot exclude the possibility that this result may attribute to the type II error. Thus, considering the aforementioned complications, care is required in interpreting our results. Third, the follow-up period was short and incidence of arthritis in the AC joint would be different in long-term follow-up. Fourth, we did not evaluate the anteroposterior translation of the AC joint via axial view. Considering that both methods could not reconstitute the AP stability of the AC joint, there would have some differences between the affected side and normal contralateral side in AP stability.

## V. Conclusion

For the treatment of acute AC joint dislocation, the K-wire trans-acromial fixation group showed a significantly greater coracoclavicular distance (CCD) than the AO locking hook plate group at one-year follow-up after surgery. In addition, during the follow-up period, incidence of complication related to implant was much higher in the trans-acromial fixation group. Although clinical outcomes were not significantly different between the two groups, the clinical outcomes of this study should be interpreted carefully.



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## ABSTRACT(IN KOREAN)

급성 견봉쇄골 관절 탈구의 치료  
:Kirschner강선과 AO잠김 갈고리 금속판의 비교

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배경: 본 연구의 목적은 급성 견봉쇄골 탈구의 치료에 있어서 Kirschner강선(K-강선)을 이용한 경-견봉(Trans-acromial) 술식과 AO 잠김 갈고리 금속판을 이용한 술식의 결과를 임상적, 방사선적으로 비교하고자 한다.

방법: 본 연구는 K-강선을 이용한 경-견봉 술식을 받은 23명의 환자와 AO 잠김 갈고리 금속판을 이용하여 개방적 정복술 및 내고정술을 받은 38명의 환자를 포함한 총 61명의 환자를 대상으로 하였다. 임상적 평가는 통증에 대한 visual analog scale (VAS) 점수, UCLA(University of California Los Angeles) 점수, ASES(American Shoulder and Elbow Surgeons) 점수와 전방거상, 외회전, 내회전을 측정하여 능동적 운동범위를 평가하였다. 방사선학적 평가는 양측 쇄골의 전후면(AP view)촬영에서 오구-쇄골 간격(Coracoclavicular distance)을 측정하여 견측과 비교하고 차이를 그룹 간에 평가하였다.

결과: 1년 추시 관찰 결과에서 경-견봉 술식을 받은 환자군에서 5명의 합병증이 발생하였으나(23%, 5/23) VAS 점수, UCLA 점수, ASES 점수, 능동적 운동범위 등의 임상적 평가에 있어서 두 그룹간의 차이는 발견되지 않았다. 방사선 평가에 있어서 1년 추시 결과 오구-쇄골 간격의 환측과 견측간의 차이는 경-견봉 술식을 받은 환자군에서  $2.4 \pm 2.2$  mm, AO 잠김 갈고리 금속판을 이용한 환자군의 차이는  $0.2 \pm 0.7$  mm 로 나타났으며, 통계학적으로 유의한 차이를 보였다( $p < 0.001$ ).

결론: 급성 견봉쇄골 탈구의 치료에 있어서 K-강선을 이용한 경-견봉 술식을 받은 환자군이 AO 잠김 갈고리 금속판을 이용한 환자군 보다 1년 추시상에 오구-쇄골 간격이 더 증가한 것을 관찰할 수 있었다. 또한 추시 기간 중 경-견봉 술식을 받은 환자군에서 합병증의 발생율이 더 높게 관찰되었다. 이러한 결과는 두 그룹간의 임상적 평가에서 통계학적으로 유의한 차이가 없다고 하더라도 주의 깊게 판단해야 할 것으로 사료된다.

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핵심되는 말: 견봉쇄골 관절, 탈구