Original Article / Özgün Araştırma

Long-term Results of Hook Plate Technique in Acromioclavicular Joint Dislocations

Akromiyoklavikuler Eklem Çıkıklarında Hook Plate Tedavisinin Uzun Dönem Sonuçları

Ali Şişman, Ali Can Çiçek, Caner Poyraz, Şevki Öner Şavk

Adnan Menderes University Faculty of Medicine, Department of Orthopedics and Traumatology, Aydın, Turkey

Abstract

Objective: The aim of this study is evaluating the long-term results and complications of hook plate (HP) used in acromioclavicular joint (ACJ) dislocations.
Materials and Methods: Sixty-two cases who were operated for ACJ separation with HP technique between 2010 and 2015 were evaluated retrospectively. Clinical and radiological outcomes and long term complications evaluated.
Results: The mean disabilities of the arm, shoulder and hand questionnaire score was 5±1, the mean Constant-Murley score was 92±6. Coracoclavicular distance measurement on the first day after surgery showed an overcorrection compared to the intact extremity. Some reduction loss was detected in the fifth year measurements.
Conclusion: Decrease in reduction loss at the end of the fifth year did not have a negative effect on the clinical outcomes of the shoulder.

Keywords
Acromioclavicular joint separation, hook plate, long-term outcomes

Öz

Amaç: Bu çalışmanın amacı; akromiyoklavikuler eklem (ACJ) çıkıklarına uygulanan hook plate'in (HP) uzun dönem sonuçlarını ve komplikasyonlarını değerlendirmektir.
Gereç ve Yöntemler: ACJ separation nedeni ile 2010 ila 2015 yılları arasında HP kullanılarak opere edilen 62 olgu retrospektif olarak değerlendirildi. Klinik, radyolojik sonuçlar ve uzun dönem komplikasyonlar incelendi.
Bulgular: Klinik değerlendirmeler sonucunda ortalama kol, omuz ve el sorunları anketi skoru 5±1, Constan-Murley skoru ortalama 92±6 idi. Korakoklaviküler mesafe ameliyat sonrası ilk gün ölçümünde sağlam ekstremite ile kıyaslandığında fazladan düzeltme (overcorrection) görüldü. Beşinci yıl ölçümlerinde ise bir miktar redüksiyon kaybı tespit edildi.
Sonuç: Beşinci yılın sonunda redüksiyon kaybındaki bu düşüşün omuz klinik sonuçlarına negatif etkisi görülmemiştir.

Anahtar Kelimeler
Akromiyoklaviküler eklem çıkığı, hook plate, uzun dönem sonuçlar

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Address for Correspondence/Yazışma Adresi:
Lect. Ali Şişman, MD,
Adnan Menderes University Faculty of Medicine, Department of Orthopedics and Traumatology, Aydın, Turkey
Phone : +90 506 880 02 62
E-mail : ali_sisko@hotmail.com
ORCID ID: orcid.org/0000-0001-8461-3258

Introduction

Acromioclavicular joint (ACJ) separation accounts for 9% to 12% of all shoulder girdle injuries (1). Rockwood type I and II injuries in which the coracoclavicular ligaments are still intact are usually treated conservatively (2). In Type III-V injuries, surgical treatment is generally recommended (3).

Up to know several surgical procedures including; open reduction and fixation methods with many different methods such as screw, plate, Kirschner wire, sutures and hook plate (HP) have been described in the surgical treatment of ACJ separation (4). Despite the fact that the HP technique being used frequently, it is associated with a high rate of complications needing implant removal (3). However, current literature lacks of long term follow-up studies to show exact results with HP technique. Although there are some short-term studies after HP technique, studies showing long-term results are needed.

The aim of the current study is to evaluate the long-term clinical and radiological results of ACJ separation cases operated with HP.

Materials and Methods

The study protocol was approved by the Ethics Committee from Aydın Adnan Menderes University Faculty of Medicine (protocol number: 2022/103, date: 09.06.2022). Seventy-four patients who operated with HP between 2010 and 2015 for ACJ separation were evaluated retrospectively. Informed consent has been provided from all patients before surgery. Patients aged 18 years and over and treated surgically by HP method were included in the study. Total sixty-two patients who met the inclusion criteria were included in the study. The shortest follow-up period was determined to be five years. No additional pathology, no previous surgical history from the same extremity were required in the inclusion criteria. Those who did not come for follow-up after 5 years (n=9), those who had additional injuries (n=2), and those who had a previous upper extremity surgery (n=1) were excluded from the study.

All patients were operated with same procedure and same trauma surgeon: open reduction and internal fixation with HP. In this procedure patients were operated in beach chair position. After incision and dissection, ACJ reducted and held with a reduction clamp. HP with 18 mm offset were used. Final location of hook was just near to acromial joint posterior border. No repair were performed for ligament recontruction.

The ACJ separation classification of all cases were carried out according to the Rockwood classification with preoperative X-rays (5). Implant removal times were evaluated as well. The coracoclavicular distance (CCD) was measured to evaluate the reduction quality. CCD measurements on radiographs were carried-out without using weights, as suggested by Bossart et al. (6). CCD was measured preoperatively for injured and intact extremities. In addition, CCD measurements were carried out on the first day after surgery and at the last follow-ups after five years.

In the rehabilitation program, passive movements were applied in the first postoperative week, active training of shoulder muscle groups after 3-6 weeks, active sports and strength exercises were started after 6 months, for a total of 1 year.

The disabilities of the arm, shoulder and hand questionnaire (DASH) and Constant-Murley score (CMS) were used to evaluate clinical outcomes (7). DASH scores were evaluated at the first follow-up and fifth year. CMS was measured preoperatively for intact and injured extremities. Then, CMS evaluation of the injured extremity was performed on the first postoperative day and at the last follow-up by the same orthopedic surgeon. CMS of postoperative first day and last measurement were compared. Range of movement (ROM) of injured side and additional potential complications were evaluated and noted at the last follow-ups as well.

Statistical Analysis

SPSS (IBM Statistics, Version 26) was used for statistical analysis of the data. Categorical variables were summarized as number (n) and percent (%), continuous variables as mean ± standard deviation, median (min-max). Since continuous variables were not normally distributed (Kolmogorov-Smirnov and Shapiro-Wilk $p<0.05$), test were used to evaluate continuous variables. The changes between preoperative and postoperative values were evaluated with Wilcoxon signed ranks analysis. $P<0.05$ was considered to be statistically significant.

Results

The mean age was 45.35±13.65. Twenty-nine of the patients were female and 33 were male. The

operated shoulder was right in 33 and left in 29 patients. The cause of injury was sports injury in 12 (19.3%) patients, traffic accident in 20 patients, and simple traumas in 30 patients. While trauma exposure was direct in 46 patients, it was indirect in 16 (25.8) patients.

According to the Rockwood classification, 13 patients were type III, 3 patients were type IV, and 46 patients were type V injuries. The mean follow-up period was 65.82±4.65 months. Implant removal was performed in all patients after one year. The mean time of removal of the implant was determined as 409.14±32.5 (377-432) days (Table 1).

Radiological results revealed that, the mean CCD was 8.92±2.8 in the non-injured extremity. While the mean preoperative measurements were 20.26±6.87 on the injured side, it decreased to 8.59±2.69 on the first postoperative day ($p<0.001$). Compared to the intact extremity, the CCD was lower in the operated extremity, and overcorrection was achieved with surgery ($p<0.001$). In CCD final control measurements, the mean was 11.49±3.99. Compared to the first day after surgery, a significant increase in the amount of CCD was observed at the last follow-up ($p<0.001$) (Table 2,3).

Considering the clinical results, at the last follow up: the mean DASH score of the patients was 5.06±0.82, the CMS score was 92.29±6.5.

At the last follow up a palpable pain on ACJ was evident in 10 patients and during active ROM in 4 patients. ACJ separation reoccurred in one case on the 10th postoperative day. This case operated using a longer HP and did not encounter a following complication during five year follow ups.

Superficial infection was observed in two patients and the infection regressed in both patients after oral antibiotic treatment. Heterotopic ossification was observed in two patients. He was followed up without any intervention. (Table 2).

Discussion

In our study, the long-term radiological and clinical results of the patients in which HP technique was used for ACJ separation were evaluated. The applied method was evaluated with clinical scoring systems and successful results were obtained. As a result of radiological evaluations, disadvantages such as increased CCD and loss of reduction were detected. However, these results had no effect on the clinical evaluation of the patient. Data on long-term results

Table 1. Demographic and clinical data of patients

Age (year) Mean ± SD, Median (min-max)		**45.35±13.65**	**45 (22-74)**
Gender	Female	29	46.8
	Male	33	53.2
Injured side	Right	33	53.2
	Left	29	46.8
Cause for ACJ separation	Sport	12	19.4
	Traffic accident	20	32.3
	Everyday routine	30	48.4
Trauma mechanism	Direct impact	46	74.2
	Indirect impact	16	25.8
Rockwood clasification	Type 3	13	21.0
	Type 4	3	4.8
	Type 5	46	74.2
Follow-up time (month) Mean ± SD, median (min-max)		65.82±4.65	64 (60-80)
Time of implant removal (day) Mean ± SD, median (min-max)		409.14±32.59	406.5 (365-502)

min-max: Minimum-maximum, SD: Standard deviation, ACJ: Acromioclavicular joint

of HP surgery for ACJ seperation are not available in literature. In this sense, this study, which evaluates long-term results with a follow-up period of at least five years, may be a pioneer in the literature.

Many surgical options have been described in the treatment of ACJ dislocations, and the advantages and disadvantages of these treatments have been reported in the literature (8). HP technique, which is one of the most commonly used methods in surgical treatment, is widely used because it provides stable fixation against deforming forces in the rotational, horizontal and vertical axis and allows early movements (9). CMS scores are generally used in studies to evaluate the clinical success of the HP technique. For example Koukakis et al. (10) was found CMS score 6 months after plaque removal 96.4 and it was found to be 97 in Salem and Schmelz's (9) 30-week follow-up study (9-10). Di Francesco et al. (11) had reported a mean 91.79 CMS after mean 18 months follow-up. Also Jafary et al. (12), had reported a mean 94.5 point CMS result after 9 months of follow up. In our study, the mean CMS value was 92.29±6.5. Although implant removal was performed later in this study compared to other studies, similar results were obtained in CMS values when compared with short and medium-term studies. These results showed us that there is no harm in performing implant removal in the late period.

Complications such as implant failure, implant loosening, instability, penetration into the humeral head, subacromial impingement, rotator cuff muscle degeneration, infection, subacromial erosion, and neurovascular injury have been reported after HP technique (13,14). Huang et al. (15) had reported the complication rate after HP to be 37.5%. In our study, the complication rate was found to be 11.3% in the follow-ups of the cases who were operated using HP for fixation. However, in our study, subacromial erosion could not be measured because of insufficient measurement with direct radiography. Current literature reports that the rate of subacromial erosion evaluated with computed tomography (CT) to be 30% (16). There is a need for a study measuring subacromial erosion in patients with late implant removal and in cases with long follow-up. Our treatment choice was in the direction of HP due to our clinical experience and surgeons preference.

There is no definite consensus regarding the time of removal of the implant in patients who underwent HP. Generally, removal of the implant depends on the patient's symptoms, and if there is persistent pain in the postoperative period, it is recommended to be performed within the first 3 months (9-11,13,17-20). If the patient does not have shoulder pain, it is recommended to remove the implant after the first 3 months (12,17-20).

Table 2. Clinical and radiological outcome of patients

DASH score last control		5.06±0.82	5 (4-9)
CMS uninjured side-preoperation		93.63±6.58	94 (52-100)
CMS last control		92.29±6.5	92 (54-100)
VAS last control		0.11±0.48	0 (0-3)
CCD uninjured side-preoperation Mean ± SD, median (min-max)		8.92±2.8	7.9 (3-15.2)
CCD injured side-preoperation Mean ± SD, median (min-max)		20.26±6.87	18.35 (6.9-34.2)
CCD injured side-postoperation 1. day Mean ± SD, median (min-max)		8.59±2.69	7.55 (2.5-16)
CCD last control Mean ± SD, median (min-max)		11.49±3.99	10.4 (3.1-23.8)
Pain around the ACJ with palpation	Yes	10	16.1%
	No	52	83.9%
Pain during motion around the ACJ	Yes	4	6.5%
	No	58	93.5%

DASH: The disabilities of the arm, shoulder and hand questionnaire, CMS: Constant-Murley score, VAS: Visual analogue scale, CCD: Coracoclavikuler distance, ACJ: Acromioclavicular joint, min-max: Minimum-maximum, SD: Standard deviation

Table 3. Comparative results of coracoclavicular distance measurement

	p-value
CCD injured side-preoperation - CCD injured side postoperation 1. day	<0.001
CCD injured side-postoperation 1. day - CCD last control	<0.001
CCD uninjured side - CCD injured side postoperation 1. day	<0.001

CCD: Coracoclavicular distance

Contrary to the general opinion, there are articles recommending that implant removal should not be performed in the first three months, even if there is pain and limitation of movement. however, there are also studies suggesting removal of the implant in early period (21-23).

Pain scores have been reported to better when implant removal performed in 3 months after surgery (9-11,13,17-20). Koukakis et al. (10) have reported a mean 0.87 VAS, Sarrafan et al. (19) reported a mean 4 VAS, and Steinbacher et al. (20) had reported a mean 1.8 VAS. In these studies, the implant removal time is earlier than in our study. In our study, as per our clinical practice, if there was no severe limitation of movement or intolerable pain, implant removal was performed one year later at the earliest. Despite the altered implant removal time in our study, a lower pain score is detected compared to the medium and short-term results.

Loss of reduction after implant removal is one of the controversial issues. Reduction loss has been reported for 3-67% of cases after removal of the HP (9,10,17,21). In the study of Hemmann et al. (24), an increase in CDD distance of 3.8±0.6 was observed when the implant was removed after a mean 64±2 days of surgery. Although radiological findings of reduction loss are obtained, there are articles showing that this loss is not reflected in clinical results. In the article published by Smith et al. (25) in 2011, conservative treatment and surgical treatment were compared. In this study, it was stated that anatomical reduction is not essential for good functional outcomes. In our study, implant removal was performed after a mean 409.14±32.59 days, and 2.9 mm increase in CCD was detected. In our study, the implants were removed later than in the literature and it was observed that the reduction loss was less.

The study has several limitations. Retrospective design and the inaccessibility of data for some of the patients can be seen as the most important limitations when evaluating long-term results. In addition, due to our clinical practice in radiological evaluation, not having stress radiographs and not using CT before implant removal prevent drawing exact results. It would be illuminating to conduct prospectively designed, multicenter studies on this subject with a specific patient group.

Conclusion

Fixation of ACJ separation with HP appears to have satisfactory long-term clinical outcomes. The most important disadvantage is the need for an exact implant removal and reduction loss.

Ethics

Ethics Committee Approval: The study protocol was approved by the Ethics Committee from Aydın Adnan Menderes University Faculty of Medicine (protocol number: 2022/103, date: 09.06.2022).

Informed Consent: Informed consent has been provided from all patients before surgery.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: A.Ş., Ş.Ö.Ş., Concept: A.Ş., C.P., Ş.Ö.Ş., Design: A.Ş., Ş.Ö.Ş., Data Collection or Processing: A.C.Ç., C.P., Analysis or Interpretation: A.Ş., A.C.Ç., Literature Search: A.C.Ç., C.P., Writing: A.Ş.

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