Risk Factors for postoperative shoulder pain of acromioclavicular joint dislocation treat with hook plate

Ding Xu (xuding831129@126.com)
shangyu people's hospital

Weigang Lou
Ningbo No 6 Hospital

Peng Luo
Wenzhou Medical University

Yulong Shi
Rheinisch-Westfalische Technische Hochschule Aachen

Weijun Guo
Wenzhou Medical University

Jianming Chen
Ningbo No 6 Hospital

Research article

Keywords: Risk Factor, postoperative shoulder pain, acromioclavicular joint dislocation, hook plate

Posted Date: January 2nd, 2020

DOI: https://doi.org/10.21203/rs.2.19839/v1

Abstract

Background: Postoperative shoulder pain was a most common complication after clavicular hook plate treatment for acromioclavicular joint dislocation. However, the researches on its risk factors were rare. The purpose of this study was to evaluate the incidences of postoperative shoulder pain of acromioclavicular joint dislocation treat with hook plate and to identify risk factors in patients with an acute acromioclavicular joint dislocation.

Method: We retrospectively analyzed the prospectively collected data from 310 consecutive patients with AC joint dislocation between December 2014 and August 2019 at our institute. Patients rated the average intensity of shoulder pain using an 11-point numerical rating scale (NRS). The dependent variable was the presence of moderate-to-severe neck pain (NRS ≥4) at the last follow-up when the internal fixation will be removed. The independent variables included age, gender, body-mass index (BMI), smoking status, alcohol consumption, type of injury, Rockwood Classification, site of injury, operation time, injury-to-surgery, DHA, DH and AHP. Logistic regression analysis was performed to identify independent risk factors of moderate-to-severe shoulder pain of acromioclavicular joint dislocation treat with hook plate.

Results: A total of 292 patients were included in the study and 18 cases were lost to follow-up. The follow-up rate was 94.1%. In all cases, there were 166 male cases and 126 female cases. Of these cases, the NRS < 4 group had 219 patients. Among them, there were 120 males and 99 females. 12 patients were lost to follow-up. There were 73 patients in NRS ≥ 4 group, 46 males and 27 females. 6 cases were lost to follow-up. The number of patient in NRS ≥ 4 group accounted for about 25.0% of the total cases. DH was the significant independent risk factor for postoperative shoulder pain of acromioclavicular joint dislocation treat with hook plate. DHA and AHP were also independent factors of postoperative shoulder pain, but they were all protective.

Conclusions: DH was the significant independent risk factor for postoperative shoulder pain of acromioclavicular joint dislocation treat with hook plate. DHA and AHP were also independent factors of postoperative shoulder pain, but they were all protective. We should try to refer to these factors to avoid postoperative shoulder pain when performing clinical operations.

Introduction

Acromioclavicular joint dislocation is a common shoulder injury, accounting for about 9% of all shoulder injuries(1). Since Hachkenbruch first designed the clavicular hook plate and applied it to treat acromioclavicular joint dislocation, it has been gradually applied to the distal clavicle fracture and acromioclavicular joint dislocation in the world, and it was considered to be an ideal treatment (2, 3). With the increase in usage, Some internal fixation complications gradually emerged, such as shoulder pain after internal fixation, subacromial impingement syndrome, subacromial erosion, failure of internal fixation, stress fracture(4). Especially postoperative shoulder pain, it was a common complication after clavicular hook plate treatment of acromioclavicular joint dislocation. At the same time, it was also a

comprehensive manifestation of various complications, affecting shoulder joint activity and functional recovery and leading to a decline in quality of life. The literatures reported that the total incidence of postoperative Shoulder pain was about 14% (5, 6). “What is the cause of postoperative shoulder pain? How to prevent it? ” became a big problem that needs to be solved urgently. A large number of scholars have conducted a lot of research and found that this was often related to the position of the hook, subacromial impingement syndrome and functional exercise (7, 8). However, there were no reports on definitive risk factors for postoperative shoulder pain after hook plating until now. The purpose of this study was to evaluate the incidences of postoperative shoulder pain of acromioclavicular joint dislocation treat with hook plate and to identify risk factors in patients with an acute acromioclavicular joint dislocation.

Patients And Methods

Patients

For this research, Acromioclavicular(AC) joint dislocation were classified using the method described by Rockwood et al(9). The inclusion criteria for the research were as follows: (1) acute, AC joint dislocation (grade III, IV, V, and VI) determined according to the classification described by Rockwood et al; (2) no more than 14 days of trauma; (3) signed informed consent. The exclusion criteria were as follows: (1) other types (grade I, II) of AC joint dislocation; (2) no signed informed consent; (3) previous surgery on the shoulder; (4) history of AC joint dislocation or other shoulder trauma.

We retrospectively analyzed the prospectively collected data from 310 consecutive patients with AC joint dislocation between December 2014 and August 2019 at our institute. The research protocol was approved by the Institutional Review Board of the authors’ institute. Written informed consent was obtained from all of the participants, and the research methods were carried out in accordance with approved guidelines.

Operation

Surgery was performed under brachial plexus anesthesia or general anesthesia. Patients with supine position, and placed a pillow under the medial margin of the scapula of sick shoulder. After the routine disinfection and covering surgical position, took an incision to the arcuate of the shoulder from the distal end of the clavicle, followed by cutting the skin, subcutaneous and plastric muscles, separating the trapezius fascia to exposure the acromioclavicular joint. The dislocated lateral clavicle was reduced and temporarily stabilized by transarticular Kirschner wires from lateral acromion. The hook of the pre-curved clavicular hook plate was inserted below the acromion, the plate body was placed above the clavicle and the locking screws were fixed. Repaired the acromioclavicular joint capsule in the surgery, stitched the distal end of the clavicle angle and trapezius muscle. After intraoperative fluoroscopy and passive activities of the shoulder joint, rinsed and sutured the wound.

Dependent variable

Moderate-to-severe postoperative shoulder pain at the last follow-up when the internal fixation will be removed was presence as the dependent variable. Patients rated the average intensity of postoperative shoulder pain using an 11-point numerical rating scale (NRS) (0: no pain; 10: worst pain imaginable). The cut-off point between mild and moderate-to-severe postoperative pain intensity was set at NRS ≥ 4 (10). For logistic regression analysis, patients were categorized into two groups: (1) those who had moderate-to-severe neck pain (NRS ≥ 4); (2) those who had no or mild neck pain (NRS < 4).

Independent variables

Patient characteristics

Age at the time of surgery, sex, body-mass index (BMI), smoking status and alcohol consumption were included in the patient characteristics. According to the smoking status, the patients were categorized into two groups: current smokers and current non-smokers. The current non-smokers included the past smokers or those who never smoked (11). As for the definition of alcohol consumption, the standard we set was Alcohol > 15 drinks/week. A standard drink is 12 oz of 5% alcohol beer, 8 oz of 7% malt liquor, 5 oz of 12% alcohol wine or 1.5 oz of 40% alcohol liquor (12).

Injury mechanism

The types of injuries were divided into four major categories: (1) Car accident injury; (2) Falling injury; (3) Fell and hurt; (4) Other injuries. According to Rockwood Classification (9), all cases were divided into four categories: (1) Rockwood Ⅰ; (2) Rockwood Ⅱ; (3) Rockwood Ⅲ; (4) Rockwood Ⅳ. The site of injury was distinguished by right and left shoulders.

Surgical factors

The first was the operation time, which was specifically from the beginning of the skin incision to the final suture of the skin. The second was the time from injury to surgery which calculated in days.

Hook plate factors

Regarding the hook plate factors, this research included a total of three items. (1) The hook depth (DH), it specifically referred to the distance between the connection point between the hook body and the hook tip and the cortical bone below at the distal of the clavicle (Fig. 1). (2) The hook plate angle (AHP), the angle with hook plate body and hook tip (13) (Fig. 2). (3) The distance between hook and acromion articular surface (DHA), its definition was the closest distance from the acromial articular surface to the hook body (Fig. 3).

Statistical analysis

Means and standard deviations (SDs) were used to describe distributions for continuous variables, and proportions were used to summarize categorical variables. One-way ANOVA tests were used to compare the means of continuous and ordinal variables; values of 0.05 represent a statistically significant

difference. For categorical variables, the Pearson chi-square analysis was used, and a P value of 0.05 represented a statistically significant difference. Binary logistic regression analysis was performed to account for confounding significant variables. $P < 0.05$ was considered significant. Odds ratios and 95% confidence intervals were calculated for each of the risk factors included in the logistic regression models. Analyses were performed using SPSS version 21 (IBM).

Results

General results

A total of 292 patients were included in the study and 18 cases were lost to follow-up. The follow-up rate was 94.1%. In all cases, there were 166 male cases and 126 female cases. Of these cases, the NRS < 4 group had 219 patients. Among them, there were 120 males and 99 females. 12 patients were lost to follow-up. There were 73 patients in NRS ≥ 4 group, 46 males and 27 females. 6 cases were lost to follow-up. The number of patient in NRS ≥ 4 group accounted for about 25.0% of the total cases.

Risk Factors for postoperative shoulder pain

According to relevant literature reports(13-17) and the clinical experience of the research team, this study included a total of 13 potential risk factors：Age, Gender, body-mass index (BMI), smoking status, alcohol consumption, Type of injury, Rockwood Classification, Site of injury, Operation time, Injury-to-surgery, DHA, DH and AHP(Table 1). Age was divided into 3 categories: less than or equal to 30 years old, more than 30 years old and less than 60 years old, more than or equal to 60 years old. There were 43,148 and 28 patients in each age level of NRS < 4 group, and 11, 47, 15 patients in NRS ≥ 4 group. According to age, there was no statistical difference in the two groups (P=0.230). Similarly, it was the same in terms of gender (P=0.219). BMI was the 23.977±3.943 and 24.753±3.439 in the two groups, respectively. There was also no statistical difference (P=0.134). 76 patients had smoking history in NRS < 4 group, and 28 in NRS ≥ 4 group(P=0.572). 86 patients had the alcohol consumption in NRS < 4 group compared with 29 patients in NRS ≥ 4 group (P=0.945). In the NRS < 4 group, 55 patients were car accident injury, 43 patients were falling injury, 109 patients were Fell and hurt and 12 patients were other injuries. Compared with the NRS ≥ 4 group, it was not statistically significant (P=0.944). About the Rockwood Classification, 60 patients were included to Rockwood Ⅲ, 4 patients were included to Rockwood Ⅳ and 9 patients were adopted in Rockwood Ⅴ in the NRS ≥ 4 group. Compared with the NRS < 4 group, there was also no statistical difference (P=0.877). The statistical result of the site of injury was also similar (P=0.680). The operation time of two groups were 45.637±8.938 min and 43.465±9.398 min, the time of Injury-to-surgery were 4.790±1.884 days and 5.150±1.983 days. In statistics, they have no difference. In NRS < 4 group, the DHA was 1.662±0.649 cm, the DH was 1.319±0.484cm and the AHP was 18.118±11.144 degree. They were statistically different from NRS ≥ 4 group (P < 0.05).

All variables that yielded a p value of ≤0.2 in the *univariate analysis* were evaluated in multivariable analysis. Factors with a p value of >0.2 were not deemed clinically important enough in this context to warrant further investigation. Finally, a total of six variables were included in the regression analysis: BMI, Operation time, Injury-to-surgery, DHA, DH and AHP. According to statistical results, the independent factors that affect shoulder pain after surgery were DHA (OR=0.618, 95% CI =0.385 to 0.993,P=0.047), DH(OR=1.894, 95% CI =1.073 to 3.343,P=0.028) and AHP(OR=0.976, 95% CI =0.955 to 0.997,P=0.029). DH was the most obvious independent risk factor for postoperative shoulder pain. DHA and AHP were protective factors for postoperative shoulder pain of acromioclavicular joint dislocation treat with hook plate (Table 2).

Discussion

In this study, the incidence of postoperative shoulder pain was 25%, which was significantly higher than the 14% reported in the literatures (5, 6). Some studies had also occurred in a similar situation to this study. The incidence of postoperative shoulder pain was often higher and they were all above 20% (18). Postoperative shoulder pain had become the most common complication after the fixation of clavicular hook plate and had a great adverse impact on the patient's postoperative rehabilitation. This illustrated the urgency and necessity for the study of its causes and prevention strategies. Many scholars also conducted in-depth researches for this purpose from anatomy, biomechanics and other perspectives. Some factors related to postoperative shoulder pain had been proposed, mainly focusing on the hook plate, such as the clavicle hook hit the shoulder, the hook tail was too long and the poor hook position, etc. It was recommended to remove the clavicular hook plate as soon as possible for early functional exercise and rehabilitation(8,13). However, there were no systematic and detailed clinical studies on the factors affecting postoperative shoulder pain. This was also the purpose of our study. By analyzing the risk factors of postoperative shoulder pain, let our research provided meaningful guidance for preventing its occurrence. In this study, according to the study group members' own clinical experience and relevant literature reports, three typical and major factors of clavicular hook plate were extracted: AHP(8); DH(7); DHA(6). Combined with some basic factors of the patients such as gender, age, etc., a total of 13 potential factors were included. Through clinical follow-up, these potential factors for postoperative shoulder pain were analyzed.

For the time point of follow-up, our definition was the point in time when the patient came to the hospital for removing the clavicular hook plate and the final evaluation was performed before surgery. For the definition of postoperative shoulder pain, we did not follow the criteria of “with and without”. Instead, from a clinical perspective,“whether or not the treatment was needed” (10)，we divided the postoperative shoulder pain into two categories: the NRS for mild pain and the NRS for moderate-to-severe pain(19). The existing literature provided variable cut-off points for identifying moderate-to-severe pain, ranging from NRS ≥ 3 to NRS ≥ 6, depending on differences in diagnosis and methods of analysis，but most studies had Defining cut-off points of NRS ≥ 4，10).

According to the results of the final regression analysis, DH was the most significant independent risk factor for postoperative shoulder pain. DH was defined as the distance between the junction of the hook body and the hook tip and the subclavian cortex. The greater the DH, the deeper it was in the joint. The junction of the hook body and the hook tip was also the radian of the clavicle hook from straight to flat. The radian was often located above the supraspinatus fossa of scapula. If the hook was too deep or the subacromial space was too small, it may cause oppression to the supraspinatus muscle and shoulder pain. The report of the anatomical study also found (20) that the radian of the hook was located above the humeral head. In 15 corpse specimens, 9 cadaveric specimens were found that the clavicle hook touched the muscular abdomen of the supraspinatus muscle. Another literature reported that some scholars performed shoulder arthroscopy on 12 patients with shoulder pain and shoulder limitation. 11 cases (92%) had rotator cuff compression (7). All these showed that the repression of supraspinatus muscle by the radian of hook had a close relationship with shoulder pain, and it coincided with the finding of this study that DH is an independent risk factor for postoperative shoulder pain. DHA and AHP were also independent factors of postoperative shoulder pain, but they were all protective. DHA was the distance from the hook body to the acromion articular surface. Related literatures reported (6) that if the DHA was too small, the hook body easily came into contact with the shoulder and caused friction and pain. In general, the gap between the hook body and acromion articular surface was greater than 5 mm, we could avoid rubbing when the shoulder joint moves. The AHP was the angle of the clavicle hook. The smaller the angle, the easier the hook tip will be upturned. This often resulted in surface contact between the tip of the hook and the acromion became point contact. The stress was highly concentrated on the contact point of the tip of the hook and the acromion, which was more likely to cause the occurrence of bone erosion and pain. Some reports also suggested that (13) AHP should be controlled from 0 to 40 degrees to avoid its angle being too small.

The present study had several limitations. There was only one follow-up time point for postoperative shoulder pain in this study. The article lacked a full-time reflects of the shoulder pain. There were only 13 potential risk factors included, which were not particularly large in quantity and may have some impact on the results.

Conclusions

DH was the significant independent risk factor for postoperative shoulder pain of acromioclavicular joint dislocation treat with hook plate. DHA and AHP were also independent factors of postoperative shoulder pain, but they were all protective. We should try to refer to these factors to avoid postoperative shoulder pain when performing clinical operations.

Abbreviations

AC
Acromioclavicular
BMI

body-mass index
NRS
numerical rating scale
AHP
the hook plate angle
DHA
the distance between hook and acromion articular surface
DH
the hook depth

Declarations

Availability of data and material

All data generated or analysed during this study are included in this published article.

Competing interests

All the authors do not have any possible conflicts of interest.

Funding

Not applicable

Ethics approval and consent to participate

Written informed consent was obtained from all subjects. The study was approved by the Ethics Committee of the Shangyu people's hospital of shaoxing city, China (SYRY170601).

Consent for publication

All authors give their consent to publish this manuscript.

Authors' contributionsDX and WGL searched the scientific literature and drafted the manuscript. DX and JMC contributed to conception, design and data interpretation. PL, WGL,WJG and YLS helped to collect the data and performed statistical analyses. DX and WGL contributed toconception, design, data interpretation, manuscript revision for critical intellectual content and supervision of the study. All authors read and approved the manuscript.

Acknowledgements

Not applicable

References

1.Shaw MB□Melnemey JJ□Dias JJ□et a1□Acromioclavicular joint sprains□the post—injury recovery interval[J]□Injury□2003□34(6)□438—442□

2. Renger RJ□Roukema GR□Reurings JC□et al□The clavicle hook plate for Neer type□lateral clavicle fractures□J Orthop Trauma□2009□23(8)□570-574□
3. Muramatsu K□Shigetomi M□Matsunaga T,et al□Use of the AO hook-plate for treatment of unstable fractures of the distal clavicle□Arch Orthop Trauma Surg□2007□127(3)□191-194□
4. Kienast B□Thietje R□Queitsch C□et al□Mid-term results after operative treatment of rokwood grade□-V acromioclavicular joint dislocations with an AC-hook-plate□Eur J Med Res□2011□1 6(2)□52-56□

5.Flinkkila T□Ristiniemi J□Lakovaara M□et al□ Hook-plate fixation of unstable lateral clavicle fractures□ a report on 63 patients□ Acta Orthop Scand□2006□77□644—649□

6.Kashii M□Inui H□Yamamoto K□ Surgical treatment of distal clavicle fractures using the clavicular hook plate□ Clin orthop Relat Res□ 2006□(447)□158-164□

7. Lee KW, Lee SK□Kim KJ□et al□Arthroscopic-assisted locking compression plate clavicular hook fixation for unstable fractures of the lateral end of the clavicle□a prospective study□Int Orthop□2010□34(6)□839-845□
8. Di Francasco A□Zoeeali C□Colafarina O□et a1□The use of hook plate in type □ and Vacromio-clavicular Rockwood dislocations□clinical and radiological midterm results and MRI evaluation in 42 patients□Injury□2012□43(2)□147—152□

9.Rockwood CJ, Williams G, Yound D. Disorders of the acromioclavicular joint. In: Rockwood CJ, Matsen F, eds. The Shoulder. Vol. I. Philadelphia, PA: WB Saunders; 1998:483–553.

10.Gerbershagen HJ, Rothaug J, Kalkman CJ, et al. Determination of moderate-to-severe postoperative pain on the numeric rating scale: a cut-off point analysis applying four different methods*. Br J Anaesth* 2011;107:619-26.

11. Musallam KM, Rosendaal FR, Zaatari G, et al. Smoking and the risk of mortality and vascular and respiratory events in patients undergoing major surgery*. JAMA Surg* 2013;148:755-62.

12. 1 Staton CA, Vissoci JRN, Toomey N,et al. The impact of alcoholamong injury patients in Moshi, Tanzania: a nested case-crossover study. BMC Public Health. 2018;18(1):275.

13. Xu D, Luo P, Chen J,et al. Outcomes of surgery for acromioclavicular joint dislocation using different angled hook plates: a prospective study. Int Orthop. 2017;(12):2605-2611.

14. Yang YG, Cai XB, Wang XM,et al. Case-control study on shoulder pain caused by hook palte for the treatment of acromioclavicular joint dislocation. Zhongguo Gu Shang. 2015;28(6):491-5.

15.Nadarajah R, Mahaluxmivala J, Amin A, Goodier DW. Clavicular hook-plate: complications of retaining the implant. *Injury.*2005;36(5):681–3.

16. Lin HY, Wong PK, Ho WP, Chuang TY, Liao YS, Wong CC (2014) Clavicular hook plate may induce subacromial shoulder impingement and rotator cuff lesion—dynamic sonographic evaluation. J Orthop Surg Res 9:6.

17.Hoffler CE, Karas SG (2010) Transacromial erosion of a locked subacromial hook plate: case report and review of literature. J Shoulder Elbow Surg 19(3):e12–e15.

18. Yiyong Zhu, Jianliang Wang, Kefeng Xu, et al. Causes for shoulder pain following acromioclavicular dislocations and fractures of distal clavicle treated with hook plates. Chin J 0rthop Trauma 2007;9(7):692-693.
19. Boonstra AM, Stewart RE, Koke AJ, et al. Cut-Off Points for Mild, Moderate, and Severe Pain on the Numeric Rating Scale for Pain in Patients with Chronic Musculoskeletal Pain: Variability and Influence of Sex and Catastrophizing*. Front Psychol* 2016;7:1466.

20. ElMaraghy AW Devereaux MW Raichandiran K et al Subacromial nor-phometric assessment of the clavicle hook plate.Injury 2010 41(6) 613—619

Tables

Table 1 Potential risk factors

Potential Risk Factors				
	Means or Percentage		Statistics	P value
	NRS<4	NRS≥4		
Patient characteristics				
Gender (male/female) (n)	120/99	46/27	X^2=1.508	0.219
Age (years) (n)				
≤ 30	43	11		
>30 & <60	148	47		
≥60	28	15	X^2=2.941	0.230
BMI (kg/m^2)	23.977±3.943	24.753±3.439	F=2.255	0.134
Smoking history (yes/no)	76/143	28/45	X^2=0.319	0.572
Alcohol (yes/no)	86/133	29/44	X^2=0.005	0.945
Injury mechanism				
Type of injury(n)				
Car accident injury	55	16		
Falling injury	43	16		
Fell and hurt	109	37		
Other injuries	12	4	X^2=0.380	0.944
Rockwood Classification(n)				
Rockwood	184	60		
Rockwood	9	4		
Rockwood	26	9		
Rockwood	0	0	X^2=0.262	0.877
Site of injury (right/left), n	129/90	45/28	X^2=0.171	0.680
Surgical factors				
Operation time (min)	45.637±8.938	43.465±9.398	F=3.141	0.077
Injury-to-surgery (days)	4.790±1.884	5.150±1.983	F=1.953	0.163
Hook plate factors				
DHA (cm)	1.662±0.649	1.486±0.601	F=4.184	0.042*
DH (cm)	1.319±0.484	1.472±0.556	F=5.092	0.025*
AHP (degree)	18.118±11.144	14.739±16.154	F=3.953	0.048*

Values are shown as mean ± standard deviation, number (%). P values were calculated

using the one-way ANOVA test for means, Pearson's chi-square test for proportions."*" represents a statistical difference. AHP : angle of the hook and plate; DHA: the distance between the hook body and the articular surface; DH: depth of hook; BMI: body mass index.

Table 2 logistic regression analysis

Variable	OR	95% CI	P Value
BMI	1.061	0.988,1.140	0.104
Operation time	0.974	0.945,1.004	0.089
Injury-to-surgery	1.129	0.979,1.301	0.096
DH	1.894	1.073,3.343	0.028*
AHP	0.976	0.955,0.997	0.029*
DHA	0.618	0.385,0.993	0.047*

"*" represents a statistical difference.

Figures

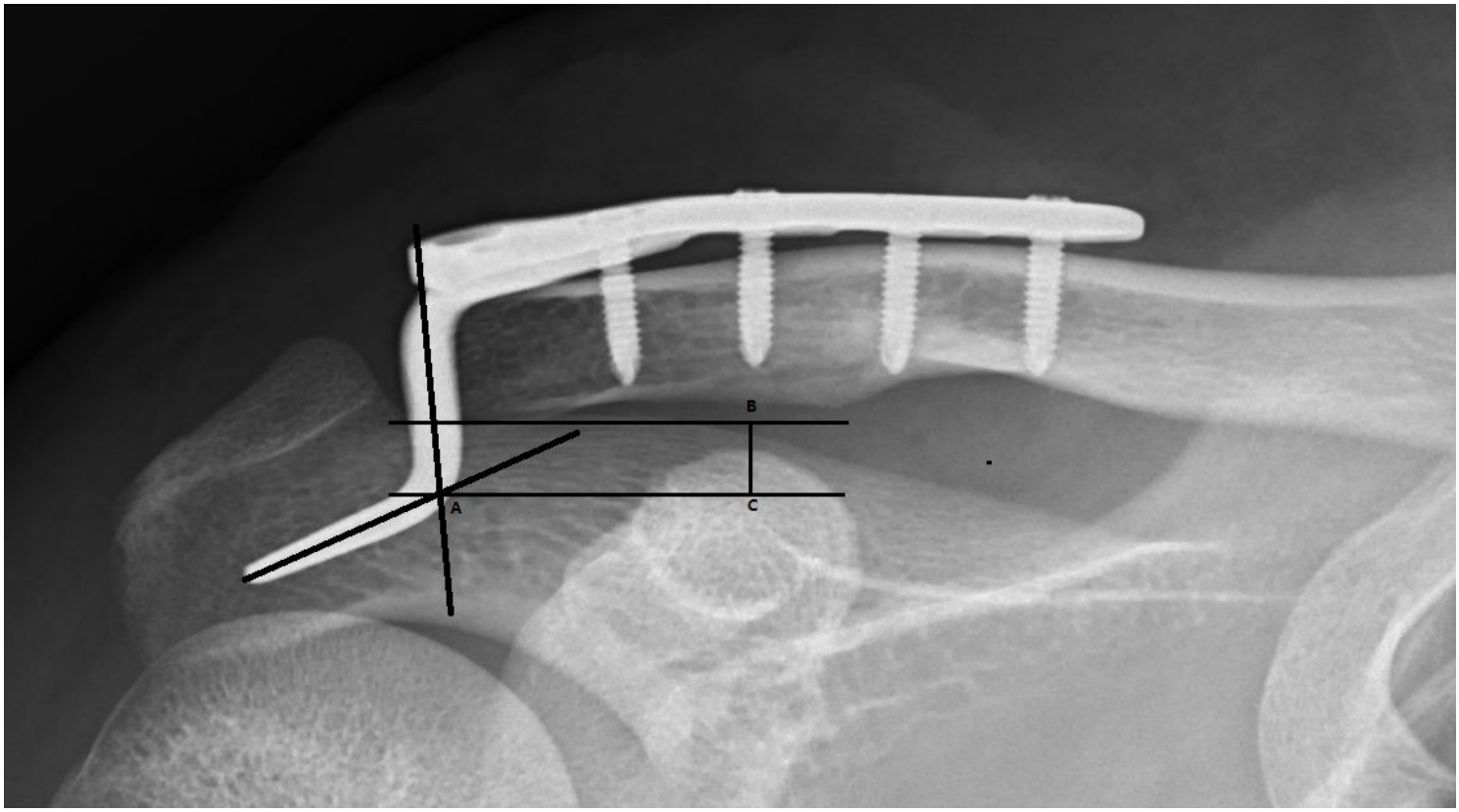

Figure 1

The schematic diagram of the hook depth Make two middle lines along the hook body and the hook tip, then to take the focus. Make a horizontal line through the focus and a horizontal line tangent to the cortical bone below at the distal of the clavicle separately. The distance between the two lines is the hook depth (DH).

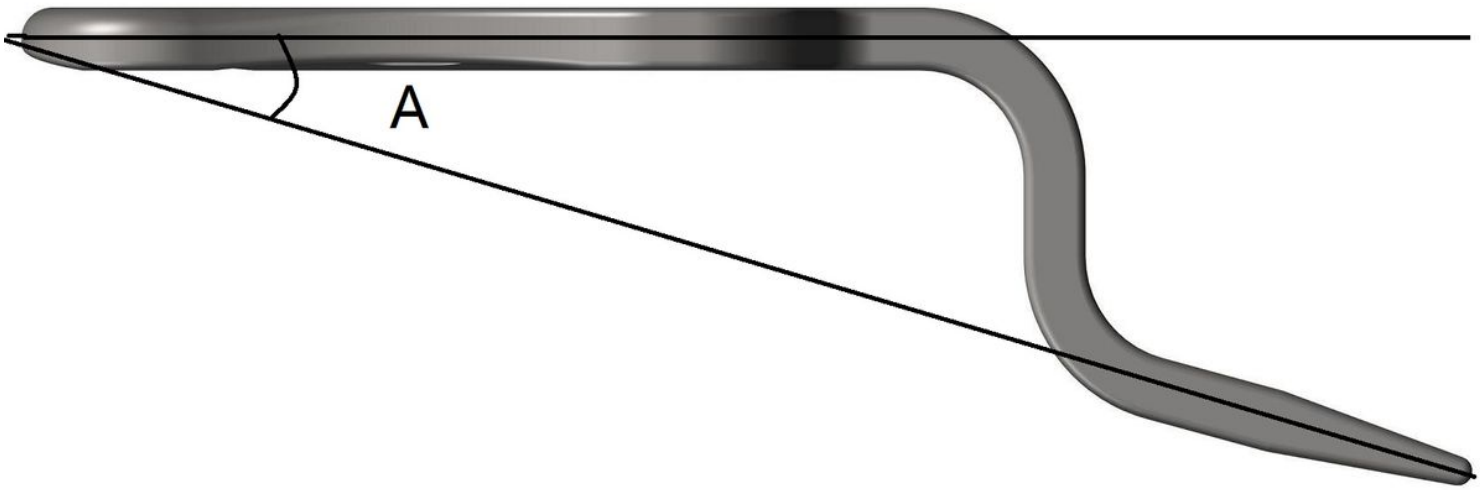

Figure 2

The explanation diagram of the hook plate angle Illustration with Hook Angle (AHP) : According to the plate body and hook, make a parallel line separately, then two lines crossed and formed an angle called A , it is the angle of Hook and plate (AHP).

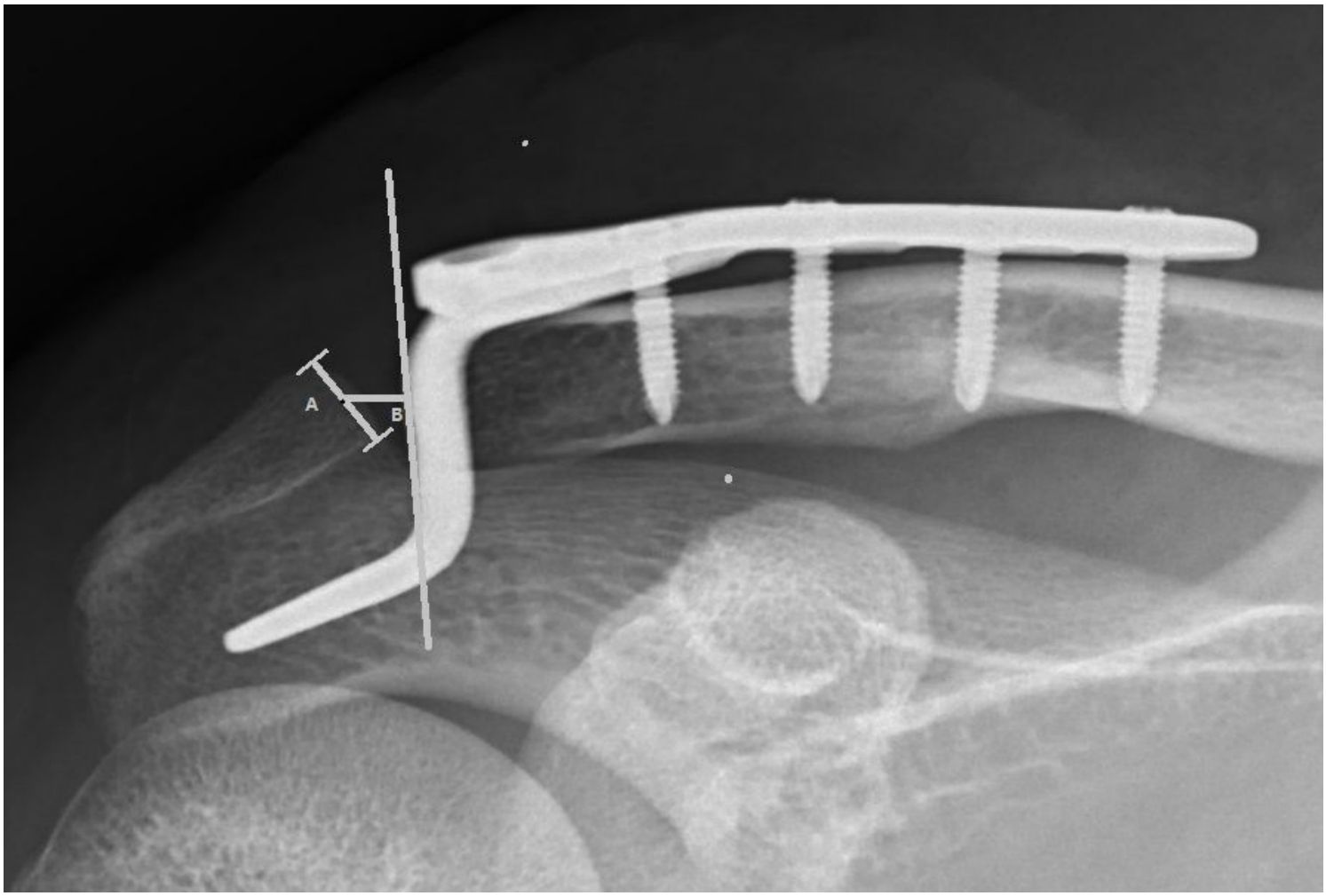

Figure 3

The abridged general view of DHA Take the two points at the maximum distance above and below acromial articular surface and make a straight line. Then take the midpoint of this line. Through this midpoint, make a horizontal line to the outside edge of the hook body. And this line is the distance between hook and acromion articular surface (DHA).