

To Explore the Reasonable Selection of Clavicular Hook Plate to Reduce the Occurrence of Subacromial Impingement Syndrome After Operation.

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Abstract

Purpose: To explore whether the existing clavicular hook plate can be reasonably selected to reduce the incidence of Subacromial impingement syndrome (SIS) and provide reference for clinical diagnosis and treatment.

Methods and methods The patients with SIS admitted from March 2019 to March 2020 were selected as the experimental group, and the asymptomatic patients after operation as the control group. The hook end depth and acromion height of the hook plate used by the patients were recorded, and the difference between them was calculated.

Results The difference between the depth of hook plate and the height of acromion in the experimental group was $(8.06 \pm 1.15 \text{ mm})$. In the control group, the difference between the depth of hook plate and the height of acromion was $(6.78 \pm 1.82 \text{ mm})$, and the difference was statistically significant $(t=2.721, P=0.009)$. The difference is greater than 0.6 mm as a grouping index to do a single factor analysis. The difference was statistically significant $(t=5.711, P=0.017)$.

Conclusions The occurrence of SIS after clavicular hook plate may be related to the difference between the depth of hook plate and the height of acromion. When the difference is greater than 6mm, it may be a factor affecting the occurrence of SIS. Pre-imaging measurement of acromion height can provide suggestions for selecting the type of hook plate during operation.

Introduction

Acromioclavicular joint dislocation is a common shoulder joint injury in clinic. Clavicular hook plate technique is commonly used in clinical surgical treatment, and the curative effect is affirmed. However, some patients will have symptoms such as shoulder abduction limitation, shoulder discomfort and joint pain after operation [1-2]. At present, it is believed that the symptoms of shoulder discomfort can be relieved and disappeared after the hook plate is removed after the second operation [3]. However, the quality of life of these patients was seriously reduced before the hook plate was removed. Most scholars think that the shape of the acromion is poorly matched with the currently used steel plate for the cause of acromial impact sign Subacromial impingement syndrome (SIS) after hook plate operation [4-5], but it is difficult to design a fully fitted hook plate because of individual differences. We retrospectively analyzed the patients with SIS from March 2019 to March 2020 to explore whether we can reasonably choose and use the existing clavicular hook plate type in order to reduce the occurrence of SIS and provide reference for clinical diagnosis and treatment.

Materials And Methods

The patients with SIS from March 2019 to March 2020 were taken as the experimental group, and the asymptomatic patients after operation in the same period were taken as the control group. Inclusion criteria: (1) Rockwood I and above patients undergoing clavicular hook plate surgery; (2) Patients older

than 18 years old; fresh closed fractures within 32 weeks; (3) Complete clinical data and follow-up data; (4) Patients with good compliance. Exclusion criteria: (1) Fracture with other parts; (2) Osteoporosis; (3) Pathological fracture; (4) Patients with serious internal diseases, tumor or mental illness without functional exercise; (5) Poor ligament healing; (6) Patients with a history of shoulder disease. A total of 34 patients had acromion impact syndrome, and 25 patients met the admission criteria. There were 25 patients in the experimental group and 25 patients in the control group. In the experimental group, there were 17 males and 8

females, with an average of 29.92 (± 6.278) years (range: 19–48 years), 11 on the left and 14 on the right. In the control group, there were 12 males and 13 females, with an average of 33.5 (± 9.734) years (range: 21–54 years), 9 on the left and 16 on the right. There was no significant difference in sex, age and position between the two groups ($P > 0.05$) (Table 1)

Table 1
Patient data

| Variable | Experimental group (n = 25) | Control group(n = 25) | Test Statistics | P Value |
|----------------------|-----------------------------|-----------------------|-----------------|---------|
| Age(yr) | 29.92 \pm 6.278 | 33.52 \pm 9.734 | 1.554 | 0.054 |
| Gender(male/female) | 17/8 | 12/13 | 2.053 | 0.152 |
| Position(left/right) | 14/11 | 16/9 | 0.333 | 0.564 |

Surgical treatment

Under general anesthesia or nerve block anesthesia, the patient took beach chair position, shoulder pad high, affected limb placed beside, routine disinfection. Along the distal clavicle, acromioclavicular surface arc incision, cut the skin, subcutaneous, latissimus cervicalis in turn, do blunt separation, expose the distal clavicle and acromioclavicular joint, select the appropriate clavicular hook plate, place the hook end under the acromion, then press the clavicle cadre of the plate to the supraclavicular surface, screw fixed the plate, examine the movement of the shoulder joint under fluoroscopy, prevent the shoulder joint abduction and external rotation when the hook plate hit the humeral head, after successful reduction, close the wound layer by layer.

Follow-up

After operation, the upper arm is suspended and fixed, and the shoulder pendulum training is started immediately after the anesthesia dissipates. After 2 weeks, the sling is removed, and the patient is told to start the unrestricted joint motion training. The patients were followed up 2 weeks, 1 month, 3 months, 6 months and 8 months after the operation. The rehabilitation plan was made according to the patient's

recovery. After 8 months, if the patient had symptoms such as limited abduction of shoulder joint, shoulder discomfort and joint pain, and positive neer impact sign and Hawkins impact sign, we diagnosed the patient as SIS after excluding hook plate dislocation, stress fracture and other diseases.

Before surgery, we used spiral CT to examine and diagnose patients (Fig .1), The height of the acromion was measured on the coronal plane, that is, the thickest of the acromion on the coronal plane (Fig .2). Then the depth of the hook end (Fig .3) and the height of the acromion were recorded, And calculate the difference between. Clavicle hook plate is selected from Tianjin Zhengtian Company. The hook length is 20mm, the width is 6mm and the thickness is 3mm. There are three specifications for the depth of the clavicle hook plate: 12mm, 15mm and 18mm.

Statistical analysis

The Statistical Package for Social Sciences software version 19(IBM, Chicago, Illinois) was used. The data are presented as the means and standard deviations except where noted. χ^2 and Fisher exact tests were performed for the categorical variables as appropriate. Comparisons between intergroups were performed using Student *t* test for continuous variables.

Results

In the experimental group, there were 17 males and 8 females, with an average of 29.92 (± 6.278) years (range: 19–48 years), 11 cases on the left side and 14 cases on the right side. In the control group, there were 12 males and 13 females, with an average of 33.5 (± 9.734) years (range: 21–54 years), 9 cases on the left side and 16 cases on the right side. The height of acromion in the experimental group was (8.86 ± 1.54 mm), while that in the control group was (9.06 ± 1.78 mm). There was no statistical difference ($t = 0.438, P > 0.05$). The difference between the depth of hook plate and the height of acromion in the experimental group was (8.06 ± 1.15 mm). In the control group, the difference between the depth of hook plate and the height of acromion was (6.78 ± 1.82 mm), and the difference was statistically significant ($t = 2.721, P = 0.009$). Finally, the difference greater than 0.6 mm is taken as the grouping index to do univariate analysis.(Table 2). The difference was statistically significant ($t = 5.711, P = 0.017$). Therefore, the occurrence of SIS after operation may be related to the fact that the difference between the depth of hook plate and the height of acromion is greater than that of 6 mm.

Table 2
Univariate analysis of influencing factors of acromion impingement syndrome

| Variable | Experimental group (n = 25) | Control group (n = 25) | Test Statistics | P Value |
|----------|-----------------------------|------------------------|-----------------|---------|
| D-value | | | | |
| >6 mm | 23 | 16 | 5.711 | 0.017 |
| ≤ 6 mm | 2 | 9 | | |

Discussion

Clavicular hook plate is designed according to the shape of human acromioclavicular joint, and the reduction of acromioclavicular joint is realized by lever principle^[6]. The risk of plate fracture after operation is low. Because of its simple operation and good curative effect, clavicular hook plate is widely used in clinic. However, a series of complications can occur after clavicular hook plate operation^[7]. (1) Failure of internal fixation and poor ligament repair; (2) Postoperative SIS symptoms such as periacromial pain, upper limb weakness and limited abduction of shoulder joint; (3) Subacromial osteolysis; (4) Clavicle stress fracture, acromial stress fracture.

The incidence of SIS after clavicular hook plate operation is 19% ~ 25%^[8-9]. People have never stopped exploring the causes of SIS after clavicular hook plate operation. Macdonald et al.^[10] thought that the appearance of SIS after clavicular hook plate was related to the shape of acromion, and curved and hooked acromion were more likely to cause SIS than straight acromion. A number of studies^[11-13] have shown that older patients after hook plate surgery may increase the risk of SIS, which may be related to shoulder tissue degeneration. Macdonald et al.^[14] found that the placement of clavicular hook plate would inevitably narrow the subacromial clearance, which may be related to the appearance of SIS. Elmaraghy et al.^[15] simulated clavicular hook plate implantation on cadavers and reached the same conclusion. It can be seen that there are many reasons for SIS after operation. We hope that the appropriate hook plate can be selected to reduce the possibility of SIS. Analysis reasons: when the type of hook plate used by the patient does not match with the patient itself, the difference between the depth of hook end and the height of acromion will be too large, resulting in the reduction of subacromial space. When the space occupied by the hook end is too much, the pain will be caused by the hook plate pressing the subacromial tissue, such as the acromial bursa and the long head of biceps brachii muscle^[16].

Many scholars have put forward some suggestions on how to prevent the occurrence of SIS after hook plate operation. Li Kui et al.^[17] suggested using shoulder arthroscopy to check whether the hook plate obviously occupies the acromion space during the operation, and then adjust the type of the hook plate. Li-Kun Hung et al.^[18] simulated the implantation process of clavicular hook plate at different hook angles (90°, 95°, 100°, 105° and 110°) for the treatment of acromioclavicular joint dislocation, and found clavicle

hook plates with different hook angles It will cause different biomechanical behaviors of the clavicle and acromion. It is recommended to implant clavicle hook plates with different hook angles according to different shoulder joint shapes. Yin JP et al.[¹⁹]conducted morphological studies on clavicular hook plate and acromioclavicular

joint, and found that the appearance of SIS was related to the mismatch between clavicular hook plate and acromioclavicular joint, suggesting personalized use of clavicular hook plate. However, due to the influence of intraoperative patient position, X-ray acromial imaging is not accurate [²⁰], and it is difficult to promote the application of shoulder arthroscopy in the intraoperative assessment of the subacromial space clinically. As a result, it is difficult to measure the space occupied by hook plate in subacromial space, which can not provide suggestions for surgeons to choose hook plate type. It is difficult to design and use individualized clavicular hook steel plate because of the great individual difference in the shape of acromion. We think that the height of acromion can be measured by CT before operation, and the difference between the depth of hook end of hook plate and the height of acromion should be controlled within 6 mm in order to reduce the possibility of SIS after operation.

Preoperative imaging measurement of the height of the acromion is helpful to the selection of the type of hook plate used during the operation, but the data of the acromion may be inaccurate due to the presence of CT bone artifacts and cartilage. Therefore, it is better for the surgeon to measure the acromion height during the operation and select the appropriate clavicular hook plate. Our team developed a device to measure acromion height during surgery (Fig. 4).

After intraoperative exposure of acromioclavicular joint, the A side was placed at the distal end of the clavicle, and the B side was placed under the acromion. The height of the patient's acromion was measured by rotating the handle. The appropriate plate is then selected to reduce the presence of SIS after surgery. At present, the measuring instrument is in production, and its effect should be further studied after it is used in clinic.

To sum up, the appearance of SIS after clavicular hook plate operation may be related to the difference between the depth of the hook plate and the height of the acromion peak. When the difference is greater than 6 mm, it may be an influential factor for the appearance of SIS. The measurement of acromion height by imaging before operation can provide advice for the selection of hook plate model during operation, but there are defects. We expect the use of acromion height meter in clinical practice.

Abbreviations

Subacromial impingement syndrome , (SIS)

Declarations

Ethics approval and consent to participate

Approval was obtained from the Clinical Trials and Biomedical Ethics Committee of Hong Hui Hospital and written informed consent was obtained from all participants.

Consent for publication

Not applicable.

Availability of data and material

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

Declaration of conflict of interest

The authors declare no conflict of interest.

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Authors' contributions

ZS and KZ were responsible for the study design, the definition of intellectual content, and for literature research. RQ and JRY analyzed and interpreted data. RQ and JRY performed the statistical analysis. RQ and JRY drafted the manuscript. ZS and KZ revised the manuscript. All authors read and approved the final manuscript.

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References

1. Qi W, Xu Y, Yan Z, et al. The Tight-Rope Technique versus Clavicular Hook Plate for Treatment of Acute Acromioclavicular Joint Dislocation: A Systematic Review and Meta-Analysis. *J Invest Surg.*

- 2019;6:1–10.
2. Lin HY, Wong PK, Ho WP, et al. Clavicular hook plate may induce subacromial shoulder impingement and rotator cuff lesion - dynamic sonographic evaluation. *Journal of Orthopaedic Surgery Research*. 2014;9:6–6.
 3. Reška M, Konečný J, Kašpar M, et al. Stabilisation of the dislocated acromioclavicular joint and lateral fractures of the clavicle using a hook plate. *Rozhl Chir*. 2013;92:143–50.
 4. Yoon JP, Lee YS, Song GS, et al. Morphological analysis of acromion and hook plate for the fixation of acromioclavicular joint dislocation. *Knee Surgery Sports Traumatology Arthroscopy*. 2016;25:1–7.
 5. Shih CM, Huang KC, Pan CC, et al. Biomechanical analysis of acromioclavicular joint dislocation treated with clavicle hook plates in different lengths. *Int Orthop*. 2015;39:2239–44.
 6. Kashii M, Inui H, Yamamoto K. Surgical treatment of distal clavicle fractures using the clavicular hook plate. *Clin Orthop Relat Res*. 2006;447:158–64.
 7. Flinkkil T, Ristiniemi J, Lakovaara M, et al. Hook-plate fixation of unstable lateral clavicle fractures: a report on 63 patients. *Acta Orthop*. 2006;77:644–9.
 8. Bigliani LU, Levine WN. Current concepts review—Subacromial impingement syndrome. *J Bone Joint Surg*. 1998;79:1854–68.
 9. Meda PVK, Machani B, Sinopidis C, et al. Clavicular hook plate for lateral end fractures—A prospective study. *Injury-international Journal of the Care of the Injured*. 2006;37:277–83.
 10. Mayerhoefer ME, Breitenseher MJ, Roposch A, et al. Comparison of MRI and conventional radiography for assessment of acromial shape. *Ajr American Journal of Roentgenology*. 2005;184:671.
 11. Meda PV, Machani B, Sinopidis C, et al. Clavicular hook plate for lateral end fractures: a prospective study. *Injury*. 2006;37:277–83.
 12. Renger RJ, Roukema GR, Reurings JC, et al. The clavicle hook plate for Neer type II lateral clavicle fractures. *J Orthop Trauma*. 2009;23:570–4.
 13. Lin HY, Wong PK, Ho WP, et al. Clavicular hook plate may induce subacromial shoulder impingement and rotator cuff lesion - dynamic sonographic evaluation. *Journal of Orthopaedic Surgery Research*. 2014;9:6–6.
 14. Bonsell S, Pearsall AW, Heitman RJ, et al. The relationship of age, gender, and degenerative changes observed on radiographs of the shoulder in asymptomatic individuals. *Journal of Bone Joint Surgery-british Volume*. 2000;82:1135–9.
 15. Elmaraghy AW, Devereaux MW, Ravichandiran K, et al. Subacromial morphometric assessment of the clavicle hook plate. *Injury-international Journal of the Care of the Injured*. 2010;41:613–9.
 16. Sanders TG, Jersey SL. Conventional radiography of the shoulder. *Semin Roentgenol*. 2005;40:207–22.
 17. 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;34:839–45.

18. Hung LK, Su, Kuo-Chih, Lu WH, et al. Biomechanical analysis of clavicle hook plate implantation with different hook angles in the acromioclavicular joint. *Int Orthop*. 2017;41:1663–9.
19. Yoon JP, Lee YS, Song GS, et al. Morphological analysis of acromion and hook plate for the fixation of acromioclavicular joint dislocation. *Knee Surgery Sports Traumatology Arthroscopy*. 2016;25:1–7.
20. Peh WC, Farmer TH, Totty WG. Acromial arch shape: assessment with MR imaging. *Radiology*. 1995;195:501.

Figures



Figure 1

Male, 32 years old, fell to right acromioclavicular joint dislocation, preoperative CT



Figure 2

Measurement of acromion height on coronal plane of CT

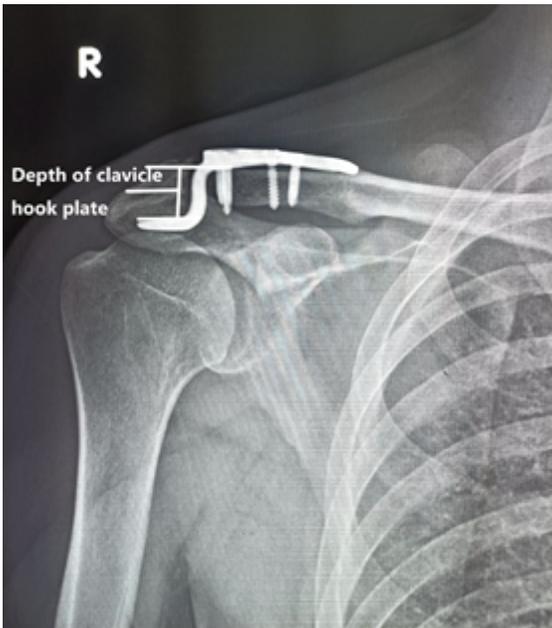


Figure 3

The depth of the hook plate used by the patient

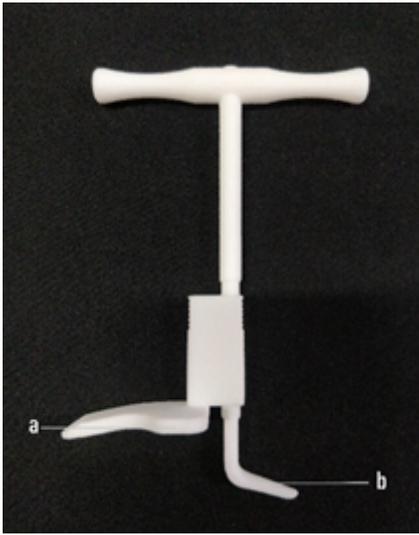


Figure 4

Acromion height measuring device

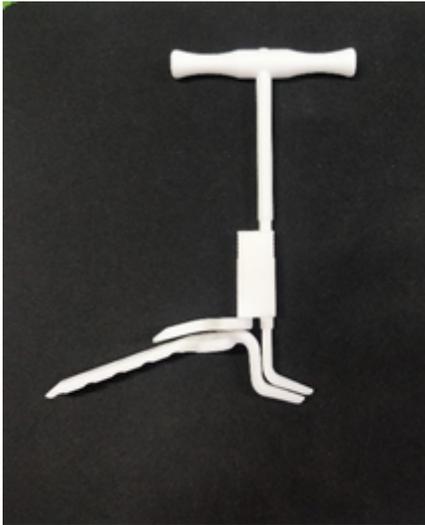


Figure 5

Acromion height measuring instrument and clavicular hook plate