

A Prospective Study on the Operative Management of Fractures of The Lateral End of Clavicle And Acromio- Clavicular Joint Disruption

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Abstract

Introduction: Clavicular fractures are relatively common due to its subcutaneous position. They can be due to low or high energy trauma, as isolated injury or part of a polytrauma spectrum. Distal clavicular fracture is a special form of injury and have been estimated to account for only 12% to 15% of all clavicle fractures. The present study is to evaluate the feasibility and the eventual outcome in the study subjects following operative management of the fractures of the lateral end of the clavicle and acromioclavicular disruption with clavicular hooked plates and locking compression clavicular plates.

Methodology: In a prospective controlled study was carried out for one year which included patients having fracture lateral end clavicle and patients having acromioclavicular joint dislocation. The age group of the patients is 18 to 60 years, The surgery and follow-up conducted at the same centre. Patients will be followed up at regular intervals and outcome variables assessed and recorded.

Results: In our study, in the subgroup of fracture lateral end clavicle, 66.67% had **excellent** results at the end of evaluation while 33.33% had **good** results while with AC joint dislocation, 62.50% had excellent and 37.50% had good results and none had poor results based on Disability of Arm Shoulder and Hand (DASH) score.

Conclusion: Clavicle hook plate is a very good implant for treating fractures of the lateral end of clavicle and displaced AC joint dislocation. The overall prognosis in our study was very good with excellent improvement of symptoms following the procedure. The use of this implant warrants quicker rehabilitation and return to normal activities of daily living with better patient satisfaction and clinical outcome.

Keywords: Clavicle hook plate, lateral end clavicle, acromioclavicular joint dislocation.

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I. Introduction

Clavicular fractures are relatively common in the modern society which is filled with activities which can be termed both hectic and hazardous. Thus the clavicle is a bone that frequently gets fractured. The injuries can be due to low or high energy trauma, as isolated injury or part of a poly-trauma spectrum. The clavicle is very prone to injury following direct violence because of its subcutaneous and superficial presence. The serpiginous shape of the bone along with its precarious position and its vulnerability leads to its fracture and dislocations in a manner which can be termed not quite uncommon. Its peculiarity of being the only horizontal long bone and its strut like disposition also accounts for its uniqueness in both function and its injuries.

Clavicle fractures account for 2.6% of all fractures of the body and 44% to 66% of all shoulder fractures. Due to this frequency of occurrence of fractures in the clavicle there have been many methods and modalities that came up. These modalities have been revised and corrected and modified across the centuries. The sad fact is although we have a very good understanding of the mechanics and the physiology of the fractures of the clavicle, we still do not have a universal consensus regarding their absolute and definitive management. In our study we chose the operative fixation of the displaced fractures of the lateral end of the clavicle using the clavicle hook plate. Lateral end of clavicle fractures are somewhat unstable and requires surgical fixation. Distal third clavicle fracture is a special form of injury and has been estimated to account for only 12% to 15% of clavicular fractures. Coming to the acromioclavicular injuries, though they are less frequently encountered in clinical practice we cannot deny that subclinical and non-diagnosed cases form the base of the iceberg of this entity. The superficial disposition of this joint and its proximity to the glenohumeral joint, any significant pathology to it drastically decreases shoulder function. Just like the clavicle its superficial disposition is an important reason for it to get injured in direct trauma to the shoulder. The AC joint is a diarthrodial joint located between the lateral end of the clavicle and the medial margin of the acromion process of the scapula. The articular surfaces initially are hyaline

cartilage. The joint has very little rotatory movements

Lateral end of clavicle fractures and acromioclavicular disruption can be operatively treated with Kirschner wires or coracoclavicular screws. Moreover they can be operatively managed by using clavicle hook plates or locking compression clavicle hook plates. The present study was aimed at evaluating the feasibility and the eventual clinical and radiological outcome following operative management of fractures lateral end of the clavicle and displaced acromioclavicular joint dislocations using the clavicle hook plate. The present study was aimed at evaluating the feasibility and the eventual clinical and radiological outcome following operative management of fractures lateral end of the clavicle and displaced acromioclavicular joint dislocations using the clavicle hook plate. The outcome was evaluated using the Karlsson's criteria and the DASH score. The Karlsson's criteria are a qualitative assessment of function while the DASH score is a quantitative one. The parameters of the Karlsson's criteria are tabulated below.

Karlsson's criteria :

category	Degree		
Pain	No	Subtle	Serious
Myodynia	Normal	Medium	Weak
Movement	Flexible	90 ^o -180 ^o	Limited from every direction
Criteria	A	B	C

In our study criterion A was categorized as excellent outcome while B and C categorized as good and poor respectively. DASH (Disability of the Arm, Shoulder and Hand) score is a quantitative assessment score of the shoulder function. It was used in this study to quantitatively assess the improvement or deterioration of the shoulder function in the patients. It's a questionnaire with 30 items on it. For disability/symptom score at least 27 out of 30 should be completed. 100 is the score for totally disabled limb while 0 is the perfect extremity score

II. Materials And Methods

All patients from age group 18 to 60 years irrespective of sex the study was carried out as a prospective study for one year which included patients having fracture lateral end clavicle and patients having acromioclavicular joint dislocation. All of these patients were treated operatively using the clavicle hook plate. Subsequently these patients were followed up regularly and clinical as well as radiological outcomes were evaluated.

Inclusion criteria of patients:

- 1) All cases with displaced fracture lateral end of clavicle and acromioclavicular disruption within four weeks of injury.
- 2) Patients giving consent to surgery.
- 3) Patients meeting the routine medical standards to undergo surgical procedure.
- 4) Preoperatively patient is having a limb with intact neurovascular status.
- 5) Patient willing to cooperate in regular follow-up.

Exclusion criteria:

- 1) Patient not giving consent to surgery.
- 2) Patients with associated medical contraindications to surgery.
- 3) Patients with compound fractures
- 4) Patients with systemic infections
- 5) Patients with poor skin conditions

All details of the participating patients were recorded. (Annexure-V). The lateral end of clavicle fractures was assessed by anteroposterior and cephalad-caudad obliquity views x-rays pre-operatively. Postoperatively similar x-rays were taken for the part. For acromioclavicular joint injuries anteroposterior views, an axillary lateral view and the Zanka view (15° cephalic tilt view) were taken preoperatively. Post operatively similar x-rays were taken for the part. In all the patients, blood routine examinations, ECG, chest x-rays, blood glucose levels, bleeding time clotting time were done. Blood grouping and cross matching of patients were done after admission. Patients were given arm sling pouch on their admission. The implant of choice in our study was the clavicle hook plate. It's a pre-contoured stainless steel, dynamic compression plate with a wider antero lateral end and a lateral extension into a hook which is placed below the acromion. The newer variety of LCP (Locking compression plate) has elongated combination holes [threaded hole for locking head screws (LHS) and dynamic compression unit (DCU) for cortex screws]. Offers better anatomic fit. In our study the LCP variant has been primarily used.

The patients were put in an arm sling pouch after the surgical procedure. The wound was inspected on 3rd day and the patients were discharged on 5th-10th day if no complications were present. Patients discharged on 10th

day had their stitches removed before their discharge. The clinical outcome was evaluated using the Karlsson's criteria¹⁶ and the DASH¹⁷ (Disability of the Arm, Shoulder and Hand) score. The fractures and the dislocations were assessed radiologically respectively with the preordained views of each type of injury. The physiotherapy regimes were carried out in similar manner for all the patients. The patients were assessed at 4 weeks(1 month), at 8 weeks(2 months) at 3 months and 6 months. Pendulum exercises were started on 3rd day onwards. From 20th day full range of motion of the shoulder both assisted and active under the supervision of a physiotherapist were started. The clavicle hook plate is an implant that has to be removed once it has served its purpose for it causes discomfort and some amount of joint mobility restriction because of its design and its unique placement.

III. Observation And Results

For Fracture Of Lateral End Clavicle -

Definition of union- Fracture united within 4 months

Delayed union- Union occurring from 4months to 6 months

Non-union- Fracture not united beyond 6 months

Patients followed for 3 months and beyond- 18

out of total 21 only 18 were followed up beyond 3 months. So only in these patients could we comment on the union. Out of these 18 union was achieved in 15 patients. So the union rate is 83.33%. Of these 2 had delayed union and one non-union. So non-union was 5.56% and delayed union was 11.11%.

So the average union time was 3.27 ± 0.59 months for those patients who achieved union.

For Subgroup Of Acromioclavicular Dislocation-

Definition of the fusion of AC joint post-surgery is a clinical one as fibrous union was the outcome that was expected after curettage of the articular cartilages of the AC joint. Union was defined as absence of tenderness over the AC joint both anteriorly and superiorly on all range of motions within 3-4 months. Failure to achieve clinical union after 4 months was considered delayed union and failure to achieve union beyond 6 months as non-union. Patients followed up for 3 months and beyond of the total 16 – 13.

In the above table out of 16 only thirteen were followed up beyond 3 months. So only these patients could be chosen to comment on their union. Of these, 2 achieved delayed union while there was no case of non-union.

So the rate of union was 84.61% and the rate of delayed union was 15.38%.

The average period of union was 3.88 ± 0.46 months.

Functional outcome:

Based on Disability of Arm Shoulder and Hand (DASH)¹⁷ score and the Karlsson's criteria¹⁶ the patients were evaluated both quantitatively and qualitatively respectively. The score for perfect extremity for DASH is 0 while a disabled limb it is 100. For Karlsson's criteria the limb function was graded excellent, good and poor depending on the criteria i.e. A, B, and C attained on limb function assessment.

For the group of fracture lateral end of clavicle:

Preoperative mean DASH score- 82.76 ± 6.42

Mean DASH score at final evaluation (pre implant removal-all patients)- 17.76 ± 10.12

Mean DASH score before implant removal(of the patients that underwent removal)- 12.54 ± 8.71

Mean DASH score of patients who underwent implant removal(final evaluation)- 8.54 ± 3.93

It is seen that there was significant reduction in the DASH scores from the time of injury till final evaluation. Of these 11 patients underwent implant removal. Of these 14 patients out of 21 had Karlsson's A score while 7 had B. Thus **66.67%** had **excellent** results at the end of evaluation while **33.33%** had **good** results. **None** had **poor** results in our study in the subgroup of fracture lateral end clavicle.

For the group having their implants removed the mean DASH score before removal was 12.54 ± 8.71 and after removal it was 8.54 ± 3.93 . This difference was found to be **not quite significant** (P value-0.0902).

For the subgroup of AC joint dislocation:

Preoperative mean DASH score- 83.25 ± 6.88

Mean DASH score at final evaluation (pre implant removal-all patients)- 13.81 ± 7.90

Mean DASH score before implant removal(of the patients that underwent removal)- 13.17 ± 9.11

Mean DASH score of patients who underwent implant removal(final evaluation)- 11.17 ± 7.31

It is thus seen that there was significant reduction in the DASH scores at final follow up compared to the scores at presentation. The total number of patients with AC joint dislocation was 16. Out of these 6 underwent implant removal. Of the total 16, 10 i.e. 62.50% had Karlsson's criteria A at final evaluation while 6(37.50%) fulfilled criteria B. Thus 62.50% had excellent and 37.50% had good results and none had poor results.

For the group having their implants removed the mean DASH score before removal was 13.17 ± 9.11 and after removal it was 11.17 ± 7.31 . This difference was found to be **not significant** (P value **0.4496**).

IV. Complications:

For the subgroup of fracture lateral end clavicle:

In our study it's seen that the major complication for the group of fracture of the lateral end clavicle was **subacromial osteolysis** and **impingement syndrome**, both comprising of **28.57%** of the sample each. They are followed by **delayed union** which comprised of **9.52%** of the total sample of the patient. Subacromial osteolysis is seen on x-rays as lucency around the tip of the hook.

For the subgroup of ac joint dislocation:

In our study for the subgroup of AC joint dislocation the major complication we encountered was **impingement syndrome (37.5%)** and **delayed union(12.5%)**. About one case i.e. **6.25%** case had **AC joint arthrosis**.

V. Discussion

Fracture union in case of the group of fracture lateral end of the clavicle in our study was found to be **83.33 %**. The rate of delayed union was **11.11%** and non union was **5.56%**. The average time of union was **3.27 ± 0.59** months. As only 18 patients of the total 21 patients were followed up till 3 months or more so union was commented on only these patients. 15 patients of these 18 achieved union. Neer had found in his study that fractures of the lateral end clavicle is a special entity and is prone to undergo non-union⁵⁵. **Davut Tiren et al.**⁴⁰ had achieved a union rate of 87.5 % comparable to our study and a non –union rate of 12.5%. **Tapio Flinkkilä et al.**^{25,28 29} achieved a union rate of **93.65%**. While the rate of non-union was found to be 4.76 % and delayed union to be 1.6%. **Hong-Lve-Tan et al.**⁴² achieved union at 8.75 ± 2.55 weeks (range 6-13 weeks). **Tzu Liang Hsu et al.**³⁵ achieved union at a mean of **14.2** weeks. One patient in which there was non union in our study, the cause was found to be a misplaced screw which was in the fracture site, thus preventing bridging callus formation. The patient however had no clinical disability and had full range of movements after implant removal and didn't require any other surgical procedure to address the same. **Daniel W. Good et al.**⁴³ in their study achieved union in 95% of the cases and in a period of 3 months. **Chun-kuan Lu et al.**³⁷ achieved union in 100% of their cases.

For our group of AC joint dislocation as fibrous ankylosis at the AC joint was the goal to be achieved after reduction with a hook plate, we defined fibrous union to have occurred when there is absence of tenderness over the AC joint both anteriorly and superiorly at all range of motion. For our study it was achieved at a mean period of **3.88 ± 0.46 months**. The union rate achieved in our study was **84.61%**. The rate of delayed union was found to be **15.38%**. **De Baets et al.**⁴⁸ achieved this clinical union in **75%** patients at an average **12 weeks**. The rate of non union was **25%**.

For the subgroup of fracture lateral end of the clavicle **66.67%** had **excellent** result, i.e. they had Karlsson's criteria A, while **33.33%** had **good** results with Karlsson's criteria B. **None** of the patients had **poor** results. For this group of patients the final evaluation DASH score was **17± 10.12** which was just below 20 for a normal excellent limb function. This score was in all patients before implant removal. While those patients who underwent implant removal the mean DASH score before implant removal was **12.54± 8.71**. While the DASH scores after implant removal for this group of patients was **8.54±3.93**. This difference was found to be **not quite statistically significant (P value 0.0902)**. Thus there was not quite significant improvement clinically in the patients who underwent implant removal in immediate follow-up evaluation. Thus implant removal was not a very important factor to improve clinical outcome in the patients.

For the subgroup of AC joint dislocation **62.50%** of the patients had **excellent** results i.e. Karlsson's criterion A, while **37.50 %** had **good** results i.e. Karlsson's criterion B. None of the patients had poor result. For this group of patients the DASH score at final evaluation for the entire group was **13.81±7.90**. this was all before the implant removal had taken place. Out of the total 16 only 6 underwent implant removal in our study. For these patients the mean DASH score before implant removal was found to be **13.17 ± 9.11**. After implant removal the mean DASH score was **11.17 ± 7.31**. This difference was **not found to be significant (P value 0.4496)**. Thus in this group too implant removal did little to improve the clinical outcome of the patients. So implant removal was not an important criterion to improve the clinical outcome of the patients in the group of AC joint dislocation.

Samir Ejam et al.⁴⁸ had achieved excellent results in almost all patients treated with clavicle hook plate for AC joint dislocation. **De Baets et al.**⁴⁷ in their study found that 75% of their cases treated with clavicle hook plate for AC joint dislocation, while 25% had good results. They thus opine that the clavicle hook plate is a good implant to treat displaced AC joint dislocations. **A.A. Faraj et al.**⁴⁶ in their study has opined that there is considerable chance of subacromial impingement in using the hook plate for AC joint dislocation. However if the procedure is coupled with Weaver-Dunn procedure then this complication is drastically decreased. They opine that the clavicle hook plate is a good implant for AC joint dislocation.

VI. Conclusion

Displaced fractures of the lateral end of the clavicle are notorious for delayed and non-union while displaced AC joint dislocation contribute quite a bit in causing morbidity and decreased shoulder joint function. Previously these two entities were treated non-operatively leading to myriads of complications. Our study aimed at operative fixation of these two entities with the clavicle hook plate and study the role of operative management.

Our study showed that operative fixation of the aforesaid entities with clavicle hook plate gave very good patient oriented, surgeon oriented outcomes with very early rehabilitation leading to excellent clinical outcome in majority of the patients. There was better outcome than previously mentioned studies of conservative management of the same. There was excellent fracture healing following the use of these plates in the fractures of the lateral end of the clavicle. It also lead to very sound fibrous ankylosis with a very anatomically aligned sound functioning AC joint when used in AC joint dislocation.

In our study there were no intra-operative complications and all surgeries went smoothly. There were no hardware related problems in our study. We encountered complications like impingement and subacromial osteolysis due to the subacromial positioning of the hook. But these were not too disabling to the patients and were improved on physiotherapy. Non-union and delayed union were found too in a very small number of patients but these were related to wrong placement of screws, not because of the implant per se. However a second operation to remove the implant is a potential drawback of this implant which may be cause of decreased patient and surgeon compliance with the procedure. The principal drawback of our study was the limited number of patients and the limited duration of study which may have affected the results. We conclude that clavicle hook plate is a very good implant for treating fractures of the lateral end of clavicle and displaced AC joint dislocation. The overall prognosis in our study was very good with excellent improvement of symptoms following the procedure. The use of this implant warrants quicker rehabilitation and return to normal activities of daily living with better patient satisfaction and clinical outcome.

Case 1: 28 Yo Male Left Sided Fracture Of Lateral End Clavicle

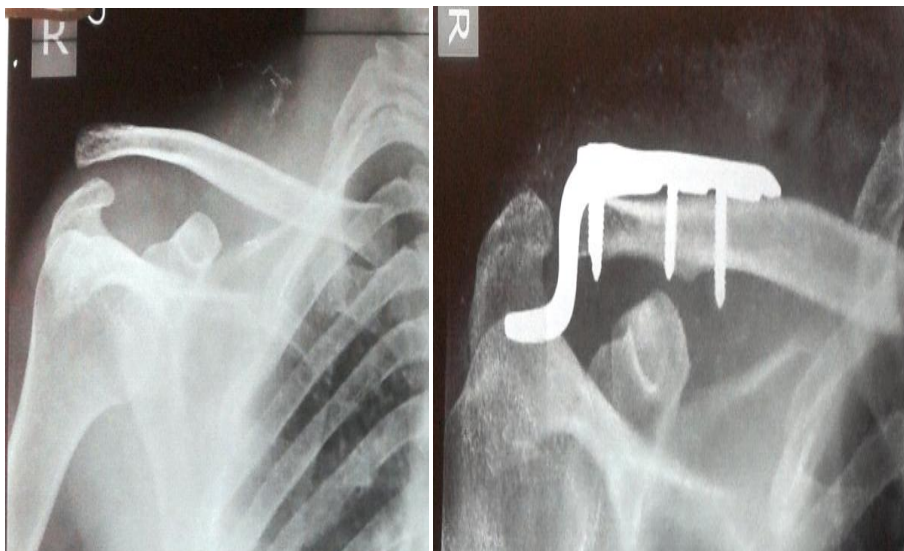


Post operative X-ray
Preoperative X-ray

Movements at 3rd month post surgery



Case 2: 48 year old male with right sided ac joint dislocation.
Post operative X-ray



Preoperative X-ray



Movements at one month after surgery.

REFERENCE

- Craig EV. Fractures of the clavicle. In: Rockwood CA, Matsen FA, eds. *The Shoulder*. Philadelphia: WB Saunders, 1990:367-412.
- Craig EV. Fractures of the clavicle. In: Rockwood CA, Matsen FA, eds. *The Shoulder*, 3rd ed. Philadelphia: WB Saunders, 1998:428-482.
- Crenshaw AH. Fractures of the shoulder girdle, arm and forearm. In Willis CC, ed. *Campbell's Operative orthopaedics*, 8th ed. St. Louis: Mosby-Year Book, 1992:989-995.
- Adams F. *The genuine works of Hippocrates*. New York: William Wood and Co., 1886.
- Allman FL Jr: Fractures and ligamentous injuries of the clavicle and its articulation. *J Bone Joint Surg Am* 49:774-784, 1967.
- Rowe CR: An atlas of anatomy and treatment of midclavicular fractures. *Clin Orthop* 58:29-42, 1968.

- Neer CS 2nd: Fractures of the distal third of the clavicle. *Clin Orthop* 58:43-50, 1968.
- Robinson CM. Fractures of the clavicle in the adult. *J Bone Joint Surg Br* 1998;80B: 476-484.
- Robert W. Bucholz, Charles M. Court-Brown, James D. Heckman, Paul Tornetta III eds. *Rockwood and Green's Fractures in Adults, Vol-2. 7th edition. Philadelphia: Lippincot Williams & Wilkins:2010.*
- Kenneth A. Egol, Kenneth J. Koval, Joseph D. Zuckerman eds. *Handbook of Fractures. 4th edition. Philadelphia: Lippincot Williams & Wilkins: 2010.*
- Tossy JD, Mead NC, Sigmond HM. Acromioclavicular separations: useful and practical classification for treatment. *Clin Orthop Relat Res.* 1963;28:111-9.
- Rockwood CA, Jr: Injuries to the acromioclavicular joint, in Rockwood CS, Jr, Green DP (eds): *Fractures in Adults. Philadelphia 974-982, Saunders, 1984, pp 860-910.*
- Larsen E, Bjerg-Nielson A, Christensen P: Conservative or surgical treatment of acromioclavicular dislocation: A prospective, controlled, randomized study. *J Bone Joint Surg* 68A:552-555, 1986.
- Neer CS II. Fracture of the distal clavicle with detachment of the coracoclavicular ligaments in adults. *J Trauma* 1963;3:99-110.
- Bosworth BM. Acromioclavicular separation. New method of repair. *Surg Gynecol Obstet* 1941;73:866-71.
- Karlsson J, Amarnson H, Sigurjonsson K. Acromioclavicular dislocations treated by coracoacromial ligament transfer. *Arch Orthop Trauma Surg.* 1986;106(1):8-11.
- Hudak PL, Amadio PC, Bombardier C. Development of an upper extremity outcome measure the DASH. *Am J Ind Med* 1996 Jun; 29(6): p 602-8.
- Susan Standring ed. *Gray's Anatomy. 40th edition. London: Churchill Livingstone, Elsevier:2008.*
- *Gray's Anatomy. 37th edition. London: Churchill Livingstone, Elsevier: 1989.*
- Robert W. Bucholz, Charles M. Court-Brown, James D. Heckman, Paul Tornetta III eds. *Rockwood and Green's Fractures in Adults, Vol-2. 6th edition. Philadelphia: Lippincot Williams & Wilkins:2006.*
- Robert W. Bucholz, Charles M. Court-Brown, James D. Heckman, Paul Tornetta III eds. *Rockwood and Green's Fractures in Adults, Vol-2. 7th edition. Philadelphia: Lippincot Williams & Wilkins:2010.*
- Bezer M, Aydin N, Guven O. The treatment of distal clavicle fractures with coracoclavicular ligament disruption: a report of 10 cases. *J Orthop Trauma* 2005; 19 (8): 524-8.
- Hessman M, Kirchner R, Baumgaertel F, Gehling H, Gotzen L. Treatment of unstable distal clavicular fractures with and without lesions of the acromioclavicular joint. *Injury* 1996;27:47-52.
- Li Y, Shi S, Ou-Yang YP, Liu TL. Minimally invasive treatment for Neer IIb distal clavicle fractures with titanium cable. *J Trauma.* 2011;71(2):E37.
- Flinkkila T, Ristiniemi J, Hyvonen P, Hamalainen M. Surgical treatment of unstable fractures of the distal clavicle: a comparative study of Kirschner wire and clavicular hook plate fixation. *Acta Orthop Scand* 2002;73:50-3.
- Brent A. Ponce, Peter J. Millet, Jon J.P. Warner. Acromioclavicular joint instability-reconstruction indications and techniques. *Operative Techniques in Sports Medicine, Vol 12, No 1 (January), 2004: pp 35-42.*
- [Meda PV](#), [Machani B](#), [Sinopidis C](#), [Braithwaite I](#), [Brownson P](#), [Frostick SP](#). Clavicular hook plate for lateral end fractures:- a prospective study. [Injury.](#) 2006 Mar;37(3):277-83. Epub 2006 Jan

- Flinkkila T, Ristiniemi J, Lakovaara M, Hyvonen P, Leppilahti J. Hook-plate fixation of unstable lateral clavicle fractures: a report on 63 patients. *Acta Orthop* 2006;77:644-9.
- Saadallah George, Kamalakannan Murali Krishnan, Subodh Chandrakant Deshmukh. Hook Plate fixation for type II fractures of the lateral end of the clavicle. *Journal of Shoulder and Elbow Surgery*. Volume 15, Issue 4, July-August 2006, Pages 419-423.
- [Muramatsu K](#), [Shigetomi M](#), [Matsunaga T](#), [Murata Y](#), [Taguchi T](#). Use of the AO hook-plate for treatment of unstable fractures of the distal clavicle. [Arch Orthop Trauma Surg](#). 2007 Apr;127(3):191-4. Epub 2007 Jan 13.
- [T. Taneja](#), [D. Zaher](#), [A. Koukakis](#), [C. Apostolou](#), [S. Owen-Johnstone](#), [T. Bucknill](#), [A. Amini](#), [D. Goodier](#) and [P. Achan](#). Clavicular hook plate: not an ideal implant. *J Bone Joint Surg Br* 2009 vol. 91-Bno. SUPP I 11.
- Steven M. Klein, Brian L. Badman, Christopher J. Keating, Dennis S. Devinney, Mark A. Frankle, Mark A. Mighell. Results of surgical treatment for unstable distal clavicular fractures. *J Shoulder Elbow Surg* (2010) 19, 1049-1055.
- Saurabh Odak, David Burton. Early acromial erosion with the Synthes Hook Plate: an unusual complication and its treatment. *Journal Compilation* © 2010 British Elbow and Shoulder Society. *Shoulder & Elbow* 2010 2, pp 182–184.
- Ilias BISBINAS, Petros MIKALEF, Ioannis GIGIS, Theodoros BESLIKAS, Nikolaos PANOU, Ioannis CHRISTOFORIDIS. Management of distal clavicle fractures. *Acta Orthop. Belg.*, 2010, 76, 145-149.
- Tzu-Liang Hsu, Shao-Keh Hsu, Hsueh-Ming Chen, Shih-Tien Wang. Comparison of Hook Plate and Tension Band Wire in the Treatment of Distal Clavicle Fractures. *Orthopaedics* December 2010-Volume 33. Issue 12.
- Olivier A. van der Meijden, Trevor R. Gaskill, Peter J. Millett. Treatment of clavicle fractures: current concepts review. *J Shoulder Elbow Surg* (2011), 1-7.
- Chun-Kuan Lu, Feng-Chen Kao, Kuo-Yao Hsu, Chin-Hsien Wu, Cheng-Yo Yen, Yuan-Kun Tu. Evaluation of a clavicle hook plate for fixation of unstable distal end comminuted clavicle fractures: Seven case reports. *Formosan Journal of Musculoskeletal Disorders*. Volume 2, Issue 3, August 2011, Pages 102–105.
- Su-Han An, Hyung-Chun Kim, Kwang-Yeol Kim, Ji-Hoon Lee, Seung-Hyun Yoon. Complications of Hook-Plate Fixation for Distal Clavicle Fractures. *Journal of the Korean Fracture Society* Vol. 25, No. 1, January, 2012.
- WU Xiao-ming, GAO Wei, Li Fan, SAN Wei-lin, GaoKan-dai, Wang Qiu-gen. Complications of hook plate and corresponding management. *Chin J Orthop*, April 2012, Vol 32, No. 4.
- Davut Tiren, Alexander JM van Bommel, Dingeman J Swank and Frits M van der Linden. Hook plate fixation of acute displaced lateral clavicle fractures: mid-term results and a brief literature overview. *Journal of Orthopaedic Surgery and Research* 2012, 7:2.
- Tsai-Hsueh Leu, Wei-Pin Ho, Poo-Kuang Wong, Tai-Yuan Chuang, Chin-Chean Wong. Clavicular hook plate: A better Implant Choice for Fixation of Unstable Distal Clavicle Fractures? *J Exp Clin Med* 2012;4(5):270-274.
- Hong-Lve Tan, Jin-Kun Zhao, Chen Qian, Yan Shi, Qi Zhou. Clinical Results of Treatment Using a Clavicular Hook Plate Versus a T-plate in Neer Type II Distal Clavicle Fractures. *Orthopaedics*, August 2012, Vol 35, No. 8.
- Daniel W. Good, Darren F. Lui, Michael Leonard, Seamus Morris, John P. McElwain. Clavicle hook plate fixation for displaced lateral-third clavicle fractures (Neer type-II): a functional outcome study. *Journal of Shoulder and Elbow Surgery*. Volume 21, Issue 8, August 2012, pages 1045-1048.
- Sylvia A Stegeman, Hakan Nacak, Koen HJ Huvenaars, Theo Stijnen, Pieta Krijnen, and Inger B Schipper. Surgical treatment of Neer type-II fractures of the distal clavicle. A meta-analysis. *Acta Orthopaedica* 2013; 84 (2): 184–190.
- Julie Y. Bishop, Michael Roesch, Brian Lewis, Grant L. Jones, and Alan S. Litsky. A Biomechanical Comparison of Distal Clavicle Fracture Reconstructive Techniques. *The American Journal of Orthopedics*® March 2013.
- A. A. Faraj, B. Ketzer. The use of a Hook-Plate in the management of Acromioclavicular Injuries. Report of Ten cases. *Acta Orthopaedica Belgica*, Vol. 67 - 5 – 2001.
- Thierry DE BAETS, Jan TRUIJEN, Ronald DRIESEN, Theo PITTEVILS. The treatment of acromioclavicular joint dislocation Tossy grade III with a clavicle hook plate. *Acta Orthop. Belg.*, 2004, 70, 515-519.

- Samir EJAM, Thomas LIND, Boe FALKENBERG. Surgical treatment of acute and chronic acromioclavicular dislocation Tossy type III and V using the Hook Plate. *Acta Orthop. Belg.*, 2008, 74, 441-445.
 - Hsin-Hua Liu, Yi-Jiun Chou, Chi-Hui Chen, Wei-Tso Chia, Chi-Yin Wong. Surgical Treatment of Acute Acromioclavicular Joint Injuries Using a Modified Weaver-Dunn Procedure and Clavicular Hook Plate. *Orthopaedics August 2010-Volume 33.Issue 8.*
 - B. Kienast, R. Thietje, C. Queitsch, J. Gille, A. P. Schulz, J. Meiners. Mid-term results after operative treatment of Rockwood grade III-V acromioclavicular joint dislocations with an AC-hook-plate. *Eur J Med Res (2011) 16: 52-56.*
 - Andrés Arismendi Montoya, Juan Carlos Jaramillo Fernández, y María del Pilar Duque Orozco. Double fixation for acute acromioclavicular dislocation: Recovery of horizontal stability as a key factor for anatomical reduction. *Rev Colomb Ortop Traumatol.* 2013;27(2):89-96.
 - R. Nadarajah, J. Mahalaxmivala, A. Amin, D.W. Goodier. Clavicular hook-plate: complications of retaining the implant. *Injury, Int. J. Care Injured (2005) 36, 681–683.*
 - Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. *J Bone Joint Surg Am.* 1976;58:453–458.
 - Gustilo RB, Mendoza RM, Williams DN. Problems in management of type III (severe) open fractures: a new classification of type III open fractures. *J Trauma.* 1984;24:742–746.
 - Berkheiser EJ: Old ununited clavicle fractures in the adult. *Surg Gynecol Obstet* 64:1064-1072, 1937.
 - Ghormley RK, Black JR, Cherry JH: Ununited fractures of the clavicle. *Am J Surg* 51:343-349, 1941.
 - Neer CS II: Nonunion of the clavicle. *JAMA* 172:1006-1011, 1960.
 - Sakellariades H: Pseudarthrosis of the clavicle. *J Bone Joint Surg Am* 43:130-138, 1961.
 - Johnson EW, Collins HR: Nonunion of the clavicle. *Arch Surg* 87:963-966, 1963.
 - Simpson NS, Jupiter JB: Clavicle nonunion and malunion: evaluation and surgical management. *J Am Acad Orthop Surg* 4:1-8, 1993.
- Nordqvist A, Peterson C: The incidence of fractures of the clavicle. *Clin Orthop* 300:127-132, 1994.

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