

Management of Clavicular Fracture in Adults by Plating : A Systematic Review

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Abstract

The management of the clavicular fracture still controversy between conservative treatment and surgical intervention. Also the methods of the surgical interventions have different variety between plates and screws, IMN and K wires. We review previous publications comparing the the different approaches and types of plates used in the surgical interventions with the aim of determining if any of the available interventions gives better outcomes compared to others. A systematic literature review of previous publications on the various techniques employed in the Management of clavicular fracture in adults by plating .We suggest that where the expertise is available, intervention by minimally invasive techniques should be preferred to the conventional open surgical approaches. If otherwise, the choice of operative technique should simply be based on the experience of the surgeon, the available facilities and equipment.

Keywords: Acute clavicular fractures, Fracture clavicle fixation by plates, Types of plates for clavicular fixation and minimal invasive plate fixation of fracture clavicle.

1. Introduction

Clavicle is the anterior member of the shoulder girdle extending from the manubrium sterni to the acromion process and representing the only bony connection between the upper extremity and the axial skeleton [1]. It presents as S shaped tubular bone with a double curvature, convex anteriorly in the medial two thirds and concave anteriorly in the lateral third [2].

Fractures were classified based on their anatomic location in descending order of fracture incidence [3]. Type I fractures occur within the middle third of the clavicle, whereas type II and type III fractures represent involvement of the lateral and medial thirds, respectively [4].

A more detailed classification system [Edinburgh classification] was proposed by Robinson , Similar to earlier descriptions, the primary classification is anatomically divided into medial [type I], middle [type II], and lateral [type III] thirds [5].

Type 1Medial
A: Non-displaced
A1: Extra-articular
A2: Intra-articular
B: Displaced
B1: Extra-articular
B2: Intra-articular
Type 2Middle
A: Cortical alignment
A1: Non-displaced
A2: Angulated
B: Displaced
B1: Simple or single butterfly fragment
B2: Comminuted or segmental
Type 3Distal
A: Non-displaced
A1: Extra-articular
A2: Intra-articular
B: Displaced
B1: Extra-articular
B2: Intra-articular

A direct blow on the point of the shoulder is the commonest reported mechanism of injury that produces a mid-shaft fracture of the clavicle [6].

Most authors, who have written on the treatment of fracture clavicle, recommended a conservative approach [7]. However, studies showed higher rates of nonunion, malunion and poor functional outcomes after

conservative treatment. Hence, authors have suggested that a subset of patients may be best treated by operative intervention [8 , 9].

Biomechanically, locking plates are identical to external fixators as the angular stability between the plate and screws means that the plate does not need to be in contact with the bone. This creates the option to use mono-cortical screws, negates the need for inferior cortex penetration and reduces the risk of brachial plexus and subclavian vessels injury [10].

Some risk factors are discovered to predispose to fracture nonunion including local and general factors, the local factors are type II distal fractures, open fractures, soft tissue interposition[11], shortening [12] or displacement of ≥ 20 mm, refracture[13],increased comminution and inadequate method and/or duration of initial immobilization [14], while the general factors are old age, female sex, diabetes mellitus, smoking, malnutrition and steroid intake [5].

The aim of this study is to review the different indications and techniques of plating of clavicular fractures also the results and the complications of each technique.

2. Materials and methods

Method and selection criteria [Search strategy]

The literature search was done using the following electronic databases: PubMed, SCOPUS, Web of Science, and The Cochrane Library. The search strategies were developed and edited by the authors to maximize the sensitivity. The search strategy included several different terms and synonyms for clavicle and clavicular fracture in combination with plating, surgical treatment and surgical approach, functional ability or physical activity.

Eligibility

We depended a strategy in this review in which the primary measured outcomes were symptomatic hardware [implant prominence or irritation] and infection rate. The secondary outcomes were fracture union, nonunion, malunion, Disabilities of the Arm,

Shoulder and Hand score, Constant score, and implant failure. Both primary and secondary outcomes were extracted from the studies according to their availability, as it was common for studies to examine some but not all the outcomes.

Literature search [Selection of studies]

The initial database search yielded 98 articles. Fifty one studies remained after removing duplicate articles. After screening the abstracts and titles, 40 relevant studies were further excluded because of use of nonstandard plates , a subject pool not exclusively

consisting of acute fractures, inadequate reporting of functional outcomes , a duplicate group of patients and inaccessible articles. So finally eleven articles were used in this systematic review. with total 2370 patients who underwent primary ORIF for clavicular fracture were included in the analysis, these were all the papers in our database who meet the inclusion criteria of the systematic review.

The key findings from these publications are as summarized in tables and discussed further in this paper Tables (1-3).

Table (1) Frequency of union, non-union, implant failure and postoperative infection among the enrolled studied patients in relation to approach and name of author [n=2370].

Approach	Author [No. of patients]	The enrolled studied patients [n=2370]										
		Union patients		Non-union patients		Implant failure		Postoperative infection		Total patients [n=2370]		
		N	%	N	%	N	%	N	%	N	%	
Anterior inferior	Sohn [18]	1394	96.8	46	3.2	50	3.5	35	2.4	1440	60.7	
	Hulsmans [39]											
	Alex Nourian [1140]											
Superior	Rafael [118]											
	Xioben [125]											
	Sohn [19]	660	98.6	9	1.3	92	13.7	66	9.9	669	28.2	
Direct transverse	Hulsmans [60]											
	Alex Nourian [390]											
	Rafael [134]											
MIPO	Xioben [34]											
	Erdle [32]											
	Raju [32]	236	98.3	4	1.7	35	14.6	7	2.9	240	10.1	
Total	Alzahrani [102]											
	Kingsly [55]											
	Raghuraj [16]											
	Raghuraj [21]	20	95.2	1	4.8	1	4.8	0	0	21	0.9	
		2370	2310	97.5	60	2.5	17	7.5	108 / 2176	5.0	2370	100

Table (2) Frequency of union, non-union, implant failure and postoperative infection among the enrolled studied patients in relation to type of plate and name of author [n=2370].

Type of plate	Author	The enrolled studied patients [n=2370]									
		Union patients		Non-union patients		Implant failure		Postoperative infection		Total patients [n=2370]	
		N	%	N	%	N	%	N	%	N	%
Non locking reconstruction plate	Rafael Alzahrani	379	98.4	6	1.6	65	16	9	2.3	385	16.2
	Kingsly [31 pt.]						.9				2
locking reconstruction plate	Sohn Hulsmans	283	95.9	12	4.1	41	13	6	2.0	295	12.4
	Xioben						.9				4
locking precontoured plate	Alex Nourian	1551	97.5	40	2.5	71	4.5	93	5.8	1591	67.1
	Kingsly [24 pt.]						5				1
Hook plate	Raghuraj	66	98.5	1	1.5	1	1.5	0	0	67	2.8
	Erdle Wonyong						5				5
locking plate with lateral extension	Raju	31	96.9	1	3.1	0	0	0	0	32	1.3
		2310	97.5	60	2.5	178	7.5	108 / 2176	5.0	2370	100

Table (3) Score among the enrolled studied patients.

Authors	Outcome measure	Approach or Plate type	Score
Sohn [15]	Constant score measure [26]	Ant. Inf.	97.27±4.99 point
		Superior	95.75±4.25 point
Hulsmans [16]	Implant related irritation	Ant. Inf.	22%
		Superior	18%
Alex Nourian [17]	The mean DASH score [27]	Ant. Inf.	5.18 point
		Superior	9.71 point
Erdle [18]	The constant score	Anterior superior	90.3 point
Rafael [19]	Implant related irritation	Ant. Inf.	5%
		Superior	25%
Raju [20]	The constant score	Horizontal incision on distal clavicle	96.25 point
Wonyong Lee[21]	The quick DASH score	10 cm on distal clavicle	1.4±0.9 point
Xioben [22]	Implant related irritation	Ant. Inf.	11.4%
		Superior	21.5%
Alzahrani [23]	The constant score	Transverse incision	95.8 point
Kingsly [24]	Quick DASH score	Anatomical plate	25.44 point
		Reconstruction plate	32.65 point
Raghuraj [25]	Quick DASH score	Open longitudinal	4.1 point
		MIPO	4.7 point

3. Discussion

The main finding of the present study is as follows: We had performed a systematic review of fixation techniques in unstable clavicle fracture patients. Four classes of surgical approaches and five different types of fixation plates have been used and studied :

3.1 Surgical approaches

Anterior inferior approach used in 5 papers with total patient number 1440. It is considered one of the best approaches used in the review with the least complication rate [in relation to implant failure and infection] and good union rate [96.8%].

Superior approach used in 6 papers with total patient number 669. Easy approach to use for fracture reduction and plate fixation . Despite the best union rate [98.6%] it has a very high complication rate according to implant failure [13.7%] and infection rate [9.9%]

Direct transverse approach used in 4 papers with total patient number 240. It is a direct incision across the fracture. Union rate is 98.3% . this approach has the heist implant failure rate by 14.6% and infection rate 2.9% .

Minimally invasive plate osteosynthesis [MIPO] used in only one paper with total patient number 21. A difficult surgical approach in controlling the fracture but it preserves the vascularity of the clavicle. Union rate is 95.2%. None of the cases has been infected but there is only one case [4.8%] with implant failure.

3.2 Plates

Non locking reconstruction plate used in 3 papers with total patient number 385 and with union rate 98.4%. It was the first plate to be used in the fixation of fracture clavicle but it shows high

complication rate. In this study it has the heist rate of implant failure [16.9%] and the infection rate was 2.3%.

locking reconstruction plate used in 3 papers with total patient number 295 and with union rate 95.9%. It provides more rigid fixation than the Non locking reconstruction plate specially with comminuted fractures so implant failure rate is lower [13.9%] but the infection rate is higher than that of the Non locking reconstruction plate [4.1%].

locking precontoured plate used in 3 papers with total patient number 1591 and with union rate 97.5%. This is now the most common plate used in fixation of clavicle fractures specially the middle third fractures. In this study the implant failure rate is 4.5% and the infection rate is 5.8% which is the heist rate of infection among the study.

Hook plate a special plate for the lateral third clavicular fractures, used in 2 papers with total patient number 67 and with union rate 98.5%. None of the cases has got infected but there is only one case [1.5%] with implant failure.

locking plate with lateral extension also a special plate for the lateral third clavicular fractures as the hook plate, used in one papers with total patient number 32 and with union rate 96.9%. None of the cases has got infected or has implant failure. It is just one patient [3.1%] with non union.

4. Conclusion

Plate fixation has several advantages including

- 1- For transverse fractures, compression across the fracture site is achieved and for oblique fractures or butterfly fragments, a lag screw is possible with a neutralization plate.
- 2- [2]Secure rotational control of the fracture.
- 3- Fixation is rigid enough to allow early use of the arm for the activities of daily living.

Implications:**Two main surgical techniques for fracture plating****1- open reduction and internal fixation****Anterosuperior plating:**

It is the preferred technique because of the simple approach, the well proved clinical record and the several biomechanical studies suggesting that it is the optimal plate location.

Anteroinferior plating

Advantages include easier screw entry, less risk of serious injury, the ability to insert longer screws in the wider AP dimension, decreased hardware prominence and easier plate contouring along the anterior border.

Postoperative protocol

An arm sling is used for comfort and gentle pendulum exercises are allowed. The patient is seen after 10-14 days during which the wound is checked and radiographs are taken. The sling is discontinued and unrestricted ROM exercises are allowed. After 6 weeks, radiographs are taken to ensure bony union.

2. Minimally invasive plate osteosynthesis [MIPO]

MIPO has several advantages being safe, minimally invasive, biological, simple and effective procedure leading to rapid recovery, high union rate and function restoration as it reduces soft tissue disruption, preserves blood supply and lowers the chance of cutaneous nerve injury and scarring on the prominent plate.

Clavicle fractures which fixed with 3.5 mm reconstruction plates were more likely to exhibit plastic deformation, whereas 2.7 mm plating constructs utilizing reconstruction plates were more likely to fail by plate breakage.

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