

Surgical Options for Fixation of Mid-Shaft Clavicle Fractures

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Abstract

Background: The clavicle fractures are common. The mid-shaft is the commonest part to be fractured. Traditionally, conservative treatment has been the major treatment of the clavicular fracture. Due to the poor outcome the conservative treatment and the rise in the expectations, especially manual workers, athletic patients and those with high muscular demand, operative treatment becomes increasingly popular. Open reduction and plating is considered the standard surgical option for mid-shaft clavicle fracture. It is used because of its capability of restoration and keeping the length and the anatomy of the clavicle. However, there is another surgical method for the mid-shaft clavicle fracture fixation, which is intramedullary fixation, and different types of devices have been used for intramedullary fixation of the clavicle throughout the years, including smooth K-wires, Hagie pins, Knowles pins, Rockwood Clavicle Pins, and titanium elastic nails, and the last one is the most commonly used option.

Keywords: Mid-Shaft Clavicle Fractures, Plate Fixation, Intramedullary Fixation, Titanium Elastic Nail

Introduction

Clavicle fractures are common fractures, comprising 2.6% to 4% of all fractures ⁽¹⁾. With the mid-shaft clavicular fractures being the most common, representing 69 to 82% of all fractures of the clavicle, and most of them are displaced ^(2, 3). they occur due to falls on the lateral aspect of the shoulder, fall on outstretched hand or due to high-energy direct impact over the bone in young individuals, whereas in elderly is due to low energy trauma ⁽⁴⁾.

Traditionally, conservative treatment has been the major treatment of the mid-shaft clavicular fracture. In two major studies from 1960s done by Neer and Rowe, noted low

rates of nonunion when the conservative treatment was used (0.1% and 0.8% respectively) ⁽⁵⁾.

Neer reported nonunion in only three out of 2235 mid-shaft clavicular fracture patients treated conservatively, whereas Rowe reported four non-unions out of 566 patients ^{(6), (7)}. These findings have dominated the clinical approach for displaced clavicular fractures for a long time. However, more recent studies showed much higher nonunion rates and unsatisfactory functional outcomes when using the conservative management ^{(8), (9), (10)}.

A 2012 meta-analysis shows the nonunion rate to be 15% in non-surgical management of the MCF ^{(11) (12)}.

A more recent multicenter randomized, controlled trial (RCT) reveal high nonunion rate of 26% in those managed non-surgically compared with 1% in those managed surgically ^{(11) (13)}.

In addition, the poor outcome of Displaced Mid Clavicular Fracture treated conservatively and the rise in the expectations, especially manual workers, athletic patients and those with high muscular demand, surgical treatment Displaced Mid Clavicular Fracture of becomes increasingly popular ⁽¹⁴⁾.

Surgical treatment

Surgical treatment comprises open reduction and internal fixation using plates and screws or intramedullary fixation ⁽¹⁵⁾.

❖ Absolute indications:

- Open fractures.
- Fractures with impending skin perforation ^{(16) (17) (18)}.

❖ Relative indications:

- Concomitant ipsilateral upper limb injuries.
- Floating shoulder injuries.
- Poly trauma Fractures associated with neurovascular injuries.
- Ipsilateral multiple rib fractures with chest wall deformity.
- Significant displacement (shortening and/or elevation) more than 2.5cm.
- Scapular winging because of shortening ^{(16) (17) (18)}.

❖ Relative contra indication:

- Infection.
- Severe skin condition (e.g, acne).

- Stroke patient with little extremity usage ⁽¹¹⁾.

1- Plate fixation:

Open reduction and plating is considered the standard surgical option for mid-shaft clavicle fracture ⁽¹⁾.

Plate options are tubular plates, dynamic compression plates, or reconstruction plates ⁽¹⁹⁾ ⁽¹⁴⁾. Open reduction and plating is considered the standard surgical option for (Fig. 1) ⁽¹⁾.

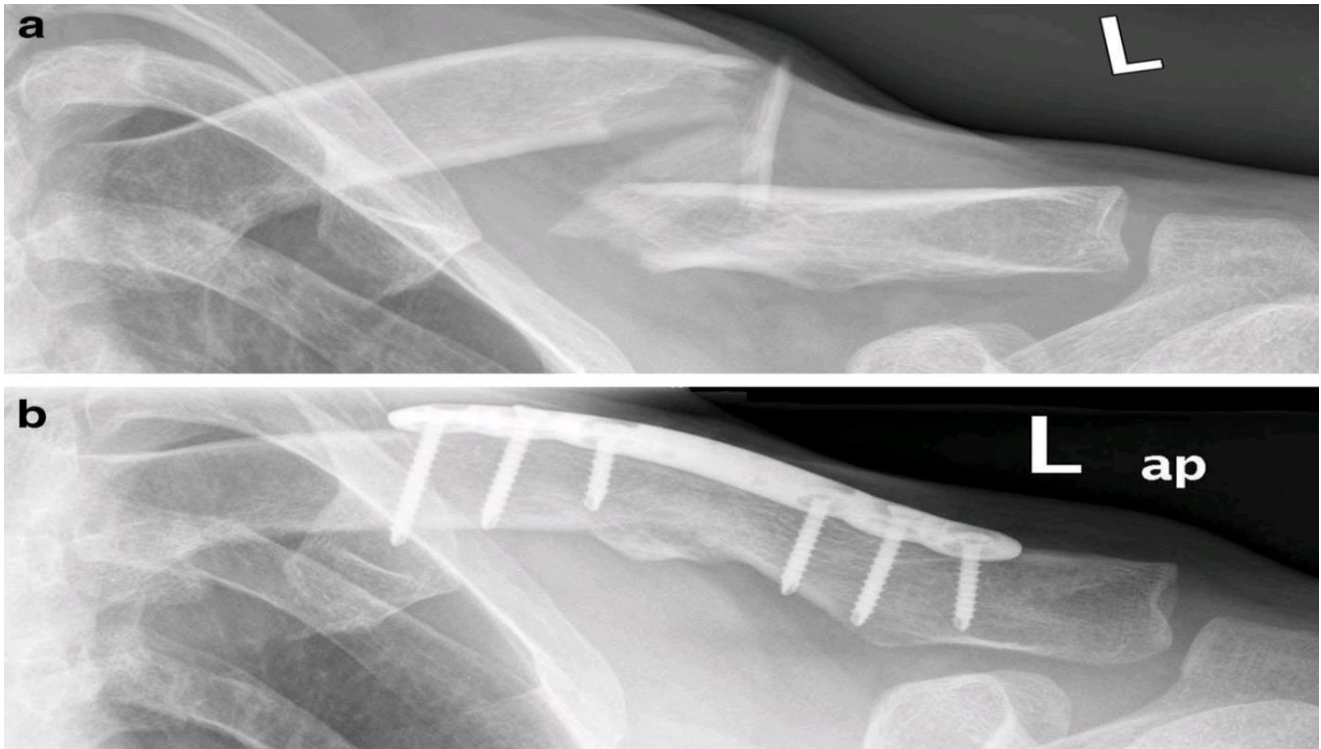


Figure 1: A pre & post operation x-ray of left mid-shaft clavicle fracture treated surgically by plate and screw fixation ⁽²⁰⁾ ⁽²¹⁾.

❖ Advantages:

- The capability of restoration and keeping the length and the anatomy of the clavicle ⁽¹⁾.
- It Resists the bending forces especially the antro-inferior plate placement (greater resistance to cantilever bending) ⁽¹¹⁾ ⁽²²⁾ ⁽²³⁾ ⁽²⁴⁾.

❖ Disadvantages:

- Wound infection.
- Non-union due to an extreme periosteal stripping.
- Bad cosmetic results because of the scare of the large incisions.
- Re-fracture after plate removal.

- Hypertrophic scars.
- Implant loosening.
- Intraoperative vascular injury.
- Deformation at the fracture site, decreasing the chance of union, they are prone when using reconstruction plates.
- The bicortical screws may act as multiple stress raisers on the clavicle, which can lead to fractures of the bone ^{(1), (19)}.

❖ **Biomechanics:**

The Comparisons between the different plate positions are controversial, where the studies present differing outcomes depending on testing design. However, three recent biomechanical studies have explain an agreement on the antro-inferior plate placement, because it leads to greater resistance to cantilever bending ^{(11) (22) (23) (24)}.

2- Intramedullary fixation:

The plate fixation is considered the standard surgical option. However, there is another surgical method for the MCF fixation, which is intramedullary fixation ⁽¹⁾. Different types of devices have been used for IMF of the clavicle throughout the years, including smooth K-wires, Hagie pins, Knowles pins, Rockwood Clavicle Pins, and titanium elastic nails, and the last one is the most commonly used option (Fig. 2) ⁽¹⁾.

❖ **The criteria of the intramedullary devises:**

- Devices need to be very flexible.
- The implant needs to be very stable.
- It must be small enough to pass through the medullary space at the most narrow point in the middle of the clavicle.
- The implant must be stable enough to neutralize the potentially disruptive forces ⁽¹⁹⁾.



Figure 2: Mid-shaft clavicle fracture treated by different intramedullary methods; the left radiograph is for Titanium nail, as for the one on the right is for Rockwood pin ⁽¹⁹⁾.

❖ **Advantages:**

- It consider a minimally invasive approach, as it needs a small incision rather than large ones.
- No periosteal stripping, which result in less occurring of nonunion, infection, and small scars.
- Easier hardware removal.
- Shorter hospital stay.
- Allows for a stable fixation for early function and restitution of clavicle symmetry (1), (19).

❖ **Disadvantages:**

- Radiological exposure due to lack of direct vision.
- Iatrogenic injury to neurovascular structures.
- The risk of migration, which require the removal of the implant.
- Implant shortening.
- Implant breakage.
- Temporary brachial plexus palsy.
- Skin break down at the site of insertion.
- Superficial infections.
- Delayed union.
- Non-union.

- Re-fractures.
- It does not allow for as much rotational stability as plate fixation ^{(19), (25)}.

❖ Biomechanics:

The intramedullary fitting using the elastic nails gives the optimal position for the implant to keep a tension adequate for position under loaded stress. All hardware can be removed at the time when the union become completed, which is an average of 6 months postoperatively ⁽¹⁹⁾.

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