International Journal of Research in Orthopaedics
Narayanan AR et al. Int J Res Orthop. 2022 May;8(3):309-313
http://www.ijoro.org

Original Research Article

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20221010

Mid-shaft clavicle fractures-factors influencing the clinical outcome after plate osteosynthesis

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Received: 16 March 2022
Revised: 03 April 2022
Accepted: 04 April 2022

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ABSTRACT

Background: Clavicle fractures constitute 5-10% of all fractures with. These fracture result from accidental fall, sports injuries or road traffic accidents The location and fracture pattern are important as it decides treatment and outcome. Our study is aimed to assess the various factors like: fracture pattern, type of implant used, and plate positioning and assessing their influence on clinical outcome.
Methods: It was a prospective case-study. The study was done in department of orthopaedics, Government Villupuram Medical College Hospital Villupuram between December 2017 and December 2019. Those patients in whom there was indication for surgical management, and who were willing for surgery were admitted. Plate osteosynthesis was done using anatomical locking plate, recon plate, tubular plate. Post operative rehabilitation done. Functional and radiological assessment done at regular interval till fracture union.
Results: All 32 patients had good union. Mean interval for fracture union was 4 months. 2 cases had implant failure, for which implant exit was done without any complication.
Conclusions: Anatomical locking plate prove to be the ideal implant for management of mid shaft clavicle fracture. Failure by mechanical mode can be prevented by using lag screws and avoiding fracture spanning. Biological mode of failure can be prevented by guarded post operative rehabilitation in comminuted fractures.

Keywords: Clavicle fracture, Locking plate

INTRODUCTION

Clavicle fractures constitute 5-10% of all fractures.[1] These fractures often result from accidental fall, sports injuries or road traffic accidents. Sports injuries are reason for nearly more than 50% of all clavicle fractures this group includes in particular young male individuals, with high-demanding activities. Low-energy fractures happen in elderly people predominantly result from accidental falls. Pathological fractures as a result of metastatic or metabolic disease are rare. The commonly used classification for clavicle fracture is Allman classification and/or the Robinson classification.[2] The location and fracture pattern is important as it decides the treatment and outcome. This paper focuses on the mid-diaphysis fracture of clavicle, the commonest pattern. Described conservative treatment methods for the management of clavicle fracture consists of temporary immobilization using arm sling or collar and cuff along with analgesics. Surgical treatment options are open reduction and internal fixation (ORIF) by using plates and screws or intra-medullary fixation (IMF). Classical indications for ORIF are compound fractures, skin tethering, neurovascular injury related complications or an associated fracture of the scapular neck (floating shoulder).[3] Others have described relative indications for operative management, which are displaced midshaft clavicle fractures, a shortening of ≥2 cm, age, activity level and dominant side.[4]

Clinical outcome of mid third shaft clavicle fractures after plate-osteosynthesis is influenced by many factors. Our study is aimed to assess the various factors like: fracture pattern, type of implant used, and plate positioning and assessing their influence on clinical outcome.

Aims and objectives

The aim of our study was: to assess the clinical outcome of mid third shaft clavicle fracture managed by plate osteosynthesis, and to assess the various factors which influence the clinical outcome.

METHODS

It was a prospective case-study. The study was done in department of orthopaedics, Government Villupuram Medical College Hospital Villupuram between December 2017 and December 2019 after obtaining institutional ethical committee clearance. Those patients who had indication for surgical management, and who were willing for surgery were admitted. Meticulous anaesthetic evaluation was completed. Open reduction and plate osteosynthesis were done in the standard technique. Plate osteosynthesis was done using anatomical locking plate, recon plate, tubular plate. Post operative rehabilitation done. Functional and radiological assessment done at regular intervals till fracture union.

Inclusion criteria

Those patients who had mid third shaft clavicle fractures and indication for surgical management: age between 18-60, displaced fractures, fracture less than 2-week duration, and patients who were willing for surgery were admitted for the study.

Exclusion criteria

Patients with age less than 18 years, more than 60 years, undisplaced fractures, associated vacular/neurological deficit, fracture more than 2 weeks old, and patients not willing for surgery were excluded.

Surgical technique

Anaesthetic evaluation was done after getting consent. All patients were operated in supine position with sand bag under ipsilateral shoulder to aid in reduction. Open reduction and plate osteosynthesis were done in the standard technique. Plate osteosynthesis was done using anatomical locking plate, recon plate. Plates were placed in superior surface of the clavicle (Figure 1). Post operatively, arm sling was used for a period of 6 weeks. Pendular exercises started after 1 week. Abduction restricted to 90 degrees in the first 6 week. Overhead abduction exercises after 6 weeks. Lifting weights and driving two-wheeler advised after radiological union.

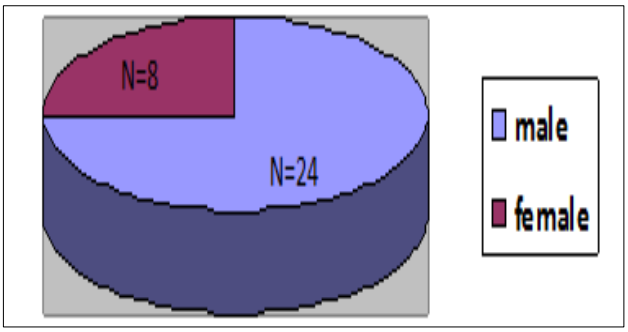

Figure 1: Sex distribution.

RESULTS

32 cases were available for this study during this period. Out of the 32 cases, 24 were male and 8 were female patients (Figure 4). Right side clavicle fracture was in 19 cases. Left side fracture in 13 cases (Figure 2).

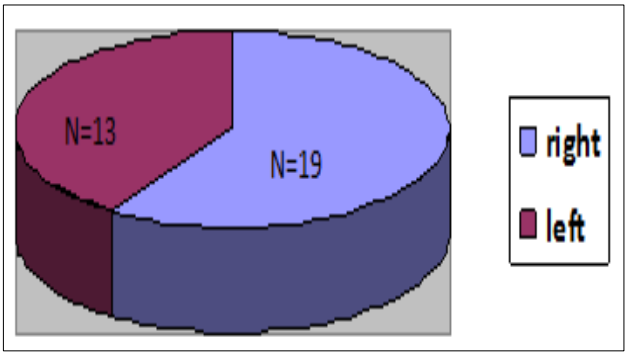

Figure 2: Side distribution.

4 cases had associated rib fractures. 2 cases had associated tibial shaft fracture. Mode of injury was road traffic accident (RTA) in 27 cases. Fall from height 2 cases. Fall of heavy weight object over his shoulder 1 case, sports injury 2 cases (Table 1).

Table 1: Mode of injury.

Mode of injury	Number of patients
Road traffic accident	27
Fall from height	2
Fall of heavy object	1
Sports injury	2

Mean age was 28 (range 18-38) (Figure 3).

Mean injury to surgical fixation interval was 72 hours. 28 cases were operated with anatomic locking plate. For 4 cases, 3.5 recon plate was used for fixation. Mean time for complete union of fracture was 4 months with a range of 3 to 5 months.

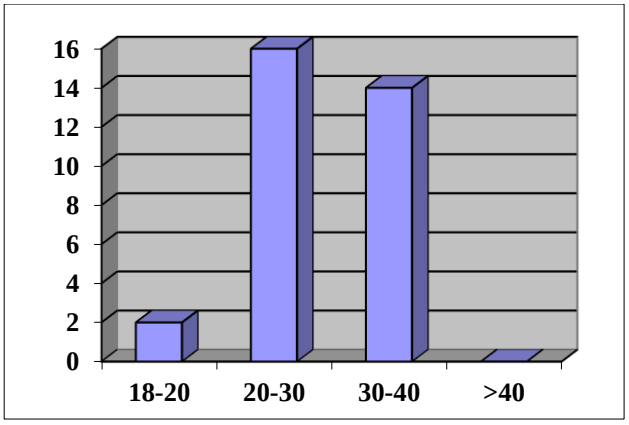

Figure 3: Age distribution.

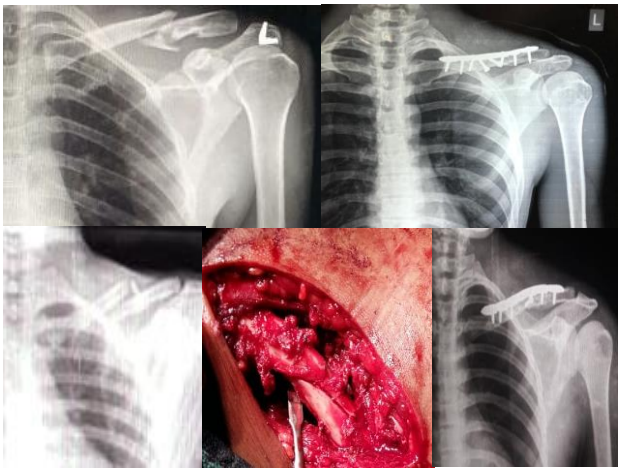

Figure 4: Superior plate fixation.

DISCUSSION

Anatomy

The clavicle bone is a horizontally lying long bone which ossifies by membranous ossification. It has double curve, 'S' shaped bone. It is the only direct link between the axial skeleton and appendicular skeleton. It is a highly variability in shape, length, density, relationship to vital neuro vascular structures. Many studies have shown the length to be approximately 140 to 150 mm (range, 118-162 mm surrounding neurovascular structures includes the right and left subclavian artery and vein, internal jugular vein, axillary artery, supraclaviclar nerves, and brachial plexus.[5] These structures may sometimes be injured in association with the fracture, and they must also be looked for when considering surgical intervention.[6] The cupula of the lung, which is one another important structure lies just posterior to the clavicle. Pneumothorax is another potentially dangerous complication during surgical fixation of clavicle. Human clavicle shows unpredictability in its shape (Grant, 1971) amongst individuals with different age, sex, race and occupation. This anatomic inconsistency of clavicle bone has been widely researched for clinical interventions and forensic anthropological identifications. Further, the designing of fixation devices like anatomical locking plates, used for treatment is based on the anatomical and biomechanical characteristics of this bone. Ignoring such variations may restrict the use of anatomically pre-contoured plate.

Factors influencing the outcome include: fracture pattern, implant used, and position of implant.

Transverse fractures were well managed by anatomical locking plate. Comminuted fractures always are difficult to align anatomically.[7] Usage of lag screw at appropriate site is must for plate fixation. Though reconstruction plates are commonly used, various studies have shown that, are relatively biomechanically less rigid. Tubular plate is rarely used nowadays.

Nonlocking plates are less widely used and are biomechanically reasonable in cases where good bony apposition can be obtained. But locking plates give comparatively stiffer constructs and are indicated in patients with gross osteoporosis or severely comminuted fractures.[8] Mid third clavicle fractures fixed using 3.5 mm low profile reconstruction plates are more likely to exhibit plastic deformation. Whereas 2.7 mm plating constructs utilizing reconstruction plates with thicker plate profile are more likely to fail by plate breakage.[9] Plate positioning remains controversial. Superior plate placement follows the principle of fracture fixation on the tension side of the fracture, but it leads to prominent hardware related complications.[10] Theoretical benefits of antero-inferior plate placement include usage of greater screw length and better purchase, safer screw trajectory, less prominent hardware, and less need for hardware removal after fracture union later. The antero-inferior placement of the plate, led to a deformation mode force acting analogous to the intact clavicle in both loading configurations, whereas the deformation mode with the superior plate placement was non-physiological.[11] 3 new recent biomechanical studies have proved that there is greater resistance to cantilever bending in antero-inferior plate placement. A comparison of the 2 plating techniques has shown that plate removal was more often with superior than antero-inferiorly placed plates.

The screw for which there is maximum risk of injury to vital structure during drilling and insertion for both superior and antero-inferior plates was the second medial screw hole. Proximity to vital structure in both the supine and beach chair positions was also defined (supine superior plating: 8.2±3.1 mm [minimum: 1.1 mm]; beach chair antero-inferior plating: 7.6±4.2 mm [minimum: 1.1 mm]).[12]

Patient positioning also affected the distances between the tip of the riskiest screw and the nearby vital neurovascular structures. In superior plating, changing the patient position from the supine position to the beach chair position enhanced this distance by 1.4 mm (95% CI -2.8 to -0.1; supine 8.2±3.1 mm, beach chair 9.6±2.1 mm;

p=0.037). By contrast, in antero-inferior plating, changing the patient position from the beach chair position to the supine position improved this distance by 5.4 mm (95% CI 3.6 to 7.4; beach chair 7.6±4.2 mm, supine 13.0±3.2 mm; p<0.001.[13]

Failure by mechanical or a biological mode

Biological reasons for fixation failure are poor bone quality, age, and fracture location.

In biological mode, the mechanism of failure is described as a gradual loosening of fixation during the course of union, leading to pull out of the plate screw hardware construct.

Mechanical reasons for fixation failure include, bending stress leading to plate failure typically at the screw–plate junction, screw not backing out, and plate breakage.

Mechanical mode, a formal breakage of the hardware (plate) occurs, while the screws remain rigidly fixed to the bone without loosening.

Figure 5: Mechanical mode failure.

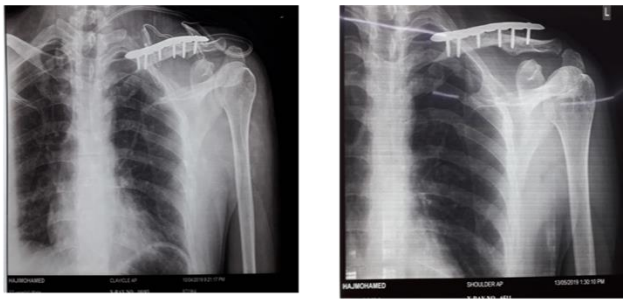

Figure 6: Biological mode failure.

The failure analysis, by Marinescu et al has proved that the plate breakage happens at the point where there is maximal elastic stress and minor deformation takes place. The clinical implication to be considered is that, no hole should be left free of screw, particularly in comminuted fractures during clavicle plate fixation. The implant to be used should be based on clavicle morphology. In comminuted clavicle fracture, principle of anatomic bridging with locked plate technique leads to implant failure, due to stress raise in the midshaft area.

Hardware prominence and need for second procedure to remove the implant, are unavoidable and accepted complication. Theoretically, antero inferior plating offer lesser hardware prominence than superior plating.[14]

Limitations

The major limitation of our study is the relatively small number of operated cases. Other methods of fixation like intra-medullary devices and external fixators, comparison with non-operative treatment have not been included in this study.

CONCLUSION

Anatomical locking plate prove to be the ideal implant for management of mid shaft clavicle fracture. Mechanical mode of plate fixation failure can be avoided by using lag screw and avoiding fracture spanning. Biological mode of failure can be prevented by guarded post operative rehabilitation in comminuted fracture.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

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Cite this article as: Narayanan AR, Ponnappan L. Mid-shaft clavicle fractures – factors influencing the clinical outcome after plate osteosynthesis. Int J Res Orthop 2022;8:309-13.