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Assessment of patients suffering from clavicle fracture managed by anatomical locking compression plate

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Abstract
Operative treatment consists of open reduction and internal fixation with plates and screws or intramedullary nail. Plating techniques continue to evolve. Newer precontoured anatomical locking plates allow more accurate fitting while maintaining strength; compared to earlier locking compression plates and reconstruction plates. Currently, most commonly used technique is superior placement of plate but when the fracture configuration allows we prefer anteroinferior plate placement because of the safe screw trajectory and less hardware irritation. Hence, this study was taken up to assess the various aspects of clavicle fractures treated with open reduction internal fixation with pre contoured locking compression plates.
The study was planned in the Department of the Orthopaedics in Nalanda Medical College and Hospital, Patna from Feb 2018 to July 2018. Total 10 patients admitted for the reason of the displaced clavicular fractures were enrolled in the present study.
The data generated from the present study concludes that displaced mid-shaft clavicle fractures treated with precontoured locking compression plates gave good functional outcome and patient satisfaction. They also had low complication rates and excellent reunion rates, retaining the normal "S" shape of the clavicle. The surgical procedure was also easy and less time consuming, with very less intraoperative bleeding.

Keywords: clavicle fracture, surgery, locking compression plates

Introduction
A clavicle fracture, also known as a broken collarbone, is a bone fracture of the clavicle. Symptoms typically include pain at the site of the break and a decreased ability to move the affected arm. Complications can include a collection of air in the pleural space surrounding the lung (pneumothorax), injury to the nerves or blood vessels in the area, and an unpleasant appearance. It is often caused by a fall onto a shoulder, outstretched arm, or direct trauma. The fracture can also occur in a baby during childbirth [1]. The middle section of the clavicle is most often involved [3]. Diagnosis is typically based on symptoms and confirmed with X-rays [2]. Clavicle fractures are typically treated by putting the arm in a sling for one or two weeks. Pain medication such as paracetamol (acetaminophen) may be useful. It can take up to five months for the strength of the bone to return to normal [3]. Reasons for surgical repair include an open fracture, involvement of the nerves or blood vessels, or shortening of the clavicle by more than 1.5 cm in a young person [4].
Clavicle fractures most commonly occur in people under the age of 25 and those over the age of 70. Among the younger group males are more often affected than females. In adults they make up about 5% of all fractures while in children they represent about 13% of fractures [3].
Clavicle fractures are commonly known as a breaking of the collarbone, and they are usually a result of injury or trauma. The most common type of fracture occurs when a person falls horizontally on the shoulder or with an outstretched hand. A direct hit to the collarbone can also cause a break. In most cases, the direct hit occurs from the lateral side towards the medial side of the bone. The muscles involved in clavicle fractures include the deltoid, trapezius, subclavius, sternocleidomastoid, sternohyoid, and pectoralis major muscles. The ligaments involved include the conoid ligament and trapezoid ligament. Incidents that may lead to a clavicle fracture include automobile accidents, biking accidents (especially common in mountain biking), horizontal falls on the shoulder joint, or contact sports such as football, rugby, hurling, or wrestling.
It is most often fractured in the middle third of its length which is its weakest point. The lateral fragment is depressed by the weight of the arm and is pulled medially and forward by the strong adductor muscles of the shoulder joint, especially the pectoralis major. The part of the clavicle near the center of the body is tilted upwards by the sternocleidomastoid muscle. Children and infants are particularly prone to it. Newborns often present clavicle fractures following a difficult delivery. After fracture of the clavicle, the sternocleidomastoid muscle elevates the medial fragment of the bone. The trapezius muscle is unable to hold up the distal fragment owing to the weight of the upper limb, thus the shoulder droops. The adductor muscles of the arm, such as the pectoralis major, may pull the distal fragment medially, causing the bone fragments to override. Surgery typically involves putting the broken pieces of bone back into position and preventing them from moving out of place until they are healed. This can improve shoulder strength when you have recovered.
Open reduction and internal fixation. This is the procedure most often used to treat clavicle fractures. During the procedure, the bone fragments are first repositioned (reduced) into their normal alignment. The pieces of bone are then held in place with special metal hardware.

Common methods of internal fixation include [5]

Plates and screws: After being repositioned into their normal alignment, the bone fragments are held in place with special screws and metal plates attached to the outer surface of the bone. After surgery, you may notice a small patch of numb skin below the incision. This numbness will become less noticeable with time. Because the clavicle lies directly under the skin, you may be able to feel the plate through your skin. Plates and screws are not routinely removed after the bone has healed, unless they are causing discomfort. Problems with the hardware are not common, but some patients find that seatbelts and backpacks can irritate the collarbone area. If this happens, the hardware can be removed after the fracture has healed.

Pins or screws: Pins or screws can also be used to hold the fracture in good position after the bone ends have been put back in place. The incisions for pin or screw placement are usually smaller than those used for plates. Pins or screws often irritate the skin where they have been inserted and are usually removed once the fracture has healed.

The goals of treatment are to restore normal anatomy, limit pain, and promote a quick return to activity or play. Non-operative management remains the most common approach to non-displaced midshaft clavicle fractures. This consists of immobilization in a sling or figure-of-eight dressing. Although the figure-of-eight dressing is still widely used, several studies have demonstrated similar union rates and increased satisfaction in patients treated with a simple arm sling. The figure-of-eight dressing may cause discomfort and is often cumbersome to adjust. Immobilization is maintained for comfort and can be discontinued in one to two weeks or when the major pain subsides. Range-of-motion pendulum exercises can be started as soon as pain allows, with gradual progression to active range-of-motion and strengthening exercises over four to eight weeks. Displaced midshaft clavicle fractures have higher rates of non-union and a greater risk of long-term sequelae. Studies have shown that operative treatment results in a lower rate of fracture non-union and improved patient-oriented outcomes compared with non-operative treatment. Therefore, although non-operative treatment is a viable option to treat displaced mid-shaft fractures, operative repair should be considered in patients with multiple risk factors for non-union, especially significant fracture displacement or clavicle shortening [6].

Return to activity recommendations for patients with midshaft clavicle fractures depend on patient age, level of contact, and presumed trauma risk. Before returning, an athlete should have full range of motion, normal shoulder strength, clinical and radiographic evidence of bony healing, and no tenderness to palpation. Patients usually can return to noncontact sports and full daily activities six weeks after injury. Contact and collision sports should be delayed for two to four months until solid bony union occurs. If surgery is performed, some surgeons recommend removal of hardware before returning to sports [7]. However, plate removal may delay return to sports and is not recommended by other surgeons.

Operative treatment consists of open reduction and internal fixation with plates and screws or intramedullary nail. Plating techniques continue to evolve. Newer precontoured anatomical locking plates allow more accurate fitting while maintaining strength; compared to earlier locking compression plates and reconstruction plates [8]. Currently, most commonly used technique is superior placement of plate but when the fracture configuration allows we prefer anteroinferior plate placement because of the safe screw trajectory and less hardware irritation. Hence, this study was taken up to assess the various aspects of clavicle fractures treated with open reduction internal fixation with pre contoured locking compression plates.

Methodology

The study was planned in the Department of the Orthopaedics in Nalanda Medical College and Hospital, Patna from Feb 2018 to July 2018. Total 10 patients admitted for the reason of the displaced clavicular fractures were enrolled in the present study. The approval of the institutional ethical committee was taken prior to conduct of the study. All the patients were informed consents. The aim and objective of the present study were conveyed to them.

Plain radiograph of clavicle with shoulder in anteroposterior view was taken to assess the site of fracture and the fracture type (Displacement and comminution). The fractures were classified according to Robinson's classification. The affected upper limb was immobilised in an arm pouch.

Patient was induced with general anaesthesia positioned in beach chair position; 7-8 cm of incision was taken over the clavicle after stretching the skin proximally, centring over the fracture; subcutaneous tissue, fascia and platysma were dissected; fracture was exposed and muscles were elevated from the periosteum, fracture reduced and stainless steel precontoured anatomical plates were used to fix the fracture with min 3 no, 3.5 mm cortical screws on either side. Wound was closed in layers, sterile dressing applied and limb immobilised with arm pouch. The operated upper limb was immobilised in an arm pouch. Check x-rays were taken to study the alignment of fracture fragments. The wound was inspected at 3rd or 4th postoperative day. Suture removal was done on 10th postoperative day. Patients were discharged with the arm pouch. Rehabilitation of the affected arm was started at the end of 2 weeks. Gentle pendulum exercises to the shoulder in the arm pouch were allowed. At 4 to 6 weeks gentle active range of motion of the shoulder was allowed, but abduction is limited to 80 degrees. At 6 to 8 weeks, active range of motion in all planes were allowed.

Exclusion criteria

- Patients below 18 years of age, having open or pathological fractures, fractures in the proximal or the distal third of the clavicle, or those which were associated with head injury.
- Patients with a neurovascular injury, established non-union from previous fracture or with acromioclavicular joint dislocation were also excluded from the study.

Results & Discussion

The data from the 10 patients were collected and presented as below. The data were compared with the already reported literature findings.

Clavicle fracture is one of the most commonly encountered fractures in present day scenario of trauma care. As the lifestyle of citizen changes, his requirements, needs, wants and understanding towards a medical condition completely changes with time. With the era where a person immobilised for a long duration would face utter economic distress, the conservative means of treating most of the fractures

including clavicle fractures has become obsolete. Moreover, there have been a few studies which have reported a poor outcome and higher rates of non-union of the fractures by the conservative methods [9-10]. Patients seek for faster and better functional outcome and are ready for the risk of surgery. With the advent of better surgical techniques, sterile maintenance, better post op protocols the results of surgical management are far superior compared to conservative means.

Table 1: Evaluation of Cases

Characteristics	No. of Patients	Percentage of Cases
Age		
Less than 20 years	2	20 %
20 – 30 years	5	50 %
31 – 40 years	1	10 %
41 – 50 years	2	20 %
51 – 60 years	0	0 %
Gender		
Male	8	80 %
Female	2	20 %
Nature of Trauma		
Road accident	9	90 %
Slip and Fall	1	10 %
Side involved:		
Left	6	60 %
Right	4	40 %
Intra Operation Complication	No Case	--
Extra Operation Complication	One Case with mild pain	--
Mean Union Time	6-7 weeks	--
Final Results		
Excellent	1	10 %
Good	8	80 %
Poor	1	10 %
Full range of motion	Full	--

Management of clavicular fractures may be of different types such as intramedullary, plates and external fixators. Like K wire, Steinmann pin, recon plate, new generation pre-contoured anatomical plates. The main purpose of these surgical treatments is the anatomical reduction and reconstruction of the clavicular length and alignment of the shoulder girdle. In order to prevent stress to the implant, it is necessary that it is strong in comparison to the bone strength. Therefore precontoured plates are preferred as they involve locking between the screw and the plate. As there is minimal contact between the plate and the cortical bone, there is no hindrance to the blood supply as well as minimizing the risk of injury to the subclavian artery or brachial plexus, more so because tip of the screw does not reach the opposite bone cortex. Periosteal stripping is minimized to promote rapid union [11].

Clavicle fractures are usually treated conservatively. In a study conducted to analyse the results of conservative treatment by Hill *et al.* [10] in 1997, Nordqvist *et al.* [12] in 1998 and Robinson *et al.* [9] found poor results following conservative treatment of displaced middle third clavicle fracture. There are specific indications like displacement, with or without comminuted middle third clavicle fracture (Robinson Type2B1, 2B2). In this study all Patients with midshaft clavicle fractures were of closed type. This is comparable to Bostman *et al.* [13] and Cho *et al.* [14] Study which also showed all their patients were closed fractures.

Robinson CM, in a prospective, multi centre, stratified, randomized controlled trial, 200 patients between sixteen and sixty years of age who had an acute displaced midshaft clavicular fracture were randomized to receive either primary open reduction and plate fixation or non-operative treatment [9]. The rate of non-union was significantly reduced after open reduction and plate fixation as compared with non-operative treatment. Overall, Dash score was significantly better after open reduction and plate fixation than after nonoperative treatment at the time of the one-year follow-up concluded that Open reduction and plate fixation reduces the rate of non-union after acute displaced midshaft clavicular fracture compared with non-operative treatment and is associated with better functional outcomes [15-16]. Regarding acute, displaced fractures, an on-going debate in the literature shows that there is no consensus concerning the optimal choice of treatment. Midshaft clavicle fractures more common in male than female. Understanding the mechanism of injury is essential for anatomical reduction and fixation. Clavicle alignment (length, rotation) has to be maintained for lateral stability of the shoulder. Anatomical reduction with restoration of the articular congruence is essential in all fractures. Open reduction and internal fixation restores the congruity of the clavicle.

Excellent results are obtained with stable fixation of fracture. Precontoured locking plate for clavicle helps in fixation of clavicle to its normal anatomical contour and stability. Functional results improve when the normal bend of the clavicle is restored while plating. Chances of non-union due to soft tissue interposition were avoided by surgical treatment. Delayed union of three cases, were possibly due to unsatisfactory reduction at time of surgery. Functional outcomes are better with surgical management of middle third clavicle fractures with locking compression plate. The successful use of locking compression plate for middle third fractures of clavicle requires careful assessment of fracture pattern, patient selection, meticulous operative technique, appropriate choice of fixation, judicious internal fixation, careful post-operative monitoring and aggressive early institution rehabilitation. The final functional result of treatment of middle third fractures not only depends on anatomical reduction but also depends on surrounding soft tissue injuries and mobilization.

Undisplaced clavicle fractures are treated conservatively but the indications for which operative treatment are comminuted, displaced middle third clavicle fractures and displaced lateral third clavicle fracture. Among the internal fixation methods intramedullary fixation with K-wire or Steinmann pin do not control rotation and have low resistance to torque, carry risk of pin loosening and infection, so they require longer period of immobilisation till union. Open reduction and internal fixation with plates, such as Sherman plates, dynamic compression plates and semitubular plates can be effective in obtaining anatomical reduction, applying direct compression to fracture site and producing resistance to torque. However, it is disadvantageous in achieving firm fixation because it is difficult to hold plates to the clavicle in severely comminuted fracture cases. In contrast, reconstruction plates can be manipulated to fit the contour of the clavicle and fracture pattern to obtain firm fixation, are lighter and thinner than dynamic compression plates and are durable to multidirectional mechanical stress imposed on the fracture site.

Conclusion

The data generated from the present study concludes that displaced mid-shaft clavicle fractures treated with precontoured locking compression plates gave good functional outcome and patient satisfaction. They also had low complication rates and excellent reunion rates, retaining the normal "S" shape of the clavicle. The surgical procedure was also easy and less time consuming, with very less intraoperative bleeding.

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