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ORIGINAL ARTICLE

OPERATIVE TREATMENT OF CLAVICULAR FRACTURES: A PROSPECTIVE STUDY

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ABSTRACT: BACKGROUND: Fractures of clavicle constitute one of the commonest fractures in orthopaedic practice and till recently most of these fractures were treated conservatively. The advent of various implants for the fixation of these fractures along with safe surgical practices made the surgery more widely accepted and the definite indications for open reduction and internal fixation were formulated. **MATERIAL & METHODS:** In this prospective study, conducted in the department of orthopedics and Traumatology of Osmania General Hospital, Hyderabad, 4o patients who were operated for fracture clavicle were included. The study period was from September 2012 to September 2014. **CONCLUSIONS:** Operative treatment of fracture clavicle offers a definitive method of treatment in some specific instances. It reduces the time of union, stiffness of the adjoining joints and morbidity.

KEYWORDS: Fracture clavicle, Operative fixation of clavicle, Plate synthesis for clavicle.

INTRODUCTION: Clavicle is the bony link from thorax to shoulder girdle and contributes to movements at shoulder girdle. Clavicle fracture is a common traumatic injury around shoulder girdle due to their subcutaneous position. It is caused by either low-energy or high-energy impact. Fracture of the clavicle accounts for approximately 2.6% to 5% of all fractures and up to 35% of injuries to the shoulder girdle. About 70% to 80% of these fractures are in the middle third of the bone and less often in the lateral third (12% to 15%) and medial third (5% to 8%).[1,2]

Fractures of the clavicle have been traditionally treated non-operatively. Although many methods of closed reduction have been described, it is recognized that reduction is practically impossible to maintain and a certain amount of deformity and disability is expected in adults. More recent data based on detailed classification of fractures, suggest that the incidence of nonunion in displaced comminuted clavicular fractures in adults is between 10 and 15%. All fractures with initial shortening of >2cm resulted in nonunion.[3,4]

Several studies have examined the safety and efficacy of primary open reduction and internal fixation for completely displaced fractures clavicle and noted high union rate with a low complication rate. There are various methods for treating clavicle mid shaft fractures such as pre contoured clavicular locking plates, reconstruction plates, dynamic compression plates, intramedullary nails etc.[5]

For lateral third clavicular fracture operative treatments include transacromial Kirschner wire, cancellous compression screw and coracocalvicular screw. AO/ASIF group has recommended the use of tension band wire construct for fixation of displaced lateral third clavicle fracture.

The purpose of this study is to gain experience with the surgical management of fresh displaced, comminuted middle third clavicle fractures with plate and screws and Kirschner wires with tension band construct for displaced lateral third clavicle fractures.

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AIMS AND OBJECTIVES:

1. To study the role of open reduction and internal fixation in clavicular fractures.
2. To study various surgical procedures for fracture clavicle.
3. To clinically evaluate the results of various surgical procedures for fracture clavicle.
4. To discuss merits and demerits of the various surgical procedures.

Pecularity of Clavicle:

- It is the only long bone to lie horizontally in the body
- It is the only bone with membranous ossification
- It is the first bone to ossify in the body
- It lacks a well-defined medullary cavity
- It is subcutaneous throughout its whole extent
- The shaft ossifies from two primary centers.

FUNCTIONS OF THE CLAVICLE:

1) Power and stability of the arm:
2) Motion of the shoulder girdle:
3) Muscle attachments:
4) Protection of neurovascular structures:
5) Respiratory function:
6) Cosmosis:
7) Protection to lungs:

INCIDENCE OF INJURY: Fractures of the clavicle account for approximately 5 to 10% of all fractures and up to 44% of all injuries to the shoulder girdle. The site of fracture also depends upon the age of the patient and mechanism of injury.[6]

Elderly men-proximal third clavicle fracture Children-middle third clavicle fracture, un-displaced. Adolescents - middle third clavicle fracture, displaced Middle aged patient- distal third clavicle fractures.

The incidence of both lateral and medial clavicular fracture rose sharply after the age of 75 years suggesting that these areas become substantially more susceptible to fracture when osteoporotic.[7,8]

MECHANISM OF INJURY[9]: The primary mechanism of clavicular failure is by compression it may be caused by either low energy or high energy impact like.

i. Fall on the shoulder-87%
ii. Direct blow on to shoulder-7%
iii. Fall on to an outstretched hand-6%.

TREATMENT: The exact method of treatment of a fractured clavicle depends on several factors including the age, medical condition of the patient, the location of the fracture and associated injuries. It is important to achieve antero-posterior and lateral alignment of the fracture because the clavicle is a curvilinear bone.

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In adults with clavicular fractures the goal of treatment as with other fractures is to achieve healing of bone with minimal morbidity, loss of function and residual deformity. General methods of treatment of fractures of the clavicle can be broadly grouped into the following ways;

- Conservative or non-operative treatment.
- Operative treatment.

OPERATIVE TREATMENT: The chief goal in this method of treatment is to achieve a healed clavicular strut in a normal anatomical position as possible. The healed clavicular bone in good position provides stability to the shoulder girdle. It may be by any of these methods;

i. Intramedullary fixation
ii. Internal fixation with plates and screw
iii. External fixation.

Indication: Indications for operative treatment of clavicular fractures are;

1. Severe displacement caused by comminution with resultant angulation and tenting of the skin severe enough to threaten its integrity and that fails to respond to closed reduction.
2. Symptomatic non-union like shoulder girdle dysfunction neurovascular compromise.
3. Neurovascular injury or compromise that is progressive or that fails to revere after the closed reduction of the fracture.
4. Open fracture.
5. Type II distal clavicular fracture (displaced).
6. Multiple traumas, when mobility of the patients is desirable and closed methods of immobilization are impractical or possible.
7. Floating shoulder.
8. Inability to tolerate closed immobilization such as neurological problems of Parkinsonism, seizure disorders.
9. Cosmetic reasons.
10. Relative indications include shortening of more than 15 to 20mm and displacement more than the width of the clavicle.

COMPLICATIONS:

a) Malunion.[10]
b) Nonunion.[11,12]
c) Neurovascular sequelae.[13]
d) Post traumatic arthritis:

Complications of Surgery and its Treatment:

1) Hard ware problems:
2) Infection:
3) Hypertrophic scar:
4) Refracture:
5) Non-union, delayed union and malunion:

REHABILITATION: Objectives: Improve and restore the function of the shoulder for activities of daily living, vocational and sports activities.

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Duration: The expected duration of rehabilitation is for 10 to 12 weeks.

Rehabilitation protocol[14]: Day one to one week: Limb is immobilized in a sling with shoulder held in adduction and internal rotation. Elbow is maintained at 90° of flexion with no range of motion at shoulder.

i. At two weeks: After suture removal gentle pendulum exercises to the shoulder in the sling as pain permits is allowed.
ii. At four to six weeks: At the end of 6 weeks gentle active range of motion of the shoulder is allowed. Abduction is limited to 80°.
iii. At six to eight weeks: Active to active – assistive range of motion in all planes is allowed.

At eight to 12 weeks: Isometric and isotonic exercises are prescribed to the shoulder girdle muscles.

MATERIALS & METHODS: The present study is prospective study and was carried out from September 2012 to September 2014 at Orthopedics Department in Osmania General Hospital, Hyderabad. During this period 40 patients of clavicle fractures were treated surgically and were included in the study.

Inclusion Criteria:

1. Age between 18 and 60 years.
2. All compound fractures of clavicle.
3. All clavicle fractures with neurovascular deficit.
4. All displaced or comminuted fractures.
5. All fractures with tenting of skin.
6. No medical contraindication to general anaesthesia.
7. All clavicular fractures with >20mm bone loss.

Exclusion Criteria:

1. Age < 18 years and >60 years.
2. Pathological fractures.
3. Undisplaced fractures.
4. Associated head injury.
5. Any medical contraindication to surgery or general anaesthesia (heart diseases, renal failure or active chemotherapy).
6. Lack of consent.

General information like name, age, sex, occupation and address were noted. Then a detailed history was elicited regarding mode of injury like fall on the shoulder, Road traffic accident, direct injury to shoulder and fall on outstretched hand. Enquiry was made to note site of pain and swelling over the affected clavicle. Past medical illness and family history were also recorded.

Procedure: Minimal soft tissue and periosteum dissection was done. Fracture fragments were reduced, provisionally hold with k-wires and plate was applied over the superior aspect of the clavicle.

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i. At the junction of the medial and middle third of the clavicle, the inferior surface is exposed so that a protective instrument can be inserted during drilling to prevent injury to neurovascular structure underneath it.
ii. The pre contoured locking plate or recon plate or DCP was fixed to the medial and lateral fragment with locking screws/ cortical screws and at least three screws in medial and lateral fragment were applied.
iii. IM nail fixed by taking an entry point into medial or lateral end of clavicle and progressed under c-arm control.

Post-Operative Care: Patients were kept nil orally for 4 to 6 hours post-operatively. Intravenous fluids were given as needed. Antibiotics were continued for 10 days. Analgesics and tranquilizers were given according to the needs of the patient. The operated upper limb was immobilized in an arm pouch. Check X- rays were taken to study the alignment of fracture fragments.

The wound was inspected at 3rdor 4thpostoperative day. Suture/ staple 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 in limited to 80 degrees. At 6 to 8 weeks active range of motion in all planes were allowed.

Follow up:

Regular follow up for every 4 weeks was done.

Local examination of the affected clavicle for tenderness, instability deformity and shoulder movements were assessed.

X-rays were taken at each follow up visits to known about progressive fracture union and implant position.

Rehabilitation of the affected extremity were done according to the stage of fracture union and time duration from day of surgery.

Patients were followed up till radiological union.

The functional outcome was assessed by Constant and Murley score.[15]

CONSTANT AND MURLEY SCORING: The patients are graded as follows

CATEGORY: A) SUBJECTIVE:

1) Pain - 15 Points;

No pain - 15
Bearable pain - 10
Disabling pain - 5

2) Activities of daily living: 20 Points;

Ability to perform full work - 04
Ability to perform Leisure activities/ Sports - 04
Unaffected sleep – 02.

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Level at which work can be done:

Up to Waist - 02
Up to Xyphoid - 04
Up to Neck - 06
Up to Head - 08
Above head - 10

B) OBJECTIVE: RANGE OF MOVEMENTS: 40 POINTS:

a) Active flexion without pain

00 – 30 Degrees:	00
31-60 Degrees:	2
61-90 Degrees:	4
91-120 Degrees:	6
121-150 Degrees:	8
> 151 Degrees:	10

b) Functional external rotation:

Hand behind head with elbow forwards -	2
Hand behind head with elbow backwards -	4
Hand above head with elbow forwards -	6
Hand above head with elbow backwards -	8
Full elevation from on top of head –	10

c) Active abduction without pain:

With dorsum of hand on back, head of third metacarpal reaches

00 – 30 Degrees:	00
31-60 Degrees:	2
61-90 Degrees:	4
91-120 Degrees:	6
121-150 Degrees:	8
> 151 Degrees:	10

d) Functional internal rotation:

Ipsilateral buttock:	2
S1 spinous process:	4
L3 spinous process:	6
T12 spinous process:	8
T7 spinous process:	10

e) Strength of abduction: 25 Points

OBSERVATIONS AND RESULTS: The present study is a prospective study consisting of 40 patients of fresh fractures of the clavicle which satisfying the inclusion and exclusion criteria were treated surgically between September 2012 and September 2014 at Osmania General Hospital. All the patients were available for follow-up and they were followed every 4 weeks. Results were analyzed both clinically and radiologically.

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Age Incidence: Majority of the patients were with middle third clavicle fracture i.e. 16 patients (40%) were in the age group of 19-29 years. The youngest patient was 19 years and oldest patient was 59 years. The average patient age was 32 years.

Most patients 4 cases (10%) with lateral third clavicle fracture were between 40-49 years. The youngest patient was 21 years and oldest patient was 52 years with average age of 37.5 years.

Sex Incidence: In middle third clavicle fracture the majority was males, 32 patients (80%) and females were 4 patients (10%)

In lateral third clavicle fracture all the 4 patients (10%) were males and no females.

Mode of Injury: In Middle third clavicle fractures direct injury occurred in 32 patients(80%) among them 24 patients (60%)were due to road traffic accident, 8 patients (20%)were due to fall on the shoulder after slipping. Indirect injury occurred in 4patients (10%) due to fall on outstretched hand.

In lateral third clavicle fracture the direct injury occurred in 4patients (10%) due to Road traffic accident.

Site of Fracture: In this present study there were 36 patients (90%) of middle third clavicle fracture and 4 patients (10%) were lateral third clavicle fracture and there were no medial third clavicle fracture.

All the patients in both middle and lateral third clavicle fracture were closed type. There was no associated medical illness in any patient.

Side Affected: In this study for middle third clavicle fractures there were 20patients (50%) of Left sided fracture and 16 patients (40%) of Right sided fracture.

For Lateral third clavicle fracture there were 2 patients (5%) on the left side and 2 patients (5%) on the Right side.

Plain radiograph of clavicle with shoulder is taken in anteroposterior view to assess the site of fracture and the type of fracture (Like Displacement, Angulation, and Comminution). In this study Robinson classification[16] was followed.

There was no type-1 (medial third) fracture. In type-2 middle third fracture type-2 B1 (displaced with simple or single butterfly fragment) occurred in 32 patients (80%) and type-2 B2 (displaced with comminuted or segmental) fracture occurred in 4 patients (10%).

In lateral third clavicle fracture there was type- 3 B1 (displaced with extraarticular) occurred in 4 patients (10%). There were no type- 3 B2 fracture (Displaced with intra articular).

Time Interval for Surgery: All the patients were operated as early as possible once the general condition of the patients was stable.

In middle third clavicle fracture 32 patients (80%) were operated in the first week and 4 patients (10%) were operated in the second week due to fixed OT days in Osmania Government Hospital

In lateral third clavicle fracture all the 4 patients (10%) under gone surgery within 1 week.

All the patients were operated under general anaesthesia

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Types of Implant: The middle third fracture is fixed with plate and cortical screws and intra medullary nails. The following types of implants are used.

In 20 patients (55%) pre contoured plates were used. In 12 patients (33%) reconstruction plates were used. In 2 patients (6%) dynamic compression plates were used, in 2 patients (6%) IM nails were used. Commonly pre contoured plates were used.

For type-2 B1 Robinson classification (Displaced with simple or single butterfly fragment of middle third clavicle fracture) reconstruction plates were used in 10 patients (25%), pre contoured plates in 20 patients (50%) and dynamic compression plates in 0 patients (0%),IM nails used in 2 patients(5%). For type-2 B2 Robinson classification (Middle third clavicle fracture with comminution) reconstruction plates were used in 2 patients (5%) and dynamic compression plates in 2 patients (5%).

Types of Plate and Length: The plates were intra-operatively bent to the contour and curvature of the clavicle if needed. The length of the plate to be used was determined according to the extent of comminution at the fracture. The aim was to place at least three screws in the medial and lateral main fragments through both cortices of the bone.

In 4 patients (10%) 6hole reconstruction plates were used. In 4patients (10%) 7 hole reconstruction plates were used and in another 4 patients (10%) 8 hole reconstruction plates were used.

- In 7 patients (17.5%) 6 hole pre contoured plates were used.
- In 7 patients (17.5%) 7 hole pre contoured plates were used.
- In 6 patients (15%) 8 holed pre contoured plates were used.
- In 2 patients (5%) 7 holed DCP were used.
- Commonly 7 hole plates were used i.e. 13 patients (32.5%).
- Cortical screws were used of following sizes from 12 to 16 mm.

All the 4 patients of lateral third clavicle fracture were fixed with Kirschner wire and tension band wire in 3 and recon plate in one patient through the distal end of clavicle.

Suture removal was done on 10th post-operative day on all patients. Rehabilitation of the affected side shoulder was done at the end of 2 weeks. These patients were followed up every 6 weeks.

Duration of Union: The fracture was considered to be united when clinically there was no tenderness, radiologically the fracture line was not visible and full unprotected function of the limb was possible.

In middle third clavicle fracture 32 patients (80%) united at the end of 12weeks. In 4 patients (10%) delayed union occurred. In 2 patients it was due to large butterfly fragment at fracture site which united at 16 weeks and another 2patient it was due to comminution which went on to unite at 20weeks.

In lateral third all the 4 patients united at the end of 12 weeks.

COMPLICATIONS: Major complication: A complication requiring inpatient treatment and resulting in an additional morbidity of 2 months or more was regarded as a major complication.

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In middle third clavicle fixation 8 patients (20%) had hypertrophic skin scar and in 6 patients (15%) plate prominence occurred. In 4 patients (10%) delayed union occurred. In 2 patient (5%) plate loosening/superficial infection occurred which went for malunion.

In 2 patients (5%) superficial infection occurred which was treated with oral antibiotics for 5 days and in another 2 patients (5%) restriction of shoulder movements. The patient was notable to follow the shoulder exercises because of pain.

Functional Outcome: In this study on 36 patients (90%) with middle third clavicle fracture treated with plate and screws and IM nails 28 patients (70%) had excellent functional outcome, good functional outcome in 6 patients (15%) and fair functional outcome in 2patients.

For 4 patients of lateral third clavicle fracture fixed with Kirschner wire and tension band wire 2 patients (5%) had excellent functional outcome results and 2 patients (5%) had fair functional outcome.

DISCUSSION: Good results with excellent union and low complication rates were seen in numerous studies done on primary fixation of clavicle fractures negating the pessimism that surrounded prior studies where a poor understanding of soft tissue handling, selection bias of patients and inadequate implants combined to produce inferior results.

Recent studies show increasing evidence that non-operative treatment of displaced, comminuted mid shaft fractures of clavicle was not as optimal as once thought Non-union rates, strength and endurance deficits are common in cases treated conservatively.

Zlowodzkiet al.,[17] in a meta-analysis of literature found that the nonunion rate of clavicles treated non-operatively was 15.1%, much higher than that was described earlier by Neer (0.1%). Stanley and Norris[18] stated that 33% of patients treated conservatively had symptoms 3 months after fracture. Sankarankutty and Turner reported15% of patients with deformity at the fracture site in 100 cases treated non-operatively.

Displaced fractures of the clavicle can never be treated the same way as un-displaced or minimally displaced fractures for the deforming pull of the Sternocleidomastoid is too great and that the deformity recurs shortly after figure of eight bandage. It has been shown that mid third clavicle fractures with >2cm displacement or 15mm shortening are at increased risk of nonunion.

Thompson[19] reviewed 100 cases of mid clavicular non-unions and found that 90% of the original fractures had displacement > 100%, overriding>1cm or had severe comminution, thus necessitating surgical stabilization.

Plate fixation provides immediate pain relief and stabilization, facilitates early mobilization and early return to pre injury activities.

A multicentric trial conducted by Canadian orthopedic trauma society[20] on 111 patients showed good overall shoulder function, rapid recovery and relief of pain with lower malunion and nonunion rates and a shorter overall union time in clavicular fractures treated with plating.

Kaisa et al.,[21] in a study comparing sling with plate osteosynthesis for displaced clavicular fractures found that operative stabilization to be a reliable method with low complication rate and high union rate. He also noted that non-operative treatment resulted in a higher nonunion rate of 24%.

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Clavicle fractures are usually treated conservatively. In a study conducted to analyze the results of conservative treatment by Hill et al.[22] In 1997, Nordqvist et al.[23] In 1998 and Robinson et al.[24] In 2004 found poor results following conservative treatment of displaced middle third clavicle fracture. Conservative treatment of displaced lateral third clavicle fracture has higher rate of nonunion and residual shoulder dysfunction as showed by Edwards et al.[25] In 1992. So there are specific indication like displacement, with or without comminuted middle third clavicle fracture (Robinson Type-2B1,2B2) and displaced lateral third clavicle fracture (Robinson Type-3 B1, 3B2) for which operative treatment is needed.

The present study of patients with middle third clavicle fractures is compared with Bostman et al.[26] study, which treated only middle third clavicle fractures, in this totally 103 patients were treated by early open reduction and internal fixation with plate and screws. Kao et al.[27] study treated 12 patients with only lateral third clavicle fracture by Kirschner wire with tension band wire is compared with the present study for patients with lateral third clavicle fracture fixed with Kirschner wire with tension band wire. Also compared with lokesh H, et al.[28] Study which includes both middle and lateral third clavicular fractures.

Mechanism of Injury: In this study the patients with middle third clavicle fracture the mechanism of injury was due to fall on the shoulder from bike in 12 patients (30%), Road traffic accident in 12 patients (30%), simple fall on the shoulder in 8 patients (20%), Fall on outstretched hand in 4 patients (10%).

In Bostman et al study the mechanism of injury was due to fall from the two wheeler in 38 Patients (36.8%), slipping and fall in 24 Patients (23.30%),motor vehicle accident in 19 patients (18.45%) and sports in injury 22 patients(21.36%). This shows direct injury to the shoulder is the common cause of this fracture.

In lokesh H, et al. study middle third fractures 32(80%), due to fall on shoulder from two wheeler in 10(25%),due to road traffic accident 18(45%),simple on shoulder due to slip in 2 patients (5%),due to fall on to outstretched hands 1(2.5%),in 1(2.5%) patient injury occurred by hitting train. In lateral third clavicular fractures direct injury occurred in 8(20%) patients, among them 2(5%) patients were due to fall on shoulder from height, and 6(15%) patients due to road traffic accident.

In this study 2 patients (5%) of lateral third clavicle fracture was caused by fall from motor cycle and 2 patient (5%) due to road traffic accident. In Kao et al. study 12 patients (100%) injury was caused by motor cycle accident.

Age Incidence: Middle third clavicle fracture commonly occurred between the age group of19 to 29 years in 16 patients (40%). The youngest patient age was 19 years and oldest patient age was 59 years. The average patient's age was 38 years.

In Bostman et al. Study patients average age was 33.4 years and the youngest patient age was 19 years and oldest patient age was 62 years.

In this study the patient's age with lateral third clavicle fractures range from 27 to 59 years and average age was 37.5 years. Most patients 4 cases (10%) with lateral third clavicle fracture were between the ages of 40 to 49 years.

In lokesh H, et al. study majority of patients with middle third clavicular are in age group of 19- 29 i.e. 12 (30%), the youngest patient is 19 years and oldest is 63 years. The average patient was 35.65 years. Most patients 3 cases (7.5%) with lateral third clavicle fracture was between 30-39 years. The youngest patient was 27 years and oldest was 57 years with an average of 37.5 years.

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In Kao FC et al. Series patients age range from 13 to 58 years and average age was 31.7 years.

Sex Incidence: In this study patients with middle third clavicle fracture were 32males (80%) and 4 females (10%) patients.

In Bostman et al. Series also commonly males are affected 76 Patients (73.79%) compared to females 27 patients (26.21%).

In this study of lateral third clavicle fractures there are 4 males (100%) and no females.

This is comparable to Kao FC et al study which also shows male preponderance i.e. males (66.67%) and females (33.33%).

In lokesh H, et al study in middle third clavicular fractures majority were males 28 (70%), females were 4 (10%).in lateral third clavicular fractures majority were males 6 (15%), females were 2 (5%).

Associated injuries:

- In this study there are no associated injuries present.
- In Bostman et al. Series also there was no associated injuries.
- In lokesh H, et al. study in middle third clavicular fractures there were 8 patients (20%) had associated injuries among them 2 had scapular body fractures, 2 had rib fractures, 1 had Ipsilateral ulna fracture and 1 had distal radius fracture, 1 had glenoid fossa fracture and 1 patient had brachial plexus injury. In lateral third clavicular fractures 3 patients (7.5%) had associated injuries. 2 patients had scapular body fractures and 1 had rib fracture.
- In Kao FCet al. Series there was no associated injuries.

Type of Fracture: In this study all patients with middle third and lateral third clavicle fractures were of closed type.

This is comparable to Bostman et al. Study and lokesh h.et al in which also showed all their patients were closed fractures.

In Kao et al study also all the patients are closed type.

Type	Bostman et al.	Kao et al.	Lokesh H.et al.	Present study
Open	Nil	Nil	Nil	Nil
Closed	All	All	All	All

Table 1

Fracture Classification: In this present study middle third clavicle fracture patients with RobinsonType-2 B1 (Displaced with simple or butterfly fragment) were more common and there were 32 patients (80%). Type-2 B2 (Displaced with comminution) occurred in only 4 patients (10%).

In Bostman et al study also Robinson type-2B1 was common in 81patients (78.64%). Robinson type-2 B2 occurred only in 22 patients (21.36%).

In lokesh H, et al study 12 patients (30%) are Robinson type 2B1 and 20 patients (50%) were Robinson type 2B2.In lateral third clavicular fractures 6 patients (15%) were Robinson type 3B1 and 2 patients (5%) were Robinson type 3B2.

In present study in lateral third clavicle fractures all the 4 patients (20%) are Robinsontype-3 B1.

In Kao et al Series also all the 12 patients belong to Robinson type-3 B1 (Neers type- II).

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Time Interval for Surgery: Most of the patients in the present study were operated in the first week i. e., 36 patients (90%). 4 patients (10%) were operated in the second week due to fixed OT days in Osmania General Hospital. In Bostman et al Study all the patients were operated within 3 days of injury.

Types of Implant: In this study the middle third clavicle fractures were fixed with reconstruction plate in 12 patients (30%). Pre contoured plates in 20 patients (50%) and dynamic compression plates in 2 patients (5%). Pre contoured locking plates were commonly used, as it gave stable fixation.

This in comparison with Bostman et al. Study was reconstruction plates were used in 46 patients (44.66%). Dynamic compression plates were used in 55patients (53.40%) and semi tubular plates in 2 patients (1.94%). In the initial period of his study reconstruction plates were used then in later part of his study dynamic compression plates were used. Later found there was no difference in the complication rate between the patients treated by dynamic compression plate and reconstruction plate.

In lokesh H, et al study locking compression plates were used in 20 patients (50%), reconstruction plates in 6 patients (15%), dynamic compression plates in 6 patients (15%), commonly locking compression plates were used. One reconstruction breakage occurred after 6 months due to road traffic accident.

Plate Length: In this study 7 hole plates were used in 13 patients (32.5%). In 11 patients (27.5%) 6 hole plates were used and in 10 patients (25%) 8 hole plates were used depending upon type of fracture.

In Bostman et al Study plate length was above 6 holes to place at least three screws in each fragment. Plate length also depends upon the amount of comminution.

Procedure for Lateral third clavicle fracture:

In all 4 patients of lateral third clavicle fracture the Kirschner wire was passed through the distal end of clavicle and then tension band applied in 3 cases for early postoperative mobilization of the shoulder and to prevent acromioclavicular arthrosis. No repair of coracoclavicular ligament was done in one case reconstruction plate applied along with k –wire.

In Kao et al study also in all the 12 patients Kirschner wire was passed through distal end of clavicle and then tension band wire was applied.

Duration of Union: In this study majority of the middle third clavicle fracture cases united between 8 to 12 weeks i.e. 32 patients (80%). In 4 patients (10%) delayed union occurred. It was due to a large displaced butterfly fragment which united with the main fragment at the end of 14 weeks in one case, at the end of 16 week in another case, at the end of 18 week in one case and at the end of 20th week in one case. There was no non-union. Lazarus MD stated radiological union occurred approximately between 6 to 12 weeks. All the latera1/ third clavicle fracture (4 patients) united at the end of 12 weeks. In Kao et al. Series union occurred after an average period of 4 months (range 3-6 months).

In lokesh H, et al study in middle third clavicular fractures, 28 patients (70%) united at the end of 12 weeks. In 4 patients (10%) delayed union occurred. It was due to large butterfly fragment

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at fracture site which united at 16 weeks. In lateral third 7 patients united at end of 12weeks. In one patient (treated with hook plate) united at the end of 14 weeks.

Complications: (For middle third clavicle fracture)

A. Major Complications:

Plate Breakage: In this study there are no cases of plate breakage.

In Bostman et al study 2 patients treated with semi tubular plate had implant breakage at 2nd and 7th postoperative weeks respectively. Both cases were treated by replating using dynamic compression plate with bone grafting.

B. Minor complication:

Plate Loosening: Plate loosening occurred in 1 patient (2.5%) at the end of 6 weeks postoperatively. The cause in this patient was also due to noncompliance with the post-operative protocol. The patient went for farming in the field before the fracture union. With further advice of not to lift heavy weights in the affected limb clavicle fracture went to unite in mal position at end of 12 weeks and no reoperation was performed for this.

In Bostman et al Study 7 patients (6.80%) had implant loosening. In all the patients loosening occurred at 6 postoperative weeks. Malunion of varying degree followed in all of these patients and no reoperations were performed.

Delayed Union: Delayed union occurred in 4 patients (10%), as there was a large butterfly fragment which united with main fragment comparatively late.

In Bostman et al study delayed union occurred in 3 Patients (2.91%).

In lokesh H, et al study delayed union occurred in 4 patients (10%).

Skin Complications: There was cosmetically unacceptable hypertrophic skin scar in 8 patients (20%). Plate prominence through the skin was reported in 6 patients (15%).Among them 1 patient had dynamic compression plate fixation and 3patients had reconstruction plate fixation and 1 patient had pre contoured plate fixation.

The total complication in this study was 20% excluding skin related minor complications. The total complication rate of Bostman et al study was 23%.

In lokesh H et al study for middle third clavicular fractures 4 patients (10%) had hypertrophic scar and 6 patients (15%) had plate prominence. In 2 patients restriction of shoulder movement occurred. In one patient (2.5%) plate loosening occurred which went for malunion and in one patient (2.5%) plate breakage occurred. In one patient (2.5%) superficial infection occurred which was treated with oral antibiotics for 5 days.

Complications: (For Lateral third clavicle fracture)

A. Major Complication:

Restriction of Shoulder Movements: 2 patients with distal clavicle fracture had restriction of shoulder movements. During 3rd postoperative week because of pain patient was uncooperative with postoperative exercises. At the end of 3 months patient had restriction of shoulder movements which improved with physiotherapy but residual shoulder restriction was still present.

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In lokesh H et al study 2 patients (5%) had restriction of shoulder movements occurred due to associated glenoid fossa fracture.

B. Minor Complication:

Superficial Infection: In this study 2 patients (5%) had superficial infection in the immediate post-operative period which was controlled with antibiotics for another 5 days

This in comparison with Kao et al study there was no complication in 11patients (91.67%). In 1 patient (8.33%) had a fall at 2 months after operation. This patient received a revision surgery with distal clavicle resection and coracoclavicular reconstruction.

Functional Outcome: The functional outcome according to Constant and Murley in this study of total 36 patients of fresh middle third clavicle fracture fixed with plate and screws showed excellent results in 28 patients (70%) and good functional outcome in patients 6 patients (15%). Fair functional outcome in 2patients (5%) where plate loosening occurred and the patients had some pain over the shoulder in over-head activities and decrease in strength in shoulder abduction.

Out of 4 patients fixed with Kirschner wire with tension band wire 2patients had excellent functional outcome and 2 patients had fair functional outcome due to restriction of shoulders movements in that patients.

In lokesh H et al study 32 patients(80%) middle third clavicular fractures treated with plate and screws 24 patients (60%) had excellent functional outcome, good functional out come in 6 patients (15%) and fair functional out come in 2 patients (5%). For 8 patients of lateral third clavicle fracture fixed with Kirschner wire and tension band wire 4 patients (10%) had excellent functional outcome results and 2patients (5%) had good functional outcome 1 patient had fair functional outcome and with 1 patient fixed with 4 hole hook plate had fair functional outcome due to associated scapula body fracture

The advantage of rigid internal fixation and early mobilization of fresh displaced clavicle fracture is that it (Displaced comminuted middle third and displaced lateral third clavicle fracture) gives immediate pain relief and prevents the development of shoulder stiffness and non-union.

FINAL RESULTS:

Results	Lokesh. H et al	Present study
Excellent	70%	75%
Good	20%	15%
Fair	10%	10%
Poor	-	-

Table 2

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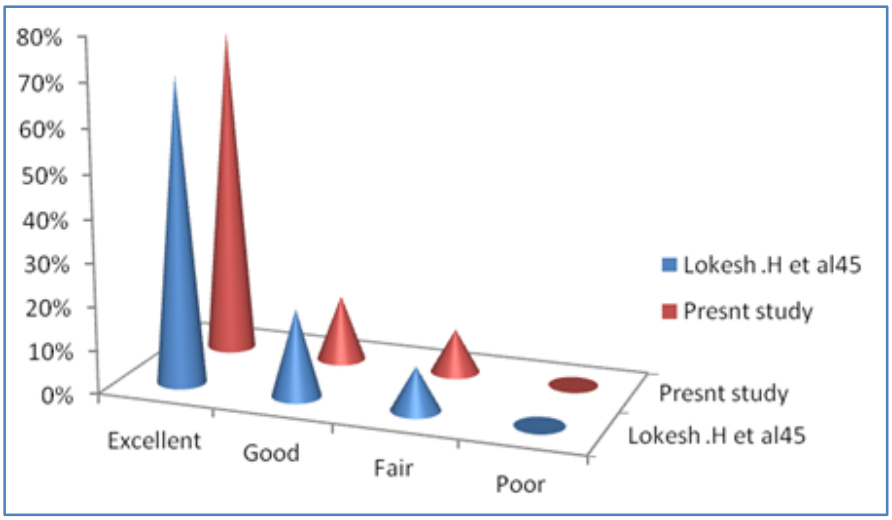

CONCLUSION:

- Specific indications for which operative treatment is needed like comminuted, displaced middle third clavicle fractures and displaced lateral third clavicle fracture.
- Primary open reduction and internal fixation with plate and screws of fresh middle third clavicle fractures provides a more rigid fixation and does not require immobilization for longer periods.
- Among the internal fixation methods intramedullary fixation do not control rotation so they require longer period of immobilization till union.
- Dynamic compression plate is strong and gives better stability in comminuted and three part fractures.
- Pre-contoured anatomical locking plates are associated with less hardware related problems than with reconstruction plate or DCP plate.

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