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Original Research

Study On Surgical Management Of Shaft Of Humerus Fractures With Locking Compression Plate

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ABSTRACT

Background:The recent development of LCP has revolutionized the surgical treatment of fractures by overcoming the few drawbacks of older internal fixators. The fractures of the shaft of humerus are one of the commonest fractures found and the accepted management for fractures shaft of humerus is open reduction and internal fixation using compression plating. Our present study is aimed at the assessment of results of plate osteosynthesis of diaphyseal fractures of humerus using locking compression plate and to assess the functional recovery with this procedure.

Materials and Methods: It is a prospective study which was carried out from December 2019 to June 2021 atDistrict Hospital, Eluru. In this study period 20 cases of fracture shaft of the humerus were treated by open reduction and internal fixation using Locking Compression Plate.

Results: In our series, majority of the patients were males, middle aged, with road traffic accidents being the commonest mode of injury, involving middle third. 90% of the fractures united with excellent, 5% good and 5% poor results.

Conclusion: The LCP for humeral shaft fractures produce excellent results, the advantage being better stability, early mobilization, early union but the complication, duration of surgery and surgical techniques remains unchanged.

Keywords: Humeral shaft fractures, LCP, Open reduction and internal fixation.

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INTRODUCTION

Fractures of the humeral shaft account for roughly 3% of all fractures; most can be treated non-operatively. Charnley stated, “It is perhaps the easiest of the major long bones to treat by conservative methods.”. Historically, methods of conservative treatment have included skeletal traction, abduction casting and splinting, Velpeau dressing, and hanging arm cast, each with its own advantages and disadvantages. Functional bracing has essentially replaced all other conservative methods and has become the “gold standard” for non-operative treatment because of its ease of application, adjustability, allowance of shoulder and elbow

motion, relatively low cost, and reproducible results. The choice of operative treatment for a humeral shaft fracture depends on multiple factors.: (1) fracture indications, (2) associated injuries, and (3) patient indications. Some indications are more absolute than others. Failure of conservative treatment, pathological fracture, displaced intra-articular extension, vascular injury, and brachial plexus injury almost always require surgery. Other conditions, such as minimally displaced segmental fractures and obesity, are only relative indications. Our most common indication for operative treatment is early mobilization of patients with polytrauma. Treatment decisions must take all factors into consideration, tailoring the treatment to the specific patient.

The goal of operative treatment of humeral shaft fractures is to reestablish length, alignment, and rotation with stable fixation that allows early motion and ideally early weight bearing on the fractured extremity. Options for fixation include plate osteosynthesis, intramedullary nailing, and external fixation. Plate osteosynthesis remains the "gold standard" of fixation for humeral shaft fractures. The successful treatment of a humeral shaft fracture may not end with bony union. In the current emphasis on a holistic approach to patient care the treating Orthopaedic surgeon may be in an ideal position to intervene and improve a patient's life beyond what is traditionally recognized as the surgeon's role. As with most orthopaedic injuries, the successful treatment of a humeral shaft fracture demands a knowledge of anatomy, surgical indications, techniques and implants, patient functions and expectations. The locked compression plate (LCP), which has features of compression and point bone-plate contact (minimum contact) is used for fixation of humeral shaft fractures. Many authors have proved the superiority of locking plates over dynamic compression plates in various cadaveric long-bone models. Some biomechanical studies have suggested that locking-plate constructs are stiff and suppress interfragmentary motion to a level that may be insufficient to reliably promote secondary fracture-healing. Plate Osteosynthesis with LCP provides stable fixation, direct visualization, radial nerve protection & promotes rapid union. LCP is costly but gives more stable strut & angle stable fixation so it is more useful because of large amount of stress on humerus bone due to versatility of shoulder joint and technically a mature option in complex fracture, revision operations and osteoporotic bones. The number of studies on the use of LCP in humerus fractures are very less.[1-5]

Current research in this area focuses on defining the incidence and health care resources required to treat this injury, refining the indications for surgical intervention, decreasing the surgical failure rate through new implants and techniques and minimizing the duration and magnitude of disability post injury. The successful treatment of a humeral shaft fracture may not end with bony union. In the current emphasis on a holistic approach to patient care the treating Orthopedic surgeon may be in an ideal position to intervene and improve a patient's life beyond what is traditionally recognized as the surgeon's role. most orthopedic injuries, the successful treatment of a humeral shaft fracture demands a knowledge of anatomy, surgical indications, techniques and implants, patient functions and expectations.[6]

With this background, this study is to determine the efficacy of Locking compression plate in the treatment of humeral shaft fractures.

Hence, To study the functional outcome of treating humeral shaft fractures with Locking Compression Plate.To study the duration of union with Locking Compression Plating.

To study the complications of humeral shaft fractures and complications of treatment with Locking Compression Plate.

MATERIALS & METHODS

Patients who have a fracture of the shaft of humerus and are admitted to District Hospital, Eluru, AP will be taken for this study after obtaining their consent. Total of 40 patient who had humerus diaphyseal fracture was treated with ORIF with LCP. This is a prospective study from December 2019 to June 2021.

Inclusion criteria:

Male and female patients aged >18years with fracture shaft of humerus who have given their consent for the procedure.

Exclusion criteria:

- Patients age <18years
- Patients not willing for surgery.
- Patients medically unfit for surgery.

On admission demographic data was recorded and thorough history and clinical examination was done. We assessed the neurovascular status and radiological assessment of the fractured limb.

Further investigations were done depending on the general condition of the patient and the routine pre-operative protocol as per our hospital guidelines. Preoperatively the exact modality of surgery and fixation was decided. The number of screws that will be used on either side of the fracture, locking (or) conventional, the use of combihole, distance of the screw placement from the fracture site were all planned prior to the surgery. Thedistance between the plate and the bone also determine the formation of callus and the integrity of periosteal blood supply. The distance between the fracture fragments, the communition of the fracture and the soft tissue involvement also decided the exact modality of the treatment.

The physical examination of the patient on admission to the institution includes complete general and local examination as per detailed proforma specially prepared for the study. Any open wound, deformity and neurovascular deficit were all recorded.

Investigation:

Apart from X-ray and complete hemogram, urine analysis, chest X-ray, electro cardiogram, blood grouping and cross matching was done. Radiological evaluation, was also the technique that was to be deployed on the patient. The operation theatre had appropriate facilities like pneumatic tourniquet, c-arm intensifier and power drill.

We followed standard methods and suitable surgical approaches as per the standard guidelines described for humerus which were treated with open reduction and internal fixation.

Technique of inserting the locking screws:

The primary difference with the locking compression plate is the method of locking head screw insertion. Here since the locking head of the screw has to get locked in the locking part of the combi-hole, the direction of the drilling has to be perfect. Hence drilling for all locking head screws has to be after fixing the screw-in drill sleeve (available with the locking compression plate set).

Also the tactile surgeon has when inserting the regular cortical screw is lost while inserting the locking head screw, as this gets locked regardless of the quality of bone and the depth of insertion. Hence we actually determined the length of the screw so as not to miss thefar cortex. We also made sure that whenever using the non locking regular cortical screws in the fixation, they were inserted prior to the insertion of the locking screws.

Surgical Approach to Humerus

The humerus is one of the most common upper limb bones to be fractured. Ever since surgical fixation of bones evolved, there has been a number of approacheswhich were popular in particular period of time.

Though many standard approaches to humerus are available like.

- Anterolateral approach.
- Posterior approach
- Modified lateral approach.

In our study of 20 patients with diaphyseal humerus fracture we followed antero lateral (Thompson Henry) for exposing the shaft of humerus for 10 cases and posterior for 10 cases.

Posterior approach

Position: A lateral position on the operating table with the affected side uppermost or a prone position with the arm abducted. Make a longitudinal incision in the midline of the posterior aspect of the arm, from 8 cms below the acromion to the olecranon fossa.

Incise the deep fascia of the arm in line with the skin incision. Identify the gap between the long heads of triceps muscle.

Proximally develop the interval between the two heads by blunt dissection, retracting the lateral head laterally and the long head medially. Distally split their common and the accompanying profunds brachii artery.

Incise the medial head of the triceps in the midline. Strip the muscle off the bone subperiosteally. The radial nerve which runs just proximal to the origin of the muscle in the spiral groove, must be identified and preserved. The muscle must be stripped from the bone below the level of the periosteum to avoid damaging the ulnar nerve, which pierces the medial intermuscular septum. Preserve as much soft tissue attachments to the bone as possible.

The advantage of this approach is that it is a classical extensile, providing excellent access to the lower 3/4th of the posterior aspect of the humerus, allows more direct exposure of the radial nerve, allows application of a broad plate to flat surface of distal humerus for distal third fractures.

Post-operative:
In the immediate post operative period, care was given to the general condition and fluid balance. Adequate antibiotics were given as per the hospital protocol for orthopaedic surgeries. Oral analgesia was started from 2nd day till adequate pain relief was obtained. This also helped us to mobilize the patients faster.

Mobilization:
Post operatively shoulder range of motion and elbow movements is begun within the 3 or 4post operative day.

Follow UP:
The first follow up was done at4 weeks, 8 weeks,12 weeks, 6months and 1 year respectively.

During the Follow up:

- The course of fracture healing was documented radiologically (with minimum of 6 weeks between successive radiographs). The moment of complete healing was defined as radiologically complete bone regeneration at the fracture site.
- Evaluation of any possible loss of reduction that might have occurred, compared to immediate post of radiographs.
- Assessment and analysis of any complications observed.
- Addressing patients problems, if any.

Follow up of our patients ranged from 6 months to 18 months. No patient was lost to follow up.

RESULTS

The present study consists of 40 cases of humerus shaft fracture in adults treated surgically by open reduction and internal fixation using LCP between December 2019 to June 2021. All patients were available for follow up(6 to 18 months).

Age Distribution
Age of these patients ranged from 18 to 60 years with 26 (65%) patients between 3rd and 4th decade. The average age was 40 years.

Table 1:Age distribution

Age	Male	Female	Total
18-20	2	0	2
21-30	4	2	6
31-40	8	6	14
41-50	8	4	12
>51	2	4	6
Total	24	16	40

Sex Distribution
Majority of the patients, 24(60%) were male and 16(40%) were females

Table 2: Sex distribution

Sex	No of patients	Percentage
Male	24	60%
Female	16	40%
Total	40	100%

Mode of Injury

We found that road traffic accident was the most common cause of injury being responsible for 75% of cases followed by domestic accidents (10%), fall from height (10%) and assault (5%).

Table 3: Mode of injury

Mode of Injury	No. of Cases	Percentage(%)
RoadTrafficAccidents	30	75%
DomesticAccidents	4	10%
FallfromHeight	4	10%
Assault	2	5%
Total	40	100%

Associated Injuries

24 out of 40 (60%) cases suffered from other injuries besides fracture of shaft of humerus.

Table 4: Associated injuries

Type of injury	No. of cases	Percentage (%)
Headinjury	4	16.67
Chestinjury	8	33.33
Forearmfractures	2	08.33
HandInjuries	4	16.67
RadialnerveInjury	4	16.67
BothBonefractureleg	2	08.33
Total	24	100.00

Side Affected

There was an appreciable difference in the involvement of the sides in our series. Right extremity was more often involved 60%. Left extremity was involved in only 40% of cases.

Table 5: Side of injury

Side affected	No of patients	Percentage
Right	24	60%
Left	16	40%

Fracture characteristics:

1. Clinical - 14 fractures were closed and 6 were open fractures.
2. Level of fracture

Most of the fractures were located in the middle third of the shaft (50%).

Table 6: Distribution according to the level of fracture

Level of fracture	No. of cases	Percentage (%)
Proximalthird	8	20
Middlethird	20	50
Distalthird	12	30
Total	40	100.00

Type of fracture:

Majority of fractures (45%) were transverse type. In (10%) fractures were oblique type, in (40%) comminuted type, in (5%) spiral type

Table 7: Type of fractures (Hans dencker classification, 1955)

Type of fracture	No. of fractures	Percentage (%)
Transverse	18	45
Oblique	4	10
Spiral	2	5
Comminuted	16	40
Segmental	0	0
Total	40	100.00

Statistics of surgery:

24 cases were operated under general anaesthesia, 16 cases under brachial block. The anterolateral approach of Thompson and Henry was used in 20 cases and posterior approach was used in 20 cases. Tourniquet was not used in any of our cases, as it comes in the way of surgery.

The follow up ranged from 6 months to 18 months.

Duration of fracture union:

The fracture was considered to be united when clinically there was no pain and no subjective complaints, radiologically fracture line was not visible and full unprotected function of the limb was possible.

Table 8: Time of union

Duration (in weeks)	No. of cases	Percentage (%)
10-12 weeks	18	45%
13-15 weeks	18	45%
16-18 weeks	02	5%
>18weeks	02	5%
Total	40	100%

38(95%) patients had sound union in less than 18 weeks, 2(5%) patient had non-union and 2(5%) had superficial infection.
Nonunion was due to inadequate reduction of fracture fragments and early weight bearing by the patient.

Range of mobility of the shoulder and elbow joints:
38(95%) patients recovered full range of motion of shoulder and elbow joint while 2 (5%) patient recovered good range of motion (within 10-15% of full range).

ASES Score
The American Shoulder and Elbow Surgeons (ASES) shoulder score is for 13 activities of daily living requiring full shoulder and elbow movement. The maximum possible score is 52 points. The average ASES score obtained was 50. Total period of hospitalization:
The number of days in the hospital ranged between 15 days and 45days.

Complications
Intra operative: There were no intraoperative complications. Post-operative:

- 1. Radial nerve injury: There were 4(10%) cases of radial nervepalsy following surgery; it may be due to excessive retraction of soft tissues with the nerve. They recovered in 3-4 months.
- Out of two preoperative radial nerve injury cases, both of them recovered following surgery after releasing radial nerve from the fracture ends.
- Superficial infection: there was 2 case of superficial infection after fracture union and plate was removed after achieving fracture union
- Nonunion: There was 2 case of nonunion. Nonunion was due to inadequate reduction of fracture fragments and early weight bearing by the patient.

Rommens et al series grading excellent:
Solid union - anatomic reconstitution, Less than 10% loss of range of motion, no significant subjective complaints.

GOOD
Solid union - anatomic reconstitution, 10-30% loss of range of motion, Minimal subjective complaints.

POOR:

Non anatomic results or nonunion, greater than 30-degree loss of range of motion, Moderate subjective complaints.

36(90%) patients had excellent results, 2(5%) patients had good results, 2 (5%) patient had poor result

Table 9: Functional Assessment

Results	No of cases	Percentage (%)
Excellent	36	90
Good	02	5
Poor	02	5
Total	40	100

DISCUSSION

Concepts in the management of trauma in Orthopaedics are very rapidly changing to keep pace with the increasing severity and complexities of the fractures. The management of humeral shaft fractures is always a challenging problem to orthopaedic surgeon, as they are very frequently associated with multiple injuries, leading to complications like shortening, malunion, infection, delayed union and non union.

The aim of treatment in these fractures is to achieve length and alignment and produce favorable environment for bone and soft tissue healing. The classical method of treatment of humeral shaft fractures has been the use of U-plaster cast. Although satisfactory results can be obtained with this method but residual angulation, malrotation and limb length inequality is well documented.

Operative treatment may be considered to avoid complications such as malunion, delayed union, rotational deformity, shoulder and elbow stiffness, limb length discrepancy, psychological problems and long hospital stay.

This study was done to determine the efficacy of LCP in the treatment of fractures of the shaft of humerus. 40 cases of humerus were treated with open reduction and internal fixation using LCP.

At present, open reduction and compression plating remain the treatment of choice for humeral shaft fractures that require operative intervention. Locking the screws to the plate allows the plate to sit at a distance offset from the underlying bone surface providing a biologic advantage for bone fracture healing by preserving the periosteal blood supply underlying the plate.[8] Mechanically this provides stability without the need for the plate to match the curvature of the bone surface and without the need to compress and maintain friction between the plate and bone surface.[8] Nowadays, all of the locking plates modeled were offset 1 mm from the cortex avoiding undue stress shielding and contact below the plate. This advantage with locked plates has been suggested to prevent local bone necrosis.[16] It is, therefore, advocated that compression plating offers the best treatment for humeral shaft fractures that require surgical intervention.[4,17] However, the risks of any musculoskeletal procedure cannot be overlooked and in the case of compression plating include extensive dissection, iatrogenic radial nerve injury, an increased risk of infection, and non-union.[17]

Surgical stabilization is considered to be better treatment for bilateral fractures of the humerus and ipsilateral fractures of the humerus and forearm, as well as in cases of polytrauma, progressive neurological deficit, vascular injury, and failed conservative treatment.[18] The most frequent indication for operative treatment is the presence of associated multiple injuries.[19] In a comparative study of dynamic compression plating versus locked intramedullary nailing for humeral shaft fractures shows significant association with a higher risk of infection and post-operative nerve palsy in those fixed by plating, but there is no difference with respect to non-union and revision rate.[20]

The posterior approach allows for direct observation of the fracture and posterior and lateral plate placement but requires the nerve to be dissected out because it is in the middle of the operative field. In contrast, the anterolateral approach avoids direct observation of the nerve and allows for anterior and lateral plate placement.[21]

Fractures of the middle and middle-distal parts of the shaft had a significantly higher association with radial nerve palsy than those in other parts. Transverse and spiral fractures were more likely to be associated with radial nerve palsy than oblique and comminuted patterns of fracture.[22] The surgical approach and plate fixation technique are of immense importance to avoid radial nerve injuries and achieve a high degree of absolute stability.[23]

Pal et al. described modified functional cast brace as one of the options in treatment for humeral shaft fractures as it can be applied on the 1st day of the presentation in most of the situations also mentioned about the usefulness of simple objective scoring system, particularly in uneducated patients.[24]

One of the disadvantages of conservative treatment being a constant contraction of the surrounding muscles and the pull of gravity which tends to distract the fracture fragments. Other disadvantages of conservative treatment include joint stiffness, edema, muscle atrophy, and osteoporosis. Inadequate immobilization may lead to delayed union and non-union, whereas prolonged immobilization may lead to stiffness of elbow and shoulder joint. Therefore, transverse fractures should be treated with a compression plate, as it aids achieving bone-to-bone contact, and dynamic compression screws can pull opposite fracture fragments together when tightened.[25]

The attractive theoretical advantages of locking humeral nails have not been borne out in clinical studies by Bhandari et al., but complications such as shoulder pain, delayed union or non-union, fracture about the implant, iatrogenic fracture comminution, and the difficulty in the reconstruction of failures have diminished their usefulness. The precise role of locking nails in the treatment of humeral shaft fractures has yet to be defined. Furthermore, when surgical treatment is contemplated, it is still generally believed that intramedullary nailing may not be the best choice.[26] The suitability of antegrade interlocking humeral nailing by flexible nailing technique has been described by some authors due to their non-requirement of extensive soft tissue dissection, bone grafting, and external immobilization in case of comminuted and segmental fracture patterns.[27]

Demirel et al. in their studies shown additional advantage of retrograde locked nailing by sparing the rotator cuff and subacromial bursa, thus preserving the shoulder functions.[28]

Although nailing and plating are effective treatments for fractures of shaft of humerus, antegrade nailing may not be suitable in elderly patients, as it can cause significant shoulder

dysfunction.[29,30] The patients operated with interlock nailing underwent more number of secondary bone grafting procedures.[30]

Various methods of the treatment of humeral shaft have been described, some author mentioned about minimally invasive plate osteosynthesis (MIPO) giving a good and reproducible results with few risks, but MIPO is a complex technique, requiring a relatively long learning curve. The plate placement and indirect reduction require experience.[31] Ilizarov method is another treatment option, the main disadvantages of Ilizarov fixation include the presence of a bulky implant on the arm, pin-tract infection, painful impingement of the frame on the chest wall, and the possibility of neurovascular injury due to the wires.[32,33]

In this present study, We evaluated our results and compared them with those obtained by various other studies utilizing different modalities of treatment. Our analysis is as follows.

Age Incidence: In our series, out of twenty humeral fractures, most of the fractures were in age group of 30-50 years (65%). This is due to the fact that persons of this age group are more exposed to road traffic accidents and other trauma, which are the commonest cause of humeral shaft fractures.

Sex Incidence: In our series, there were 12 males (60%) and 8 females (40%). The sex incidences in other series are as follows:

Mode of Injury: The commonest mode of injury was road traffic accidents (75%) in our series, out of which 60% were vehicle occupants and 15% were pedestrians. The incidences of mode of injury in other series are as follows:

Side affected: In our series, right humerus was involved in 60% cases, while left was involved in 40% cases.

Type of fracture: Most of the fractures in our series were transverse, 9(45%) patient

Site of fracture: In our series, 50% cases fractures were located in middle third of shaft, in 20% cases the fractures were at the junction of upper and middle third, and in 30% cases fractures were located at junction of middle and lower third of humeral shaft.

Different authors used different criteria to label union. Healing or union has
been variously defined as the presence of bridging callus on x-ray (Aim 1952, Hamza 1956), the absence of pain on deformation at fracture site (Vicoldo et al 1962), the ability of the patient to bear full weight without external support (Groven et al 1972) or a combination of these.

Fracture union:

19 (95%) fractures out of our 20 cases united with 1(5%) case of nonunion.

Out of 20 patients in our series, all patients had good range of movements at shoulder and elbow.

Our results in mobility at shoulder and elbow joints are comparable with those of Bell MJ et al, McCormack RG et al.

ASES Score:

The average ASES score obtained was 50 in our series. This is comparable to the ASES score of 48 obtained by McCormack RG et al when treating humeral shaft fractures with DCP and a score of 47 when treating with interlocking intramedullary nail fixation.

Overall results:

We had 18(90%) patients with excellent, 1(5%) patient with good result, 1(5%) patient had poor result.

The results obtained by various authors using various modalities of treatment have varied from 75% good or excellent results to 100% good or excellent results. Our study had an 90% excellent result.

Strict adherence to the AO principles during fixation, meticulous attention to maintenance of sepsis during surgery, patient education and well planned rehabilitation programme are required to obtain better results.

If these principles are adhered to LCP fixation of humerus shaft will result in fewer complications and greater patient satisfaction.

CONCLUSION

Fracture shaft of humerus in adults is fairly common with an overall incidence of about 3 % in all fractures. The mode of injury is usually a direct trauma following road traffic accident. As the fracture might accompany complications like radial nerve palsy, a detailed neurovascular examination is a must at presentation. Majority of the fractures were transverse and comminuted in the middle third and most of them were closed injuries. Early postoperative mobilization following rigid fixation of the fracture of humerus, with LCP lowers the incidence of stiffness and sudecks dystrophy. Conservative management has provided good union rates but has been plagued with the complications of stiffness and sudecks dystrophy. Prolonged immobilization goes against the AO principle of obtaining early, active, pain free mobilization. Internal fixation of the humerus with LCP avoids these complications and achieves higher union rates as compared to conservative management. LCP of humerus produces comparable better results than antegrade interlocking intramedullary nailing. Proper preoperative planning, minimal soft tissue dissection, adherence to AO principles, strict asepsis, proper post operative rehabilitation and patient education are more important to obtain excellent results.

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