Section: Orthopaedics

JAMP

Original Research Article

TO EVALUATE THE CLINICAL, RADIOLOGICAL AND FUNCTIONAL OUTCOME OF AN OPERATIVE TECHNIQUE OF MINIMAL INVASIVE PLATE OSTEOSYNTHESIS (MIPO) FOR HUMERAL SHAFT FRACTURES

Siddhant R. Shah[1], Dhrumil S. Dave[2], Suril A. Shah[3], Miteshkumar J. Patel[4]

[1,2]Assistant Professor, Department of Orthopaedics, Smt. NHL Municipal Medical College, Ahmedabad, Gujarat, India.
[3]Associate Professor, Department of Orthopaedics, GMERS Medical College, Gandhinagar, Gujarat, India.
[4]Fellow, Hip & Pelvi-Acetabular Reconstruction Surgery & Arthroplasty, Max Super Specialty Hospital, Mohali, Punjab, India.

Received : 21/04/2023
Received in revised form : 10/05/2023
Accepted : 01/06/2023

Keywords:
Operative Technique, Minimal Invasive Plate Osteosynthesis, Humeral Shaft Fractures.

Corresponding Author:
Dr. Miteshkumar J. Patel
Email: miteshvagadoda63@gmail.com

DOI: 10.47009/jamp.2023.5.4.13

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2023; 5(4); 58-62

CC BY NC

Abstract

Background: Minimally invasive approaches should be considered to plate a multifragmentary humeral shaft fracture and are usually performed with a pair of incisions, one distal and one proximal. The present study was conducted to evaluate the radiological and functional outcome of an operative technique of minimal invasive plate osteosynthesis (MIPO) for humeral shaft fractures. **Materials & Methods:** The present prospective study was conducted among patients attending Department of Orthopaedics in GCS Medical College, Hospital & Research Centre. All patients were assessed postoperatively clinically, radiologically at 3 months, 6 months and 2 months followup and score calculated at each visit. **Results:** Among the 20 cases, 10 cases had no angulation & 6 cases did have Minimum angulation of less than 10° of varus or valgus angulation were accepted which remodeled to correct alignment overdue course of time. 1 case had varus angulation (>10 degree) which showed no significant functional impairment and no cases had valgus angulation. 3 cases had reported posterior angulation because of excessive plate contouring. None of the patients had any amount of rotational malalignment or shortening. In 90% patients, <12 weeks were taken for union and in 10% patients, >12 weeks were taken for union. With respect to shoulder Range of Motion, Among the 20 patients; 14 patients (70%) had excellent results, 4 patients (20%) had good result, 2 patients (10%) had fair result and no poor result. With respect to Elbow Range of Motion, Among the 20 patients; 17 patients (85%) had excellent results, 3 patients (15%) had good result, no fair result and no poor result. Clinical Excellent shoulder function found in 18 patients and good score found in 2 patients. Clinical Excellent elbow function found in 19 patients and good score found in 1 patient. 30% patients were followed up for 1-6 months whereas 70% patients were followed up for 7-12 months. **Conclusion:** Minimal invasive plate osteosynthesis offers excellent functional outcome for shaft of humerus with better union rate and decreased risk of nonunion compared to ORIF.

INTRODUCTION

Humeral shaft fractures make up approximately 1% of all fractures. Typically, they are the result of direct trauma but also occur in sports where rotational forces are greater, for example, baseball or arm wrestling. Fractures of the middle or distal third of the shaft put the radial nerve at risk. In a small percentage of cases humeral shaft fractures are associated with a vascular injury.[1] Nonoperative treatment of diaphyseal humeral fractures can be accomplished with various techniques such as velpeau bandage, a sling and body bandage, abduction cast or splint, coaptation splint or u-slab, hanging arm cast, and functional bracing. Functional bracing, as described by sarmiento et al is widely used by orthopedic practitioners for the management of acute diaphyseal humeral fractures. Sarmiento et al. have also presented the largest series of 620 patients treated with functional bracing with adequate follow-up.[2] Plating enables the surgeon to reduce and hold the critical articular or periarticular fragments. Although plating can be technically demanding, the results are predictable. Associated shoulder or elbow stiffness is infrequent, unless there is periarticular or intraarticular extension of the fracture planes. Plating is also best for holding corrected malunion cases following osteotomy and remains the treatment of choice for nonunion of the humerus.[3] Another option for managing humeral fractures is intramedullary nailing. Recent designs include nails with smaller diameters, which are more flexible, have multiple locking options, and can compress the fracture. Humeral nails can be inserted either antegrade or retrograde in a reamed or unreamed manner.[4] Minimally invasive approaches should be considered to plate a multifragmentary humeral shaft fracture and are usually performed with a pair of incisions, one distal and one proximal. Minimally invasive plate osteosynthesis techniques are challenging and have the benefit of reducing soft tissue damage but are not without their risks.[5]

The present study was conducted to evaluate the radiological and functional outcome of an operative technique of minimal invasive plate osteosynthesis (MIPO) for humeral shaft fractures.

MATERIALS AND METHODS

The present prospective study was conducted among patients attending Department of Orthopaedics in GCS Medical College, Hospital & Research Centre from July 2020 to January 2021 who was diagnosed with shaft of humerus fracture and willing for surgery. Patients who fail to maintain adequate close reduction and intolerance to cast, close fractures, open grade 1 & 2 fractures, segmental or comminuted fractures, with or without radial nerve palsy were included in the study. Patients who had Juxta/Intra articular fracture of humerus, open grade 3, vascular injury, pathological fracture were excluded from the study. Timing Of Surgery was 1 to 5 days from the time of injury.

Pre-Operative Assessment:

1. X-ray of the affected arm including one joint above and one joint below; including the ipsilateral shoulder and elbow joints
2. Minimum two views are necessary: Antero-posterior and Lateral Views.
3. Anteroposterior and lateral radiographs were used to template the exact length of implant
4. The Fracture pattern was classified according to Orthopaedic Trauma Association classification

Procedure:

Surgical approach[5]

With the arm and forearm fully supinated and supported on a surgical table, two small windows must be made on the anterior surface of the arm. The most proximal window is made between the pectoralis major and the medial border of the deltoid.

Incision

Proximal: A 3 cm longitudinal incision is made proximally starting approximately 6 cm distal to the anterior part of the acromion process. The dissection is carried down to the humerus using the intermuscular interval described above.

Distal: A 3 cm longitudinal incision is made on the anterior aspect of the arm in the midline 3 cm proximal to the flexion crease of the elbow.

Exposure: The interval between the biceps brachii and the brachialis is identified. The biceps is retracted medially with the lateral cutaneous branch of musculocutaneous nerve which lies on the anterior surface of the brachialis. The brachialis is then split longitudinally along its midline to reach the periosteum of the anterior cortex of the distal humerus. The lateral cutaneous branch of the musculocutaneous nerve is retracted together with the medial half of the split brachialis muscle using Army Navy retractors. The lateral half of the brachialis muscle serves as a cushion to protect the radial nerve, which, at this point, has pierced the lateral intermuscular septum and is lying between the brachioradialis and brachialis muscles.

Preparation and Introduction of the Plate: The critical steps to take before introducing the plate are to prepare adequate space for the tunnel through the tight musculotendinous section between the brachialis and the deltoid muscles, and ensure that the tunnel is in the correct plane and direction. Before insertion of the plate the fracture must be initially reduced to achieve correct alignment and rotation. Once the plate is placed in the tight tunnel and a screw is inserted in one fragment, rotation cannot be altered. The plate can be introduced directly from the proximal window to the distal window manually, keeping the elbow at 90° with the forearm supinated to protect the radial nerve. Some difficulty may be encountered during passage of the plate under the brachialis in the middle portion of the arm. It is important to slide in the plate with contact on the bone until it reaches the distal window. During this procedure the elbow must be kept in traction and aligned by an assistant. The LCP can be introduced using two drill sleeves attached to one end to act like a handle. Another technique to introduce the plate uses a tunneling instrument introduced deep to the brachialis from the distal to the proximal incision. Some difficulty may be encountered at the proximal part of the tunnel during passage of the tunneling instrument due to the intricate blending of the fibers of the brachialis and deltoid muscles along the lateral aspect of the tunnel at this point. To avoid injury to the radial nerve at the lateral aspect of the distal humerus, the tunneling instrument should be passed along the anterior, or slightly anteromedial aspect of the humerus. The selected narrow LCP is then tied with a suture to a hole at the tip of the tunneling instrument and pulled back with it along the track that was created.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Reduction and Fixation[5]: When using the LCP, an LCP drill sleeve attached to each end of the plate is helpful to manipulate the plate into the correct position. These drill sleeves are used as a guide for correctly placing the plate on the anterior surface of the humerus by putting the sleeve perpendicular to the bicondylar plane of the elbow.

After positioning the plate over the center of the anterior surface of the distal humerus, it is fixed with one cortex screw distally which is not completely tightened. Reduction of the fracture is usually achieved by traction to restore length, abduction, and correct varus. The intercondylar axis is kept perpendicular to the long head of the biceps to correct rotational deformities. The assistant maintains this position and alignment is checked with image intensification. In the proximal window the plate is maintained in place using the drill guide and the drill hole is made. The screw is inserted proximally and both screws are tightened. The alignment is verified with image intensification. If it is correct one or two more screws are inserted into each fragment. It is preferable to fix the screws in a divergent direction to catch more of the cortex. The divergent screw direction also requires smaller incisions. When using an LCP, it is advisable to first put one conventional unicortical screw in each fragment to reduce the fracture in the sagittal plane before fixing it with two more locking screws.

Post operative protocol: All patients are immobilized with arm sling.

- At the end of 48 hrs – pendular exercise and elbow ROM started.
- When Pain reduces – Active assisted Shoulder & elbow ROM exercises were started.
- Wound inspection was done on 3rd, 6th & 9th POD
- Suture removal was done on 11thPost operative day.

Union was assessed by absence of pain & tenderness at fracture site and presence.

- of bridging callus in 3 out of 4 cortices
- Patients were followed up Clinically and Radiologically at 6wks, 3 months, and 6 months & yearly intervals until the fracture heal completely.

At the time of admission fractures were classified according to the Orthopaedic Trauma Association classification. Nature of the injury was also noted.

In the post operative radiographs humerus malalignment was measured. The degree of the angulation (varus or valgus), (Antero-posterior), (rotational) and shortening were evaluated radiologically and clinically.

Postoperative Scoring System:

1. Clinical Assessment:

Constant Murley Score for Shoulder

All patients were assessed postoperatively at 3 months, 6 months and 2 months followup and score calculated at each visit. The score is calculated for 100 points with the following 4 parameters,

Pain: 15 Points

Activity of Daily Living: 20

Strength: 25

Range Of Motion: 40

Mayo Elbow Performance Score for Elbow

All patients were assessed postoperatively at 3 months, 6 months and 2 months followup and score calculated at each visit. The score is calculated for 100 points with the following 4 parameters.

Pain: 45 Points

Activity of Daily Living: 25

Stability: 10

Range Of Motion: 20

2. Radiological Assessment:

- Degree of angulation at the fracture site
- Evidence of union at the Fracture site

RESULTS

Out of the 20 cases, 6 cases had angulation 0-10 degrees. 1 case had reported varus angulation >10 degree, but without functional impairment. No cases reported valgus angulation. 3 case reported posterior angulation. 10 cases have no radiographic malalignment.

With respect to shoulder Range of Motion, Among the 20 patients; 14 patients (70%) had excellent results, 4 patients (20%) had good result, 2 patients (10%) had fair result and no poor result.

Among the 20 patients; 17 patients (85%) had excellent results,3 patients (15%) had good result, no fair result and no poor result.

Clinical Excellent shoulder function found in 18 patients and good score found in 2 patients.

Clinical Excellent elbow function found in 19 patients and good score found in 1 patients.

In 90% patients, <12 weeks were taken for union and in 10% patients, >12 weeks were taken for union. 30% patients were followed up for 1-6 months whereas 70% patients were followed up for 7-12 months.

Table 1: Radiological Valgus/Varus Angulation

Malalignment	Frequency	Percentage (%)
None	10	50
0-10 Degree Varus	6	30
>10 Degree Varus	1	5
Valgus	0	0
Antero-Posterior Angulation	3	15
Total	20	100

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Table 2: Shoulder Range of Motion

Range of Motion	Frequency	Percentage (%)
Excellent (100%)	14	70
Good (75 – 100%)	4	20
Fair (50 – 75%)	2	10
Poor (<50%)	0	00
Total	20	100

Table 3: Elbow Range of Motion

Range of Motion	Frequency	Percentage (%)
Excellent (100%)	17	85
Good (75 – 100%)	3	15
Fair (50 – 75%)	0	00
Poor (<50%)	0	00
Total	20	100

Table 4: Shoulder and Elbow Function Evaluation (Clinical)

Function Evaluation	Shoulder Function (Constant Score)	Elbow Function (MEPS Score)
Excellent	18	19
Good	2	1
Fair	0	0
Poor	0	0

Table 5: Pattern of Time of Union

Weeks	Frequency	Percentage (%)
<12	18	90
>12	2	10
Total	20	100

Table 6: Duration of Follow Up

Time In Months	Frequency	Percentage (%)
1-6 Months	6	30
7-12 Months	14	70
Total	20	100

DISCUSSION

Minimally invasive surgical treatment of skeletal injuries aims to preserve the biology of soft tissue and bone. The rationale for performing mechanical stabilization through fracture fixation is the obvious need to restore anatomy and mechanical function of the bone. Optimal bone healing requires a balance between mechanics and biology and is aided by modern osteosynthesis. In ORIF, The problem was that, all too often, precise reduction and absolute Rigid fixation were achieved at the expense of extensive soft-tissue trauma caused by the surgery.[6]

Minimally invasive surgery is not determined by the length of the incisions but more by the reduction technique and soft-tissue handling, a definition of MIO includes the following recommendations:[7]

- Small soft-tissue windows are used to allow the insertion of implants and instruments remote from the fracture site.
- Minimal additional trauma to the soft tissue and fractured fragments results from performing mainly indirect reduction. Direct reduction only when it is necessary to achieve fracture alignment.

The average union time for fractures in our study was 11.9 weeks (range: 8–20 weeks) and union rate was 93.7 %. One case shows delayed union by 20 weeks. The fracture was fixed in distraction at fracture site due to excessive traction after initial proximal screw placement. The results were good compared to Concha et al study where Union rate was 91.5% (32/35) at an average of 12 weeks. All the cases showed union without primary or secondary bone grafting.[8]

ORIF for comminuted fractures draws the need for lag screw fixation or bone grafting which prolongs the surgery time, blood loss and postoperative morbidity. Nevertheless, the risk of nonunion rate is higher than MIPO due to extensive soft tissue stripping according to literature around 5.8 %. MIPO gains advantage over ORIF in these issues.

Esmailiejah, et al. found better results with MIPO when compared to open reduction and plating as regard to the time of surgery and iatrogenic radial nerve injury (3% versus 12%) and the rate of infection (0% versus 6%), patients managed with the MIPO technique had also shorter time for union and earlier return to their previous level of activities.[9]

Out of the 15 cases, 4 cases had more than 10 degree angulation which does not show any functional impairment. So near normal biological reduction in

ISSN (O): 2687-5365; ISSN (P): 2753-6556

MIPO does not compromise on functional outcome of the patient.

The mean surgical time with MIPO was 69 minutes (range: 60 – 90 minutes) which was less compared to M Shantharam Shetty et al study which was 91.5.[10]

Shoulder function was assessed by CONTSANT MURLEY SCORE which was 87 on affected side and 90.67 on healthy side and better compared to Apivatthakakul et al study which reported 85.8 on affected side and 90.6 on the healthy side.[47] The mean MEPS score for elbow is 97.66 which was comparable to other studies.

CONCLUSION

Minimal invasive plate osteosynthesis offers excellent functional outcome for shaft of humerus with better union rate and decreased risk of nonunion compared to ORIF.

Limitations of the Study

1. Sample size is small compared with other similar studies.
2. Not a comparative study

Suggestions:

1. A larger sample size will improve the quality of the study.
2. Comparison with intramedullary nailing and ORIF needs to be studied for comminuted fractures.

REFERENCES

1. Bounds EJ, Kok SJ. Humeral shaft fractures. In: Stat Pearls. Treasure Island, FL: Stat Pearls Publishing; 2019.
2. Sarmiento A, Zagorski JB, Zych GA, Latta LL, Capps CA. Functional bracing for the treatment of fractures of the humeral diaphysis.JBoneJoint Surg Am.2000;82(4):478-86.
3. Filh GM, Galvão MV. post-traumatic stiffness of the elbow. Rev Bras Ortop 2010;45:347-54.
4. Garnavos C. Diaphyseal humeral fractures and intramedullary nailing: Can we improve outcomes? Indian J Orthop 2011;45:208-15.
5. Apivatthakakul T, Arpornchayanon O, Bavornratanavech S. Minimally invasive plate osteosynthesis (MIPO) of the humeral shaft fracture. Is it possible? A cadaveric study and preliminary report. Injury 2005;36:530-8.
6. Basic mechanobiology of bone healing Markus, Windolf, Stephan M Perren,10.1055/b-0034-87595
7. Babst, Reto et al. "History and evolution of minimally invasive plate osteosynthesis." (2012).
8. Concha JM, Sandoval A, Streubel PN. Minimally invasive plate osteosynthesis for humeral shaft fractures: Are results reproducible? Int Orthop 2010;34:1297-305.
9. Esmailiejah AA, Abbasian MR, Safdari F, Ashoori K. Treatment of humeral shaft fractures: Minimally invasive plate osteosynthesis versus open reduction and internal fixation. Trauma Mon 2015;20:e26271.
10. Shetty, M. S., Kumar, M. A., Sujay, K., Kini, A. R., & Kanthi, K. G. (2011). Minimally invasive plate osteosynthesis for humerus diaphyseal fractures. Indian journal of orthopaedics, 45(6), 520–526.

ISSN (O): 2687-5365; ISSN (P): 2753-6556