Prospective study of clinical, radiological and functional outcome of anterior bridge plating for shaft of humerus fracture

Abhishek Kumar¹, Rahul Bade²*

¹Department of Orthopedics and Joint Replacement, Fortis Hospital, Kangra, Himachal Pradesh, India
²Department of Orthopedics, RCSM Government Medical College, Kolhapur, Maharashtra, India

Received: 03 August 2020
Accepted: 14 September 2020

*Correspondence:
Dr. Rahul Bade,
E-mail: rahulbade76@gmail.com

INTRODUCTION

Humeral shaft fractures account for 1 to 3% of all fractures in adults and for 20% of all humeral fractures.¹ ² These fractures have an annual incidence from 13 to 14.5 per 100,000 people.³ ⁴ The goals of treatment include not only solid bone healing but also restoration of limb function and full range of motion as soon as possible. While non-operative management is still the standard treatment for isolated humeral shaft fractures, this method can present unsatisfactory results, such as nonunion and shoulder impairment.⁵ ⁶ Further, 14% of patients treated with this method have restricted range of motion and 12.6% have consolidation, with more than 10° of displacement.⁷

Regarding surgical treatment, there is considerable conflict between the need for absolute anatomical reduction and the desire for soft tissue preservation. While classical intramedullary nailing is minimally invasive, it can result in rotator cuff damage, causing shoulder impingement. This can occur either due to subacromial impingement by a prominent nail or scar tissue and/or damage to the rotator cuff in its critical zone of hypovascularity, resulting in tendon tears. Indeed, precise reduction and absolute stable fixation involve a biological...
price in terms of soft tissue loss. To overcome this drawback of stable mechanical fixation, several studies have examined the alternative of biological fixation and have found the latter to be superior.11,12 This has led to advancements in the techniques of biological fixation including the development of stabilization systems.13,14 Anterior bridge plating, which utilizes the minimally invasive approach popularly known as the minimally invasive plate osteosynthesis (MIPO) technique, is the latest entrant on this list.15

The present study aimed to evaluate the radiological outcomes of anterior bridge plating through MIPO of humeral shaft fractures, in terms of time required for radiological union. We also aimed to study the clinical and functional outcomes assessed using the mayo elbow performance index (MEPI) and University of California, Los Angeles (UCLA) scoring systems as well as by clinical examination of the range of motion of the shoulder and elbow joints. Other variables of interest included the duration of surgery and radiation exposure. The study was conducted based on the hypothesis that the anterior bridge plating technique through MIPO of humeral shaft fractures was associated with favorable radiological, clinical, and functional outcomes by virtue of minimal soft tissue dissection.

METHODS

Patients

This longitudinal prospective study without a control group was conducted between October 2017 and May 2018 at our tertiary care institution after receiving approval from the institutional scientific and ethical committee (RCSMGMCK/Pharmac/Ethics Comm/23/2018). The study complied with the requirements of the declaration of Helsinki. Written informed consent was obtained from all 30 patients with humeral shaft fracture who were included in the study after applying the inclusion and exclusion criteria for anterior bridge plating through MIPO.

The inclusion criteria included skeletally mature patients with closed fractures as well as Gustillo Anderson type I open fractures of the humeral shaft. We excluded patients with pathological fractures, as well as cases with intraarticular extension of the fracture, associated fracture of the same limb radius, ulna, or clavicle, or associated neurovascular injury.

Methods

The anterior approach was used to perform MIPO surgery using skin incisions of approximately 3 cm proximally as well as distally. An extraperiosteal tunnel was prepared and the plate was slid into place following manual reduction, after which it was fixed with two or three bicortical screws proximally and distally.
Figure 4: Radiograph of the arm on postoperative day 1 (anterior-posterior view).

Statistical analysis

Categorical variables are expressed as counts and percentages, and numerical variables are expressed as mean±standard deviation (SD). Associations among study groups were assessed using the Fisher’s test, student’s t test, and chi-square test. A p value of less than 0.05 was considered significant.

RESULTS

The mean age of patients was 38.6±10.45 years. There was male preponderance at 70%.

Radiological outcomes

Fracture union was observed in the majority of the patients (18 of 30, 60%) at 9-12 weeks postoperative; union occurred in 7 (23.3%) and 3 (10%) patients at 5-8 weeks and ≤4 weeks postoperative, respectively. Only 2 (6.7%) fractures took >12 weeks to unite, due to smoking and osteoporosis (Table 1).

Table 1: Time to radiological union following anterior bridge plating through MIPO of humeral shaft fractures.

| Time to radiological union (weeks) | N  | Percent (%) |
|-----------------------------------|----|-------------|
| ≤4                                | 3  | 10.0        |
| 5-8                               | 7  | 23.3        |
| 9-12                              | 18 | 60.0        |
| >12                               | 2  | 6.7         |
| Total                             | 30 | 100.0       |

Clinical and functional outcomes

Postoperative MEPI score

The MEPI score was classified as follows: a score of >90 was graded as excellent, 75-89 as good, 60-74 as fair, and <60 as poor. At 6 months, almost all (29 of 30, 96.7%) patients had an excellent MEPI score, while only one patient had a good score (Table 2). There was no significant difference in MEPI scores over time (p>0.05).

Table 2: Postoperative MEPI score at discharge and at each follow-up.

| MEPI score    | On discharge | 1 month | 3 months | 6 months | p value |
|---------------|--------------|---------|----------|----------|---------|
|               | N    | Percent (%) | N   | Percent (%) | N   | Percent (%) | N   | Percent (%) |       |
| Excellent (>90) | 24   | 80.0       | 25  | 83.3       | 27  | 90.0       | 29  | 96.7       | >0.05 |
| Good (75–89)   | 2    | 6.7        | 3   | 10.0       | 2   | 6.7        | 1   | 3.3        |       |
| Fair (60–74)   | 4    | 13.3       | 2   | 6.7        | 1   | 3.3        | 0   | 0          |       |
| Poor (<60)     | 0    | 0          | 0   | 0          | 0   | 0          | 0   | 0          |       |
| Total          | 30   | 100.0      | 30  | 100.0      | 30  | 100.0      | 30  | 100.0      |       |

Postoperative UCLA score

The UCLA score was classified as follows: >27 points was graded as excellent to good and <27 as fair to poor. At discharge, 26 (86.7%) patients had an excellent to good score while the remaining 4 (13.3%) patients had a fair score. The UCLA score at 6 months was excellent or good in almost all (29 of 30, 96.7%) patients while only one patient had a fair score (Figure 5). There was no significant difference in UCLA scores over time (p>0.05).

Range of motion

The difference in range of motion between operated and non-operated sides was statistically significant (p<0.05). However, there was no clinical difference in subjective postoperative range of motion.

Figure 5: Postoperative UCLA scores at discharge and at each follow-up.
Figure 6: (a) sutured wound, (b), (d) and (f): postoperative range of shoulder movement at 3 month, (c) postoperative range of movement of elbow at 3 month, (g) postoperative radiograph of the arm (anterior-posterior and lateral view) at 3 months, and (h) radiograph of arm on postoperative day 1 (lateral view).

**Duration of surgery and duration of radiation exposure**

Mean duration of radiation exposure was 178.7±41.2 seconds. While 10 (33.3%) patients were exposed to radiation for 100-150 seconds, a similar number (9, 30%) was exposed for 150-200 seconds (Table 3). Eleven (36.7%) patients were exposed for 200-250 seconds.

**Table 3: Radiation exposure in patients treated with anterior bridge plating through MIPO of humeral shaft fractures.**

| Radiation exposure (seconds) | N     | Percent (%) |
|-----------------------------|-------|-------------|
| 100-150                     | 10    | 33.3        |
| 150-200                     | 9     | 30.0        |
| 200-250                     | 11    | 36.7        |
| Total                       | 30    | 100.0       |

**Complications**

Varus/valgus angulation occurred in 4 (13.3%) patients. Once case each of radial nerve neuropaxia, delayed union, and screw back out/loosening occurred.

**DISCUSSION**

In recent times, MIPO and intramedullary nailing have emerged as popular procedures for surgical biologic fixation. In the treatment of humeral shaft fractures, MIPO using an anteriorly placed plate is advantageous since neither the fracture site nor the radial nerves need to be dissected. In contrast, intramedullary nailing involves insertion of the nail into the bone marrow cavity, including the fracture segment. Furthermore, while intramedullary nailing may lead to major shoulder pathology over time, the rotator cuff is spared in anterior bridge plating. Indeed, the primary advantage of anterior bridge plating is the combination of stability with minimal soft tissue and periosteal disruption. Additionally, unlike posterior plating, it requires a smaller incision and adheres to the MIPO principle, which makes it biologically and cosmetically preferable. Moreover, anterior bridge plating affords relative and elastic stability, which is superior to the absolute rigidity offered by open reduction and internal fixation using the posterior approach. This is because in the former, healing takes place by secondary healing and callus formation, which is stronger, whereas the latter involves primary healing without callus formation. Furthermore, the purpose of using a long plate in anterior...
bridge plating is to decrease the stress per unit area by distributing it over a larger surface area. Therefore, the plate placed on the anterior tensile surface can withstand a larger amount of rotational and bending stresses than the shorter plate. In the present study, we found that the anterior bridge plating technique through MIPO of humeral shaft fractures was associated with favorable radiological (time required for radiological union), clinical, and functional (MEPI scores, UCLA scores, and range of motion) outcomes. Most of the fractures (60%) in our study were united in 9-12 weeks. Similar observations were noted in the studies of Sharma et al, Vegad et al, Ibrahim et al, and Mahajan et al.18,20,21,26

At discharge, 26 (86.7%) patients had an excellent to good UCLA score while the remaining 4 (13.3%) patients had a fair score. At 6 months’ follow-up, 29 (96.7%) patients had an excellent to good score while only 1 (3.3%) patient had a fair score. There was no significant difference in UCLA score (p>0.05). This is similar to the findings of Vegad et al and Ibrahim et al.20,21 At discharge, 24 (80%) patients had an excellent MEPI scores while 2 (6.7%) and 4 (13.3%) patients had good and fair scores, respectively. At 6 months’ follow-up, 29 (96.7%) patients had excellent scores while only 1 (3.3%) patient had a good score. There was no significant difference in MEPI score as per the chi-square test (p>0.05). This is comparable to the studies of Mahajan et al and Sharma et al.18,26 Although the difference in the range of motion between the operated and non-operated sides was statistically significant, there was no clinical difference in subjective postoperative strength.

In the present study, we found varus/valgus angulation in 13.3% patients and one case each of radial nerve neuropraxia, delayed union, and screw back out/loosening. These complications were similar to those in the studies by Sharma et al and Mahajan et al.18,26

The current study was limited by the lack of a comparison group and by the short duration of follow-up.

CONCLUSION

We found that the anterior bridge plating technique through MIPO of humeral shaft fractures was associated with favorable radiological (time required for radiological union), clinical, and functional (MEPI scores, UCLA scores, and range of motion) outcomes. Anterior bridge plating for mid-shaft humerus fractures is a safe and effective treatment modality yielding high rates of union, excellent functional recovery, minimal biological disruption, and better cosmesis.

ACKNOWLEDGEMENTS

The authors would like to thank Editage for assistance with English language editing.

Funding: No funding sources
Conflict of interest: None declared

Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

1. Emmett JE, Breck LW. A review and analysis of 11,000 fractures seen in a private practice of orthopaedic surgery, 1937–1956. JBJS. 1958;40(5):1169-75.
2. Schemitsch EH, Bhandari M, Talbot M. Fractures of the humeral shaft. In: Skeletal Trauma: Basic Science, Management and Reconstruction, 4th ed. Philadelphia, PA: Saunders. 2008;2:1593-4.
3. Rose SH, Melton JL, Morey BF, Ilstrup DM, Riggs BL. Epidemiologic features of humeral fractures. Clin Orth Rel Res. 1982;168:24-30.
4. Brinker MR, O’Connor DP. The incidence of fractures and dislocations referred for orthopaedic services in a capitated population. JBJS. 2004;86:A(2):290-7.
5. Ekholm R, Adami J, Tidermark J, Hansson K, Törnkvist H, Ponzer S. Fractures of the shaft of the humerus: an epidemiological study of 401 fractures. JBJS Br. 2006;88(11):1469-73.
6. Sarmiento A, Kinman PB, Galvin EG, Schmitt RH, Phillips JG. Functional bracing of fractures of the shaft of the humerus. JBJS. 2010;82(1):596-601.
7. Balfour GW, Marrero CE. Fracture brace for the treatment of humerus shaft fractures caused by gunshot wound. Orthop Clin N Am. 1995;26(1):55-63.
8. Rosenberg N, Soudry M. Shoulder impairment following treatment of diaphyseal fractures of humerus by functional brace. Arch Orthop Trauma Surg. 2006;126(6):437-40.
9. Denard A Jr, Richards JE, Obremskey WT, Tucker MC, Floyd M, Herzog GA. Outcome of nonoperative vs operative treatment of humeral shaft fractures: a retrospective study of 213 patients. Orthopaedics. 2010;11(8):33.
10. Wallny T, Westermann K, Sagebiel C, Reimer M, Wagne UA. Functional treatment of humeral shaft fractures: indications and results. J Orthop Trauma. 1997;11(4):283-7.
11. Iwegbu G. Principles and Management of Acute Orthopaedic Trauma. 3rd ed. Bloomington: Author House. 2015.
12. Baumgaertel F, Buhl M, Rahn BA. Fracture healing in biological plate osteosynthesis. Injury. 1998;29(3):3-6.
13. Dickson KF, Munz JW. Locked plating: Biomechanics and biology. Tech Orthop. 2007;22:4.
14. Wagner W, Frenk A, Frigg R. Locked plating: Biomechanics and biology and locked plating: Clinical indications. Tech Orthop. 2007;22:4.
15. Greiwe R. Proximal humerus fractures: Percutaneous fixation, proximal humeral nailing, and open reduction and internal fixation. In: Greiwe RM, editor. Shoulder and Elbow Trauma and its

International Journal of Research in Orthopaedics | November-December 2020 | Vol 6 | Issue 6 | Page 1249
16. Shetty MS, Kumar MA, Sujay K, Kini AR, Kanthi KG. Minimally invasive plate osteosynthesis for humerus diaphyseal fractures. Indian J Orthop. 2011;45(6):520-6.
17. Matsunaga FT, Tamaoki MJ, Matsumoto MH, dos Santos JB, Faloppa F, Belloti JC. Treatment of the humeral shaft fractures - minimally invasive osteosynthesis with bridge plate versus conservative treatment with functional brace: study protocol for a randomised controlled trial. Trials. 2013;14:246.
18. Sharma J, Jain A, Jain PG, Upadhyaya P. Anterior bridge plating with mini incision MIPO technique for humerus diaphyseal fractures. Indian J Orthop Surg. 2015;1:171-5.
19. Mahajan AS, Kim YG, Kim JH, D'sa P, Lakhani A, Ok HS. Study in Athletes and Manual Laborers. Clin Orthop Surg. 2016;8(4):358-66.
20. Vegad T, Suthar D. Follow up assessment of patients with humeral bridge plate technique with two year period. Int J Res Orthop. 2017;3:867-70.
21. Ibrahim M, Rathod VH. A clinical study of minimal invasive anterior bridge plating for humerus shaft fractures. Int J Orthop Sci. 2018;4:1-5.
22. An Z, Zeng B, He X, Chen Q, Hu S. Plating osteosynthesis of mid-distal humeral shaft fractures: minimally invasive versus conventional open reduction technique. Int Orthop. 2010;34(1):131-5.
23. Malhan S, Thomas S, Srivastav S, Agarwal S, Mittal V, Nadkarni B, Gulati D. Minimally invasive plate osteosynthesis using a locking compression plate for diaphyseal humeral fractures. J Orthop Surg (Hong Kong). 2012;20(3):292-6.
24. Vilaça PR Jr, Uezumi MK. Anterior minimally invasive bridge-plate technique for treatment of humeral shaft nonunion. J Orthop Traumatol. 2012;13(4):211-6.
25. Uhthoff HK, Poitras P, Backman DS. Internal plate fixation of fractures: short history and recent developments. J Orthop Sci. 2006;11(2):118-26.
26. Mahajan AS, Kim YG, Kim JH, D'sa P, Lakhani A, Ok HS. Is anterior bridge plating for mid-shaft humeral fractures a suitable option for patients predominantly involved in overhead activities? A functional outcome study in athletes and manual laborers. Clin Orthop Surg. 2016;8(4):358-66.
27. Singisetti K, Ambedkar M. Nailing versus plating in humerus shaft fractures: a prospective comparative study. Int Orthop. 2010;34(4):571-6.

Cite this article as: Kumar A, Bade R. Prospective study of clinical, radiological and functional outcome of anterior bridge plating (MIPO) for shaft of humerus fracture. Int J Res Orthop 2020;6:1245-50.