



Open Reduction with Internal Fixation of Proximal Humeral Fractures with Plates: Results of 20 Operated Patients

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Authors' contributions

This work was carried out in collaboration between all authors. Author BG designed the study, performed the statistical analysis and wrote the first draft of the manuscript. Authors BG and REA wrote the protocol. Author AS managed the analyses of the study. Authors AS and TE managed the literature searches. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Introduction: This study evaluates the functional and radiological results of surgical treatment with plate and screws of proximal humeral fractures focusing on short and long-term complications.

Materials and Methods: This retrospective study was conducted at Hotel Dieu de France Hospital in Beirut. Inclusion criteria were: (1) Age >18 years old and (2) proximal humeral fracture operated on with the use of a plate (DCP (Dynamic compression plate) or LCP (Locking compression plate)). Only 45 patients met these criteria since more than 70% of patients operated on were treated by other methods or dead. 20 patients presented to last follow up. Data collection included: Fracture type (using 2 classification: Codman/Neer and Hertel), early complications (infection, implant failure, stress riser fracture...), functional evaluation of the patient (using the "simple shoulder test"), and late complications (necrosis of the humeral head (NHH), malunion, osteoarthritis...) evaluated on x-rays by 2 independent physicians.

Results: Analysis of the 20 patients revealed 9 males and 11 females; with the mean age of 68 years and a mean follow up of 45 months. The most frequent type (60%) was a three-part fracture involving the great tuberosity. A standard 3,5 plate was used in 6 patients and a proximal humeral locking plate in 14, through a deltopectoral approach.

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There was neither early superficial nor deep infection. No vascular or neurological complications were noted. Mean SST score was 9.95. No differences between DCP and LCP fixation was noted ($P=.27$). Fixing tuberosities was not correlated with the SST (Simple Shoulder Test) score ($P=.73$). Latest x-ray evaluation showed 4 NHH. No correlation was found between functional outcome and the development of NHH ($P=.18$). Malunion was found in 6 patients (3 varus, 3 valgus). Perforation of the articular surface from long screws was noted in 3 patients. Intraarticular screw had no effect on functional outcome ($P=.3$).

Conclusion: With a careful preoperative patient's selection and a good surgical technique, ORIF with both conventional and locking plates gives satisfactory functional results. AVN of the humeral head, when present, does not affect the shoulder's function.

Keywords: Proximal humerus; fracture; plate fixation.

1. INTRODUCTION

The incidence of fractures of the proximal humerus is significantly increasing with the aging of the population, becoming the third most frequent fracture in the osteoporotic population just after hip and wrist fractures [1]. There is a controversy regarding the treatment of 3 and 4 parts fracture of the proximal humerus, with some studies favoring osteosynthesis with plate and screw whereas others preferring arthroplastic techniques. Internal fixation with plate provide a scaffold for the bone to heal thus decreasing the possible complications of arthroplasty [2].

The main aim of this retrospective study is to evaluate the functional and radiological results of surgical treatment with plate and screws of proximal humeral fractures. It searches for a possible correlation between the radiological and the functional results. It also focuses on long-term complications, especially avascular necrosis (AVN) and osteoarthritis, in order to establish a possible correlation between fixation methods and fracture type on one hand, and the development of short-term complications.

2. MATERIALS AND METHODS

This retrospective study was conducted in Hotel Dieu de France Hospital in Beirut. Inclusion criteria were: (1) Age > 18 years old and (2) proximal humeral fracture operated on with the use of a plate (Conventional or LCP). Exclusion criteria: (1) death of patients and (2) surgical treatment methods other than a plate (nail, screws, K wires...). Only 45 patients met these criteria since more than 70% of patients operated on were treated by other methods or died. 25 patients refused to participate in the follow up study and hence only 20 patients were evaluated.

Data collection included:

1. Fracture type: Fracture type was evaluated on first day X ray using two classification: the classification of Codman [3] and Neer [4] and the classification of Hertel [5].
2. Early complications (infection, implant failure needing a revision, stress riser fracture) were evaluated using the medical records.

3. Functional evaluation of the patient: patients' shoulders were evaluated using the "simple shoulder test" (Appendix 1) and patients were evaluated either in a direct interview or by phone call.
4. Late complications (necrosis of the humeral head (NHH), malunion, osteoarthritis) were evaluated on the newest x-rays. NHH was evaluated using the Cruess classification [6] and osteoarthritis was classified according to Samilson [7]. X-rays were evaluated by two independent physicians (an orthopedic surgeon and a radiologist).

Statistical analysis was done with the use of Mann-Whitney test to evaluate difference in treatment modalities. Pearson correlation test was used to evaluate different correlation between functional outcome and complication rate, according to age, sex, fracture type, and surgical intervention. P value was fixed at .05 and statistical analysis was done using PAWS statistics (version 18.0) software.

3. RESULTS

Twenty patients (9 males and 11 females), with the mean age of 68 years and a mean follow up of 3 years 9 months, were included in this study.

Radiological analysis showed that most frequent type according to Neer classification was a three-part fracture with the great tuberosity as the third part (twelve fractures=60%). There were also four two-part fractures and four four-part fractures. Hertel classification showed four fractures of type 1, two fractures of type 2, ten fractures of type 7 and four fractures of type 12.

Surgical treatment was done through deltopectoral approach with the use of plates, by the two upper limb specialists at Hotel Dieu de France Hospital in Beirut. In 6 patients, a standard DCP plate was used whereas in 14 a proximal humeral LCP plate was implanted (PHILOS plate, Synthes®). Fixing the rotator cuff with strapping K-wires was done in 6 patients (2 in DCP plates and 4 in LCP plates).

There was neither early superficial nor deep infection. No vascular or neurological complications were noted. One patient presented 6 weeks postoperatively with a break in the LCP plate which did not require revision since fracture was solid.

Mean postoperative SST score was 9.95 (maximum of 12). Good and excellent results were found in 18 patients (90%) while fair results were found in 2 patients (10%) due to pain and movement limitation. No differences between DCP and LCP fixation was noted ($P=.27$). Fixing tuberosities was not found to be correlated with the SST score ($P=.73$).

Latest x-ray evaluation showed 4 NHH (20% of patients) with one patient classified type 2 on Cruess classification (sclerosis and areas of osteopenia) and three patients with type 4 (Collapse of joint surface and subchondral bone (fragmentation, loose bodies, secondary arthritis)). No correlation was found between functional outcome and the development of NHH ($P=.18$). One patient was operated using a standard DCP plate while the other 3 patients were operated with an LCP Fig. 1.

Osteoarthritis was found in 6 patients: 4 type 1 of the Samilson (1 DCP and 3 LCP) and 2 patients of type 3 (LCP plates). In the patients with stage 3 OA, some degree of OA was noted on preoperative radiographs. Malunion was found in 6 patients (3 varus, 3 valgus).

Perforation of the articular surface from long screws was noted in 3 patients. Intraarticular screw had no effect on functional outcome (P=.3), Fig.2.



Fig. 1. X-ray of a left shoulder treated with a locking plate showing avascular necrosis of the humeral head



Fig. 2. X-ray of a right shoulder fracture showing screw protrusion into the joint

4. DISCUSSION

Proximal humeral fracture represents 5% of all fractures[1]. With aging of the population, this fracture represents the third most frequent fracture after hip and distal radial fracture [8]. 70% are more than 60 years old and more than 75% are females [1]. The results of this study shows a female predilection(55%) with a mean age of 68 explained by the high incidence of osteoporosis making surgical fixation difficult [9–12].

Many controversies exist in the treatment algorithm of proximal humeral fractures. 80% of fractures are stable and minimally displaced requiring only orthopedic treatment. Open reduction and internal fixation was only recommended in three and four part fractures of the proximal humerus [2].

This study showed that surgical treatment of proximal humeral fracture with a plate (DCP and LCP) have excellent functional results (SST=9.95/12). Lu Yi found a similar SST (SST=9.5) in a similar study evaluating complication on proximal humeral fracture treated with an LCP plate [13]. Wild found a mean SST of 7.6 (± 3.8) in patients with three and four part fractures of the proximal humerus treated with plate fixation [2]. Other found a less satisfactory score (SST=8) following surgical fixation [14].

Implant failure (pop up of a screw, break in the plate...) has been reported with high incidence in the literature (16to27%) [1]. This is particularly true in osteoporotic patients with three and four part fractures and medial comminution. This leads to a loss of reduction and possibility of nonunion. We only found one case of material failure (5%) with no consequences. Thanasas found a plate fracture rate of 0.7% and a loss of reduction of 12.2% [15]. In their multicentric study, Südkamp found a loss of reduction in 7% of their series [16]. Screw penetration in the articulation was found in 10% in our series. Thanasas reported screw perforation to be the most common perioperative finding (2%-17.9%) [15].

NHH has an elevated rate in four part proximal humeral fracture ranging from 34% to 85% in some studies [17,18]. We found a 20% rate of NHH with no correlation to functional outcome with no revision or treatment undertaken to relieve the patient. Thanasas found a 7.9% of NHH in their review of surgical treatment of proximal humeral fractures with 14.5% in the four part fractures [15]. On the other hand, Hente showed a 16% NHH rate [19] while Südkamp had a 4% rate [16] and Brunner had an 8% rate [20]. Nonetheless, development of NHH is not predictive of a poorer functional outcome as presented in the current study and noted by Gerber [17].

Osteoarthritis was shown at a mean follow up of 45 months to be present in 33% of patients. Most of patients developing OA had a preexisting OA. Literature is poor in studies evaluating postoperative OA.

This study had several limitations. Patient number is low, lowering statistical power. High patient's refusal to be enrolled in our study (55%) may be due to the special character of the Lebanese patient or could sign the unsatisfactory outcome of this treatment modality. Nonetheless our results are compatible with the literature and conclusion could be drawn based on these similar results. Larger series are required to establish correlation between treatment modalities, classifications and complications.

5. CONCLUSION

Despite the small number of patients included in this study, we have demonstrated, like most of the articles in the literature, the efficacy of open reduction and internal reduction with plates of 3 and 4 fragments fractures of the proximal humerus. With a careful preoperative patient's selection and a good surgical technique, this type of treatment gives satisfactory functional results with both conventional and locking plates. The incidence of both short and long-term complications is rare. AVN of the humeral head, when present, does not affect the shoulder's function whereas osteoarthritis, also rare, significantly decreases the shoulder's long-term functional result.

CONSENT

All authors declare that 'written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images.

ETHICAL APPROVAL

The study was approved by the Ethical Research Committee of Hotel Dieu de France Hospital, Beirut

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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