

Outcomes after nail and plate fixation of humeral shaft fractures

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ISSN 0394-0772

DOI: 10.12920/jopola.2013.02

Abstract

Unstable and comminuted diaphyseal humeral fractures have traditionally been treated with lateral plating. However, recent developments in implant design have spurred new interest for locked intramedullary nailing as a pertinent alternative.

We have retrospectively analyzed our series of humeral diaphyseal fracture cases treated by these two methods. 43 patients in the plating group and 22 in the nailing group were considered for evaluation at a mean follow up of 5.3 years for the former group and 2.7 for the latter group respectively. Nailing produced more minor perioperative incidents, took slightly longer to achieve radiographic consolidation and more patients needed implant removal. The duration of the procedure was relatively constant for plating but decreased consistently for the nailing group. There were no major dif-

ferences regarding deep infection and revision for pseudarthrosis. Axial restoration was significantly better with nailing but no clinical differences could be noted. A clear learning curve and adaptation was seen for the nailing group. In the same group, outcomes improved continuously. One radial injury was noted after plate revision for non-union. Shoulder discomfort improved with technical accuracy.

We consider plating to be a reliable option with predictable, good outcomes. A learning curve and adaptation were seen for the nailing group. In the same cohort, outcomes improved continuously. Shoulder discomfort amended with technical accuracy. Nevertheless, we find nailing to be a worthwhile procedure with promising results for diaphyseal humeral fractures.

Key words: humeral shaft fracture, treatment, outcome, nail, plate.

Riassunto

Le fratture scomposte e comminute della diafisi omerale sono state tradizionalmente trattate con delle placche laterali. Tuttavia, il recente sviluppo del design dei mezzi di sintesi ha suscitato un nuovo interesse per la sintesi con chiodo endomidollare quale valida alternativa.

Abbiamo analizzato, in modo retrospettivo, una serie di casi di frattura diafisaria omerale trattati con queste due metodiche. Nello studio si sono valutati 43 pazienti inseriti nel gruppo trattato con placca (PG) e 22 pazienti nel gruppo trattato con chiodo endomidollare (NG); la valutazione è stata eseguita ad un follow-up medio di 5.3 anni per il gruppo PG e di 2.7 anni per il gruppo NG. La sintesi con chiodo ha prodotto minori complicanze perioperatorie, ha richiesto tempi maggiori per il consolidamento radiologico e un maggior numero di pazienti trattato con questa metodica ha necessitato della rimozione dell'impianto. La durata degli interventi è stata relativamente costante per la sintesi con placche, mentre si è ridotta sensibilmente nei casi trattati con chiodo endomidollare. Nessuna differenza tra i due gruppi è stata evidenziata rispetto al numero di infezioni occorse e di revi-

sioni chirurgiche per pseudoartrosi. Il ripristino assiale è stato significativamente migliore nei casi trattati con chiodo endomidollare, mentre dal punto di vista clinico non si sono osservate differenze tra i due gruppi. Il gruppo di sintesi con chiodo endomidollare ha mostrato chiaramente una curva di adattamento. Nello stesso gruppo, i risultati sono migliorati costantemente. Una lesione del nervo radiale è stata riscontrata dopo una revisione chirurgica di una placca resa necessaria da una mancata consolidazione. Il perfezionamento della tecnica ha determinato minor disagio della spalla.

Consideriamo la sintesi con placca e viti una scelta affidabile e con buoni esiti predicibili. Curve di apprendimento e di adattamento sono state osservate nel gruppo trattato con chiodo endomidollare. Nella stessa coorte, i risultati sono migliorati continuamente. Il disagio alla spalla è migliorato con la precisione tecnica. Tuttavia, riteniamo che l'inchiodamento endomidollare sia una procedura utile con risultati promettenti per le fratture della diafisi omerale.

Parole chiave: frattura omerale, risultato del trattamento, chiodo endomidollare, placca.

Introduction

Humeral shaft fractures are a relatively common incident of the late adult life. There is a higher incidence in women and many are found on osteoporotic bone. Most consolidate with conservative treatment which is also usually the first therapeutic option¹. In addition, humeral shaft fractures consolidate with a high tolerance for misalignment, angulation or shortening¹.

Unstable and comminuted diaphyseal humeral fractures that fail with conservative treatment have been traditionally internally fixed with lateral plating, in favor of locked nailing². Both techniques boast advantages and offer good outcomes³. The two procedures have been compared in recent literature with different results.

Plating has been associated with an invasive approach, extensive dissection of the radial nerve and devitalization of comminuted fragments⁴. On the other hand, antegrade nailing has led to shoulder pain in an unacceptable number of times, due to the entry point through the rotator cuff⁵ which inevitably led to increased reoperation rates².

However, recent developments in implants have spurred new interest in locked intramedullary nailing as a pertinent alternative⁶. The study by Changulani et al.⁷ proved that this type of nailing can be considered a better surgical option for humeral shaft fractures. This has led to a review of the 2006 meta-analysis of Bhandari et al. which concluded that previously identified advantages of plating are no longer founded^{2,8}.

This shift in operative treatment implant choice was also identified in our surgical experience. We therefore aimed at investigating what the clinical consequences are for this trend towards expanding indications for locked intramedullary fixation of humeral shaft fractures.

Materials and Methods

We have retrospectively analyzed our series of humeral diaphyseal fracture cases treated by these two methods. The data was collected retrospectively using patient charts and electronic patient data up until the last available presentation including patients operated on by 6 different surgeons over 7 years. 43 patients in the plating and 22 in the nailing group were available for evaluation at a mean follow up of 5.3 years for the plating group and 2.7 for the nailing one respectively. 31 plates were compressive and 12 bridging, with an



Fig. 1 - Consolidated humeral diaphyseal fracture at 5-year follow-up; plate osteosynthesis.

average of 3.8 screws on each side of the fracture. All nails were antegrade and 15 were reamed. The locking was performed with 2 proximal and 2 distal screws in 17 patients and the remaining patients had a single distal screw. Instrument guidance was used for both proximal and distal locking. Circumferential cerclage wires were used in conjunction with intramedullary fixation to stabilize long bone fragments in only 3 cases (all in nailing group). The consolidation was estimated based on unsystematized serial radiographs^{9,10}: radiographic evaluation was performed taking into account the formation of the bone callus, the positioning of the prosthesis stem and the periprosthetic bone remodeling. Statistical analysis used an unpaired t-test for a clinically significant two-tailed p of less than 0.05 and was computed using *GraphPad Prism*. Descriptive statistics presented with mean \pm (sd; standard deviation). Patient demographics are presented in *tab. 1*.



Fig. 2 - Consolidated comminuted humeral diaphyseal fracture at 1-year follow-up; locked nail osteosynthesis.

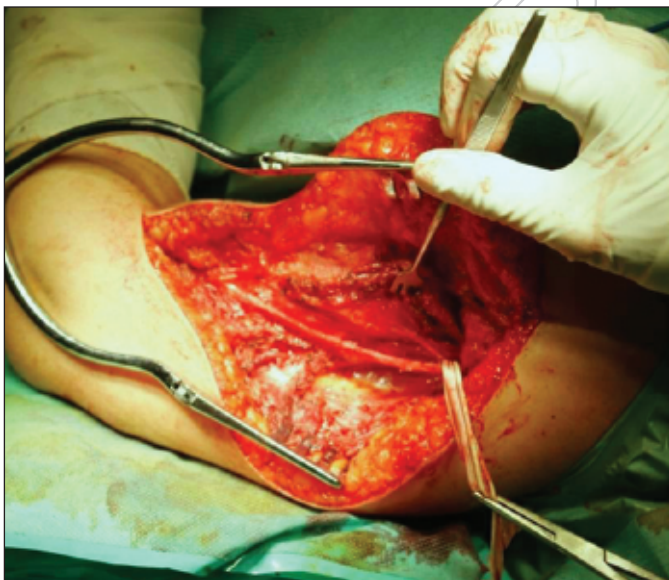


Fig. 3 - Radial nerve dissection during approach for humeral shaft pseudarthrosis after initial plate fixation.

Results

Nailing produced more minor perioperative incidents: in 5 cases the second screw could not be inserted using the guide. In addition, there was: one postoperative hematoma that required drainage, one diaphyseal fracture with no influence on the final fixation and one fracture gap which was incompletely reduced due to the excessive length of the implant; this being resolved by early dynamization. The mean operative time took 117 ± 12 minutes for plating and 78 ± 19 for nailing ($p=0.0001$).

The nailing group also took slightly longer to achieve radiographic consolidation. For 27 patients in the plating group and 20 in the nailing, unsystematized serial radiographs were reviewed. Radiographic consolidation was apparent after 15.1 ± 3.3 weeks with plating and 16.7 ± 3.5 with nailing respectively ($p=0.1162$) (Fig. 1,2). When evident, fracture gap was higher in the nailing group compared with plating ($2.2/0.7$ versus $1.7/0.5$ mm, $p=0.0041$). Mean maximal axial deviation of the two fragments was 5.2 ± 2.0 degrees in the nailing group and 6.9 ± 2.1 in the plating respectively ($p=0.0022$). 13 of the 22 nails were considered to be prominent at the humeral head.

6 patients in the nailing group had their implants removed due to shoulder impingement, out of which 3 had persistent malfunction. 3 cases in the plating group and one in the nailing required re-intervention for non-union. One permanent radial nerve injury was noted after plate revision, as well as one deep infection (Fig. 3). 9 patients in the plating group had wounds that required a daily change of dressing up to the end of the first postoperative week, compared to one in the nailing group.

Tab. 1 Patient demographics

	Male	Female	Age
Plate	11	32	57.3 ± 12
Nail	6	16	54.8 ± 22

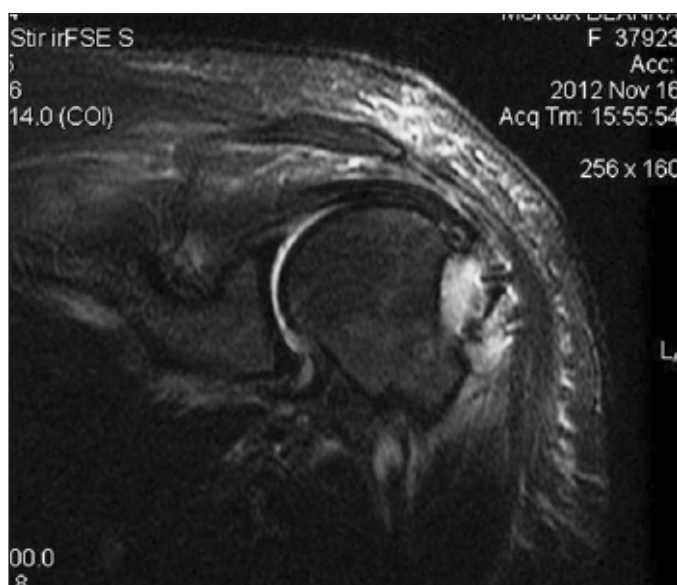


Fig. 4 Coronal MRI of supraspinatus tear following intramedullary nail fixation of humeral shaft fracture in a 46-year-old female at 3-year follow-up and implant removal.

Discussion

There are several limitations to our study. The consolidation was estimated based on unsystematized serial radiographs. Fracture gap was estimated by one single examiner in comparison to the screw / nail size. In addition, axial deviation was determined on a single antero-posterior view, as was the prominence of the nail from the humeral head and no new, independent examination was performed.

Chapman et al also found a higher percentage of healing at 16 weeks for compression plates as well as a decrease in shoulder or elbow range of motion³. Bhandari et al found a risk reduction of 74% for reoperation associated with plate fixation². In an effort to decrease trauma to the rotator cuff at the nail insertion site during removal and to allow an earlier recovery, Kim et al performed arthroscopic removal of the nail, and rotator cuff repair¹¹. Our study included early experience with nailing and this has clearly biased the results which were therefore less favorable than those of

Changulani et al.⁷. Our complication rates are comparable to those reported by Rommens et al.⁶.

Over the last few years, locked nailing has become more popular and produced consistent results with a marked decrease in operative time¹². Even in low income countries, intramedullary nailing has shown favorable functional outcomes and reduced infection rates¹³ (Fig. 4). Coupled with autologous bone grafting, it can also be used for treating non-unions¹⁴. Having said that, optimal clinical management of humeral shaft fractures still remains controversial. Nevertheless, current knowledge expands operative indications with traditional plate fixation as well as intramedullary nailing¹⁵.

Conclusion

We consider plating to be a reliable option with predictable good outcomes. The duration of the procedure was relatively constant for plating but decreased consistently for the nailing group. There were no major differences regarding deep infection and revision for pseudoarthrosis. Axial restoration was significantly better with nailing but no clinical differences could be noted. A learning curve and adaptation were seen for the nailing group. In the same cohort, outcomes improved continuously. Shoulder discomfort amended with technical accuracy. Nevertheless, we find nailing to be a worthwhile procedure with promising results for diaphyseal humeral fractures.

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