Surgical Treatment in Maresca Type A2 Bifocal Humeral Fractures

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ABSTRACT

Bifocal humeral fractures are infrequent injuries, and fractures involving the proximal and diaphyseal humerus are even rarer. We present four patients with bifocal humeral fractures of the Maresca type A2 classification. We detail the surgical plan, technical pearls, and functional outcomes.

Keywords: Bifocal fractures; humerus fractures; surgical treatment.
Level of Evidence: IV

Tratamiento quirúrgico para fracturas bifocales de húmero tipo Maresca A2

RESUMEN

Las fracturas bifocales de húmero son lesiones infrecuentes, más aun las que ocurren asociadas con fracturas en el húmero proximal y diafisario. Presentamos a cuatro pacientes con fracturas bifocales de húmero proximal y diafisario (Maresca A2), la planificación quirúrgica, los detalles técnicos y sus resultados funcionales.

Palabras clave: Fracturas bifocales; fracturas de húmero; tratamiento quirúrgico.
Nivel de Evidencia: IV

INTRODUCTION

Humerus fractures are injuries that any orthopedist treats frequently. Experience and indications are extensive for fractures of either the proximal end, diaphysis or distal end.[1] However, bifocal or multifocal fractures of the upper limb are very rare, accounting for 4.8% of humerus fractures. Fractures specifically involving the proximal humerus and diaphysis are even less frequent (0.4%).[2]

There is no consensus on the ideal method of stabilization of bifocal humerus fractures and, as they are infrequent, only isolated case series have been published.[1,2]

The aim of this article is to describe the surgical planning, technical details and functional outcomes in four adult patients operated on for bifocal humerus fractures type A2 of the Maresca classification, with the goal of optimizing healing in a functional position with early rehabilitation; a literature review on the injury is also provided.

MATERIALS AND METHODS

A retrospective series of four consecutive adult patients with bifocal fractures of the humerus, operated on at two highly complex medical centers by surgeons with experience[3] in the surgical treatment of upper limb pathology, was evaluated. The descriptive AO[4] classification was used for each fracture pattern, and the Maresca[1] classification was used for bifocal humerus fractures (Table).

Surgery was the treatment of choice due to marked instability in all cases, with open reduction and internal fixation with plates and screws (3 cases) or intramedullary nail (1 case).

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Table. Classification of bifocal fractures of the humerus (Maresca)

Type	Description		
A	Proximal humerus + diaphysis	Subtypes	
		1	Nondisplaced proximal fracture + displaced diaphysis
		2	Displaced proximal fracture + displaced diaphysis
		3	Proximal fracture with extension to diaphysis
B	Diaphysis		
C	Diaphysis + distal humerus		

Surgical technique

Plates with screws

Patient in beach chair position and under regional anesthesia; in three of the four cases, open reduction and internal fixation with an anatomic extra-long proximal humerus plate and screws, with a screw diameter of 3.5 mm, was planned.

A double approach was performed. The first was an anterolateral shoulder mini-approach in the intramuscular plane between the anterior and middle deltoid, always stopping proximal to the axillary nerve safe zone 6 cm from the anterolateral edge of the acromion.[5] The second was a distal lateral approach between the triceps muscle bellies and the brachialis muscle with careful management of the radial nerve. This is followed by radial nerve neurolysis and reduction of the diaphyseal fracture site using a distal approach with forceps. According to the pattern, absolute stability is provided to the distal focus (Case 3). The length of the implant is selected according to the radiographic planning. The extra-long proximal humerus plate is introduced from the proximal mini-approach in the submuscular plane, through the deltoid, respecting the safe zone. The plate is slid across both fractures. Provisional proximal and distal pins are placed to corroborate correct implant placement and provide temporary stability. This is followed by the indirect reduction and screw placement in the holes proximal and distal from the plate to the proximal fracture. Finally, the distal focus is fixed with the plate providing a mixed fracture stability system (Figure 1).

Figure 1. Surgical details.

Intramedullary nail

Under radioscopic control, a 2.5 mm diameter pin was placed at the level of the humeral head and transverse to the shaft of the diaphysis, to control the axes as a *joystick*. An anterolateral mini-approach is performed on the shoulder. This is followed by dissection of the deltoid and supraspinatus or remnants. The anterograde nail is inserted according to the traditional technique. It can be used in association with the pin described above as a *joystick* for reduction and stabilization of the proximal focus. The distal focus is reduced and stabilized with traction and external maneuvers according to the usual technique.

Postoperative controls were performed 7, 15 and 30 days after surgery. Except for one patient who was lost to follow-up at the fifth month, patients were examined once a month until consolidation and then once a year for remote clinical follow-up.

Clinical and radiological parameters[6] were used to verify fracture healing, as well as the Constant-Murley score[7] to assess function. The usual complications related to the surgical procedure (infection, radial palsy, omalgia) were investigated.

RESULTS

Four bifocal humerus fractures were documented in adult patients from 2018 to 2021 at two high-complexity medical centers. These were type A2 fractures of the Maresca classification, with involvement of the proximal humerus and diaphysis. All four patients underwent surgery and the clinical and radiological outcomes were favorable.

CLINICAL CASE 1

A 70-year-old woman with bifocal fracture of the left humerus, Maresca type A2, 11B2 and 12A1 of the AO[4] classification (Figure 2); trauma of three days of evolution. Based on the clinical-radiological picture, open reduction and internal fixation were indicated. The technique previously described was performed.

Figure 2. Fracture 11B2 and 12A1 of the AO classification.

At the control two years after surgery, both fractures were found to have healed, with complete restoration of range of motion, without pain or weakness of the limb. The functional score on the Constant-Murley scale was 91. The described complications were not observed (Figure 3).

Figure 3. Radiographs and clinical outcomes two years after surgery.

CLINICAL CASE 2

A 68-year-old woman with bifocal fracture of the right humerus Maresca type A2, 11A1 and 12A2 of the AO[4] classification (Figure 4); trauma of six days of evolution. Surgery was indicated with the same detailed surgical tactics.

Figure 4. Fracture 11A1 and 12A2 of the AO classification.

Clinical-radiological consolidation was reached at five weeks. At the 1-year distant control, functional restoration of the limb was verified with a functional score on the Constant-Murley scale of 85. No complications were observed (Figure 5).

Figure 5. Radiographs and clinical outcomes two years after surgery.

CLINICAL CASE 3

A 71-year-old woman, with bifocal fracture of the right humerus Maresca type A2, 11A2 and 12A1 of the AO[4] classification (Figure 6); trauma with one month of evolution. The surgical tactics described above were followed.

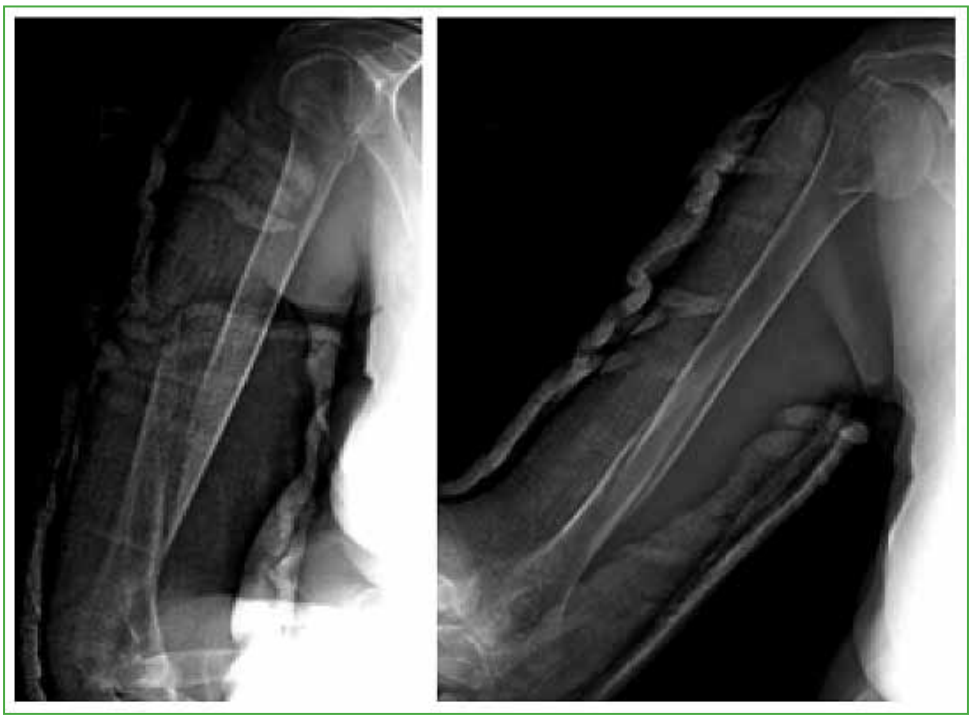

Figure 6. Fracture 11A2 and 12A1 of the AO classification.

As a valuable technical detail, the provisional reduction and stabilization of the distal trace was performed with extra-strength wires (Fiberwire®) using the Nice point[8] for blocking (Figure 7), definitively synthesizing the focus with two transfracture screws and with the extra-long plate of the proximal humerus as a bridge as in the previous cases.

Figure 7. Surgical details.

The result four months postoperatively was satisfactory with fracture healing, no pain and a Constant-Murley functional (provisional) score of 50 (Figure 8). It was not possible to locate the patient at the controls after the fifth month for a final functional evaluation.

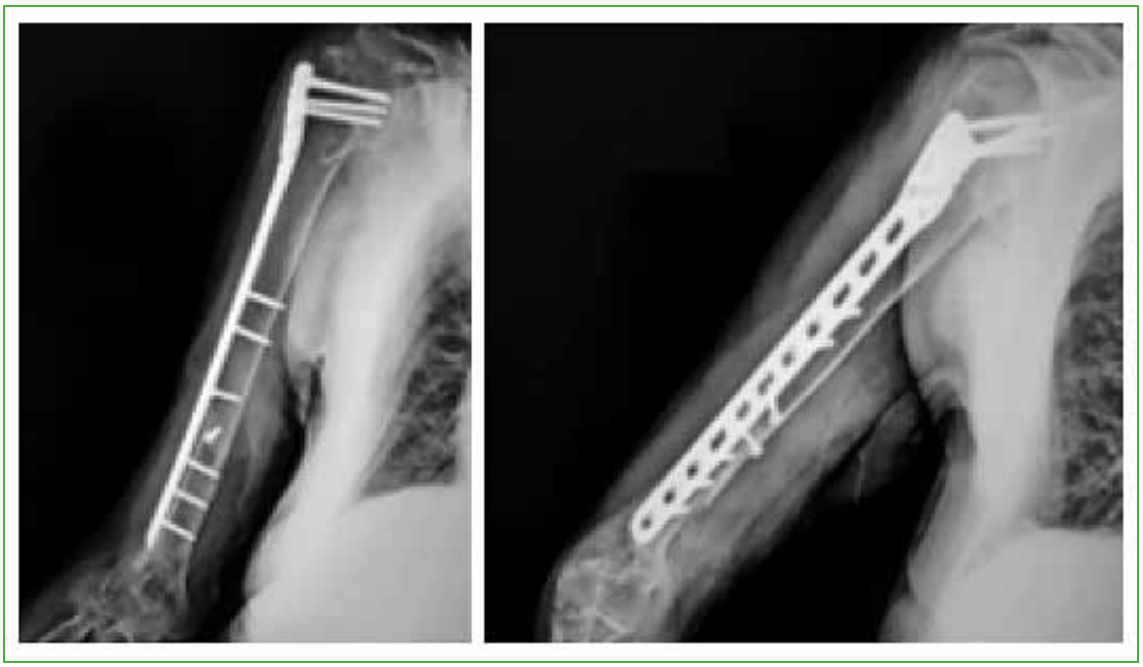

Figure 8. Radiographs four months after surgery.

CLINICAL CASE 4

A 96-year-old man, active and independent. Radiographs showed a bifocal fracture of the right humerus Maresca type A2, 11A3 and 12B1 of the AO[4] classification (Figure 9).

Figure 9. Fracture 11A3 and 12B1 of the AO classification.

Given the functional demands of the patient, which were unrelated to his chronological age, mini-invasive surgery with intramedullary nailing was chosen to relieve pain and improve the functionality of the limb.

Surgical details: With the patient in the beach chair position and under regional anesthesia, an anterograde anchored intramedullary nail (Polarus Acumed^{R}) was placed using an anterolateral mini-approach, joining both fractures. The restoration of the axis, the contact between fragments and the relative stability of the traces was achieved.

The immediate evolution was good; fracture consolidation was verified at three months. The patient was performing activities of daily living three years after the intervention, with a Constant-Murley score of 65, and no early or distant complications (Figure 10).

Figure 10. Radiographic and clinical control three years after surgery.

DISCUSSION

Bifocal fractures of the humerus are very rare. Broadbent et al. found only seven cases of bifocal humerus fractures in 13,560 fractures recorded over eight years in patients >13 years of age. Four of them corresponded to the association of the proximal humerus and diaphysis; two, to the proximal and distal humerus, and one, to the diaphysis and distal humerus.[2]

In 2014, Maresca found 35 bifocal humerus fractures out of 717 which had been surgically treated (4.8%). In a case series, the author developed a descriptive classification for bifocal or multifocal fractures of the humerus that is still the only one available. Thus, he divided them into three types: A, fractures involving the proximal humerus and diaphysis; B, fractures in the humeral diaphysis; and C, fractures of the diaphysis associated with the distal humerus.[1] Type A was further divided into three subgroups: 1, nondisplaced fractures of the proximal humerus associated with displaced fractures of the diaphysis; 2, displaced fractures of the proximal humerus and diaphysis; and 3, multifragmentary fractures of the proximal humerus with extension to the diaphysis. In his series of 35 patients, all fractures were type A, and the most frequent group was subgroup 1 (20 cases), and group 2 was very infrequent (3 cases).[1]

The four cases in our study belonged to type A, subgroup 2.

When planning the treatment of this type and group of fractures, we are faced with the controversy that sometimes some fractures are associated with indications for surgical and non-surgical treatment, and secondly, it is possible that the method of surgical stabilization of one of the fractures does not resolve the other.

Regarding the first situation, we consider it advisable to be guided by the treatment of the more complex fracture, stabilizing both fractures to allow early mobilization of the limb. In the case of the second, the ideal stabilization should include both fractures avoiding a zone of mechanical stress between the implants with a risk of refracture.

Published surgical options generally include the use of the anterograde intramedullary nail or plate with screws for isolated proximal humerus or diaphyseal humerus fractures.[9,10]

However, the method of choice for bifocal fractures of this type and group is still debated. The advantage of the intramedullary nail is that its placement requires less soft tissue dissection when compared to plate osteosynthesis, and it allows both fractures to be joined with very little dissection. However, omalgia related to nail insertion through the supraspinatus is a known complication. The benefits of the use of plates and screws or nails on the rate of consolidation have been discussed.[11-16]

Plates with screws allow stabilization of both fractures with an anatomical reduction and use of bone graft, if necessary. In addition, through the same approach, the radial nerve can be explored if a neural lesion is suspected. However, it leads to opening of the fracture hematoma, deperiostization and a theoretical increase in the infection rate due to exposure. The introduction of the MIPO (minimally invasive plate osteosynthesis) technique conceptually decreases these complications.[17]

In 2008, Levy et al. published the results of treatment of a long segmental (bifocal) humerus fracture stabilized with a 4.5 mm straight plate using two approaches and submuscular gliding, with excellent outcomes.[18]

Meanwhile, in 2018, Toulopakis et al. published a series of 11 patients with multifocal fractures of the proximal humerus with diaphyseal extension treated with extra-long anatomic proximal humerus plates and MIPO technique. It should be clarified that, in this series, there were no type A2 fractures (published in our series), and their cases represent diaphyseal extensions of fractures of the proximal humerus. Consolidation was achieved in all patients and the complications were four radial nerve neuropraxias.[19]

In 2010, Garnavos and Lasanianos reported the outcomes of 18 patients with fractures of the proximal humerus extended or combined to the humeral diaphysis, treated with locking intramedullary nails. In this series, eight corresponded to Maresca type A2 and consolidation was achieved in all of them with good functional outcomes.[20]

In our series of Maresca type A2 fractures, due to the lack of consensus guidelines and the scarce published literature, we customized surgical tactics according to the clinical characteristics and functional demand of each patient.

However, as a guideline, we rely on opening the distal fracture site prioritizing absolute reduction and stabilization of the main fracture line, adding an anterolateral mini shoulder approach to allow an anterograde submuscular sliding of an anatomic extra-long proximal humerus screw plate. In this way, we achieve firm stabilization of the distal line with a more elastic stabilization of the proximal line. We only modified the technique in one case due to the advanced age of the patient, and with the objective of reducing the surgical and anesthetic risk.

When deciding on open reduction and stabilization with plate and screws, it is essential to recognize and carefully repair the radial nerve in the distal approach and to recognize the axillary nerve passing through the deep epimysium of the deltoid 6 cm from the acromion for its protection.

In the four cases presented, the fracture healed, on average, within eight weeks. Patients returned to their activities without functional limitations and limb range of motion was restored at the time of the remote control (Constant-Murley >65 in all cases). One of the patients did not continue with the follow-up, which prevented evaluation of the final functional outcome.

CONCLUSIONS

We do not have a sufficient number of cases to reach relevant conclusions. However, we have observed that, for bifocal humerus fractures with involvement of the proximal humerus and diaphysis (Maresca type A2), surgery with extra-long proximal humerus plates and screws using a double approach, as well as the use of the anterograde intramedullary nail for an elderly patient or with a higher surgical risk, achieved fracture healing in all cases. The patients had a good overall functional outcome and returned to their usual pre-trauma activities.

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