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The role of external fixation in the treatment of humeral shaft fractures: A retrospective case study review on 85 humeral fractures

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ABSTRACT

There is no consensus among surgeons on the treatment for humeral fractures: the best it is still a matter of some debate. The aim of our work was to demonstrate that external fixation may be considered a valid method not only in emergencies but also for the definitive treatment of such fractures. We perform a retrospective case study review on 85 humeral fractures, 62 shaft fractures, and 23 extrarticular distal third fractures treated with external fixation. Clinical (Disabilities of the Arm, Shoulder and Hand (DASH) score and SF-36) and radiographic follow-up lasted on average 30 months (minimum 12 to maximum 36). Complete healing of fractures was achieved in 97.6% of cases (83 patients), with an average consolidation time of about 12 weeks (83.2 days). One case of delayed union and one case of refracture were encountered. Eighty-one patients demonstrated SF-36 scores at or above the national average and an average DASH score of 8.9. External fixation of humeral shaft fractures is considered a valid treatment method as it provides good results in terms of stability of reduction, tolerability, healing times, and functional recovery.

Introduction

Humeral shaft fractures represent approximately 2–3% of all fractures, having an average incidence of 14 out of 100,000 [1–3].

They present a bimodal peak incidence: they are more frequent in males under 50 years of age and in females over 70.

In the case of males, the causative event is generally high-energy trauma due to road accidents, sports injuries, or falls from a considerable height.

On the other hand, in females, in addition to high-energy trauma, low-energy impacts such as a fall at home from a modest height often precipitate such fractures due to a clinical condition of osteoporosis [1,4].

The most frequent and dangerous complication of humeral shaft fractures is represented by damage to the radial nerve, which runs along the rear surface of the bone in the spiral groove of the humerus. This lesion is present in 11.8% of all cases (15.2% of all shaft fractures) and most frequently associated with spiral Holstein–Lewis fractures [5].

The nerve may be bruised or stretched by the fracture fragments, or may even tear. In the latter case, the onset of paralysis is abrupt and presents as a deficit in extension of the finger (falling hand) and wrist, with hypo-anaesthesia of the first and second fingers and the first and second metacarpus on the back of the hand.

Partial functional recovery may take several months and is usually complete within 2 years, so progress should be monitored with electromyograph studies.

In most closed fractures, up to 100% for some authors, radial nerve recovery is complete and it can last up to 6 months. Surgical revision of the nerve is necessary only if functional recovery has not yet begun after 6 months from the traumatic event [6,7].

Other complications that may occur in humeral shaft fractures are nonunion and brachial artery injury.

The appearance of nonunion is extremely variable, from 2% to 33% of humerus fractures, its occurrence depending on many concomitant causes and factors [8,9].

In humeral fractures, nonunion is defined as the radiographic detection of delayed consolidation of the fracture 6/8 months after treatment [10,11].

The main cause is instability of the fracture (i.e., the presence of abnormal movements at the fracture site) due to inadequate treatment and poor reduction. Most fractures exhibiting nonunion are revealed to have been treated with conservative methods [12].

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According to several authors, obesity, defined as body mass index (BMI)> 30, is a contributory cause factor in 35–37% of nonunions. Other predisposing risk factors, in addition to the already mentioned instability of the reduction, are the daily use of tobacco (38–53%), cardiovascular disease (37%), metabolic bone disease (32%), and polytrauma with multiple fractures of long bones [13,14].

Another cause of nonunion is the exposure of the fracture, which causes the loss of fracture hematoma, compromising the beginning of the consolidation process. In addition, exposure can also lead to bone fracture infection, resulting in nonunion [10,11].

Finally, bone necrosis due to poor blood supply is another condition favouring evolution towards nonunion.

Injury of the brachial artery is a rare but dreaded complication that requires urgent treatment.

In recent years, the most commonly used treatment methods for humeral shaft lesions have been conservative, with casts and braces, and surgical with internal fixation, intramedullary nailing (IMN), and external fixation.

Our experience with external fixation devices has allowed us to assess how the use of the fixators produced clinically and radiographically similar results to other more invasive methods, while affording the advantages of speed and low invasiveness.

In the following we review the cases of humeral shaft fracture treated in our clinic between 2001 and 2010 with the aim of determining whether the use of external fixators should be considered a valid method, not only in the event of an emergency but also for the definitive treatment of such fractures.

Materials and methods

We treated 85 patients (63 males and 22 females) with external fixation out of a total of 270 humeral fractures who underwent surgery. The mean follow-up was 30 months (minimum 12 to maximum 36).

The patients' average age was 43.9 years (minimum 10 to maximum 86).

Most of the fractures resulted from high-energy trauma in young-adult males.

In nine cases the patients had undergone polytrauma, with other skeletal segment lesions. The fractures were graded according to the AO Foundation and Orthopaedic Trauma Association (AO/OTA) classification.

Applying this classification to our series, we found:

12-A1: 12; 12-A2: 12; 12-A3:4; 12-B1:18; 12-B2:4; 12-B3:4; 12-C1:3; 12-C2:2; 12-C3:3; 13-A1: none; 13-A2:19; and 13-A3:4

All patients had a soft tissue lesion greater than or equal to grade 2 Tscherne.

There were also four exposed fractures.

We used the Stryker Hoffmann type II external fixator, which is a modular fixator consisting of aluminium and carbon fibres and aluminium bars.

The operative technique consists of placing the patient supine on the operating table with the affected arm abducted at 45–60° and the elbow flexed at 90°.

Anaesthesia is generally locoregional, with continuous interscalene brachial plexus block. This technique enables immediate passive mobilisation of the operated segment thanks to the possibility of prolonging the analgesic effect in the postoperative period.

The screws are self-tapping with a diameter of 4 or 5 mm and are always inserted manually, usually two proximal and two distal to the fracture site, depending on the complexity of the fracture. Some interfragmentary screws can be used to better stabilise the fracture.

For the insertion points, we follow the technique and mapping described by Professor Bianchi Maiocchi [15] to fix all the screws on the lateral humerus.

One screw is inserted in a position just proximal to the olecranon fossa under fluoroscopic guidance: in order to avoid the ulnar nerve, we proceed with lateral-to-medial insertion of a Kirschner wire (K-wire), slightly tilted in the posterior–anterior direction in a selected area of the lateral cortex. Then we remove the K-wire and use its entrance hole on the lateral cortex as a guide for the first screw.

The second screw is fixed on the same plane as the first, keeping the elbow flexed and the arm abducted. This will slacken and shift the radial nerve forward. The area chosen for insertion is a safe zone 8.5 cm proximal to the epicondyle. To improve security, we use the anchor positions 1–4 or 2–4 of the clamp.

The proximal screws are inserted into the lateral humerus, proximal to the "V" of the deltoid muscle, accessing the bone via a blunt dissection through the muscle fibres of the deltoid.

We proceed to the installation of the connecting bars, usually two, and reduction of the fracture under fluoroscopic guidance.

Then we close the system and stabilise it with a crossbar to increase the stability of the implant.

The use of two proximal and two distal screws and a "long" implant lends proper flexibility and stability to the fracture. Stability is further increased for the first 30 days by the crossbar connection.

As a final step, any intermediate fragments are set. In cases where it was necessary to fix a third fragment (medial, butterfly), we follow AO techniques for the stabilisation of small fragments: a 5-mm hole is effected on the lateral cortex and then a 4-mm-diameter screw is used to pierce the medial cortical fragment to enable it to be pulled through, so as to improve fracture reduction and implant stability (Fig. 1).

In the postoperative period, antibiotic prophylaxis is continued for 5 days, and patients are subjected to early mobilisation of the operated arm.

The screws should be medicated every other day with sterile saline solution or hydrogen peroxide.

Patients were followed up with clinical checks every 15 days in a specialised ward in order to assess the condition of the skin around the screws, and a clinical and radiographic exam every 30 days to assess the progress of fracture consolidation. After 30 days, dynamisation of the fixation system was performed removing the crossbar connection. The external fixator was removed through a day-surgery hospitalisation after complete healing of the fracture.

Patients underwent further clinical and radiographical follow-up, which lasted for an average of 2.5 years.

The results were evaluated from both a clinical and radiographic point of view, considering the average consolidation time, and the onset of any nonunion, refracture, and/or angular defects.

The most widely used health international questionnaire the Short Form Health Survey (SF-36) was used to standardise the results in terms of functional limitations to patients.

The SF-36 offers the advantages of being fast (the interview takes only a few minutes) and easily reproducible. It is a multidimensional questionnaire consisting of 36 questions that explore eight health domains: AF (physical activity), RP (role limitations due to physical health), RE (role limitations due to emotional state), BP (bodily pain), GH (general health perception), VT (vitality), SF (social activities), MH (mental health), and a single question on the patient's perceived change in health status.

The results were standardised by sex and age according to the average values in the population.