The application of minimally invasive surgical techniques with humeral shaft fractures.

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Minimally invasive plate osteosynthesis of the humeral shaft

Although conservative management of humeral diaphyseal fractures has shown good results in about 90% of cases [1, 2], there are both absolute and relative indications for surgical treatment, such as polytrauma, open fractures, bilateral fractures, floating elbow, etc [3]. Minimally invasive surgical techniques in diaphyseal fractures of long bones have shown advantages over the open conventional techniques, especially when they preserve the biological media of the fracture focus allowing a better environment for consolidation with fewer complications such as infection and nonunion [3, 4]. These techniques have not been very popular in the humeral diaphysis due to its anatomical complexity and the fear of damaging vital structures.

The surgical technique was described in Belangero and Livani’s publication [5]. Based on cadaveric anatomical studies and clinical experience with 43 cases, the most relevant points of the surgical technique will be presented so complications that may derive from faulty indications or inadequate technical performance are avoided.

Contraindications for the application of this technique As in every biological fixation method, the objective is to achieve relative stability at the fracture site so that callus is formed. Thus patients with a compromised soft-tissue environment such as a flaccid paralysis (brachial plexus lesion, poliomyelitis, etc) or open fractures with soft-tissue loss are contraindicated for this procedure [5].

Surgical technique for fractures of the middle third of the humerus

Patient positioning The patient is in the supine position, with the arm resting on the surgical table and the elbow flexed to approximately 70°. The forearm and the elbow are kept in this position by an assistant who applies slight traction during the whole procedure. This position facilitates access for plate introduction reducing the risk of vital structure injury.

Surgical approach An anterior approach to the surface of the humerus should be used to avoid a radial nerve lesion. Two cuts, approximately 3 cm long, are made on the anterior arm surface. The proximal access is located between the biceps brachii muscle medially, and the deltoid and the cephalic vein laterally. The distal access is located on the anterior surface of the arm and the biceps muscle is retracted medially. After the lateral cutaneous nerve of the forearm is identified, the brachial muscle is longitudinally split to expose the anterior surface of the humerus. Brachialis function is not compromised due to its double innervations. Under no circumstances should lever retractors be used for humeral exposure. Instead, Farabeuf type retractors should be applied in order to avoid radial nerve lesion from compression or stretching.

Implant placement In middle third fractures the plate should be introduced in a proximal to distal direction, sliding on the anterior surface of the humerus (Fig 1). The implant should not reach the coronoid fossa. After the plate is introduced, the first
screw should be placed in the distal fragment and left relatively loose to allow the final fracture reduction. The varus deformity is corrected by arm abduction at 90° and rotational deviations are avoided by aligning the bicondylar axis on an orthogonal plane to the biceps brachii tendon. After these maneuvers the second screw is placed in the proximal fragment and the distal one is tightened, securing the plate to the bone. Reduction quality is clinically and radiographically assessed before the remaining proximal and distal screws are placed (Fig 2).

In good quality bone only two screws inclined and well spaced need to be inserted into each bone segment. The utilization of wide plates should be avoided, as this may increase assembly rigidity and lead to retardation of fracture healing. For the same reason, locked plates should use only two locked screws in each fragment so that the assembly does not become excessively rigid [7].

**Surgical technique for distal humeral fractures**

**Patient positioning** The same position as used for medial third fractures.

**Surgical approach** The proximal access is the same as previously described. For distal access, when there is not enough space for plate fixation on the anterior humeral surface, Kocher's incision is used to expose the lateral column of the humerus. Subperiosteal dissection of the brachioradialis and extensor carpi radialis longus muscles, together with the radial nerve, exposes this surface. There is no need to identify the radial nerve, unless it becomes necessary to explore it further.

**Implant placement** In this type of fracture the plate has to be contoured internally to adapt it to the lateral column and to the anterior surface of the humerus. It is introduced in a distal to proximal direction, sliding on the lateral column and the anterior surface of the humerus, with the assistant keeping the elbow flexed and the arm under slight traction, supported by the surgical table [5]. Screw insertion is similar to the previously described technique (Fig 3).

**Humeral fractures associated with radial nerve lesion** The systematic and careful analysis of studies published in the last forty years concerning radial nerve injury associated with a humeral shaft fracture shows an incidence of 11.8%. The average spontaneous radial nerve resolution rate is 70 to 80%. Therefore expectant management regarding the radial nerve is indicated [8–10].

The use of minimally invasive plate techniques has not been popular in humerus because of the fear of damaging the neurovascular structures that traverse the humerus. However, if employed according to these recommendations, the application of minimally-invasive technique is still possible in this situation.

In the proximal third of arm the radial nerve is not tethered by the intramuscular septum so fractures occurring in this region usually cause a neuropraxia, with greater possibility of spontaneous recovery. In the distal third of the humerus the radial nerve is tethered by the intramuscular septum and in close contact with the humeral diaphysis, creating a greater chance of nerve injury by fracture site impingement thus
making spontaneous recovery unpredictable [10]. When the treatment of choice for distal third humeral fractures with a radial nerve lesion is the MIPO technique, the nerve should be first explored by means of an oblique access between the brachialis and brachioradialis muscles. After its identification, the nerve should be explored past the fracture site and its entry through the lateral intermuscular septum (Figs 4–6). Following that procedure, the same technique already described for distal humeral fractures is performed [6].

**Conclusion**  Minimally invasive osteosynthesis is a simple technique, reproducible, with few risks. The method is supported by the fact that the radial nerve crosses the anterior surface of the humerus only in its distal third. Thus, the iatrogenic lesion of this structure will only take place if the implant is not placed in the anterior surface of the diaphysis or if there is nerve contusion or compression as a result of inadequate use of retractors or levers during humeral exposure.

**Bibliography**