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Minimally Invasive Plate Osteosynthesis in Humeral Shaft Fractures:tips and tricks

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INTRODUCTION:

Nonoperative treatments (U-slab or hanging cast) can successfully treat the majority of humeral shaft fractures [1, 2]. However, these techniques necessitate high compliance, and the choice of patient is a crucial element determining success or failure. Controlling fracture alignment is challenging in obese patients. The short-term effects of prolonged arm immobilization are negative and can result in impairment.

A common surgical technique that achieves a high union rate and permits early active motion of the shoulder and elbow is compression plate fixation. The radial nerve may be injured during the substantial surgical dissection of the compression plate [3].

According to reports, the locking intramedullary nail has an advantage in terms of biomechanics, causes less soft tissue damage, and produces excellent results [4, 5]. Those receiving nailing treatment have a higher prevalence of delayed union and shoulder dysfunction compared to those receiving open reduction and compression plating [4].When a patient has an open growth plate, a narrow or malformed medullary canal, or when intramedullary nails are not an option, they may not be able to undergo intramedullary nailing.

Minimally invasive plate osteosynthesis (MIPO), which was developed by the expert group of the AO, has recently become more popular in the successful treatment of lower extremity fractures [6, 7, 8, 9], but there are few reports of MIPO in the treatment of upper extremity fractures, such as humeral shaft fractures [10, 11, 12, 13, 14].The ability to perform MIPO of the humerus shaft via the anterior approach has been demonstrated in cadaveric research [11].Yet, it is a technically challenging procedure that requires anatomical knowledge of the structure that is at risk. In this article, a less intrusive surgical procedure for plating humeral shaft fractures is illustrated.

Principles and Goals of Surgery:

Less invasive percutaneous implantation of the plate using separate proximal and distal incisions on the anterior aspect of the humerus. Healing is aided by indirect reduction of the fracture, which preserves soft tissue at the fracture site. The musculocutaneous nerve on the anterior surface of the brachialis is recognized at the distal incision. The radial nerve on the posterolateral is shielded by the lateral half of the brachialis, which is divided in half along its midline and utilized as a cushion to protect the musculocutaneous nerve (medial half). Internal fixation with a 4.5-mm-narrow LCP (Locking Compression Plate) and reduction by manual traction.

Advantages:

1. The soft tissue and blood supply in the fracture zone are preserved through indirect reduction of the fracture by closed manipulation, accelerating indirect bone healing by callus development.
2. Tiny incisions, less bleeding.
3. Early rehabilitation; minimal soft-tissue dissection to prevent iatrogenic injury to the radial nerve.

Disadvantages:

1. Surgically demanding procedure.
2. An image intensifier is necessary for the indirect reduction of the fracture.

Indications:

1. Humeral shaft fractures, which are categorized as 12-A, B, or C by the AO.
2. Proximal or distal humeral shaft fractures, as well as a narrow or malformed medullary canal, which impede intramedullary nailing.
3. An open growth plate with a fractured humeral shaft that could be damaged by intramedullary nailing.

Contraindications:

1. Primary radial nerve palsy associated with humeral shaft fractures.
2. Fractures of the proximal humeral shaft that extend to the humeral head.
3. Significant tissue loss leaving bare bone unprotected.
4. Osteomyelitis or localized infection.
5. Delayed surgery makes closed reduction challenging.
6. Open surgery is necessary for reconstructive procedures (delayed union with necessary bone grafting).

Patient Information:

1. Common surgical risks like infection and problems with wound healing.
2. Radial nerve damage resulting in temporary motor and sensory dysfunction.
3. Musculocutaneous nerve damage resulting in temporary sensory impairment.
4. Postoperative radiographs demonstrating that while the bone has not completely reduced, it is still suitable for proper function.
5. A period of restricted activity, particularly when the arm must rotate due to proximal or distal shaft fractures, allowing for the fixation of each fragment with just two locking screws.
6. A 12–20 week healing period is anticipated.

Preoperative Work Up:

1. Radiographs of the affected arm's lateral and anterior-posterior (AP) surfaces. To confirm that the humeral head is free from fracture, the humeral head must be visible.
2. To allow fixation with at least two locking screws, the fracture's most proximal extension should be distal to the bicipital groove.
3. To permit fixation with at least two locking screws, the fracture's most distal extension should be close to the olecranon fossa.
4. Preoperative planning, including determining the plate's length, location, screw fixation sequence, and reduction manoeuvre.
5. The 4.5-mm narrow LCP does not require precontouring.
6. LCP is preferable in osteoporotic bone.

Surgical Instruments and Implants:

1. Instrument set for LCP large-fragment instruments.
2. Instrument for tunnel preparation.
3. Soft-tissue retractor
4. Tunneling instrument

Anesthesia and Positioning:

1.For total relaxation of the arm muscle during closed manipulation, general anesthesia is preferred.
2.Supine position with the forearm fully supinated and the arm abducted by 60 degrees. The arm is resting on a side table that is radiolucent. The assistant sits on the medial side of the arm, while the surgeon is seated on the lateral side.
3.On the other side of the arm from the surgeon, an image intensifier is situated. The humeral head's relationship to the olecranon fossa is verified in the image.
4.Unrestricted arm and shoulder draping.

Surgical Technique:

The conventional anterior approach to the humerus is merely two 3-cm incisions deep in the proximal region and one 3-cm deep in the distal region.

One feels the proximal incision and the space between the medial border of the deltoid and the lateral border of the proximal section of the biceps. A 3-cm proximal incision is made roughly 6 cm distal to the front part of the acromion process, and the dissection is then continued down to the humerus [10].

The 3-cm distal incision is made along the lateral side of the biceps, about 5 cm in front of the elbow's flexion crease. It is determined how much space there is between the brachialis and the biceps brachii. The radial nerve is located between the brachioradialis and the brachialis, posterior to the brachialis. The forearm needs to remain fully supinated. The radial nerve moves more laterally away from the distal humerus and the plate when the forearm is supinated, which reduces the risk of injury. To reveal the musculocutaneous nerve on the brachialis' anterior surface, the biceps is retracted medially [10].

To access the front surface of the distal humerus, the brachialis is divided longitudinally along its midline. The retractor is used to retract the musculocutaneous nerve and the medial part of the brachialis. The retractor is used to retract the lateral portion of the brachialis, which acts as a cushion to protect the radial nerve.Because the Hohmann retractor's tip will compress the radial nerve, it must not be used.

By advancing the tunneling instrument deep into the brachialis from the distal to the proximal incision, a sub brachial tunnel is made. Due to the close blending of the brachialis and deltoid muscle fibers along the anterolateral face of the tunnel, there may be some difficulties experienced during passage of the tunneling device at its proximal part.The tunneling instrument can penetrate through these muscle fibers at the tip and make the proximal incision by doing so. The tunneling instrument should be contacted and moved along the anterior or slightly anteromedial aspect of the humerus in order to prevent damage to the radial nerve at the lateral aspect of the distal humerus.

The chosen thin 4.5-mm LCP is linked with a suture to a hole at the tip of the tunneling instrument following preparation of the anterior sub brachial tunnel. Afterwards, the tunneling tool is removed, pushing the plate along the track it had previously made. By using this technique, the radial nerve is protected and the plate is directed into the proper tunnel. Depending on the level of the fracture, the plate is changed to the proper position.

By feeling the medial and lateral epicondyles and adjusting the image intensifier for a true AP view of the distal humerus, the plate is precisely positioned on the anterior surface of the distal humerus. While employing the LCP, one or two screws are used to initially secure the plate to the distal humerus. Manual manipulation is typically used to reduce the fracture. To restore the length and rotation, traction is utilized . One screw is placed into the proximal fragment after the length and rotation have been adjusted. At this point, the image intensifier can be used to manipulate the varus-valgus angulation. Lastly, at least two screws are placed in each fragment to complete the fixation.One locking screw is placed into each piece after the alignment is perfect. The alignment is checked once again using the image intensifier to make sure the locking screw is positioned correctly. If successful, each fragment is fixed with a minimum of two bicortical locking screws. Two bicortical locking screws are suitable for treating proximal and distal shaft fractures, with some postoperative activity. No suction drain is required.

Tips to Avoid Nerve Injury:

Hohmann retractors must not be utilized in the proximal or distal incisions because the tip will entrap the radial nerve on the medial or lateral of both incisions.

To ensure that the musculocutaneous nerve retracts with the medial half of the brachialis, the musculocutaneous nerve must be located before the brachialis is split.

There is a significant risk of radial nerve injury during bicortical drilling and screw fixation in the center of the humerus. Where possible, monocortically placed screws should be used to fixate the midshaft area.

Special Considerations:

1.Transverse fractures are more difficult to reduce than comminuted fractures. Comminuted fractures can be slightly shorted, however transverse fractures require the proper length to minimize the fragments; otherwise, the fracture would become angulated.

2.The MIPO technique is not advised for humeral shaft fractures with primary radial nerve palsy since there is no way to tell whether the harm to the radial nerve was caused by the surgery itself or another factor.

3.The LCP is preferred when the fragment is brief and the length only accommodates two screws. If used properly, the LCP offers angular stability in osteopenia bone and lowers the possibility of implant failure.

4. It is also beneficial to temporarily fix the plate to the bone during reduction using the TomoFix guide sleeve for 2.0-mm Kirschner wires, as well as to make sure the plate is in the centre of the bone by feeding the Kirschner wire through both cortices.

Postoperative Management:

1.On the second day following surgery, the patient is encouraged to move the shoulder and elbow as tolerated without external support.

2.Rotation of the arm is restricted until the callus is visible, often after 6 weeks, when the fixation is limited to only two screws in any fragment. Flexion and extension of the elbow and pendulum exercises of the shoulder are permitted.

3.Follow-up radiographs are taken at 6, 12 and 20 weeks, and at 12 months.

4.Removal of implant is optional

Errors, Hazards, Complications:

Before dividing the brachialis, the musculocutaneous nerve must be located to ensure that the nerve will be retracted together with the medial half of the brachialis: The sensory impairment brought on by nerve damage is usually minor and reversible. No surgical procedure is advised.

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