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Helical plating of the proximal humerus

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Summary The ideal treatment for fractures of the proximal humerus has not been definitively agreed upon. Several recent reports have described a technique of helical plating for proximal humeral fractures, in which the proximal plate is placed laterally on the greater tuberosity, and spirals 90° distally to lie on the anterior surface of the humeral shaft. The purpose of this study was to evaluate the feasibility of helical plating using a less invasive surgical approach and placing screws percutaneously in the distal plate. Dissection of 10 cadaveric upper extremity specimens was performed, using an extended anterolateral acromial approach followed by percutaneous helical plating. With the plate secured, the neurovascular structures which crossed the anterior humerus superficial to the plate were exposed and identified. Only the musculocutaneous nerve crossed anterior to the plate and was at risk for percutaneous screw placement. The nerve location was found in a consistent location among the specimens. The danger zone for the nerve location was found to be at an average of 13.5 cm from the greater tuberosity (99% CI: 12.2—14.8 cm). Though clinical experience is necessary to validate this plating technique, it appears that avoiding this danger zone in which the musculocutaneous nerve crosses will allow safe percutaneous screw placement and permit minimally invasive plating of these fractures.

Introduction

Fractures of the proximal humerus remain unsolved fractures. The vast number of surgical treatment methods which have been attempted and recommended in the past, as well as the debate between operative versus nonoperative management attests to this. Traditional plate fixation has been used frequently in the past, but has seen modest results, with several authors reporting significant rates of avascular necrosis and fixation failure.[1—4] These results may be due in part to devascularisation of the fracture fragments using an extensile open exposure, and also to the fact that many proximal humerus fractures occur in elderly patients with osteoporosis and poor bone quality for screw fixation.[5] The recent development and refinement of locking plate technology, in which the screws have threads on the conical undersurface of the heads to allow angular stability when fully seated in the plate, has led to new

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methods of ''biologic fixation'' which may be preferable in treating certain fractures.

There has been recent enthusiasm for locking plate constructs due to the fact that they address both devascularisation of the fracture site and osteoporotic bone fixation. These constructs may lead to improved stability compared to traditional plates in osteoporotic bone,[6] and are ideal for use with minimally invasive insertion techniques, so called ''biologic fixation'',[7–9] to avoid devitalising the soft tissue envelope of the fracture site. We have recently described the extended anterolateral acromial approach to the proximal humerus which involves isolation of the axillary nerve, and may be tailored to percutaneous plate fixation.[10] The distal extent of plate insertion along the lateral humerus, however, is limited by the deltoid insertion which is stout, and often difficult and undesirable to partially detach.[11,12]

The concept of helical plating has recently been described for the proximal humerus, in which a plate is twisted 90° to lie on the lateral aspect of the greater tuberosity proximally and the anterior or anteromedial humeral shaft distally.[11–13] Using the anterolateral acromial approach coupled with helical plating would be an attractive option for treating these fractures, allowing a minimally invasive surgical approach, avoidance of fracture site stripping, and application of percutaneous screws distally. Distal to the axillary nerve, the one neurovascular structure at risk with placement of percutaneous screws from anterior to posterior is the musculocutaneous nerve, which crosses from medial to lateral and runs distally between the biceps brachii and the brachialis. The purpose of this anatomic study was to determine the location of the musculocutaneous nerve as it crosses the anterior humeral shaft, and to describe a ''safe zone'' for percutaneous screw placement along the anterior proximal and middle humeral shaft.

Materials and methods

Ten fresh-frozen human cadaveric shoulders, each from a different donor, were obtained from the Anatomic Gift Registry. Average age was 67 years, and gross examinations and clinical histories were reviewed to exclude any history of shoulder pathology. Specimens included the entire scapula, clavicle and humerus, with intact associated soft tissues.

With the shoulder in 0° of abduction, a skin incision was made from the anterolateral tip of the acromion, extending approximately 8–10 cm distally. An extended anterolateral acromial approach to the proximal humerus was performed, and the axillary nerve was identified and protected, as previously described. Following splitting of the anterior deltoid raphe and identification of the axillary nerve, an elevator and tonsil clamp was slid deep to the nerve and deltoid distally to the deltoid tuberosity to create a path for the plate. Once the deltoid insertion was reached, the instrument was slid medially and continued distally deep to the biceps brachii to free the investing alveolar tissue.

A 16-hole, 4.5 mm locking reconstruction plate (Synthes, Paoli, PA) was then contoured, based on an anatomical model of the humerus. The configuration was such that the proximal limb was flush on the greater tuberosity laterally, and the distal limb rotated 90° anteriorly to pass between the deltoid and pectoral insertions to lie on the anterior humeral shaft (Fig. 1). The plate was then secured in place proximally by fixation into the humeral head, and distally to the humeral shaft using a stab incision anteriorly. Dissection was then performed in each specimen of the proximal region of the musculocutaneous nerve, paying particular attention to where the nerve crossed to lie anterior to the humeral shaft. A K-wire was placed along the medial margin of the humerus, at the apex of the ''V'' formed by the nerve and the humerus. The distance between the lateral prominence of the greater tuberosity and the level of the crossing of the musculocutaneous nerve on the humerus (as previously marked with a K-wire) was measured using a dial caliper accurate to within 0.025 mm. The mean and standard deviations were then calculated for the group of specimens, as were the limits of the 99% confidence interval. In addition, the number of the hole of the plate which was in the closest proximity to the crossing of the nerve was determined.

Results

A submuscular path was successfully created between the humerus and the deltoid and biceps in all specimens. After plate insertion and fixation, the musculocutaneous nerve was found without difficulty. The average distance from the lateral prominence of greater tuberosity to the point where the nerve crossed the medial border of the humeral shaft was 13.5 cm (range, 11.8–15.4 cm, S.D. 1.3 cm). The lower boundary of the 99% confidence interval was 12.2 cm and the upper boundary was 14.8 cm.

Discussion

To preliminarily determine the feasibility of inserting percutaneous screws anteriorly into the upper