Spatial Anatomy of the Radial Nerve in the Extended Deltopectoral Approach
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INTRODUCTION:
The extended deltopectoral approach is frequently used in revision shoulder arthroplasty and periprosthetic trauma. Iatrogenic radial nerve injury is a known complication during shoulder and humerus surgery. A detailed understanding of the anatomic course of the radial nerve relative to intraoperative landmarks is essential in preventing iatrogenic radial nerve injury.

METHODS:
Twenty fresh frozen upper extremities (ten intact cadavers) were dissected using an extended deltopectoral approach. We measured the relative distances of the upper margin (UMRN) and the lower margin (LMRN) of the radial nerve (defined as the points where the nerve crossed the medial and lateral humeral planes, respectively), to the proximal and distal pectoralis major and deltoid insertions both manually and fluoroscopically. The tendinous borders were used to demarcate four proximal humeral zones (Zone I: proximal pectoralis major tendon to proximal deltoid tendon, Zone II: proximal deltoid tendon to distal pectoralis major tendon, Zone III: distal pectoralis major tendon to distal deltoid tendon, Zone IV: distal to the distal deltoid tendon). The zone where the radial nerve crossed the medial humeral plane was recorded.

RESULTS:
On fluoroscopic measurement, the mean distances between the UMRN and the proximal pectoralis major tendon was $71.6 \pm 2.1 \text{mm}$, the proximal deltoid tendon to UMRN was $26.2 \pm 2.5 \text{mm}$, and the distal pectoralis major insertion to UMRN was $3.3 \pm 2.7 \text{mm}$. Unlike the other three tendinous landmarks, the distance between the distal deltoid tendon to UMRN was $-37.8 \pm 3.1 \text{mm}$ (located distal to the UMRN). The incidence of radial nerve either entering or having already entered the spiral groove within each defined zone was: Zone I- 0%, Zone II-50%, Zone III and IV- 100%. There was a significant association between anatomic zone and radial nerve entry into the spiral groove ($\chi^2(3) > 64.53$, $p < 0.001$).

DISCUSSION AND CONCLUSION:
Cerclage wiring proximal to the proximal deltoid tendon insertion avoids entrapment of the radial nerve, as none of the specimens in this study exhibited radial nerve entry into the spiral groove in Zone I. The closest longitudinal distance between the UMRN and the proximal deltoid insertion was 6.0mm on manual measurement and 5.2mm on fluoroscopic measurement. The risk of iatrogenic radial nerve injury can be mitigated by understanding the surrounding anatomic landmarks, specifically the deltoid and pectoralis major tendon insertions on the humerus. We recommend cerclage wiring proximal to the proximal aspect of the deltoid insertion, (Zone I) from lateral to medial, in order to avoid entrapment of the radial and axillary nerves.