Is sparing the pronator quadratus muscle possible in volar plating of the distal radius?

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Abstract
We measured the length of the distal radius that can be exposed by mobilizing the distal edge of pronator quadratus (PQ) without detaching its radial attachment. Measurements were made in 20 cadaveric upper limbs from the distal margin of the radius in line with the scaphoid and lunate fossae to the distal margin of the PQ, before and after mobilization of the muscle from its distal attachment. The mean distance from the distal edge of the PQ to the scaphoid fossa was 13.1 mm and to the lunate fossa was 10.7 mm. This increased to a mean of 26.2 mm for the scaphoid and a mean of 23.8 mm for the lunate fossa following mobilization of PQ. Subperiosteal retrograde release of the PQ from its distal margin will allow for the placement of a volar plate and insertion of locking peri-articular screws in the great majority of volar locking plate systems on the market.

Keywords
Distal radius fracture, pronator quadratus sparing approach, volar plating of distal radius, cadaver study

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Introduction
Pronator quadratus (PQ) is a quadrilateral muscle with attachments at the distal volar aspect of the ulna and radius. Superficial and deep heads have been described. It is thought that the superficial head is responsible for pronation of the forearm, whilst the deep head is involved in stabilization of the distal radio-ulnar joint (DRUJ) [Stuart, 1996; Gordon et al., 2003]. With the development of volar locking plates, the volar approach to the distal radius is being increasingly used for fracture management. This approach involves dividing the PQ from its radial border and reflecting it ulnarily. Repair of the PQ at the end of the operation is difficult. This can leave the metalwork in direct contact with the overlying flexor tendons. In addition, post-operative scarring around the PQ may cause pain or impede forearm pronation and supination, leading some authors to advocate preserving the PQ during the volar approach for plating of the distal radius [Imatani et al., 2005; Dos Remedios et al., 2009; Sen et al., 2008] provided it does not compromise the operation.

The aims of this study were to assess the length of the distal radius that can be exposed by mobilizing the distal edge of PQ without detaching its radial attachment and whether this exposure is adequate for the reduction and fixation of fractures of the distal radius.

Materials and Methods
Twenty cadaveric upper limbs (10 left, 10 right) preserved using the method of Thiel (1992) were used. This unique embalming technique was developed...
over a period of 30 years in the Department of Anatomy at the University of Graz, Austria. It preserves tissue colour and consistency, as well as allowing an almost full range of movement at articular joints. The mean age of the donors had been 75 years (range 60–82 years) at time of death. There were 10 male and 10 female donors. All limbs exhibiting intra-articular pathology or signs of previous injury were excluded.

A longitudinal incision was made over the tendon of flexor carpi radialis (FCR). The tendon was identified and mobilized to the radial edge of the incision. The bed of the FCR tendon sheath was incised in line with the skin incision. Blunt dissection was then performed to expose PQ. At this point the maximum width of PQ along the anatomical axis of the radius was measured. Further soft tissue dissection allowed the exposure of the entire distal border of PQ and the distal most projection of the volar surface of the radius (Figure 1). A volar capsulotomy facilitated the identification of the middle of the scaphoid and lunate fossae.

Measurements were made in millimetres from the distal margin of the radius in line with the scaphoid and lunate fossae to the distal margin of the PQ using a vernier caliper (Figure 1). The distal edge of PQ was then mobilized first by sharp dissection with a knife from the periosteum (Figure 2) and then with a periosteal elevator, preserving the radial insertion (Figure 3). This allowed proximal retraction of the muscle revealing more of the distal radial cortex. The measurements were then repeated with the muscle retracted (Figure 4).

Results

PQ had a mean width of 44.6 mm (range 33–52; SD 4.9). Mean distance from the distal edge of the PQ to the scaphoid fossa was 13.1 mm (range 8–18; SD 2.7) (Figure 1). This increased to a mean of 26.2 mm (range 19–32; SD 3.3) after PQ was mobilized (Figure 4). Mean distance from the distal edge of the PQ to the lunate fossa was 10.7 mm (range 5–18; SD 3.6) (Figure 1). This increased to a mean of 23.8 mm (range 11–32; SD 5.7) following mobilization of PQ (Figure 4). We did not note any difference between male and female limbs.

Discussion

PQ was demonstrated by Stuart (1996) to possess superficial and deep heads. Using in vitro and in vivo techniques, the main role of the superficial head was
Figure 2. Distal border of PQ is mobilised. PQ, pronator quadratus.

Figure 3. Subperiosteal mobilisation of PQ. PQ, pronator quadratus.

Figure 4. Capsulotomy to identify lunate and scaphoid fossae for measurement. Pronator quadratus is mobilised and retracted. The distances measured from the lunate (L) and scaphoid (S) fossae are indicated in mm.
shown to be forearm pronation, whereas the main role of the deep head was in the dynamic stabilization of the distal radioulnar joint.

In the standard volar approach to the distal radius, release of PQ at its radial insertion may compromise the muscle’s function and affect recovery. The repair of PQ is often suboptimal due to the very short tendon or a very contused and friable muscle that cannot be sutured. As a result, repair is often incomplete and may leave the plate in direct contact with the overlying flexor tendons, leading to an increased propensity for tendon irritation and rupture (Ateschrang et al., 2010). In addition, even if the PQ is anatomically repaired pain may restrict functioning, certainly in the short term, but scarring may affect functioning in the long term.

The pronator sparing technique, as described by Sen et al. (2008), avoids division of the PQ at its radial border and utilizes subperiosteal dissection of the PQ in a retrograde fashion from its distal margin. It utilizes two small incisions: one for the insertion of the diaphyseal screw in the oblong hole of the plate and the more distal incision for plate insertion and placement of the peri-articular screws. This limits dissection so it is only appropriate for extra-articular and some partial articular fractures amenable to closed reduction techniques. With preservation of PQ in an otherwise standard volar approach the plate is slid in a retrograde fashion from the distal margin of PQ and screws inserted via stab incisions through the midsubstance of PQ (Figure 5). This allows for better mobilization and reduction of more complex articular fractures. There is a theoretical additional advantage of better preservation of the blood supply to the distal radius and DRUJ by avoiding damage to the branches of the anterior interosseous artery that pass through the PQ (Mikic, 1992; Rath et al., 1990; Sheetz et al., 1995).

This cadaveric study demonstrates that following subperiosteal retrograde release of PQ from its distal margin, on average 26.2 and 23.8 mm of the distal radius may be adequately exposed from the scaphoid and lunate fossae, respectively. This will allow for the placement of the plate and insertion of locking peri-articular screws in the great majority of volar locking plate systems on the market.

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**Conflict of interests**

None declared.

**References**


