Submuscular plate position in volar plating of the distal radius – an anatomic study

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The aim of this study was to assess the length of the distal radius that is possible to expose by mobilizing the distal edge of Pronator Quadratus (PQ) without detaching its radial attachment and whether this exposure is adequate for the reduction and fixation of fractures of the distal radius.

A total of twenty cadaveric upper limbs (10 left, 10 right) were used. The distal radius was approached through a standard incision through the bed of flexor carpi radialis. Measurements were made from the distal margin of the radius in line with the scaphoid fossa and lunate fossa to the distal margin of the PQ. The distal edge of PQ was then mobilized first by sharp dissection with a knife from the periosteum and then with a periosteal elevator, preserving the radial insertion. This allowed proximal retraction of the muscle revealing more of the distal radial cortex. The measurements were then repeated with the muscle retracted.

The mean distance from the distal edge of the PQ to the scaphoid fossa was 13.1mm (Range 8 – 18; SD ±2.7) and to the lunate fossa was 10.7mm (Range 5 – 18; SD ±3.6). This increased to a mean of 26.2mm (Range 19 – 32; SD ±3.3) for the scaphoid and a mean of 23.8mm (Range 11 – 32; SD ±5.7) 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.

Pronator quadratus (PQ) is a quadrilateral muscle with attachments at the distal volar aspect of the ulna and radius. A superficial and deep head have been described in the PQ. 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) (1,2). The volar approach to the distal radius is being increasingly used for fracture management with the development of volar locking plates. This approach involves dividing the PQ from its radial border and reflecting it ulnarly. Repair can be suboptimal as the radial insertion of PQ has a very short tendon and the contused muscle is often impossible to suture. 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 to advocate preserving the PQ during the volar approach for plating of the distal radius (3–5). This of course should not be undertaken if it compromises the access to the distal radius, the reduction of the fracture or the fixation with a correctly positioned plate.

The aim of this study was to assess the length of the distal radius that is possible to expose 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 & methods

A total of twenty cadaveric upper limbs (10 left, 10 right) preserved using the method of Thiel were used (6). This unique embalming technique was developed over a period of 30 years in the Department of Anatomy in the University of Graz, Austria. It preserves tissue color 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 to 82 years) at the time of death. Ten limbs were from male and 10 from 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 preformed 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. A volar capsulotomy facilitated the identification of the middle of the scaphoid and lunate fossae.

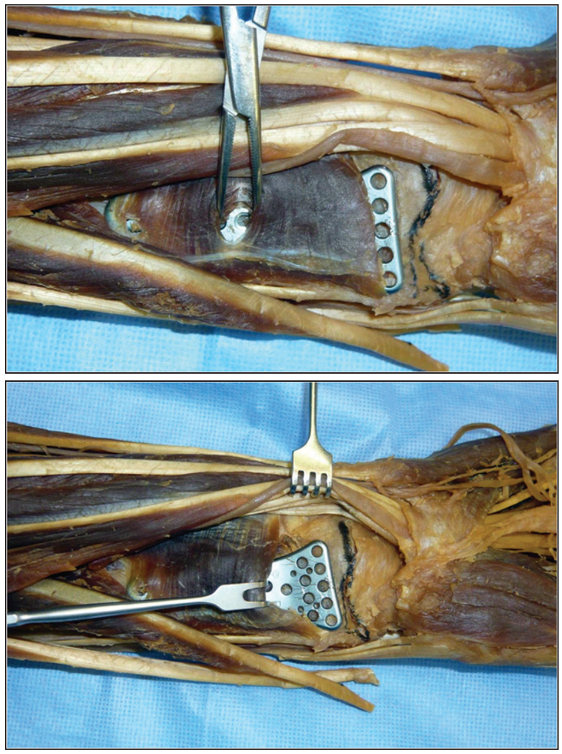
Measurements were made from the distal margin of the radius in line with the scaphoid fossa and lunate fossa to the distal margin of the PQ. The distal edge of PQ was then mobilized first by sharp dissection with a knife from the periosteum and then with a periosteal elevator, preserving the radial insertion. This allowed proximal retraction of the muscle revealing more of the distal radial cortex. The measurements were then repeated with the muscle retracted. All measurements were recorded in millimeters using a vernier caliper.

Results

Pronator quadratus had a mean width of 44.6 mm (Range: 33 – 52 mm, SD: ±4.9).

The mean distance from the distal edge of the PQ to the scaphoid fossa was 13.1mm (Range 8 – 18; SD ±2.7) . This increased to a mean of 26.2mm (Range 19 – 32; SD ±3.3) after PQ was mobilized.

The mean distance from the distal edge of the PQ to the lunate fossa was 10.7mm (Range 5 – 18; SD ±3.6) . This increased to a mean of 23.8mm (Range 11 – 32; SD ±5.7) following mobilization of PQ .



Figures: anatomic specimen

Discussion

The PQ was demonstrated by Stuart to possess a superficial and a deep head (1). Through in vitro and in vivo techniques, the superficial head was shown to be the prime mover in forearm pronation, whereas the deep head was shown to be involved in the dynamic stabilization of the distal radioulnar joint.

In the standard volar approach to the distal radius, the release of the PQ at its radial insertion may compromise this 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 which 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 ruptures (7). In addition, even if the PQ is repaired anatomically 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 (5) spares 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 place 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. We suggest only the preservation of PQ in an otherwise standard approach where the volar plate is slid from the distal margin of the PQ in a retrograde fashion and screws may be inserted via stab incisions through the PQ. This allows for better mobilization and reduction of more complex articular fractures. The additional theoretical advantage of using such an approach is the preservation of the blood supply to the distal radius and DRUJ (8,9). The anterior interosseous artery, radial and ulnar arteries supply the PQ and branches from the anterior interosseous artery pierce the periosteum to supply the distal radius (10).

This cadaveric study demonstrates that following subperiosteal retrograde release of the PQ from its distal margin, on average 26.2mm and 23.8mm 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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