Pronator Quadratus Rotational Muscle Flap Technique for Coverage of Hardware After Distal Radius ORIF

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ABSTRACT

Flexor tenosynovitis and tendon rupture are rare. Yet these occurrences can be serious complications after treatment of a fractured distal radius with a volar plate. The highest incidents of rupture are associated with the plate on or distal to the watershed line of the radius. Although studies have shown that reattachment of the pronator quadratus (PQ) following plating does not lead to improved measures in grip strength or range of motion, it is possible that doing so may reduce the incidence of flexor tendon irritation or rupture. Reattachment of the PQ after a standard approach does not often capture the distal edge of the plate. We present a new technique for a rotation muscle flap of the PQ muscle that improves coverage of the volar distal radius plate.

Keywords: Pronator Quadratus, Distal Radius Fracture, Volar Plating, Tendon Rupture

INTRODUCTION

Repair of the pronator quadratus (PQ), in the context of volar plating for distal radius fractures, has been challenged in recent years. The pronator quadratus is a trapezoid-shaped muscle that originates from the volar distal fourth of the ulna, and inserts into the volar lateral border of the distal fourth of the radius. It is composed of two heads with different functions: (1) a superficial and distal head mainly involved with pronation, and (2) a deep proximal head that stabilizes the distal radioulnar joint (DRUJ).[1,2,3] Although evidence for repair of the PQ is still ambiguous,[4,5] many surgeons still routinely repair the PQ in their practice. This practice is typically performed to prevent plate irritation and possible postoperative rupture of the flexor tendons.[6] Distal radius fractures can be associated with high-energy trauma, leading to partial destruction of the PQ and making primary repair challenging. In order to overcome this problem, various authors have developed innovative techniques. Huang et al[7] performed a technique where the PQ is split along its more distal aspect in a transverse fashion. This technique allows a portion of the muscle to cover the distal aspect of the volar plate, which is at the highest risk for flexor irritation. Most recently, Hohendorff et al[8] published a technique where part of the brachioradialis muscle is included during the PQ muscle dissection, thus facilitating primary repair. To overcome the disruption of the PQ muscle altogether, some authors have suggested the use of pronator quadratus-sparing approaches for distal radius fracture fixation.[9,10]

Repair of the PQ can be difficult owing to individual anatomical differences, destruction secondary to trauma, and poor suture retention by muscle tissue.[11] To allow for appropriate advancement of the muscle tissue to cover the volar and most distal aspect of the plate, we propose releasing the pronator quadratus proximally and ulnarly after volar plating of the distal radius for fracture or osteotomy. The muscle functions as a biological gliding pad, allowing for the flexor pollicis longus (FPL), flexor digitorum profundus (FDP), and flexor carpi radialis (FCR) tendons to glide over the muscle without direct contact with the plate.[11] The pronator quadratus is also important in forearm pronation, grip strength, and DRUJ stability.[11] It has been found to contribute considerably to pronation, and it can result in functional deficits if damaged.[11] Although PQ repair does not seem to affect clinical outcomes in regard to DASH (Disabilities of the Arm, Shoulder, and Hand) scores, some patients have shown improvement in strength postoperatively.[11,12,13]

The anterior interosseous nerve (AIN) innervates the PQ muscle after supplying the FPL and FDP. The AIN and anterior interosseous artery (AIA) follow the same course between the interosseous membrane and the deep aspect of the PQ muscle. The entry zone of the AIN branch to the PQ is 3 cm proximal to the ulnar

styloid process, and covers the distal 13% of the forearm length.[2] The AIA and AIN enter the muscle centrally and dorsally, thus ulnar-sided back cutting will not devascularize or denervate the muscle.

This procedure can be used as an adjunct for plate coverage during volar plating of the distal radius for both fracture fixation and osteotomy. This procedure is useful in trauma cases where the PQ muscle is damaged, limiting its use for coverage of the volar plate. The exposure of the entire PQ muscle is generally required for volar plating of the radius, thus there is no increase in needed exposure. There is no absolute contraindication to this technique. However, considerable damage to the anterior interosseous artery could preclude its use, because the creation of the flap could alter the muscle's blood supply and lead to necrosis.

TECHNIQUE

The distal radius is approached using the extended FCR approach.[6] The pronator quadratus is raised off the volar aspect of the distal radius to obtain adequate exposure. The dissection starts distally at the lunate facet and moves to the radial aspect of the radius (Figure 1). At this point, the ulnar attachment of the muscle is left untouched and the muscle is reflected ulnarly. After completion of the distal radius fixation, the pronator quadratus muscle is addressed (Figure 2). In order to obtain complete coverage of the distal aspect of the plate, the ulnar aspect of the muscle is transected from proximal to distal. This incision is done on the ulnar aspect of the PQ muscle tendon insertion to ensure preservation and inclusion of the neurovascular bundle into the flap. An incremental increase of the ulnar sided incision will allow more mobility of the muscle flap, thus providing better plate coverage distally (Figures 3 and 4). Transection of more than 75% will result in further distal plate coverage, but proximal plate coverage will begin to be sacrificed.

DISCUSSION

The key objective of this technique is to obtain coverage of the volar plate in order to reduce irritation of the flexor tendon. The creation of a back cut should allow adequate mobilization of the PQ muscle, thus creating a flap that will preserve its function and place vascular muscle as padding between the plate and overlying flexor tendons. Other authors have described the distal radius approach with pronator sparing technique, but

Figure 1. *Appearance of the pronator quadratus (PQ) muscle after dissection for volar plating. The neurovascular bundle is indicated by the blue arrow. The PQ spans from the 8 to 13 cm markings.*

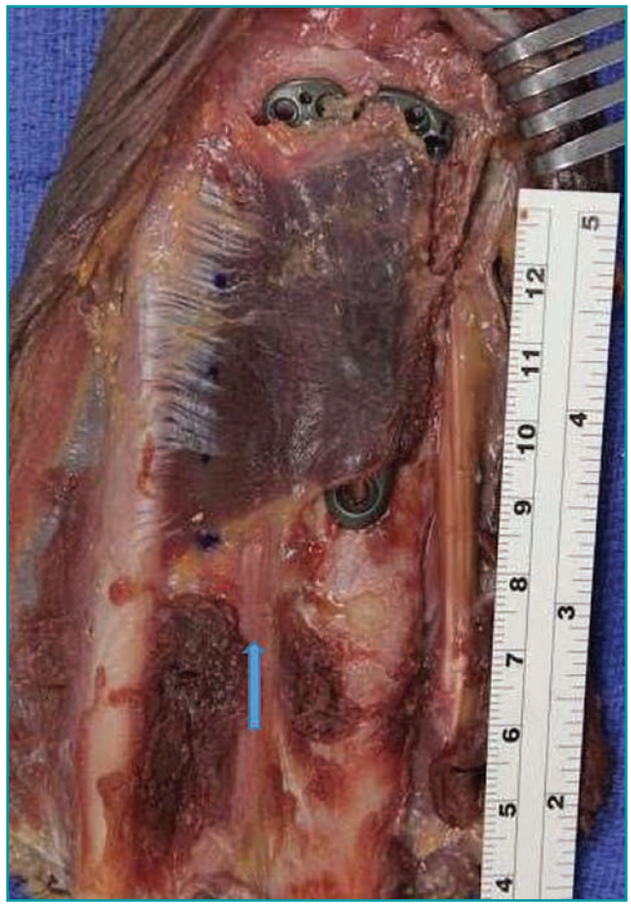

Figure 2. *Appearance of pronator quadratus (PQ) muscle once volar locking plate is in place. The blue arrow indicates the neurovascular bundle. The PQ was raised radially for the exposure and is able to be mobilized distally by about 1 cm.*

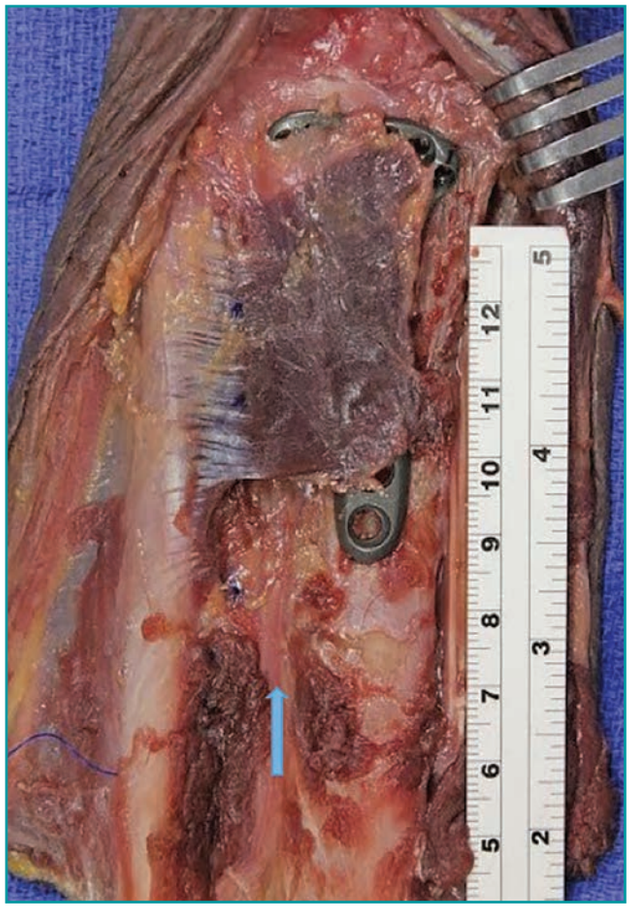

Figure 3. *Creation of the muscle flap with back-cut of 25% of the ulnar side of the muscle. The blue arrow indicated the neurovascular bundle. The pronator quadratus is able to be mobilized distally by about 2 cm.*

Figure 4. *Muscle flap created with incision of 50% of the ulnar side of the pronator quadratus. Note the increased reach of the muscle flap distally.*

few reports of muscle flap have been published so far.[7,8] Descriptions of minimally invasive plate osteosynthesis utilization have been increasingly published in the literature. However, acceptance by upper-extremity surgeons is limited due to the technical complexity.[9,10] This technique is straightforward and offers an adjunct to standard PQ repair.

The main complication associated with this procedure is injury of the neurovascular bundle during flap elevation, which could lead to paralysis secondary to anterior interosseous nerve injury with subsequent loss of pronator function. Likewise, injury to the anterior interosseous artery can cause muscle necrosis with loss of plate coverage as an end result. However, this complication can be prevented if the muscle dissection is performed with the known anatomic landmarks of the neurovascular bundle in mind.

A possible criticism of this technique is whether the muscle will retain its function after the procedure. Although we do not yet have studies evaluating the strength and function of PQ after this technique, the muscle's insertion is reestablished during repair and half of the origin is preserved. The muscle also should retain its vascularity and innervation, given that the neurovascular pedicle is not disturbed. The effect of the strength and function of PQ would be a possible future area of investigation.

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