Introduction

Distal radius fractures continue to be the most common fractures of the upper extremity. Volar plating of these fractures has become the new bastion of open treatment with the development of a multitude of volar fixed angle plating systems. This approach has many benefits: early return of function, improved final motion, and the virtual elimination of routine plate removal.

Frequently overlooked is the damage to the overlying soft tissue envelope that can occur quite often during traumatic fractures. Although most fractures of the distal radius are closed, soft tissue injury varies with the mechanism of injury. Specifically, perforation of the soft tissue by the ulnar styloid can occur after traumatic radial shortening, creating open fractures and wounds that require complex reconstruction.

Complex injuries including distal radius fractures and soft tissue injury need combined boney and soft tissue reconstruction that can frequently be treated simultaneously with careful preoperative planning. This work describes an operative technique used for the combined volar approach to open reduction and internal fixation of the distal radius with concomitant flap elevation and soft tissue coverage using a radial artery perforator flap. The relevant anatomy, combined operative approach, and clinical example are described.

Case Presentation

The patient is a 46 year-old right-handed female who presented with severe polytrauma after a motor-vehicle accident. She sustained a Galeazzi-type injury with dislocation of the left distal ulna perforating the soft tissue and a comminuted fracture of the left distal radius. Due to the overall critical nature of her initial status, the radius fracture was stabilized with an external fixator and the open ulna wound was debrided resulting in a 4 x 2 centimeter wound.

Over the course of the ensuing week, it was noted that the radial fracture was losing height due to the communition even with the external fixator stabilization. Subsequent removal of the external fixator and open reduction internal fixation for stabilization of the radius fracture was planned. In addition, the significant soft tissue injuries also need to be rectified. The triangular fibrocartilage complex needed repair and the ulnar wound also required surgical attention as there was exposed bone additionally necessitating definitive reconstruction.

The radial artery perforator flap was preoperatively marked. Flap harvest and fracture plating was planned through the same volar linear incision (Figure 1) and carried out by first carefully raising the flap followed by internal fixation of the radius. A linear skin incision along the axis of the radial artery is made in the volar forearm and the skin is elevated off the underlying fat and fascia. Next, a 4-cm-wide adipofascial flap that includes the deep fascia is raised from a proximal to distal

direction, leaving the radial artery intact. The perforator vessels in the proximal forearm can be ligated as need to allow and adequate arc of rotation of the flap. To avoid injury, the distal perforating vessels used to supply the flap are not isolated or skeletonized. Care is taken to preserve the integrity of the superficial radial nerve and it branches.

After the pedicle is raised, the proximal end of the flap is transected and the flap is transposed and inset along similar lines to the retrograde radial forearm fascial flap. The flap can be safely passed through a subcutaneous tunnel to the distal defect. The flap is the inset into the defect. The forearm donor site can be closed primarily with the plan for skin graft coverage of the flap in a subsequent procedure.

Discussion

Weinzweig et al. had originally described several case studies, one involving a gunshot wound to the hand requiring an open reduction and internal and external fixation with bone graft along with a radial fasciosubcutaneous flap. The flap and overlying skin graft appeared ischemic on post-operative day 6 and eventual debridement was performed, but it has since been described that delaying skin grafting greatly affects viability due initial flap edema.[9] This initial flap edema may be due to the time-delay needed for reversal of venous blood flow. We had delayed skin grafting for several days to allow for edema to diminish and improve skin graft take.

Chang et al. first described the radial artery perforator flap in 1988 as an alternative to previously used soft tissue reconstructive methods including the radial forearm fasciocutaneous flap, free flaps with microsurgery, and distant flaps.[10] Chang's method was mainly a comparison between the radial forearm fasciocutanous and fasciosubcutaneous flaps. Both allow for excellent coverage of soft tissue defects and maintain pliability and tendon gliding with the utilization of local tissue. The latter has fallen into favor with the advantage of better cosmetic appearance, ability to be preformed in one operation, and no need for microsurgery. It also has the capability to be used when there is a direct contraindication to the former procedure, which requires a completely patent ulnar collateral circulation since the radial artery must be sacrificed.[2, 7, 8, 9] The fasciosubcutaneous perforator flap instead utilizes the retrograde circulation plexus of deep perforator branches of the radial artery and their counterpart venous system that have been identified by various anatomic cadaveric dissections.[1, 8, 9]

The distal radius fractures are most commonly repaired via a volar approach, as was done with our case. The benefits of the volar versus dorsal approach are directly related to the increased tendon space between the skin and bone surface, the concave surface of the distal radius, and the less precarious blood supply as compared with the dosal surface of the forearm.[1, 6] Galeazzi fractures specifically can present a particular challenge with complications including decreased grip strength, decreased range of motion, sensory and motor deficits, and radial shortening after healing.[4] Consequently it is important to identify them and take

special care to ensure approximation at both the diaphyseal break and the distal radial unlar joint (DRUJ) with a possible repair of the triangular ligament complex.

Radial artery perforator flaps have been described in several studies as the best option for soft tissue defects of the hand, [1, 2, 3, 9] and seen used in conjunction with elbow reconstruction performed by Tiengo et al.[8] This case presented similar to ours with the initial surgery consisting of wound debridement and external fixator placement, but Tiengo subsequently repaired the soft tissue defect first with the proximal radial artery perforator flap prior to the permanent repair of the boney defect rather than in a one step procedure like ours.

Summary

Distal radius fractures can be associated with destruction of the soft tissue envelope specifically, puncture wounds resulting from traumatic ulna perforations. A combination approach for volar plating of the distal radius fractures can be used in conjunction with radial artery perforator flap elevation to address both injuries simultaneously through the same surgical wound.

COMORBID CONDITIONS
SOFT TISSUE EDEMA AND THEN CAN LOSE YOUR REPAIR
PLATING NEEDED

References

1. Chang, S., Hou, C., Zhang, F., Lineaweaver, W.C., Chen, Z., Gu, Y. Distally based radial forearm flap with preservation of the radial artery: anatomic, experimental, and clinical studies. *Microsurgery* 2003; 23(4): 328-337.

2. Ho, A. M., Chang, J. Radial artery perforator flap. *Journal of Hand Surgery* 2010; 35(2): 308-311.

3. Matel, I., Georgescu, A., Chiroiu, B., Capota, I., Ardelean, F. Harvesting of forearm perforator flaps based on intraoperative vascular exploration: clinical experiences and literature review. *Microsurgery* 2008; 28(5): 321-330.

4. Moore, T.M., Klein, J.P., Patzakis, M.J., Harvey, J.P. Results of compression-plating of closed Galleazzi fractures. *The Journal of Bone and Joint Surgery* 1985; 67-a(7): 1015-1021.

5. Orbay, J. Volar plate fixation of distal radius fractures. *Hand Clinics* 2005; 21; 347-354.

6. Protopsaltis, T. S., Ruch, D.S. Volar approach to distal radius fractures. *Journal of Hand Surgery* 2008: 33A: 958-965.

7. Saint-Cyr, M., Mujadzic, M., Wong, C., Hatef, D., Lajoie, A.S., Rohrich, R. The radial Artery perforator flap: vascular analysis and clinical implications. *Plastic & Reconstructive Surgery* 2010; 125(5): 1469-1478.

8. Tiengo, C. Macchi, V., Porzionato, A., Stecco, C., Parenti, A., Bassetto, F., De Caro, R. The proximal radial artery perforator flap (PRAP-flap): an anatomical study for its use in elbow reconstruction. *Surgical Radiologic Anatomy* 2007; 29: 245-251.

9. Weinzweig, N., Chen, L., Chen, Z. The distally based radial forearm fasciosubcutaneous flap with preservation of the radial artery: an anatomic and clinical approach. *Plastic and Reconstructive Surgery* 1994; 94(5): 675-684.

10. Chang, Y.T., Wang, X.F., Zhou, Z.F., Di, S.Y., Sun, Y.C., Chang, J. The reversed forearm island fasciocutaneous flap in hand reconstruction: Ten successful cases. *Chinese Journal of Plastic Surgery and Burns* 1988; 4: 41-42.