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Case Report

Hand and wrist reconstruction with a posterior interosseus artery flap: case report and literature review

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ABSTRACT

The posterior interosseous artery flap (PIAF) is an invaluable tool in reconstructive hand surgery, providing a versatile and reliable option for soft tissue defects while maintaining the major vascular axes of the upper limb. We provide a comprehensive review of the PIAF, describe the relevant vascular anatomy, including the origin and course of the posterior interosseous artery (PIOA), and discuss the many advantages of this flap, such as excellent tissue match and the avoidance of major artery sacrifice. Also, discussed are the surgical technique and possible complications, particularly venous congestion, and their management. Finally, we address the disadvantages of the procedure, including the challenging dissection near the posterior interosseous nerve and the limitations in flap width, to provide a balanced perspective for the reconstructive surgeon.

Keywords: Posterior interosseus artery, Posterior interosseus artery flap- hand reconstruction, Dorsal hand defects, Upper limb reconstruction

INTRODUCTION

A better understanding of the vascular architecture of the upper limb has led to an increase in the number of flap choices available for upper limb reconstruction. The reconstruction of the upper limb was previously accomplished using random flaps and staged pedicled remote flaps, both of which produced disappointing outcomes. The common interosseus artery and, less frequently, the ulnar artery in the proximal forearm are the two arteries that give rise to the posterior interosseus artery, also known as the PIOA.[1] It does not sacrifice a major artery of the hand; it has an excellent color, texture, and size match for hand and wrist reconstruction; it preserves the lymphatics on the volar forearm; and it has a reliable vascular anatomy, with its long, straight vascular pedicle with a satisfactory rotation arc. These are just a few of the many advantages it offers. Disadvantages include the fact that the PIOA is located near the posterior interosseous nerve, which makes it difficult to separate the two. To avoid injuring the posterior interosseus nerve, it is necessary to employ effective microsurgical techniques.[2] Additionally, the width of the PIAF is restricted, and the donor site must

undergo a split skin graft if the width exceeds 5 centimeters. Furthermore, the procedure requires a laborious dissection.[3]

CASE REPORT

62-year-old male with a 15-year history of poorly controlled type 2 diabetes. Ten days before the presentation, the patient visited the emergency department due to severe pain, swelling, redness, and increased temperature on the dorsal aspect of the right hand, specifically affecting the 4th metacarpal region and ring finger. The patient was admitted to the Department of Plastic and Reconstructive Surgery and underwent surgical debridement and amputation of the fourth finger. The dorsal defect of about 10 cm involving the extensor tendons was covered with a posterior interosseous flap. This flap evolved satisfactorily without tissue loss, providing a complete coverage of the dorsal hand. The hand can be brought up and flexed at the wrist without limitation. Also, the forearm shows supination and pronation without any compromise. We have evaluated this case carefully and the clinical and functional results were satisfactory after 3 months. We believe that this flap is an excellent choice for providing protection to the distal formarm and dorsal aspect of the hand.



Figure 1: Dorsal surface of the right hand, principal defect.



Figure 2: Design, interosseous posterior flap.



Figure 3: Dissection interosseus posterior flap.



Figure 4: Defect cover with PIAF, postoperative results.



Figure 5: Follow-up 14 days after surgery.

DISCUSSION

The history of upper extremity reconstructive surgery is one of the most intriguing stories in the history of plastic surgery. For decades, the treatment of soft tissue abnormalities of the hand and wrist has posed a problem for surgeons who have had to rely on limited and often inadequate instruments. Before the advent of axial pattern flaps, random patterns and staged pedicled remote flaps were common.[4] They were unreliable covers. The results were not satisfactory. This phenomenon was particularly

seen when the flap was transferred to a compromised recipient or when larger dimensions were required. Flaps were random, lacked an axis, and were subject to the tenuous blood supply of the subdermal plexus, and, as a consequence, their survival was unpredictable.[5] Large surgeries like the groin flap and cross-finger flap required prolonged hospital stays and immobilization, leading to significant patient discomfort and delay in functional recovery.[6] These procedures, although sometimes successful, often resulted in poor cosmetic results, infection, and partial necrosis, which were disappointing for both the patient and the surgeon. The PIAF, first described by Zancolli and Angrigiani in 1985, was a real paradigm shift in hand reconstruction in this challenging situation. The PIAF is a practical and refined anatomical basis, a significant application of vascular anatomy to the resolution of clinical problems.[7] The PIOA of the forearm is usually a branch of the common interosseous artery of the ulnar artery. [8] Anatomical variations may lead to the PIOA originating directly from the ulnar artery in the proximal part of the forearm. The PIOA passes distally in the posterior compartment after it has crossed the interosseous membrane between the extensor carpi ulnaris and the extensor digiti minimi muscles. As it progresses, it sends out a series of 4 to 8 fasciocutaneous perforators that nourish the overlying fascia and epidermis.[9] At this level the artery presents a constant and reliable anastomosis with the anterior interosseous artery, located approximately 2 to 3 cm proximal to the distal radioulnar joint. The distal anastomosis is the key element of the reverse-flow design of the flap, which allows for distal movement of the flap to correct deformities of the hand and wrist.[10] One of the reasons for its popularity is that the vascular structure of the flap is present in more than 90% of the population. However, there is a significant anatomic variation, and it is strongly recommended that a comprehensive preoperative workup, including Doppler ultrasonography, be performed to confirm the patency of the vessels and to determine the most favorable perforators for flap design. [11] Many surgeons prefer the PIAF due to its significant and compelling advantages in reconstruction. The main advantage is the conservation of the main vascular axis of the hand. The PIAF preserves the radial and ulnar arteries, while the radial forearm flap transects the radial artery. This is of the utmost importance as it ensures the preservation of dual arterial blood flow to the hand, thus decreasing the chance of ischemia, cold intolerance, and vascular compromise, especially in those with preexisting peripheral vascular disease or traumatic injuries. This property makes the PIAF an important tool in the reconstructive armamentarium. [12] The skin (epidermis and subcutaneous tissue) of the dorsal forearm is similar in color, texture, and thickness to that of the dorsal hand and wrist. This leads to a better cosmetic result, with the reconstructed area blending more smoothly into the surrounding tissue and without the bulkiness or color mismatch that often occurs with other flaps. Moreover, the PIAF has the significant advantage of preventing postoperative edema and lymphedema by preserving the superficial lymphatic network of the volar forearm. Such advantages can have a significant impact on the comfort and hand function of the patient. The lengthy, straight vascular pedicle allows for tension-free rotation of the flap to the dorsum of the hand, first web space, and volar wrist. The flap is also very versatile and can be harvested as a fasciocutaneous, adipofascial, or osteocutaneous flap.[13] The latter option includes a segment of the ulna when bone replacement is needed for defects. The PIAF has many advantages. However, when selecting the most appropriate reconstructive method, one should consider the limitations and disadvantages of this flap. The great disadvantage is the technically difficult dissection for flap elevation. The PIOA is adjacent to the posterior interosseous nerve, and the separation requires careful microsurgical dissection and excellent surgical skills. Unintentional nerve injury is a challenging complication to treat and is disabling, with potential nonmotor deficits or wrist drops. The PIAF is not a popular choice for many surgeons who consider the dissection too time-consuming and laborious, probably because of the anatomical proximity. The size of the dorsal forearm skin also limits the width of the flap. If the width of the flap exceeds 5 cm, the donor site cannot be primarily closed, and a split-thickness skin graft is indicated. This technique results in a less cosmetically acceptable donor site, contour irregularities, and intermittent tendon adherence. This complication adds to the overall morbidity of the procedure and prolongs the recovery period. Venous congestion is another common problem. Venous congestion is a frequent complication of reverse-flow flaps because of the retrograde nature of the venous drainage.[14] Venous congestion is a serious complication that can compromise the success of the reconstruction and can lead to partial or total flap necrosis. Therefore, it is crucial to recognize and treat venous congestion early. This problem is still a big problem, although several strategies have been proposed, such as preservation of the superficial venous network and the venous supercharging.

CONCLUSION

The PIAF has revolutionized the hand reconstructive surgery. The change from staggered and fragmented to a consistent, single-stage approach preserves vascularity and tissue matching. The main advantage of the PIAF is that it can repair complex wrist and hand abnormalities without cutting off the main artery supply to the hand. Disadvantages of the procedure are the need for skilled surgery, wide dissection, proximity to the posterior interosseous nerve and width limitations but benefits outweigh disadvantages. The PIAF allows the microsurgeons to treat difficult soft tissue anomalies of the upper extremities with excellent functional and aesthetic outcomes.

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