The posterior interosseous artery flap (PIAF) in reconstructive surgery of the hand: strategies of use and medico-legal implications

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Abstract

Background and aim. The fascio-cutaneous posterior interosseus artery flap (PIAF) is used in hand reconstruction, especially to repair skin or tissue defects such as burn injuries, open fractures, gunshot wounds or traumatic amputations. The aim of this study is to examine the anatomical features of this flap, to describe the surgical harvesting technique and the difficulties associated with the dissection.

Methods. From January 2016 to January 2022, we performed PIAF in 10 patients (3 women and 7 men) with a mean age of 28 years (range 22-44). This flap is taken from the back of the forearm, between the extensor carpi ulnaris (ECU) muscle and the extensor digitorum common (EDC) muscle.

Results. We analyzed retrospectively our patients indicating the failures of this reconstructive surgery, the complications that have arisen and the results using DASH score with the related clinical and medico-legal implications.

Conclusions. Due to its location and structure, PIAF is one of the most versatile fascio-cutaneous flaps in upper limb reconstructive surgery and can be used to reconstruct parts of the hand, wrist, or elbow, allowing to restore limb function and improve the quality of life of patients even if there could be some medico-legal implications. Clin Ter 2023; 174 (6):498-502 doi: 10.7417/CT.2023.5016

Key words: hand reconstruction, hand surgery, medico-legal implications, PIAF, posterior interosseus artery flap

Introduction

The fascio-cutaneous posterior interosseous artery flap (PIAF) is used in the reconstruction of the hand, especially to repair skin or tissue defects such as burn injuries, open fractures, gunshot wounds or traumatic amputations. The use of PIAF, a versatile and safe pedunculated flap, in hand surgery allows to respect the main vascular axes of the hand, to leave scarce scars in the donor site, and to avoid distant skin flaps and microsurgical free flaps (1-7). The PIAF was described simultaneously in 1986 by Zancolli, Masquelet and Panteado, based on anatomical studies of vascular forearm system (3-6). The posterior interosseus artery (PIOA) usually originates from the common interosseus artery. It passes to the posterior forearm compartment and emerges between the oblique cord and the interosseous membrane, then crosses between the supinator muscle (SM) and abductor pollicis longus (APL) (3). At this level, the artery divides into an ascending branch, the posterior radial recurrent artery which ends with muscular and cutaneous branches in the elbow region, and a descending branch, the interosseous artery proper, which descends into the forearm with the posterior interosseous nerve (PIN) and along the septum between the extensor digiti minimi (EDM) and extensor carpi ulnaris (ECU).

The posterior interosseous artery (PIOA), at the level of the posterior external forearm, runs close to the interosseous membrane often in contact with the ulna, included in the intermuscular septum that superficially separates the EDM and ECU muscles. The artery, in depth, is in contact with the muscle of the extensor indicis proprius (EIP) and extensor pollicis brevis (EPB). At this level, the artery supplies 7 to 14 perforating branches which, running in the thickness of the intermuscular septum, are distributed to the fascia and skin of the posterior region of the forearm.

At the wrist, the PIOA terminates by anastomosing with the dorsal carpal arch on one side and with the anterior interosseus artery (AIOA) on the other side through a communicating branch below the tendon of the EIP proximal to the head of the ulna (3-6).

The course of the posterior interosseous artery, within the intermuscular septum, is drawn on the dorsal skin of the forearm by a line joining the lateral epicondyle to the distal radioulnar joint; its origin is located between the upper third and the middle third. The center of rotation of the flap is located at the level of the head of the ulna. The maximum dimensions of the flap are 5-7 cm wide and 10-12 cm long.
Materials and methods

From January 2016 to January 2022, at Hand and Peripheral Nerve Center in Physiatric Orthopedic Clinic (C.O.F.) Lanzo Hospital (Alta Valle Intelvi, Como, Italy) we performed PIAF in 10 patients (3 women and 7 men) with a mean age of 28 years (range 22-44). In our experience, we used the posterior interosseus artery flap as a retrograde or direct pedicle fascio-cutaneous flap.

It is very important to conduct an anatomical study of the flap dissection on fresh cadaver, before starting clinical experience on this type of reconstruction. The learning curve of surgical harvesting of the flap are mandatory on anatomical specimen on fresh cadaver (Fig. 1-2).

In our series the left upper limb was involved in 4 cases (40%) and the right side in 6 cases (60%). The flap was used in 6 patients (60%) to cover the dorsal region of the hand; in 2 patients (20%) to reconstruct the first commissure; in 1 patient (10%) to cover the dorsal part of the first ray, in 1 patient (10%) to cover the hypothenar region.

The cause of lesion was a mechanical injury in 4 cases (40%), 1 patient (10%) had a car crash, 3 patients (30%) had motorcycle accident, and 2 patients (20%) had a post-burn contracture.

The flap dissection was performed in all patients with the arm abducted with a pneumatic cuff in place without squeezing to ensure vessels do not collapse completely and to allow a better visualization. Then the cutaneous landmarks were identified with a line between the lateral epicondyle and the ulnar styloid corresponding to the axis of the flap. The size of the flap was drawn on the skin based on the area to be covered. Dissection was initially carried out along the radial semicircle of the flap, after the incision of the skin and the fascia, and then along the ulnar semicircle by lifting the fascial plane on both sides and fixing it with detached stitches to the subcutaneous tissue to avoid unthreading of the flap. At this point we reach the level of the intermuscular septum between the superficial EUC and EDM and the deep EIP and identify the perforating vessels and the vascular pedicle of the flap (Fig. 3).

During detachment, the motor nerve branch of the EUC...
can be encountered, which is located proximally to the emergence of the artery. Extreme caution must be exercised in the dissection of the flap that has numerous vascular branches, which must be tied with vascular micro-clips. Once the complete isolation of the vessels of the septum has been obtained, the PIOA is ligated at the level of its origin and the flap is lifted from distal to proximal. At the end of the dissection, the flap is wrapped in warm moist compresses for a few minutes, waiting for the vascular flow to settle.

After positioning and fixing the flap in the receiving site with detached stitches (Fig. 4).

The flap is covered with a gauze impregnated with Hyaluronic acid and sodium salt (e.g., Connetivina Garze® Fidia Farmaceutici S.p.A., Abano Terme, Padua, Italy) and a slightly compressive dressing with sterile gauze.

The forearm is immobilized using a cast with the wrist positioned at 15° in extension for two weeks, to avoid traction on the pedicle.

In all patients it was possible to directly suture the donor area with restoration of the anatomical planes, after adequate residual hemostasis. At the donor site an intradermal suture with absorbable filament (Velosorb™ Fast, Medtronic Italia SpA, Milan, Italy) was performed in all cases.

On the 15th postoperative day, the cast and flap sutures were removed. All patients were instructed to initiate gentle passive mobilization until 30th postoperative day, then a cautious resumption of active mobilization was indicated.

Patients were reviewed clinically at 30, 60, 90 days of follow-up (FU). At last FU, all patients responded to the DASH (Disabilities of Arm, Shoulder and Hand) questionnaire, with possible score ranges from 0 to 100 points. 0 represent complete and unrestricted upper limb function, while 100 points represent the maximum possible functional impairment. Also, the aesthetic and clinical healing of the flap was assessed at the last FU.
Results

In all patients the flap was monitored with a clinical examination every 3 hours for the first 72 hours to detect any signs of venous congestion, loss of soft tissue, nerves, and blood vessels. It can be harvested from the posterior forearm and transferred to the injured site. The PIAF requires a great experience in microsurgery and the use of advanced dissection techniques. Once the flap has been transplanted, it can provide a stable and strong source for tissues reconstruction. It is particularly useful for hand and wrist reconstruction, especially for the dorsal part, preserving the ulnar artery and the radial artery, and providing tissue for the coverage of tendons, nerves and blood vessels that are essential for movement and sensation in the upper limb.

The primary advantage of PIAF is its ability to deliver a significant amount of soft and strong tissue, which can be shaped to fit the specific needs of the patient. Furthermore, this flap has a good success rate and a relatively low incidence of complications, thanks to its good vascular supply and its ability to facilitate the healing process.

Possible complications associated with the use of the PIAF are infection tissue necrosis, nerve damage, scarring, bleeding and hematoma, delayed healing, mostly influenced by patients’ factors such as age, general conditions, and comorbidities (11). However, venous congestion or partial flap necrosis usually can be managed conservatively, only in few cases may require secondary surgical procedures (12).

The type of flap and the planning of intervention must be carried out in an accurate and personalized way for each patient, based on his needs and health conditions. The patient information phase is mandatory and the surgeon has the professional duty to illustrate the risks, benefits, and possible alternatives to the procedure, including the possible prognostic options and the therapeutic procedures feasible at any specific moment of the care. Explaining and discussing possible alternatives is a key element of the informed consent (13). It’s essential to refer to validated and official guidelines, to avoid medico-legal consequences due to allegations of malpractice or negligence. Especially in the civil sphere, the health professionals have the burden of demonstrating adherence to the official guidelines and recommendations, if it comes to litigation following adverse outcomes (14). In the absence of ministerial guidelines, the good practices of Plastic Surgery about this flap should be used as a frame of reference and guidance. About the remaining medico-legal implications, the use of PIAF has some contraindications, such as circulatory discrepancies in the donor or injured area due to insufficient perfusion with possible necrotic evolution and need for tissue removal, or radial nerve lesions, or sensitive alterations in the donor and recipient areas (15,16). Therefore, it will be necessary to appropriately evaluate the advantages and disadvantages of the procedure, based on the specific needs of the patient, being aware that the loss of substance of an upper limb due to trauma, disease or amputation can have a significant impact on the quality of life of the patients. Indeed, soft tissue repair must be simple, versatile, and safe (17).

The PIAF should be considered an important reconstructive option in the management of hand and wrist defects for plastic and hand surgeon (18). The use of the PIAF by a highly qualified surgeon specialized in reconstructive surgery and microsurgery is recommended, to minimize risks and obtain the best possible result (19). The functionality of PIAF depends on several factors such as its length because if the flap is too short may not provide the necessary coverage and support to restore the functionality of the limb; its position and its ability to integrate with the surrounding tissues. Burns and their consequent contractures, for example, have devastating functional and aesthetic consequences that disproportionately affect the upper limb, making it necessary to restore function in conjunction with shape and aesthetic appearance (20).

The success of the reconstruction also depends on the post-operative rehabilitation. It is recommended to make patients aware of compliance with an appropriate and personalized rehabilitation program to maximize flap functionality. The patient’s ability to adapt to the reconstructed flap should not be neglected, to acquire an acceptable neuro-sensory perception and try to compensate the proprioceptive discrepancy secondary to the traumatic and surgical injury.

Conclusions

The reliability of PIAF makes it a valid tool in upper limb reconstructive surgery, avoiding the risks and inconveniences of other operations. In hand surgery, The PIAF respects the main vascular axes and allows the reconstruction of a large part of the loss of substance in the wrist and hand. The isolation technique must be delicate and meticulous due to the small caliber of the artery and sepal vascular branches and
should be performed by an expert in reconstructive surgery and microsurgery surgeon to minimize the risks and obtain the best possible results.

It is important that patients are adequately informed about the risks and benefits of the procedure and the possible stages in healing process. The surgeon must always be ready to provide clarifications and support during the various phases of treatment until complete recovery, without neglecting the rehabilitation period.

References