Journal of Plastic, Reconstructive & Aesthetic Surgery (2016) 69, 827—834

JPRAS
An International Journal of Surgical Reconstruction
www.JPRASurg.com

Superficial circumflex iliac artery pure skin perforator-based superthin flap for hand and finger reconstruction☆

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Received 6 November 2015; accepted 6 March 2016

KEYWORDS
Thin flap;
Finger;
Hand;
Perforator;
Reconstruction;
Superficial circumflex iliac artery

Summary For hand and finger reconstruction, thin and flexible skin coverage is ideally required. A free flap is one of the surgical options used for large defects. However, a flap containing the fat layer is bulky. Several debulking surgeries are often needed for aesthetic and functional purposes. To overcome this disadvantage, we herein report our experience of six cases of hand and finger reconstruction using a pure skin perforator (PSP) flap concept. A PSP flap is a thin skin flap that is vascularized by a perforator branch penetrating the dermis. The thickness of the PSP flap could be approximately ≤2 mm as needed. The superficial circumflex iliac artery and superficial inferior epigastric artery were used as a flap pedicle. Secondary defatting operations were not required. For the success of PSP flap elevation, we applied three techniques: the microdissection technique for vessel separation, thin flap elevation at the superficial fascial layer, and the temporary clamping method. Temporary clamping was applied for the main trunk of pedicle vessels during debulking to prevent unwanted bleeding, which allowed us to freely perform three-dimensional defatting. Using these three techniques, the PSP flap can be elevated and adjusted for complex contouring of the hand and finger. Although the use of the PSP flap requires further study, the PSP flap is an effective, superthin flap with the advantages of both skin graft and perforator flaps.

☆ Prior presentations: Cases in part have been previously presented at WSRM 21st March 2015.

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http://dx.doi.org/10.1016/j.bjps.2016.03.005

Introduction

For hand and finger reconstruction, thin and flexible skin coverage is ideally required. A wide and thin skin graft is one of the surgical options for reconstructing large defects. However, there are several disadvantages to using a skin graft, such as skin contracture, joint stiffness, pigmentation, and the necessity of a good wound bed.[1] Conversely, a flap is soft, is less pigmented, and does not require a good wound bed. However, the area between the flap and skin graft has a defined border that cannot be surmounted due to a thin adipose layer of the flap containing the subdermal plexus. The concept of thin flaps was initially established by Colson in 1967 and subsequently developed by Thomas in 1980.[2] The authors described that if the subdermal plexus is undamaged, then the flap should have an adequate blood supply.[2] However, the adipose layer of a flap is still bulky for several parts of the hand. Thus, multiple rounds of defatting are necessary, because a bulky flap can result in a poor cosmetic appearance and functional disturbance. Therefore, we considered that if we could use a superthin flap, such as a skin graft, then the superthin flap coverage could be an ideal and helpful procedure for reconstruction of the hand and fingers. We recently reported this conceptual flap, referred to as a pure skin perforator (PSP) flap, for the treatment of congenital auricular atresia.[3,4] A PSP flap is a thin skin flap that is a preserved perforator branch which penetrates the dermis. We herein report our experience of hand and finger reconstruction cases using the PSP flap.

Material and methods

Between June 2010 and January 2015, six patients with soft tissue defects of the hand and finger were reconstructed with the PSP flaps using the superficial circumflex iliac artery (SCIA) and superficial inferior epigastric artery (SIEA) as the recipient vessels. The study included four male and two female patients with an average age of 41.7 $\pm$ 3 years (range, 19—62 years). The site of the defects was finger in three patients, hand in two patients, and thumb in one patient. The original cause of the defects was arteriovenous malformation resection in four patients, burn injury in one patients, and accidental injury in one patient.

Surgical procedure

After confirming the pathway of the vessels preoperatively by sound Doppler and color Doppler, the skin was incised below 1 cm parallel to the groin ligament. The superficial circumflex iliac artery perforator (SCIP) and the SIEA that was branched from the femoral artery were initially identified in the groin area. Indocyanine green (ICG) angiography was performed to confirm the perfusion of PSP. ICG angiography with a near-infrared camera (Hamamatsu photonics Co. Ltd, Japan) involves the dilution of 2.5 mg/mL of normal saline. Then, 1—2 mL of ICG was administered via a peripheral intravenous bolus followed by 10 ml of normal saline.[5] When intra-arterial angiography could be performed, ICG (diluted 0.25 mg/mL) was administered to the femoral artery just above the SCIA, which branches out from the femoral artery. Then, the SCIA and/or SIEA were traced distally and laterally until penetrating the deep dermal layer (Figure 1a). This branch of the perforator is referred to as the "pure skin perforator (PSP)." The vessel between the PSP and subdermal vein was distinguished by the presence of vena comitans and pulsation under a microscope. If there were several PSPs, the PSP with the strongest pulsation under the microscope and a vessel diameter of $\geq$0.2 mm immediately below the dermis was chosen as the main pedicle. After marking the PSP and confirming the pedicle length and flap design, the thin perforator flap including the adipose tissue was elevated above the superficial fascial layer using an electric knife (Figure 1b). The large subcutaneous vein in the fat layer was included to improve venous drainage of the flap as much as possible. When a sensate flap was made, the lateral intercostal artery perforator with the intercostal nerve was included in the flap. The main trunk of the pedicle vessels was temporarily clamped by a microvascular clamp (Figure 1c). When necessary, the adipose layer can be dissected by scissors under a microscope, regardless of the presence of the subdermal plexus (Movie 1). After completing fat dissection, the pedicle of the flap was declamped. The PSP flap vascularity was confirmed by bleeding from the dermis and an ICG examination, as described earlier (Movie 1). Then the pedicle vessels were ligated and resected for transplantation. As a postoperative vasodilator, an intravenous drip containing alprostadil

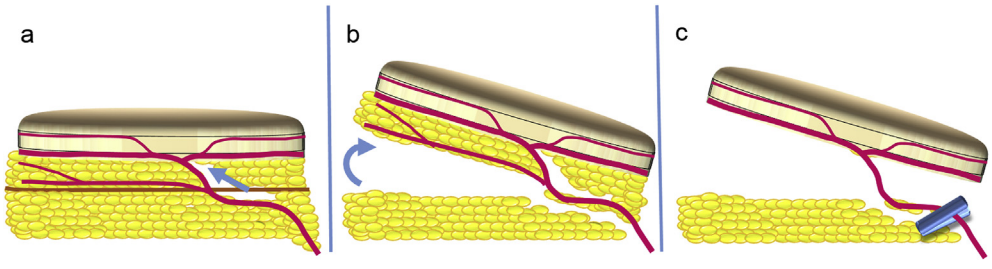

Figure 1 Three techniques for PSP flap elevation. a. The first method is microdissection when a branch of the SCIP is traced distally until it penetrates the dermis. Blue arrow: direction of microdissection to detect PSP. b. The second method is primary flap thinning that is performed at the superficial fascial layer. c. The last method is temporary clamping. After flap elevation at the superficial fascial layer, the main trunk of the pedicle vessels is temporally clamped with a microvascular clamp. After completion of defatting, the microvascular clamp is removed to confirm blood circulation of the PSP flap.