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Hand

Flexibility of the Superficial Circumflex Iliac Artery Perforator Free Flap for Hand Reconstruction

Linh Tuan To, MD, MSc*†
Tuan-Anh Hoang, MD, DDS, PhD*‡
Ha Hong Nguyen, MD, PhD†
Son Thiet Tran, MD, PhD*
Sung-Kiang Chuang, DMD, MD, DMSc§¶‖**
Kevin C. Lee, MD, DDS††

Background: The superficial circumflex iliac artery perforator (SCIP) flap has several advantages in hand reconstruction. It is thin and pliable, the extensive branching of the arterial system allows for multiple components, and the donor site can be closed inconspicuously. This article reports our experience using the SCIP flap for hand reconstruction, and we highlight the flexibility of the SCIP for extended and chimeric flaps.

Methods: We conducted a retrospective cohort study from November 2022 to January 2024 of patients with complex hand defects (exposure and/or defect of the bone or tendon) who underwent reconstruction with an SCIP flap. The plane of dissection was above the layer of superficial fascia. In overweight patients, the superficial fat lobules were removed under the microscope to thin the flap. Tailoring, chimeric, and supercharged flaps were constructed as needed for complicated hand defects. Data collected included defect characteristics, flap design, and outcomes.

Results: A total of 44 flaps were performed on 43 patients. The average flap length was 17.8 cm (range 10–42 cm), the average flap width was 7.6 cm (range 2–11 cm), and the average flap thickness was 2.5 mm (range 2–4 mm). Hand defects were reconstructed with 9 chimeric flaps, 8 tailored flaps, 3 chimeric and tailored flaps, and 2 supercharged flaps. Overall, 42 flaps (95.5%) survived and 2 flaps (4.5%) experienced necrosis.

Conclusions: The SCIP flap is a reliable option for complex hand defect reconstruction. This technique can provide a large, thin, pliable skin paddle incorporating components from the external oblique fascia and iliac bone. We did not encounter any recurrent issues when using it as a supercharged flap, tailored flap, or chimeric flap. Reconstructive surgeons should develop comfort with the SCIP flap in hand reconstruction given its versatility. *(Plast Reconstr Surg Glob Open 2025; 13:e6534; doi: 10.1097/GOX.0000000000006534; Published online 14 February 2025.)*

*From the *Department of Plastic and Reconstructive Surgery, Hanoi Medical University, Hanoi, Vietnam; †Department of Maxillofacial Plastic and Aesthetic Surgery, VietDuc University Hospital, Hanoi, Vietnam; ‡Department of Microsurgery, Plastic, Aesthetic and Maxillofacial Surgery, Hanoi Medical University Hospital, Hanoi, Vietnam; §Department of Oral and Maxillofacial Surgery, University of Pennsylvania, School of Dental Medicine, Philadelphia, PA; ¶Brockton Oral and Maxillofacial Surgery, Inc., Brockton, MA; ‖Department of Oral and Maxillofacial Surgery, Good Samaritan Medical Center, Brockton, MA; **Department of Oral and Maxillofacial Surgery, School of Dentistry, Kaohsiung Medical University, Kaohsiung, Taiwan; and ††Department of Oral and Maxillofacial Surgery, University of Washington, Seattle, WA.*

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INTRODUCTION

The superficial circumflex iliac artery perforator (SCIP) flap evolved from the traditional free inguinal flap, which was popular in the 1970s–1980s but fell out of favor due to disadvantages such as excessive bulk, inconsistent vascularity, and short pedicle.[1] In 2004, Koshima et al[1] introduced the perforator-dissected SCIP flap based on anatomical studies of the perforating cutaneous branches of the superficial circumflex iliac artery (SCIA), which offered improved flap thinness and simplified harvest while maintaining a large flap size. Subsequent studies have demonstrated the SCIP flap's versatility for reconstruction of various body regions. With its extensive branching pattern, the flap can be designed as chimeric, microscopically thinned, tailored, or supercharged.[2–5]

Disclosure statements are at the end of this article, following the correspondence information.

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Hand reconstruction is highly complex due to its unique anatomy and functional importance. Numerous prior techniques have been described in an effort to identify an ideal flap that offers adaptability to various types of hand injury, ensures the best functional recovery, and addresses aesthetic concerns.[6–8] To our knowledge, no studies to date have specifically examined the unique compatibility of the SCIP flap for hand reconstruction. This report aimed to investigate the versatility of the SCIP flap in hand reconstruction.

Takeaways

Question: How reliable and versatile is the superficial circumflex iliac artery perforator (SCIP) flap for hand defect reconstruction?

Findings: In our series, SCIP flap success rates were more than 95% with good functional outcomes. The SCIP flap reliably provides thin, pliable tissue and can be extended to incorporate additional soft tissue, tendon, and bone depending on the reconstructive needs.

Meaning: The SCIP flap is a useful flap for hand reconstruction and can be adapted to address most defects.

MATERIALS AND METHODS

This was a retrospective cohort study of patients treated by the Department of Maxillofacial, Plastic and Aesthetic Surgery at Viet Duc University Hospital from November 2022 to January 2024. Patients were included in the study if they had complex hand defects (exposure and/or damage to the bone and/or tendon) treated with SCIP free flap reconstruction. Patient demographics, characteristics of the hand defects, flap characteristics, and associated complications were analyzed. The study was conducted at Viet Duc University Hospital and was approved by the institutional review board of Hanoi Medical University (No. 903/GCN-HDDDNCYSH-DHYHN on August 1, 2023).

Work-up

Preoperatively, we utilize 256-slice computed tomography angiography (CTA) to characterize the perforator anatomy and vascular patterns. This imaging modality allows us to precisely map the course of the superficial and deep branches of the SCIA system, the superficial circumflex iliac vein, and the viability of the recipient vessels (Fig. 1). This comprehensive vascular mapping is then translated onto the patient's skin surface to guide our flap design. By using the point where the perforator penetrates the superficial fascia as the center of the flap, we design the skin paddle slightly larger than the defect requirement, with the axis preferably following from the pubic tubercle to the anterior superior iliac spine. After initial trauma, the wounds are put on negative pressure wound therapy. Reconstruction is realized after the soft tissue has shown definitive demarcation and no signs of infection are observed. This is usually achieved in about 1 week postinjury. Intraoperatively, the hand defect is thoroughly debrided and cleaned of any necrotic tissue to prepare the recipient bed. Following debridement, the final hand defect was measured to design the flap size, shape, and components. (**See figure, Supplemental Digital Content 1**, which displays individualized SCIP flap design based on the characteristics of the defect and CTA result. A, Preoperative defect. B, CTA image with point A indicating the common trunk of the SCIA. C, Flap design with primary bifurcated skin paddle oriented along the anterior iliac spine to the pubic tubercle. D, SCIP flap raised with 2 separate skin paddles. E, Immediate postoperative result after inset, **http://links.lww.com/PRSGO/D850**.)

Flap Elevation

The SCIP flap design is individualized for each defect considering the unique features of each patient's injury, including its location, size, and composition. Flap elevation starts from laterally to medially. (**See Video 1 [online]**, which demonstrates flap elevation in a plane superficial to the superficial fat fascia.) The plane of dissection is

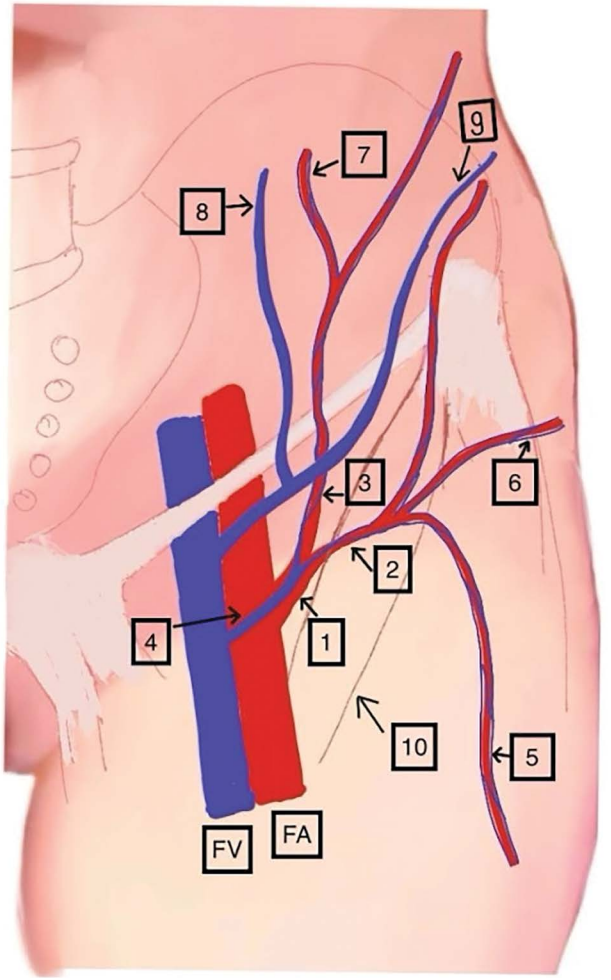

Fig. 1. Graphic representation of the SCIA and the venous system including (1) the SCIA, (2) the deep branch of SCIA, (3) the superficial branch of SCIA, (4) venae comitantes, (5) the descending branch, (6) the transverse branch, (7) the branch supplies the external oblique fascia, (8) the superficial inferior epigastric vein, (9) the superficial circumflex iliac vein, and (10) sartorius muscle. FA indicates femoral artery; FV, femoral vein.

directly above the layer of superficial fascia. After the percutaneous branches of the deep and superficial branches of SCIA are identified, the pedicle dissection is continued up to the point of SCIA origin from the femoral artery. In addition to the venae comitant draining to the femoral vein, we usually incorporate the superficial circumflex iliac vein lying in the superficial fat. In overweight patients with excessively thick flaps, we remove the superficial fat lobules under the microscope to thin the flap, as described by Kimura.[3] (**See Video 2 [online]**, which displays additional thinning of the superficial fat under the microscope.)

If the defect is too large or circumferential, we extend the flap to the angiosome of the descending branch with the lateral femoral circumflex artery as a supercharging flap. Chimeric flap with multiple skin islands, abdominal external oblique fascia, or iliac bone can be used to reconstruct complicated hand defects. After raising the flap, we observed the flap clinically for approximately 1 hour to assess flap perfusion. Following this period, we partially inset the flap, repair the tendinous and bony defect, and then perform the microanastomosis of the flap to the recipient vessels. Our postoperative care and monitoring protocol is as follows: loose and noncompressive dressings, a protective cast to safeguard the flap while allowing for flap monitoring, antibiotic prophylaxis, heparin drip for the first 7 days postoperatively then transition to aspirin therapy, pain management to reduce stress and vasospasm, anti-inflammatory medications to reduce edema and flap tension, and early rehabilitation under the guidance of specialized rehabilitation physicians and trained technicians.

Variables and Statistical Analysis

For each patient, we recorded the source of injury, the final hand defect size, the flap size and components, and the flap outcomes with any additional management. At the 6 month postoperative visit, we had all patients rate the aesthetics of their reconstruction as excellent, good, or bad after assessment of the color match, thickness, shape, contour, and flap hair growth. Before and after surgery, patients were also requested to complete a QuickDASH-11 scale to assess for improvements in hand function.

RESULTS

The final study sample included 43 patients of whom there were 30 (69.8%) men and 13 (30.2%) women. The average age was 38.8 years (range 14–65 y). The source of injuries included labor accidents (58.1%), explosive accidents (16.3%), traffic accidents (14.0%), and other causes (scar contraction, infection, etc.) (11.7%). A total of 44 SCIP free flaps were performed in this sample (Table 1). The average defect size was 15.7 × 6.2 cm and ranged from 7 × 2 to 40 × 15 cm. The average flap size was 17.8 × 7.6 cm and ranged from 10 × 2 to 42 × 11 cm. The flaps were designed to be uniformly thin with an average thickness of 2.5 ± 0.5 mm (range 2–4 mm). All flaps were dissected above the superficial fascia, and 4 flaps underwent worm-eaten defatting with the average flap thickness before and after thinning being 5.6 ± 1.1 and 3.3 ± 0.9 mm, respectively.

Based on our CTA findings, the SCIP flap demonstrated consistent vascular anatomy and reliable blood supply across all cases, with no contraindications identified through CTA examinations. CTA played a crucial role in our preoperative planning process, enabling the comparison of the vascular characteristics among the bilateral groin regions. Although the contralateral donor site allows ease of positioning for the co-surgeon, pedicle size and the presence of the SCIA common trunk are the most important factors affecting total surgical time and flap survivability.

Overall, 42 (95.4%) flaps were successful and survived, and 2 (4.6%) flaps experienced total necrosis/flap loss. There were no cases of partial flap loss. Both flap failure cases were associated with patients who were heavy smokers. In the first case, the patient had a blast injury resulting in extensive soft-tissue loss of the entire hand including amputation of the thumb. The reconstruction involved a toe-to-thumb transfer and an SCIP flap for coverage, all leading to a scarcity of recipient vessels. Consequently, the SCIP flap was anastomosed to the retrograde radial artery in the anatomic snuffbox which ultimately resulted in an inadequate blood supply and flap failure. After 3 weeks, we performed a second operation transferring the contralateral SCIP connected to the anterograde radial artery which had previously supplied blood for the toe flap. The second SCIP flap failure occurred in a 44-year-old man. The reason for flap failure was unclear in that case. The flap showed signs of compromise on the fifth postoperative day with ischemia progressing from distally to proximally. This occurred despite good Doppler signals at the anastomosis site and no evidence of venous congestion. The flap became completely necrotic on the sixth day and was debrided and replaced with a skin graft. All the flaps that did survive had good cosmetic results; 97.7% of the

Table 1. Characteristics of the Hand Defects and the Corresponding Flap Design

Defect	Total, n (%)	Flap Design	Total, n (%)
Dorsal and palmar hand skin defect	10 (22.7)	Single island thin flap	22 (50.0)
Digital skin defect	6 (13.6)		
Digital and hand skin defect	6 (13.6)		
Multiple skin defects	11 (25.0)	Multiple skin island flap	11 (25.0)
Total degloved hand injury	2 (4.5)	Extended supercharged (SCIP–ALT) flap	2 (4.5)
Extensor tendon defect	7 (15.9)	Chimeric (adipofascio-osseocutaenous) flap	9 (20.5)
Flexor tendon defect	1 (2.3)		
Bony defect of the thumb	1 (2.3)		

flaps were judged as excellent, and 2.3% were judged as good. All donor sites were primarily repaired. Six (14.0%) of 43 patients experienced donor site dehiscence. Of these, 2 cases required re-suturing, 2 cases necessitated additional skin grafting, and 2 cases with minor dehiscence healed secondarily. One patient developed a seroma that was successfully managed with aspiration and compression bandaging. Six (14.0%) patients ultimately required reoperation. Ultimately, 37 (86.0%) patients without digital amputation had some degree of functional return, as judged by QuickDASH-11 scores. The average QuickDASH-11 score was 16.5 with 55.6% good, 41.7% fair, and 2.7% average. The QuickDASH scores positively correlated with severity of the wound. Seventeen hands with multiple layer defects (tendon and bone exposure) had higher average DASH scores (27.3) than skin defect–only subjects (12.7). There is no statistically significant difference between the groups of flap design.

DISCUSSION

Issues with hand injuries have a significant impact on the patient's family economy, working, and studying. As a result, selecting a course of treatment that enables patients to quickly resume their ordinary life is a crucial decision that has social and professional implications. According to Ono's[7] classification, every case in our study involved large-sized hand defects situated on the various anatomical areas with multiple damaged components. As a result, conventional plastic materials such as skin grafts and local flaps fell short of the reconstructive goals. The SCIP flap emerged as an ideal thin material for hand skin coverage.[9]

Different adjustable approaches to designing and using the SCIP flap are available, depending on the specific characteristics of each patient's defect and reconstructive needs. Our study included 22 cases utilizing the SCIP flap for simple skin-only coverage of hand defects: 10 hand/wrist defects, 3 finger defects, 6 hand/finger defects, and 3 hand stump defects, requiring large thin pliable flap over exposed tendons/bones. Defect sizes varied considerably, with an average of 15.7 × 6.5 cm, necessitating flaps averaging 17.8 × 7.6 cm (typically 10%–20% larger than the defect to avoid ischemia-inducing tension). According to Lee and Hwang,[10] the digital skin, which is among the thinnest on the body, plays a unique role when vital organs such as tendons, muscles, bones, and hand joints are situated directly beneath the skin. Therefore, the most important consideration when selecting a coverage option is to use thin flap materials that do not impair movement, that allow early mobilization, and that guarantee aesthetics.[10] Using the Hong[11] principles, meticulous subfascial dissection under loupe magnification was performed following the "freestyle" technique from outside-in. The superficial fascia layer is a thin, white fibrotic layer between the small superficial fat lobules above and larger deep fat lobules.[11] In patients with higher adiposity, multiple membranous layers of superficial fascia can be observed with significant fatty tissue among these layers. Our technique involves meticulous dissection at the most superficial fascial plane possible. After the initial dissection, if the suprafascial flap remained excessively thick, worm-eaten defatting techniques by Kimura et al[3] and Lee et al[12] were used to achieve the desired flap thinness for hand coverage. Previous studies have reported high SCIP flap survival rates of 95%–97% when elevated on the superficial fascial plane, with mean flap thicknesses ranging from 3 to 5 mm.[9,11,12] This is a safe dissection plane that avoids lymphatic disruption and minimizes postoperative seroma formation compared with traditional subfascial dissection.

Our series included 2 degloving injuries requiring very large flaps to resurface the entire hand. Multiple authors have reported the use of a supercharged SCIP flap with an additional thoracodorsal artery perforator flap, inter costal artery perforator flap, or deep inferior epigastric perforator flap pedicle[5,13,14]; however, we found that these flaps are usually thick or have a limited area of safe perfusion, which is unsuitable for convex defects of the hand. The anterolateral thigh flap is one of the largest free flaps that has a consistent vascular anatomy and allows for microdissection thinning[11] (Fig. 2). (**See Video 3 [online]**, which displays the postoperative functional result of the patient presented in Figure 2.)

The skin between 2 angiosomes demonstrates reliable survivability, thanks to the descending branch of the deep branch of the SCIA that permits potential flap dimensions up to 42 × 10 cm for complete hand coverage.

In cases with multifocal hand defects, we utilized tailored flaps (with incomplete splitting) or chimeric flaps (with complete splitting) to reconstruct multiple defects simultaneously. Eight tailored flaps and 3 chimeric flaps were used to reconstruct defects on multiple units of the hand and finger surface. This approach capitalized on the versatile perforator anatomy to customize flap designs, addressing complex defects. Using this technique, the surgeon must have a firm understanding of the anatomical features of the SCIP system. They must also be able to flexibly adjust the design based on the location and path of the perforating vessels under the microscope. Even so, with the help of preoperative CTA, we rarely have to modify the flap design to accommodate for unexpected vascular variation. Li et al[15] operated on 7 pediatric patients, 4–11 years of age, with 2-island SCIP chimeric flaps to reconstruct defects on multiple fingers at the same time without failure. Chao et al[2] repaired complex defects in the maxillofacial region and limbs in 18 patients using the chimeric SCIP flap, all flaps survived with good postoperative recovery.

We performed 1 case of on-top plasty using an SCIP flap with a vascularized iliac bone to restore thumb length along with soft-tissue coverage (Figs. 3, 4). (**See Video 4 [online]**, which displays the postoperative functional result of the patient presented in Figures 3 and 4.) Anatomical studies have demonstrated the vascular basis for harvesting such osteofascial or osteomuscular flaps from the iliac crest based on the SCIA. Yoshimatsu et al[16] studied the anatomy of the SCI vessels on 20 specimens from 10 cadavers, assessing the blood supply capacity of the deep branch of the iliac crest bone and a portion of the sartorius muscle. The iliac crest bone-skin flap and the fibula skin flap did not differ in terms of the bony fusion and the pedicle properties. The SCIP osteocutaneous flap has been proven

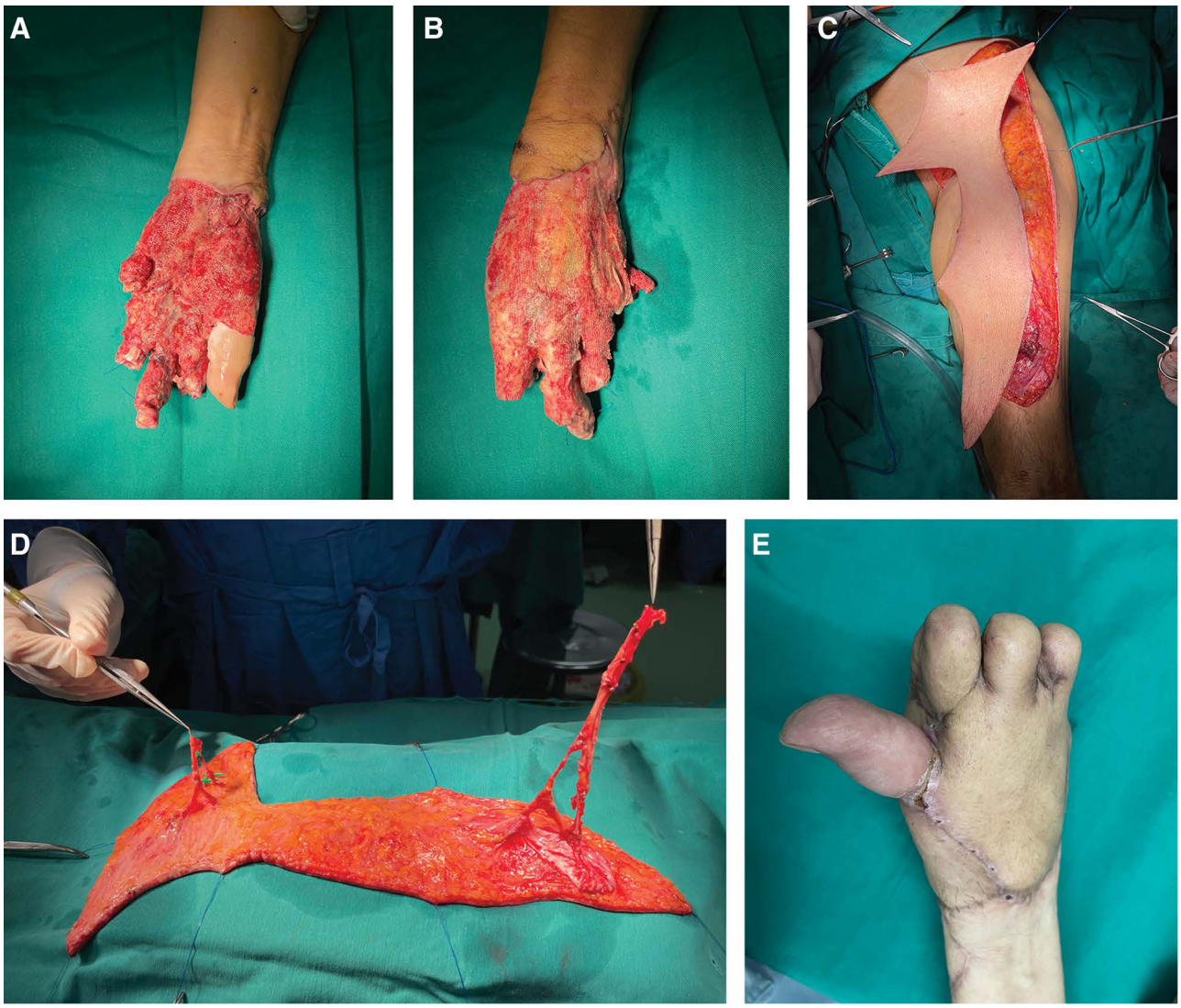

Fig. 2. Example of an individualized SCIP flap design based on the characteristics of the defect and CTA result. A, Preoperative defect. B, CTA image with point A indicating the common trunk of the SCIA. C, Flap design with primary bifurcated skin paddle oriented along anterior iliac spine to pubic tubercle. D, SCIP flap raised with 2 separate skin paddles. E, Immediate postoperative result after inset.

to be a good option for small- to medium-sized bone defects, and it is particularly useful for reconstructing the metacarpal bones.[17] This is a crucial characteristic that demonstrates the SCIP flap's versatility as a reconstructive material.

In cases involving tendon defects, we used a chimeric fasciocutaneous SCIP flap for both tendon reconstruction and soft-tissue coverage. (**See figure, Supplemental Digital Content 2**, which displays a 61-year-old male patient with a dorsal hand defect and long-span extensor gap [A]. B, C, Given the tendon defect he was reconstructed with a chimeric deep fascial SCIP flap. D, The adipodermal thickness is 2.2 mm. E, F, Follow-up at 6 months with good cosmetic and functional results, **http://links.lww.com/PRSGO/D851**.) Vascularized fascial grafts offer several advantages over nonvascularized alternatives, including minimal adhesion formation, reduced risk of rupture, and improved joint mobility and range of motion.[18] Although tripartite SCIP flaps have been described for tendon reconstruction, Chu et al[19] utilized the fascia lata rather than the external oblique fascia. The external oblique fascia component of the SCIP flap has predominantly been used for coverage and fascia repair in the literature.[20–22] Although there have been reports of using the deep abdominal fascia for tendon reconstruction, these studies used composite flap designs with the fascia vascularized in a random pattern.[22–24] Coskunfirat et al[24] noted that the external oblique fascia is sufficiently robust to withstand the forces exerted on the Achilles tendon. However, the composite approach results in a thick flap, similar to the conventional groin flap, as it is elevated beneath the deep fascia. The novelty of our technique lies in the consistent observation of a branch originating from the superficial branch of the SCIA system, which supplies the external oblique fascia. Through meticulous microdissection under loupe magnification, we can harvest a chimeric SCIP flap

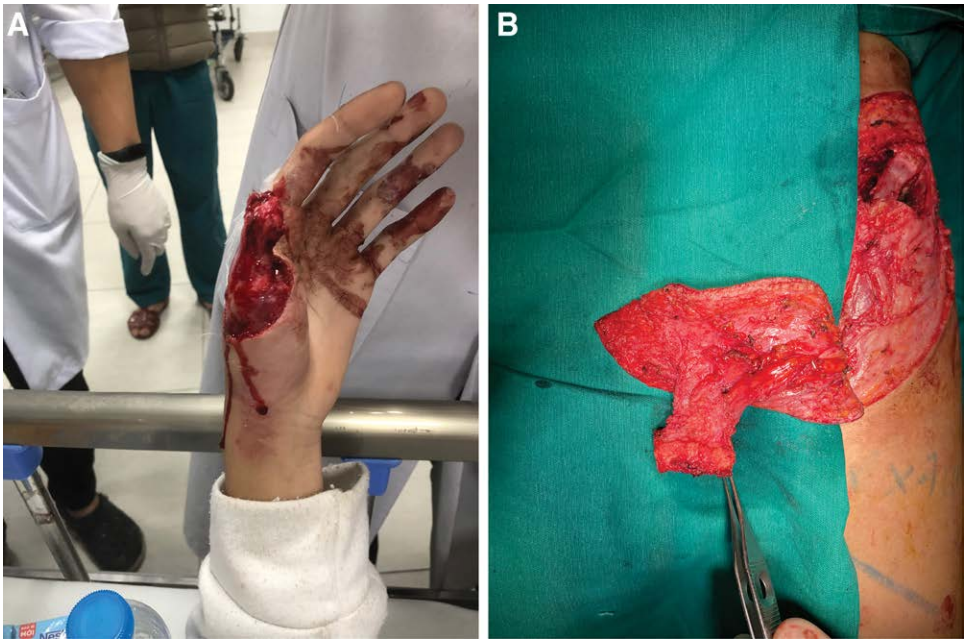

Fig. 3. Example of the osteocutaneous SCIP flap for a composite defect of the thumb. The flap is elevated with preserved attachments to the underlying iliac crest. A, Bony thumb defect, given the extent of the foreshortening decision was made to perform osteocutaneous SCIP flap. B, Osteocutaneous free flap consisting of SCIP with attached vascularized iliac crest bone.

Fig. 4. Example of the osteocutaneous SCIP flap for a composite defect of the thumb. The flap is elevated with preserved attachments to the underlying iliac crest. A, Osteocutaneous free flap consisting of SCIP with attached vascularized iliac crest bone. B, Fixation and inset of the bony flap into the defect. C, Final cosmetic result at postoperative follow-up.

that maintains a slim contour while comfortably including an 8 × 3 cm fascia patch. This approach allows for tendon reconstruction without compromising the integrity of the abdominal wall fascia, as evidenced by the absence of postoperative hernias in our series.

In our series, the overall flap survival rate was 95.4%, with complete necrosis in 2 cases (4.6%); our results are similar to the study by Goh et al[9] with a success rate of 95.2% and Lee et al[12] at 97.5%. Among patients without amputation, good functional hand recovery was seen in 62.2%, with 32.4% achieving fair function and 5.4% achieving minimal function. Long-term hand aesthetic outcomes were satisfactory in 97.7% of cases, on average in 2.3% of cases. Compared with traditional methods, the SCIP flap provided the advantages of reliable thin pliable coverage, aesthetic scar camouflage, ability to resurface complex hand defects in a single stage, and avoidance of secondary debulking procedures—collectively reducing hospitalization costs. There were no body mass index cutoffs for using the SCIP free flap in our series, and we performed microdissection to achieve appropriate thinness when needed. Limitations of this study include the short postoperative follow-up period, and the lack of more formal documentation of patient satisfaction, suffering, and functional and aesthetic outcomes.

In conclusion, the SCIP flap demonstrates versatility as a robust reconstructive option for hand defects. Its thinness achieved through subfascial elevation allows for resurfacing in areas that require pliable and thin coverage. The various flap modifications—tailored design, supercharged pedicle extension, chimeric multilobar paddles, and incorporation of fascia or bone—enable customized single-stage reconstruction of even the most complex hand injuries with a well-concealed donor site.

Tuan-Anh Hoang, MD, DDS, PhD
Department of Microsurgery
Plastic Aesthetic and Maxillofacial Surgery
Hanoi Medical University
1 Ton That Tung St, Hanoi 116001, Vietnam
E-mail: tuananhcmfs@gmail.com

DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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