SAS Journal of Surgery
Abbreviated Key Title: SAS J Surg
ISSN 2454-5104
Journal homepage: https://www.saspublishers.com

OPEN ACCESS

Surgery

Lower Extremity Soft Tissue Defect Reconstruction Using the SCIP Free Flap: A Comprehensive Review

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DOI: https://doi.org/10.36347/sasjs.2025.v11i01.002 | **Received:** 15.11.2024 | **Accepted:** 30.12.2024 | **Published:** 08.01.2025

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Abstract | **Original Research Article**

The reconstruction of lower extremity soft tissue defects requires a flap capable of covering vital foot structures while withstanding the stresses of walking and shoe pressure. The Superficial Circumflex Iliac Artery Perforator (SCIP) flap provides finely detailed tissue and minimal donor site sequelae. Its surgical technique is safe, accessible, and benefits from preoperative echo-Doppler mapping for enhanced precision. The SCIP flap's numerous advantages make it an essential component in the plastic surgeon's decision-making algorithm for lower extremity soft tissue reconstruction, offering a renewed perspective on inguinal donor site management.

Keywords: SCIP Flap, Perforator Flap, Angiosome, Donor Site, Reconstruction.

INTRODUCTION

Perforator flaps consist of a skin paddle and a variable amount of subcutaneous fat. The vascularization of perforator flaps relies on one or more vessels destined for the skin, known as "perforators". Their harvesting follows the perforator to its origin vessel while preserving the underlying tissues: deep fascia, muscles, and nerves.

The vascularization of the flap can depend on one or several perforators. According to the angiosome theory of Taylor and Palmer, during flap elevation, the redistribution of vascular flow causes a perfusion hyperpressure that extends the anatomical skin territory of the perforator to a larger dynamic territory encompassing the neighboring perforasome. This principle explains the possibility of harvesting large skin paddles perfused by a single perforator.

Therefore, the manipulation of the transferred tissue must be extremely careful during dissection. It should also be noted that significant skin scars at the donor site or heavy smoking can contraindicate the harvesting of a perforator flap.

History

The groin flap based on the superficial circumflex iliac artery (SCIA), described in 1972 by McGregor and Jackson, achieved its first success the following year through the pioneering work of Daniel and Taylor in free skin flaps. Its easily concealable donor site and large area of hairless skin made it highly popular for many years.

However, the subsequent development of new techniques highlighted numerous shortcomings of the groin flap, such as postoperative lymphedema, variability in arterial anatomy, short pedicle length, and the thickness of its skin paddle. These factors gradually led to the inguinal donor site falling out of favor in favor of safer musculocutaneous flaps.

In 2004, Koshima first mentioned a groin flap based on an SCIA perforator. The SCIA perforator flap, or SCIP flap, is described as a refined groin flap of exceptional finesse, allowing for coverage of both local and distant tissue defects while overcoming all the disadvantages associated with the traditional groin flap.

PATIENTS AND METHODS

A review of international literature was conducted using the PubMed database, covering the period from January 2004 to August 2016. All types of publications (reviews, original articles, case reports, technical notes, editorials) in both English and French were included.

The flap harvest follows the concept of the "free-style perforator flap" as described by Wei and Mardini. It begins with preoperative vascular mapping using color Doppler ultrasound to locate the dominant perforator accurately.

The design of the flap is oriented based on the preoperative localization of the dominant perforator and can extend posteriorly to the posterior superior iliac spine (PSIS) towards the midline of the back (Fig. 1). A pinch test is performed to ensure the possibility of direct closure.

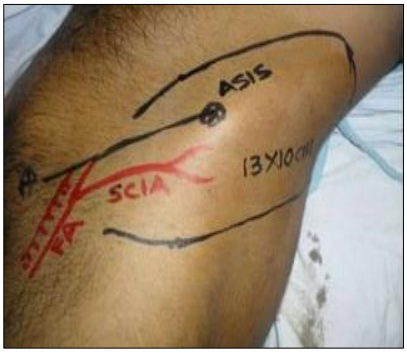

Fig. 1: Preoperative identification and marking of the SCIP flap:
SCIA = superficial circumflex iliac artery, ASIS = anterior superior iliac spine, FA = femoral artery
Source: Goh TLH, Hong JP. The search for the ideal thin skin flap: superficial circumflex iliac artery perforator flap--a review of 210 cases. Plast Reconstr Surg. févr 2015.

The initial incision is made along the inferolateral border extending to the superficial fascia, following the technique of Hong *et al*., The dissection continues above the Scarpa's fascia in the plane of the superficial fascia between deep and superficial fat layers, using the thin flap technique [1]. This plane spares lymphatics and nodes located in the deep adipose layer. Bloodless dissection with very low-power electric cautery or cold blade is essential to avoid inadvertent injury to unnoticed perforators.

As perforators are approached, dissection continues with Ragnell scissors. Lateral to medial dissection identifies a dominant perforator from the deep branch, followed by identification of a dominant perforator from the superficial branch. Perforators from the superficial branch are generally preferred due to easier dissection, reducing the risk of injury to the lateral femoral cutaneous nerve [2, 3]. These can be musculocutaneous, septocutaneous, or direct cutaneous perforators [4]. In case of uncertainty, a clamping test may be performed to determine sufficiency of the superficial branch perforator (Fig. 2).

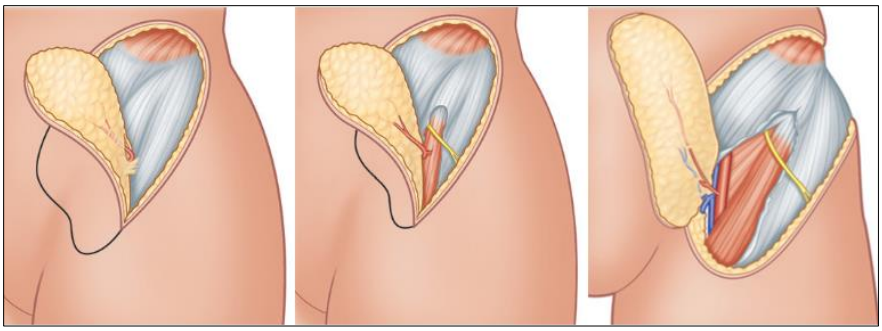

Fig. 2: Step-by-step procedure for groin flap
Source: Redrawn from Strauch B, Yu H-L. Atlas of microvascular surgery. 2nd ed. Thieme Medical Publishers; 2006.

Ultimately, the dominant perforator, identified preoperatively by its pulsatility [5], and imaging, is isolated and skeletonized. Its course is followed retrogradely through the fascia along the superficial branch until a sufficient length and caliber pedicle are obtained. Vessels are handled delicately with regular irrigation [3].

The superficial venous system within the adipose plane is included as the accompanying vein is often too small (in 88.3% of cases) to provide adequate venous drainage [6]. Once the pedicle is completely individualized and the skin incision completed, the flap is raised and transferred to the recipient site for microsurgical anastomoses. Skin nerves are preserved during flap dissection. The donor site is closed layer by layer to prevent dead space and reduce the risk of seroma formation. A Redon drain is placed for three days.

The dotted line illustrates the dissection plane between the deep and superficial adipose layers. The flap is raised from lateral to medial until identification of the deep branch of the superficial circumflex iliac artery (SCIA). In the majority of cases, a superficial vein (asterisk) is included (Fig. 3).

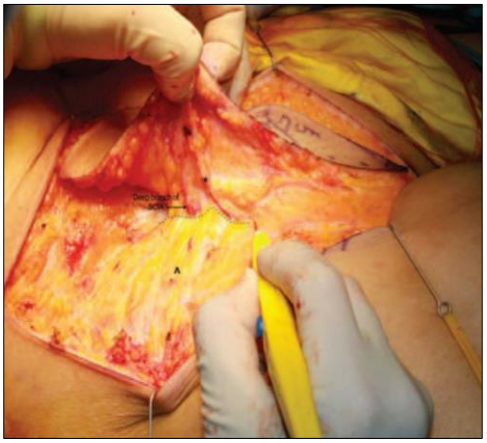

Fig. 3: Thin SCIP flap elevation

Source: Goh TLH, Hong JP. The search for the ideal thin skin flap: superficial circumflex iliac artery perforator flap--a review of 210 cases. Plast Reconstr Surg. févr 2015.

RESULTS

The literature search identified 50 articles published over a 12-year period on SCIP flaps, comprising a total of 442 flaps.

- ***Demographic Characteristics***

Among these 442 patients, there were 272 males (61.6%) and 170 females (38.4%). The mean age was 43.2 years.

- ***Preoperative Vascular Mapping***

Out of the 21 articles reporting routine preoperative imaging techniques:

- 10 (47.6%) authors used acoustic Doppler
- 6 (28.5%) used color Doppler ultrasound
- 2 (9.5%) used CT angiography
- 1 (4.7%) used fluorescein angiography
- 2 (9.5%) used combined imaging techniques.

It is noteworthy that before 2015, acoustic Doppler was predominantly used, while after 2015, the majority of authors switched to color Doppler.

- ***Indications***
- **Heel Soft Tissue Defect Reconstruction**

A 28-year-old male presented with a 5 x 4.5 x 1 cm soft tissue defect of the right heel following excision of an arteriovenous malformation of the right foot. The defect was covered using a 6x6 cm SCIP flap with microsurgical anastomoses to the posterior tibial artery and vein using 10/0 sutures. The postoperative course was uneventful (Fig. 4)

Fig. 4: Reconstruction of Heel Soft Tissue Defect:

(A) **Soft tissue defect:** initial loss of substance at the heel; (B**) Thin SCIP Flap:** utilization of a thin SCIP flap to cover the defect; (C) **Outcome at 1 Year:** resultant appearance one-year post-reconstruction.

(**Source**: N. Sidhoum, S. Dast, S. Perez, N. Assaf, C. Herlin, R. Sinna. Superficial Circumflex Iliac Artery Perforator flap (SCIP flap): Revival of the inguinal donor site. Plast Reconstr Surg. févr 2017).

A 30-year-old female patient had a history of a motorcycle accident, in which she sustained an injury to the right lower leg. The patient had an open wound and an Achilles tendon defect. She was treated at another hospital by skin grafting the wound and then referred to our center for further management. The plan was to release the scar contracture, fill in the defect with vascularized soft tissue, and repair the Achilles tendon. A vascularized composite adipocutaneous flap with external oblique fascia was harvested based on the superficial circumflex iliac artery. The fascia was tubed to form an inter- position graft between the proximal and distal aspects of the native tendon. Shows the flap after harvest; the external oblique fascia and the pedicle of the flap are marked with arrows. Is a posterior view of the patient 10 years post- operatively standing on her forefoot. The patient is able to sustain plantar flexion against resistance, demonstrating the strength of the tendon repair (Fig. 5).

Fig. 5: This young woman had a history of a motorcycle accident in which she sustained an injury to the right lower leg which was treated with a skin graft.

(A) The patient was left with discontinuity of the Achilles tendon and severe scarring; (B) A groin flap was designed, including external oblique fascia; (C) Flap after harvest; (D) The patient 10 years postoperatively, demonstrating a well-healed wound and reasonable function of plantar flexion of the foot

(Source: Koshima et al. Superficial circumflex iliac artery perforator flap for reconstruction of limb defects. Plast Reconstr Surg 2004; 113 :233-40).

- ***Coverage of Ankle Soft Tissue Defect***

A 66-year-old man presented with a soft tissue defect at the ankle, which exposed hardware 3 weeks after ankle prosthesis placement. Following thorough irrigation and debridement, a 9 × 5 cm thin flap was harvested to cover the defect (Fig. 6).

Terminal-to-terminal anastomoses were performed using 11.0 sutures on the posterior tibial pedicle. The patient had a straightforward recovery, enabling the preservation of the hardware.

Fig. 6: Reconstruction of a soft tissue defect on the dorsum of the foot with exposure of prosthetic material:
(A) Soft tissue defect; (B) Thin SCIP flap; (C) One-year outcome; (D) Donor site showing scar concealment under clothing
(**Source**: N. Sidhoum, S. Dast, S. Perez, N. Assaf, C. Herlin, R. Sinna. Superficial Circumflex Iliac Artery Perforator flap (SCIP flap): Revival of the inguinal donor site. Plast Reconstr Surg. févr 2017).

- **Coverage of a Lower Leg Soft Tissue Defect**

A 42-year-old woman with chronic tibial osteomyelitis underwent debridement resulting in a lower leg soft tissue defect measuring approximately 13 x 5 cm (Fig.7). One month after debridement, the defect was covered with a thin SCIP flap. The postoperative course was uneventful without notable complications.

Fig. 7: Coverage of a lower leg soft tissue defect with thin SCIP flap:
(A) Chronic tibial osteomyelitis; (B) Soft tissue defect after debridement; (C) One-year postoperative result after coverage with thin SCIP flap.
(Source: Goh TLH, Park SW, Cho JY, Choi JW, Hong JP. The search for the ideal thin skin flap: superficial circumflex iliac artery perforator flap-a review of 210 cases. Plast Reconstr Surg. févr 2015).

- **Reconstruction of a Soft Tissue Defect of the Foot**

A 46-year-old male was run over by a car, and the patient visited our clinic with a degloving injury of the right foot dorsum and linear fracture of the first metatarsal bone. After simple wound dressing, pain management and intravenous antibiotics coverage was provided, and an operation was performed on the following day. A 5 x 10 cm sized skin defect with an exposure of the fractured first metatarsal bone was present, and, to cover the defect, a 6 x 11 cm sized SCIP flap was elevated. The dorsalis pedis artery and subcutaneous vein of the foot dorsum was used as recipient vessels. Two 1 x 2 cm split thickness skin grafts were applied to cover the remnant defect on the lateral and superior flap margins. The patient was discharged 9 days after the surgery without a major complication.

After 1 month, he received a revision surgery to remove the previously grafted skin. At postoperative 3 months, axial circumference discrepancy was measured to be 11 mm, and the patient experienced no discomfort on the operated foot. No additional debulking operation was needed. During 19 months of follow-up, he felt no discomfort during normal ambulation and daily activities (Figure 8).

Fig. 8: Reconstruction of soft tissue defect of the foot:
(A) Preoperative photo of patient with skin and soft defect combined with linear fracture of metatarsal bone; (B) Immediate postoperative photo; (C) Postoperative 3 months result, the patient had no complaint about performance and aesthetic appearance of operated foot.
(Source: N. Sidhoum, S. Dast, S. Perez, N. Assaf, C. Herlin, R. Sinna. Superficial Circumflex Iliac Artery Perforator flap (SCIP flap): Revival of the inguinal donor site. Plast Reconstr Surg. févr 2017).

DISCUSSION

- **Vascular Anatomy**

As described in anatomical studies, cutaneous perforators exhibit significant variations in diameter and location that are difficult to systematize. The vascular supply of the SCIP flap is predominantly through perforators, typically numbering 4 to 5 according to Salmon [8], which are distributed by the SCIA along its course along the groin. The SCIA (1.92 ± 0.6 mm) originates from the anterolateral aspect of the common femoral artery, 2.5 cm below the inguinal ligament, and extends laterally for 1.5 cm parallel to it until reaching the medial border of the sartorius muscle, where it bifurcates into a superficial and a deep branch (1.35 ± 0.41 mm) [9]. The deep branch ascends upwards and laterally beneath the deep fascia, crossing the femoral cutaneous nerve of the thigh, and typically gives off at least two perforators with an average diameter of 0.85 mm for the dominant one, accompanied by a smaller accompanying vein (average diameter = 0.73 mm) located in the anterolateral region of the groin. The superficial branch evolves above the fascia of the sartorius and gives off several perforators to the middle portion of the anteromedial region of the groin [10] (Figure 24).

According to Hong [3], a dominant perforator can be isolated more frequently 3 cm inward from the ASIS along a line traced between a point located medially 1 cm below the inguinal ligament and a second point located laterally 1 cm above the ASIS. Chuang *et al*., [11], on the other hand, propose the "two-finger traverse rule". Hong (3) also finds that in 92% of cases, both branches are sufficiently robust to support flap vascularization. In cases where the superficial branch is absent or too thin (8%) [3], the deep branch is typically found to be large and long. Conversely, the presence of a significantly large superficial branch suggests a reduced deep branch (7, 10). It is worth noting that in cases of particularly extensive flaps, Koshima *et al*., [10], recommend preserving both dominant perforators.

- **Pre-Operative Vascular Mapping**

Given the significant variation in vascular anatomy of the groin region, characterization of flap vascularization and pre-operative vascular mapping are crucial for patients undergoing SCIP flap reconstruction. This allows for procedural adjustment, reducing operation time and enhancing flap vascular safety. In the absence of pre-operative imaging, it is necessary to dissect all perforators in the region and select the dominant perforator based on its diameter and pulsatility, though without knowing the length of its intramuscular course. This lengthy and delicate exploration of perforators carries risks of injury or arterial spasms that may compromise flap vitality and prolong operation time. Pre-operative imaging ideally identifies the dominant perforators based on their locations, intramuscular courses, diameters, and vascular flow characteristics.

Several tools are available to surgeons, including acoustic Doppler [12], color Doppler ultrasound [13], CT angiography [14, 15], and MR angiography [16]. Each of these methods has its advantages and disadvantages, resulting in no clear gold standard but rather proponents for each technique.

- **Acoustic Doppler**

Giunta [17], and Hallock [18], recommend the use of acoustic Doppler for all perforator flaps. It is a portable, simple, non-invasive, and cost-effective technique. Hsu *et al*., [4], also advocate for its sensitivity and the ability to use it intraoperatively as needed. The intensity of the sound signal correlates with vessel diameter and vascular flow. High frequencies, ranging between 5 and 8 MHz, identify the most superficial vessels. However, Doppler pulse provides limited and imprecise information, according to Yu and Youssef [12], especially regarding the distinction between superficial axial vessels and perforators. Therefore, Doppler's specificity and positive predictive value are low, and it lacks 3D representation. Nonetheless, Iida [19], and Hong [1], two leading experts in SCIP flap surgery, recommend pre-operative identification of perforators using Doppler pulse alone, along a line traced between a point located medially 1 cm below the inguinal ligament and a second point located laterally 1 cm above the ASIS (Fig. 9).

- **MR Angiography**

Despite its precision and highly positive findings by Versluis *et al*., [16], who reported 100% concordance between acquisitions and intraoperative clinical observations for locating the dominant perforator in DIEP flaps, MR angiography is costly, time-consuming, and less available in routine practice.

- **Color Doppler**

Color Doppler provides comprehensive information on SCIA characteristics, its branches, and perforators with dynamic assessment of vascular flow [20]. It also offers valuable insights into subcutaneous plane characteristics and perforators smaller than 0.5 mm, surpassing CT angiography and MR angiography in this regard, according to Tashiro *et al*., [20]. Blondeel *et al*., [21] assessed its sensitivity at 96.2%, with a positive predictive value of 100%, for an average examination time of 10 minutes as evaluated by Tashiro *et al*., [20]. Its non-ionizing nature, high sensitivity, low cost, and bedside capability make it a preferred examination tool. Tian *et al*., [22], however, criticize its lack of precision and reproducibility due to operator dependency, which requires a learning curve to master. Nonetheless, it remains our reference for examination (Fig.10).

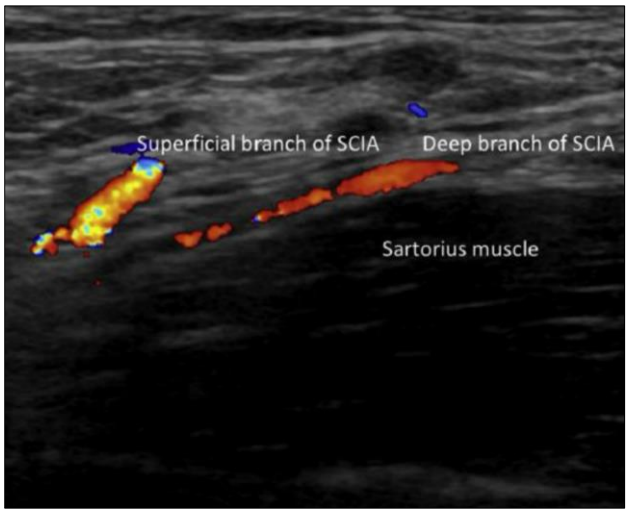

Fig. 9: Color Doppler visualizing the superficial and deep branches of the SCIA along with the sartorius muscle.
(Source: He Y, Jin S, Tian Z, Fang Z, Ma C, Tao X, et al., Superficial circumflex iliac artery perforator flap's imaging, anatomy et clinical applications in oral maxillo-facial reconstruction. J Cranio-Maxillo-fac Surg Off Publ Eur Assoc Cranio-Maxillo-fac Surg. Mars 2016).

- **Surgical Technique**
- **Patient Positioning and Anesthesia**

The patient is positioned in dorsal decubitus with legs extended. One of the main advantages of dorsal decubitus positioning is the ability to work with two surgical teams simultaneously in most reconstructions. The protocol involves general anesthesia with orotracheal intubation for patient and surgical team comfort, given the frequent time-consuming nature of reconstructive surgeries. Monitoring of blood pressure is crucial during the procedure, as perforating vessels are particularly sensitive to blood volume and hypotension, which significantly impacts surgical comfort during dissection and anastomosis times [23]. Special attention should also be paid to hemoglobin levels (9-10 g/dL) and urine output (> 0.5 mg/kg/h).

- **Flap Elevation**

The technical subtlety of SCIP flap harvesting is reflected in the average operation duration (61 minutes), which is comparable to times described by Koshima (30 minutes) [24], and Hong (45 minutes) [3], considering the number of cases we have performed and the learning curve associated with this technique. It's worth noting that the thin flap technique was chosen in 11 out of 13 cases due to the quality it offers in recipient sites where a thicker flap could pose aesthetic or functional issues. Moreover, there was no need for secondary debulking maneuvers on any of the flaps. Additionally, the versatility and adaptability of the SCIP flap have allowed for numerous technical variations, demonstrating its versatility in addressing various types of soft tissue defects.

- **Flap Characteristics**

A single dominant perforator of the SCIA can provide a flap as large as a conventional groin flap. According to Koshima *et al*., [25], the SCIP flap territory extends from the point where the SCIA perforator emerges through the sartorius fascia, extending superiorly to the umbilical line and inferiorly to the trochanteric line. The territory also includes the anteromedial portion of the groin and extends posteriorly to the back. When a thicker flap is desired, Iida *et al*., [26], recommend designing a flap that includes subcutaneous tissues from the flanks; for a thinner flap, the preference is to center the flap over the iliac crest [26, 27]. The average surface area of our flaps was 62.5 cm² [21; 180 cm²], which is close to the average found among 442 other cases reported in the literature (77.4 cm²). An anatomical study by Sinna *et al*., [9], reported flaps reaching up to 375 cm², a size clinically confirmed by Koshima, who described a flap of 432 cm² (24). Goh and Hong [3], in a series of 210 SCIP flaps, found flap widths ranging from 3.5 to 12.0 cm, lengths from 5.0 to 25.0 cm, and an average flap thickness of 5 mm (3 to 7 mm). The average length of pedicles was 5.0 cm (2.5 to 7.0 cm) (Figure 42).

- **Microsurgical Anastomoses**

♣ **Arterial Anastomosis:**

Microsurgical arterial anastomoses for SCIP flaps are considered by some authors [28], to be technically more challenging than those for conventional flaps due to vessel diameter, which typically ranges from 1.35 ± 0.41 mm [9]. Goh and Hong [3], use a perforator from the superficial branch in 92% of cases. In this regard, Iida *et al*., [19], often perform end-to-side anastomoses to avoid excessive dissection in search of a recipient vessel of similar caliber.

♣ **Venous Anastomosis:**

The smaller accompanying vein (average diameter = 0.73 mm) often yields to the larger superficial vein (average diameter = 1.5 mm) due to its more favorable diameter (9). Goh and Hong [3], in a series of 210 SCIP flaps, describe double venous anastomoses in 31.4% of cases, with no significant difference in flap survival compared to single venous anastomoses. They further specify that nowadays, they generally perform only one venous anastomosis, usually to the superficial vein [5].

- **Post-Operative Monitoring**

Hourly clinical surveillance post-operatively focuses on flap coloration, temperature, and capillary refill time. The use of anticoagulants in microsurgery remains controversial and lacks consensus [29], with major complications including bleeding, which can lead to spasm and compressive hematoma. Their primary benefits are reducing blood viscosity, platelet function, and fibrin formation. Oh and Hong [30], introduce post-operative IVSE vasodilator therapy (Welfide®) consisting of 10 μg per day of lipo-prostaglandin E1 in 5% dextrose over 4 hours for the first 5 post-operative days, combined with prophylactic low molecular weight heparin (Fraxiparine® 3800 IU). They also recommend applying graduated compression stockings to the lower limbs from day 5 to day 7 to reduce edema and shape the flap, allowing for early ambulation (Day 1 for head and neck, Day 7 for lower limbs) and discharge by Day 10. Hsu *et al*., [4], prefer anti-thrombotic prophylaxis with aspirin or IVSE heparin (5000 U/day) for 5 days.

- **Complications**
  - **Flap Complications**
    - Failures (2.7%)
    - Revisions (10%)
    - Partial necrosis (6.7%).
  - **Donor Site Complications:**

Direct closure, with its low scar burden and absence of post-operative complications, has been a significant added value of the SCIP flap compared to other surgical options in such clinical scenarios. The donor site consistently allowed for direct closure and was characterized by particularly inconspicuous inguinal scars. Only one case presented a recipient site

complication (7.6%), specifically post-operative algodystrophy.

- **Indications**

This was initially presented as the primary indication for the SCIP flap by Koshima in 2004 [10]. Several authors [3], highlight the advantages of the SCIP flap over the ALT flap in lower limb reconstructions. Hui-chou *et al*., [31], see it as a particularly effective option for Gustilo grade IIIB defects and for covering soft tissue losses in the foot or ankle that require thin flaps. Hong *et al*., [5], also reports excellent results in 21 cases of lower limb osteomyelitis.

CONCLUSION

The SCIP free flap overcomes all the drawbacks of the conventional groin flap and offers new advantages, such as the ability to create customized flaps. The technique is safe, accessible, time-efficient, and precise, especially with pre-operative assessment using color Doppler ultrasound. It preserves the donor site, which suffers significantly with conventional flap harvesting, both functionally and cosmetically by concealing the scar under clothing.

We believe that the use of the SCIP flap will rejuvenate interest in the inguinal donor site for managing various types of tissue defects due to its versatility. It stands as one of the flagship flaps in reconstructive surgery for the future.

REFERENCES

1. Hong, J. P., Choi, D. H., Suh, H., Mukarramah, D. A., Tashti, T., Lee, K., & Yoon, C. (2014). A new plane of elevation: the superficial fascial plane for perforator flap elevation. *Journal of Reconstructive Microsurgery*, *30*(07), 491-496.
2. Ma, C., Tian, Z., Kalfarentzos, E., Zhang, Y., Zhang, Z., Lam, D., ... & He, Y. (2016). Superficial circumflex iliac artery perforator flap for tongue reconstruction. *Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology*, *121*(4), 373-380.
3. Goh, T. L., Park, S. W., Cho, J. Y., Choi, J. W., & Hong, J. P. (2015). The search for the ideal thin skin flap: superficial circumflex iliac artery perforator flap—a review of 210 cases. *Plastic and reconstructive surgery*, *135*(2), 592-601.
4. Hsu, W. M., Chao, W. N., Yang, C., Fang, C. L., Huang, K. F., Lin, Y. S., & Lee, T. H. (2007). Evolution of the free groin flap: the superficial circumflex iliac artery perforator flap. *Plastic and reconstructive surgery*, *119*(5), 1491-1498.
5. Hong, J. P., Sun, S. H., & Ben-Nakhi, M. (2013). Modified superficial circumflex iliac artery perforator flap and supermicrosurgery technique for lower extremity reconstruction: a new approach for moderate-sized defects. *Annals of plastic surgery*, *71*(4), 380-383.
6. Spalteholz, W. (1888). *Die Vertheilung der Blutgefässe im Muskel: Aus dem Physiologischen Institute zu Leipzig*. S. Hirzel.
7. Ma, C., Tian, Z., Kalfarentzos, E., & He, Y. (2015). Superficial circumflex iliac artery perforator flap: a promising candidate for large soft tissue reconstruction of retromolar and lateral buccal defects after oncologic surgery. *Journal of Oral and Maxillofacial Surgery*, *73*(8), 1641-1650.
8. Salmon, M., Taylor, G. I., & Tempest, M. N. (1988). Michel Salmon: Arteries of the Skin. Churchill Livingstone; 174.
9. Sinna, R., Hajji, H., Qassemyar, Q., Perignon, D., Benhaim, T., & Havet, E. (2010). Anatomical background of the perforator flap based on the deep branch of the superficial circumflex iliac artery (SCIP Flap): a cadaveric study. *Eplasty*, *10*.
10. Koshima, I., Nanba, Y., Tsutsui, T., Takahashi, Y., Urushibara, K., Inagawa, K., ... & Moriguchi, T. (2004). Superficial circumflex iliac artery perforator flap for reconstruction of limb defects. *Plastic and reconstructive surgery*, *113*(1), 233-240.
11. Chuang, D. C. C., Chen, H. C., & Wei, F. C. (1992). Technique of foot lengthening and shaping with free vascularized iliac osteocutaneous flap. *Plastic and reconstructive surgery*, *90*(3), 492-496.
12. Yu, P., & Youssef, A. (2006). Efficacy of the handheld Doppler in preoperative identification of the cutaneous perforators in the anterolateral thigh flap. *Plastic and reconstructive surgery*, *118*(4), 928-933.
13. Cina, A., Salgarello, M., Barone-Adesi, L., Rinaldi, P., & Bonomo, L. (2010). Planning breast reconstruction with deep inferior epigastric artery perforating vessels: multidetector CT angiography versus color Doppler US. *Radiology*, *255*(3), 979-987.
14. Rozen, W. M., Phillips, T. J., Ashton, M. W., Stella, D. L., Gibson, R. N., & Taylor, G. I. (2008). Preoperative imaging for DIEA perforator flaps: a comparative study of computed tomographic angiography and Doppler ultrasound. *Plastic and reconstructive surgery*, *121*(1), 9-16.
15. Smit, J. M., Dimopoulou, A., Liss, A. G., Zeebregts, C. J., Kildal, M., Whitaker, I. S., ... & Acosta, R. (2009). Preoperative CT angiography reduces surgery time in perforator flap reconstruction. *Journal of Plastic, Reconstructive & Aesthetic Surgery*, *62*(9), 1112-1117.
16. Versluis, B., Tuinder, S., Boetes, C., Van Der Hulst, R., Lataster, A., Van Mulken, T., ... & Leiner, T. (2013). Equilibrium-phase high spatial resolution contrast-enhanced MR angiography at 1.5 T in preoperative imaging for perforator flap breast reconstruction. *PLoS One*, *8*(8), e71286.
17. Giunta, R. E., Geisweid, A., & Feller, A. (2000). The value of preoperative Doppler sonography for planning free perforator flaps. *Plastic and reconstructive surgery*, *105*(7), 2381-2386.

18. Hallock, G. G. (2009). Attributes and shortcomings of acoustic Doppler sonography in identifying perforators for flaps from the lower extremity. *Journal of reconstructive microsurgery*, *25*(06), 377-381.
19. Iida, T. (2014). Superficial circumflex iliac perforator (SCIP) flap: variations of the SCIP flap and their clinical applications. *Journal of reconstructive microsurgery*, *30*(07), 505-508.
20. Tashiro, K., Harima, M., Kato, M., Yamamoto, T., Yamashita, S., Narushima, M., ... & Koshima, I. (2015). Preoperative color Doppler ultrasound assessment in planning of SCIP flaps. *Journal of Plastic, Reconstructive & Aesthetic Surgery*, *68*(7), 979-983.
21. Blondeel, P. N., Beyens, G., Verhaeghe, R., Van Landuyt, K., Tonnard, P., Monstrey, S. J., & Matton, G. (1998). Doppler flowmetry in the planning of perforator flaps. *British journal of plastic surgery*, *51*(3), 202-209.
22. Tian, Z., Ma, C., & He, Y. (2016). Re:'Preoperative color Doppler ultrasound assessment in planning of SCIP flaps'. *Journal of plastic, reconstructive & aesthetic surgery: JPRAS*, *69*(3), 440-442.
23. Choi, D. H., Goh, T., Cho, J. Y., & Hong, J. P. (2014). Thin superficial circumflex iliac artery perforator flap and supermicrosurgery technique for face reconstruction. *Journal of Craniofacial Surgery*, *25*(6), 2130-2133.
24. Koshima, I., Nanba, Y., Tsutsui, T., & Itoh, S. (2004). Sequential vascularized iliac bone graft and a superficial circumflex iliac artery perforator flap with a single source vessel for established mandibular defects. *Plastic and reconstructive surgery*, *113*(1), 101-106.
25. Koshima, I., Nanba, Y., Nagai, A., Nakatsuka, M., Sato, T., & Kuroda, S. (2006). Penile reconstruction with bilateral superficial circumflex iliac artery perforator (SCIP) flaps. *Journal of reconstructive microsurgery*, *22*(03), 137-142.
26. Iida, T., Mihara, M., Yoshimatsu, H., Narushima, M., & Koshima, I. (2014). Versatility of the superficial circumflex iliac artery perforator flap in head and neck reconstruction. *Annals of plastic surgery*, *72*(3), 332-336.
27. He, Y., Jin, S., Tian, Z., Fang, Z., Ma, C., Tao, X., ... & Zhang, C. (2016). Superficial circumflex iliac artery perforator flap's imaging, anatomy and clinical applications in oral maxillofacial reconstruction. *Journal of Cranio-Maxillofacial Surgery*, *44*(3), 242-248.
28. Green, R., Rahman, K. M. A., Owen, S., Paleri, V., Adams, J., Ahmed, O. A., & Ragbir, M. (2013). The superficial circumflex iliac artery perforator flap in intra-oral reconstruction. *Journal of Plastic, Reconstructive & Aesthetic Surgery*, *66*(12), 1683-1687.
29. Askari, M., Fisher, C., Weniger, F. G., Bidic, S., & Lee, W. A. (2006). Anticoagulation therapy in microsurgery: a review. *The Journal of hand surgery*, *31*(5), 836-846.
30. Oh, T. S., Lee, H. S., & Hong, J. P. (2013). Diabetic foot reconstruction using free flaps increases 5-year-survival rate. *Journal of plastic, reconstructive & aesthetic surgery*, *66*(2), 243-250.
31. Hui-Chou, H. G., Sulek, J., Bluebond-Langner, R., & Rodriguez, E. D. (2011). Secondary refinements of free perforator flaps for lower extremity reconstruction. *Plastic and reconstructive surgery*, *127*(1), 248-257.