

Pedicated Split Hypogastric Flap (Superficial Inferior Epigastric Artery flap): A New Technique for Coverage of Nonadjacent Defects in the Hand

Shanmuganathan Raja Sabapathy, MS, MCh, DNB,
Murugesan Senthilkumaran, MS, MCh, and Monusha Mohan, MS

Abstract: Flap coverage of soft tissue defects on both surfaces of the hand or of nonadjacent defects in the hand is a challenge. Two flaps are needed or if a single flap is used, the intervening normal area or part of the flap must be deepithelialized or the flap tunneled under the normal bridge segment. We are presenting a new technique whereby the hypogastric flap based on the superficial inferior epigastric artery is split into 2 components for the coverage of such defects. The hypogastric flap is separated into a cutaneous component and an adipofascial component at the level of Scarpa fascia. The flaps are separated almost to the base to increase mobility. Now it can be used to cover 2 defects separated by 5 to 7 cm or for defects in the dorsum and the palm. We have used it in 3 patients, in 2 for the coverage of palmar and dorsal aspect of the hand and in one for the coverage of nonadjacent defects on the dorsum of the hand and distal forearm after postburn contracture release. We achieved good results with no flap-related complications.

Key Words: soft tissue cover hand, SIEA flap, split hypogastric flap, hand flaps, nonadjacent defects

(*Tech Hand Surg* 2021;25: 191–196)

Pedicated flaps from the lower abdomen based on the superficial inferior epigastric artery (SIEA) have long been used for the coverage of hand defects,¹ being popular next only to the groin flap described by McGregor and Jackson.² When defects on both the dorsum and volar aspects of the hand need to be covered or nonadjacent defects on the same surface are to be covered, planning becomes a challenge. A combination of groin and hypogastric flaps or a hypogastric flap combined with local random pattern flaps have been used.³ We present a new technique of splitting the SIEA flap and using the 2 components to resurface 2 separate defects in the hand.

Primary thinning of the SIEA flaps has been practised, as the distal part of the flap survives on the subdermal plexus of vessels.⁴ To reduce the bulk, the loose fat layer deeper to Scarpa fascia is excised without endangering the vascularity of the skin flap.⁵ During thinning of the hypogastric flap, we observed that the adipose tissue deeper to Scarpa fascia

maintained the vascularity when separated as a flap even up to the level of the inguinal ligament. This led us to use this tissue as a separate flap when we had to cover 2 separate defects. The technique that we have termed as the split hypogastric flap has been successfully used in 3 patients. We find it a reliable and easy option in these demanding situations.

RELEVANT ANATOMY

The SIEA arises from the anterior aspect of the femoral artery 2.5 cm below the inguinal ligament. It arises as a separate branch in 17% of patients and as a common trunk with superficial circumflex iliac artery (SCIA) in 48% of patients.⁶ Either way, it courses upwards and crosses superficial to the inguinal ligament in line with the femoral artery. It courses upwards branching medially and laterally anastomosing medially with the deep inferior epigastric artery and the superior epigastric artery system and laterally with the superficial circumflex iliac and intercostal arterial systems. This permits us to raise flaps of large dimensions from the lower abdomen with a relatively small base. Even in the 35% cases where Taylor and Daniel⁶ did not find an identifiable SIEA branch taking origin from the femoral artery, he found that there were enough blood vessels around the normal site of the crossing of the SIEA over the inguinal ligament that flaps could still be raised with impunity.

The lower abdominal wall has superficial dense fat and a deeper layer of loose adipose tissue. They are separated by Scarpa fascia. The blood supply of the abdominal wall has been studied and it has been found that the main axial vessels soon after crossing the inguinal ligament become superficial and blood supply is found in 2 planes—a subdermal plexus and a subcutaneous plexus. The subcutaneous plexus is at the level of Scarpa fascia. It has been found that the whole of the adipose tissue deeper to Scarpa fascia can be excised as part of primary thinning of the flap showing existence of individual blood supply to the 2 layers.⁷ This factor has been used in the development of the technique of the presently described split hypogastric flap.

INDICATIONS

The ideal indication for the split hypogastric flap would be situations where we need to provide soft tissue cover to defects on both the dorsum and volar aspects of the hand at the same level. This is a common injury when the hand gets crushed in industrial accidents. The other indication would be during elective surgery like release of postburn scar contractures of the hand, wherein the critical areas needing flap cover are separated by normal native skin, a previous flap, or a defect that can accept a graft. If these critical areas are separated by 5 to 6 cm then usually the whole area is covered with a big flap. In situations where a big flap cannot be harvested or is not ideal, this split hypogastric flap is an ideal choice. As both the flaps share the same pedicle, the defects ideally must be separated by not > 5 to 10 cm.

From the Department of Plastic, Hand, and Reconstructive Microsurgery, Ganga Hospital, Coimbatore, Tamil Nadu, India. S.R.S. and M.S.: were involved in the clinical care of this patient. Our study was performed in accordance with and conforming to the Declaration of Helsinki.

Conflict of Interest and Source of Funding: The authors report no conflicts of interest and no source of funding.

Address correspondence and reprint requests to: Shanmuganathan Raja Sabapathy, MS, MCh, DNB, Department of Plastic, Hand, and Reconstructive Microsurgery, Ganga Hospital, 313, Mettupalayam Road, Coimbatore 641043, Tamil Nadu, India. E-mail: rajahand@gmail.com.

Supplemental Digital Content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's website, www.techhandsurg.com. Copyright © 2020 Wolters Kluwer Health, Inc. All rights reserved.

TECHNIQUE

The surgery is performed under regional block in our center, a brachial block for the upper limb and spinal anesthesia for raising the flap from the abdomen. The anterior superior iliac spine and the pubic tubercle are marked and when connected would represent the inguinal ligament (Fig. 1). This will mark the inferior limit for raising the flap. The femoral artery pulsation is identified, marked, and a line extended upwards across the inguinal ligament. This would denote the line of the SIEA.⁸ By placing the hand in a comfortable position in the area, a flap is designed keeping the SIEA in the base. While planning the flap, proximal to the area of attachment of the flap to the defect, the pedicle can be narrowed. We have found that if we have a base of about 4 to 5 cm centering on the line of the femoral artery, the flap always has the pedicle in the base.

If a large defect is to be covered, the territories of SIEA and SCIA could be recruited together, and the adipofascial flap can be raised in the territory of the SIEA flap and used as per the need (Fig. 2).

The skin flap is raised at the level of the external oblique aponeurosis. It is raised to the line of the inguinal ligament. The viability of the flap is checked by looking for subdermal bleeding. When we look at the cut edge of the flap end on, a line is identifiable denoting the level of Scarpa fascia (Fig. 3). All the tissues deeper to Scarpa fascia are dissected toward the base from the edge of the flap (see Video, Supplemental Digital Content 1, which demonstrates the technique of splitting the hypogastric flap, <http://links.lww.com/BTH/A108>). As we separate, a clear plane of the fascia is visible. Care is taken to raise the whole of the deeper tissue as a single flap. This is important not to devascularize the deeper component. The adipofascial component is separated till it would reach the second defect though it can safely be separated up to the base. The viability of the flaps are assessed, and the donor area is closed primarily or covered with split skin graft based on the size of the flap.

The skin flap is preferentially attached to the defect where future access would be needed for secondary procedures or

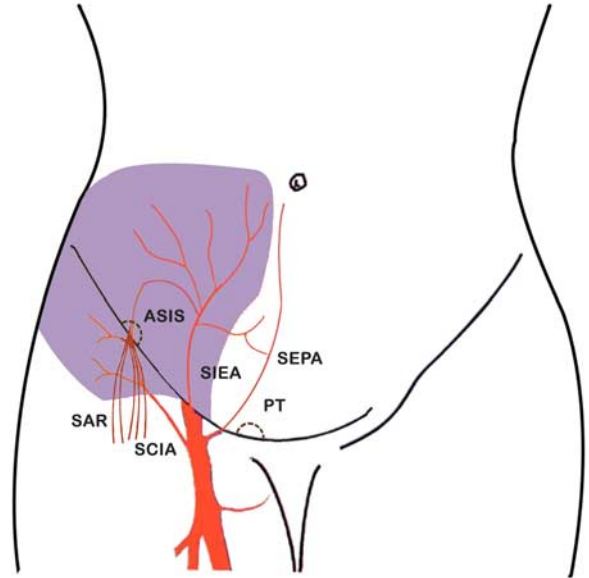


FIGURE 2. For larger defects, both the hypogastric flap and the groin flap could be combined keeping the SIEA and SCIA in the base of the pedicle. In these situations, the adipofascial flap also could be raised in the territory of the hypogastric flap. ASIS indicates anterior superior iliac spine; PT, pubic tubercle; SAR, sartorius; SCIA, superficial circumflex iliac artery; SEPA, superficial external pudendal artery; SIEA, superficial inferior epigastric artery.

where many gliding structures are present underneath to facilitate early rehabilitation. The adipofascial flap is covered with skin graft. Flaps are divided at 3 weeks. Division of the flap can be done without an earlier prior delay if the flap inset is > 70%.

CLINICAL CASES

Case 1

A 28-year-old man sustained machine crush injury to his left hand with fractures of metacarpals, extensor tendon injuries, and skin loss. After debridement, he needed flap cover on the

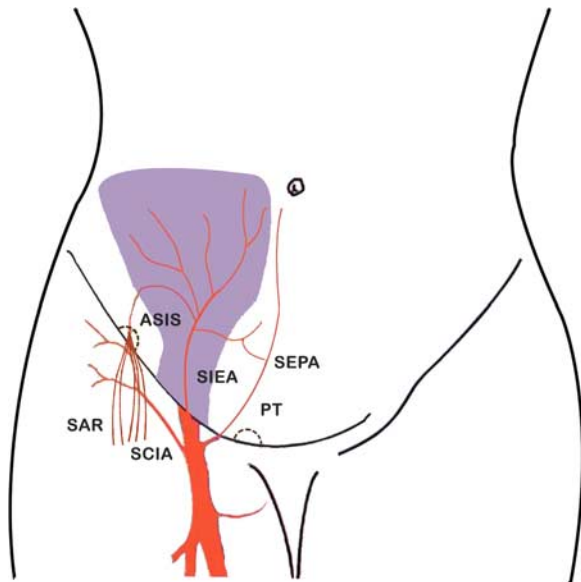


FIGURE 1. Line diagram showing the marking of the hypogastric flap. ASIS indicates anterior superior iliac spine; PT, pubic tubercle; SAR, sartorius; SCIA, superficial circumflex iliac artery; SEPA, superficial external pudendal artery; SIEA, superficial inferior epigastric artery.



FIGURE 3. The cut end of the hypogastric flap viewed to show a thin line (arrows) separating the superficial and the deeper part at the level of Scarpa fascia.



FIGURE 4. A and B, Postdebridement dorsal and volar views of machine crush injury of the hand showing the need for flap cover. C, The hand placed on the abdomen with the hypogastric flap marked. D, The flap raised and split into 2 components superficial and deep to Scarpa fascia. The superficial part inset to cover the dorsum (E) and the deeper adipofascial part attached to the cover of the volar defect (F), long-term results showing well-settled flaps on the dorsum and the volar side with good function (G–I).

dorsum and the volar side of the hand, with the volar side defect smaller than that of the dorsum (Figs. 4A, B). A hypogastric flap was marked to the size of the larger dorsum defect (Fig. 4C). The flap was raised and the tissue layer beneath Scarpa fascia was separated as a flap (Fig. 4D). Both flaps showed good vascularity. The skin flap was inset to the dorsum and the adipofascial flap was inset on the volar side and was covered with split skin graft (Figs. 4E, F). Flap delay was done by partial division of the pedicles at 3 weeks and the flaps were divided a week later. There was uneventful healing of the flaps and the patient went on for rehabilitation to achieve good outcomes (Figs. 4G–I). He was offered further thinning of the skin flap which he would take later.

Case 2

A 37-year-old woman came for correction of the contractures of her left hand following a burn injury which she sustained 5 years ago. She had undergone a release and a groin flap to the dorsum of the hand 6 months after injury, but it had not improved her functional status.

At 5 years, she had flexion deformity at the wrist, dorsal contractures at the metacarpophalangeal joints, thumb contractures, and a narrowed first web space (Figs. 5A, B). There was a groin flap on the dorsum of the hand. Contractures were released retaining the groin flap. Following the release of the contractures she had raw areas on the volar aspect of the wrist,

and on either side of the previously done groin flap on the dorsum (Figs. 5C–E).

The volar defect was managed with a transposition flap with split skin graft for the donor areas. A hypogastric flap was planned in the space between the existing scar lines of the groin flap and the Pfannenstiel incision placed for a cesarean section (Fig. 5F). The previously done groin flap was left undisturbed, though few small tunnels were made to tenolyse the tendons and mobilize the joints. The hypogastric flap was then split into 2 and the skin flap was used for the bigger distal defect and the adipofascial component was used to cover the proximal smaller defect around the wrist and covered with skin graft (Figs. 5G, H). Flaps were divided at 3 weeks. The patient made an uneventful recovery and went on to rehabilitation (Fig. 5I).

Case 3

A 27-year-old had an accidental fall from a train and sustained below-elbow amputation on the right side, circumferential degloving with skin loss with amputation of all fingers at the metacarpal base level, and thumb at the proximal phalangeal level. He reached us 3 months later with complete skin grafted left forearm and hand (Figs. 6A, B). Thumb was immobile. Since the right side had a below-elbow amputation reconstruction of the left side was important. Plan was to excise the skin graft and provide flap cover for future toe transfer for the ulnar post. Since vessels were at a distance, we wanted to

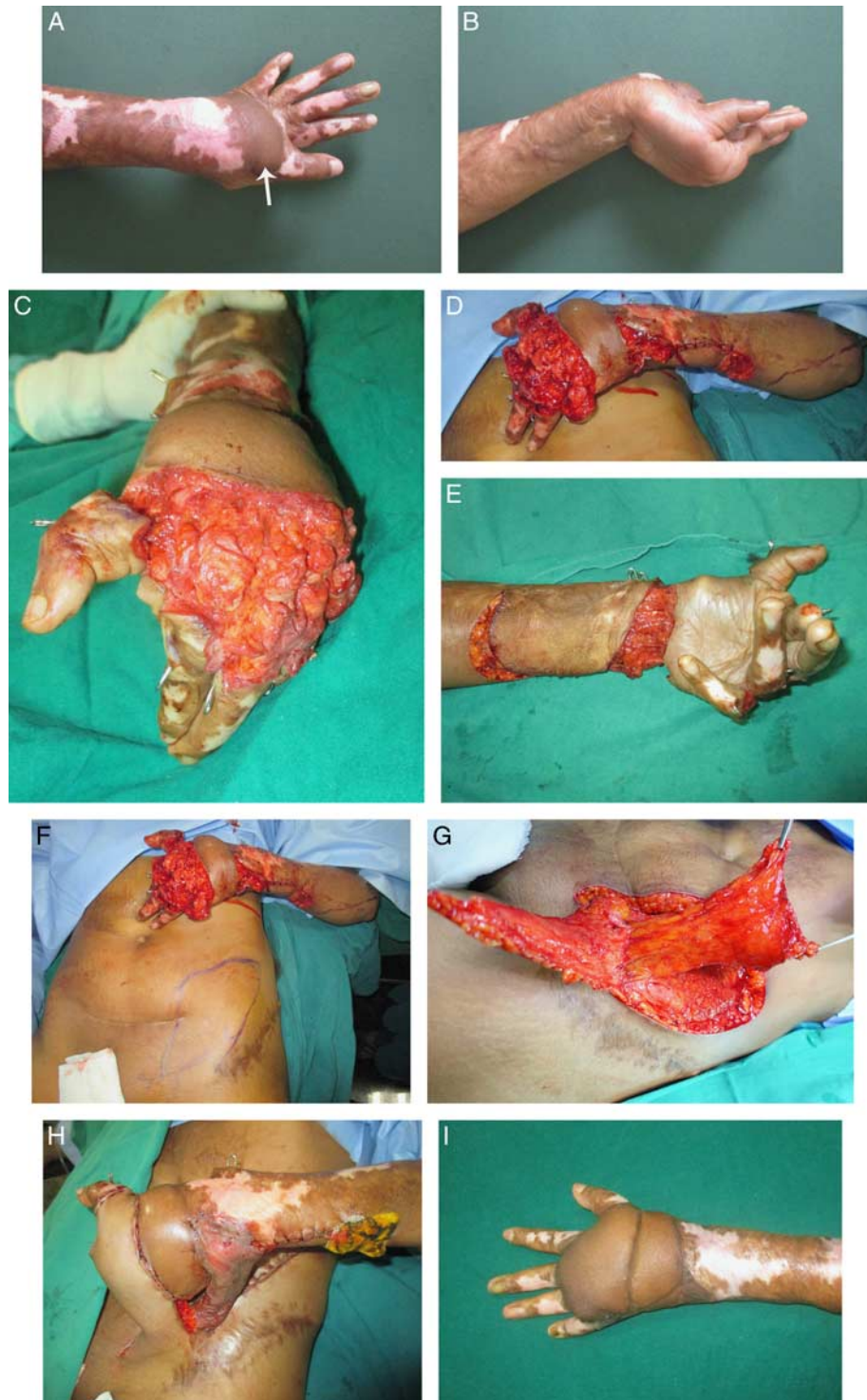


FIGURE 5. A and B, Postburn deformity of the hand with severe dorsal and first web contracture. The arrow shows a previously done groin flap after attempted correction. C–E, The defects after release of contractures. The dorsal defects separated by the previous groin flap needed flap cover and the volar defect could be covered by a transposition flap. F, The skin marking of the flap, designed between the incisions of the groin flap and the Pfannenstiel incision. G, The hypogastric flap split into 2 components. H, Skin flap attached to the distal raw area and the adipofascial flap attached to the proximal defect. I, Postoperative picture showing well-settled flaps.

preserve forearm vessels and the vein grafts for the future microsurgery procedure and hence decided on pedicled flap cover.

All the grafts were excised, thumb was released, and tendon reconstruction was done (Fig. 6C). He had raw area both on the volar and the dorsal side (Fig. 6D). A large abdominal



FIGURE 6. A and B, Circumferential skin grafted forearm and thumb amputated at the interphalangeal joint level. C, Skin graft excised on the volar side, and thumb and wrist flexors reconstructed. D, Defect on the dorsum after excision of the skin graft, needing a flap cover to provide access and pathway for vessels and tendons of future microsurgical reconstruction. E, Flaps planned for dorsal and volar coverage. F, The adipofascial flap split in the territory of the hypogastric flap. G and H, Hypogastric and groin flap covering the dorsum and the web and the adipofascial flap covering the volar side which was grafted. I and J, The flap at 3 years follow-up.

flap including both the SIEA and SCIA was planned to cover the dorsum and a flap based on the superficial external pudendal artery was planned for the volar side (Fig. 6E).

After raising the flaps, we found that the skin flap meant for the volar side was not comfortably inset in the volar raw area. Then the idea of using the split hypogastric flap was considered

(Fig. 6F). The adipofascial part was separated and it comfortably covered the complete raw area (Figs. 6G, H). The adipofascial flap was grafted. The superficial external pudendal artery flap was returned to its original site. The split hypogastric flap was very useful in a demanding situation. The patient went on to rehabilitation and the flap has settled well at 3 years (Figs. 6I, J).

DISCUSSION

Pedicled flaps still play a great role in the coverage of soft tissue defects in the hand. By refining the techniques, we are now able to achieve consistently good outcomes.⁹ When multiple flaps have to be done, many methods have been suggested.^{10,11} They all need meticulous planning as a minor error will cause major problems in the ease of inset.

The split hypogastric flap as we have described is especially useful to cover nonadjacent defects on the same surface or defects in the volar and the dorsal side of the hand. The adipofascial flap has good blood supply and is viable almost to the same size as the skin flap.¹² As it has no skin, it can be used to fill in cavities and making it to the same size of the defect is not required.

The blood supply of the deeper adipofascial flap has not been fully elucidated. From the clinical experience, we feel that the SIEA should be giving adequate branches to the deeper fat layer at the level of the inguinal ligament. There are no studies to confirm this hypothesis. The blood supply of the SCIA perforator flap raised nearby has been studied in detail and it has been shown that the superficial circumflex iliac artery gives off a good vessel to supply the deeper tissues.¹³ Possibly such a system exists here also.

This is a hitherto undescribed procedure and is useful in not so common but challenging situations. Such situations are rare to produce a big series. In a unit performing around 250 distant flaps for the upper limb in a year, we have found it useful in 3 cases and in all 3, the reconstructive goal has been achieved. But when such situations do occur this technique will come handy.

When skin flaps only are done, we usually do not perform a delay before division of the flap. In this case, one of the flaps is without the skin component. There are no studies to clarify if flaps without skin need delay before division. To be safe, we performed the delay procedure by partially dividing the pedicle.

We consider split hypogastric flap is simple to design, easy to execute, and a reliable option for nonadjacent defects on the same side of the hand or defects on both sides of the hand.

REFERENCES

1. Wood J. Case of extreme deformity of the neck and forearm from the cicatrices of a burn, cured by extension, excision, and transplantation of skin, adjacent and remote. *J R Soc Med.* 1863;46:149–159.
2. McGregor IA, Jackson IT. The groin flap. *Br J Plast Surg.* 1972;25:3–16.
3. Sabapathy SR, Kumaran MS. Abdominal flap. In: Chung KC, Moran SL, eds. *ASSH Surgical Anatomy: Flap Reconstruction.* Chicago, IL: American Society for Surgery of the Hand; 2018:166–173.
4. Colson P, Houot R, Gongolphe M, et al. Use of thinned flaps (flap grafts) in reparative hand surgery. *Ann Chir Plast.* 1967;12:298–310.
5. Gousheh J, Arasteh E, Mafi P. Super-thin abdominal skin pedicle flap for the reconstruction of hypertrophic and contracted dorsal hand burn scars. *Burns.* 2008;34:400–405.
6. Taylor GI, Daniel RK. The anatomy of several free flap donor sites. *Plast Reconstr Surg.* 1975;56:243–253.
7. Hester TR Jr, Nahai F, Beegle PE, et al. Blood supply of the abdomen revisited, with emphasis on the superficial inferior epigastric artery. *Plast Reconstr Surg.* 1984;74:657–666.
8. Reardon CM, O’Ceallaigh S, O’Sullivan ST. An anatomical study of the superficial inferior epigastric vessels in humans. *Br J Plast Surg.* 2004;57:515–519.
9. Sabapathy SR. Refinements of pedicle flaps for soft tissue cover in the upper limb. In: Venkataswami R, ed. *Surgery of the Injured Hand—Towards Functional Restoration.* New Delhi, Delhi, India: Jaypee Publishers; 2009:131–138.
10. Sabapathy SR, Bajantri B. Indications, selection and use of distant pedicled flaps in upper limb reconstruction. *Hand Clin.* 2014;30:185–199.
11. Mathew P, Venkatramani H, Sabapathy SR. Mini-abdominal flaps for preservation of digital length in an 18-month old child. *J Hand Surg Eur Vol.* 2013;38:89–91.
12. El-Mrakby HH, Milner RH. Bimodal distribution of the blood supply to lower abdominal fat: histological study of the microcirculation of the lower abdominal wall. *Ann Plast Surg.* 2003;50:165–170.
13. Koshima I, Nanba Y, Tsutsui T, et al. Superficial circumflex iliac artery perforator flap for reconstruction of limb defects. *Plast Reconstr Surg.* 2004;113:233–240.