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Direct Transfer of Large Free Groin Skin Flaps to the Lower Extremity Using Microvascular Anastomoses

Kiyonori Harii and Kitaro Ohmori*

Department of Plastic and Reconstructive Surgery,
Tokyo Metropolitan Police Hospital (Head: Seiichi Ohmori), Tokyo, Japan

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Summary. Recent development of microvascular surgery makes it possible to transfer a large sized free skin flap directly to the recipient site.

Six clinical applications of free groin flaps to the lower extremities are reported and the advantages and disadvantages in our clinical experience are outlined.

A direct transfer of free composite tissue has, in recent years, become clinically possible by microvascular anastomosis.

The purpose of this article is to present our clinical cases which were lesions of the lower extremities treated by microvascular free groin flaps, and to mention the procedure and advantages of this method.

Operative Procedure

Our operative procedure of free flap transfers is composed of the following four stages.

The first stage is preparation of the recipient site, exposing the recipient vessels. The next stage is elevation of the donor flap which is the same size as the recipient defect, being careful not to injure its nourishing vessels.

The third stage is the free flap transfer using microvascular anastomoses. Finally both donor and recipient sites are closed.

In the free groin flap transfer to the lower extremity, it is essential that the surgeons are well experienced in microvascular anastomosis and it is also essential that they know the vascular anatomy of both donor and recipient areas. It is necessary before the operation to carefully select a recipient artery and vein which have healthy vascular walls with suitable diameters and a flow powerful enough to nourish the transplanted flap.

1. Vascular Anatomy of the Groin Region and Elevation of the Groin Island Flap

In 1972 McGregor and Jackson reported "the groin flap" which they stated has a unique arterio-venous closed circuit system similar to Bakamjian's delto-pectoral skin flap. It has in its pedicle the superficial circumflex iliac artery and

* Department of Plastic and Reconstructive Surgery, Tokyo Metropolitan Police Hospital. 2-10-41, Fujimi, Chiyoda-ku, Tokyo, Japan.

can be raised safely beyond the breadth-length ratio of the conventional random pattern skin flap.

Textbooks of human anatomy describe that the groin and hypogastric areas are mainly nourished by both the superficial circumflex iliac artery and the superficial inferior epigastric artery.

However, no textbook was found which described the detailed relationship between the two arteries.

We found that the superficial circumflex iliac artery usually emerges from the anterolateral surface of the femoral artery and turns laterally towards the anterior superior iliac spine just beneath the fascia lata. In many cases it divides into two branches at the medial border of the sartorius muscle; the superficial branch pierces the fascia and runs immediately into the subcutaneous layer, the deep branch runs beneath the deep fascia of the sartorius and pierces the fascia after it crosses the lateral cutaneous nerve of the thigh. The deep branch which sometimes is the main branch can be very small in which case the superficial branch is very small, too. We prefer, therefore, to elevate the flap including both branches, dissecting beneath the deep fascia of the sartorius muscle (Fig. 1).

The superficial epigastric artery pierces the cribriform fascia at the saphenous opening and turns upwards in front of the inguinal ligament. The relationship between the two arteries are important.

In our experience of 29 clinical dissections, these two arteries make various vascular patterns to nourish the groin and hypogastric areas; frequently one of the two is dominant in its diameter. However they anastomose closely with each other so that a groin island flap nourished by one of them can safely be elevated.

There are three venous systems contained in the groin island flap. The main axial vein is the superficial circumflex iliac vein which joins with the superficial epigastric vein in most cases to form a common trunk before passing through the saphenous opening and flowing into the saphenous bulb. The other venous systems are the deep venae comitantes of the superficial circumflex iliac artery and epigastric artery. These veins usually run parallel to the arteries and flow directly into the femoral vein. As our routine, the common trunk of the superficial veins is isolated and sectioned at the saphenous opening. On some occasions they do not form a common trunk and enter into the bulb separately, in such a case, the best way is to pick out the two veins together with the saphenous bulb.

Designing the Groin Island Flap

The groin flap of the same size as the recipient defect is designed in the groin and hypogastric area. The flap base is located just over the femoral artery. The central axis of the flap usually is the line drawn between the point on the femoral artery about one inch below the inguinal ligament and the anterior iliac spine.

The dissection is commenced from the lateral to the medial side beneath the Scarpa's fascia.

At the lateral border of the sartorius the dissection is carried under the deep fascia so that the deep branch of the superficial circumflex iliac artery is included into the flap. When the dissection reaches the lateral border of the femoral artery, the root of the superficial circumflex iliac artery is usually found to enter the flap

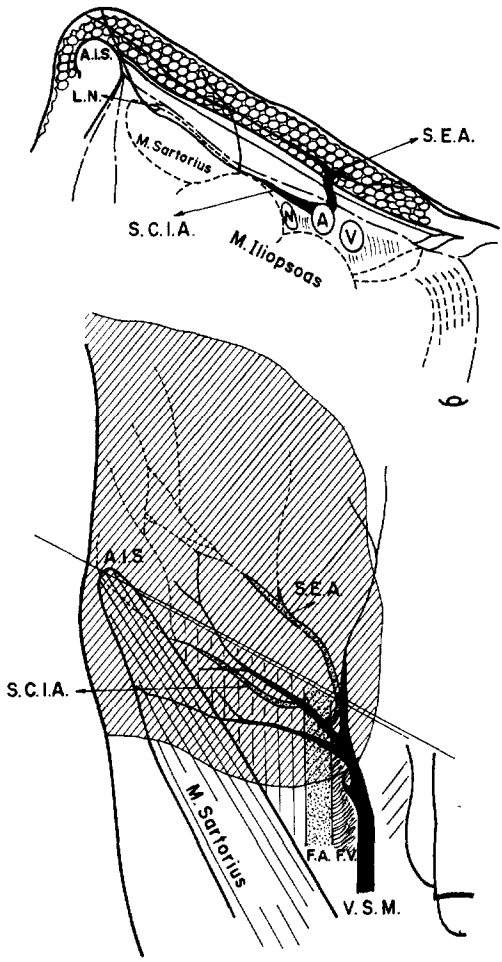


Fig. 1. The vascular anatomy of the "groin flap". The upper illustration shows the two arteries emerging from the femoral artery. The lower shows the relationship between the two arteries and the superficial veins. The deep venae comitantes are not shown in this illustration. The obliquely lined area shows the vascular territory nourished by the two arteries. (*S.E.A.* Superficial epigastric artery, *S.C.I.A.* Superficial circumflex iliac artery, *L.N.* Lateral femoral cutaneous nerve, *A.I.S.* Anterior superior iliac spine, *V.S.M.*; Great saphenous vein, *F.A.* and *F.V.* femoral artery and vein)

with a pair of venae comitantes. Further dissection reveals the root of the superficial epigastric artery with a pair of venae comitantes and its relation to the superficial circumflex iliac artery. After both roots of the two arteries are separated, the base of the flap is carefully cut so as to dissect and expose the subcutaneous veins.

The groin flap is thus isolated as an island with its arteries and veins. A little bleeding usually occurs from its lateral edge. The main artery and vein are then

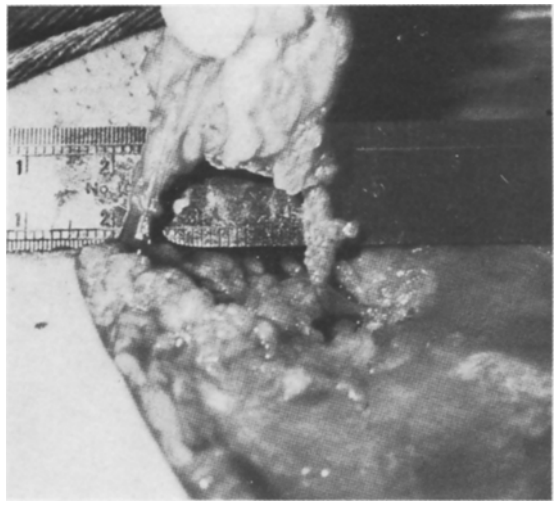


Fig. 2. Prepared pedicle artery (right) and vein (left) at the base of the island groin flap

selected (Fig. 2) and clamped with fine vascular clips (the author prefers to use Heifetz's neurosurgical clips). The remaining vessels are ligated.

2. Microvascular Anastomoses and Free Groin Flap Transfer

After the recipient site is prepared and the recipient vessels are exposed by the second team, the clamped pedicle artery and vein of the flap are cut and the flap is transferred to the recipient site.

The vascular stumps are washed with heparin-saline solution (20 i.u. heparin in 1 cc saline), however the whole flap is *never* irrigated.

Vascular anastomoses are established between the donor and recipient vessels under an operating diploscope using 10-0 monofilament nylon interrupted sutures. Routinely only one artery and one vein are anastomosed by end-to-end method. There is usually a difference in the diameter between the two anastomosed vessels (Fig. 3). The smaller one is cut obliquely and spread gently with fine microsurgical forceps so as to adjust the circumference. When the two anastomoses are accomplished, the vascular clamps are released.

Usually good circulation returns quickly and brisk dermal bleeding is noted, sometimes however capillary return is slow.

The donor site in the groin is closed with a split thickness skin graft, or it is closed directly when the flap is not large.

No heparin is used systemically during or after the surgery. The total time of the surgery averages about 5 to 6 hours. Ischemic time of the flap is between 60 to 90 min.

Case Reports

Case 1. A 36 year old male had a deep burn scar on his left lower leg due to an explosion during the 2nd World War. The scar of the anterior tibial region was unstable and there was a deep penetrating chronic ulcer in its center (Fig. 4a). All of the ulcer and surrounding unstable

Fig. 3. Microvascular anastomosis between the two arteries of the different diameters (smaller one; 1.0 mm, larger one 2.5 mm) using 10-0 monofilament nylon. The magnification is about 15 times

scar tissue was excised and the resultant soft tissue defect needed flap coverage. The wide scars prevented local flap procedures and the head of his right hip joint had been replaced about 10 years ago with an acrylic prosthesis. (Fig. 4b).

In such a condition, we decided to apply a free groin flap to cover the defect. After the extensor hallucis longus and tibialis anterior muscles were separated, the anterior tibial artery and its two venae comitantes were exposed and about 5 cm was prepared from the surrounding tissues. Some of their branches were ligated. The artery and one of veins were cut and shifted subcutaneously between the two muscles.

A free groin flap large enough to cover the deep soft tissue defect was elevated and the nourishing arteries and veins were dissected out at its base (Fig. 5a and b). In this case the main donor artery formed a common trunk between the superficial circumflex iliac and superficial epigastric artery. We tagged the arteries from the common trunk so that the two nourishing arteries were included in the flap. The main vein was tagged at the saphenous opening where a few superficial veins came together.

Microvascular anastomoses were performed between the donor artery and vein and the recipient anterior tibial artery and one of the venae comitantes. The leg was fixed in a plaster cast for two weeks, and the flap took perfectly. The patient started to walk on the third week after the surgery (Fig. 6a and b).

Case 2. A 35 year old male received an avulsion injury of his left foot in a traffic accident. The dorsal skin of the foot was avulsed resulting in the exposure of extensor tendons and metatarsal bones (Fig. 7). The avulsed skin flaps were returned to their beds after initial toilet and observed about one week with saline dressings. After a week the necrotic skin was debrided and the defect was covered by a 16 cm × 12 cm free groin flap at the same operation (Fig. 8a and b).

Fig. 4a and b. (Case 1) A 36 year old man had a deep chronic ulcer and wide unstable scar at the left anterior tibial region (a). The cross leg flap was not applicable, because the head of his right hip joint had been replaced about 10 years previously with an acrylic prosthesis (b)

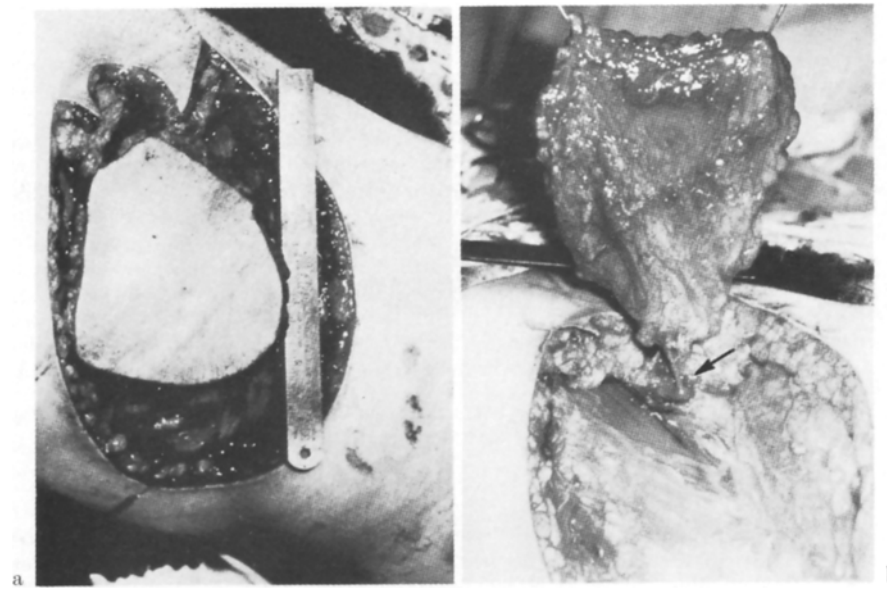


Fig. 5. A 15 cm × 11 cm free groin flap was raised (A). The pedicle artery of the flap was a common trunk between the superficial circumflex iliac artery and epigastric artery (B. Arrow shows the common trunk)

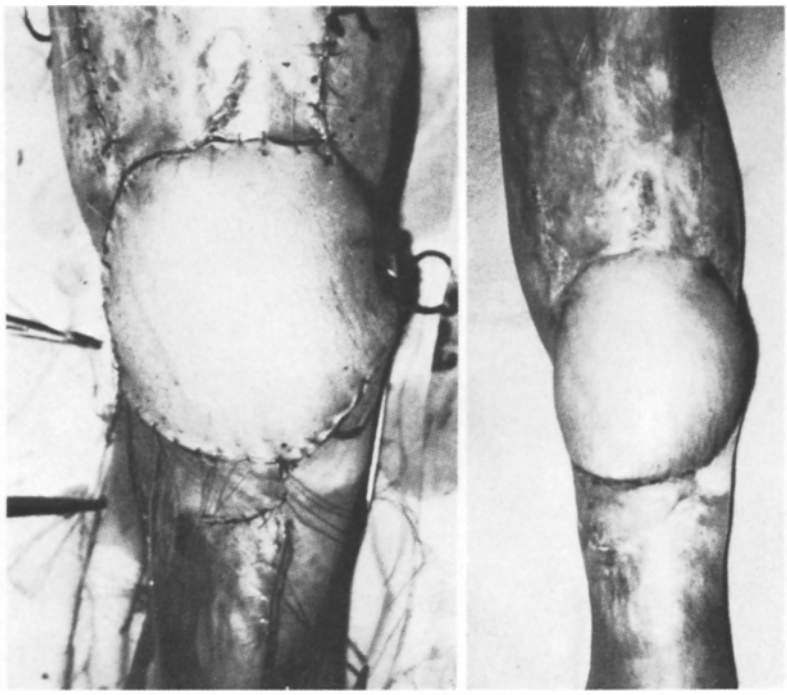
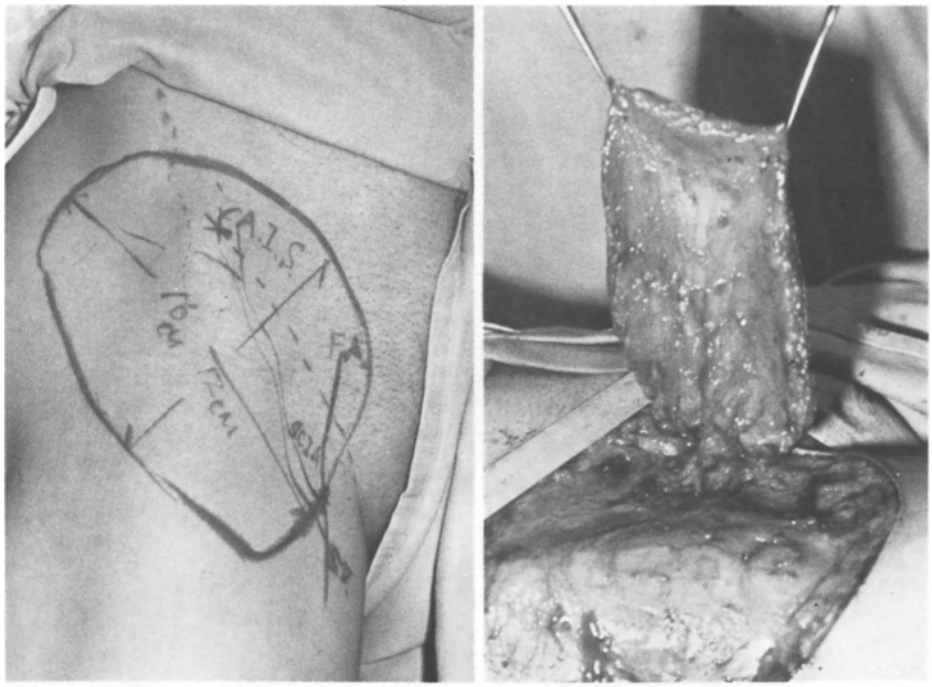


Fig. 6a and b. The flap immediately after revascularization (a) and the flap one month after surgery (b)

Fig. 7. (Case 2) A 35 year old male sustained an avulsion injury on his left foot. The extensor tendons and metatarsal bones were exposed

The diameter of the donor superficial circumflex iliac artery was 1.0 mm and that of vein 2.5 mm. The diameter of the recipient dorsalis pedis artery was 2.5 mm and that of the long saphenous vein 2.5 mm.

Anastomoses were done under an operating diploscope by an end-to-end method, using 10-0 monofilament nylon. The flap took well and he was able to walk a month after surgery (Fig. 9).



a b

Fig. 8a and b. The design of the 16 cm × 12 cm free groin flap (a), and elevation of the island flap nourished by the superficial circumflex iliac artery and drainage vein (b)

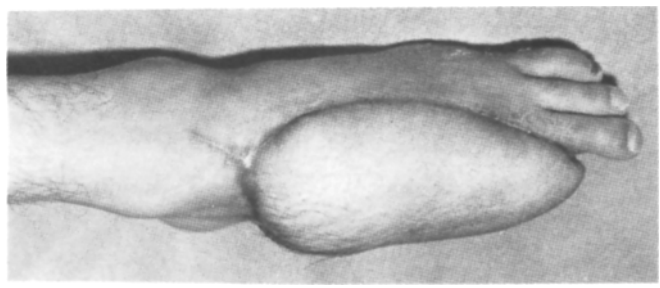


Fig. 9. The flap took well and he was able to walk a month after surgery

Case 3. A 28 year old male had been involved in a traffic accident at the age of seven and crushed the lower third of his left leg resulting in a compound fracture of the tibia and fibula with a large soft tissue defect. After the fractures were treated initially, and over a period of six years several free skin graftings were employed to cover the defect, but resulted in unstable scarring. Osteomyelitis and extensive ulceration developed and a thoracoepigastric tube and a cross leg flap were applied, but in vain.

At the time of admission to our unit, he had extensive ulcers overlying the fibular fracture site with soft tissue covering only the pretibial area. The ulcers were dirty and cultures revealed pseudomonas (Fig. 10a and b).

The X-ray film showed that the osteomyelitis was controlled well and there was good union of the fractures. When the ulcer and unstable skin were widely debrided, the tendons

Fig. 10a and b. (Case 3). A 28 year old male had extensive ulcers on his left lower leg which were dirty and revealed a pseudomas infection on culture (a). The ulcers and osteomyelitis were treated by a thoracoepigastric tube and a cross leg flap, but in vain (b)

and a part of the fibula were exposed. A 25 cm × 14 cm free groin flap was used to cover the defect at the same time. (Fig. 11a and b). The superficial circumflex iliac artery (about 1.1 mm in diameter) was selected as the donor artery and the superficial veins were tagged at the saphenous bulb. The recipient artery was the anterior tibial artery (its diameter about 4 mm) and the vein one of its venae comitantes.

The recipient vessels were transposed subcutaneously between the tibialis anterior and hallucis longus muscles. The large free skin flap was transferred successfully with revascularization by end-to-end anastomoses of one artery and one vein. About two weeks later the flap had taken well and the infection subsided. About 50 days postoperatively the patient could walk without any trouble. The arteriogram at that time showed good patency of the anastomosis (Fig. 12a and b).

Case 4. A 30 year old male had a deep burn on his left knee. About three weeks later the burn eschars were debrided and a mesh free skin grafting was applied (Fig. 13).

Two weeks after the surgery, sloughed skin grafts were debrided again and the exposed patella and knee joint were covered immediately with a 19 cm × 15 cm free groin flap. (Fig. 14a and b). The recipient vessels were anterior tibial artery and one of its venae comitantes transposed subcutaneously between the muscles. The flap took well and three weeks later the patient was able to flex his knee and walk easily.

Discussion

Extensive soft tissue loss of the lower extremity usually requires resurfacing with various types of skin flap. A local flap repair, of course, is most ideal, however, there is great limitation in its use according to the condition of the surrounding tissues.

On the other hand a distant flap is most useful to transfer a large amount of tissue. However, tedious staged procedures are usually necessary with a long

Fig. 11a and b. Wide debridement was achieved (a) and a 25 cm × 14 cm large free groin flap was devised to cover the defect (b)

hospital stay and a heavy economic burden on the patient. A cross leg flap is most applicable because of its direct transfer of suitable skin, but associated injuries of the joints, bones or recipient leg may make it impossible. It is not generally satisfactory for patients over 45 years of age or patients who have some kind of joint disease, because the joint fixation with a plaster cast is of long duration (three or four weeks). It is also inappropriate for female patients because of the ugly donor scar.

Recent development of microvascular surgery makes it possible to transfer a free skin flap directly to the recipient site. In 1973 Daniel and Taylor and O'Brien *et al.* reported successful clinical transfer of free groin flaps to the lower extremity. Currently we have performed six free groin flaps to the lower extremity as shown in Table 1. We would like to mention further application of the free groin flap to the lower extremity according to our experience.

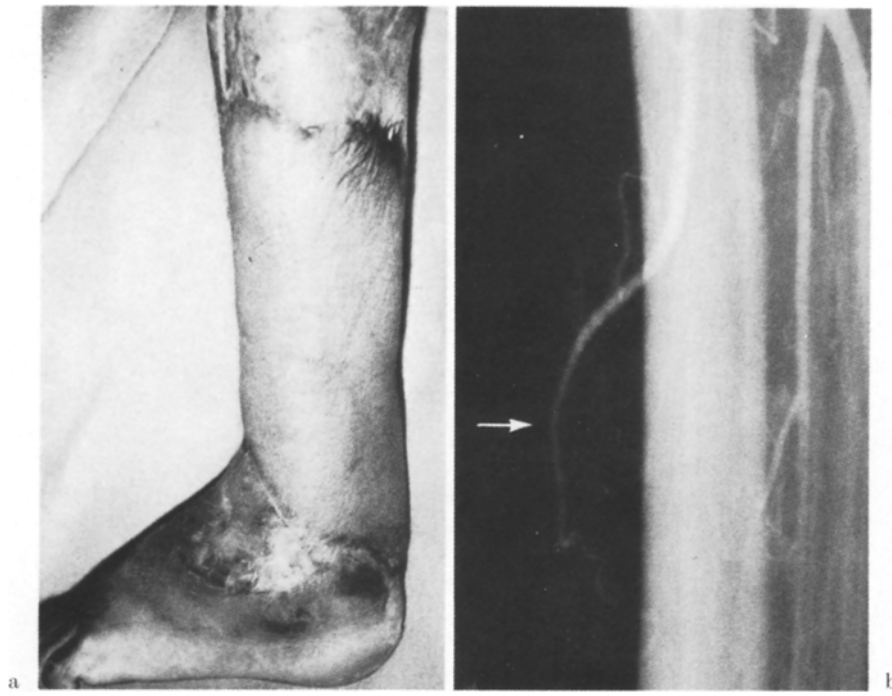


Fig. 12. The flap about 50 days after operation. He could walk without any trouble (a). The arteriogram shows good patency of the anastomosis (b)

Fig. 13. (Case 4) A 30 year old male had a deep burn on his left knee

The advantages of the free groin flap for reconstruction of the lower extremity are multiple.

1. It is very convenient in resurfacing soft tissue defects of the lower extremity, because a large skin flap can be transferred directly without any fixation to the donor site or delay procedure. The largest of our successfully transferred free groin flaps in six cases is 25 cm $\times$14 cm (shown in case 3). However the size of the flap could be enlarged, because no one knows the maximum vascular territory of the superficial circumflex iliac and superficial epigastric vessels.

2. It is suitable for acute coverage of exposed bones, tendons and nerves, in order to prevent further contamination or sequestration of bones exposed without periosteum (shown in case 2).

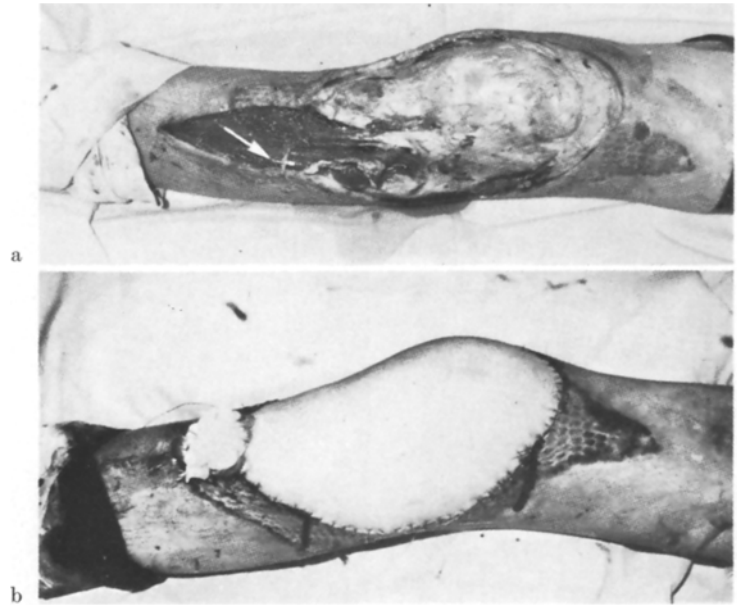


Fig. 14a and b. Sloughed skin grafts were debrided (A. Arrow shows recipient anterior tibial vessels transposed subcutaneously between the muscles), and the resultant defect was covered with 19 cm × 15 cm free groin flap (b)

Fig. 15a and b. The flap took well (a). Three weeks later he was able to flex his knee and walk easily (b)

Table 1

Case No.	Lesions	Size of flap (cm)	Donor vessels	Recipient vessels	Results
1	Lower leg ulcer	15 × 11	Common trunk Cut. vein	Ant. tibial a. V. comitans	perfect take
2	Avulsion injury	16 × 12	S.C.I.A. Cut. vein	Dorsalis pedis a. Gr. saph. vein	perfect take
3	Lower leg ulcer with osteomyelitis	25 × 14	S.C.I.A. Cut. vein	Ant. tibial a. V. comitans	perfect take
4	Burned ulcer	19 × 15	S.C.I.A. Cut. vein	Ant. tibial a. V. comitans	perfect take
5	Osteomyelitis	20 × 8	S.C.I.A. Cut. vein	Post. tibial a. Gr. saph. vein	complete necrosis
6	Ulcer due to Raynaud's disease	8 × 6	S.C.I.A. Cut. vein	post. tibial a. (branch) Gr. saph. vein	superficial necrosis

S.C.I.A. = Superficial circumflex iliac artery. Cut. vein = Superficial drainage vein.

3. The transferred free skin flap has an abundant blood supply, so that it can be suitably applied to a lesion of poor blood supply, for example a chronic lower leg ulcer, chronic osteomyelitis, or ununited fracture.

4. It is more suitable for the covering of the area of a joint than the multiply delayed flap, because it is less fibrotic and therefore softer and extensible (shown in case 4).

5. The patient can begin to walk earlier. Usually the leg is lowered about three weeks after operation and the patient begins to walk in the 4th week.

6. There is no open wound remaining so that bone or tendon grafting can be performed at the same time with minor risk of infection.

7. The residual scar is inconspicuous.

The main disadvantage of this method is a technical one; the surgeons are required to be skilled in microvascular anastomosis and to have detailed knowledge of the vascular anatomy of both donor and recipient sites.

Our two failures had degenerative changes of the recipient vessels; one case was due to chronic inflammation caused by osteomyelitis (case 5), another to Raynaud's disease (case 6).

It is therefore necessary, we believe, to select healthy recipient vessels with suitable diameters, locations for anastomoses and blood flow good enough to supply the transferred flap. We were able to transfer a large size free groin flap successfully by anastomoses of a single artery and vein. The total operation time is about 5 hours to 6 hours. Postoperative management is very easy because no heparin is used systemically.

The color of the flap should be checked three or four times daily for three days after the operation. Thrombosis, of course, produces total necrosis of the flap, however, when there are signs of thrombosis in the early stage, thrombectomy can

be performed so that the flap might be saved. As mentioned above we believe that a free groin flap to the lower extremity has more advantages than the conventional pedicle flaps and its application is highly recommended.

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Dr. Kiyonori Harii
Department of Plastic
and Reconstructive Surgery
Tokyo Metropolitan Police
Hospital
2-10-41, Fujimi, Chiyoda-ku
Tokyo, Japan