

Microvascular Reconstruction of Extensive Foot Injuries

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〈국문요약〉

유리피판술을 이용한 족부재건

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정윤규 · 정 섬 · 김주봉

해부학적으로 족부는 주위에 이용할 수 있는 연조직이 별로 없을 뿐 아니라 이용할 수 있더라도 크기가 제한되어 있으므로 광범위한 연부조직 결손시 이의 복원이 어렵다.

광범위하고 오염된 족부의 창상을 재건시 이상적인 조직의 조건으로서는 감염에 잘 견디고, 가능한 원래의 모양 및 크기에 가깝게 복원해야 하며, 적절한 감각이 있어야 하고, 끊임없는 마찰력과 체중 부하에 잘 견뎌야 할 것이다.

미세혈관술을 이용한 유리조직이식은 비교적 위와같은 장점들을 제공할 수 있다.

저자들은 최근 약 4년간 외상과 전기화상 및 화상후 후유증으로 인하여 족배부, 발꿈치, Achilles건, 족저부등에 광범위한 결손 및 변형이 있었던 환자 21예에서 미세혈관술을 이용하여 Fasciocutaneous, musculocutaneous, muscle with skin graft 등으로 족부를 재건하여 추적중에 있으며 현재까지 관찰된 결과 및 장점, 단점과 문제점들을 보고하는 바이다.

Key Words : Extensive foot injury, Free flap, Muscle flap

INTRODUCTION

The number of patients warranting extensive foot reconstructions has steadily increased with the major cause being motor vehicle accidents. These injuries are usually of the high energy trauma type and are commonly combined with open fractures of the lower leg as with extensive

soft tissue loss and bacterial contamination.

Limitations in the ability to reconstruct soft tissue injuries of the lower leg especially extensive foot injuries were generally treated in the past with below-knee amputations¹⁾. It was only after the introduction of microsurgery that previously unsalvageable foot injuries were adequately reconstructed with a variety of free flaps²⁾.

The ultimate goal in any foot reconstruction is

the patient being able to walk comfortably. Therefore flaps that are thin enough to conform to the contours of the foot and at the same time durable to constant weight bearing movement should be used.

We treated twenty-one patients suffering from extensive soft tissue loss of the foot due to trauma, electric burn or postburn sequelae. The patients underwent foot reconstructions with fasciocutaneous, musculocutaneous or muscle free flaps with skin grafting based on the location, volume of tissue required, and the functional anatomical requirement of the injured site. Experience with this patient group forms the basis of our report.

MATERIAL & METHODS

From July 1990 to September 1993, twenty-one patients with extensive soft tissue defects of the foot due to trauma, electric burn or postburn sequelae were treated. Each patient underwent a free tissue transfer for foot reconstruction. The specific location and size of the defects are listed in Table 1. The type of free flap used is also listed in Table 1. The latissimus dorsi muscle free flap with skin graft was used most often (7 cases). The mechanism of injury is listed in Table 2. Motor vehicle injury was the most common cause (15 cases).

The patients were separated into four groups based on the time-lapsed from onset of injury to treatment with a free flap; acute (less than 6 days), subacute (6 days to 6 weeks), chronic (more than 6 weeks), and secondary cases (healed

Table 1. Results in Treating Major Foot Injuries with Free Flaps

Case	Sex/Age	Defect	Size (cm)	Flap Used	Result	Followup (months)
1	F/40	Heel	19×12	LD	S	48
2	M/5	Dorsum	13×10	LD	S	45
3	F/10	Heel	10×6	Parascapular	S	44
4	M/4	Dorsum	17×6	LDMC	S	44
5	M/64	Heel	5.5×5	Forearm	S	43
6	M/21	Malleolar	15×8	LD	S	41
7	F/16	Malleolar	12×7	LD	S	37
8	M/30	Malleolar	17×9	LD	S	37
9	M/42	Malleolar	9×7	Rectus	S	37
10	M/28	Heel	25×10	LD	F	35
11	M/8	Heel	10×5	Rectus	S	34
12	M/52	Dorsum	8×4	Rectus	S	30
13	M/6	Dorsum	15×8	LDMC	S	24
14	M/52	Heel	11×5	Rectus	S	22
15	M/31	Heel	18×15	LD	S	17
16	M/32	Dorsum	18×15	Rectus	S	16
17	M/54	Dorsum	9×9	Forearm	S	15
18	M/33	Heel	12×4	Gracilis	S	14
19	M/35	Dorsum	14×6	Forearm	S	13
20	M/20	Dorsum	15×8	Forearm	S	11
21	M/10	Dorsum	13×6	Parascapular	S	10

LD: Latissimus dorsi muscle with skin grafting

LDMC: Latissimus dorsi musculocutaneous

S: Success

F: Fail

Table 2. Mechanism of Injury

Type	Number
Motor vehicle injury	15
Farm machine injury	1
Coal mine injury	1
Electric burn	2
Postburn sequelae	2

wounds and more than 12 months needing secondary reconstruction).

RESULTS

Twenty free flaps survived (success rate: 95%)(Table 1). In one patient the transferred flap failed (Case No. 10). In two patients marginal flap necrosis occurred (Case No. 1 and No. 4) In five patients, partial skin graft loss occurred in the early postoperative period but all healed after conservative management (Table 3). Defatting procedures were additionally done in two patients (Case No. 3 and No. 13) due to flap bulkiness. Infection occurred in one patient (Case No. 21).

The time-lapsed from onset of injury to treat-

ment with a free flap is summarized in Table 4. No patient was treated within six days of injury. Eleven patients (52%) were treated between 6 days and 6 weeks, five patients (24%) were treated after more than 6 weeks, and five patients (24%) were treated as secondary cases. The average duration from onset of injury to operation was 39.4 days. The single failure as well as the two

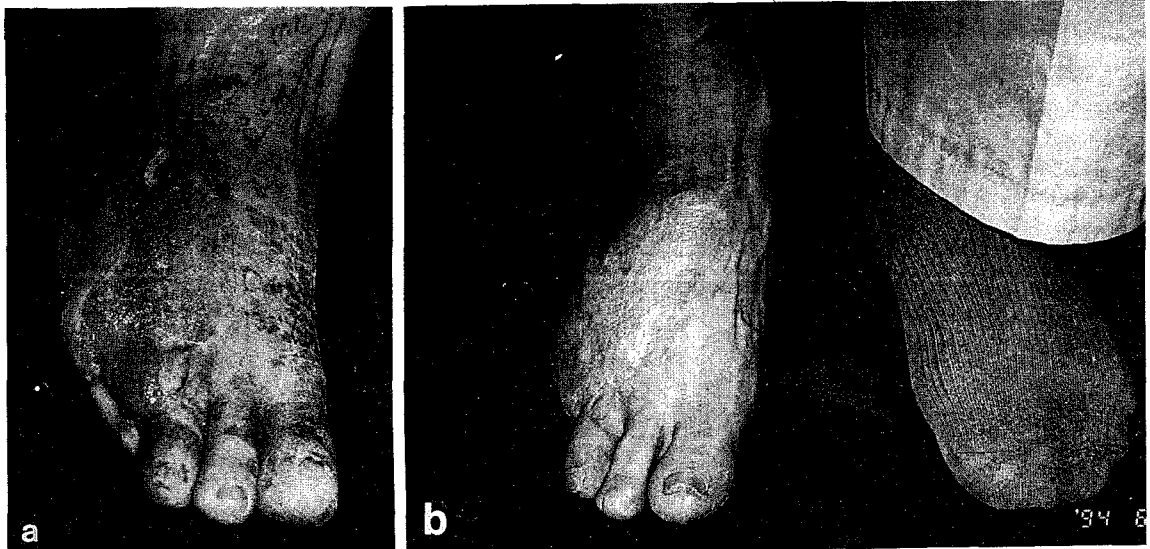
Table 3. Complications

Type	Number(%)
Infection	1(4.7%)
Total flap failure	1(4.7%)
Partial flap failure	2(9.5%)
Partial skin graft loss	5(23.8%)

Table 4. Time-lapsed from Onset of Injury to Treatment

Duration	Number of Cases
Acute(less than 6 days)	0
Subacute (more than 6 days, less than 6 weeks)	11(52%)
Chronic(more than 6 weeks)	5(24%)
Secondary (healed wounds and more than 12 months)	5(24%)

Average time-lapsed : 39.4 days.

**Fig. 1.** Case 12

(a) Defect of dorsum, digits and distal plantar area.

(b) Reconstructed with rectus abdominis muscle free flap with skin grafting. Twenty-nine months postoperatively.

cases of partial flap necrosis belonged to the secondary cases, but there was no correlation between the subacute and chronic group in relation to postoperative wound complications.

The patients have been followed postoperatively for a mean of 29 months (range minimum of 10 months to maximum of 48 months). Each patient is ambulatory. The wounds, especially of weight bearing areas are stable. We have not seen any problems with the donor sites. Figures 1 to 5 are our representative cases.

DISCUSSION

The aim in treating the extensively traumatized foot with microvascular free flaps is so that eventually the patient will be able to walk. The foot

should ideally be reconstructed to its original size and shape with tissue durable enough to withstand constant frictional movement.

Numerous local flaps have been used previously in the treatment of soft tissue defects of the foot^{3,10}. However due to the limitation in size, local flaps were usually effective in covering small wounds. Free flaps on the other hand utilized tissue with greater area and volume, and thus were readily applied in the treatment of complex and extensive foot wounds⁹. The use of these distant flaps also offered the additional advantage of avoiding or reducing any further functional disability sometimes inherent in using local tissue in an already heavily traumatized foot.

In reconstructing the foot, it is considered convenient to consider the foot injury by anatomic

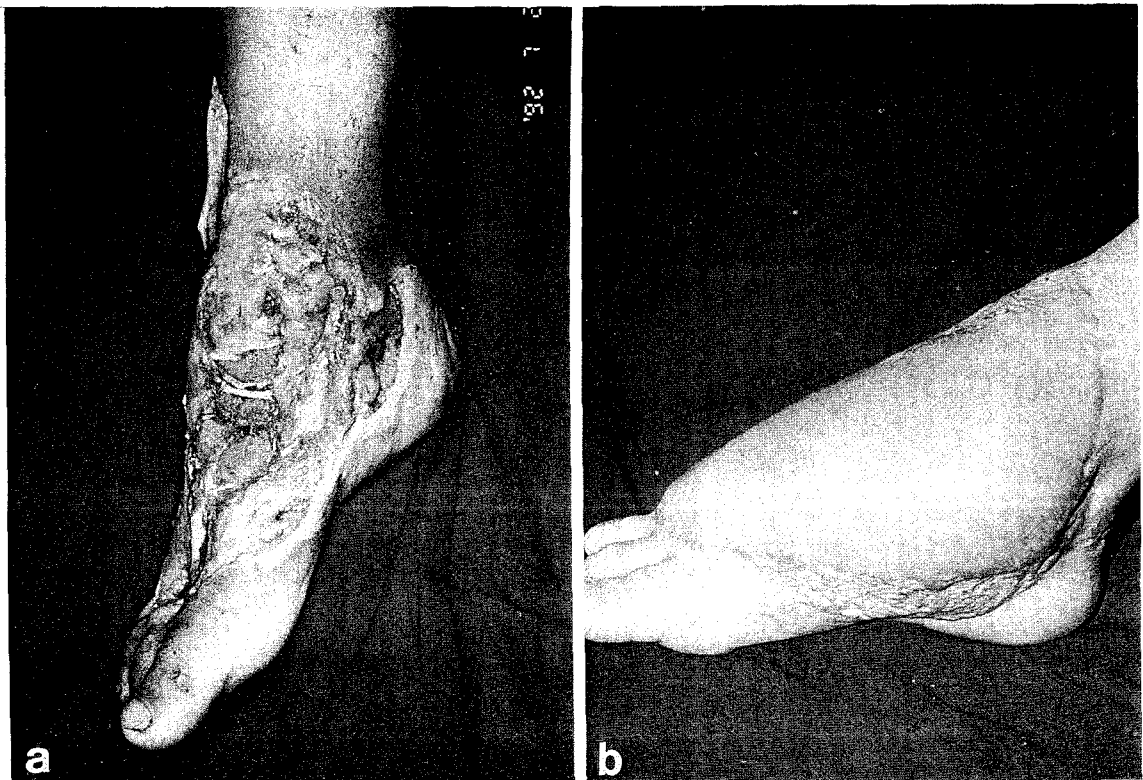


Fig. 2. Case 13

- (a) Defect of dorsum with exposed bone and joints.
- (b) Reconstructed with latissimus dorsi musculocutaneous free flap. Twenty months postoperatively. Defatting was later done due to flap bulkiness.

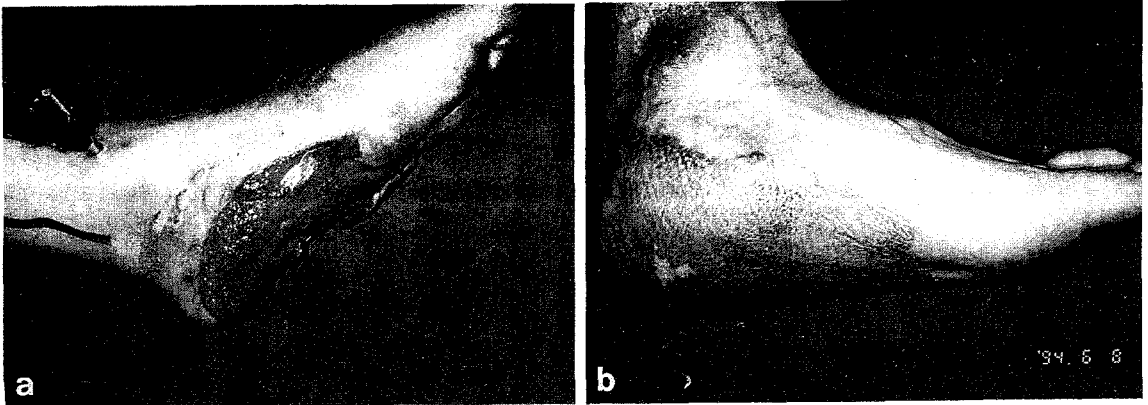


Fig. 3. Case 15

(a) Defect of heel and midplantar area.

(b) Reconstructed with latissimus dorsi muscle free flap with skin grafting. Sixteen months postoperatively.

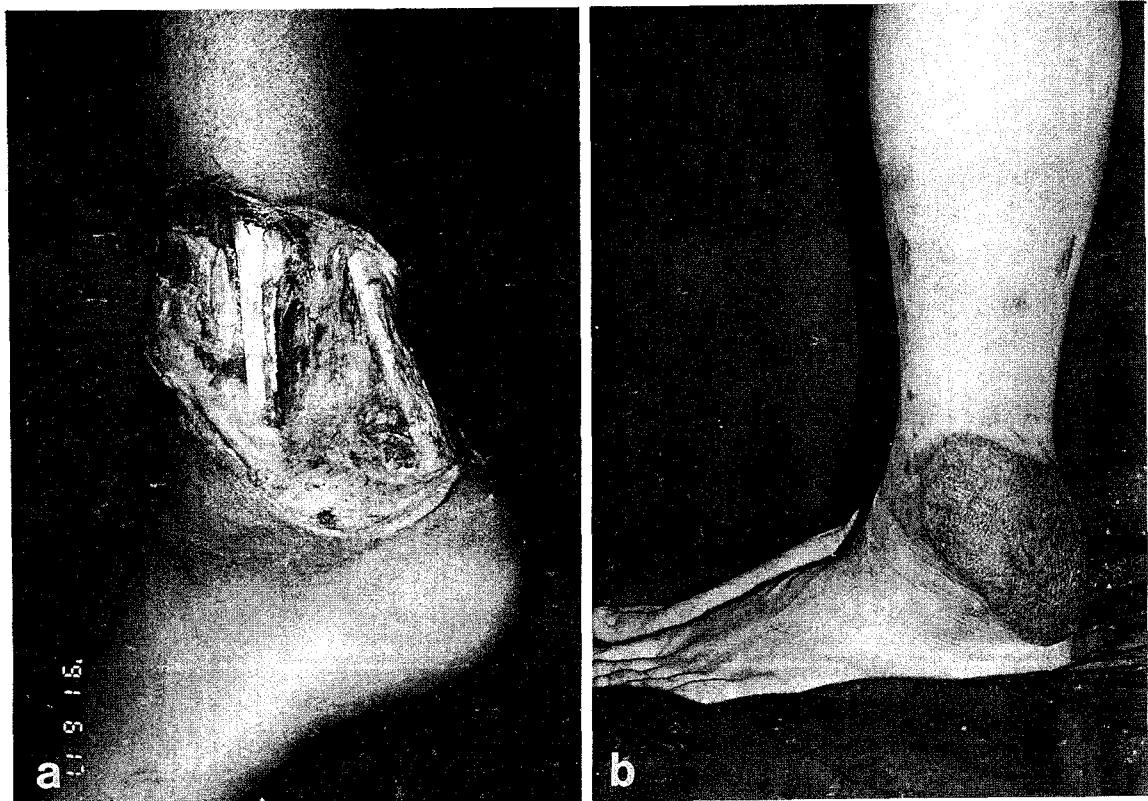


Fig. 4. Case 8

(a) Defect of lateral malleoli and Achilles tendon.

(b) Reconstructed with latissimus dorsi muscle free flap with skin grafting. Ten months postoperatively.

regions: (1) the heel and midplantar area: (2) the distal plantar area: (3) the malleoli, Achilles tendon, and (4) the dorsum of the foot.¹²⁾ In addition,

the ideal method of treatment is restoration of normal sensation and anatomic contour of the foot, and ultimately the patient being able to walk with

a normal gait.

The type of flap to be used was decided after considering cause of injury, condition and extent of the wound, and time lapsed since injury. The majority of the wounds we encountered were the result of acute high energy trauma and also heavily contaminated, and therefore we favored muscle flaps^{13,14}. Skin flaps were usually chosen for patients needing secondary reconstructions (ie. post-burn sequelae) and in situations where associated injuries made it difficult to harvest a muscle flap. In one patient, the parascapular flap became infected, but we believe there is insufficient data from our group of patients to conclude that fasciocutaneous flaps have a greater chance of infection than muscle flaps since our other fasciocutaneous flaps (total : 5) healed without infection or other complications.

The most difficult region of the foot to treat successfully is the weight bearing heel. As numerous authors have written that the heel should be reconstructed with "like-tissue": sensate and durable to friction^{12,15,16}. But this is not always possible in the case of extensive loss of the heel area.

When we compared the latissimus dorsi muscle and skin graft with the parascapular flap in heel reconstructions, we found the skin flap to be bulky during suturing to the wound, and even after several months, the skin flap continued to be pendulous, requiring ancillary defattings (Case No. 3). Furthermore, the skin was not durable to the constant pressure and friction, resulting in occasional surface breakdown. Contrastly, the muscle free flap with skin grafted heel was durable, albeit small blisters did occasionally occur over the calcaneus in the early postoperative period of weight bearing.

We used the latissimus dorsi musculocutaneous flap in two patients (Case No. 4 and 13) with extensive dorsal defects. While the musculocutaneous flaps provided satisfactory wound healing and coverage, an unattractive attribute was the excessive bulk, which ultimately required defatting. Thus subsequent use of a musculocutaneous flap was avoided.

Regardless of the type of flap used, the weight bearing wounds were not without the occasional problem, but we believe the muscle free flap with

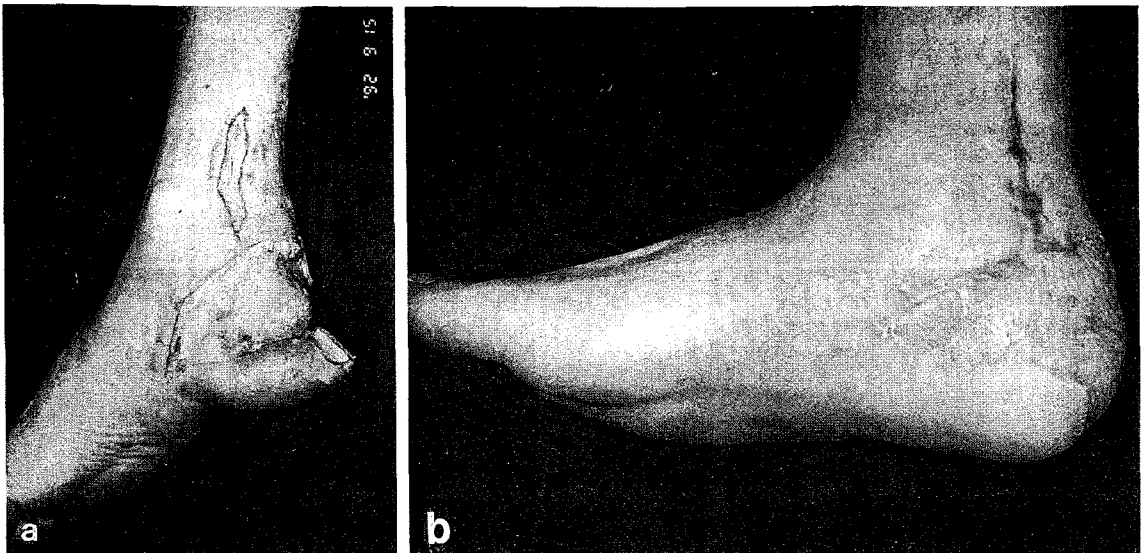


Fig. 5. Case 14

(a) Defect of non-weight bearing posterior heel.

(b) Reconstructed with rectus abdominis muscle free flap with skin grafting. Nineteen months postoperatively.

skin graft allowed for better wound management than the skin or musculocutaneous flap.

In reconstructing the extensively traumatized foot, we learned from our patients that the occasional surface breakdown was a minor nuisance, but the excessive flap bulk was a great inconvenience since it prevented them from wearing conventional footwear. We therefore conclude that an important factor to consider when selecting a flap for use in foot reconstruction is thickness, and from our experience a muscle free flap with skin graft offers the most favorable outcome.

CONCLUSIONS

1. Muscle flaps with skin grafting is the choice of treatment in extensive severely contaminated wounds.
2. Avoid musculocutaneous flap reconstructions for all parts of the foot.
3. Exact contouring of muscle flaps to the foot is essential.
4. Use thin flaps.
5. Heel pad reconstructed with muscle flaps with skin grafting is durable.

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The successful treatment of the extensively traumatized foot warrants reconstruction utilizing tissue that will provide adequate coverage, is resistant to infection, thin enough to conform to the contours of the foot as well as durable to constant frictional movement and weight bearing. Currently, free flaps offer the best means in achieving these difficult and sometimes contradictory goals.

We treated twenty-one patients suffering from extensive soft tissue loss of the foot due to trauma, electric burn or postburn sequelae with free flaps. A fasciocutaneous, musculocutaneous or muscle flap with skin grafting was used based on the location, volume of tissue required, and the functional anatomical requirement of the injured region. The follow-up duration averaged twenty-nine months. From our group of patients, we believe that the muscle free flap with skin grafting offers the most favorable outcome.

Key Words: Extensive foot injury, Free flap, Muscle flap