USE OF GRACILIS MUSCLE FREE FLAP FOR RECONSTRUCTION OF CHRONIC OSTEOMYELITIS OF FOOT AND ANKLE

P. LORÉA, N. VERCRUYSSE, B. C. COESSENS

Despite low donor-site morbidity and a straightforward dissection, the gracilis muscle flap is still for many surgeons a second choice in microsurgical reconstruction of the lower extremity in cases of osteomyelitis. They underscore the difficulty of the procedure, and the problems of insufficient muscle volume and a small sized vascular pedicle. The aim of this study was to assess the reliability of the gracilis muscle free flap in the treatment of osteomyelitis of the foot and ankle.

Between 1992 and 1999, 12 consecutive cases (age 9 to 71 years) of osteomyelitis of the foot and ankle were treated using a skin-grafted gracilis free muscle flap. Criteria for osteomyelitis were the presence of exposed bone, positive cultures and bone scans. The wound defect surface ranged from 9 to 90 cm^2 (mean 50.5 cm^2). Six flaps were applied on the weight bearing area of the foot. Flap harvesting time never exceeded 30 minutes. The mean follow-up is 15 months (range 2 to 60 months).

All flaps survived completely. Secondary skin grafts were needed in two cases. One hematoma was noted at the flap donor site. Two patients (18%) had persistent osteomyelitis due to insufficient debridement in the presence of what appeared to be extensive bone involvement. Attempt to salvage the extremity was first performed but ultimately led to amputation. No patients complained of any donor site morbidity.

Failure to cure the osteomyelitis was never caused by inadequate flap coverage. Gracilis muscle flap reliability in terms of vascular supply and ease of dissection made it our first choice in osteomyelitis of the foot and ankle. In the presence of extensive bone involvement, complex bone reconstruction is necessary to avoid amputation.

Keywords : gracilis ; osteomyelitis ; ankle ; foot ; free flap.

Mots-clés : gracilis ; ostéomyélite ; cheville ; pied ; lambeau libre.

INTRODUCTION

Free-tissue transfer has greatly increased our ability to cover all soft tissue defects and to sterilize septic bone cavities, but some debate continues between the proponents of skin flaps (19, 26, 29) and skin-grafted muscle flaps (18, 21, 30) for the weight-bearing area. Free muscle flaps are an effective method for the reconstruction of deep three-dimensional defects, especially in cases where there is evidence of chronic osteomyelitis (7). Among skin-grafted muscle flaps, the latissimus dorsi and rectus abdominis are the most popular (12). The gracilis, owing to a smaller vascular pedicle and a smaller size is less commonly used. Owing to the minimal donor site dysfunction and morbidity (3), the gracilis is our first choice for foot and ankle reconstruction. The aim of this study was to evaluate the ability of the free gracilis transfer to fill in and resurface defects left by the debridment of chronic osteomyelitis of the foot and ankle.

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Table I. — Details of patients in the study

Patient	Age	Gender	Etiology	Previous surgery	Location	Flap Surface (cm^2)
CV	26	F	Myelomeningocele	1	1	9
DA	25	M	Composite wound	5	3	80
MA	39	F	Composite wound	1	2	40
PJ	11	M	Tibial fracture	2	2	32
SL	57	M	Talus fracture	3	2	45
TV	34	M	Malleolus medialis fracture	1	2	50
TE	33	M	Malleolus lateralis fracture	1	2	90
BM	53	M	Diabetic ulcer	3	3	80
JJ	60	M	Diabetic ulcer	2	3	40
VJ	42	M	Diabetic ulcer	1	1	80
HF	71	M	Calcaneus fracture	2	1	40
LZ	9	F	Composite wound	2	4	20

Gender : M = male, F = female.
Location : 1 : proximal sole, 2 : ankle, 3 : distal sole, 4 : dorsum of the foot.

MATERIAL AND METHODS

Between 1992 and 2000, 12 consecutive cases of osteomyelitis of the foot and ankle were covered with a skin-grafted gracilis muscle free flap in a one-stage procedure after radical debridement was performed (table I). Age at the time of surgery ranged from 9 to 71 years (mean 38.3 years). There were 9 males and 3 females. Criteria for osteomyelitis were the presence of exposed bone, positive cultures and positive bone scans (6). The etiology was trauma in eight cases (composite wound : 3 patients ; open fracture : 3 patients ; exposed hardware : 2 patients), infection of a diabetic ulcer in 3 cases and infection of a neuropathic ulcer in one case (myelomeningocele). The external wound defect size ranged from 9 to 90 cm^2 (mean 50.5 cm^2). Six defects were located on the plantar aspect of the foot or heel and 6 on the ankle or the dorsum of the foot. Arteriograms were obtained only if the vascular status of the foot or the recipient donor vessels were questionable after physical examination.

Surgery included radical debridement of all infected, fibrotic or scarred bone and soft tissues. Any exposed hardware was removed and replaced by external fixation. Heterolateral gracilis muscle harvesting was performed as described elsewhere (14). For defects involving the lateral aspect of the foot or the ankle, the tibialis posterior vessels were isolated, and the pedicle was then delivered through a tunnel dissected between the Achilles tendon and the distal part of the tibia. This was facilitated by plantar flexion of the foot (5).

The muscle was tailored to match the debrided cavity. For the larger defects, epimysiotomy was performed in order to increase muscle surface as described by Holle *et al.* (14). A meshed split-thickness skin graft was applied at the end of the operation.

RESULTS

The mean follow-up was 14.8 months (range 2-60 months) (table II). During this period all the flaps survived completely. One flap required revision of the arterial anastomosis at 24 hours. Early minor complications were encountered in 4 cases : partial loss of the skin graft occurred and needed regrafting in 2 cases ; the skin graft donor site became infected and was treated by local wound care in one case ; one hematoma occurred at the flap donor site. The hospitalization time ranged from 10 to 79 days, with a mean of 30 days. The length of the hospitalization time was influenced by systemic conditions of the patients. Two patients with weight-bearing flaps developed ulceration of the skin graft, respectively at 1 and 3 months ; both healed with conservative management and did not recur. All patients but one were ambulatory without the need for modified shoes. Debulking of the flap was performed in only one patient.

Primary healing without recurrence of the infection occurred in all but two patients. In the first case

Table II. - Summary of postoperative courses

Patient	Follow-up (in months)	Early complications	Late complications	Outcome
CV	7	Thigh hematoma	Flap laxity	Ambulatory
DA	2	Arterial thrombosis Cutaneous infection	Graft ulceration	Ambulatory
MA	60	–	–	Ambulatory
PJ	6	–	–	Ambulatory
SL	26	–	Recurrent osteomyelitis	Ambulatory
TV	3	–	–	Ambulatory
TE	6	–	–	Ambulatory
BM	3	Partial skin necrosis	Graft ulceration	Ambulatory
JJ	50	Partial skin necrosis	Recurrent osteomyelitis	Forefoot Ambulatory
VJ	2	–	–	Ambulatory
HF	6	–	–	Ambulatory
LZ	7	–	–	Ambulatory

***Fig. 1.* —** Preoperative view of case LZ. Osteomyelitis of the first metatarsal head following crush injury and two previous operations.

***Fig. 2.* —** Early postoperative aspect after gracilis muscle free transfer.

(SL), the surgery was indicated to treat osteomyelitis of three year's duration of the distal part of the tibial bone and of the talus bone, following ankle arthrodesis. During surgery it appeared that optimal debridement would require removal of the entire articular complex. Therefore the extent of the resection was limited to the infectious process leaving scarred bone tissue and filling the defect with a gracilis free transfer. The wound healed primarily, but oozing recurred 2 months later. The patient declined revision surgery and is still treated conservatively. The second patient (JJ) presented with osteomyelitis of the second to fifth metatarsal heads secondary to a neglected diabetic ulcer. Because he was reluctant to undergo forefoot amputation, debridement and free gracilis muscle reconstruction were attempted. Recurrent osteomyelitis occurred two months later, and the amputation was then accepted by the patient and subsequently performed.

Fig. 3. — Postoperative appearance at 2 months' follow-up

DISCUSSION

Reconstruction of soft tissue defects of the foot and ankle continues to pose problems for the plastic surgeon, especially in case of chronic osteomyelitis. Successful treatment of chronic osteomyelitis of the foot and ankle has to achieve two goals : to sterilize the infection and to restore skin integrity and sensibility of the weight-bearing areas when involved.

Since Stark (24) and Ger (8) there is no debate about the need for adequate wound debridement in the cure of osteomyelitis. If adequate debridement is not achieved at the time of the first surgery, immediate amputation or delayed bone reconstruction should not be considered as a failure. In our experience, for the two cases where debridement was limited at the time of surgery (in order to avoid bone loss), osteomyelitis recurred, leading to amputation in one case and to a persistent fistula in the other.

Before the development of microsurgery, the options available for coverage after debridement were limited to skin grafting and local muscle or fasciocutaneous flaps (6). Skin grafts result too often in unstable coverage with a high recurrence rate of the osteomyelitis (25, 27). The use of local pedicle flaps is limited by their moderate size, arc of rotation or blood supply (4,24). Furthermore, their utility may be compromised by injury at their donor site.

The development of free flaps has provided a new option for the coverage of distal-third lower extremity wounds : free-tissue transfer allows more radical debridement and obliteration of dead space.

Debate persists regarding the use of skin-grafted muscle, myocutaneous or fasciocutaneous free flaps for the coverage of the weight-bearing area. Indeed, sensibility of the heel and sole is a main concern in order to avoid recurrent ulceration. On the other hand, distinct anatomic properties of this area must be restored to avoid shearing forces that will lead to ulceration. While fasciocutaneous flaps offer the theoretical advantage of reinnervation (29), their anatomic properties do not fit the requirements needed for the sole and heel reconstruction (18). Skin-grafted muscle flaps eliminate the excess bulk or friction of a fasciocutaneous unit and provide a nonmobile soft tissue cover over the weight-bearing area. However, a free muscle flap is a completely denervated tissue at the time of transfer, but although satisfactory innervation of the overlying skin graft appears to be an unexpected phenomenon (1), most patients develop deep pressure sensibility in the flap area (13). Indeed, in the long term, patients who have had nonsensate reconstruction do not report any difficulties with their daily routine compared with sensate reconstructions (15, 18). Our results support this view : only two patients presented with minor ulceration of the skin graft which healed with conservative management and did not recur. One other advantage of skin-grafted muscle flaps compared to fasciocutaneous flaps is that their thickness can be tailored and leave a less conspicuous scar at the donor site.

Furthermore, the use of muscle flaps has proven to be one of the most effective improvements for reducing the recurrence rate after chronic osteomyelitis (7, 10, 16, 17, 28). Although the mechanisms are still controversial, experimental data demonstrate increased oxygen tension, increased phagocytic activity, decreased bacterial counts and increased antibiotic delivery in muscle flaps (11, 23).

The most frequently used free-muscle flaps for cover of the lower extremity are the latissimus dorsi (10, 17) and the rectus abdominis (22). While

gracilis muscle transfer is commonly used as a motor-unit transfer (2, 20), only a few teams recommend its use as a first choice for lower extremity reconstruction (14, 32). Indeed the gracilis muscle is usually reported to be a rather slim muscle suitable only to cover small defects, although after removal of the epimysium its width can be extended considerably, on average by over 100%, allowing coverage of defects measuring up to 300 cm^2 (14). One of the main advantages of the gracilis muscle is the low donor site morbidity. Indeed, harvesting of this muscle does not impair the limb function, even in young and active patients (9, 12, 31). In addition, dissection of the donor and recipient sites can be performed simultaneously with the patient lying supine. The length of the pedicle, which is said to be short, was never a problem in our experience, even for defects located at the opposite side of the recipient vessels. Arterial and venous anastomoses were always performed on the tibialis posterior vessels without the need for vein grafting. In fact, when dissecting the pedicle of the flap beneath the adductor longus muscle to its origin from the profunda femoris artery, the pedicle length can increase up to 8 cm.

Bringing rich blood supply, free muscle flaps are advocated as helpers in the treatment of chronic osteomyelitis. In this series the gracilis could always adequately fill the defect created by the debridement. It provided stable wound coverage.

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SAMENVATTING

P. LORÉA, N. VERCRUYSSE, B. C. COESSENS. De vrije gracilis-spierflap voor de behandeling van chronische osteomyelitis van enkel en voet.

Veel chirurgen beschouwen genoemde spierflap als een tweederangsoplossing voor de behandeling van osteomyelitis in deze regio. Ze beweren dat de ingreep moeilijk is, dat de spierbuik slechts een klein volume heeft, en dat de vaatsteel eerder bescheiden is. Het doel van deze studie was het toetsen van deze bewering.
Tussen 1992 en 1999 werden 12 opeenvolgende gevallen van osteomyelitis op deze wijze behandeld. De patiënten leden allen aan osteomyelitis van enkel of voet ; ze waren 9 tot 71 jaar oud. De diagnose „osteomyelitis" steunde op de aanwezigheid van blootliggend bot, positieve culturen en een afwijkende botscan. Na débridement was er een weefseldefect van 9 tot 90 cm², gemiddeld 50,5 cm². Zes van de 12 spierflaps werden aangebracht op de voetzool. De gemiddelde follow-up was 15 maanden (uiterste waarden : 2 en 60 maanden).
Alle spierflaps overleefden. Tweemaal was een secundaire huidgreffe nodig. Eén enkele maal ontstond er een hematoom op de donorplaats. Twee patiënten (18%) zagen geen verbetering van hun osteomyelitis, wegens onvoldoende curettage van een uitgebreide osteitiszone. Bij hen werd eerst nog een ultieme reddingspoging gedaan, maar uiteindelijk drong amputatie zich op. Niemand had last van de donorplaats.
In geen enkel geval was het persisteren van de osteomyelitis te wijten aan een onvoldoende overdekking. De betrouwbaarheid van de vrije gracilis-spierflap, voor wat beteft bloedvoorziening en gemak van dissectie, maakten hem in de ogen van de auteurs tot een eersterangsbehandeling voor hoger genoemde pathologie. Wél was het zo dat bij uitgebreide bot-aantasting alléén een doortastende botreconstructie een amputatie kon vermijden.

RÉSUMÉ

P. LORÉA, N. VERCRUYSSE, B. C. COESSENS. Utilisation du lambeau libre de droit interne dans la reconstruction des osteomyélites chroniques du pied et de la cheville.

Malgré la faible morbidité du site donneur et une dissection aisée, le lambeau musculaire de droit interne est pour de nombreux chirurgiens un second choix pour la reconstruction microchirurgicale du membre inférieur en cas d'ostéomyélite. Ces derniers arguent la difficulté de l'intervention, le faible volume du muscle et la petite taille du pédicule vasculaire. Le but de cette étude est d'évaluer la fiabilité du lambeau libre de muscle droit interne dans le traitement des ostéomyélites du pied et de la cheville.
Entre 1992 et 1999, 12 cas successifs (âgés de 9 à 71 ans) d'ostéomyélites du pied et de la cheville ont été traités à l'aide d'un lambeau libre de droit interne. Les critères diagnostiques d'ostéomyélite étaient la présence d'os exposé, la positivité des cultures et des scintigraphies osseuses. La surface de la perte de substance après débridement allait de 9 à 90 cm² (moyenne 50.5 cm²). Six lambeaux ont été appliqués sur la zone porteuse. Le suivi moyen est de 15 mois (allant de 2 à 60 mois).
Tous les lambeaux ont survécu. Une greffe de peau secondaire a été nécessaire dans deux cas. Un hématome

a du être déploré au site donneur du lambeau. Deux patients (18%) ont présenté une persistance de l'ostéomyélite due à un débridement inefficace en présence d'une atteinte osseuse étendue. Un essai de sauvetage du membre avait d'abord été entrepris mais s'est finalement soldé par une amputation. Aucun patient ne s'est plaint de la morbidité du site donneur.

L'échec du traitement de l'ostéomyélite n'a jamais été dû à une insuffisance de couverture. La fiabilité du muscle de droit interne en termes d'apport vasculaire et de facilité de dissection en a fait notre premier choix pour les ostéomyélites du pied et de la cheville. En cas d'atteinte osseuse étendue, seule une reconstruction osseuse complexe peut éviter l'amputation.