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Long-term evaluation of patients with free tissue transfer to the lower leg in terms of functional, socioeconomic, and esthetic aspects

Received: 7 June 2002 / Accepted: 18 March 2003 / Published online: 9 May 2003
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Abstract A retrospective, quantitative, long-term evaluation of patients with a free flap transfer to the lower extremity was carried out with respect to functional, socioeconomic, and esthetic outcome. The study included 57 patients who were examined by questionnaire filled out by both an examiner and the patients themselves. Indications for the free flaps were acute trauma or osteomyelitis and unstable scars arising from a previous trauma to the lower leg. The flap success rate was 94.7%. The period between the operation and evaluation was at least 3 years. A local, flap-specific functional impairment was found in 17 patients (30%) and a general impairment of the lower extremity in 56% of the subjects. With respect to the socioeconomic outcome more than two-thirds of the patients returned to their previous occupation with no restrictions; approximately 20% of subjects had to switch to a less strenuous job. Although from the viewpoint of the examiner the esthetic appearance was satisfactory in 44 free flaps (77%), the majority of the patients were conscious of pigmental, textural, or contour changes which produced a subjective esthetic compromise in 56% of cases. In conclusion, despite a considerably high rate of local functional impairment the majority of patients (89%) were satisfied and judged the application of a free flap as having been beneficial in preventing a loss in socioeconomic status. The high rate of esthetic problems demonstrates the importance of including esthetic considerations in designing the free flap, in particular with regard to (a) meticulously tailoring the flap, (b) aiming at a homogeneous skin surface, and (c) thoroughly shaping the affected lower extremity.

Keywords Free flaps · Lower extremity trauma · Functional outcome · Socioeconomic consequences · Esthetic aspects

Introduction

Early in the era of free flap use most attention was directed to the challenging technical details of the procedure, such as the surgical perfection of the anastomosis and to identifying the factors crucial to flap survival. Later the use of free flaps became routine in many centers with microsurgical expertise, and the general success rate climbed to over 90% [1, 10, 11, 12, 14] and even to 100% for nontrauma cases [15, 20]. However, free flaps to the lower extremity, after trauma, continued to have higher rates of complications and failures than free flaps to other parts of the body, and unfortunately the loss of a free flap significantly affected the potential to salvage a lower extremity [4].

As the use of free flaps became increasingly familiar, the aspects of functional and socioeconomic outcome gained more weight in operative and postoperative evaluations [8, 24]. Gone were the times when limb salvage was a protracted affair that sometimes destroyed patients physically, psychologically, and socially. With the advent of modern concepts of early, aggressive débridement of injured tissues, limb salvage by primary, “emergency” defect reconstruction [21], internal bone fixation techniques, early rehabilitation, and the best possible recovery of limb function became a priority.

Most recently the esthetic aspects of body parts resurfaced by free flaps have become of major interest. Patients now urgently request not only functional but also cosmetic restoration [13, 20]. Over the past 100 years there has been a major change in body image in Western society. Areas of the body that traditionally remained concealed from view have now become highly visible [23]. Especially for women, disfigurements of the legs have become as distressful as deformities of the face or the hands in the sense of reducing their feelings of attractiveness and femininity. Even if limb salvage with free flap coverage provided no benefit over simple amputation in terms of functional and socioeconomic aspects [6, 9, 17], it would still provide a clear advantage in terms of esthetic considerations by avoiding the stigma of having a prosthesis [5].

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For these reasons we addressed not only the question of successful flap survival in our evaluation but also the long-term functional, socioeconomic, and esthetic results of the procedure [8, 22]. In addition, we have attempted to define the features of treatment critical to the esthetic outcome to improve patient satisfaction with the esthetic appearance of free flap coverage in the future.

Patients and methods

The medical histories of all patients who had a free tissue transfer to the lower extremity within the period of 1975–1992 (the early era of the free flap procedure) were reviewed retrospectively in 1996. Included in the study were all patients with soft tissue defects (with or without bony defects and/or osteomyelitis) or unstable scars on the lower leg due to trauma. Of the 197 patients who received a free tissue transfer during the time span examined 96 had a transfer of free tissue to the lower extremity. Of this group 57 patients (59%) were seen for the long-term evaluation (43 men, 14 women) with a mean age of 35.2 years at the time of operation (men 36.6 years, range 10–68; women 33.3 years, range 16–62). The other 41% of patients had either a nontrauma indication (11%) or could either not be contacted (patients from abroad, 18%) or were unwilling to take part in the study (12%). Of these nonincluded trauma patients the majority had an uneventful postoperative course, and thus no selection bias was anticipated in the responding group. The indications for free flap transfer were: trauma to the lower leg with soft tissue defects without underlying bony pathology ($n=3$), and/or open fractures with exposed osteosynthesis material with ($n=11$) or without osteomyelitis ($n=32$), or an unstable scar resulting from trauma ($n=11$). In seven patients the ankle/foot region was also injured beyond the free flap to the lower leg, and in one patient the additional trauma resulted in a forefoot amputation. Of the 57 patients 31 (54%) received a free latissimus dorsi muscle, 12 (21%) a partial serratus anterior muscle, 6 (11%) a scapula flap, and 2 an inguinal flap; the remaining patients received a radial forearm flap ($n=3$), dorsalis pedis flap ($n=2$), or parascapular flap ($n=1$).

Since this was to be a long-term follow-up, the minimum period since the operation was set at 3 years. The evaluation consisted of a physical examination of the recipient and donor area of the free flap, photographic documentation, and questionnaires for both patient and examiner. To avoid bias in the judgement of the results the patient and the examiner filled out their questionnaires independently. The patient's questionnaire concentrated on the subjective perspective of his or her health status and the functional outcome of the operation rather than on numerically measurable parameters. In addition, it addressed the issues of pain, satisfaction with the procedure and present quality of life. The examiner's questionnaire began with general questions about age, diagnosis, prior treatment, and medical history. The technical details of the free flap procedure were culled from the operation reports: the nature of the defect, the donor site, anastomosis, the period between trauma and reconstruction, the failure rate of the free flaps, local complications both major and minor nature, reoperations, and rehabilitation programs. The main focus was on the general functional result, including any general impairment, recreational restrictions, and partial or total disability of the lower extremity. A further section of the questionnaire dealt with the specific functional status of the free-flap in daily life and sports, and the socioeconomic ramifications of the free-flap with respect to postinjury employment. The last part of the questionnaire dealt with the esthetic outcome of the skin surface on the recipient and donor site: color match, quality, and texture of the scar and contour.

Finally, we examined the correlation between type of initial trauma and functional, esthetic, and socioeconomic outcome of the free flap procedure.

Results were analyzed using StatView 5.0.1. (SAS Institute, Cary, N.C., USA) and SPSS 6.1 (SPSS, Chicago, Ill., USA). Con-

tinuous variables were summarized as mean \pm SD. Nominal variables were presented as percentages. The trauma types were compared with respect to the outcome variables by χ^2 analysis. Differences with a probability of randomness less than 0.05 were considered significant.

Results

Of the 57 patients receiving free flaps 54 (94.7%) survived the transplantation successfully. The free flap failed completely in two cases and partially in a third; of these three patients two were successfully reoperated on using another free flap. Altogether 12 patients (21%) had another operation in the early postoperative phase, including débridement of partial flap loss or infection, split thickness regrafting or evacuation of hematoma. A further 11 patients (19%) required scar revisions or free flap trimming at a later date. All patients were able to avoid amputation.

Thirty-seven patients (65%) underwent rigorous postoperative physiotherapy including lymphatic drainage or wore compression stockings or bandages, sometimes for a period of years. The medical histories gave no information on the time span between injury and reconstruction in 27 (47%) cases. In the other 30 cases the distribution was as follows: no cases of immediate emergency application of the free flap; 5 cases of application within the first 3 weeks (shortest period 3 days); 3 cases of application within 22–60 days; 22 cases of application more than 60 days after the previous trauma (longest period 33 years). All the flap failures occurred in this final group.

Prior to the free flap transfer 13 patients had a job with predominantly light work ("white collar"), 42 had work that was light to moderate in terms of physical exertion, and 21 were laborers ("blue collar"; N.B. patients could give more than one answer). After the operation the number of patients working at sedentary jobs increased to 17, the "light to moderate" exertion group decreased from 42 to 36, and those carrying out heavy physical labor decreased from 21 to 16. In the long term 35 patients (61%) returned to their previous work, and a further 4 returned to school. Ten patients (18%) had to change their occupation (three with disablement of 40–50%); the proportion of those affected was particularly high in the group of laborers. Five patients remained unemployed, and three took early retirement; six of these eight had additional traumatic ankle/foot involvement.

Forty patients (70%) confirmed that the injury or the operation had not led to a change in their social status or their standard of living. Certain difficulties were reported with sporting activities, in particular hiking and skiing, because of the special boots required. Of the 32 patients (56%) who experienced a general functional impairment, or who had to wear special clothing or shoes the majority ($n=27$) blamed the underlying pathology as the predominant factor, and only 5 (9%) blamed the soft tissue coverage by the free flap as an additional factor (one, due

solely to the free flap; four, due to both). Not unexpectedly, unchanged life-style showed a significant correlation between good function ($P=0.023$) and unchanged occupation ($P=0.003$).

A local free flap specific impairment of the skin in terms of fragility or disease was reported by 17 patients (30%) while 40 (70%) perceived no difference. Additional pain was experienced by 31 patients (54%). Of these, 12 (21%) had minor pain, 15 (26%) moderate pain, and 4 (7%) severe pain (the categories on the questionnaire were no pain, minor, moderate, and severe pain). Fifty-three patients (93%) had decreased tactile sensitivity on their flaps.

With regard to esthetic outcome the examiner rated 44 free flaps (77%) as being satisfactory enough as not to be conspicuous at first glance. Upon closer observation 15 patients (26%) showed partial hyperpigmentation and 5 (9%) hypopigmentation. Eight patients (14%) reported other pigment irregularities, and in 5 patients (9%) the mesh pattern of the skin graft was readily visible. Fifty patients (88%) were concerned about contour deformities. In 8 patients (14%) the free flap area was very bulky, and in 6 (11%) areas of the free flap were below the level of the surrounding skin. Overall 32 patients (56%) stated that the free flap was an esthetic problem for them. Of these, 23% ($n=13$) rated it as a minor concern 16% ($n=9$) as a moderate concern, and 11% ($n=6$) as a major concern (problem without quantification, $n=4$). Of the patients who had esthetic problems 4 (7%) had esthetic problems at work, while the rest experienced the esthetic problem during their leisure time, i.e., sporting activities, especially swimming. At the donor site 52% of the patients found the scars unsightly and 21% judged them ugly.

Nevertheless, 51 patients (89%) were satisfied with the overall result. No patient claimed to be particularly dissatisfied with the free flap.

Discussion

The results of our retrospective series were very similar to other retrospective studies with respect to the general technical details of the free flap procedure (i.e., preference of a latissimus dorsi flap [16, 21]) and the overall survival rate of 94.7% [12, 19]. The high rate of satisfied patients in our series, despite a functional and esthetic impairment rate of over 50%, shows that the patients tended to be realistic and generally realized the severity of the underlying pathology that had originally required the free flap, i.e., the severity of exposed or severely fractured bones and muscular and nerve impairment. Similar results were reported in a group of 72 patients with Gustilo grade IIIB open tibial fractures [7]. Here the satisfaction rate of the patients was 96%, despite a significantly decreased range of motion in the ankle in 66% of cases and despite more than one-half the patients occasionally requiring some type of assistance with walking 3 years after the operation. In defects affecting

only the skin or soft tissue, function should generally not be grossly impaired. However, in major soft-tissue defects there may be associated functional problems; in particular, the area around joints may cause a significant limitation in motion due to a scarred or bulky free flap.

Despite reports to the contrary [18] we found considerable discrepancies between the patients' subjective and objective measures of functional impairment. Therefore in this study the patients' self-reported degree of function, satisfaction, and quality of life were given priority over measurable clinical parameters and functional measurements such as joint mobility, stability, balance, strength, gait, motor status (circumference of the leg), stamina, and temperature tolerance. Other authors [17] have also reported a high (89%) satisfaction rate in patients when they performed a comprehensive subjective functional assessment. While one may argue that such a subjective assessment of function and impairment is "unscientific," and that a comprehensive and critical assessment of the functional results of severely injured extremities is the study design of choice [17], it is ultimately the judgement of the patients themselves that dictates their attitude towards employment, working abilities and quality of life.

Interestingly, of the patients who noted functional impairment, one-half were not disturbed by this, although 54% of all patients experienced pain. This is probably the reason why such a high proportion (68%) returned to their former occupation after rehabilitation, even though all had suffered a trauma or were operated due to the consequences of a trauma. These patients even improved their working abilities after the application of a free flap and had the feeling that their life-style and their socioeconomic status had not deteriorated. This explains the significant correlation between the unchanged life-style and unimpaired function and unchanged occupation.

In contrast, Francel [7] reported an extremely high rate of unemployment of 72% in one of his early series of Gustilo IIIB open tibial fractures. Thanks to a campaign of aggressive reconstruction, rehabilitation, and personal intervention on the part of the physician the unemployment rate began to decrease to 67% in a prospective series. Francel also discovered that it was not the loss of range of motion (function) following injury that was critical with regard to unemployment. Instead, the critical factors were (a) the number of days to obtain soft-tissue cover, (b) the number of days until weight-bearing, and (c) the preaccident status. Nevertheless, free flap patients needed more local treatment and tended to have more pain (and edema [6]) and a longer rehabilitation time than amputees: limb salvage does not mean normal limb function. Overall (and particularly with respect to esthetic considerations) patients usually prefer a salvaged limb over an amputated limb.

In our study the examiner judged the esthetic result as "good" in more than four-fifths of patients, whereas more than one-half of patients felt that the flapped extremity was an esthetic problem for them (88% of the women and 28% of the men). This is in accordance with

the findings of another study [8] in which examiners judged 80% of the patients to have a good or excellent esthetic result, while 90% of patients were self-conscious regarding the deformity and would not go out in public without covering the injured leg. One reason that patients tend to rate the esthetic impairment higher than do physicians is that the former compare their injured leg with the normal, contralateral leg.

The latissimus dorsi and the serratus anterior flaps were the most widely used donor sites in this series (75%), irrespective of the patient's gender [24]. Other, more rarely used flaps, for example, the inguinal, the radial, the forefoot, and the parascapular, were favored for a short time after their introduction but were abandoned because of the availability of more robust flaps or flaps with less donor side morbidity. Muscular flaps on the thoracodorsal vessel system are still our favorites for cover of defects on the lower extremity, but for the use of fasciocutaneous flaps there is a recent trend towards perforator-based flaps of the anterolateral thigh since no intraoperative position changes are needed and still a two-team approach is possible. For esthetic reasons the use of myocutaneous latissimus dorsi flaps in defect coverage of the lower leg has become rarer, since the flap in this design is often bulky with a thick subcutaneous layer and the donor site is very conspicuous. The muscle flaps alone are pliable and can be divided along the muscle fibers into multiple strands which can be used to fill dead space and give contour. When a skin island is used today it is preserved for contouring the extremity.

One esthetic drawback is the widely practiced use of meshed skin grafts on the free flap. The mesh pattern usually remains visible, and the mesh graft is also partly responsible for pigment changes which are esthetically disturbing and difficult to correct. Despite these known disadvantages the decision to mesh a skin graft can be justified if the recipient area is very large; otherwise meshing should be avoided whenever possible.

The esthetic outcome of the flaps can be further improved by paying particular attention to the optimal shape of the free flaps (88% contour problems in our series). Much can be obtained by trimming and aiming for a homogeneous surface. Regarding the donor site, as small incisions as possible are recommended, and running cuticular sutures are beneficial.

In general this retrospective study suffers from the same drawbacks as many other retrospective studies from the early era of free flaps, i.e., the diversity of the patients' indications for a free flap to the lower leg and incomplete retrospective data [17]. It was especially difficult to find details on the size and type of soft tissue injury, preoperative ambulatory status, and duration and type of osteomyelitis [2]. The decision to apply a free flap in this early era did not follow an exact decision-making protocol or other current indices such as the Abbreviated Injury Score or overall Injury Severity Score [3]. Despite these shortcomings a clear conclusion is possible: the majority of patients rated the application of a free flap as beneficial with respect to their socioeconomic status and

employment abilities irrespective of a considerable rate of (self-assessed) local functional impairment. The high rate of esthetic problems demonstrate how important it is to include esthetic considerations into the concept of free flap coverage with (a) meticulously tailoring the flap, (b) aiming at a homogeneous skin surface, and (c) thoroughly shaping the affected lower extremity.

Acknowledgements This paper is dedicated to Prof. Meyer on the occasion of his 65th anniversary.

References

1. Acland RD (1990) Refinements in lower extremity free flap surgery. *Clin Plast Surg* 17:733–744
2. Anthony JP, Mathes SJ, Alpert BS (1991) The muscle flap in the treatment of chronic lower extremity osteomyelitis: results in patients over 5 years after treatment. *Plast Reconstr Surg* 88:312–318
3. Baker SP, O'Neill B, Haddon W, Long W (1974) The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. *J Trauma* 14:187–196
4. Benaquista T, Kasabian AK, Karp NS (1996) The fate of lower extremities with failed free flaps. *Plast Reconstr Surg* 98:834–842
5. Dagum AB, Best AK, Schemitsch EH, Mahoney JL, Nahomed MN, Blight KR (1999) Salvage after severe lower-extremity trauma: are the outcomes worth the means? *Plast Reconstr Surg* 103:1212–1220
6. Dahl B, Andersen AP, Andersen GR, Ebskov LB, Reumert T (1995) Functional and social long term results after free tissue transfer to the lower extremity. *Ann Plast Surg* 34:372–375
7. Francel TJ (1994) Improving reemployment rates after limb salvage of acute severe tibial fractures by microvascular soft-tissue reconstruction. *Plast Reconstr Surg* 93:1028–1034
8. Francel TJ, van der Kolk CA, Hoopes JE, Manson PN, Yaremchuk MJ (1991) Microvascular soft-tissue transplantation for reconstruction of acute open tibial fractures: timing of coverage and long-term functional results. *Plast Reconstr Surg* 89:478–487
9. Gooden MA, Gentile AT, Mills JL, Berman SS, Deman CP, Reinke KR, Hunter GC, Westerbrand A, Greenwals D (1997) Free tissue transfer to extend the limits of limb salvage for lower extremity tissue loss. *Am J of Surg* 174:644–649
10. Gürlek A, Kroll SS, Schusterman MA (1997) Ischemic time and free flap success. *Ann Plast Surg* 38:503–505
11. Hallock GG (2000) Utility of both muscle and fascia flaps in severe lower extremity trauma. *J Trauma* 48:913–917
12. Harashina T (1988) Analysis of 200 free flaps. *Br J Plast Surg* 41:33–36
13. Hülsbergen-Krüger S, Müller K, Partecke BD (1996) Der Hebedefekt nach Entnahme freier und gestielter Unterarm-lappen: funktionelle und kosmetische Ergebnisse. *Handchir Mikrochir Plast Chir* 28:70–75
14. Irons GB, Wood MB, Schmitt III EH (1987) Experience with one hundred consecutive free flaps. *Ann Plast Surg* 18:17–23
15. Khouri RK, Shaw WW (1989) Reconstruction of the lower extremity with microvascular free flaps: a 10 year experience with 304 cases. *J Trauma* 29:1086–1094
16. Kroll SS, Schusterman MA, Reece GP, Miller MJ, Evans GRD, Robb GL, Balwin BJ (1996) Choice of flap and incidence of free flap success. *Plast Reconstr Surg* 98:459–463
17. Lange RH (1989) Limb reconstruction versus amputation decision making in massive lower extremity trauma. *Clin Orthop* 243:92–99
18. MacKenzie EJ, Cushing BM, Jurkovich GJ, Morris JA, Burgess AR, deLateur BJ, McAndrew MP, Swiontkowski MF (1993) Physical impairment and functional outcomes six months after severe lower extremity fractures. *J Trauma* 34:528–539

19. Melissinos EG, Parks DH (1989) Post-trauma reconstruction with free tissue transfer—analysis of 442 consecutive cases. *J Trauma* 29:1095–1103
20. Ninkovic M, Schoeller T, Benedetto KP, Anderl H (1996) Emergency free flap cover in complex injuries of the lower extremities. *Scand J Plast Reconstr Hand Surg* 30:37–47
21. Ninkovic M, Mooney EK, Ninkovic M, Klestil T (1999) A new classification for the standardization of nomenclature in free flap wound closure. *Plast Reconstr Surg* 103:903–914
22. Serletti JM, Carras AJ, O’Keefe RJ, Rosier RN (1998) Functional outcome after soft-tissue reconstruction for limb salvage after sarcoma surgery. *Plast Reconstr Surg* 102:1576–1585
23. Shaw WW (1986) Aesthetic reconstructions of the leg after trauma. *Clin Plast Surg* 3:723–733
24. Stern PJ, Neale HW, Gregory RO, McDonough JJ (1983) Functional reconstruction of an extremity by free tissue transfer of the latissimus dorsi. *J Bone Joint Surg Am* 65:729–737