A Recommended Protocol for the Immediate Postoperative Care of Lower Extremity Free-Flap Reconstructions

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ABSTRACT

The success of lower extremity microsurgical reconstructions may be compromised postoperatively secondary to several factors, including thrombosis, infection, bleeding, and edema. To address edema, surgeons may use protocols for gradually dangling and/or wrapping the affected extremity. Such protocols vary widely among surgeons and are typically based on training and/or prior experience. To that end, we distributed surveys to five plastic surgeons who are experienced in microvascular lower extremity reconstruction at five different institutions. The surveys inquired about postoperative management protocols for lower extremity free flaps with regard to positioning, compression, initiation and progression of postoperative mobilization, nonweightbearing and weightbearing ambulation, assessment of flap viability, and flap success rate. These protocols were then evaluated for similarities to create a consensus of postoperative management guidelines. Progressive periods of leg dependency and compression therapy emerged as important elements. Although the consensus protocol developed in this study is considered safe by each participant, we do not intend for these recommendations to serve as a standard of care, nor do we suggest that any one particular protocol leads to improved outcomes. However, these recommendations may serve as a guide for less experienced surgeons or those without a protocol in place.

KEYWORDS: Lower extremity, free flap, dependency, protocol

Complex injuries of the lower extremity commonly present to level-1 trauma centers. Although many of these injuries can be managed with dressing changes or local flaps, microsurgical reconstruction is often required for the more severe injuries.[1] Lower extremity oncological resections may also necessitate reconstruction with free flaps. Several articles have described the surgical management of severe lower extremity injuries using free tissue transfer.[2–4] However, treatment continues after the technical completion of the free-flap reconstruction.

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J Reconstr Microsurg 2009;25:15–20.

Received: January 14, 2008. Accepted: April 12, 2008. Published online: October 31, 2008.
DOI 10.1055/s-0028-1090600. ISSN 0743-684X.

Lower extremity edema and overly aggressive mobilization can compromise the free flap. In fact, patients may spend several weeks in the hospital postoperatively.[5] If free-flap reconstruction of the lower extremity is to be successful, algorithms for postoperative management must be described and well established. Surgeons who have extensive experience with lower extremity free flaps can provide insight into the best course of management for these flaps with respect to patient mobilization and limb dependency.

We describe a consensus protocol for postoperative management of lower extremity free flaps that answers the following questions:

1. When is leg dependency started?
2. When is it appropriate, and how often is the extremity dangled?
3. Is the extremity wrapped with a compressive elastic bandage (e.g., ACE® Brand; Becton, Dickinson and Company, Franklin Lakes, NJ)?
4. When is nonweightbearing ambulation initiated?
5. When is the patient permitted to bear weight on the reconstructed extremity?
6. Which pertinent factors should cause a surgeon to adjust the details of the postoperative protocol?

METHODS

During the spring of 2006, we surveyed five plastic surgeons in the United States, including the corresponding author, who frequently perform lower extremity microvascular reconstructions. These surgeons and/or their centers have published articles about lower extremity microsurgical reconstruction.[6–26] The questionnaire requested data on the immediate postoperative management of lower extremity free flaps. Questions covered the following topics: position of the extremity, wrapping of the extremity, initiation and progression of postoperative mobilization, nonweightbearing and weightbearing ambulation, assessment of flap viability, and lower extremity flap success rate. The survey also requested that each surgeon submit, if available, a printed protocol of dangling and ambulation in the postoperative period.

RESULTS

All questions were answered by each surgeon. Three surgeons provided their printed protocols. Table 1 contains a summary of the postoperative protocols for each surgeon. Based on the compilation of these protocols, we developed specific recommendations for postoperative rehabilitation of a lower extremity after microsurgical reconstruction (Table 2). All five surgeons reviewed the recommendations and agreed with their presentation.

DISCUSSION

Microvascular surgery has enabled the coverage and salvage of complex lower extremity wounds. However, postoperative lower extremity edema can threaten the success of the free-flap reconstruction. Gravity contributes to increases in capillary pressure, more fluid leaking into the interstitium, and worsening edema. Extremity swelling can lead to venous congestion of the flap, which, if not treated, can result in flap failure.

The blood supply of a flap is comprised of both macrovascular and microvascular components. At the level of the microcirculation, the arterial inflow provides nutrients and oxygen to the flap while the venous outflow carries away carbon dioxide and waste products. The systemic regulation of this blood flow is mediated neurally by α-adrenergic, β-adrenergic, and serotonergic receptors and humorally by vasoactive substances such as norepinephrine, epinephrine, serotonin, histamine, and prostaglandins.[27]

When a flap is elevated, sympathetic nerves and inflow vessels are immediately divided, resulting in decreased perfusion.[28] Studies have shown that the blood flow at the base of a pedicle flap is maintained after elevation; within 6 to 12 hours after elevation, however, the blood flow at the distal end of the flap is often 20% of normal. The longitudinal flow from the pedicle recovers to ~75% of normal by 1 to 2 weeks and to 100% within 3 to 4 weeks.[29–32]

Meanwhile, inosculation and neovascularization increase the blood flow to the flap. Numerous experimental studies have suggested that flow from neovascularization can completely sustain a flap from 3 to 10 days postoperatively.[33–36] Case reports have demonstrated survival of free flaps after arterial occlusion on postoperative days 9 and 17.[37,38] In both case reports, the authors noted peripheral hyperemia, which indicated neovascularization.

Venous drainage is also imperative for a successful flap. The ligation of an axial vein in an axial pattern flap results in flap necrosis.[39,40] Fukui et al demonstrated increased survival in musculocutaneous flaps with the preservation of a distal draining vein.[41] The authors concluded that distal flap necrosis is due to venous stasis. Recent studies have also shown that increased venous drainage improves flap survival.[42,43]

Isenberg et al quantified the effect of dangling on the postoperative rehabilitation of lower extremity microvascular free flaps. When dangling, each free flap demonstrated decreased arterial velocity and cross-sectional area with a concomitant increase in venous cross-sectional area. These results led the authors to institute a postoperative regimen with dangling beginning on postoperative day 3. After advancing to 40 minutes of dangling on postoperative day 11, patients received therapy for crutch-assisted nonweightbearing ambulation. Many patients were

Table 1 Postoperative Protocols after Lower Extremity Free Flaps

	NYU/Bellevue Hospital Jamie Levine, M.D.	Buncke Clinic Gregory M. Buncke, M.D.	University of Kentucky Lee Pu, M.D.	Duke University L. Scott Levin, M.D.	Stanford University Geoffrey C. Gurtner, M.D.
Start Protocol	Day 10–14	Day 14 (21 if cannot wrap with compressive elastic bandage)	Day 7	Week 4	Days 11–14
Method	Dangle and wrap with compressive elastic bandage	Dangle Wrap with compressive elastic bandage unless ex-fix bars too close	Dangle Wrap with compressive elastic bandage after successful dangling (2 wk)	Dangle Wrap with compressive elastic bandage after wound is mature and healing well (4–6 wk)	Dangle Wrap with compressive elastic bandage
Personnel	Resident or nurse/physician's assistant	Physical therapist	Senior resident	Physician assistant and patient	Resident
Assessment	Doppler, venous appearance, swelling	Color, swelling, temperature, evidence of infection, throbbing	Assess for venous congestion	Engorgement, swelling, color, congestion Doppler not assessed	Color, swelling, throbbing, evidence of infection
Printed Protocol	No	Yes, for past 15 y	Yes	No, but standard instructions given in clinic	Yes
Protocol Advancement	5 min 2 × /d with wrap Then 5 min 3 × /d Then 10 min 3 × /d Increase by 5 minutes 3 × /d up to 30 min 3 × /d	3 min 2 × /d Then 3 min 4 × /d Then add 30 sec each session 4 × /d (2 min/d) up to 15 min 4 × /d Then increase as tolerated	5 min/h for days 1 and 2 Then 10 min/h for days 3 and 4 Then 15 min/h every 5th and 6th day	10 min/h 6–8 × /d Increase by 10 min/h every other day	3 min 2 × /d Then add 30 sec each session Progress as tolerated to 15 min 2 × /d Then 15 min 3 × /d Then 30 min 3 × /d
Compressive Wrap (e.g., ACE)	With every dangling Then all the time once at 30 min 3 × /d	With every dangling Thought to be very important for improving venous return and contouring flap	At 2 wk, if patient tolerating dangling	At 4–6 wk when wound is mature and healing well Constant compressive elastic bandage wrapping for venolymphatic support	With every dangling
Advance or Delay Protocol	Depending on amount of swelling and weeping of flap	Ability to wrap lower extremity with compressive elastic bandage	Uncomplicated surgery or amount of edema in flap	No earlier than 3 wk Later if wound healing problem/skin graft problem	Decrease sessions by 30 sec if excess throbbing for > 5 min or swelling
Weightbearing	Once at 30 minutes 3 × /d with compressive elastic bandage all the time; can weightbear ad libitum	If no skeletal problem, as soon as they can dangle; walking can help with venous return	At 3 wk, progressive weightbearing with compressive elastic bandage protection for up to next 3 mo	When wound is mature About 4–8 wk depending on location of wound and factors such as diabetes Anterior tibia: sooner Heel: later, ~8 wk	If no skeletal issues, begin weightbearing with dangling If skeletal problem, as per orthopaedist
Discharge Plan	After ~3 wk, usually to rehab	Depends on patient understanding and home situation: 1 wk to months	POD 4, weightbearing issues per orthopaedics	POD 6–7 Patient starts dangling at home/rehab under direction of physician assistant first time	After 3 d of dangling, to rehab or to home if reliable
Success Rate	> 92%	98–99%	> 95%	99%	99%
Flap Problems from Failure to Dangle Properly	None known	No flap loss but some tip necrosis of larger flaps and partial loss of skin graft	One patient with flap failure	Rarely; < 1% No problem with patient understanding	50% complication rate when protocol is deviated from

POD, postoperative day.

Table 2 Recommendations for Postoperative Care of Lower Extremity Free Flaps

- A printed protocol should be available for the surgical staff and patients.
- Any personnel with specific training in the protocol and assessment of the flap may start dangling.
- Start the dangling protocol at postoperative day 14.
- Delay the start if there is prolonged swelling or excessive edematous fluid drainage of flap.
- Start dangling at 5 minutes twice a day and increase by 5 minutes per session per day or add an additional period of dangling per day until patient is tolerating 30 minutes of dangling at least six times per day.
- Compressive wrapping can be approached in two ways:
  - Wrapping is critical to improvement of venous return and the extremity should be wrapped with each dangling.
  - Compressive wrap is critical for long-term venolymphatic support but should not be placed until the wound is mature/healing and the patient is tolerating dangling.
- Assess flap before and after dangling/wrapping.
  - Assess color, temperature, swelling, engorgement, patient symptoms of pain/throbbing (Doppler assessment not necessary with each dangling but may be considered with first few danglings).
- Bear weight per orthopaedics if there is a fracture.
- If no fracture, begin weightbearing when the wound is mature and the patient is tolerating dangling at least 30 minutes 6 times per day.
  - Discharge patient when tolerating dangling with a good understanding of flap assessment (2–3 weeks); later if the patient is likely to be noncompliant with discharge instructions.

discharged during the second postoperative week with uneventful healing of the flap.[44]

This article compiles the postoperative rehabilitation protocols of five surgeons experienced in lower extremity free-flap reconstruction. In all five protocols, extremity dependency is started between 1 to 3 weeks postoperatively. The duration and frequency of progressive dependency periods is variable but do not differ by >5 minutes per session once started. Ultimate goals of progressive weightbearing and ambulation are achieved in all protocols once flap maturation and engraftment are assured. All protocols are flexible to accommodate persistent flap swelling and edematous weeping. Wrapping with a compressive elastic bandage is deemed to be useful but is placed at different times during the dangling and flap maturation period. All surgeons believe, however, that compression management is important in the postoperative management of free-flap reconstructions for edema control.

Our consensus recommendations incorporate elements of each protocol and general time guidelines. These recommendations are meant to assist patients and health-care providers who participate in the postoperative care of lower extremity free flaps, as well as to serve as a guideline for surgeons with less experience in lower extremity reconstruction. Although the details of each protocol differ slightly and the exact time periods of dangling may vary, there is a consensus that progressive postoperative dangling and wrapping are not only important to the success of the free flap but also for the restoration of lower extremity function.

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