Journal of Clinical Orthopaedics and Trauma 10 (2019) 867–872

Contents lists available at ScienceDirect

Journal of Clinical Orthopaedics and Trauma

journal homepage: www.elsevier.com/locate/jcot

Cross-leg latissimus dorsi free flap with chimeric serratus anterior bridge for lower extremity trauma: Case report and reconstructive algorithm

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ARTICLE INFO

Article history:
Received 21 June 2019
Received in revised form
12 August 2019
Accepted 13 August 2019
Available online 14 August 2019

Keywords:
Free flap
Free tissue
Cross-leg
Trauma
Open fracture
Lower extremity

ABSTRACT

Gustilo Grade IIIB and IIIC open fractures of the lower extremity often involve complex wounds requiring bony fixation and soft tissue reconstruction. We present a case of a 32 year-old male who suffered a traumatic Gustilo Grade IIIB open fracture of the tibia and fibula with an extensive soft tissue defect. Reconstruction was first attempted with a turbocharged anterolateral thigh flap that failed due to venous thrombosis. Due to vascular injury, limited reconstructive options were available from the ipsilateral leg. Limb salvage was subsequently achieved with a chimeric cross-leg latissimus dorsi-serratus anterior (LD-SA) free flap based off the contralateral healthy leg, using the serratus for pedicle bridge coverage so that the latissimus could be fully used for defect coverage. Though not extensively described in the literature, this flap is a versatile reconstructive option for limb salvage in patients with Gustilo IIIB or IIIC injuries to the lower extremity.

1. Introduction

Open lower extremity fractures present a challenge to orthopedic and plastic surgeons. Establishing bony union and soft tissue coverage of bone and hardware is paramount to functional recovery, with Gustilo Grade IIIB and IIIC fractures causing additional complexity due to compromised native vasculature.[1] Free flaps are the preferred reconstructive method in these situations. Recipient vessels must be expendable within the extremity and outside of the zone of injury (ZOI) to optimize microvascular anastomosis and flap survival. Without such vessels, the contralateral leg may provide donor vessels for microvascular anastomosis. Soft tissue coverage of the bridged pedicle and the discomfort of 3–4 weeks of cross-leg fixation are among the challenges posed by these flaps. To mitigate these factors, we propose a unique arrangement of a cross-leg chimeric latissimus dorsi-serratus anterior free flap, utilizing the latissimus for defect coverage and the serratus for pedicle coverage.

2. Case report

A 32-year-old healthy, nonsmoking male was a pedestrian struck by a vehicle. He sustained a Gustilo IIIB open comminuted fracture of the right tibia and fibula with extensive soft tissue loss and periosteal stripping. Examination showed intact sensory innervation and adequate perfusion to the foot. He underwent emergent washout and operative stabilization of the fracture with an intramedullary nail, followed by serial debridement revealing tibia and nail exposure in the proximal/middle thirds and Achilles tendon exposure distally (Fig. 1).

CT angiography demonstrated complete anterior tibial and partial peroneal vessel occlusion. In order to avoid the large ZOI and further devascularization of the lower leg, reconstruction using recipient vessels proximal to the knee (the medial genicular artery and great saphenous vein) was first attempted. A left free anterolateral thigh (ALT) flap was extended by flowing through or "turbocharging" the lateral circumflex femoral artery (LCFA) continuation distally into a separate perforator territory, thereby enlarging the surface area (Figs. 2 and 3). A saphenous vein graft was required to bridge the long gap between the recipient vessels and defect. Unfortunately, the vein grafts thrombosed intraoperatively. After three salvage attempts, the flap was aborted and a

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https://doi.org/10.1016/j.jcot.2019.08.012
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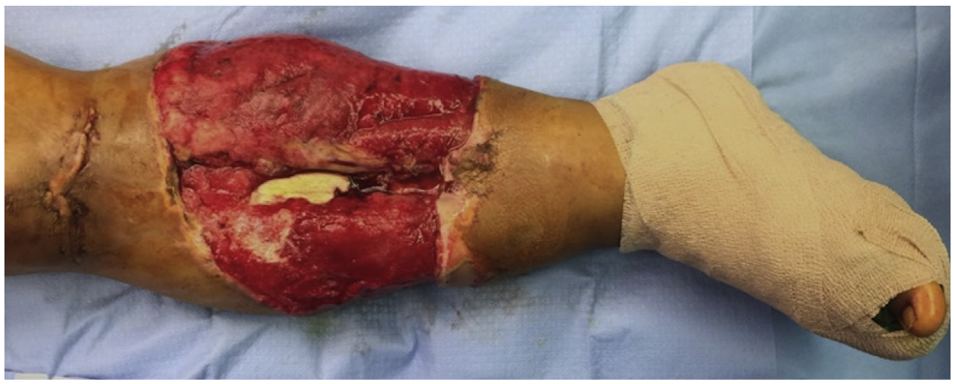

Fig. 1. Right lower extremity clean wound after bony stabilization and serial debridements.

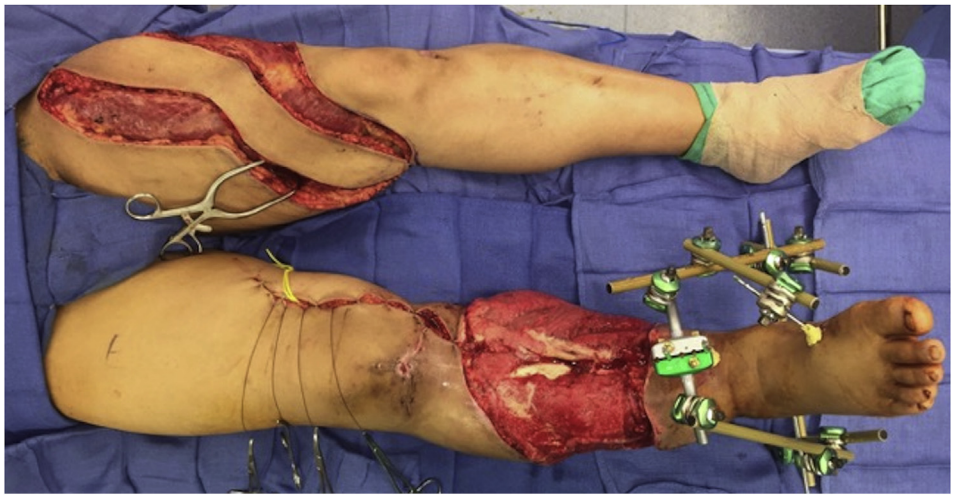

Fig. 2. Left thigh (flap donor site) with turbocharged ALT flap incised. Right leg (flap recipient site) with large, clean wound bed and exposed bone. ALT, anterolateral thigh.

negative pressure wound dressing was applied.

Three weeks later, a second reconstructive effort was planned with a chimeric LD-SA muscle free flap. To avoid vein grafts, we turned to the contralateral posterior tibial vessels. After successful anastomosis, the LD flap was bridged to the right leg and inset into the defect, while the SA was tubularized around the vascular pedicle to cover and extend the pedicle (Figs. 4 and 5). This permitted a longer crossing distance (10cm) and a comfortable external fixation with both knees neutral and free to range. Dangle protocol began postoperative day (POD) 7. On POD 15, he underwent split thickness skin grafting of the muscle flap. At POD 28, the flap was divided and remained viable (Fig. 6). After three months, the patient was ambulating, and he continued to do well at one year. (Video 1).

Supplementary video related to this article can be found at https://doi.org/10.1016/j.jcot.2019.08.012.

3. Discussion

Lower extremity reconstruction is complicated when high-energy mechanisms leave a large traumatic footprint. Here, the soft tissue defect and the vascular ZOI extended from knee to ankle, making flap design and recipient vessel selection particularly challenging. While successful free flap reconstruction in lower extremity wounds with one- or two-vessel runoff has been described,[2] we preferred to avoid using local vessels for the recipient anastomosis due to high risk of flap failure and possible iatrogenic lower limb ischemia due to further vascular injury or vascular steal phenomenon.[3] The initial reconstruction with the extended ALT demonstrated a novel use of the flow-through technique to provide complete coverage of the wound. Despite the relatively long pedicle described with ALT flaps,[4] the reconstruction required vein grafting to reach the defect. Due to the complexity of multiple anastomoses crossing a joint, flap failure was not surprising.

Cross-leg pedicled flaps were first described in 1979 by Taylor et al. as a salvage effort to reconstruct a large defect after recipient vessels in the injured leg spasmed, precluding microvascular anastomosis.[5] These flaps continue to be used today in areas of limited microsurgical expertise.[6] However, their limitations include available donor surface area, adverse functional and cosmetic outcome for the contralateral leg (from skin grafting on muscle/tendon), and restrictive locking position of the lower extremities in flexion (due to the short pedicle of random-pattern flaps). In contrast, cross-leg free flaps allow for a large variety of donor sites, including latissimus dorsi, rectus abdominis, deep circumflex iliac artery (DCIA), radial forearm, and ALT.[5–13] Since cross-leg free flaps offer more flexibility regarding donor tissue type, size, and morbidity, we tend to choose this over a cross-leg pedicled flap except in cases of patient instability where operative time is

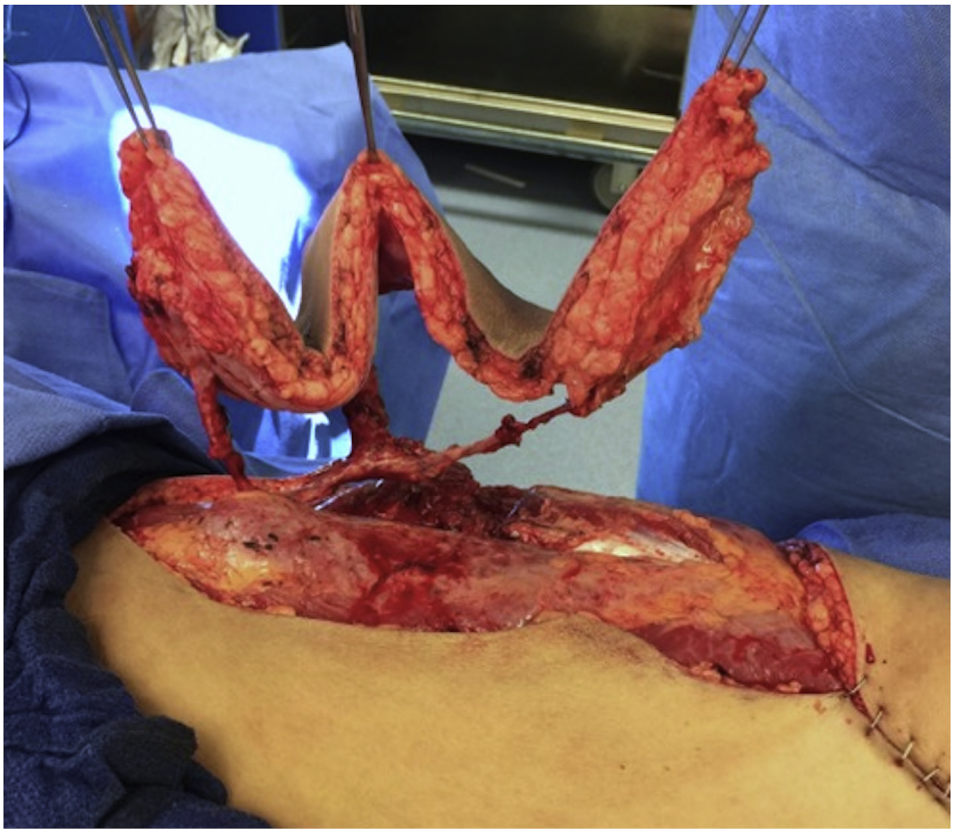

Fig. 3. Left thigh with turbocharged ALT flap elevated. Descending branch of LCFA (main pedicle) with perforators supplying the flap are shown. LCFA, lateral circumflex femoral artery.

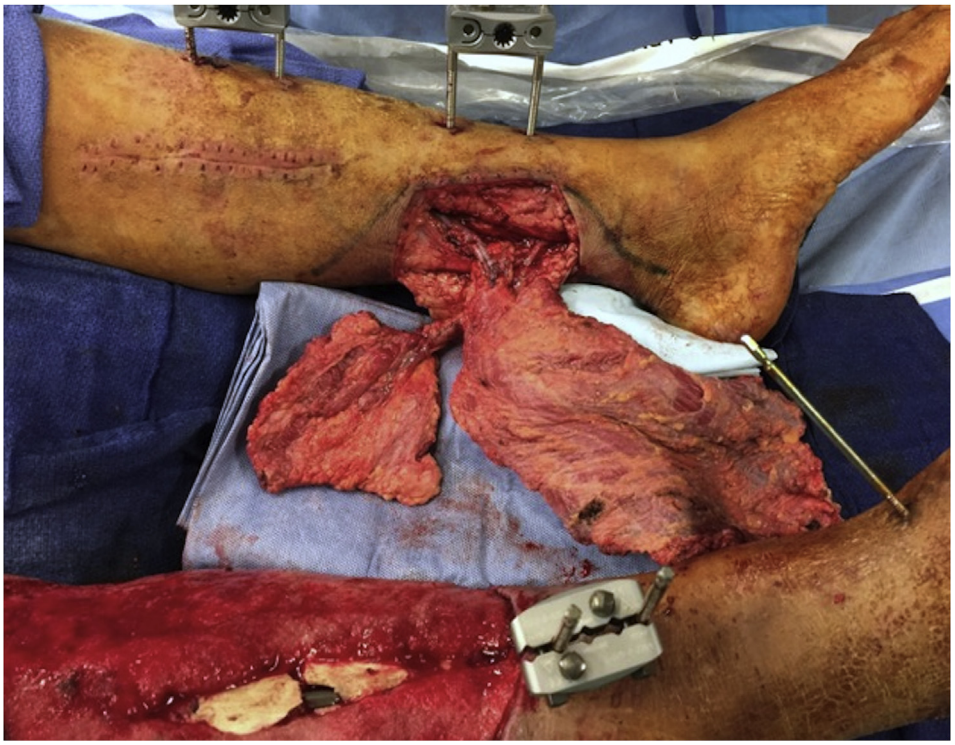

Fig. 4. Cross-leg free flap with chimeric latissimus dorsi-serratus anterior flaps anastamosed to the left (uninjured) posterior tibial vessels. The serratus anterior (left) muscle was tubularized around the latissimus dorsi pedicle to provide extra protection before flap division.

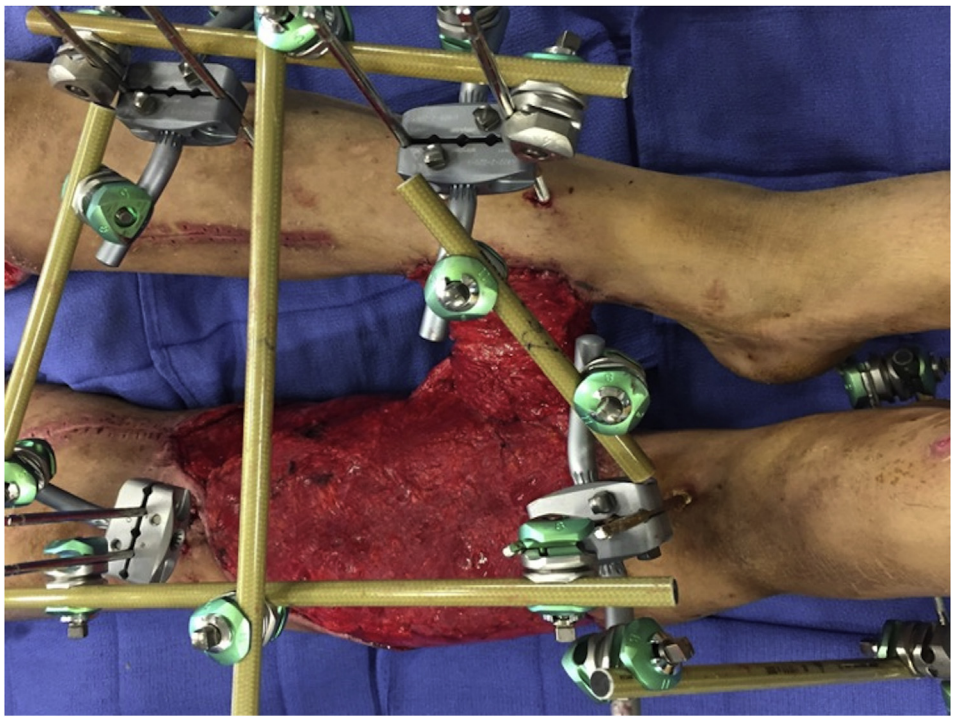

Fig. 5. Cross leg free flap inset into right leg defect, providing adequate soft tissue coverage over bone and hardware. The external fixator device holds the two limbs in place to prevent stretch or torque to the pedicle before flap division.

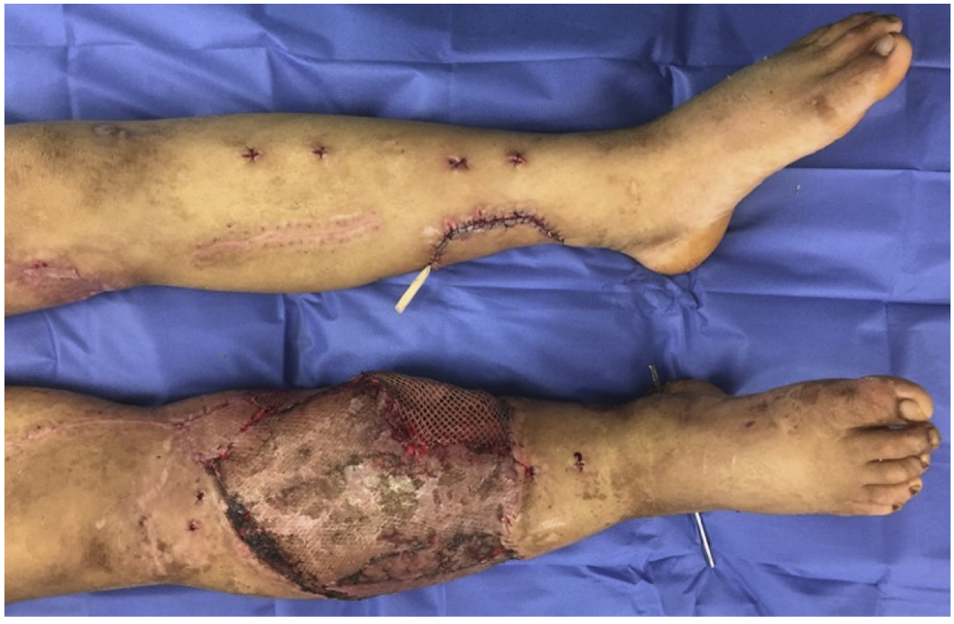

Fig. 6. The flap was divided and fully inset 4 weeks (28 days) after inset. This photograph was taken after flap division, showing adequate perfusion and vascularization of the chimeric flaps. The skin graft also had good take over the muscle flaps.

limited.

Though there are numerous reports, the indications for cross-leg free flaps remain vague in the literature. They are typically seen in cases of trauma, though also described in chronic osteomyelitis.[14] Early pioneers of cross-leg free flap reconstruction include Townsend et al. who described 10 cross-leg DCIA flaps for leg salvage with extensive soft tissue loss, segmental fracture levels, and less than two-vessel runoff or clinical signs of limb ischemia.[8] However, today we would more likely attempt to revascularize the distal extremity with vascular bypass or flow-through flaps in cases of distal ischemia. Another early contributor is Chen et al., who discussed times of appropriate flap revascularization/division at 3 weeks for cutaneous and 4 weeks for muscle flaps. Their use was based on exclusion, in cases of young patients where pedicled flaps were inadequate and ipsilateral free flaps were contraindiated.[7] Manrique et al. mentions using cross-leg free flaps for limbs with

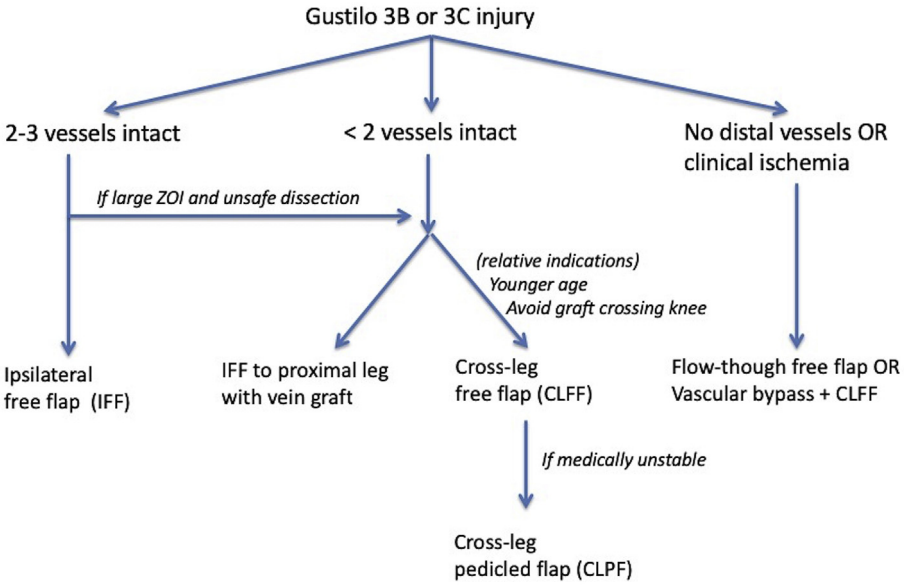

Fig. 7. Algorithm for reconstruction of Gustilo IIIB and IIIC lower extremity traumatic injuries.

larger or more distal soft tissue defects and one- or no-vessel runoff.[6] We propose an algorithm combining these criteria and suggest that the indication for cross-leg free flap be in cases of large zone of injury and reduced perfusion, where one would not want to further jeopardize the extremity, but not in cases with clinical ischemia, where a flow-through flap would be more suitable. (Fig. 7).

In a cross-leg free flap, one challenge to consider is the soft tissue coverage of the pedicle itself. It is possible to use a portion of the original flap, but this limits its use for defect coverage and shortens the crossing distance. Manrique describes the use of a second free flap (radial forearm) to create a "free cable bridge".[6] While this is innovative, it requires a second flap harvest and another pair of microvascular anastomoses, adding operative time and surgical complexity. The chimeric LD-SA flap, first described by Harii et al., is a simpler construct based on the thoracodorsal system and offers 2 large, independently mobile muscle flaps for extensive defect coverage.[13] Turgut described the first cross-leg free LD-SA flap in 2010, using both portions for coverage of the defect.[10] In our case, the SA is used to cover and lengthen the pedicle bridge so that the LD can be fully utilized for defect coverage. This allowed our patient to be fixated in a relatively comfortable position. Other chimeric systems could also be considered including LCFA, peroneal, and subscapular. Ultimately, our patient achieved functional recovery with the cross-leg chimeric free-flap reconstruction.

4. Conclusion

In healthy patients with Gustilo IIIB and IIIC lower extremity trauma resulting in less than two-vessel runoff but without evidence of distal ischemia, we believe that the cross-leg free flap is superior to the cross-leg pedicled flap due to higher donor site versatility and lower donor site morbidity. When this flap is used, a second "cable" free flap can be avoided if a chimeric flap is available for coverage of the pedicle.

Author statement

Authorship Role, Participation, and Acknowledgements:

1. Vincent Chavanon: Provided substantial contributions to conception and design, acquisition of data, analysis and interpretation of findings, drafting the article and revising it critically for important intellectual content, and final approval of the version to be published.
2. Jocelyn Lu: Provided substantial contributions to conception and design, acquisition of data, analysis and interpretation of findings, drafting the article and revising it critically for important intellectual content, and final approval of the version to be published.
3. Ilana Margulies: Provided substantial contributions to conception and design, acquisition of data, analysis and interpretation of findings, drafting the article and revising it critically for important intellectual content, and final approval of the version to be published.
4. Alice S. Yao: Provided substantial contributions to conception and design, acquisition of data, analysis and interpretation of findings, drafting the article and revising it critically for important intellectual content, and final approval of the version to be published.

Financial disclosures

None of the authors have any financial disclosures, commercial associations, or any other conditions posing a conflict of interest to report.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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