

Transition of Historical Tube Flaps to Free Flap for 2-Stage Total Knee Arthroplasty in a Patient With a History of Gustilo Grade IIIB Tibia Fracture

Sean A. Spence, BS, Erin L. Doren, MD, Deniz Dayicioglu, MD, and Thomas Bernasek, MD

Abstract

We report the case of a 56-year-old patient who had posttraumatic bilateral knee arthritis and underwent sequential bilateral total knee arthroplasty (TKA). The left knee joint required 2-stage reconstruction: a free flap for enhanced soft-tissue coverage and then left knee TKA. Uniquely, at age 16 years this patient sustained a left tibia grade IIIB high-energy crush injury in a car crash and underwent reconstruction with multiple pedicle tube flaps and transfer of soft tissues. Most of that reconstruction was done between the ages of 16 and 19. At age 56 years, staged TKA was performed.

To our knowledge, this is the first report of a knee reconstructed with pedicle tube flaps for a grade IIIB tibial fracture, followed years later by free-flap coverage before TKA. This report offers insights and treatment recommendations through long-term follow-up of a unique case and a historical perspective on how reconstructive options have evolved.

Total knee arthroplasty (TKA) is an excellent treatment for debilitating, degenerative, inflammatory arthritis. TKA for primary arthritis has a long-term success rate of 90% or higher at up to 18-year follow-up.¹⁻³ For posttraumatic arthritis, this treatment can be effective, but patients are at higher risk for complications and poor outcomes.^{4,5} Since the advent of microsurgical techniques and pedicled flaps, use of tube flaps has become limited, making free and fasciocutaneous flaps the standard of care in most cases in which soft-tissue reconstruction is required.⁶

We report the case of a 56-year-old man who sustained a fracture of the left tibia and underwent extensive soft-tissue reconstruction (tube flaps, split- and full-thickness skin grafts, free flaps) of the entire length of the tibia and then TKA. We outline

this unique treatment and the patient's long-term follow-up and outcomes. To our knowledge, this is the only reported case of TKA with a history of pedicle tube flap reconstruction of a grade IIIB tibial fracture. The patient provided written informed consent for print and electronic publication of this case report.

Case Report

A 56-year-old man was referred to our plastic surgery service for assistance in soft-tissue coverage of the left knee in preparation for TKA. Examination revealed multiple flaps and incisional scars along the entire length of the leg. Some areas had abundant soft-tissue, and others, such as the proximal anterior tibia, had thin, skin-grafted tissue (Figures 1A, 1B). At

Figure 1. Preoperative (A) anterior and (B) lateral photographs of left lower extremity.



Authors' Disclosure Statement: The authors report no actual or potential conflict of interest in relation to this article.

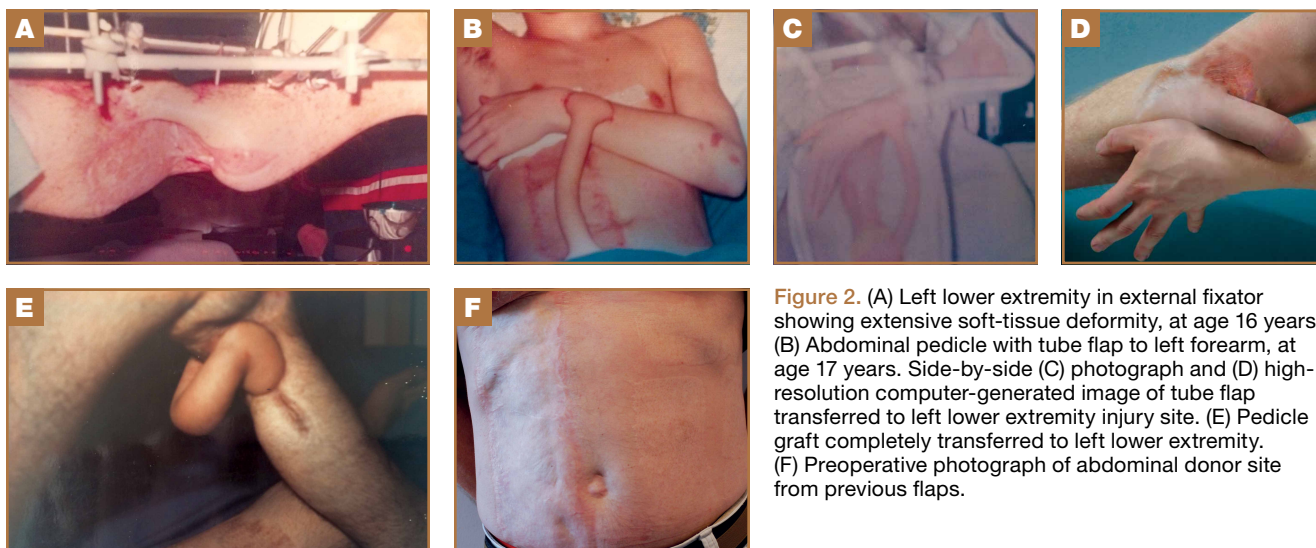


Figure 2. (A) Left lower extremity in external fixator showing extensive soft-tissue deformity, at age 16 years. (B) Abdominal pedicle with tube flap to left forearm, at age 17 years. Side-by-side (C) photograph and (D) high-resolution computer-generated image of tube flap transferred to left lower extremity injury site. (E) Pedicle graft completely transferred to left lower extremity. (F) Preoperative photograph of abdominal donor site from previous flaps.



Figure 3. Preoperative lateral radiograph of left leg shows bony lengthening and fixation still in place.

age 16 years, the patient sustained a grade IIIB tibia fracture (crush injury) in a car crash (**Figure 2A**). Between the ages of 16 and 19, he underwent multiple operations, including tube flap reconstruction for limb salvage.

Initially, the right abdominal tissue had been raised on top of the right anterior rectus sheath as a pedicled flap and tubed to the left forearm (**Figure 2B**). Three months later, the flap was disconnected from the abdomen and tubed to cover the left lower extremity defect (**Figures 2C, 2D**). After another 3 months, the tube was divided from the forearm and contoured to the left knee defect (**Figures 2D, 2E**). In addition, the patient had multiple skin grafts harvested to cover the tissue donor



Figure 4. Postoperative free rectus flap with split-thickness skin graft.

sites (**Figure 2F**). Plating and bone grafting provided fixation of this Gustilo IIIB tibia fracture.

Twenty years after the original injury, the Ilizarov bone-lengthening procedure was performed to lengthen and align the patient's left leg (**Figure 3**). Forty years after the original injury, degenerative joint disease in the right knee was treated with arthroplasty, without complication. Left knee arthroplasty was required as well, but, secondary to scarring, soft-tissue loss, and unstable skin grafts in the anterior tibial area, soft-tissue coverage was required first. As all local tissue options were exhausted, free flap was the only option. Preoperative planning included an angiogram, which showed 3-vessel patency of the left leg. The reconstruction was planned in 2 stages: free rectus flap coverage and, 3 months later, TKA.

A free rectus flap was harvested from the site of previous abdominal tube flap harvest. An end-to-end anastomosis was performed in a retrograde fashion to the anterior tibial artery. The rectus muscle was then covered with a split-thickness skin graft (**Figure 4**). Recovery was uncomplicated, and the flap healed without issue. Three months later, soft-tissue coverage was thick and pliable, and the patient was ready for TKA. The rectus flap was elevated in accordance to its previous, pre-arthroplasty medial incisions, without injuring the vascular pedicle, and TKA was

performed (**Figure 5**). Postoperative anteroposterior and lateral radiographs showed good articular alignment (**Figures 6A, 6B**). The patient healed without any complications, and he was able to proceed to early physical therapy (**Figures 7A, 7B**).

Discussion

In the TKA setting, patients with traumatic arthritis are more susceptible to complications and poor outcomes than are patients with primary osteoarthritis.^{4,5} Prior trauma may com-



Figure 5. Left knee at time of TKA.

promise the soft tissues around the knee and increase the risk for tissue breakdown and difficulties with ligamentous balance.^{5,7} In a study by Lonner and colleagues,⁴ patients who underwent TKA for posttraumatic arthritis had a 57% rate of complications, the most common being aseptic failure (26%) and septic failure (10%). Wound breakdown that required muscle-flap coverage occurred in 6% of patients. Therefore, adequate soft-tissue coverage often plays a vital role in protecting the hardware in this subset of patients.

Preoperative evaluation of a posttraumatic knee should include assessment of skin condition, soft-tissue bulk, vascular integrity, and scarring around the knee. Presence of thin skin and graft adherent to bone creates an unacceptably high risk for TKA failure caused by skin breakdown and infection. Soft-tissue reconstruction is a necessary and effective measure for preventing wound breakdown and deep infection. Pedicled fasciocutaneous and muscle flaps are commonly used to cover defects from postoperative complications of TKA. Coverage for the proximal third of the leg, or the knee, traditionally has been the pedicled medial gastrocnemius flap; other described flaps are peroneal, bipedicled fasciocutaneous, and reverse anterolateral thigh.⁸⁻¹¹ Use of flaps as a preventive in TKA is more novel.

With recent advances in microsurgery, free flaps have become a viable option for lower extremity reconstruction in Gustilo grade IIIB and IIIC tibia fractures. Free tissue transfer to lower extremity wounds has success rates ranging from 91% to 96%.¹²⁻¹⁴ Most flap losses are attributed to venous congestion.¹² Free flaps commonly used for lower extremity reconstruction are latissimus dorsi muscle, serratus anterior, gracilis,

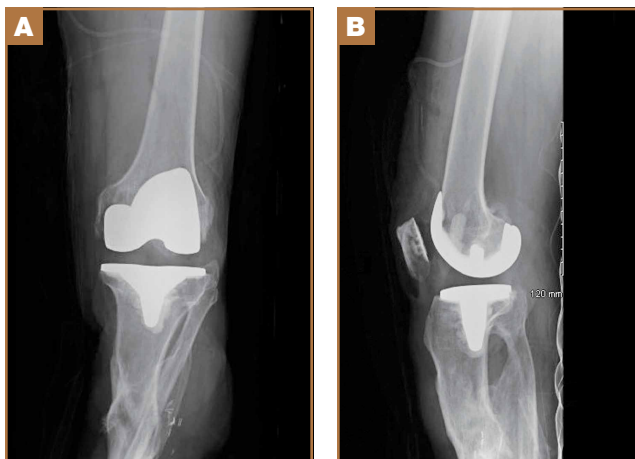


Figure 6. Immediate postoperative (A) anteroposterior and (B) lateral radiographs of left leg show good articular alignment.



Figure 7. Late postoperative (A) anterior and (B) medial views of left leg.

rectus abdominus, and anterolateral thigh.^{8,13,15-17} Flap choice is based on defect volume and surface area.⁸ We used a rectus abdominus muscle flap for our patient because of its adequate soft-tissue size and large pedicle length, and because we would be able to conceal the donor site in a previous graft site.

Staged free-flap reconstruction of soft tissues and use of free flaps concomitant with arthroplasty have been reported in the literature.^{15,17-19} Prophylactic soft-tissue coverage was de-

scribed by Markovich and colleagues¹⁸ as yielding 83% implant preservation and 100% wound revascularization. Casey and colleagues¹⁵ described similar findings, with prophylactic flap coverage yielding 100% flap survival, and flaps used in TKA salvage having a higher incidence of amputation. Soft-tissue integrity should be ensured to avoid complications and the need for post-TKA soft-tissue salvage. Candidates for prophylactic flap coverage are patients with previous knee surgeries, flaps, grafts, radiation, multiple scars (particularly parallel and < 5 cm apart), and history of wound complications or soft-tissue infections.¹⁵ Verbist and colleagues¹⁹ reported a case of simultaneous latissimus free flap and revision TKA; the patient was immobilized for 6 weeks after surgery, and the outcome was successful. Free flaps successfully used in 1-stage exposed prosthesis salvage show outcomes of 100% limb salvage and 79% to 91% prosthesis salvage.^{16,17} These studies highlight that both 1-stage and 2-stage free-flap reconstruction of high-risk arthroplasty patients can have reasonably good outcomes.

Two-stage reconstruction proved successful in our patient's case. He was able to start therapy and range of motion early after TKA because the flap was already healed and stabilized. His case is unique in that he had extensive scarring from previously indicated reconstruction techniques. In the past, tube pedicle flaps had more indications in reconstruction, but now they are used only in extreme situations, when free flaps and pedicled flaps are not available.⁶ Bone reconstruction is another interesting aspect here, as our patient underwent left tibia lengthening 20 years after the original injury, which may have contributed to the contralateral knee arthritis.

Conclusion

Two-stage free-flap reconstruction is a viable, safe option for select patients who have multiple scars and a history of trauma and need soft-tissue coverage of the knee before arthroplasty. Tube flaps have largely been replaced by free-flap reconstruction and now have applications only in extreme cases. TKA in cases of posttraumatic arthritis and concomitant soft-tissue injury requires preoperative assessment and, if necessary, prophylactic soft-tissue reconstruction to decrease the likelihood of complications.

We have presented the interesting case of a patient who underwent these 2 reconstruction techniques during different periods in the evolution of plastic surgery and orthopedic surgery techniques. Collaboration between orthopedics and plastic surgery is essential for good outcomes in this subset of patients.

Mr. Spence is Medical Student, Morsani College of Medicine, University of South Florida, Tampa, Florida. Dr. Doren is Resident, and Dr. Dayicioglu is Assistant Professor, Division of Plastic Surgery, Department of Surgery, Morsani College of Medicine, University of South Florida, Tampa, Florida. Dr. Bernasek is Director of Adult Reconstruction Fellowship, Florida Orthopedic Institute, Tampa,

Florida, and Clinical Professor and Director, Adult Reconstruction Orthopedic Residency Program, Morsani College of Medicine, University of South Florida, Tampa, Florida.

Acknowledgment: The authors thank Gallerie 454 for the computer-generated photographs.

Address correspondence to: Deniz Dayicioglu, MD, Division of Plastic Surgery, Department of Surgery, Morsani College of Medicine, 2 Tampa General Circle, 7th Floor, University of South Florida, Tampa, FL 33606 (tel, 813-362-9452; fax, 813-844-1947; e-mail, ddayicio@health.usf.edu).

Am J Orthop. 2014;43(6):E129-E132. Copyright Frontline Medical Communications Inc. 2014. All rights reserved.

References

- Ritter MA, Herbst SA, Keating EM, Faris PM, Meding JB. Long-term survival analysis of a posterior cruciate-retaining total condylar total knee arthroplasty. *Clin Orthop.* 1994;(309):136-145.
- Stern SH, Insall JN. Posterior stabilized prosthesis. Results after follow-up of nine to twelve years. *J Bone Joint Surg Am.* 1992;74(7):980-986.
- Ranawat CS, Flynn WF Jr, Saddler S, Hansraj KK, Maynard MJ. Long-term results of the total condylar knee arthroplasty. A 15-year survivorship study. *Clin Orthop.* 1993;(286):94-102.
- Lonner JH, Pedlow FX, Siliski JM. Total knee arthroplasty for post-traumatic arthrosis. *J Arthroplasty.* 1999;14(8):969-975.
- Weiss NG, Parvizi J, Hanssen AD, Trousdale RT, Lewallen DG. Total knee arthroplasty in post-traumatic arthrosis of the knee. *J Arthroplasty.* 2003;18(3 suppl 1):23-26.
- Jamie McKenzie RW, Maclean G, Ravindra Bharathi R, Raja Sabapathy S. Tube pedicle flap in the management of a Grade III C lower limb injury. *J Plast Reconstr Aesthet Surg.* 2006;59(12):1420-1423.
- Papadopoulos EC, Parvizi J, Lai CH, Lewallen DG. Total knee arthroplasty following prior distal femoral fracture. *Knee.* 2002;9(4):267-274.
- Friedrich JB, Katolik LI, Hanel DP. Reconstruction of soft-tissue injury associated with lower extremity fracture. *J Am Acad Orthop Surg.* 2011;19(2):81-90.
- Bégué T, Mebtouche N, Levante S. One-stage procedure for total knee arthroplasty in post-traumatic osteoarthritis of the knee with wound defect. Usefulness of navigation and flap surgery. *Knee.* 2012;19(6):948-950.
- Ikeda K, Morishita Y, Nakatani A, Shimozaki E, Matsumoto T, Tomita K. Total knee arthroplasty covered with pedicle peroneal flap. *J Arthroplasty.* 1996;11(4):478-481.
- Darwish AM. Bipedicled flap in reconstruction of exposed tibia. *J Plast Reconstr Aesthet Surg.* 2010;63(1):160-163.
- Pu LL, Medalie DA, Rosenblum WJ, Lawrence SJ, Vasconez HC. Free tissue transfer to a difficult wound of the lower extremity. *Ann Plast Surg.* 2004;53(3):222-228.
- Gopal S, Majumder S, Batchelor AG, Knight SL, De Boer P, Smith RM. Fix and flap: the radical orthopaedic and plastic treatment of severe open fractures of the tibia. *J Bone Joint Surg Br.* 2000;82(7):59-66.
- Parrett BM, Matros E, Pribaz JJ, Orgill DP. Lower extremity trauma: trends in the management of soft-tissue reconstruction of open tibia-fibula fractures. *Plast Reconstr Surg.* 2006;117(4):1315-1322.
- Casey WJ 3rd, Rebecca AM, Krochmal DJ, et al. Prophylactic flap reconstruction of the knee prior to total knee arthroplasty in high-risk patients. *Ann Plast Surg.* 2011;66(4):381-387.
- Cetrulo CL Jr, Shiba T, Friel MT, et al. Management of exposed total knee prostheses with microvascular tissue transfer. *Microsurgery.* 2008;28(8):617-622.
- Hiemer R, Reynders-Frederix P, Bellemans J, Stuyck J, Peeters W. Free myocutaneous latissimus dorsi flap transfer in total knee arthroplasty. *J Plast Reconstr Aesthet Surg.* 2009;62(12):1692-1700.
- Markovich GD, Dorr LD, Klein NE, McPherson EJ, Vince KG. Muscle flaps in total knee arthroplasty. *Clin Orthop.* 1995;(321):122-130.
- Verbist DE, Boyd TG, Malkani AL, Wilhelm BJ. Simultaneous latissimus dorsi myocutaneous flap transfer and revision total knee arthroplasty with allograft extensor mechanism reconstruction: a case report. *Eplasty.* 2012;12:e43.