The Journal of Foot & Ankle Surgery 58 (2019) 1273–1275

Contents lists available at ScienceDirect

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org

Replantation and Lengthening of a Lower Leg in a 7-Year-Old Child: A Case Report

Xuchao Luo, MD[1], Yilizati Yilihamu, MD[2], Anming Liu, MD[1], Yu Huang, MD[1], Changliang Ou, MD[1], Yonggen Zou, MD[1], Xu Zhang, MD[3]

[1] *Surgeon, Department of Hand Surgery, Traditional Chinese Medicine Hospital of Southwest Medical University, Luzhou, Sichuan, China*
[2] *Surgeon, Department of Plastic and Reconstructive Surgery, First Affiliated Hospital of Xinjiang Medical University, Urumqi, Xinjiang, China*
[3] *Surgeon, Department of Hand Surgery, Third Hospital of Hebei Medical University, Shijiazhuang, Hebei, China*

ARTICLE INFO

Level of Clinical Evidence: 4

Keywords:
lengthening
lower leg
replantation

ABSTRACT

Replantation of the lower leg has controversial indications, but it may be considered in carefully selected patients. Although the function of prosthetic lower legs has been improved in recent decades, leg salvage remains a laudable goal. We present the case of a 7-year-old child who sustained a traumatic amputation at the level of the middle tibia with loss of the middle portion of the lower leg. We performed successful replantation, and tibia lengthening was performed starting 10 days after replantation and lasted 6 months.

Replantation of the lower leg has controversial indications, but it may be considered in carefully selected patients. Although the function of prosthetic lower legs has been improved in recent decades, salvage of the amputated leg remains a laudable goal, especially in children. We present a 7-year-old child whose left lower leg was amputated, with loss of the middle portion of the lower leg. We performed tibia lengthening 6 months after replantation. Replantation of the lower leg and bone lengthening have been reported in the literature (1,2), but this is the first report of a case with large bone loss (14 cm in length). We also report the results of the treatments.

Case Report

A 7-year-old male child was injured in a train accident, and his right lower leg was amputated (Fig. 1*A*,*B*). The amputated limb was associated with loss of the middle third of the lower leg and avulsed injuries. The Mangled Extremity Severity Score (3) was 8 (skeletal/soft-tissue, 4; shock, 1; ischemia, 3; age, 0). Preoperative radiographs were obtained. The child received replantation of the lower leg 1 hour after injury. Under general anesthesia, the wounds were thoroughly debrided, and bones were shortened as needed. The tibia fracture was stabilized using an external fixator across the knee and pin. The anterior and posterior tibial arteries as well as their company veins were anastomosed. The great saphenous vein was also anastomosed. The tibial and peroneal nerves were repaired. The extensor digitorum longus, extensor hallucis longus, peroneus tertius, peroneus longus, gastrocnemius and soleus and Achilles tendon, tibialis posterior, flexor digitorum longus, flexor hallucus longus, flexor digitorum longus flexes, and flexor hallucus longus tendon (muscle) were repaired or reconstructed as possible depending on the remaining structures. The size of the remaining defect was 24 × 12 cm. The defect was protected temporarily using vacuum sealing drainage, followed by skin grafting 3 weeks after injury. The injured lower leg was 14 cm (33%) shorter than the opposite lower leg after replantation. The leg survived with normal color and capillary nail refill test 14 days after surgery (Fig. 1*C*).

Four months after surgery, tibia lengthening was started using an Illizarov external fixator frame (Fig. 1*D*). The lengthening rate was 0.25 mm/time, 4 times a day (4). After 6 months, the injured leg was 3 cm shorter than that of the opposite leg. The external fixator was kept in place for an additional 6 months to allow bone healing. Neither wound infection nor pin tract infection was observed.

Follow-up duration was 5.5 years (Fig. 1*F*,*G*,*H* and Video 1). At the final follow-up visit, static 2-point discrimination on the sole of the injured foot was 5 mm, and the measurement on the opposite side was 3 mm. Semmes-Weinstein monofilament scores (5) were 4.75 and 3.53 g on the soles of his injured foot and the normal foot, respectively. Active range of motion of the knees were 110° and 120°, respectively. Dorsal and plantar flexion of the ankle were 10° and 9°, respectively. The measurements on the opposite normal side were 32° and 51°.

The injured foot and lower leg were scored 5 (mild cold intolerance) based on the self-administered Cold Intolerance Severity Score questionnaire (mild, 0–25; moderate, 26–50; severe, 51–75; extreme severity, 76–100) (6). The child had no need to use thick socks to

Financial Disclosure: None reported.
Conflict of Interest: None reported.
Address correspondence to: Xu Zhang, MD, Department of Hand Surgery, Third Hospital of Hebei Medical University, Shijiazhuang, Hebei, 050051, China.
E-mail address: ahand@sina.com (X. Zhang).

1067-2516/$ - see front matter © 2019 by the American College of Foot and Ankle Surgeons. All rights reserved.
https://doi.org/10.1053/j.jfas.2019.03.018

Fig. 1. (*A*) Injury at proximal end. (*B*) Amputated part. (*C*) Two weeks after replantation. (*D*) Four months after replantation. (*E*) Radiograph showing bone lengthening starting 4 months after replantation. (*F*) Radiograph 5.5 years after lengthening. Anterior view (*G*) and lateral view (*H*) 5.5 years after lengthening.

protect the lower leg and foot in inclement weather. See Table 1 for other results.

Discussion

Traumatic amputation of the lower leg is a rare but severe injury that may include high-grade open fractures with associated nerve injury, bone and soft tissue loss, and ischemia and unreconstructable neurovascular injury. A below-the-knee amputation may be an option, taking into account the patient's age and ambulatory status (7). A primary amputation can result in disability and psychological consequences for children (7), including depression, confusion, problems with everyday activities, phantom limb sensations, and pain, all of which affect their future goals (8).

Indications for replantation are often controversial, because replantation procedures are complex and difficult to perform, and the results of modern prostheses are better than a poorly functional replanted leg. Replantation of the lower leg is nevertheless sometimes indicated, especially in children. Absolute indications are not unequivocally established, and the child and family members must be aware of their options and have realistic expectations of surgical outcomes to make informed decisions regarding replantation.

Bone lengthening is a surgical elongation of the bone. It requires a variety of orthopedic devices to distract the bone and soft tissues. With the combination of replantation and bone lengthening, an amputated limb can be salvaged and its function can be improved. Stable joint motion and the possibility of preserving sensibility of the sole broadens the scope of indications for limb salvage, even with deliberate shortening that can be restored by lengthening. Length discrepancy is not a contraindication for limb salvage. Children have a physiologically better healing response than adults, with good bone healing secondary to a rich periosteal blood supply, faster soft tissue healing, less scar formation, improved nerve regeneration, easier joint mobilization, and enhanced tendon gliding. Emara et al (9) performed tibial lengthening in 13 children aged between 10 and 12 years. The mean lengthening achieved was 37% (range 32% to 42%) of the original tibial length. Pin tract infection occurred in 5 patients (39%). The rare complications included postoperative compartment syndrome (n = 1; 8%), reflex sympathetic dystrophy (n = 1; 8%), metal failure requiring exchange of a Schanz pin (n = 1; 8%), and peroneal nerve irritation (n = 1; 8%). The authors concluded that lengthening >25% of the original length is safe (9).

Table 1
Item and scale scores for foot function index-5pt

Item	Scale Score (0–4)
Pain	0
1. Foot pain at worst	0
2. Foot pain in the morning	0
3. Pain walking barefoot	0
4. Pain standing barefoot	0
5. Pain walking with shoes	0
6. Pain standing with shoes	0
7. Foot pain at end of day	0
Disability	
1. Difficulty walking in house	0
2. Difficulty walking outside	0
3. Difficulty walking 4 blocks	0
4. Difficulty climbing stairs	1
5. Difficulty descending stairs	0
6. Difficulty standing on tiptoe	1
7. Difficulty getting up from chair	0
8. Difficulty climbing curbs	0
Pain scale score (0–100)	2
Disability scale score (0–100)	5
Foot Function Index-5pt total score (0–100)	7

A few reports exist on replantation of a lower leg in children. Masuda et al (10) performed replantation in a 4-year-old boy who sustained a sharp, complete amputation at the distal third of his left leg in a lawnmower accident. At 17-year follow-up, the patient was able to walk and run faster than average and had no problems in daily activities. In this case, the discrepancy in leg length was 3.5 cm immediately after replantation, which was overcome by overgrowth of the tibia and femur to reach 2.0 cm at the 11-year follow-up and finally 1.2 cm at maturity (10). Kim et al (11) performed replantation of both legs on a 2-year-old girl. At the end of the sixth month, both amplitude and latency were increased, showing good recovery. Zubairi and Hashmi (12) performed replantation in a 3-year-old boy who sustained a traumatic amputation of his left lower limb when he fell off a motorcycle rickshaw. The tibia was shortened 4 cm to facilitate tendon, nerve, and soft tissue approximation. After 12 years of follow-up, the patient has a normal gait with no limp. He did not require a shoe raise for his negligible limb length discrepancy (12). Krylov et al (1) performed replantation in 8 children from 2.5 to 13 years of age with railroad amputations in the lower leg. Among them, 2 children received bone lengthening because of 10-cm bone loss. The authors applied a compression-distraction external device that was removed 6 months later. The patients can walk independently 15 months after the accident (1). Datiashvili (2) performed replantation in a 3-year-old girl whose both lower legs were amputated by a mechanical field mower. After debridement, her right leg was shortened by 6 cm, and the left by 3 cm. Both legs received bone lengthening and correction after 5 years and recovered well with good function 2 years after lengthening. Follow-up continued for another 18 years (2). Physical examination of the patient was satisfactory. There were no signs of spinal deformities. Both thighs looked symmetrical with well-developed musculature. The right lower extremity was shorter than the left by 2 cm. Her lower legs were grossly asymmetrical, with some atrophy of the proximal muscles on the right leg (2).

Several issues need to be discussed. The timeframe is an important element in treating a replanted lower leg. Although many surgeons suggest that all treatments should be finished by 1 year, such a short time was not realistic in our case. Compared with sharp injuries, incidences of complications for crush injuries are higher, including wound edge and bone necrosis, wound and pin tract infection, osteomyelitis, bone nonunion and malunion, tendon adhesion, joint stiffness, and pain. Owing to the complexity of treatments, the treatment team should include the surgeon, the primary care physician, a physical therapist, and a social worker. Attempts at lower leg salvage are often made with less-than-favorable results, leaving the patient with an extremity that is less functional than a prosthesis would be and raising the expense of treatment.

In conclusion, considering the functional outcome of bone lengthening, we believe that replantation of the lower leg should be attempted whenever possible and is feasible in children.

Supplementary Materials

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1053/j.jfas.2019.03.018.

References

1. Krylov VS, Milanov NO, Peradze TY, Borovikov AM, Shilov BL. Lower leg replantation in children: railroad amputation. J Reconstr Microsurg 1987;3:321–326.
2. Datiashvili RO. Simultaneous replantation of both lower legs in a child: 23 years later. J Reconstr Microsurg 2009;25:323–329.
3. Helfet DL, Howey T, Sanders R, Johansen K. Mangled Extremity Severity Score. Clin Orthop Relat Res 1990;256:80–86.
4. Wu Y, Yin Q, Rui Y, Sun Z, Gu S. Ilizarov technique: bone transport versus bone shortening-lengthening for tibial bone and soft-tissue defects. J Orthop Sci 2018;23:341–345.
5. Carrer P, Trevisan C, Curreri C, Giantin V, Maggi S, Crepaldi G, Manzato E, Sergi G. Semmes-Weinstein monofilament examination for predicting physical performance and the risk of falls in older people: results of the Pro. V.A. Longitudinal Study. Arch Phys Med Rehabil 2018;99:137–143. e1.
6. Lannau B, Bliley J, James IB, Wang S, Sivak W, Kim K, Fowler J, Spiess AM. Long-term patency of primary arterial repair and the modified Cold Intolerance Symptom Severity questionnaire. Plast Reconstr Surg Glob Open 2015;3(11):e551.
7. Branch LG, Crantford JC, Thompson JT, Tannan SC. Pediatric lower extremity lawn mower injuries and reconstruction: retrospective 10-year review at a level 1 trauma center. Ann Plast Surg 2017;79:490–494.
8. Eshraghi A, Safaeepour Z, Geil MD, Andrysek J. Walking and balance in children and adolescents with lower-limb amputation: a review of literature. Clin Biomech (Bristol, Avon) 2018;59:181–198.
9. Emara KM, Diab RA, El Ghazali S, Farouk A, El Kersh MA. Foot and ankle function after tibial overlengthening. J Foot Ankle Surg 2014;53:12–15.
10. Masuda K, Usui M, Ishii S. A 17-year follow-up of replantation of a completely amputated leg in a child: case report. J Reconstr Microsurg 1995;11:89–92.
11. Kim HH, Jeong JH, Kim YH, Seul JH, Shon OJ. Rehabilitation after the replantation on a 2-year-old girl with both amputated legs. Br J Plast Surg 2005;58:404–408.
12. Zubairi AJ, Hashmi PM. Long term follow-up of a successful lower limb replantation in a 3-year-old child. Case Rep Orthop 2015:425376.