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CASE REPORT

Single-stage reconstruction of a traumatic tendocutaneous defect of the Achilles using free composite anterolateral thigh flap with vascularized fascia lata

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ABSTRACT

Combined tendocutaneous defect of Achilles tendon remains a complex reconstructive challenge whereby both the soft tissue coverage and tendon reconstruction have to be considered to achieve a good functional and aesthetic outcome. A 14-year-old boy who sustained an open right calcaneum fracture (Gustilo-Anderson IIIB) with a transected Achilles tendon and huge skin defect from motorcycle wheel spoke injury was admitted. The Achilles tendon repair site broke down following initial surgical debridement and primary repair, resulting in a sizeable combined tendocutaneous defect. Simultaneous soft tissue coverage and tendon defect reconstruction using composite sensate free anterior lateral thigh (ALT) fasciocutaneous flap with vascularized fascia lata was performed subsequently. The vascularized fascia lata was tubularized to wrap the native proximal stump of Achilles tendon and secured using the modified Krakow suturing technique. The distal end of tubularized fascia lata was, then, secured by drilling across right calcaneum bone, passing the suture transosseously and screwed. He led an uneventful postoperative recovery with satisfactory functional and aesthetic outcomes at one year of follow-up. In conclusion, the present case demonstrates the reliability of this technique and its advantages over other flap choices in reconstruction of a huge combined tendocutaneous defect.

Keywords: Achilles tendon, anterolateral thigh flap, combined tendocutaneous defect, compound-free flap, reconstruction, sensate, vascularized fascia lata.

The presence of combined tendocutaneous defect of Achilles tendon has made surgical reconstruction complex and challenging, owing to a lack of suitable local tissues.[1] Both the soft tissue coverage and tendon reconstruction must be considered to achieve a good functional and aesthetic outcome.

A simple Achilles tendon rupture can be managed with primary tendon repair,[2] while a segmental loss of Achilles tendon requires a more sophisticated procedures to restore its continuity. There is a great diversity of surgical techniques to Achilles tendon defects described in the literature, including tendon transfer (flexor hallucis longus [FHL], semitendinosus, peroneus brevis or hamstring tendon), percutaneous techniques (figure-of-eight stitch repair or modified Bunnell repair), gastrocnemius turn down flap with or without additional FHL augmentation, V-Y plasty, Z-plasty, synthetics (Ligament Advanced Reinforcement System [LARS] graft or polyester tape), allografts, or scar tissues interposition.[3]

Conventionally, surgical reconstruction of tendocutaneous defect of Achilles tendon involved multi-stage procedures.[4] The soft tissue defect of

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the exposed Achilles tendon was first covered with flap tissues, followed by a second-stage restoration of tendon continuity using autologous tendon graft, allograft, or synthetic Marlex mesh.[5] Such multi-stage surgeries are time- and cost-consuming with unsatisfactory results and outcomes, including prolonged hospitalization, increased risk of complications, interference with rehabilitation and preponderance to calf muscle wasting.[6]

Various reconstructive options were described to manage the complex tendocutaneous defect of Achilles tendon. Potential regional vascular compromise from previously injured leg and inability to provide tendon-like structures have rendered the non-suitability of locoregional flaps.[7] In contrast, compound-free flap with multiple tissue components represents a better solution, which offers the advantages of bringing vascularized tendon and skin coverage together in a single-stage surgery.[8]

In this article, we describe a case of functional reconstruction of a combined tendocutaneous defect of the Achilles tendon using a free sensate composite anterolateral thigh flap with vascularized fascia lata and discuss its outcomes in the light of literature data.

CASE REPORT

A 14-year-old boy presented with an open right calcaneum fracture and transected Achilles tendon from motorcycle wheel spoke injury. Following initial emergency treatment, wound debridement, primary repair of Achilles tendon and external fixator application of his right ankle were performed. Intraoperatively, necrotic tissues were debrided, including a small piece of avulsed non-viable calcaneum bone. The transected Achilles tendon was primarily repaired by suturing both proximal and distal stumps together with non-absorbable braided suture, followed by the approximation of the overlying subcutaneous tissues. Cross ankle external fixator was applied keeping the right foot in plantarflexion position. The wound was dressed with gel dressing. However, there was gapping at

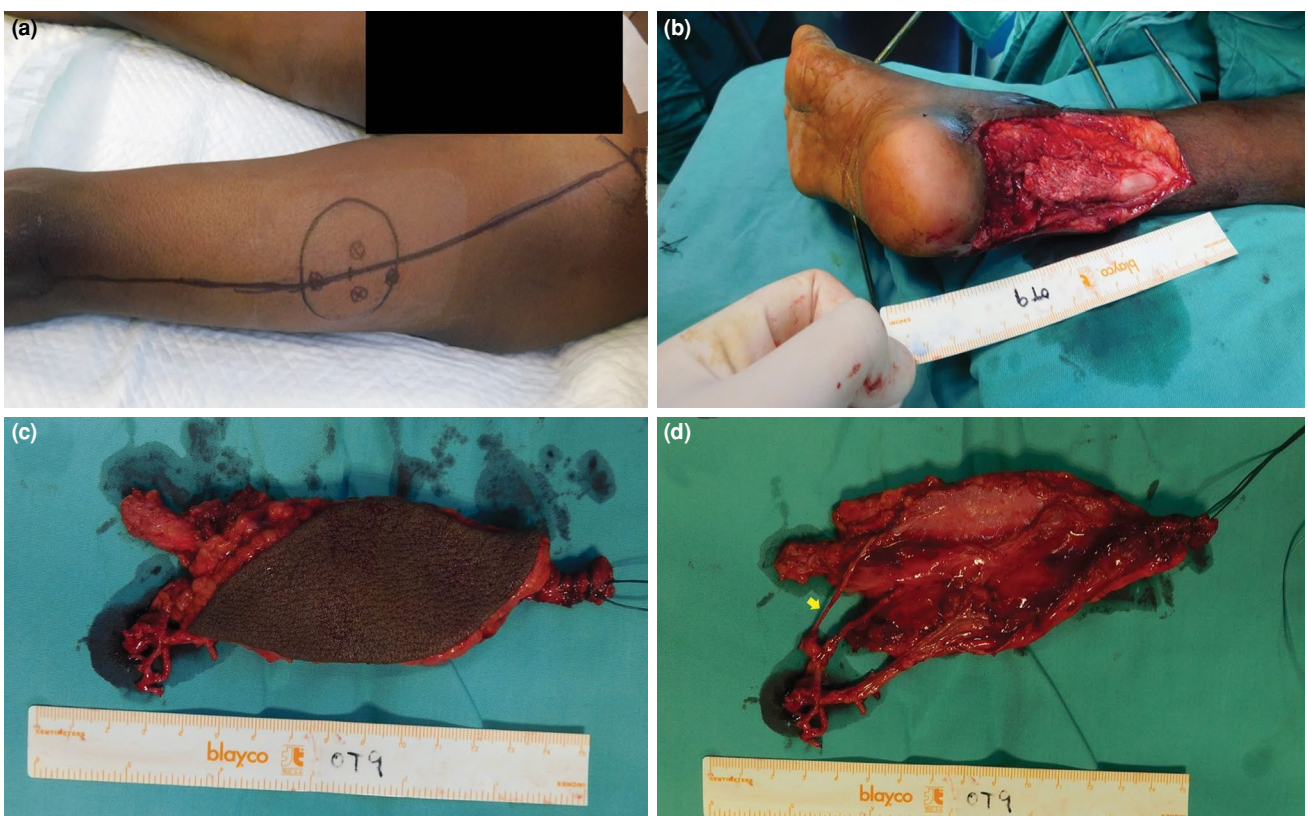

FIGURE 1. (a) Preoperative localization of ALT cutaneous perforators; **(b)** Right heel defect with skin defect of 12×6 cm and tendon defect of 6 cm; **(c)** Left anterolateral thigh flap with skin paddle dimension of 15.0×6.5 cm and tubularized fascia lata; **(d)** Left anterolateral thigh flap showing tubularized fascia lata, vascular pedicle, and lateral femoral cutaneous nerve (arrow).
ALT: Anterior lateral thigh.

tendon repair site three weeks after primary repair due to poor healing.

The soft tissue and tendon defects were subsequently reconstructed using free sensate composite anterior lateral thigh (ALT) fasciocutaneous flap with vascularized fascia lata one month after trauma. Preoperatively, the cutaneous perforators of the ALT flap were identified by Doppler ultrasound and marked (Figure 1a). Debridement of right heel wound resulted in Achilles tendon defect of 6 cm long and overlying skin defect of 12.0×6.0 cm (Figure 1b). The ALT fasciocutaneous flap, with a skin paddle dimension of 15.0×6.5 cm (Figure 1c), and lateral extension of fascia lata sheet with a dimension of 15.0×7.0 cm (Figure 2a), were raised from the left thigh. The lateral cutaneous femoral nerve of left thigh was harvested together with the flap (Figure 1d). End-to-end microvascular anastomoses were performed between the lateral circumflex femoral vessels and posterior tibial vessels at the recipient site proximal to the upper edge of pre-existing wound (Figure 2b). The lateral cutaneous femoral nerve was coapted to the right sural nerve in an end-to-side fashion. The fascia lata was tubularized to wrap the native proximal stump of Achilles tendon and secured using modified Krakow suturing technique with non-absorbable braided sutures. Distal end of tubularized fascia lata was, then, secured by drilling across right calcaneum bone, passing the suture transosseously and screwed (Figure 2c). The flap recipient and donor site were closed primarily (Figure 2d). Cross ankle external fixator was reapplied keeping the right foot immobilized in the neutral position.

Postoperative wound healing at both donor and recipient sites was uneventful. External fixator was removed six weeks after surgery. The patient was able to walk with normal gait, stand on his toes (Figure 3b), and returned to his daily ambulating activities without any support after four months postoperatively. He could also run or climb stairs without any difficulties. The aesthetic results of both donor and recipient areas were optimal with preserved normal right ankle contour and

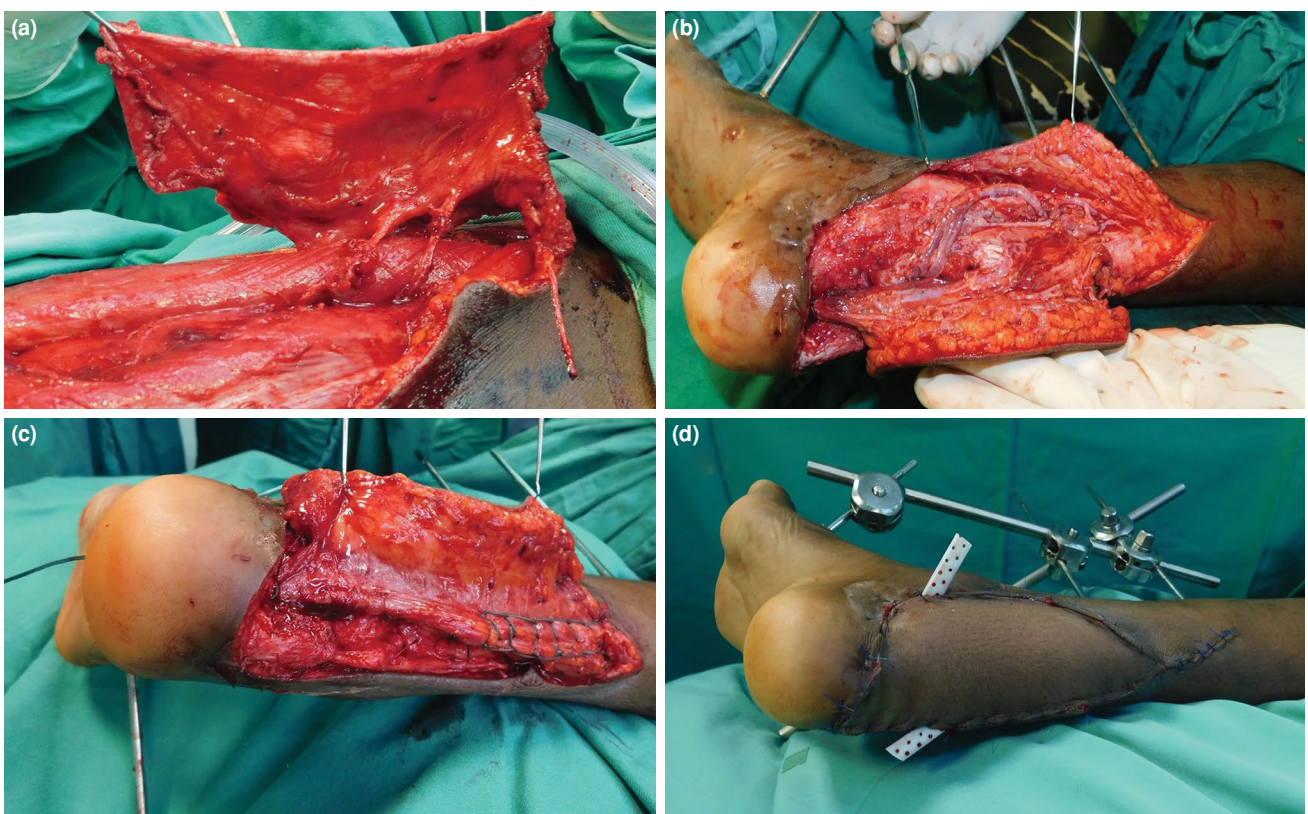

FIGURE 2. (a) Vascularized fascia lata with dimension of 15.0×7.0 cm; **(b)** Microanastomoses between flap pedicles and posterior tibial vessels; **(c)** Neo-tendon. The fascia lata was tubularized to wrap the native proximal stump of Achilles tendon and secured using modified Krakow suturing technique and 3 cm-long distal end of tubularized fascia lata was secured and transosseously and screwed; **(d)** Immediate postoperative external flap appearance.

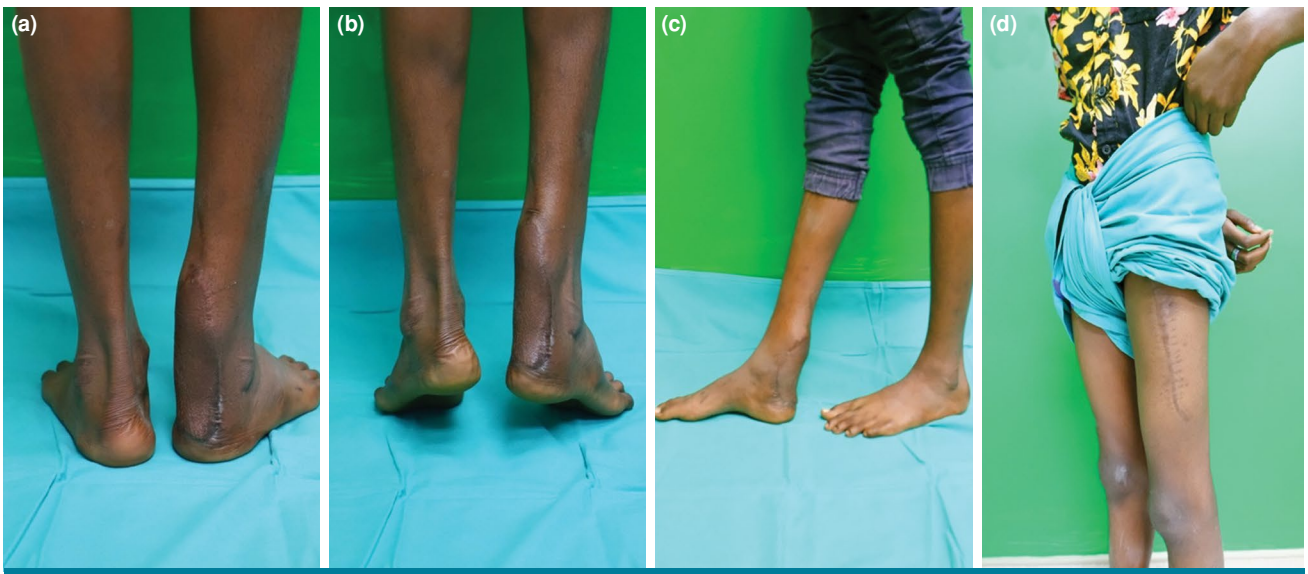

FIGURE 3. Postoperative one year **(a)** Right heel flap healed well with acceptable scar appearance. **(b)** Patient is able to perform heel rise without difficulty. **(c)** Preserved normal right ankle contour with optimal thickness of flap allowing comfortable footwear. **(d)** Acceptable donor site scar appearance.

optimal thickness of flap allowing comfortable footwear (Figure 3a-d). At one year of follow-up, the active range of motion (ROM) of right ankle joint was similar to the contralateral side, that was, 0 to 20 and 0 to 50 degrees for dorsiflexion and plantarflexion, respectively (Figure 4a, b). Moreover, the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot scores improved from 18 preoperatively to 90 postoperatively. He developed successive sensation in the cutaneous part of flap whereby he was able to differentiate between pin prick and light touch.

DISCUSSION

Compound-free flaps with multiple tissue components offer the most optimal solution to the management of combined tendocutaneous defects of the Achilles tendon. Previously, several types of free microvascular tissue transplantations were used to manage the injury including radial forearm flap with

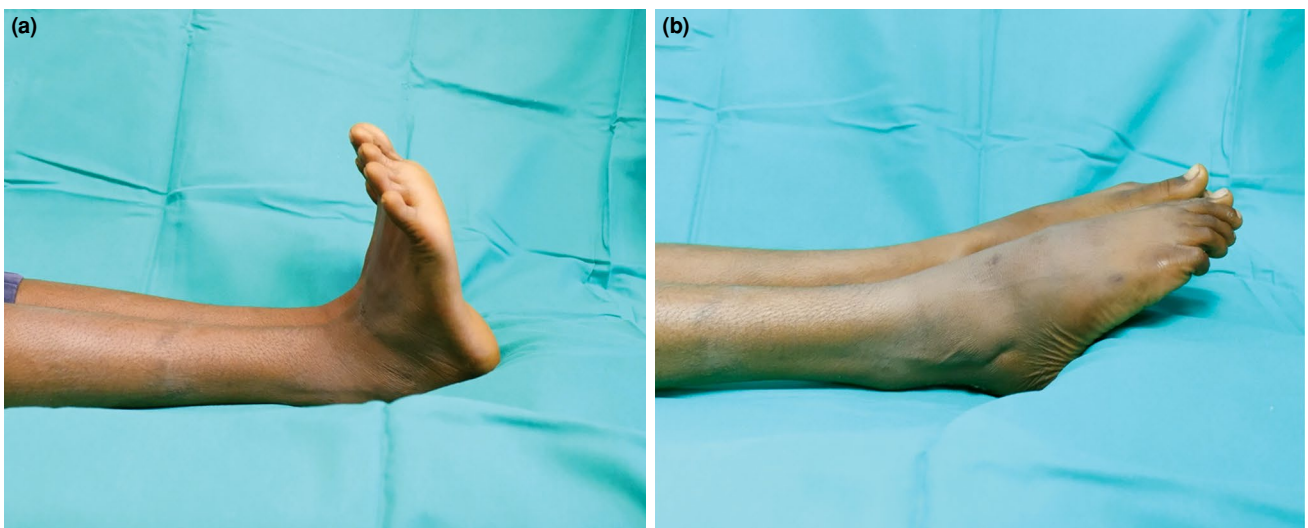

FIGURE 4. (a) Range of right ankle dorsiflexion from 0 to 20 degree, similar to the contralateral side; **(b)** Range of right ankle plantarflexion from 0 to 50 degree, similar to the contralateral side.

palmaris tendon graft alone[9] or in combination with brachioradialis[10] or flexor carpi radialis tendon,[11] lateral arm flap with triceps tendon graft,[12] groin flap with vascularized external oblique aponeurosis,[13] latissimus dorsi muscle flap,[14] and infragluteal fasciocutaneous flap.[15] *Albeit* their acceptable functional outcomes, there were shortcomings associated with their utilization such as insufficient length for tendon repair,[16] donor site morbidities associated with the inclusion of fascia,[17] bulkiness,[18] risks of abdominal hernia,[6] and nerve injury during flap harvest.[15]

In view of a large size of cutaneous defects (12.0×6.0 cm) with long segment of tendon loss (6 cm), composite-free anterolateral thigh flap with vascularized fascia lata was selected in this case. The free flap of choice provided all the tissue components needed for a single-stage reconstruction. The cutaneous territory of flap was large enough to adequately cover the wound defect. Furthermore, the feature also rendered the versatility, flexibility, and freedom in its design and orientation to conform various types of wound defects. Additionally, the skin paddle of anterolateral thigh flap was thin and pliable, thereby allowing restoration of normal ankle contour and comfortable footwear. It was also durable and strong enough to withstand repetitive friction and shearing forces from ambulation. The supple subcutaneous component served as a soft tissue cushion sufficiently thick enough to provide adequate padding, yet permitting the smooth gliding movement of the repaired tendon. In addition, the flap also provided a vascularized fascia lata, which was essential for functional Achilles tendon reconstruction. While remaining attached to anterolateral thigh flap, the vascularized fascia lata received its blood supply via ascending skin perforators of the descending branch from lateral circumflex femoral artery.[19] The vascularized tendinous substitute offered the benefits of improved healing rate, less adhesion formation, greater resistance to infection and superior gliding capacity.[6] Large sheet of vascularized fascia lata could be harvested along with the anterolateral thigh flap. Previous evidence showed that at least 10.0×4.0 cm (40 cm^2) to 24.0×14.0 cm (336 cm^2) of fascia lata sheet could be harvested.[19] This was crucial for tendon reconstruction, as larger sheet of fascia lata allowed itself to be rolled up on its own and wrapping onto the tendon remnant; therefore, as the Achilles tendon defect could be replaced adequately with sufficient length and tension. The anterolateral thigh flap could be neurotized by coapting lateral femoral cutaneous to nerve branch at recipient site. This would prevent pressure ulcer at heel region due to skin flap resensitization. Additional advantages of such flaps included a good length and diameter of vascular pedicle, easy and safe elevation of flap, surgery performance in supine position without the need of changing posture, minimal donor site morbidity, primary closure of donor site wound with width limit of ≤9 cm, concealed donor site scar and donor site that was far away from recipient site enabling two-team approach.[6,8] The present case demonstrates the reliability of this technique and its advantages over other flap choices in reconstruction of a huge combined tendocutaneous defect.[20]

One of the critical aspects of Achilles tendon reconstruction in this case lied in the method of distal reattachment of neo-tendon to calcaneus where the distal remnant of pre-existing Achilles tendon was absent. The distal tendon fixation to calcaneus was imperative to ensure an effective resistance to pull-out tension from triceps surae by neo-tendon. To mimic the biological fibrocartilaginous equivalent of tendon-bone adhesion, tendon reattachment techniques such as suture anchor fixation, transcalcaneal tunnel technique or combination of both were described.[21,22] Suture anchor technique involved fixating the tendon to bone utilizing bone anchor, while transcalcaneal tunnel technique involved suture fixation of tendon to bone through drilled holes at the calcaneus. Although the former appeared to be less invasive, the technique had certain drawbacks including biomechanical failure (suture-anchor failure, suture tearing the tendon, knot loosening, anchor pull-out or loosening of implant), high cost of foreign material implantation, and risk of infection.[21,22] On the other hand, transosseus fixation technique was shown to be more advantageous than the suture anchor technique. Transosseous technique gave rise to broader homogenous areas of contact pressure compared to the focal pressure generated by bone anchors, thereby ensuring a more secure fixation of the distal Achilles tendon.[23] Besides, transosseous tunnels were demonstrated to be more resistant against sheering and rotational forces in relative to bone anchors that provided less than physiological stress dissipation.[24] Creating a bone tunnel by drilling through the subchondral plate gave access to vascular channels and reservoirs of reparative mesenchymal stem cells, thereby enhancing extrinsic cellular reparation, osteointegration, bone remodeling at bone-tendon interface and production of collagen fibers which adhered bone and tendon in the orientation of the pull of the muscle-tendon unit.[25] In addition,

dual cortical engagement by transosseous tunnels increased the strength of repair.[26] The transosseous fixation techniques adopted in this case was proven its success in terms of functional outcome of Achilles tendon reconstruction; re-rupture of tendon was absent, and patient was able to perform single heel rise within one year of follow-up, suggesting that the repair offered sufficient fixation strength.

In conclusion, the present case demonstrates the reliability of free sensate composite ALT fasciocutaneous flap with vascularized fascia lata in reconstruction of a huge combined tendocutaneous defect of Achilles tendon. In terms of functional outcomes, our patient was able to regain full ambulatory activities and stand on his toes at four months postoperatively. The patient also achieved full active ROM of the right ankle joint with improved AOFAS ankle-hindfoot scores from 18 to 90, and resensitization of right heel skin flap during one-year follow-up. Transosseous tunnel fixation technique of the distal Achilles tendon further enhanced its fixation strength. In terms of aesthetic outcomes, the skin flap appeared to be thin that allowed restoration of normal ankle contour, thereby enabling comfortable footwear. The scars at both donor and recipient site were acceptable. There was no donor site morbidity.

Patient Consent for Publication: A written informed consent was obtained from the parent of patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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