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SUMMARY

Segmental bone loss of the tibia remains a significant reconstructive challenge, particularly in low-resource environments where access to advanced orthopedic care is limited. Multiple surgical approaches have been developed. Medial transposition of the fibula, "tibialization", offers a structurally stable and biologically active solution, particularly for children with ongoing growth potential and strong regenerative capacity. We describe a case of an 8-year-old boy who sustained a 4 cm segmental defect of the proximal tibia following chronic osteomyelitis secondary to a snake bite. Reconstruction of the tibial defect was accomplished using a pedicled vascularized fibular flap, transposed medially into the tibial defect. Post-operative rehabilitation progressed gradually, with the patient eventually achieving satisfactory graft incorporation and limb function.

Keywords: **Tibial defect, fibular tibialization, pedicled flap, pediatric bone reconstruction, limb salvage.**

INTRODUCTION

Segmental tibial bone loss presents a major reconstructive challenge, particularly in resource-limited settings. It may result from trauma, infection, tumor resection, or less commonly, neglected soft tissue injury leading to chronic osteomyelitis. Reconstruction requires a multidisciplinary approach integrating orthopedic and plastic surgery techniques (1).

Several treatment modalities exist for tibial defects, including distraction osteogenesis, non-vascularized bone grafting, and vascularized bone transfers (1). Among these, tibialization of the fibula is a time-tested technique in which the fibula is transposed medially (2). This may be performed as an on-lay graft or via true transposition (fibula-pro-tibia). Over time, the transposed fibula undergoes hypertrophy, adapting to weight-bearing stress and effectively assuming the structural role of the tibia (3).

The success of such reconstructions depends not only on skeletal continuity but also on the stability and vascularity of surrounding soft tissue. Chronic osteomyelitis is often associated with soft tissue necrosis, necessitating timely and robust soft tissue coverage to facilitate bone healing and reduce reinfection risk. Rotational muscle flaps, such as the gastrocnemius flap, offer reliable vascularized coverage and are commonly employed before definitive skeletal reconstruction.

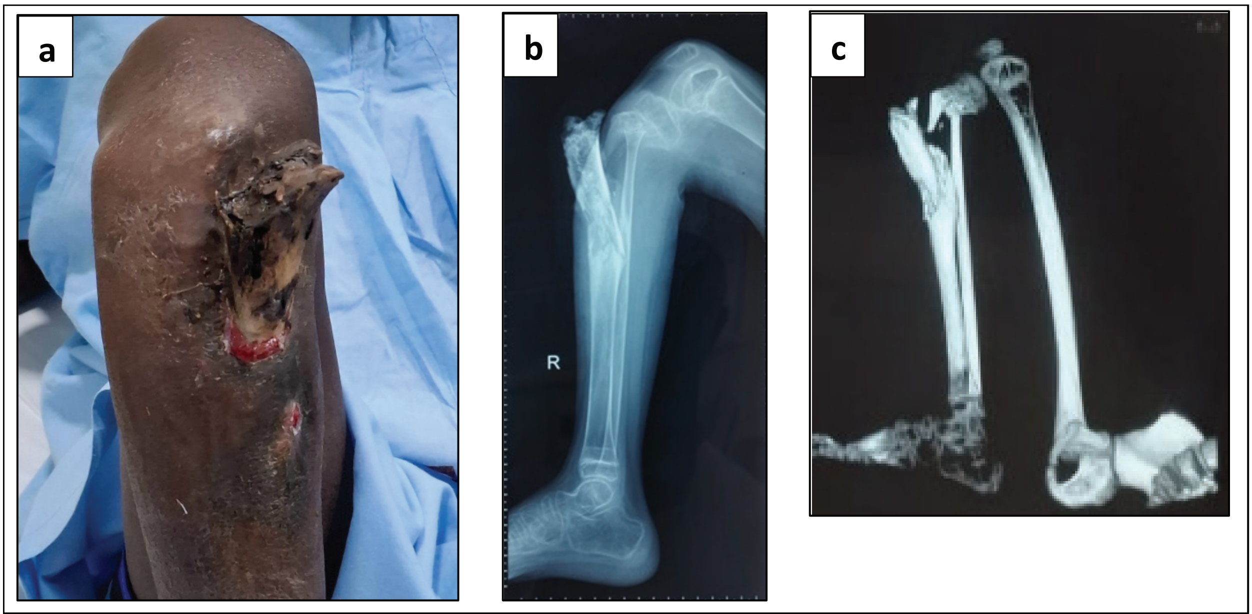
We present this case report of an 8-year-old boy who had a 6 cm right tibial gap defect following a snake bite 5 months before presentation. We performed a rotational flap after infection control and vascularized fibular graft transfer as tibialization of the fibular.

CASE PRESENTATION

An 8-year-old boy presented to the hospital casualty in October 2024 with a foul-smelling wound on the proximal anterior leg (*Figure 1a*), protruding bone, and right knee deformity, of 5 months duration, after a snakebite in his rural home in the northern semiarid area of Kenya.

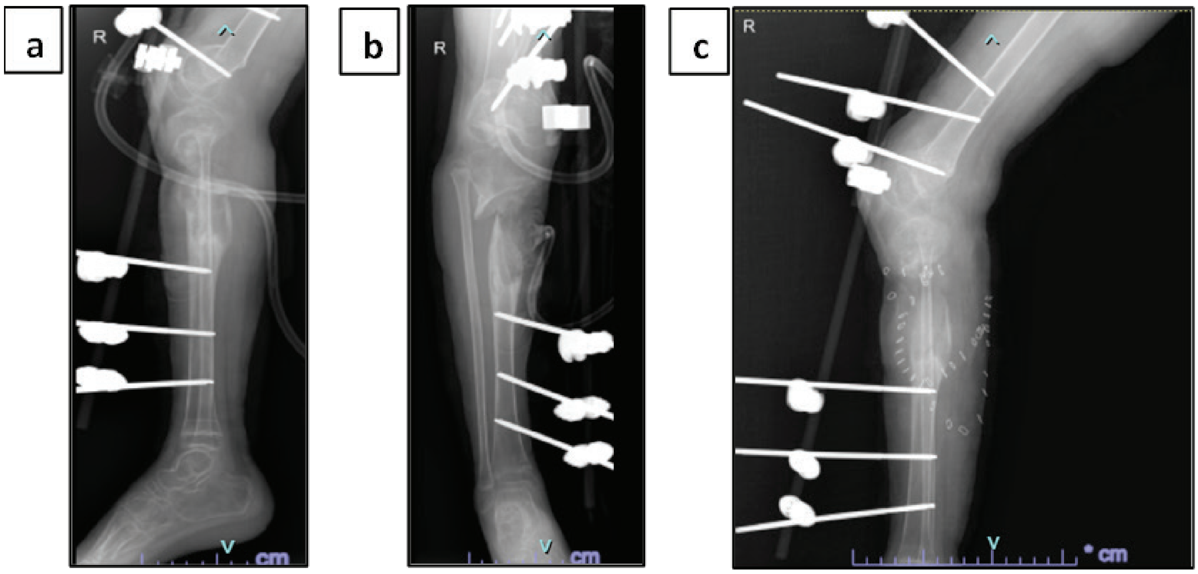
On examination, he was in fair general condition but the right limb was non-functional, with an exposed necrotic tibial segment, fixed knee flexion deformity, and with good blood supply distally. Right leg X-ray revealed radiological features of a pathological fracture, bone sequestration, and chronic osteomyelitis but no involvement of the tibia epiphyses and fibula (*Figure 1)*. A diagnosis was made of right femur and tibia osteonecrosis, right knee contracture, and proximal tibia pathological fracture with segmental bone necrosis due to chronic osteomyelitis secondary to a snake bite. Culture results demonstrated *Staphylococcus pseudointermedius*.

*Figure 1***:** *1a through 1c demonstrate the state of the right leg at admission. Figure 1a shows the exteriorized proximal tibia sequestrum from the pathological fracture. Figures 1b and 1c are the lateral view of the radiograph and CT scan images of the right tibiofibular bones with evidence of sequestrum from the pathological fracture of the tibia at the proximal third junction. The middle third of the tibia showed sclerosed areas. The other bones showed marked osteopenia. The epiphysis and the fibular were spared*



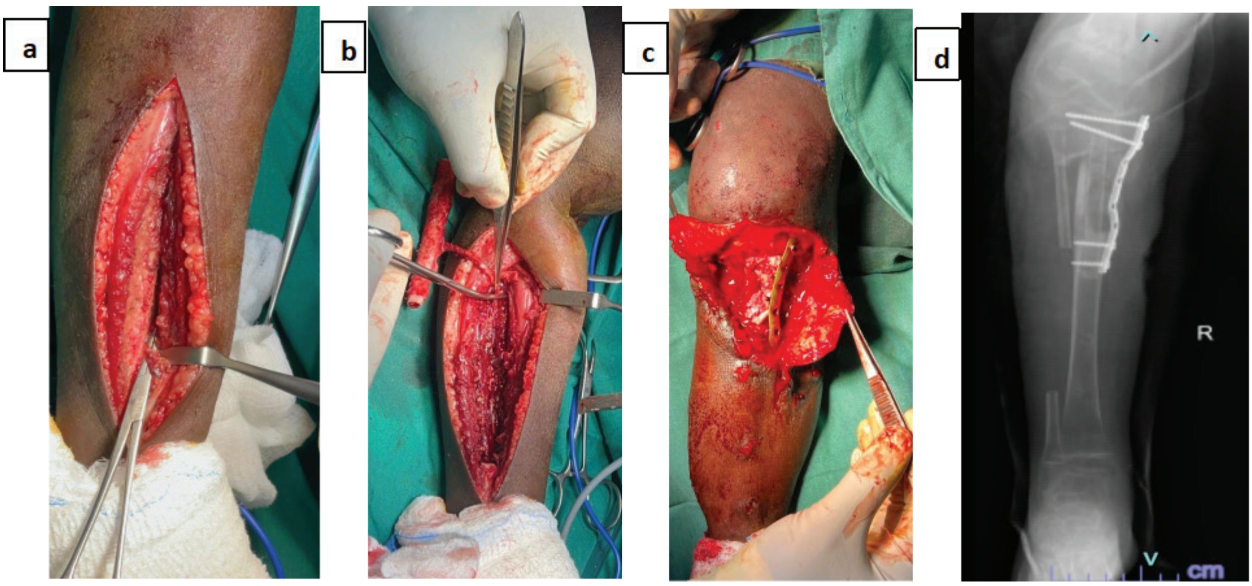
He underwent surgical toilet, sequestrectomy, vacuum dressing, and knee-spanning external fixation. The resultant tibial bone defect was 40mm long involving most of the metaphysis and proximal diaphysis (*Figures 2a and 2b*). During fixation, an iatrogenic distal femoral fracture occurred and was managed conservatively with a knee-spanning external fixator (*Figures 2a and 2b*). He had serial relook debridements and vacuum-assisted closure (VAC) dressing. There was clinically good local infection control and a significant drop of the C-reactive protein (CRP) levels, after one month of treatment. The external fixator was removed and a back slab was applied. After confirming a clean wound bed and good granulation tissue, a rotational gastrocnemius muscle flap was raised to cover the proximal tibial defect, with overlying split-thickness skin grafting. The flap healed well, with full integration noted within three weeks.

Figure 2: 2a & 2b are lateral and anteroposterior views of the right tibia and fibular showing post debridement, sequestrectomy, VAC dressing, and external fixation. The resultant distal femur fracture was splinted by the spanning external fixator. There was a significant segmental bone loss. Figure 2c shows distal femur fracture healing and fixation of a rotational flap with staples.



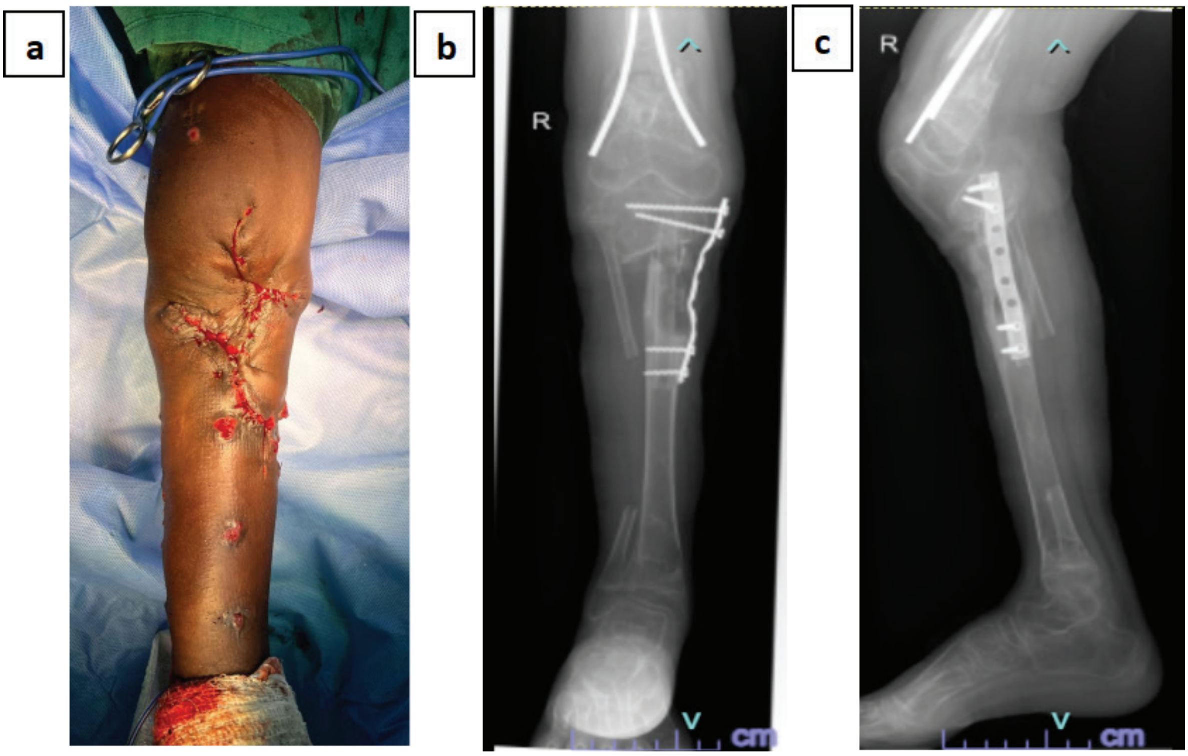
After considering the size and location of the tibial defect, a decision was made to proceed with the tibialization of the fibula using a pedicled fibular flap. Under tourniquet control, the fibula was osteotomized proximally and distally, leaving intact segments to maintain ankle and knee stability. A segment of the vascularized fibula, harvested with its periosteal and muscular pedicle based on the peroneal artery, was mobilized and telescoped medially into the prepared tibial canal (*Figures 3a and 3b*). The construct was held with a 3.5 third tubular plate and screws, while ensuring axial alignment (*Figures 3c and 3d*).

Figure 3: Intraoperative and postoperative images demonstrating tibialisation of the fibula. (a) Exposure of the fibula and preparation for pedicled transfer;(b) Mobilization of the vascularized fibula segment with preservation of periosteal and muscular pedicle;(c) Telescoping of the fibula into the tibial canal for medial transposition ("fibula-pro-tibia" technique) with plate stabilization;(d) Postoperative radiograph showing fixation of the transferred fibula using a tubular plate bridging the proximal tibial defect.



A back slab was applied for a month following which knee exercises and weight bearing were commenced. He unfortunately accidentally refractured the right distal femur which was fixed with titanium elastic nails (*Figure 4*).

Figure 4: The post-surgical (4a), anteroposterior knee radiograph (4b), and lateral knee radiograph (4c) showing stabilized vascularized fibular graft and fixation of the distal femoral fracture with titanium elastic nails.



The soft tissue cover was satisfactory and the right knee stiffness improved. He was ambulant and bearing full weight on the affected limb at the time of discharge from the hospital.

DISCUSSION

Segmental bone loss of the tibia continues to pose one of the most formidable challenges in the realm of reconstructive orthopedic surgery, especially when it affects children. Such loss may result from trauma, chronic infections like osteomyelitis, or, in this case, tissue necrosis secondary to venomous snake bites (4). Regardless of the cause, the clinical objectives are clear yet complex: eliminate any underlying infection, achieve stable structural continuity of the bone, and ultimately restore functional use of the affected limb (5). In practice, the choice of reconstructive approach is dictated not only by the size and anatomical location of the bone defect but also by the condition of the surrounding soft tissues (6).

In a case of chronic osteomyelitis such as the one in this case study, the management first entails the removal of dead bone (sequestrectomy), which, while necessary, often leaves behind significant bone defects (5). These defects are notoriously difficult to manage, particularly when the surrounding tissues are scarred, inflamed, or infected. Repeated debridement surgeries, although aimed at controlling infection, can paradoxically enlarge the defect. In many parts of the world, the financial and logistical barriers to managing such cases are substantial, rendering standard treatment options impractical or entirely inaccessible (7).

A wide array of techniques has been developed to reconstruct the tibia, each with its indications and limitations. Bone transport using external fixators—such as the Ilizarov method—has become a cornerstone of modern limb reconstruction (8). Yet it is an arduous process: long, technically intensive, and often complicated by infections at pin sites, joint contractures, and significant emotional stress, particularly in young patients who must endure months of immobilization and repeated clinical follow-up.

In our case, the initial goal was the eradication of infection through multiple surgical debridement and vacuum-assisted closure. Once infection was controlled and soft tissue coverage achieved, attention turned to skeletal reconstruction. Tibialization of the fibula offers a cost-effective and biologically sound alternative to allografts or distraction osteogenesis (9). The vascularized fibular graft offers clear advantages over non-vascularized grafts: it retains living osteocytes, resists infection, and heals through primary osteogenesis rather than creeping substitution.

The patient had a bone loss of 40 mm. Plate fixation provided initial stability, while the intrinsic vascularity of the pedicled fibula flap promoted rapid integration and reduced the risk of nonunion. With time and mechanical loading, hypertrophy of the transferred fibula—as predicted by Wolff's law—can allow it to assume a full load-bearing function, effectively transforming it into a structurally functional tibia (10).

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