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# Tibialization of Fibula in Treatment of Major Bone Gap Defect of the Tibia: A Case Report

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## Abstract

**Gap bone defect is a major challenge. Its treatment has evolved over the years from amputation to limb reconstruction through vascularised graft, distraction osteogenesis and use of customised implants. Availability and affordability of these innovative techniques have always been an additional challenge in the developing resource poor countries. We report the use of Tibialization of Ipsilateral fibula first suggested by Hahns in 1884 to bridge a gap of 12 cm in an 8 year old male, with segmental tibia loss from chronic osteomyelitis. We did an end to end transposition of the ipsilateral fibular into the tibia gap defect in a one stage procedure. This was after eradication of the infective process of osteomyelitis. He commenced partial weight bearing ambulation in cast at 3 months and out of cast ambulation at 18 months post surgery. The transposed fibula was 75% tibialized at 18 months post surgery. Conclusion: Fibular is a useful armamentarium in filling segmental bone defect.**

## Keywords

**Fibula-Pro-Tibia, Bone Gap, Outcome, Irrua**

## 1. Introduction

Bone gap defect is a known complication of chronic osteomyelitis. It may follow massive segmental bone death, radical bone debridement or wrongly timed sequestrectomy. Chronic osteomyelitis is associated with severe fibrosis and poor vascularity in the soft tissue envelope. This makes the tissues less pliable and graft-take more precarious. Other than chronic osteomyelitis other causes of bone gap would include congenital deficiency, trauma and tumour resections [1]-[5]. Treatment of major bone gap is quite challenging. The options lie between

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amputation and reconstruction. The modalities for reconstruction vary and include the use of non-vascularised graft, vascularised bone graft and limb lengthening osteogenesis.

The transposition of ipsilateral fibula to reconstruct gap defect in the tibia (Fibula-pro-Tibia) was pioneered in 1884 by Hanh [6]. Over the years, it has been subjected to various modifications. However, the principle has remained the same [7] [8]. Catagni used the ilizarov frame to medially transfer the fibular and achieved union in all seven patients with tibia gap which ranged from 7 - 28 cm [9]. While Huntington did a side to side apposition, tuli *et al.* used an end to end apposition which is less liable to fracture due to the graft being in line of the tibia mechanical axis.

This is a case report of an 8-year-old child with 12 cm right tibia gap defect following chronic osteomyelitis. We performed end to end transposition of the fibula (fibula-pro-tibia graft) after eradication of the disease process. Our choice of fibula pro tibia graft was the most viable option at the time considering the very short and poor bone quality of the proximal stump as well as the limited resources in our sub urban rural environment.

## 1.1. Case Presentation

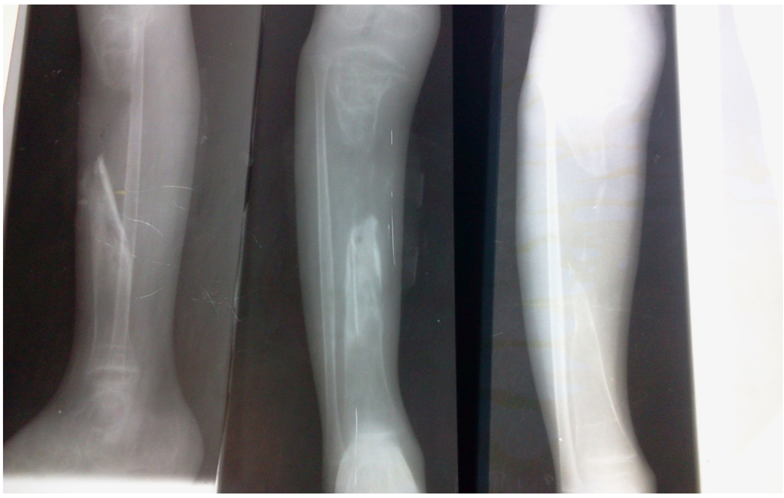
Master MK, an 8-year-old boy, was referred to our center on account of two years history of recurrent extrusion of bone from a chronic discharging right leg ulcer. This started after he had scarifications made over the leg by a traditional bone setter in an attempt to treat a close tibia fracture. The condition progressively worsened over 2 years. He has been unable to walk due to progressive pain and floppiness of the leg. He had Sequestrectomy before he was referred to us to address the bone gap.

Examination revealed a well-nourished child. He had a linear surgical and multiple hyper-pigmented healed sinus scars on the middle $3^{rd}$ of right leg medially. The distal $3^{rd}$ of the leg had an ulcer, 5 cm in its widest diameter. It had an exteriorized necrotic bone fragment surrounded by exuberant granulation tissue. There was no distal neurovascular deficit. Radiograph of the leg showed an intact fibula with 7 cm gap defect of the middle $3^{rd}$ segment of the tibia as well as sequestrum. The proximal tibia stump was osteopenic, very short and the physis partially closed. See **Figure 1(a)** and **Figure 1(b)**.

His hemoglobin genotype was Hb-AA. The white cell count was 5.6 cells × $10^9$/liter and heamatocrit was 32%. Wound swab microscopy and culture grew proteus species that were sensitive to ceftriazone and cloxacilin.

A diagnosis of chronic osteomyelitis of the right tibia with gap non union was made. He was counseled and consent obtained for a two stage surgery.

We did a repeat sequestrectomy and extensive debridement this created an additional gap defect of 5 cm. He was placed on intravenous ceftriazone and analgesics. Two weeks post surgery, an above the knee fiber glass cast was applied with a window over the wound. He was subsequently discharged home on non weight bearing



(a) (b) (c)

**Figure 1.** (a) and (b): Presenting radiograph before repeat sequestrectomy: shows an intact fibula, Gap-non union, proximal tibia physis haziness, osteopenic bones and sequestrum. (c): 3 months post repeat sequestrectomy radiograph shows good infection control and no sequestrum.

clutches to be followed up on out-patient clinic appointments. He was placed on oral antibiotics for 6 weeks as well as wound care.

### 1.2. Fibula Pro Tibia Graft

Three months post repeat sequestrectomy, all soft tissue wounds had completely healed. The radiograph showed no active bone infection (**Figure 1(c)**). He was worked up, counseled and he consented for the second stage surgery.

At surgery, the tibia recipient bed was prepared by excising the fibrous tissue between the tibia stumps. The tibia stump ends were debrided to fresh bleeding points. The fibula was osteotomized proximally and distally to create a middle piece segment that will bridge the tibia gap. The proximal oseteotomy site was 4 cm below the fibular head and distally—6 cm above the ankle joint. This was to avoid injury to the common peritoneal nerve and preserve the integrity of the ankle joint respectively.

The middle piece fibular segment was then gently pulled medially to bridge the tibia gap with all attached muscle and periostium en bloc. The transposed fibula segment was insinuated into the medullary cavity of the proximal and distal tibia stumps respectively. The construct was then stabilized with percutaneous 2.0 mm k-wire as an intramedullary strut (**Figure 2(a)** and **Figure 2(b)**). He was discharged home in cast and on non-weight bearing pair of axillary clutches. The intramedullary k wire was removed after 3 months (**Figure 2(c)** and **Figure 2(d)**) and he was commenced on partial weight bearing while still on cast.

Six months after the fibular transposition, union was achieved in the distal site and at 9 months in the proximal site (**Figure 3(a)** and **Figure 3(b)**). He continued with protective cast ambulation until 18 months after the Fibula-Pro-tibia graft having achieved 75% tibialization (**Figure 3(c)** and **Figure 3(d)**). He then commenced out of cast ambulation. However, a residual limb length discrepancy of 4 cm was observed.

## 2. Discussion

Gap non union is a known complication of chronic osteomyelitis. It is known that the disease process, its complications and or its treatments can lead to bone gap. These 3 factors are implicated in this case .The first sequestrectomy before presenting to our facility and the subsequent repeat sequestrectomy indeed contributed in widening the bone gap (**Figures 1(a)-(c)**). The challenges of managing gap non union in the presence of extensive tissue fibrosis and infection is daunting [7]. Most recent advances in addressing infected gap non union in developed economies is often lacking in resource poor countries as in our environment. We resorted to the time

(a) (b) (c) (d)

**Figure 2.** (a) and (b): Immediate post fibula strut graft (AP and lateral views); note the intramedullary K wire. (c) and (d): radiographs (AP and lateral views) shows progressive hypertrophy of grafted Fibular 3 months post surgery with K wire still *insitu*.

(a) (b) (c) (d)

**Figure 3.** Shows progressive union at the synostosis site and tibialization.

tested fibula-pro-tibia graft as the most viable option because of the very short tibia remnant which is not suitable for distraction osteogenesis [3]-[5]. We also lack micro- vascular expertise which is a requirement for the successful use of free vascularized graft [9] [10].

Our aim was to achieve normal length as compared to the contra-lateral limb. However this was rather difficult because of the amount of length lost to infection control and fibrous tissue excision [3] [8] [10].

While it is reported that 6 cm length is the maximum advised free non vascularized fibula graft that is allowed in order to achieve a significant chance of union, transposing the fibular with its blood vessels and muscles intact surmounts this restriction [4] [5] [11]. However, the length of fibular graft available for this procedure was further limited by the need to restrict the level of proximal resection to 2 cm below the neck of the fibular and that of the distal level to 6 cm above the ankle mortise. In this way injury to the common peritoneal nerve was avoided and the stability of the ankle joint was not compromised [12]-[14].

The tibia functions absolutely for weight bearing while the fibula serves for muscle attachment except for the distal 5 cm which participates in the stability and formation of the ankle motice. Less than 10% of body weight is transmitted through the fibula; indeed over 70% of the fibula shaft is considered expendable [12] [13].

The intact blood supply and periostium ensures appositional bone growth. This enhances progressive tibialization of the graft which is defined as the attainment of twice the original size of the fibular (**Figures 3(a)-(d)**). In less than 2 years we had achieved about 70% tibialization.

Intramedullary placing of the fibular graft as in this case gives it more mechanical advantage as the graft fall into the line of the mechanical and anatomical axis of the tibia. It also reduces the risk of graft fracture. This conforms with the work of Tuli *et al.* and a considerable departure from the original description by Huntington which places the graft posterior or medial to the tibia [6] [7] [14] [15]. The use of K-wire obviates the need for a second surgery which would have been the case if a screw or plate was used. Cancellous bone graft at the proximal and distal ends of the graft site would have hastened the healing process but again we decided otherwise to reduce the patient's morbidity [16] [17].

The incorporation of the fibula into the tibia (graft- take) does not require creeping substitution as will be expected in non vascularised grafts. It has all the advantages of vascularised fibular graft without the need for micro vascular expertise [11]. It also saves the patient the risk of morbidity associated with contra-lateral fibular harvest. It is therefore a viable option in resource poor rural and sub rural setting [16] [17].

Our result is in Tandem with several similar studies. Tuli worked on 21 patients with tibia gap defect due to either infection or trauma [8]. He reported union in all the patients. Similarly, Kassab *et al.* reported his success on 8 of 11 patients with tibia gap defects which range from 4 to 22 cm. The causes of the defect were tumour resection, trauma and chronic osteomyelitis [18]. Rahimnia in a review reported mean time to union of fibula-pro-tibia transposition to be 12 months with a range of 6 weeks-36months' [18] [19]. Stable fixation and younger age group are key element that enhances the success of the procedure [19].

## 3. Conclusion

Tibia-pro-Fibula transposition is a simple, non-high tech procedure that can be performed by any trained orthopedic surgeon even in a remote environment with an immense benefit to the patient. We recorded resounding success that can be easily replicated in a resource poor environment; the only requirement being the availability of an appropriate length of ipsilateral fibula.

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