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Case Report: Corrective Osteotomy and Stabilization for Tibial Reconstruction in an Adolescent with Osteogenesis Imperfecta

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Abstract: ***This case report presents the surgical management of a 12-year-old male diagnosed with Osteogenesis Imperfecta Type IV, exhibiting anterior tibial bowing and limb shortening. A corrective osteotomy combined with intramedullary stabilization using Titanium Elastic Nails (TENS) was performed to address the deformity. Postoperative recovery showed satisfactory alignment, progressive weight-bearing, and restored mobility. The case underscores the clinical feasibility and cost-effectiveness of TENS in resource-limited settings, highlighting its role in pediatric deformity correction where advanced devices may not be accessible.***

Keywords: Osteogenesis Imperfecta, corrective osteotomy, pediatric orthopedics, intramedullary fixation, Titanium Elastic Nailing System

1. Introduction

Osteogenesis Imperfecta (OI) is a rare congenital disorder of connective tissue characterized primarily by bone fragility and recurrent fractures. It has an estimated incidence of approximately 1 in 15,000–20,000 live births. This condition arises due to mutations in the genes encoding type I collagen (COL1A1 and COL1A2), which is the major structural protein of bone, skin, and tendon. The abnormal collagen results in defective mineralization and impaired bone strength, predisposing patients to fractures after minimal or no trauma.

Clinically, OI presents with a wide spectrum of severity, ranging from perinatal lethal forms (Type II) to relatively mild variants (Type I) where individuals may have only mild bone fragility and near-normal stature. The most common features across the spectrum include bone fragility, recurrent fractures, progressive deformities of long bones, ligamentous laxity, blue sclerae, dentinogenesis imperfecta, and varying degrees of hearing impairment.

Standard fracture fixation techniques frequently fail in this group due to poor bone quality and the small size of the medullary canal. Several surgical techniques have been developed to manage long bone deformities in OI. Among these, corrective osteotomy combined with intramedullary stabilization remains the cornerstone of treatment. While advanced expandable telescopic rods (such as the Fassier–Duval rod system) have revolutionized care in specialized centers, resource-limited settings often rely on more accessible devices such as Titanium Elastic Nailing System (TENS). These provide adequate stabilization, correction of deformity, and allow early mobilization.

2. Case Report

A 12-year-old male child presented with difficulty in walking due to progressive anterior bowing of his left tibia and severe limb shortening of approximately 5 cm, with no breathing difficulties. Following radiological and clinical evaluation, a diagnosis of Osteogenesis Imperfecta Type IV was established. Given the severity of deformity and progressive functional impairment, surgical intervention with tibial osteotomy and intramedullary Titanium Elastic Nail System (TENS) was planned.

Figure 1: Patient showing no involvement of sclera, appearing white on inspection.

Figure 2: Clinical picture showing anterior bowing of the tibia with limb shortening.

Figure 3: Preoperative X-ray showing "saber" shins and multiple old healed fractures

Figure 4: Clinical picture showing a positive Galeazzi sign

3. Surgical Technique

The patient was taken up for surgery under general anesthesia and positioned supine on a radiolucent operating table. A pneumatic tourniquet was applied to the thigh, and the entire lower limb was prepared and draped in the usual sterile manner.

Step 1: Planning and Entry Point Preparation
Preoperative templating using radiographs was performed to determine the level of osteotomy and appropriate nail length. Under fluoroscopic guidance, two entry points were made for the Titanium Elastic Nail System (TENS). The entry points were located just distal to the proximal tibial physis—one on the medial side and one on the lateral side of the tibial tuberosity. A small incision (~1 cm) was made at each site, and cortical windows were created using an awl.

Step 2: Nail Insertion
Two 3.5 mm pre-bent TENS nails were introduced into the medullary canal in an antegrade manner, one from each entry point. The nails were advanced gently with oscillating movements under fluoroscopy until they reached the predetermined level of planned osteotomy. Care was taken to avoid breaching the cortex or damaging the proximal growth plate.

Step 3: Osteotomy
A longitudinal incision (~4–5 cm) was made over the apex of the deformity. The periosteum was carefully elevated and preserved. Using an oscillating electric bone saw, a transverse osteotomy was performed at the site of maximal deformity. In order to maintain uniform correction and prevent secondary deformities, the fibula was also osteotomized at a corresponding level through a separate small incision.

Step 4: Deformity Correction and Nail Advancement
Following osteotomy, gentle manual manipulation was carried out to correct the anterior bowing. Once satisfactory alignment was achieved, the previously inserted nails were advanced further across the osteotomy site into the distal tibial metaphysis. Their tips were guided into divergent positions within the metaphysis to maximize three-point fixation and rotational stability. Fluoroscopic imaging confirmed appropriate alignment, nail position, and maintenance of correction.

Step 5: Closure and Dressing

The osteotomy site was irrigated with normal saline, and hemostasis was achieved. The periosteum was approximated where possible to aid biological healing. The wounds were closed in layers using absorbable sutures for deep tissues and non-absorbable sutures for the skin. Sterile dressings were applied.

Step 6: Immobilization

Postoperatively, the limb was immobilized in a well-padded below-knee plaster cast to provide additional support during the initial healing phase. The patient was kept non-weight-bearing, and postoperative analgesia and intravenous antibiotics were administered as per protocol.

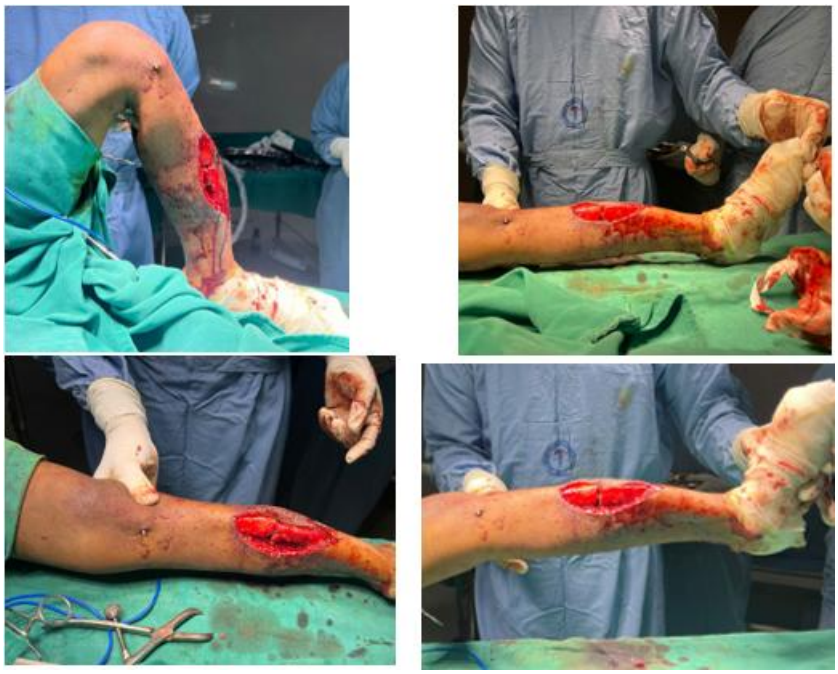

Figure 5: Intraoperative image of osteotomy being performed

Figure 6: Placement of intramedullary TENS nails under fluoroscopy

Figure 7: Immediate postoperative X-ray showing corrected alignment and intramedullary fixation.

4. Results

The patient was immobilized in a below-knee cast for six weeks, with sterile dressings changed every five days. At three months postoperatively, radiographs showed satisfactory fracture union with good realignment of the tibia and no residual limb shortening. The patient began partial weight-bearing at two months and progressed to full weight-bearing at three months. Functionally, the child regained independent mobility with significant improvement in gait.

5. Discussion

Osteogenesis Imperfecta is a connective tissue disorder associated with low bone mass and fragility. Severe long bone deformities often necessitate surgical correction to restore function and prevent progressive disability.

In resource-limited settings, where advanced telescopic rod systems are unavailable, intramedullary fixation with TENS nails provides a reliable and cost-effective option. TENS nails offer flexible stabilization, enabling correction of deformity while maintaining bone growth potential. Additionally, pharmacological management with bisphosphonates has been shown to reduce bone pain, minimize fracture frequency, and enhance functional outcomes.

This case highlights the effectiveness of corrective osteotomy combined with intramedullary stabilization in managing severe tibial deformities in children with OI, restoring mobility and improving quality of life.

6. Conclusion

The treatment of tibial deformities in children with Osteogenesis Imperfecta should focus on restoring walking ability with minimal complications. While multiple osteotomies and intramedullary fixation may be required, TENS nails provide a simple, effective, and widely applicable solution in the absence of advanced surgical systems. Successful outcomes depend on careful surgical planning, stable fixation, and gradual mobilization. This case demonstrates that even in complex deformities, appropriate surgical techniques can achieve good functional recovery and long-term stability.