Case 19: Hypertrophic Tibial Nonunion with Oblique Plane Deformity Treated with TSF

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Contents

Abstract

A 46 year old male with a hypertrophic tibial nonunion and limb length discrepancy was treated by closed means with a Taylor Spatial Frame (TSF) (Smith & Nephew, Memphis, TN, USA). Distraction and deformity correction with the TSF allowed for stimulation of the nonunion and resolution of the deformity without open approach to the nonunion. The tibial healed in 4.5 months. This case highlights the ability of hypertrophic nonunions to undergo osteogenesis in response to gradual traction.

1 Brief Clinical History

This case describes a 46 year old male who was a pedestrian struck by a car in July 1999. He suffered a closed tibial shaft fracture, which was treated with intramedullary nailing. At 8 weeks post-operatively, the patient was diagnosed with an infection; the nail was removed, and he was placed on 6 weeks of IV antibiotic therapy. The infection resolved but bony instability persisted. Over the years he had increasing deformity and pain in the right knee, leg, and ankle. He smoked 1.5 packs of cigarettes per day and consumed a six-pack of alcohol daily. The patient had full knee and ankle range of motion.

Prior to surgery, the patient was counseled on smoking and alcohol cessation. Pre-operative nutrition and infection markers were within normal limits.

2 Preoperative Clinical Photos and Radiographs

See Figs. 1, 2, and 3.

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Fig. 1 Clinical photograph of the patient standing showing large varus deformity. The patient maintained his *left* knee flexed in order to accommodate for the short right lower extremity. Note the valgus-compensated right ankle and subtalar joint to maintain a plantigrade foot. The pre-operative clinical exam demonstrated a flexible foot deformity, which indicated that the hindfoot valgus would resolve as the tibia vara was corrected

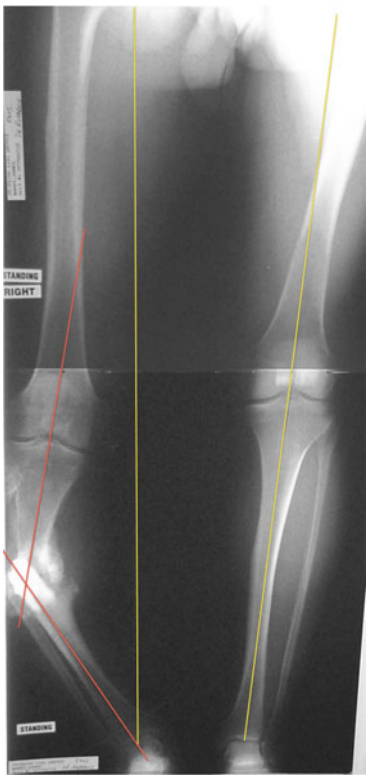

Fig. 2 Pre-operative standing 51″ erect leg radiograph. Mechanical axis deviation (*MAD*) on the *right* was 78 mm medial to *midline*; *left* was 0 mm (*yellow lines*). The center of rotation of angulation (*CORA*) was at the obvious tibial nonunion site (*red lines*), and its magnitude was 40° of varus

3 Preoperative Problem List

1. Hypertrophic "stiff" tibial nonunion, right
2. History of infection, right tibia
3. 40° tibia vara
4. 11° tibial procurvatum deformity
5. 14 mm anterior tibial translation deformity
6. 3.2 cm LLD, right short
7. Cigarette smoking
8. Alcohol abuse

4 Treatment Strategy

The surgical strategy was based on the clinical assumption that the nonunion occurred because of persistent instability and sheer forces, despite a favorable biological milieu – that is, a hypertrophic or stiff nonunion. Under anesthesia, after fibular osteotomy, the patient's tibia was examined to confirm the pre-operative hypothesis. The nonunion was tested and there was less than 5° of motion. This confirmed that it was a stiff nonunion, and we thus proceeded with the closed nonunion repair. This consisted of gradual distraction through the nonunion site, stimulating the nonunion, and gradual correction of varus, procurvatum, and anterior translation. Residual LLD would be analyzed after complete deformity correction as length will be achieved by resolving varus and procurvatum. Once the distraction phase was complete, the nonunion site was compressed to augment bone healing while in the consolidation phase.

5 Basic Principles

This case is predicated upon the presence of a hypertrophic or stiff nonunion. Specifically, the hypertrophic nonunion contains fibrocartilaginous tissue with osteogenic potential;

Fig. 3 Pre-operative (**a**) AP and (**b**) lateral tibial X-rays. Magnitudes of deformity were 40° of varus, 11° of procurvatum, and 14 mm of anterior translation. The apex of deformity was distal to the nonunion on the lateral X-ray since there was an associated anterior translation deformity

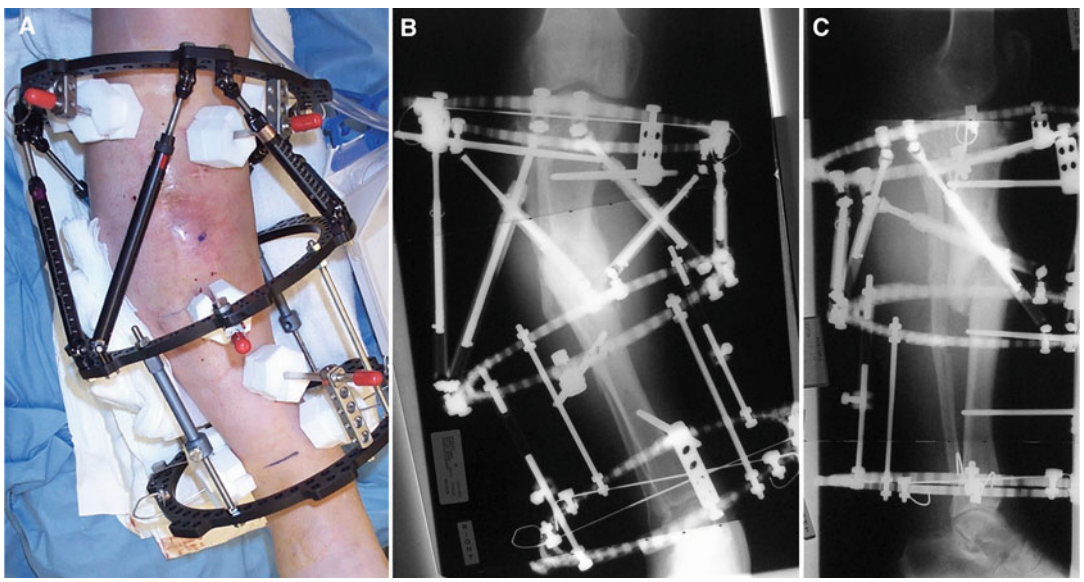

Fig. 4 (**a**) Clinical photograph in the operating room of the TSF. The proximal and middle rings were applied orthogonal to the proximal and distal reference axis. Also note the poor quality of the skin overlying the nonunion. (**b**) AP and (**c**) lateral intra-operative X-rays of the frame demonstrating frame application matching the deformity in both the coronal and sagittal planes

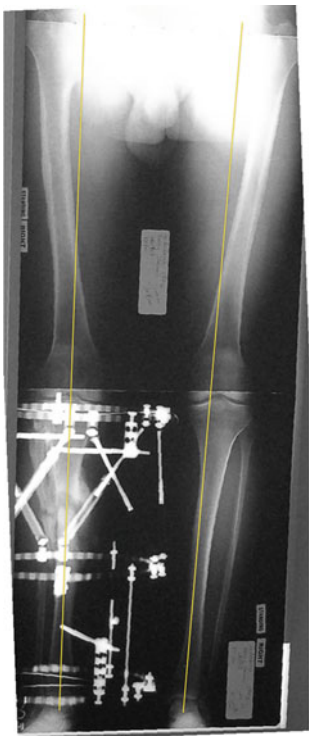

Fig. 5 Post-operative 51″ erect leg radiograph after TSF frame adjustments completed. Note mechanical axis deviation of 0 mm. Leg lengths were equalized

however, it lacks stability and the deformity causes shear forces at the nonunion. Therefore, restoring stability and correcting the deformity (without auto- or allograft material) are all that is required. Deformity correction at the nonunion site coverts the shear forces into axial compression forces. It is critical that the surgeon appreciates the difference between hypertrophic and oligotrophic nonunions as the treatment algorithm of the latter requires an open approach, debridement, and bone grafting. Intra-operative support of a stiff nonunion is demonstrated with less than 5° of sagittal or coronal motion at the nonunion site without the influence of hardware or the fibula. Assuming bone viability exists, the increased vascularity obtained during distraction of the deformity can be exploited for curing infection as well.

6 Images During Treatment

See Figs. 4, 5, 6, and 7.

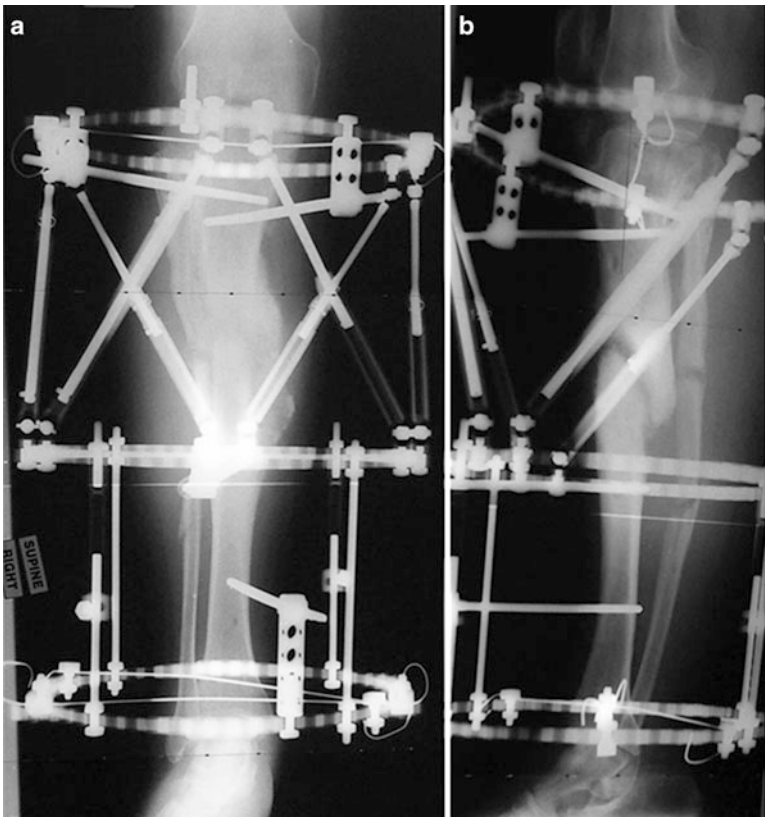

Fig. 6 36″ (**a**) AP and (**b**) lateral X-rays of the tibia after completion of frame adjustments. Note the deformity is now corrected

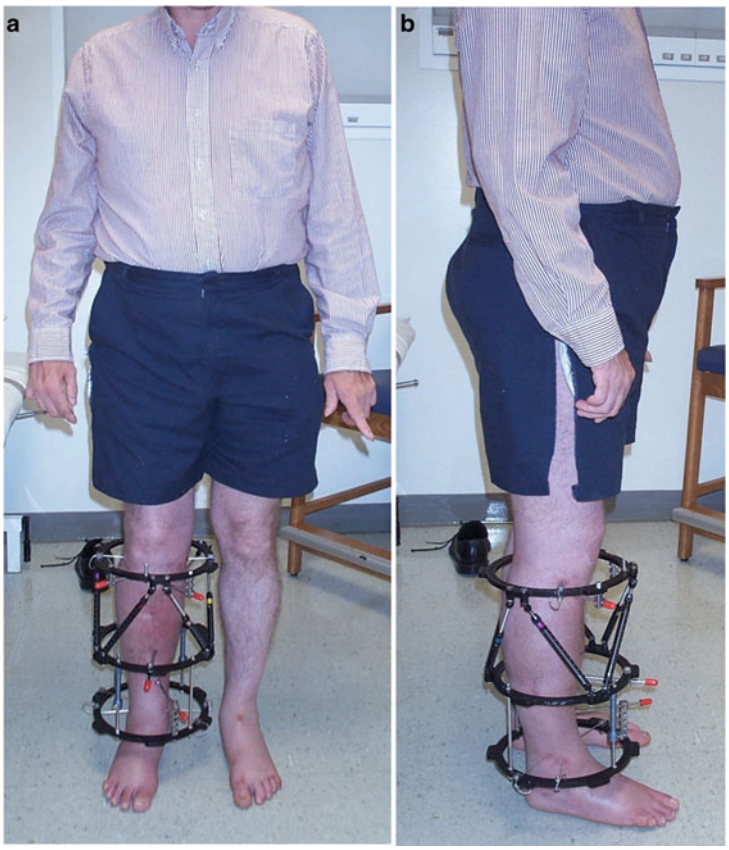

Fig. 7 Clinical photograph of the patient from the *front* (**a**) and *side* (**b**). The deformity has been corrected and the patient was allowed full weight bearing during treatment. The frame's purpose at this time was to provide stability of the nonunion, modulating the osteogenic tissue into bone

7 Technical Pearls

1. Be prepared to exclude an oligotrophic nonunion intraoperatively.
2. Ensure hardware is removed and the fibular is osteotomized before confirming lack of excessive motion at the nonunion site (less than 5° in both planes).
3. Distraction through the nonunion site is performed first to correct preexisting deformity and stimulate the tissue.
4. The amount of distraction through a hypertrophic nonunion is limited due to the inherent stiffness at the nonunion site. Maintain close follow-up of the fixation.

8 Outcome Clinical Photos and Radiographs

See Figs. 8, 9, and 10.

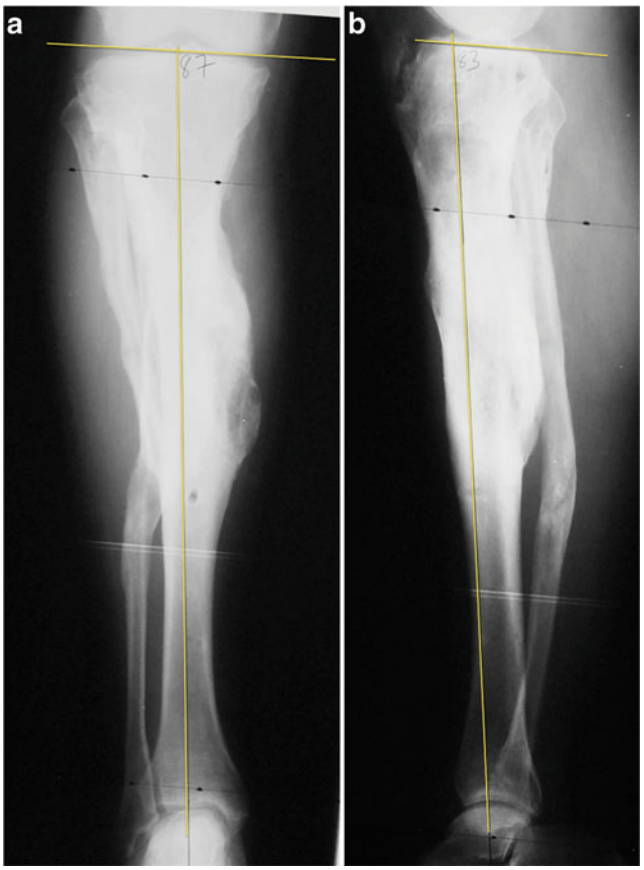

Fig. 8 Final (**a**) AP and (**b**) lateral radiograph at 2.5-year follow-up. Medial proximal tibial angle measured 87° and proximal posterior tibial angle measured 83°

Fig. 9 Clinical photograph at final follow-up. Note the complete correction of tibia vara and limb length discrepancy. Patient was ambulating without any assistant devices

9 Avoiding and Managing Problems

1. Closed treatment of the nonunion is predicated upon the presence of a stiff nonunion. One must be critical in its evaluation after hardware removal and/or fibular osteotomy. Look for less than 5° of coronal and sagittal motion.
2. The presence of nonviable bone at the nonunion site may prevent closed treatment of the nonunion. Understanding the "personality" of the nonunion based on the history, physical exam, adjunct imaging, and previous perioperative complications will determine if avascular bone is present.
3. In this case, the skin and soft tissue envelope around the nonunion was compromised. A traditional approach to this case with open repair, correction of large deformity, and insertion of internal fixation would have been dangerous. The soft tissue including the skin and neurovascular structures would be at risk. It was particularly advantageous in this case to avoid an open approach and gradually correct the large deformity.

Fig. 10 Final clinical photograph of the patient from the *side*

10 Cross-References

- Case 20: Distraction of Hypertrophic Nonunion
- Case 37: Hypertrophic Nonunion Distal Periarticular Tibia. Treatment with Callus Distraction Using a Spatial Frame

References and Suggested Reading

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