# Case 15: Bifocal Tibial Transport with the TSF

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## Contents



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**Abstract**

This is a case of a 24 year old male with a type IIIB right tibial fracture after an injury sustained after a motor vehicle collision. He had a 6 cm bone defect in the diaphysis and soft tissue invagination into the defect. He was treated with application of a Taylor Spatial Frame (TSF), bone transport, and elevation of the flap and docking site grafting.

## 1 Brief Clinical History

An otherwise healthy 24 year old male suffered an open type IIIB tibial fracture after a motor vehicle collision. He was initially treated with a spanning "trauma" monolateral external fixator. His soft tissue lesion was treated with skin grafting. He had a 6 cm distal diaphyseal bone defect that had not been yet treated. He presented to our service 6 months into treatment for management of the bone defect and invagination of the soft tissue. He had not been ambulating on his extremity and developed knee, ankle, and toe contractures. His bone quality demonstrated early signs of disuse osteopenia.

## 2 Preoperative Clinical Photos and Radiographs

See Figs. 1 and 2.

## 3 Preoperative Problem List

1. Soft tissue invagination status post free flap in distal right leg
2. Bone defect, right tibia, mid-distal third of the leg, 6.8 cm
3. Knee contracture
4. Ankle contracture

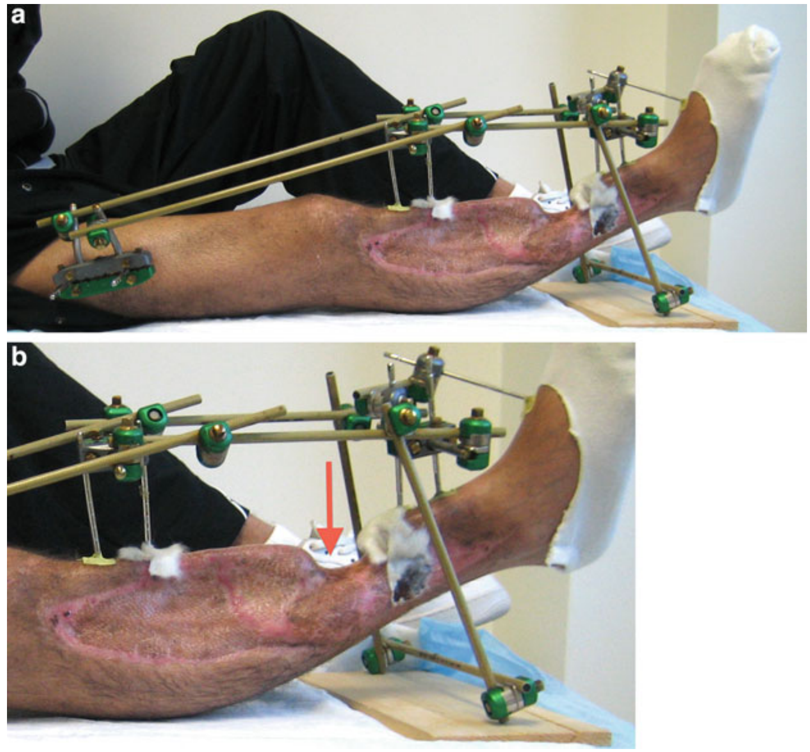


**Fig. 1** (**a**) Pre-operative clinical photos of the patient from the side and (**b**) closeup image. Patient was transferred to our care in a damage control trauma "external fixator" providing traveling traction. Skin invagination (*red arrow*) is evident in the bone defect site

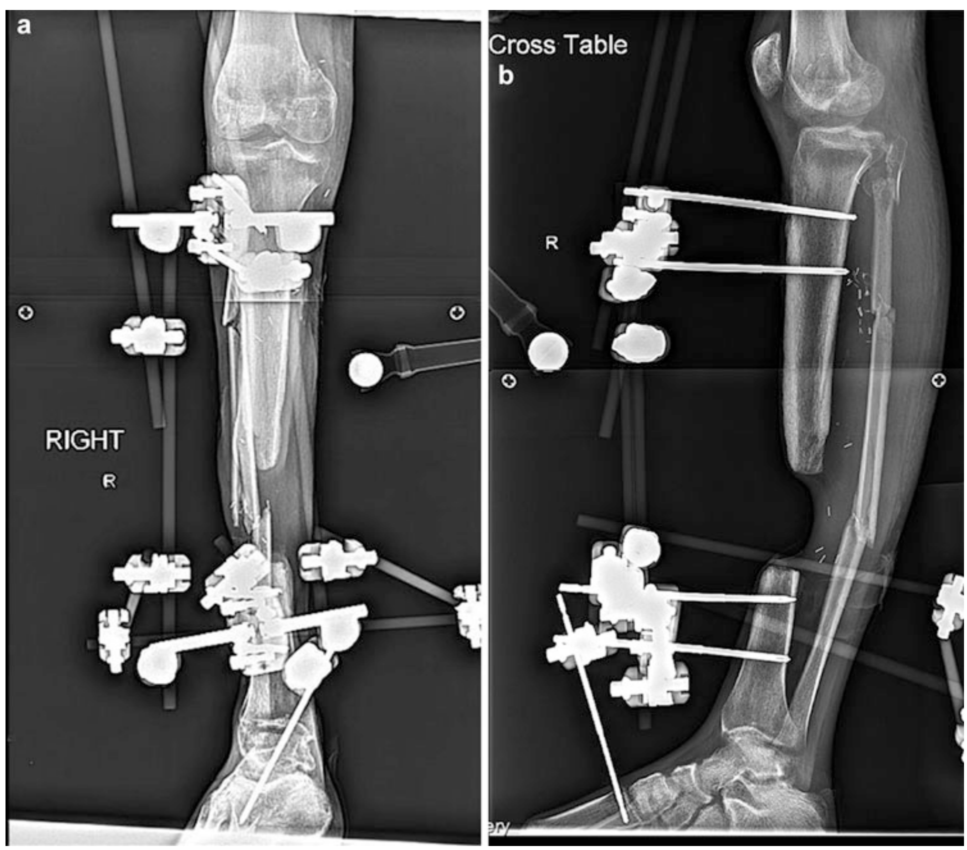


**Fig. 2** (**a**) AP and (**b**) lateral X-rays of the patient's right tibia. 6.8 cm total bone loss of the right lower extremity was evident. Axial, coronal, and sagittal alignment were well maintained during the initial limb salvage treatment

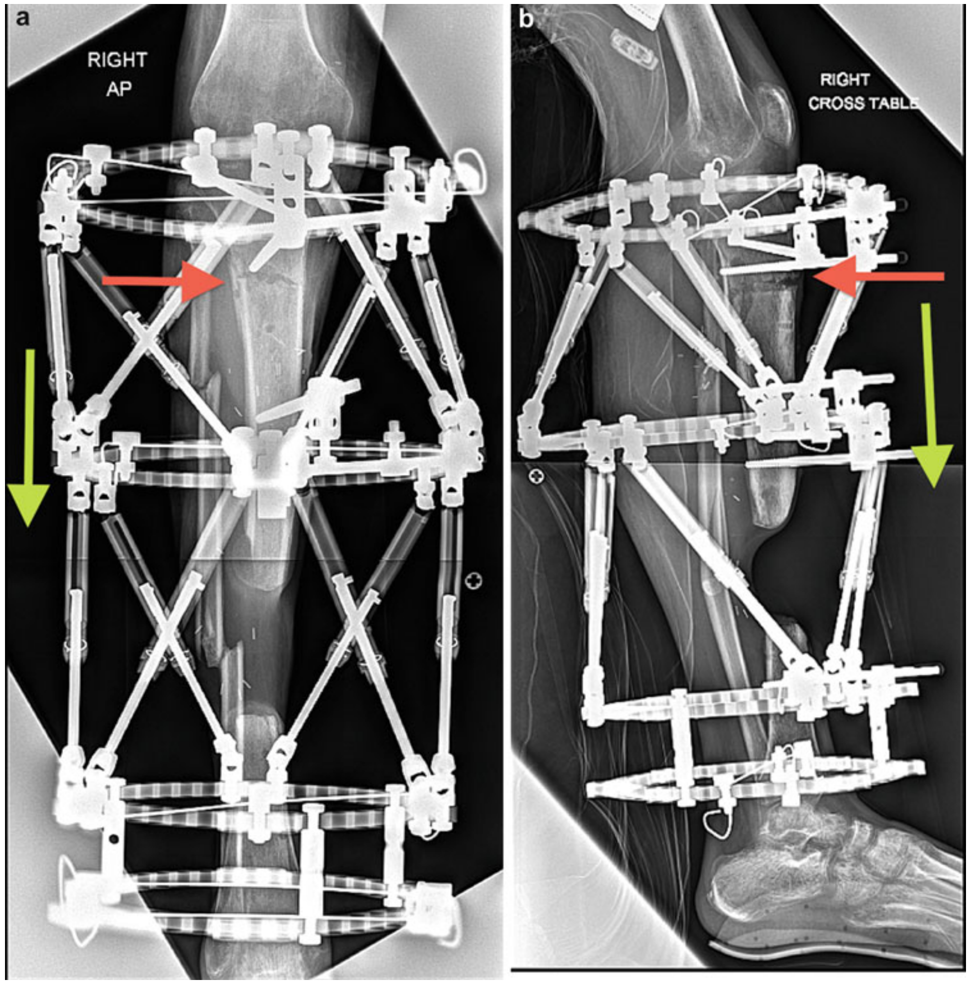


**Fig. 3** Immediate post-operative (**a**) AP and (**b**) lateral X-ray of the right tibia after removal of trauma external fixator and application of three-level Taylor Spatial Frame (*TSF*). *Red arrow* demonstrates the proximal tibial osteoplasty, performed percutaneously with a 4.8 mm drill bit and a 7 mm osteotome. *Green arrow* demonstrates direction of transport segment

5. Foot drop
6. Toe contractures
7. Status post, spanning knee and ankle frame right lower extremity

## 4 Treatment Strategy

Our limb reconstruction treatment strategy was aimed at treating the bone defect with a bifocal bone transport using a 2-level stacked Taylor Spatial Frame. The soft tissue invagination into the defect was to be managed without a formal elevation. Instead we anticipated that the transporting bone segment into the defect would expand the soft tissue, and the pliability and slow transport rate would accommodate elevation without skin breakdown. This requires bimonthly monitoring in the clinic during treatment. The plan entailed a formal elevation of the soft tissue flap and bone grafting of the docking site with the help of a plastic and reconstruction surgeon. A manipulation under anesthesia of the knee and ankle and flexor tenotomies of the toes were performed at the index surgery. The ankle joint was not spanned; ambulation during treatment was encouraged.

## 5 Basic Principles

1. Place proximal and distal rings perpendicular to their respective mechanical axes.
2. Measure and plan the distance between most distal ring block and transport ring segment. When using the TSF, there is a minimal distal that the smallest struts can shorten. The XXS (extra extra short) TSF struts collapse

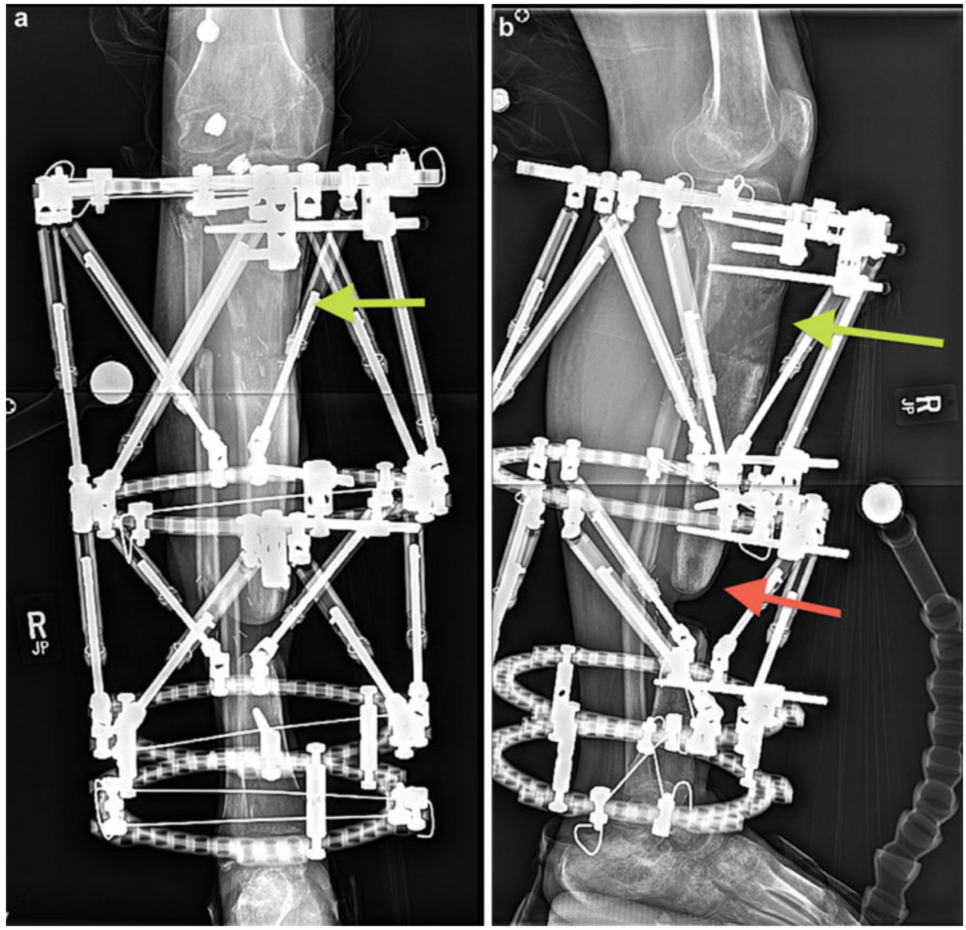


**Fig. 4** (**a**) AP and (**b**) lateral X-ray of the right tibia during the distraction phase (*green arrow*). The TSF allows for new residual programs to ensure appropriate sagittal, coronal, and axial alignments. Note the leading edge of the transport segment elevating the soft tissue flap out of the defect (*red arrow*)

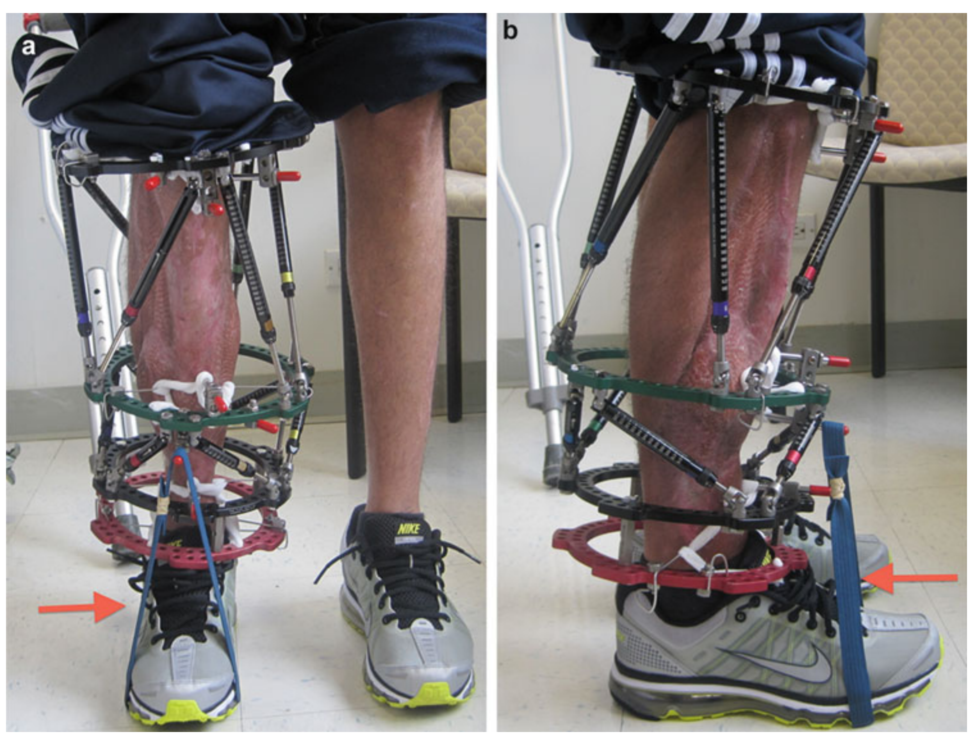


**Fig. 5** (**a**) Front and (**a**) side views of the patient during the consolidation phase. The patient suffered a foot drop at the time of injury, and because of this, he wore a strap from his forefoot to the tibial half-pin site to ensure he maintained a neutral ankle position (*red arrow*). Ambulation during treatment also helped maintain a plantigrade foot

to 59 mm. Alternatively, Ilizarov rods can be mounted if additional compression is needed and the TSF strut cannot collapse further.

3. Carefully monitor the soft tissue during transport; a plastic surgeon should be involved early in treatment in the event earlier elevation of the flap is necessary.
4. Residual deformity during transport can be corrected with a new TSF program. Typical deformities that develop are procurvatum and valgus.
5. The stacked TSF enables maximal control of the transport. The proximal frame controls the lengthening and the distal frame controls the defect shortening. This precision will prevent bone deformity and optimal contact at the docking site.
6. When the fibula is intact, the shortening and the lengthening of the distal and proximal frames, respectively, must move at the same rate maintaining the limb length. If the fibula is not intact or has been excised, the defect shortening can progress at a faster rate with the advantage of earlier docking.

## 6 Images During Treatment

See Figs. 3, 4, 5, and 6.

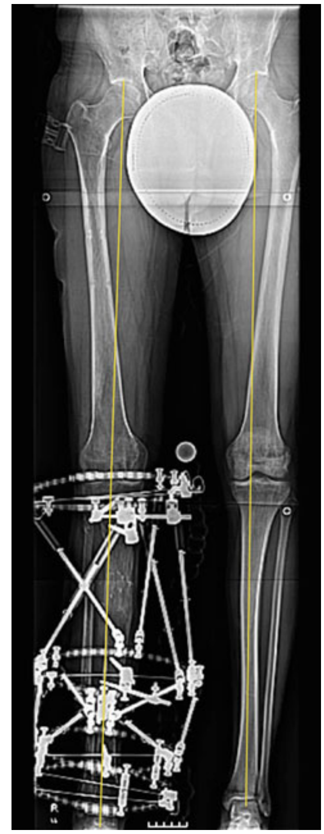

**Fig. 6** Standing 51" erect leg X-ray. Completion of bone lengthening, RLE direct measurement 885 mm, LLE direct measurement 889 mm. Mechanical axis deviation (*MAD*) RLE 0, MAD LLE 4 medial (*yellow lines*)


**Fig. 7** (**a**) AP and (**b**) lateral X-rays of the right tibia 2 years post frame removal. MPTA measured 92°, PPTA 81°. Healed regenerate and docking site


**Fig. 8** Standing final clinical photos 2 years post frame removal. (**a**) Front and (**b**) side views demonstrate healed soft tissue lesion, maintenance of sagittal and coronal alignment. (**c**) View from the back demonstrating patient able to stand on toes

## 7 Technical Pearls

1. When greater than 8 cm of lengthening needed, strongly consider trifocal bone transport; this case was less than 8 cm (6.8 cm); therefore, bifocal transport was performed.
2. Assess and manage ipsilateral adjacent joint contractures at the beginning of treatment.
3. If transporting bone segments are too small for TSF struts, utilize Ilizarov rods for short segments.

## 8 Outcome Clinical Photos and Radiographs

See Figs. 7 and 8.

## 9 Avoiding and Managing Problems

1. Bone grafting at the docking site was planned with the assistance of plastic surgery to elevate the flap. The wound was unable to be closed primarily so intentional deformation of the leg was performed. This allowed the wound to heal and a new residual TSF program was generated. Debridement of the docking site tibial bone ends with opening of the IM canals should be done prior to docking.
2. A docking site nonunion developed. This was treated with fibular osteotomy, compression through the TSF, and injection of bone marrow aspirate concentrate from the ipsilateral iliac crest.

## 10 Cross-References

▶ Case 10: Infected Nonunion of the Tibia
▶ Case 29: Infected Nonunion Tibia with Bone and Soft-Tissue Defect: Treatment with TSF, Intentional Temporary Deformation and Bone Transport

## References and Suggested Reading

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