

Case Study: Charlotte

Complex Lower Limb Deformity

Age Range During Treatment: 14 years to 16 years

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BACKGROUND

Charlotte has been my patient since she was three years old. Over the years, I've collaborated with other medical professionals to treat her for various issues with her right leg.

Her issues began with a hemangioma that involved her entire right tibia. The hemangioma damaged her knee, ankle, and foot joints in addition to her growth plates which inhibited the growth of new bone. After several minimally invasive procedures, the hemangioma was finally stabilized when she was eight years old.

At the age of 11, Charlotte underwent osteotomies and plates were put in place to treat rotational and angular deformities that had developed in her leg and foot.

Charlotte later suffered fractures in her fibula and tibia and the rods from the osteotomies had to be removed because the hemangioma had caused her bones to shift out of position and the rods to protrude causing pain.

Delayed bone growth caused by the hemangioma resulted in a large limb length discrepancy (over three inches). At the age of 13, we discussed the option of surgically correcting her limb length discrepancy and deformity with a Taylor Spatial Frame.

TREATMENT

Surgery #1

Removal of Lock Plate from the Proximal Tibia

An incision was made over the proximal tibia at which point the lock plate was found and the plate along with all screws were removed.

Removal of Intramedullary (IM) Rod from Tibia

The IM rod was located within the tibia but could not be easily removed. A surgical drill was used to cut the IM nail and to saw the rod into pieces that could be more easily removed in parts.

Proximal & Distal Tibia Deformity Correction & Lengthening w/ Application of Taylor Spatial Frame

A Taylor Spatial Frame was applied in a bifocal manner with three rings and six struts. The tibia was noted to be quite small and abnormal due to distal deformities that caused the bone to bend outwards (valgus) and inwards (varus) along with a severe proximal deformity where her knee bent backwards (recurvatum). In a rather complicated procedure, osteotomies were performed both proximally and distally as I tried to achieve approximately 5cm (2in) of increased length.



Charlotte in the hospital after having her Taylor Spatial Frame applied.

Post Op

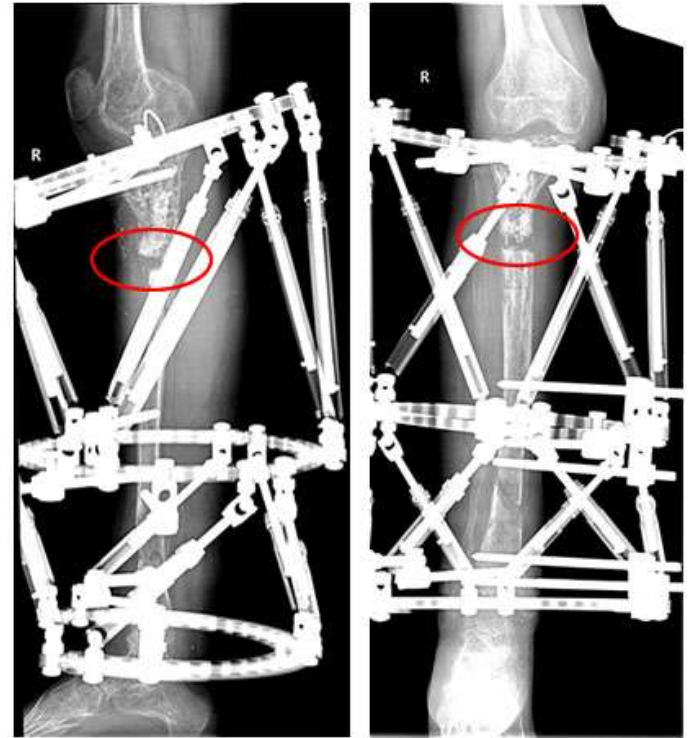
Charlotte was given schedules for adjusting the struts of the frame to create space and allow the bone to grow.



Charlotte's mom inspects her Taylor Spatial Frame.

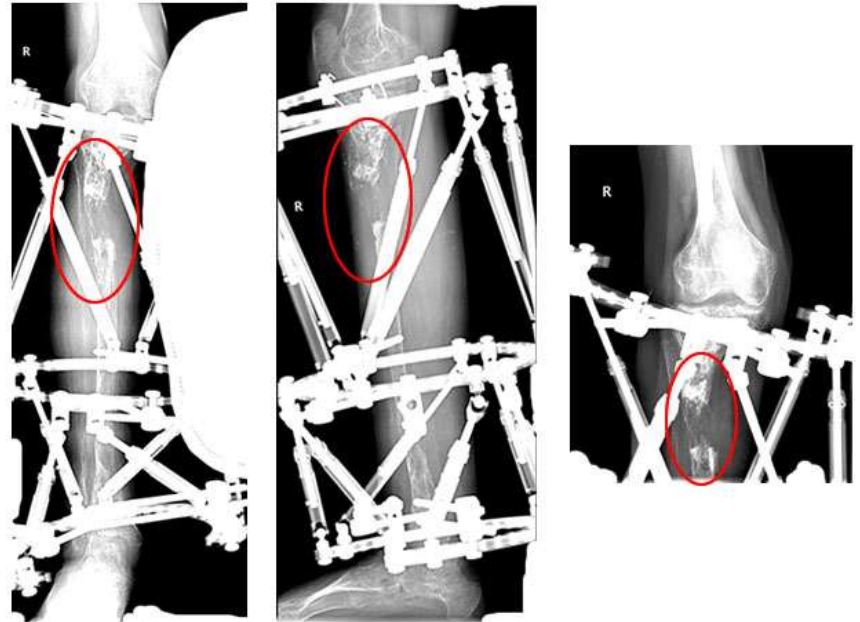
Observations

Two weeks after surgery, her sutures were removed and all pin sites were found to be clean. A week later, there was good range of motion in her knee and foot. X-rays revealed the tibia was lengthening well and in proper alignment.



Over the next few weeks, various struts in the upper and lower frames were changed to accommodate the new length of the limb.

Four months after surgery, the regenerated bone at the distal tibia osteotomy site appeared to have healed. However, the union of the regenerated bone at the proximal tibia osteotomy site was delayed. Plans were made to remove the distal frame and inject the proximal tibia site with bone marrow to promote bone growth.



Surgery #2

Injection of Bone Marrow Aspirate, Demineralized Bone Matrix into Delayed Union of Lengthening

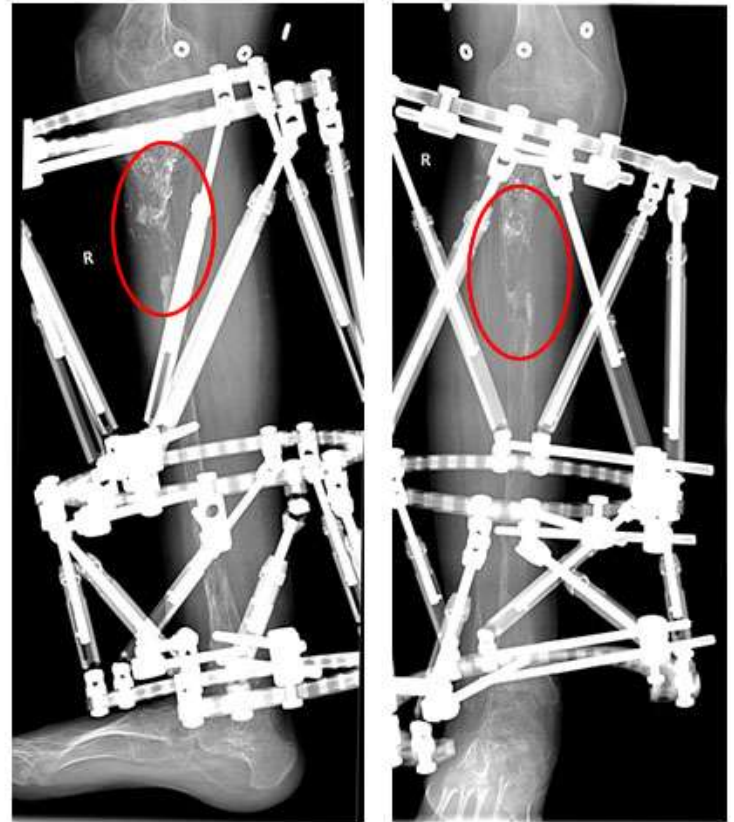
A few struts were removed from the distal frame to allow for examination of the osteotomy site to determine if it had healed. A Jamshidi needle was used to draw 20cc of bone marrow from the right iliac crest. The bone marrow was then mixed with demineralized bone matrix and dye (Hypaque). 16cc of the bone marrow mixture was injected into the proximal delayed nonunion site and 2cc were injected into the distal site.

Removal of Wire From Proximal Tibia

The entire frame was left in place but some of the transfixion wires were removed from the proximal tibia.

Observations

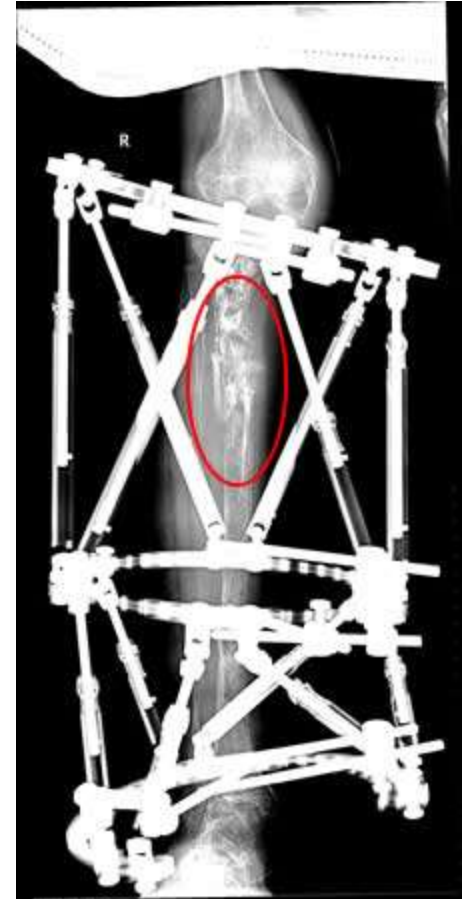
Two months after surgery, x-rays revealed insufficient bone formation. It was decided that a bone graft would be performed.



Surgery #3

Iliac Crest Graft & Infusion of Bone Morphogenetic Protein (BMP7)

The distal tibia osteotomy site was tested and noted to be moving, indicating there was still a nonunion. An incision was made over the posterior iliac spine and a graft was taken from the iliac crest. Another incision was made over the nonunion distal site, the nonunion tissue and bone was debrided, and the iliac crest graft and BMP 7 were applied to the area. This procedure was repeated at the proximal nonunion site.



Observations

Charlotte made one emergency visit to the office due to swelling in her right knee. The combination of having her leg extending for a long period of time while being fitted for a new brace and then extensive walking around school placed a lot of stress on her knee which resulted in swelling. However, there was no need for intervention beyond elevating and icing the leg while at rest.

Surgery #4

Hardware Removal

A check was performed to ensure that there was continuity of the bone within the tibia. The Taylor Spatial Frame was then removed, all pin sites were debrided, and Charlotte's leg was placed in a short-leg cast. The bone was thin but appeared intact and x-rays showed good positioning.

Observations

One month after surgery, x-rays showed no major changes from previous x-rays but a small area of buckling at the proximal tibia was of some concern. Charlotte's short leg casts were replaced with new waterproof casts and she was able to place full weight on the leg.

Surgery #5

Open Reduction Internal Fixation (ORIF) with William's Nail & Synthes Locking Plate

An incision was made over the nonunion and proximal tibia. The bone edges were aligned and a Williams rod and small plate were used to hold the previous area of nonunion in place.

Infuse at the Tibial Nonunion Site

BMP7 was used at the nonunion site to stimulate healing of the bone. Charlotte's leg was then placed in a bivalved long-leg cast.

Surgery #6

Change of Plaster & Manipulation Right Foot with Long Leg Casting

Charlotte was taken back into the operating room and her stitches and cast were removed. The wound was clean and completely healed with no signs of infection. The osteotomy, fracture, and nonunion sites appeared to be in good position and healing/strengthening. Dressings and a long leg cast were applied.

Observations

One week after surgery, Charlotte's leg cast was shortened to below her knee to allow for bearing weight on her right leg.

Four months after surgery, x-rays showed excellent bone formation in the tibia and that all hardware was in place. Plans were made for Charlotte to walk at home with her brace and no crutches and then without braces or crutches.

Five months after surgery, x-rays revealed excellent bone formation and a normal ankle. However, there was severe arthritis and a deformity in the subtalar joint which caused severe pain when the joint was moved.

It was decided that Charlotte would wear a Jobst stocking for support and continue physical therapy. Her foot would be reevaluated in six months at which point triple arthrodesis would be considered if there was no improvement.

Surgery #7



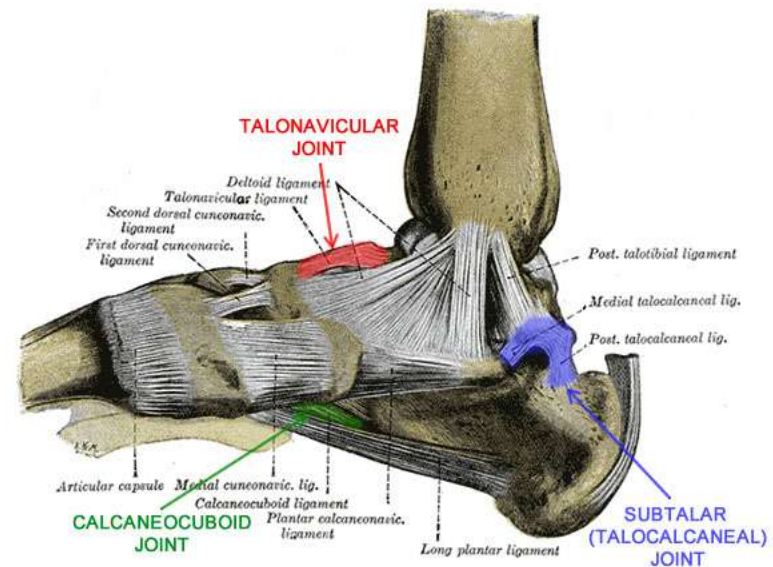
An x-ray of Charlotte's ankle five weeks before her seventh surgery.

Triple Arthrodesis of the Right Foot & Ankle Including the Subtalar, Calcaneocuboid, & Talonavicular Joints with Plates & Screws Utilized for Fixation

An incision was made over the joint between the ankle and heel (sinus tarsi) and clear liquid flowed from the wound as a result of a hemangioma on the foot; a tourniquet was applied. At this point, cartilage was stripped (denuded) from the medial and posterior facets of the joint (arthroplasty).

The talonavicular and calcaneocuboid joints were then opened with a closing wedge osteotomy on the talonavicular joint. An opening wedge osteotomy was performed at the calcaneocuboid joint. Arthroplasties were performed on all of the joints. Next, a plate was inserted into the talonavicular joint and screws were then applied to the calcaneocuboid joint. A bone transplant (allograft) was then applied to the calcaneocuboid joint and held in place with a plate and screws. Good fixation was achieved and Charlotte's foot and all hardware were in proper position.

The wound was closed and dressed, the tourniquet was removed, an ankle block was put in place, and a bivalved short-cast was applied.



Surgery #8

Change of Plaster & Removal of Sutures

All wounds were found to be dry and clean and sutures were removed. Dry sterile dressings were applied and short-leg casts were reapplied.

CONCLUSION



Charlotte is doing well overall and is actively involved with sports. I've recommended a 1cm shoe lift for better balance and symmetry in addition to ongoing physical therapy for strengthening which will allow her to eventually walk without her crutch. While it's possible that Charlotte's lower right limb may never be as strong as her left, treatment has allowed her to avoid the need for an above knee amputation and prosthesis. This case is an example of multiple complex factors requiring an extended course of treatment that is now concluding with a well functioning limb.

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