Multidirectional Deformity of the Tibia
Multidirectional

- When the deformity is present in two planes—visible on both AP & LAT xrays or when there is additional Rotational deformity or shortening.
Post-traumatic Physeal Arrest

Varus 10° Recurvatum=26° Shortening 7 cm
Proximal Tibial osteotomy for 5 cm length & correction

Distal Tibial osteotomy for 2 cm length. Fibula is lengthened at two locations.
Mech Axis Normal, Lengths equal. Full function.

Can participate in contact sports like Kick Boxing
Varus Recurvatum
Internal Rotation Shortening

After childhood growth arrest due to Osteomyelitis
Gradual Correction

First we start with Length, then gradually correct Angulation, and finally correct the Rotation at the very end.
After angulation is corrected and length is fully achieved

Empty parallel ring added for derotation
Limb Lengths & Alignment Equal

Function is full!
Physeal Arrest with bowing deformity in both Tibiae
The femur is in 20º varus
She has 3 cm shortening on left Tibia with varus and internal rotation deformity. There is varus deformity in opposite tibia as well.
We performed Varus deformity correction in the femur using a FAN technique with distal entry of the nail. She had a lengthening, varus and Internal rotation correction in the tibia with external fixation. Mechanical axis is perfectly corrected.
Finally what remained to correct was only a mild varus deformity in the Right tibia which was easily done using ilizarov external fixation. The tibia tolerates external fixation relatively easily. The Femur however benefits the most from FAN method. NJ has perfect alignment in both her legs now and can wear pretty skirts to college!
SS had lengthening for short stature and developed a severe valgus and antecurvation deformity in his Right Tibia—Lengthening Malunion.
We draw the outline of the Right foot (looking down from the top) Trace the outline of a 150mm ring with holes. Tibia is drawn in x-section. 14 and 26° of deformity are drawn as lines and the plane of the deformity (red) is drawn. Towards convexity the motor rod will be placed. Orthogonal to that (white) line represents the placement of hinges for correction of deformity.
A simple and practical method can also be employed, wherein we Position the rings exactly at right angles to each fragment in both the AP and LAT planes. After an appropriately placed osteotomy when the rings are made parallel with connecting rods, the deformity will get completely corrected.
The deformity is completely corrected in both AP & LAT planes.
Taylor’s Spatial Frame

- 6–Axis Deformity Correction—uses 6 calibrated telescoping struts

- Software control!
A typical frame has two Full rings made from Aluminium. It has projecting tabs at 60° intervals, where the struts attach. You may liken it to an Ilizarov device with TurboChargers!
A close look reveals varus, antecurvation, medial and posterior displacement of the distal fragment as well as a shortening of 3 cm.
The software program allows us to enter frame dimensions, deformity parameters as well as enter data which will orient the software to position of the bone fragments.
Gradual lengthening, correction of angulation as well as translation is seen in progress.
Fully corrected limb. MS was able to attend to his business during the entire treatment, riding a car as well as a 2 wheeler. He removed his fixator himself! The Ilizarov or TSF can be painless!
Complete correction of all deformities and length!
NB had a Cosmetic Limb lengthening procedure in England. She started with her left femur and tibia which unfortunately resulted in valgus and procurvatum deformities.
She has 14° of valgus in the tibia with 10° of antecurvation. There is similarly a valgus and antecurvature deformity in the Femur as well.
Using Trignometric formulae, we calculated the plane of the deformity in the Tibia and positioned the patient accurately. Xray on the Left shows the maximum deformity of 18º valgus and exactly at right angles which shows an xray with no deformity at all.
Graphic Method of Planning

The red line with dots shows the plane of the deformity. At right angles to this red line (with dots), on outline of the Tibia we can decide where to position our hinges in the plane of correction. If we wanted to straighten the limb the topmost white line would give us the result. NB wanted to shorten the limb so hinges were placed in the concavity (Shortening hinge).
We need to decide how much of the bone to resect at the convex cortex and also at the concave cortex to be able to achieve perfect amount of resultant length in the centre of the tibia. The formula used is that for the chord of a circle. Here $r$ (radius) is length from cortex to structure at risk which is usually the lat popliteal nerve.

Radius = Location of structure at risk

Chord length = 

$$2\pi a/360$$

$$= \frac{r \alpha}{57}$$
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Very accurately corrected Tibia are seen.
NB wanted her left tibia to become straight as well as be exactly 18 mm longer than the other side. The two xrays show full correction as well as the Right Scanogram shows L tibia exactly 18 mm longer.
Femur also has a valgus, lateral translation and antecurvation deformity.
These are Oblique plane xrays. On the left the xray shows the maximum deformity of 15.3º. At right angles to that plane (in the plane of the deformity), the xray reveals no deformity at all.
Graphic Method of Planning

Graph shows lines showing 14º valgus (apex medial) and 7º procurvatum (apex anterior). These two lines are converted into a rectangle. The diagonal line (when extended to the ring) represents the plane of the deformity. Orthogonal to that is the red line drawn in the concavity which shows hinge positioning for shortening (removal of a wedge with lesser bone from concave cortex).
Femur shows accurate correction in AP and lat Planes with no deformity at all.
Perfectly straight Left lower limb which is only 18 mm longer as desired by NB. Finally she wanted her left tibia lengthened by 18 mm to successfully conclude her cosmetic lengthening project. She went back to England very happy.
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