DISTRACTION

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Taylor Spatial Frame Disorients Ilizarovians

J. Charles Taylor, in an intellectual *coup de grace*, left Ilizarov surgeons amazed and awestruck as he unveiled his three dimensional "Spatial Frame" in Cancun and Houston this past year. Based on his earliler four-bar linkage concepts first described in the pages of *Techniques in Orthopaedics*, Dr. Taylor's Spatial Frame is an external fixator that consists of two rings connected to each other by six telescoping linkage rods. By altering the length of the rods, the relationship between the rings in three dimension space can be varied in a precise and reproducible manner. In this way, bone fragments attached to the rings can be moved through space to correct displacements of angulation, translation and rotation simultaneously. A hand-held computer is used to analyze the starting and ending position of the rings, and provide information about the necessary adjustments in the linkage rods required to change the relative position of the rings with respect to each other, thereby reducing the osseous fragments attached to them.

Dr. Taylor's handout from the Cancun Advanced Ilizarov Course is reproduced in this issue of *DISTRACTION.*

A New Look at Deformity Correction

by J. Charles Taylor, M.D.

Abstract

The Taylor Spatial Frame, a unique external fixation system, can treat a variety of fractures, nonunions, and malunions. In conjunction with a software program, the Spatial Frame can correct the simplest to the most complex skeletal deformity utilizing the same frame. Three primary methods of correction may be utilized: 1) acute fractures may be stabilized with the Spatial Frame using traditional methods; 2) rings may be attached to each fragment prior to strut attachments, for fractures or chronic deformities; 3) a frame may be adjusted to exactly mimic a deformity prior to mounting. In all cases, fragments may be further reduced after frame application by adjustment of strut lengths only.

Introduction

The Ilizarov system utilizes hinge and translation mechanisms which are specifically oriented for a given case. Complex deformities are addressed by frames which include hinge (rotation) and translation mechanisms in series or stages.

The Taylor Spatial Frame fixator consists of two rings or partial rings connected by 6 telescopic struts at special universal joints. (See figure below) By adjusting only strut lengths, one ring can be repositioned with respect to the other. 'Simple' or complex deformities are treated with the same frame. The multiple angles and translations of a given deformity are addressed by adjusting lengths of struts only. The Taylor Spatial Frame fixator is capable of correcting a six axes deformity.

The Taylor Spatial Frame fixator consists of two rings or partial rings with six telescopic struts attached at special universal joints. The universal joints are passive and do not require clamping.

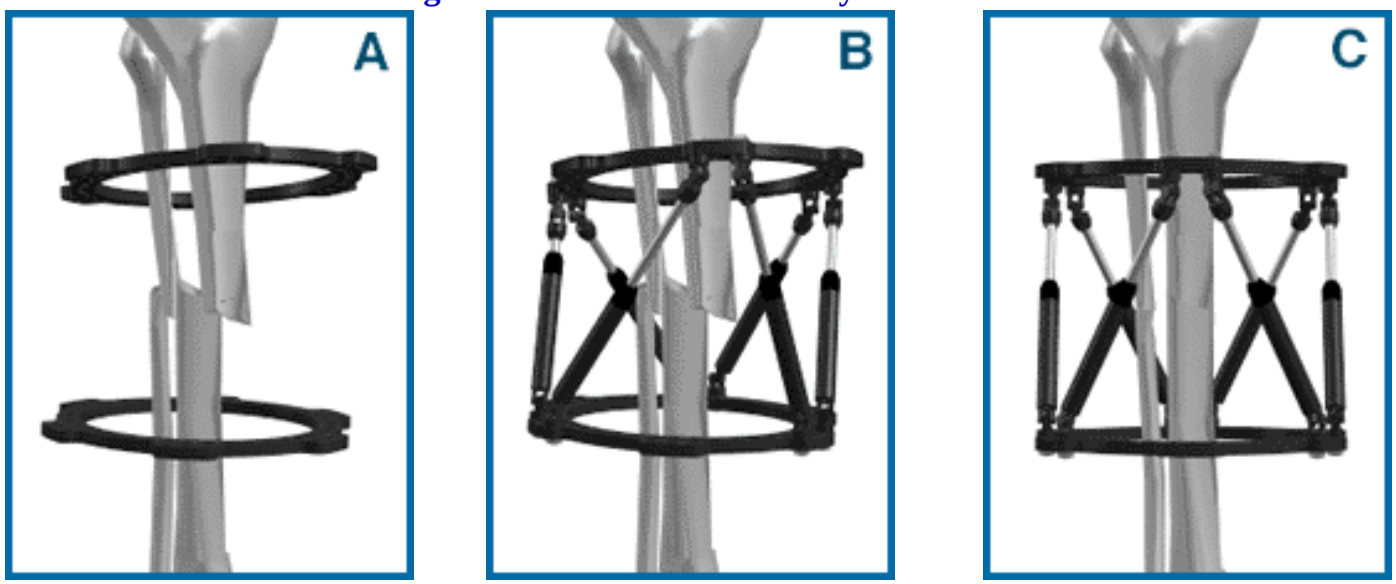
Strut lengths are changed by rotating an adjustment knob. These strut lengths may be read directly off each strut. From an initial 'neutral' position struts may be lengthened or shortened as necessary.

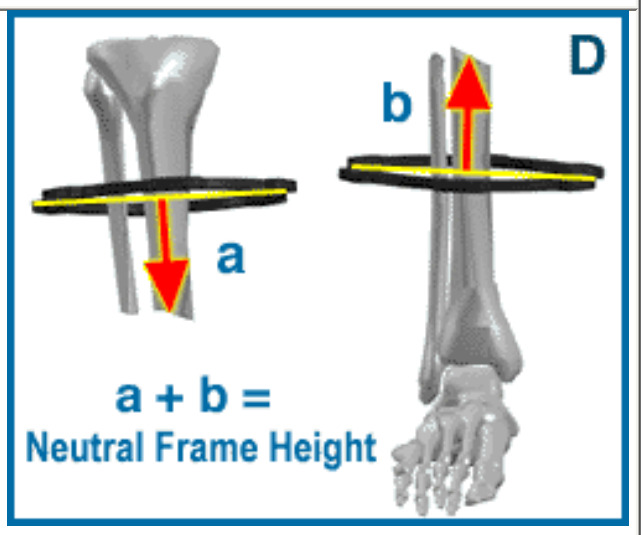
Deformity Correction

Acute fractures can be reduced with conventional technique using the Taylor Spatial Frame applied in its neutral state, adjusting fragments with olive wires, half-pins etc.

The Rings First Method of Deformity Correction, in which the rings are mounted to corresponding fragments first and struts are applied subsequently, may be applied to fractures or chronic deformities. After struts are applied, the fragments will be reduced as the struts are adjusted to their neutral or home length. (See below)

Rings First Method of Deformity Correction



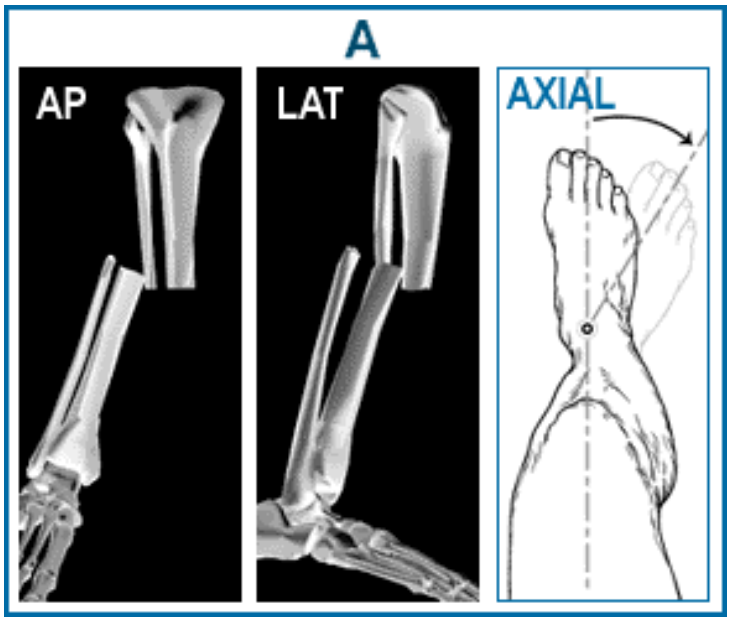


The Rings First Method may be applied to chronic deformities and acute fractures. A ring is attached orthogonal to each major fragment (A, above left). Six struts are attached between rings in the Spatial Frame configuration (B, above center). As the struts are returned to their neutral length, the fragments are reduced (C, above right). Neutral strut length is determined by measuring the distance from a ring to the interior end of its fragment for each fragment. The sum of these distances is by definition the neutral frame height (D, right). Knowing the neutral frame height, the neutral strut length can easily be determined with the software or table.

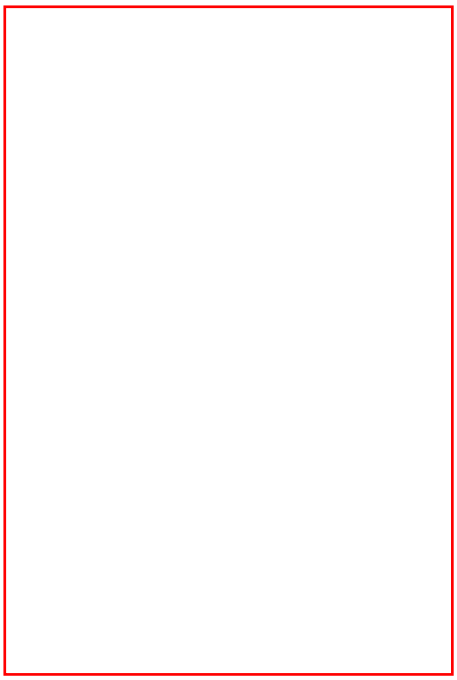
Chronic Deformity applies to congenital deformity, malunions, and stiff nonunions that can be measured fairly accurately by radiographs. The deformity should not

change on a minute to minute basis, but allow accurate orthogonal radiographs to be taken. Based on these radiographs and a clinical exam, a Spatial frame can be adjusted from its neutral or home position (at which all struts are equal length) to a deformed position that exactly matches the skeletal deformity. The Spatial Frame is then fixed to the skeleton. As the frame is returned to its neutral or home position, the fragments are restored to their anatomic positions. This process is called Chronic Deformity Correction. (See below)

Chronic Deformity Correction

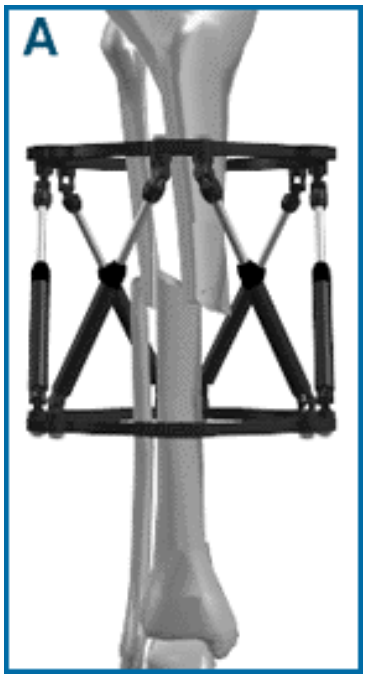


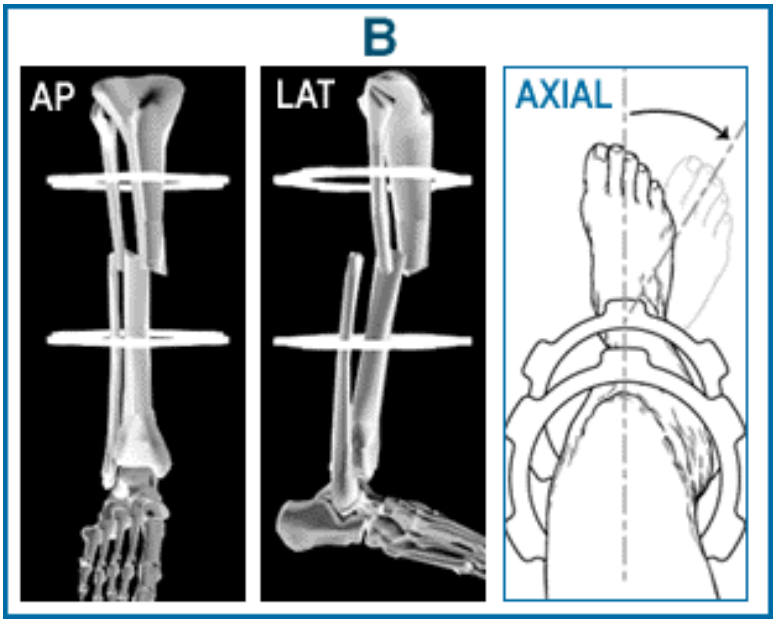
Chronic Deformity - For deformity correction, the surgeon measures AP and lateral radiographs and performs a clinical exam which yield the six deformity parameters (A, left). Clinical exam determines which ring diameters to use and whether longer or shorter struts are required - the three frame parameters. The surgeon anticipates the position of the frame with respect to the origin (usually the interior end of the reference fragment), thus providing the four mounting parameters. These 13 parameters are input to a Chronic Deformity Correction Program which returns 6 specific strut lengths to adjust the Taylor Spatial Frame fixator to exactly mimic the deformity (B, below left). The frame is then attached to the skeleton. The deformity will be fully corrected when the struts are restored to their neutral length (C, below).

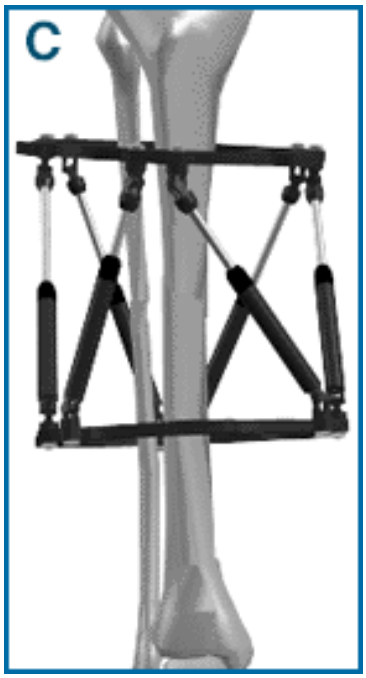


A second type of deformity is Residual Deformity. This applies to any situation with persistent skeletal deformity in a Spatial Frame in a neutral position. This may occur because of incomplete reduction of fractures, inaccurate initial assessment of chronic deformity, or excessive load on pins or wires. Based on AP and Lateral radiographs and a clinical exam for rotation, the Spatial Frame can be adjusted from its neutral position to a deformed position to compensate and therefore correct the skeletal deformity. This process is called Residual Deformity Correction. (See below)

Residual Deformity Correction







For standard acute fracture treatment, the surgeon applies an appropriately sized frame with the struts at neutral length - frame parameters (A, left top). Utilize standard reduction techniques as the neutral frame is applied. Postoperatively, AP and lateral radiographs are obtained and a clinical exam is performed (B, above). From these radiographs the six fracture deformity parameters and the four mounting parameters are measured. These 13 parameters are input to a Residual Deformity Correction Program which returns 6 specific strut lengths to adjust the Spatial Frame to exactly mirror the deformity. The deformity will be fully corrected when the struts are moved to their specified lengths (C, left).

Residual deformity correction may be used to further improve a chronic deformity correction or the rings first method.

Like the Ilizarov, the Taylor Spatial Frame fixator may be used to lengthen or shorten a limb by adjusting all struts the same increment. Unlike the Ilizarov, there is no preload on the frame as adjustments to the struts are made. Since the universal joints are free to rotate, any combination of six strut lengths is a valid frame.

Regardless of the complexity of the case, essentially the same Taylor Spatial Frame fixator is used. In this case of juxtaarticular deformity, a Taylor Spatial Frame can accomplish the same rotation and translation as Ilizarov frames.

Summary

The Taylor Spatial Frame fixator can be used for correction of chronic deformity by adjusting the frame to mimic the deformity before mounting. Residual deformity of fractures stabilized with a neutral Spatial Frame can be corrected by adjusting the frame to mirror measured deformity. The rings first method is an alternative for chronic deformities as well as fractures.

By changing strut lengths only, the Taylor Spatial Frame fixator can be adjusted to mimic or mirror skeletal deformities.

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Editor: Stuart Green, MD

3801 Katella Ave. Suite 130
Los Alamitos, CA 90720

Tele: 310-430-3561
Fax: 310-431-8882
Email: sgreen@uci.edu

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