Biomechanical Comparison of Bone Stability Using Taylor Spatial Frame Struts and Classic Ilizarov Rods

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What was the question?
The Taylor Spatial Frame (TSF) offers significant advantages in complex deformity correction; however, the universal joints in the struts appear to allow more movement than traditional threaded rods. Thus we asked, how much movement do TSF universal joints allow and under what conditions is that movement greatest?

How did you answer the question?
We mounted TSFs on PVC pipe bone model and used a camera motion tracking system to monitor the movements of various frame components while applying axial loads to simulate walking. We varied two aspects of frame design: [1] the ring–ring connection (TSF struts, vs. traditional threaded rods, vs. rods with struts); and [2] bone segment relationship (compressed vs. neutral vs. distracted against a 250N vs. a 500N spring). We tracked the changes in position of the bone ends while applying 35N of compression.

What are the results?
There was a significant main effect of ring–ring connection ($F(2,115) = 12.20$, $p = .000$) on bone end movement. Frames built with just struts allowed the most bone end movement (M=–.180 mm 95% CI [–.192, –.165]). Frames built with either rods (M = –.132 mm 95% CI [–.147, –.117]) or rods and struts (M = –.138 mm 95% CI [–.153, –.123]) allowed less movement than those built with struts alone but were equivalent to one another. There was also a significant main effect of bone segment relationship ($F(3,115) = 121.17$, $p = .000$) on bone end movement. Compression allowed the least bone end movement (M = –.011 mm 95% CI [–.029, –.006]), followed by the distraction configurations (250N spring: M=–.192 mm 95% CI[–.210, –.174]; 500N spring: M = –.169 95% CI [–.186, –.152]), which were equivalent and allowed significantly less bone end movement than neutral setups (M = –.228 95% CI [–.245, –.211]). Finally the interaction between ring–ring connection and bone segment relationship was also a significant predictor ($F(6,115) = 6.95$, $p = .000$) of bone–bone movement: struts around a neutral bone (M = –.324 mm %95 CI [–.354, –.295]) were significantly less stable than the other 11 configurations.

What are your conclusions?
Compressed frames are very stable regardless of the ring–ring connection used. Likewise distracted frames are stable regardless of the ring–ring connection used. Neutral frames built with struts allow significantly more bone end movement than do neutral frames built with either threaded rods or rods and struts.