Journal of Foot and Ankle Research

BioMed Central

Keynote presentation

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Sailing charted seas: biomechanics and the orthopedic surgeon

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from 1st Congress of the International Foot & Ankle Biomechanics (i-FAB) community
Bologna, Italy. 4–6 September 2008

Published: 26 September 2008

Journal of Foot and Ankle Research 2008, **1**(Suppl 1):K2 doi:10.1186/1757-1146-1-S1-K2

This abstract is available from: http://www.jfootankleres.com/content/1/S1/K2

Introduction

Biomechanical models have been used to study the distribution of foot forces, metatarsal stresses, heel pad, arch height, plantar aponeurosis, subtalar joint, extrinsic muscles, medial displacement calcaneal osteotomy, subtalar arthroereisis and lateral column lengthening calcaneal osteotomy in the normal and flatfoot. We review past research data and discuss results as they relate to relevant clinical topics. [1-6]

Methods

A three dimensional multi-segment biomechanical model [7] was used with anatomical data from normal feet, feet made flat and corrected feet. The model includes a series of equations that describe how the foot deforms under a theoretical applied load of 683 Newtons (70 Kg.) on one foot in static stance phase

Results

Lateral Column Lengthening Calcaneal Osteotomy (LCL) decreases the forces needed by ligaments to resist moments at the medial arch joints by -79% and the talo-navicular Joint -63% in the flattened foot.

Conclusion

The model has accurately predicted the deformation of the foot under a theoretical load of 683 Newtons. We have analyzed the effect of various surgical procedures on the flatfoot. We discussed the clinical relevance of the model data to the ankle sprain, 5th metatarsal stress fracture, posterior tibial tendon insufficiency, the flatfoot and the cavus foot.

Table 1: Moments in Newton-meters (N-m)

Joint	Normal Nm	Flatfoot Nm	Flatfoot + LCL Nm
1st Metatarsal medial cuneiform	0.20	8.76	0.51
Medial – cuneiform navicular	0.33	14.48	0.84
Talo-navicular	5.61	**21.63**	**8.05** (-63%)
Calcaneal-cuboid	5.69	0.00	7.72

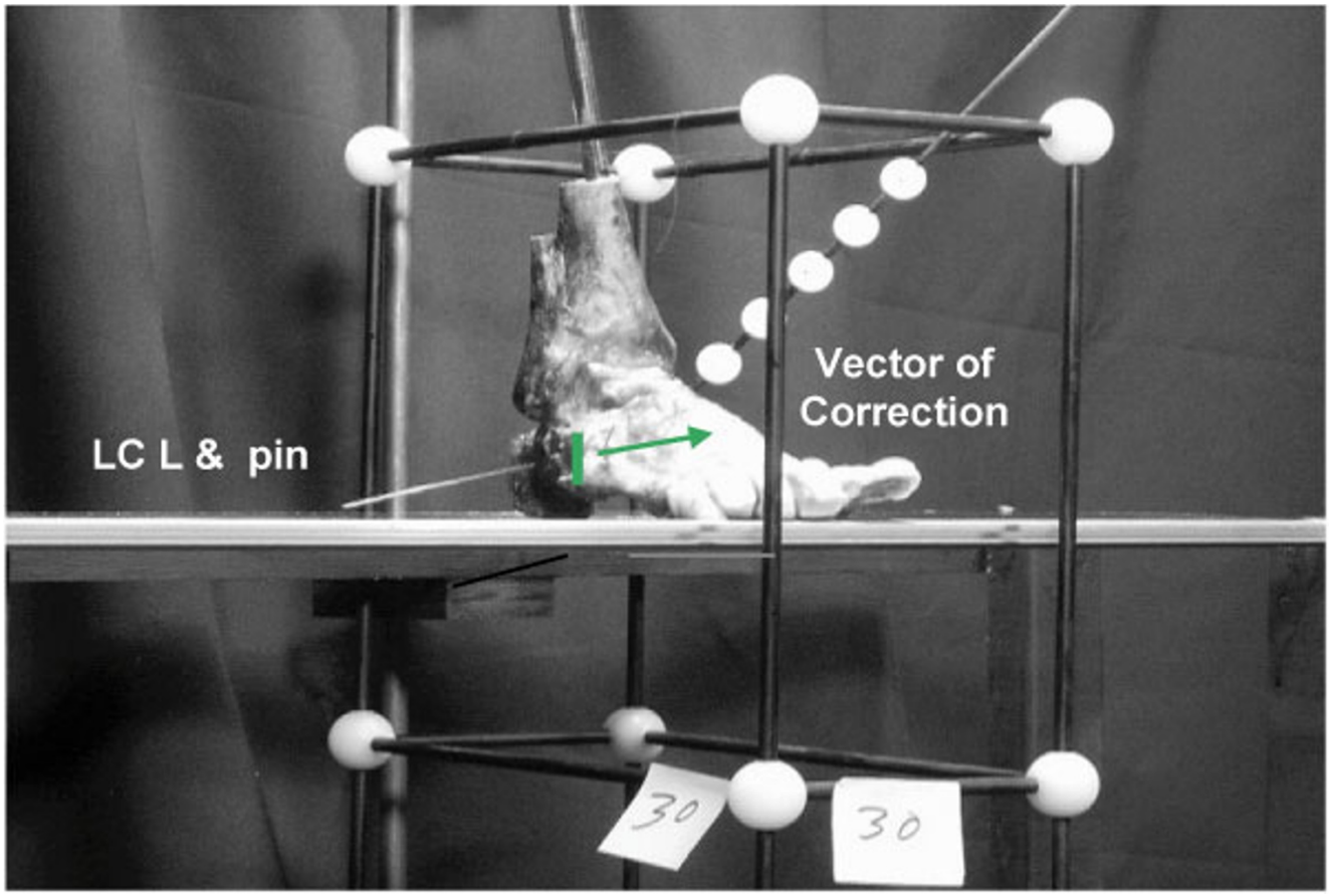

Figure 1
Cadaver Foot with calibrated cage and pointer for Direct Linear Transformation Photography illustrating LCL.

Acknowledgement
Eric P Salathe Sr. PhD.

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