A Repeatable Method for Joint Alignment of Disarticulated Human Knees

Zachary A. Pinkley, Kate B. Benfield, Trevor J. Lujan
Northwest Tissue Mechanics Laboratory
Boise State University

BOISE STATE UNIVERSITY

Introduction

- Inaccurate alignment of knee joints can increase kinematic errors 2-3 times[1]
- Misalignment can cause damage to the specimen during loading[3] **(Fig 1)**
- No current method to re-establish natural alignment of disarticulated knees

Challenge: How to relate local joint coordinate systems to clinical rotations and translations.[6]

Objective:
To define a method to repeatedly position disarticulated knees to their in-situ position using clinically significant rotations and translations.

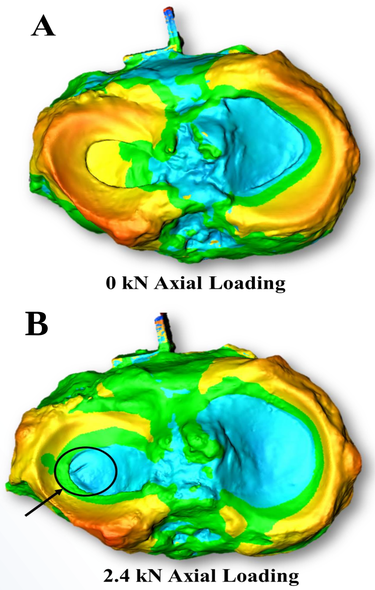

Fig. 1: 3D imaging of damage due to malalignment of disarticulated knee A) pre- and B) post 1 million cycles[3]

Methods

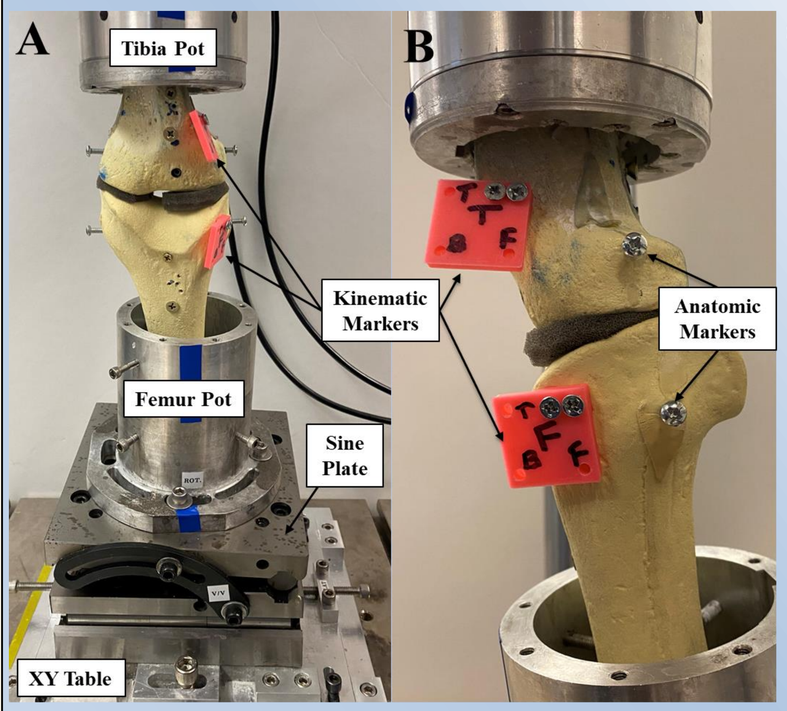

Fig. 2: Test methods. A) A Sawbones model was inserted in a knee motion simulator. B) Kinematic markers were used to digitize in-situ and final positions of the knee joint while anatomic markers were used to relate clinical rotations and translations. C) Flowchart of test procedure. In-situ kinematics were calculated, the joint disarticulated, and the kinematics re-established repeatability

Results

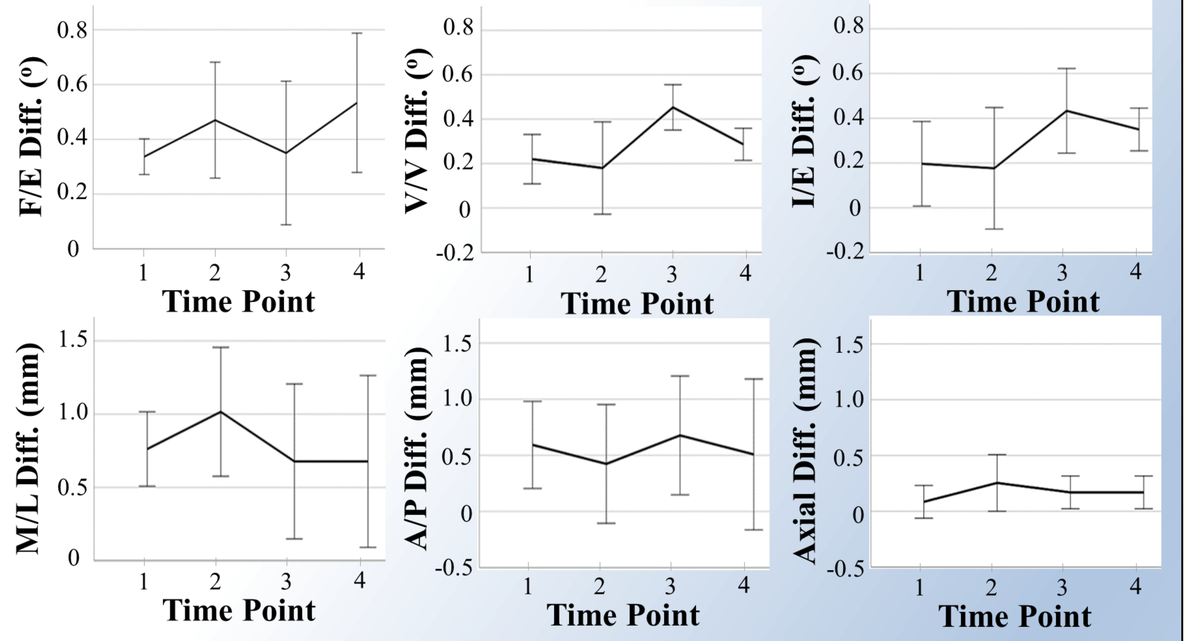

Fig. 3: Error in reproducing in-situ knee position (rotations and translations). Errors were less than 1° and 1.05 mm at all time points, with average differences of 0.33° and 0.50 mm

Discussion

- Accomplished using the clinically significant convention [6] to quantify in-situ position and guide joint positioning after disarticulation.
- First study to provide a method to re-establish in-situ joint alignment accurately and repeatedly for disarticulated knees.
- This method can be used to ensure that significant force concentrations due to malalignment are avoided.

Clinical Relevance:
By improving joint alignment, this study can help advance clinically impactful research in knee biomechanics and TKA technology.

Acknowledgements

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References

[1] MacWilliams et al, J Biom, 31, 1998. [2] Cherian et al, Curr Rev Muskel Med, 7, 2014. [3] Benfield, Thesis, 2020. [4] Goldsmith et al, Eng Phys, 36, 2014. [5] Luo et al, Knee, 11, 2004. [6] Grood et al. J Biom, 105, 1983. [7] Lujan et al, J Biom, 127, 2005.