

Precision of an automated volume-based CT radiostereometric analysis (CT-RSA) in a porcine cadaver

M. Acke¹, B. Keelson¹, L. H. W. Engseth^{3,5}, G. Van Gompel^{1,2}, F-D. Øhrn⁶, J. De Mey², A. Schulz^{3,4}, S. M. Röhrh^{3,5}, N. Buls^{1,2}

¹ Faculty of Medicine, Vrije Universiteit Brussel, Brussels, Belgium

² Radiology / Medical Physics, UZBrussel, Brussels, Belgium

³ Faculty of Medicine, University of Oslo, Oslo, Norway

⁴ Radiology, Oslo University Hospital, Oslo, Norway

⁵ Division for orthopaedic surgery, Oslo University Hospital, Oslo, Norway

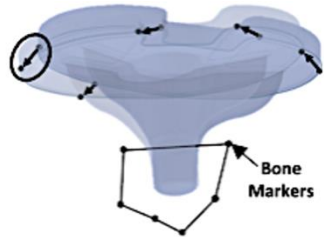
⁶ Department of Orthopaedics, Kristiansund Hospital, Norway

Purpose

To compare the performance of an automated volume-based CT-RSA and a time-consuming stepwise landmark-based CT-RSA method with existing marker-based RSA using a preclinical porcine model.

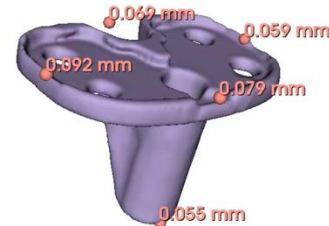
Marker-based RSAcore 4.2 (Oslo)

- 5 invasively placed tantalum beads



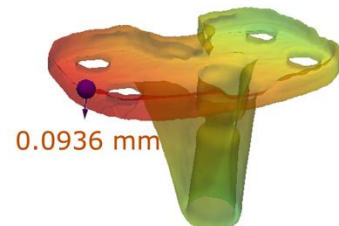
Stepwise landmark-based CT-RSA

- 5 manually placed virtual landmarks



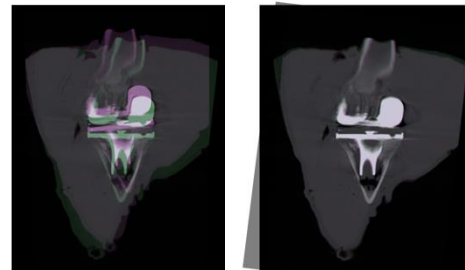
Automatic volume-based CT-RSA

- Entire volume



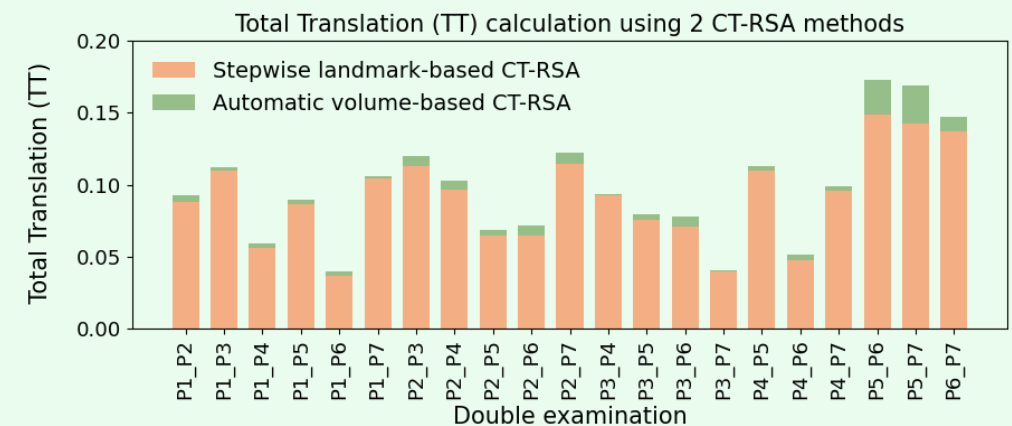
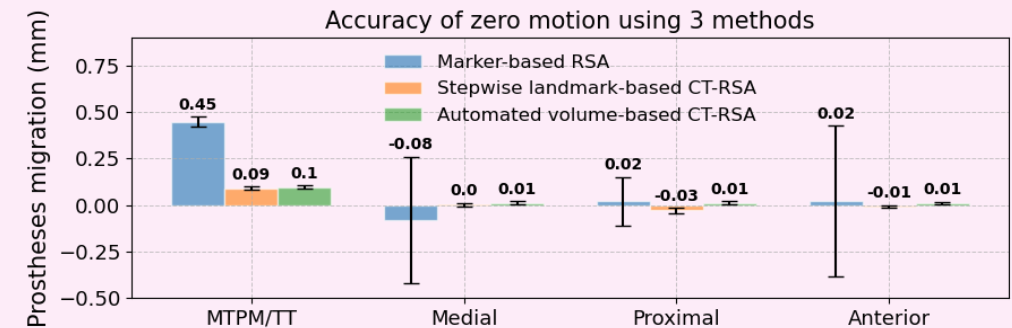
Material and Methods

1. Segmentation
2. Rigid pair-wise registration → T_{implant} & T_{tibia}
3. Total Translation (TT) calculation using T_{relative}
 - **Stepwise landmark-based CT-RSA**
 - TT for 5 virtual landmarks
 - **Automatic volume-based CT-RSA**
 - TT for entire volume + visualise heatmap and direction vector



$$T_{\text{relative}} = T_{\text{implant}} \times T_{\text{tibia}}^{-1}$$

Results



Conclusion

Both CT-RSA methods are more precise than marker-based RSA ($p < 0.001$). Volume-based CT-RSA automatically captures the **full motion of all implant surface points** without user intervention, while stepwise landmark-based CT-RSA tracks only the most displaced landmark.