AUCKLAND BIOENGINEERING INSTITUTE
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Te Whare Wānanga o Tāmaki Makaurau

Comparison and Refinement of Hip Joint Centre Prediction Methods on a Large Contemporary Population

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Hip joint centre (HJC) location is critical for accurate lower limb modelling. Methods by Tylkowski et al.[1], Bell et al.[2], and Seidel et al.[3] are used to predict the HJC from pelvic landmarks. Using a population of 159 CT-segmented pelvises, we assess the accuracy of these methods and refine their parameters.

Tylkowski et al. | Bell et al. | Seidel et al.

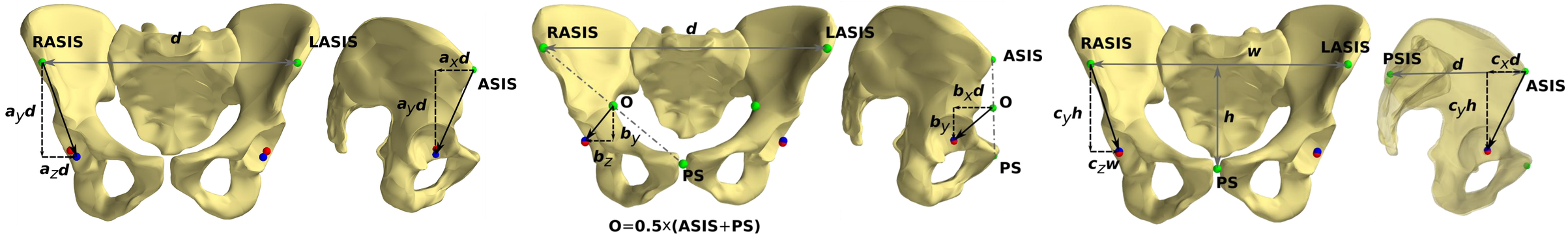

Figure 1: Three tested HJC prediction methods illustrated on a typical pelvis mesh. Green points show the required landmarks, blue points show the predicted HJC, red points show the gold truth HJC. Method parameters are values ***a***, ***b***, and ***c***.

METHODS

DATASET:

159 post-mortem CT scans collected at the VIFM*;
sex: 86 M, 73 F;
average age: 57±19;
western urban adult population.

LANDMARK MEASUREMENT:

1. An atlas mesh was customised to each segmentation[4].
2. Coordinates of landmarks in Fig.1 on each mesh recorded based on common atlas mesh coordinates.
3. Gold standard "mesh HJC" measured by fitting sphere to acetabulum of each mesh.

HJC PREDICTION:

1. Predict on all meshes using literature parameters.
2. Re-calculate parameters based on all mesh HJCs.
3. Predict on all meshes using new parameters.
4. Error calculated as Euclidean distance between predicted and mesh HJC.

RESULTS

Parameters	Lit. (adult/M/F)	New (adult/M/F)
a_x	0.22/0.22/0.22	0.15/0.14/0.16
a_y	0.30/0.31/0.29	0.36/0.35/0.37
a_z	0.14/0.14/0.15	0.14/0.15/0.13

Parameters	Lit. (adult/M/F)	New (adult/M/F)
b_x	0.22/0.22/0.22	0.15/0.14/0.16
b_y	41/46/37	33/34/32
b_z	16/17/15	29/28/31

Parameters	Lit. (adult/M/F)	New (adult/M/F)
c_x	0.34/0.34/0.34	0.24/0.23/0.24
c_y	0.79/0.79/0.79	0.89/0.89/0.88
c_z	0.14/0.14/0.14	0.12/0.13/0.11

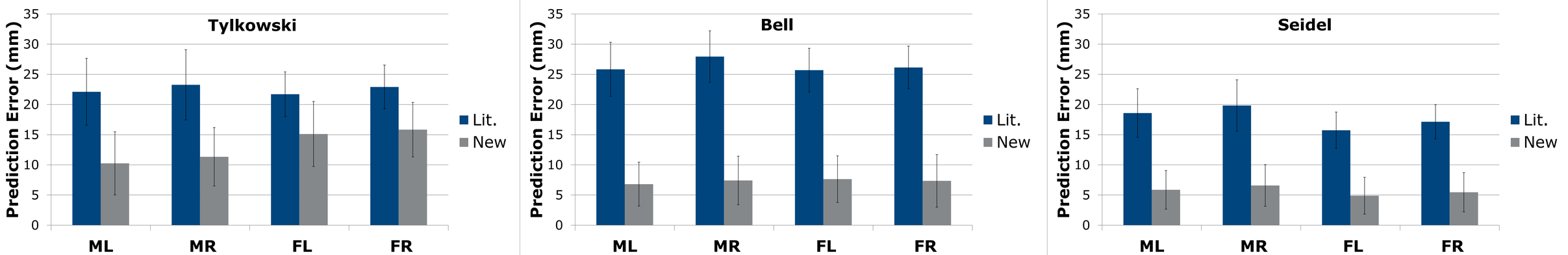

Figure 2: Prediction errors using literature (Lit.) and refitted (New) parameters, grouped by sex and side.

CONCLUSIONS

HJC prediction using new parameters improve significantly on previous works by up to 70%. For the Bell and Seidel methods, error has been reduced to below 1 cm, well below published levels. These results highlight the need to validate and re-calibrate joint centre prediction methods on large, representative datasets to account for natural morphological variations.

REFERENCES

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* Victorian Institute of Forensic Medicine. The authors acknowledge the generosity of the VIFM and its staff in providing the CT images.