Bwrdd Iechyd Prifysgol Betsi Cadwaladr University Health Board

King's College London

Quantitative Assessment of Custom Contoured Seating:

Can computational modelling be used to inform whether final custom contoured seat shapes meet the original intended postural goals?

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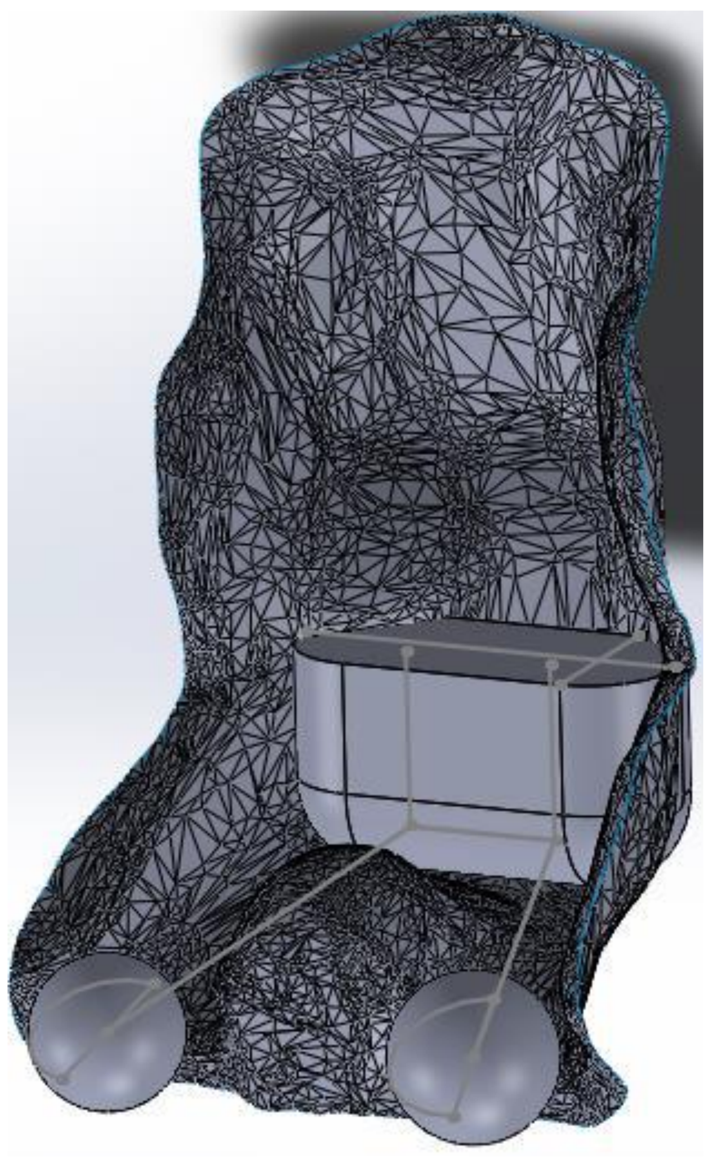
Need

The finished shape of the sitting surface is understood to be largely informed by the postural assessment, and yet the results of the postural assessment are not commonly re-considered after casting is complete. As a result, whilst there is plenty of anecdotal evidence for how to design a seat for a given posture, there is limited quantitative evidence to support this opinion. Hence, the motivation for this work was to develop a method to measure how a seat shape considered clinically appropriate by the clinician reflects the postural assessment, if at all.

Aim

"To develop a method to measure and quantitatively assess custom contoured seat shapes, to better understand the casting process and the shapes relationship to the postural assessment."

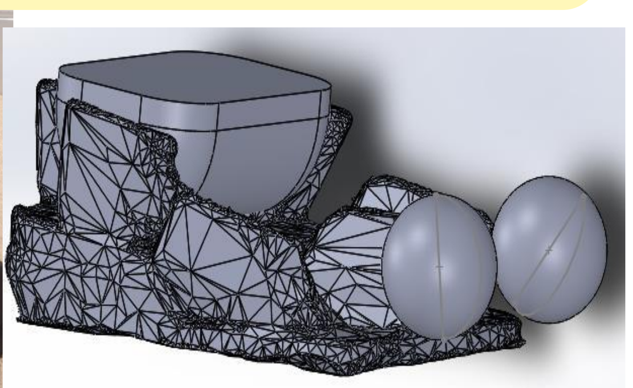


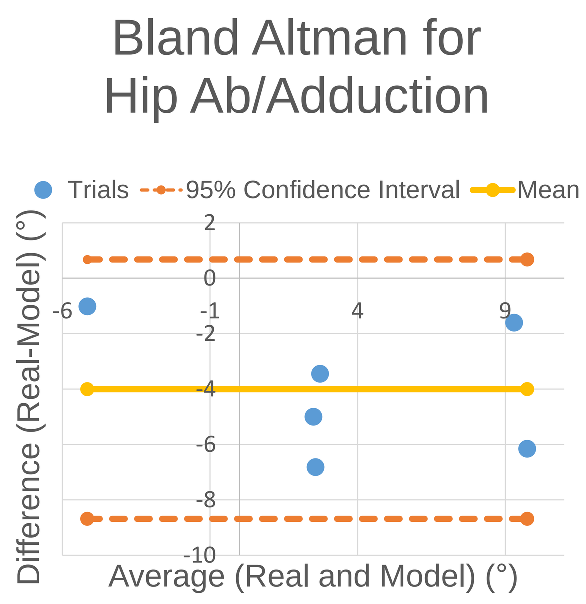
Model Development:

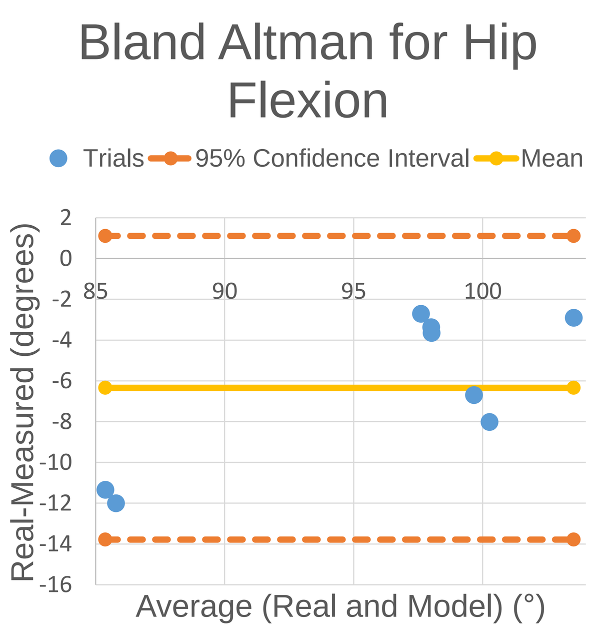
- Model developed using Artec 9 and Solidworks.
- Biomechanical model built from simple cylindrical shapes to represent the knee and pelvis.
- Knee and hip joint centres approximated using understanding of anatomy and Seidels regressions equations (Seidel, 1995).
- Model made unique to each seat shape based on measurements taken from the seat scan such as hip width and leg length.
- Angles of hip ab/adduction and hip flexion measured in degrees.

Verification

Four different modular seat cushion shapes were measured by hand and then the computational method was completed. The results were compared.



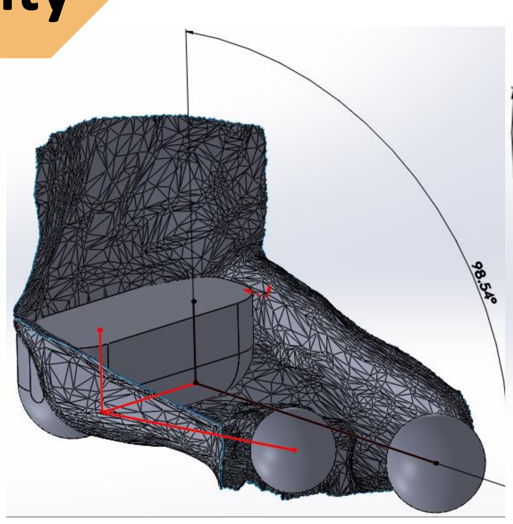


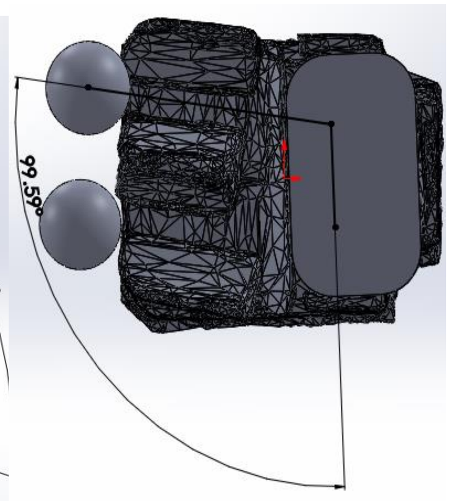


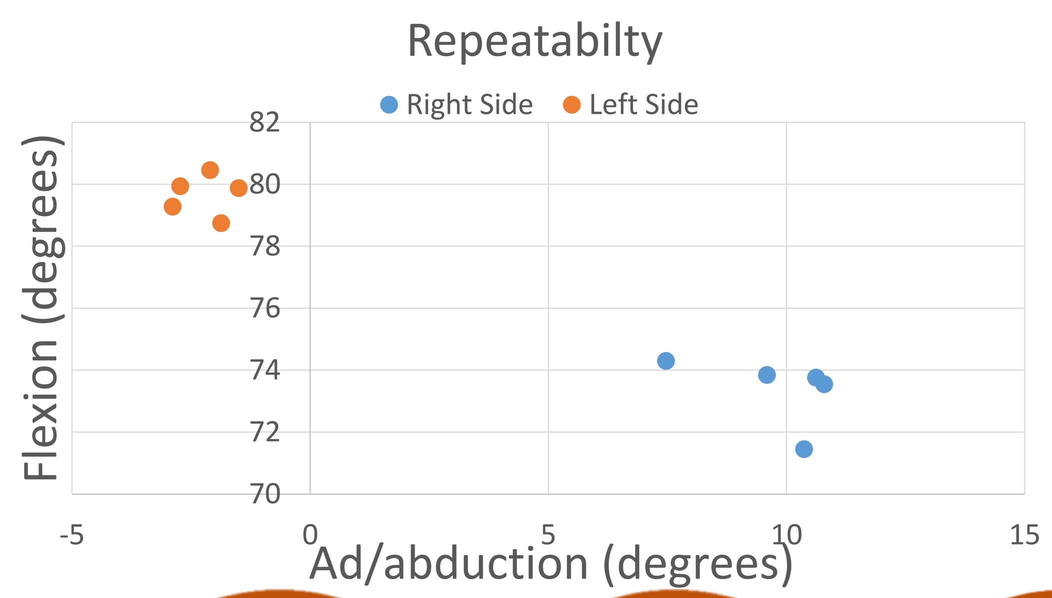
- 'Good' correlation for hip ab/adduction measurements and 'Fair' correlation for hip flexion measurements.
- Mean errors of 4° and 6.3° for hip ab/adduction and hip flexion respectively – with consistent over abduction and over flexion of the model in comparison to the real measurements.
- Errors within visual estimation errors (Parker, no date).
- No bias or proportional error observed.
- Conclusion: The model was able to measure seat shape with an output that provides an indication of both hip flexion and hip ab/adduction.

Repeatability

The same seat shape was scanned five times and the results were compared.



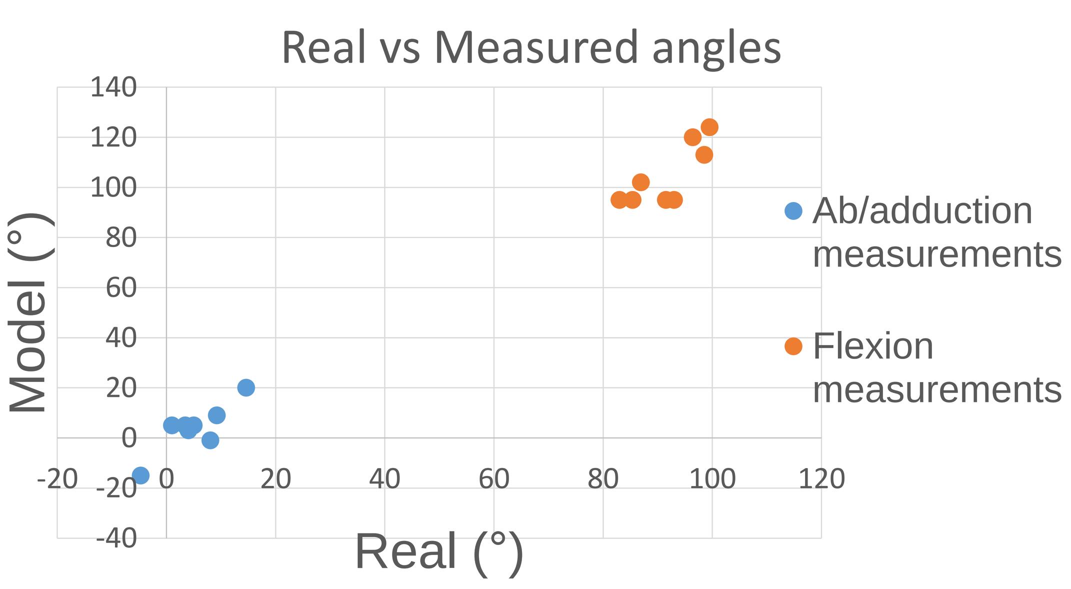




- Two factor without replication ANNOVA demonstrated that there was no significant difference in results between trials.
- Precision is 3.2°
- 'Excellent' intra-rater agreement.
- Conclusion: For the same user, implementing the model is a repeatable process.

Validation

Healthy volunteer cast four times in different seated positions, joint angles measured with a goniometer and compared to the computational model.



- A statistically significant positive linear relationship observed between the model output and real biomechanical measurements.
- Consistent over-adduction and over-flexion of the model in comparison to the real biomechanical measurements.

Limitations

- Model developed from typical anatomy and may not represent the typical patient population.
- Model consistent regardless of sex, weight, age.
- No soft tissue included.
- No inter-rater tests completed.
- Difficult to apply if pelvic well cannot be visualised in the seat shape.
- Possible confirmation bias present during model development.

Conclusion

There is evidence to suggest it is possible to use computational modelling to quantitatively assess custom contoured seat shapes. This could have applications for monitoring changes to seat shape, as a training tool, and as a method to check if the intended postural goals have been met.
Future work may include model automation, increased model complexity, and using regression analysis to assess the relationship between postural assessments and cast shapes.

References

Seidel, G.K., Marchinda, D.M., Dijkers, M. and Soutas-Little, R.W., 1995. Hip joint center location from palpable bony landmarks—a cadaver study. Journal of biomechanics, 28(8), pp.995-998.

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