SHOULDER ARTHROPLASTY: EXPERIMENTAL VALIDATION OF COMPUTER GENERATED PATIENT SPECIFIC GUIDES

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Patient Specific Guides (PSGs) are a critical tool for orthopaedic surgeons, helping them align tools to the correct placement during procedures.

Can we use mathematical analysis to improve their quality?

INTRODUCTION

Currently, PSGs are created in pre-operative planning by orthopaedic surgeons providing input on which contact surfaces they believe will provide the best grasp, based on professional experience [1][2][3].

A previous honors thesis by J. Mackey presented and validated a computational method for assessing the stability of PSGs using SolidWorks for design, and OrthoGrasp to generate stability metrics using Grasp Theory and Wrench Space [4].

OBJECTIVE

The objective of this study was to print the designed grasps for six additional glenoid samples, to test them using an improved rig and testing method, and to then analyze the data.

The data analysis will compare the experimental data to that of the existing computational method, and additionally compare the results to J. Mackey's previous work.

METHODOLOGY

Using the CT scanned, 3D modelled glenoid samples and the generated PSGs developed by M. Parmer, six new glenoid models were tested for the force of PSG dislocation from various motions.

After 3D SLA printing all six glenoid models with each of their six respective PSG's, dislocation testing began.

They were tested in four transverse and two moment directions. These values were then averaged, and then compared to the OrthoGrasp stability metrics.

Three sets of the data were compared. The original data, data cleaned of extreme values, and data in which the torsional units had been scaled.

RESULTS/ FINDINGS

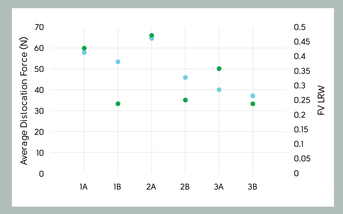
Results showed that the uncleaned data were the values most closely predicted by the model, with a correlation of 0.57 - less than J. Mackey's original correlation of 0.66.

The correlation value was heavily influence by glenoids 844 and 856. Without their results, the correlation was 0.70

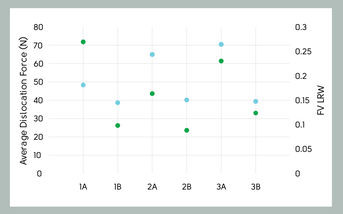
OrthoGrasp predicted the most stable grasp 50% of the time - this prediction only decreased if the data was cleaned of outliers.

Certain A-type PSGs broke during experimentation - some were unable to be fully tested due to the materials brittle nature and the tightness of the grasp.

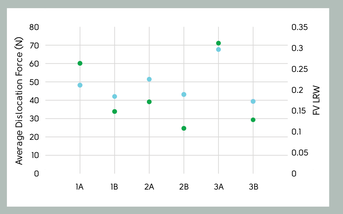
On average, the OrthoGrasp stability metrics predicted a 31.1% difference in stability between the A and B models. Experimental results showed an average of a 47% difference.



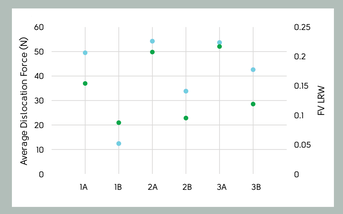
Glenoid Sample 844



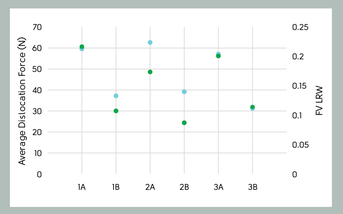
Glenoid Sample 856



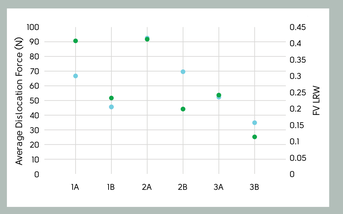
Glenoid Sample 884



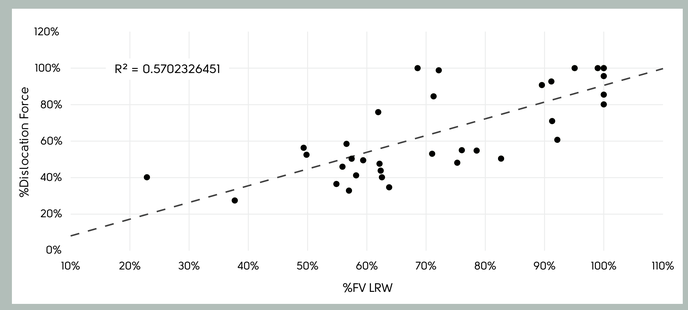
Glenoid Sample 887



Glenoid Sample 888



Glenoid Sample 914



% of Maximum Value Comparison

Above, the average dislocation force of the grasps (Green) is compared directly to the stability metrics generated by OrthoGrasp (Blue).

To the left, the % of maximum value per set of guides is graphed. This compares the OrthoGrasp and experimental values using the same units - a percentage of the maximum value of each set.

CONCLUSION

Overall, the trends showed that the OrthoGrasp stability metrics did consistently predict the most stable PSGs of those designed for each glenoid, but the difference between each stability metric did not correlate strongly with the difference between the respective PSGs dislocation forces.

The OrthoGrasp program could still be used by surgeons as a method to confirm whether or not a grasp has a high level of stability, but it should not be used as the sole tool to design a PSG with.

REFERENCES

University of Victoria