# INFLUENCE OF GLENOID FOSSA GEOMETRY ON SHOULDER STRENGTH

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## INTRODUCTION

The geometrical dimensions of the bones that make up this joint could be a key factor in strength predictability. Understanding the mechanical influence of these dimensions (individually or in combination) on shoulder strength could help explain the mechanism of musculoskeletal disorders. The following study shows how a recently discovered geometric parameter, the *area of glenoid asymmetry (AGA)*, is a good indicator of shoulder strength. It was confirmed in a previous study [1] that the *area of glenoid asymmetry (AGA)*, the surface area as represented by a product of glenoid height and the difference between the lower and upper depths of the glenoid, has an influence on arm strength during abduction; however, the significance of this parameter during adduction was not investigated [2].

## METHODS

A comprehensive study was conducted to test whether glenohumeral geometry, as measured through MRI scans, is correlated with upper arm strength. The isometric shoulder strength of 12 subjects during one-handed arm abduction and adduction in the coronal plane, in a range from 5 to 30 degrees, was correlated with the geometries of their glenoid fossae.

In order to record shoulder strength during arm abduction and adduction in a coronal plane, a posture constraining frame with twelve force sensors was designed that allowed the subject to maintain the same position throughout the experiment. The participants performed right-handed isometric abduction and adduction efforts in a laboratory setting to assess their strength in the coronal plane. The participant was asked to grip a handle and, in the coronal plane against resistance, attempt to pull or push the handle (action randomized) at six different randomized angles of 5, 10, 15, 20, 25 and 30 degrees. The maximum voluntary contraction (MVC) loads were recorded at each arm position in the coronal plane.

A mixed linear module (models with both fixed and random effects) with one-way analysis of variance (ANOVA) with repeated measures design was used to analyze the data . The assumptions included linear structure for the mixed model, the error component to be additive and normality of error distribution. The participants' mean forces and moments were split into two groups according the *AGA* area size. The mean force and moment were considered as the fixed factors, while the participant was considered as a random factor. The two trials for each condition were considered as repeated measures. The mixed procedure was used due to its advantages over other methods in employing a more general covariance structure approach, allowing covariates to vary within a subject, addressing between- and within-subject effects similarly and allowing data that are missing at random.

## RESULTS AND DISCUSSION

Statistical analyses were performed to analyze the data and included the main factor *AGA*. It was supposed [1] that a person with a smaller *AGA* might demonstrate less isometric strength during abduction and adduction than a subject with a larger *AGA*. To further investigate the relationship between the *AGA* and mean force, and the *AGA* and mean moment during adduction, the participants were divided into two groups using the same dividing magnitude of the *AGA* area of 55.00 $mm^2$ (which was approximately half of the mean of the *AGA)*, as was used for abduction [1].

Taking into account the participants' anthropometric measurements and geometric joint parameters, the *AGA* ($97.3 \pm 79.6$ $mm^2$) was a satisfactory factor for identifying two strength groups during abduction and adduction in a coronal plane. It is worthy to mention that the parameter with the highest correlation with mean moment during abduction and adduction and with mean force during adduction (0.65, $p \leq 0.05$; 0.73, $p \leq 0.01$; 0.68, $p \leq 0.05$, respectively) was the upper depth of glenoid fossa.

The statistical analysis results indicated that there were several statistically significant interactions between the *AGA* factors for the four output measures, the mean forces and mean moments measured during abduction and adduction. The results revealed statistically significant differences between the mean force and mean moment for these two groups for all considered angles of abduction and adduction.

## CONCLUSIONS

All subjects were stronger during adduction than abduction for all arm positions. The results revealed a high correlation in the coronal plane between the *AGA* and mean maximum force and mean maximum moment when an arm was abducted and adducted in a range from 5 to 30 degrees (0.80, $p \leq 0.01$ and 0.69, $p \leq 0.05$, respectively during abduction and 0.61, $p \leq 0.04$ and 0.61, $p \leq 0.04$, respectively during adduction).

This investigation revealed the repercussion of individual glenoid geometry on the maximum acceptable load applied to the hand during arm abduction and adduction in a coronal plane.

## REFERENCES

1. Gielo-Perczak K, et al., *J of Electrom. and Kinesiol.* **16**: 66-78, 2006.
2. Gielo-Perczak K,, et al., *Ergonomics.* **50:11**, 1856-1870, 2007.