# Effect of the greater tuberosity angle on the supraspinatus activity during abduction: a musculoskeletal simulation study

**Peixoto, M.**[1], Moissenet, F.[2], Cunningham, G.[3] , Tétrault, P.[4], Begon, M.[5], Hagemeister, N.[1]
[1] LIO, École de Technologie Supérieure, Montréal, (Qc), Canada
[2] Kinesiology & Biomechanics Laboratories, Geneva University Hospitals & University of Geneva, Geneva, Switzerland
[3] La Colline Shoulder and Elbow Center, Geneva, Switzerland
[4] Centre hospitalier de l'Université de Montréal, Montreal (Qc) Canada
[5]Université de Montréal, Montreal (Qc) Canada
Email: margaux.peixoto.1@ens.etsmtl.ca

## Summary

This study investigates the biomechanical relationship between the greater tuberosity angle (GTA) and the supraspinatus activity during abduction using a musculoskeletal shoulder model. Simulations reveal that higher GTAs increase the supraspinatus moment arm and activation, while decreasing the contribution of other muscles. These findings provide insights into the clinically observed correlation between the GTA and the risk of rotator cuff tear.

## Introduction

Bone morphology is a predictor of rotator cuff tear (RCT), particularly the critical shoulder angle often reported in clinical studies [1]. However, the effect of the humerus morphology remains unclear. The greater tuberosity angle (GTA) has been recently introduced to define the angle between a line parallel to the diaphyseal axis passing through the humeral head center and a line connecting the humeral head's superior border to the superolateral edge of the greater tuberosity [2]. This study aimed to simulate the effect of different GTAs on muscle activations using a musculoskeletal shoulder model. Based on Cunningham et al.'s hypothesis [2], we expected that higher GTAs would lead to an increased recruitment of the supraspinatus.

## Methods

We used Anybody musculoskeletal software (v8.0.4, AMMR library 3.0.4) with the Sphere-on-Sphere shoulder model that enables humeral head translations (https://github.com/margauxpeixoto/GH_contact_spheres). The supraspinatus being a prime mover, we simulated an arm abduction from 5 to 50° [3]. To isolate the effect of the GTA variations on the supraspinatus, its insertions were offset along the humeral diaphyseal axis to obtain GTA values ranging from 50 to 80°, reflecting patient (72.5±2.5°) and control (65.2±4.1°) groups [2]. The isometric force ratio between the deltoid and the supraspinatus was set to 2:1 [4]. The muscular redundancy was solved using a minmax criterion. Muscle moment arms and activations were compared between all GTAs.

## Results and Discussion

Increasing the GTA from 50 to 80° resulted in a 24% increase (3.7 mm) of the supraspinatus moment arm. With a larger moment arm, the supraspinatus gains a mechanical advantage, making it more favorable for recruitment. Consequently, increasing the GTA enhanced the supraspinatus activation by 14% at 30° of abduction, confirming the Cunningham et al. hypothesis [2].

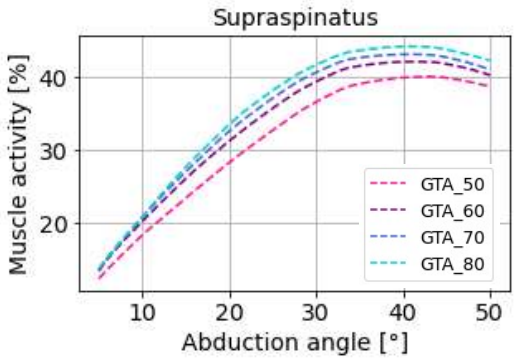


**Figure 1:** Influence of the greater tuberosity angle (GTA) on the supraspinatus muscle activity during abduction.

Furthermore, the activation of other muscles was decreased, in particular the infraspinatus (-17%) and subscapularis (-14%). This reduction in the activation of these rotator cuff muscles negatively impacted the shoulder stability. The supraspinatus, with a larger moment arm, may compensate, but this may lead to an excessive recruitment on this muscle at the expense of a balanced activation of the rotator cuff.

## Conclusions

Our findings suggest that the GTA variations affect the supraspinatus moment arm and thus its recruitment pattern. Further investigations are needed to examine the impact on the musculo-tendon strain and the potential link to rotator cuff tear.

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## References

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