

## FUNCTIONS OF HIP JOINT MUSCLES

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### INTRODUCTION

Functions of hip joint muscles are important for physical therapy and rehabilitation, but are also useful for reconstructive surgery involving e. g. tendon transfer after plexus or peripheral nerve injuries. Main muscle functions in the neutral position of the joint are well known, but secondary functions or function changes in different joint positions remain under debate. Hence we used a multibody computer model of the hip and knee for further investigation of hip joint muscle functions.

### METHODS

A 50<sup>th</sup> percentile rank male adult model regarding body height was chosen. The mass characteristics and joint positions were determined using the ADAMS/Android software package for the multibody simulation system ADAMS 7.0 (MSC Software, Santa Ana CA, USA). The attachment areas of 27 muscles crossing the hip joint were measured and centre points of the areas were calculated in a previous work[1]. The muscles were represented by straight lines connecting the muscle origin and insertion point; when the course of a muscle differed noticeable from a straight line, one additional wrapping point was used. Hip joint movements were investigated in steps of 20° using a physiological range of motion found in the literature. In each joint position, muscle lengths were determined and muscle lever arms were calculated. Additionally, the new concept of relative torques (torque acting around a single joint axis divided by the total torque which is generated by a standard muscle force) was introduced and relative torques around the three joint axes were calculated. With these parameters the functions of each muscle could be assessed in all investigated joint positions.

### RESULTS AND DISCUSSION

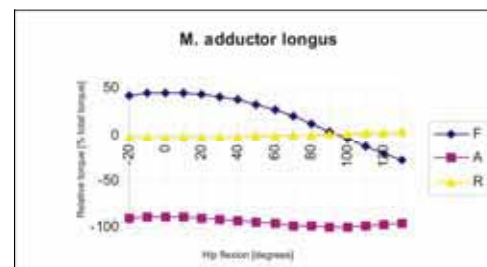
Lengths, lever arms and relative torques for 27 muscles of the hip joint were calculated. Due to the large amount of data, two muscles whose functions are under debate in the literature are presented here. There is agreement in the literature that M. adductor longus is an adductor of the hip. In our data, the muscle additionally is a flexor of the hip up to 90° of flexion. At flexion angles greater than 90°, the muscle becomes an extensor (Figure 1). The muscle also was found to be an external rotator of the hip in flexion positions up to 80° or internal rotation of the hip. The rotational function change is

not described by most of the authors and internal or external rotation is reported instead.

M. iliopsoas is a flexor of the hip in all anatomical works. In this study, when exceeding 110° of flexion the muscle became an extensor of the hip. We also found an internally rotating moment of the muscle in positions up to 80° flexion and 30° external rotation. In externally rotated positions of the hip the muscle also generated an abducting moment.

In interpretation of our data, the effects of the simplified representation of muscles which were modelled as straight lines have to be accounted for. However, as manifestly curved muscles were modelled by additional wrapping points, the errors due to this simplification were reduced.

The primary functions of hip muscles were the same as in similar studies and in the anatomical literature. Function changes during different hip joint motions were also found in other studies, but there is some debate about the exact joint position of the function change. The data presented here is in most of the cases supported by several authors.



**Figure 1:** Relative torques of M. adductor longus. *F* designates flexion torque, *A* abduction torque, *R* external rotation torque. Negative values characterise the opposite motion (i. e. negative abduction torque designates an adduction moment)

### CONCLUSIONS

The study presented here provides a comprehensive data set of hip joint muscle functions which might be of interest for physical therapy, rehabilitation and further research.

### REFERENCES

1. Lengsfeld M, Stammberger U, Reeh S: **Spatial measurement and transformation of muscular attachments at the lower extremity.** *Med Eng Phys* 1994, **16**: 518-525.