# STRAIN OF ANATOMICAL AND TRANSPOSED TERES MAJOR AND LATISSIMUS DORSI MUSCLES

[1] Jurriaan H de Groot, [2]Frans Steenbrink, [3]Lieven de Wilde, [1]Carel GM Meskers, [2]Rob GHH Nelissen
[1]Dept. Rehabilitation. Leiden Univ Med. Center, The Netherlands,
[2]Dept. Orthopaedics. Leiden Univ Med. Center, The Netherlands,
[3]Dept. Orthopedic Surgery and Traumatology, University Hospital Gent, Belgium,
email: J.H.de_Groot@LUMC.NL

## INTRODUCTION

Transpostion of the Latissimus Dorsi and Teres Major is a salvage procedure for massive rotator cuff lesions. A serious concern in these surgical reconstruction procedures is the new strain range of the muscle (fibres). Intra-operative measurement of the muscle fibre strain [1] is generally not available and cannot be tested for the active range of motion. Model simulation adds to the insights on strain and function of the transferred muscle for the active range of motion.
Kinematic data and model simulation were combined to illustrate the strains of the Latissimus Dorsi (LD) and Teres Major (TMj) muscles before and after transposition to the greater tubercle insertion area of the Supraspinate tendons (SS).

## METHODS

Arm abduction kinematics of a healthy subject were recorded by means of electromagnetic tracking [2]. The orientations of the thorax, shoulder girdle and arm defined the simulation kinematics with the Delft Shoulder [3] and Elbow Model [4] (DSEM). The DSEM includes sarcomere lengths [5].

In simulation the LD and TMj were transferred to the insertion area of the Supraspinate muscle [6]. Muscle strains were calculated from the kinematic input based on sarcomere rest length [5] and either the shortest length between origin and insertion or taking bony contour wrapping into account, in case TMj and LD around the humerus shaft; in case transferred TMj and transferred LD around the humerus head.
In comparison we assumed muscle strain to be equal to muscle fibre strain, i.e. parallel longitudinal muscle fibres and pennation angle equals $0^o$.

## RESULTS AND DISCUSSION

The strains for LD and TMj during abduction are illustrated in figure 1. For the anatomical insertion of both muscles the muscle strain for TMj during abduction is larger than the LD muscle strain, primarily because of its shorter muscle length [8].

The transferred LD and TMj muscle strains during abduction are within the strains of the muscles at the anatomical insertions. The smaller range is explained by the reduced moment arm for abduction after muscle transfer.

There are some functional differences between the anatomical and transferred muscles:

1. Transfer of the insertion results in an increased strain for both LD and TMj in the initial arm position, Figure 1. This results in the increase of the *in situ* muscle fibre or sarcomere length.

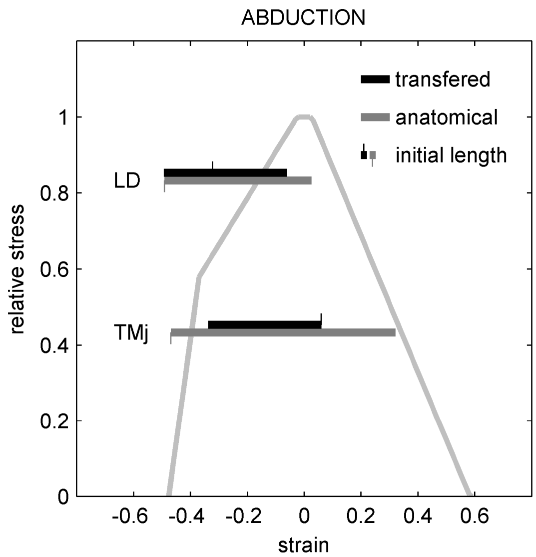


**Figure 1**: Simulated anatomical and transferred muscle strain and initial length for Latissimus Dorsi (LD) and Teres Major (TMj) during abduction, projected onto a sarcomere stress-strain reference (assuming muscle fibre strain equals muscle strain which is an overestimation).

2. Passive muscle stress at arm rest position (not illustrated) will increase due to the increased muscle strain and will intra-operatively be experienced by the surgeon. These stresses are however within the physiological range.
3. The strain at the initial position changed after transfer to intermediate (LD) or maximal (TMj). Consequently, the muscle function was changed to ABductor during either part (LD) or the full (TMj) abduction movement.

## CONCLUSIONS

Due to the transferred insertions, LD and TMj contribute (partly) to lost ABduction moment, in combination with caudal forces on the humerus stabilizing GH [7]. The strain changes are within the anatomical muscle strain range. Model simulation helps the surgeon to predict the muscle strain after surgical reconstruction.

## REFERENCES

1. Friden J et al., *J Biomech.* **35**:1039-1045, 2002.
2. Meskers CGM et al., *Clin.Biom.* **13**:280-292, 1998.
3. Van der Helm FCT, *J Biomech.* **27**:551-569, 1994.
4. Veeger HEJ et al., *J Biomech.* **30**:647-652, 1997
5. Klein-Breteler et al., *J Biomech.* **32**:1191-1197, 1999
6. Magermans et al., *Clin Biom.* **19**:116-122, 2004
7. De Groot et al., *Clin Biom.* **21**:S27-S32, 2006
8. Buijze et al.,*Clin. Anat.* **20**:919-923,2007