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# A MODEL OF THE MIDDLE FINGER EXTENSOR MECHANISM WITH THE RETENTION APPARATUS

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## Introduction

Biomechanical modeling of force transmission in fingers is important for surgical treatment planning.

In recent years, there has been an increasing interest in extensor mechanism (EM) modeling, which plays an important role in both extension and flexion of the fingers [1]. It consists of tendons transmitting active forces and retention apparatus (or ligaments) transmitting passive forces. However, no studies have added the retention apparatus into account despite its important role in finger biomechanics.

The aim of this study was to model the EM with the retention apparatus for the middle finger. Two postures, full flexion and full extension, were studied. Model deformation was compared with anatomical published data [2].

## Methods

The model was based on the modern anatomical description of EM [3]. Both elements of EM, tendons and ligaments, were modeled as elastic strings. The Minimum Potential Energy principle was used to find the equilibrium of the system. Potential energy was calculated as:

$$PE = SE + WP + PT,$$

where SE stands for energy of the system, WP is a work potential, PT is a penalty term, which is introduced to take into account the constraints, disabling the tendons from penetrating into the bones or getting out of the pulleys.

Model is shown in the Figure 1. Retention apparatus is presented by FI band (oblique retinacular ligament) and the band going from the F point to the symmetrical point on the ulnar side of the finger (triangular ligament).

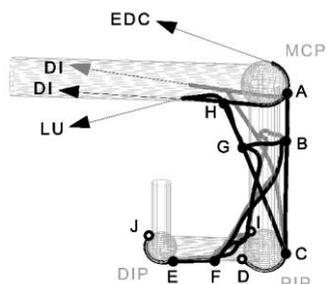


Figure 1: View of the model.

Calculations were performed in MATLAB R2011b software (The MathWorks, Inc., Natick, MA, USA).

## Results

EM deformation was studied by finding the angles between the tendons (Fig. 1). The angles produced by the model were compared with the anatomical data (Fig. 2 and 3).

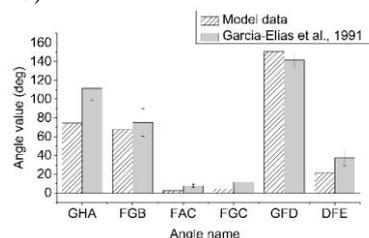


Figure 2: Model-predicted and measured angles between the tendons for full extension posture.

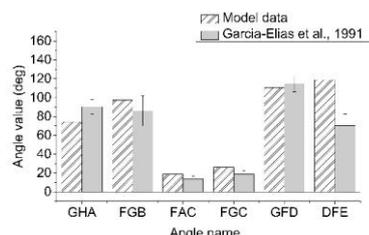


Figure 3: Model-predicted and measured angles between the tendons for full flexion posture.

## Discussion and Conclusion

The current study found good agreement between estimated and measured angles. The Root-mean-square error of modeled data was  $6.18^\circ$  for extension posture and  $6.17^\circ$  for flexion posture. Excluding of the retention apparatus from the model leads in RMSE increase until  $6.32^\circ$  (in full extension) and  $6.85^\circ$  (in full flexion).

The remaining differences from anatomical data could be explained by lack of knowledge about the model parameters values. Further work, such as model parameter estimation, needs to be done to perform better model fitting to the anatomical data.

## References

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3. Landsmeer, Anat. Rec. 104, 31–44, 1949

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