

# Biomechanical studies of finger extension function

Analysis with a new force measuring device and ultrasound examination in rheumatoid arthritis and healthy muscles

Akademisk avhandling

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av

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The thesis is based on the following papers:

- I. Brorsson S, Nilsson A, Sollerman C, Baerveldt A-J, Hilliges M. A new force measurement device for evaluating finger extension function in the healthy and rheumatoid arthritis hand. *Technology and Health Care*. 2008; 16: 283–292.
- II. Brorsson S, Nilsson A, Hilliges M, Sollerman C, Aurell Y. Ultrasound evaluation in combination with finger extension force measurements of the forearm musculus extensor digitorum communis in healthy subjects. *BMC Medical Imaging* 2008; 3: 8:6.
- III. Brorsson S, Hilliges M, Sollerman C, Aurell Y, Nilsson A. Extensor muscle force measurements and muscle architecture in rheumatoid arthritis patients. Submitted.
- IV. Brorsson S, Hilliges M, Sollerman C, Nilsson A. A six weeks' hand exercise programme improves strength and hand function in rheumatoid arthritis patients. Accepted in *Journal of Rehabilitation Medicine* 2008.

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# Biomechanical studies of finger extension function

Analysis with a new force measuring device and ultrasound examination in rheumatoid arthritis and healthy muscles

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## ABSTRACT

**Aims:** The overall aim of this thesis was to further our understanding of extensor muscles and their role for hand function. The aims of the studies were:

- *To develop and evaluate a new device for finger extensor force measurements.*
- *To evaluate ultrasound as a tool for assessment of muscle architecture.*
- *To determine the correlation between extensor muscle force and hand function.*
- *To evaluate the degree of impaired finger extensor force in rheumatoid arthritis (RA) and the correlation to impaired hand function.*
- *To analyse the effect of hand exercise in RA patients and healthy subjects with ultrasound and finger extension force measurements.*

**Method:** A new finger extension force measuring device was developed and an ultrasound based method was used to be able to objectively measure the finger extension force and analyze the static and dynamic extensor muscle architectures. Measurements were made of healthy volunteers (n=127) and RA patients (n=77) during uninfluenced and experimental conditions. A hand exercise program was performed and evaluated with hand force measurements, hand function test, patient relevant questionnaires (DASH and SF-36) and ultrasound measurements.

**Results:** The new finger extension force measurement device was developed and then validated with measurements of accuracy as well as test-retest reliability. The coefficient of variation was 1.8 % of the applied load, and the test-retest reliability showed a coefficient of variation no more than 7.1% for healthy subjects. Ultrasound examination on m. extensor digitorum communis (EDC) showed significant differences between healthy men and healthy women as well as between healthy women and RA patients. The extension and flexion force improved in both groups after six weeks of hand exercise (p<0.01). Hand function improved in both groups (p<0.01). The RA group showed improvement in the results of the DASH questionnaire (p<0.05). The cross-sectional area of the EDC increased significantly in both groups.

**Conclusions:** A new finger extension force measuring device has been developed which provides objective and reliable data on the extension force capacity of normal and dysfunctional hands and is sufficiently sensitive to evaluate the effects of hand exercise. US provide useful information about muscle architecture. A significant improvement of hand strength and hand function in RA patients was seen after six weeks of hand training, the improvement was even more pronounced after 12 weeks. Hand exercise is thus an effective intervention for RA patients, providing better strength and function.

**Keywords:** *Grip force, finger extension force, ultrasound, hand exercise, rheumatoid arthritis, muscle architecture, ultrasound, GAT, DASH, SF-36.*

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