# Co-contraction of shoulder muscles in people with muscle dystrophy vs. healthy persons during reaching

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## Summary

Facioscapulohumeral dystrophy (FSHD) causes progressive muscle weakness, fatigue, joint pain and stiffness. In this study we examined time-changes in co-contraction of scapular stabilizing and humeral mobilizing muscles in persons with FSHD vs. healthy controls performing ipsi- and contralateral reaching. Co-contraction was calculated as mean over the whole movement, and compared over time between FSHD and healthy persons using statistical parametric mapping. We found that, during contralateral reaching, mean co-contraction of the trapezius-serratus muscle pair was higher in FSHDs than controls (P<0.01, $CI_1$: +16, Hg: 0.82-2.58) and differed before reaching the target (P<0.01, $CI_1^i$: +30-48, time: 75-100%). The findings have implications for joint stability and energy expenditure.

## Introduction

Facioscapulohumeral dystrophy (FSHD) is the second most prevalent inherited neuromuscular disorder with a prevalence of ~1:15,000 [1]. FSHD results in progressive upper extremity muscle weakness and fatigue, limiting upper extremity function when performing essential daily tasks. A higher muscle co-contraction in FSHD can be hypothesized to stabilize the shoulder joint during movement. However, co-contraction may lead to less available joint torque, greater joint stiffness and energy expenditure. In this study we investigated if higher co-contraction is present in FSHDs compared to healthy controls, in the thoracoscapular and scapulohumeral muscle pairs, which could help reveal the neuromuscular adaptations in persons with FSHD. We hypothesized that the FSHD population would have higher co-contraction compared to the healthy group.

## Methods

Upper limb position and electromyograms (EMGs) of upper extremity muscles were recorded in 12 FSHD (6M/6F, 56.0±14.5yrs, 1.76±0.10m, 75±20kg) and 12 healthy control participants (6M/6F, 55.8±13.1yrs, 1.77±0.08m, 73±15kg) during maximum voluntary contractions (MVC), ipsi- and contralateral reaching (CLR).

The co-contraction index, $CI_1^i$ was calculated, for every normalized time point (0-100%), using the rectified, MVC-normalized, low-passed (5 Hz) EMG linear envelopes of two muscle pairs: trapezius ascendens-serratus anterior (T-S) and deltoid medial-latissimus dorsi (D-L). $CI_1^i$ was defined as [2]:

$$CI_1^i = \frac{lowEMG_i}{highEMG_i} \times (lowEMG_i + highEMG_i) \qquad (1).$$

Where $CI_1^i$ is index at time point *i*, $lowEMG_i$ is the EMG signal of the less active muscle at point *i* and $highEMG_i$ is that of the higher active muscle. $CI_1$ range is 0-200. Finally, the mean $CI_1$ value over the time interval was also calculated. Wilcoxon rank sum test (α=0.0125) and Statistical Parametric Mapping (SPM, α=0.0125) were used to compare the $CI_1^i$ values between FSHDs and controls as means and over time, respectively. Effect sizes were calculated as Hedges' g (Hg) using each group's standard deviation separately.

## Results and Discussion

Mean $CI_1$ of the T-S pair was higher in FSHD during CLR (P<0.01, $CI_1$: +16, Hg: 0.82-2.58). People with FSHD showed significant higher co-contraction in the T-S pair (P<0.01, $CI_1^i$: +30-48, time: 75-100%) during the final reaching to target phase of CLR (Figure 1). Co-contraction changed as the balance between shear and compressive muscle forces around the shoulder changed over time. A higher co-contraction in people with FSHD could reduce available net joint torque and increase energy expenditure.

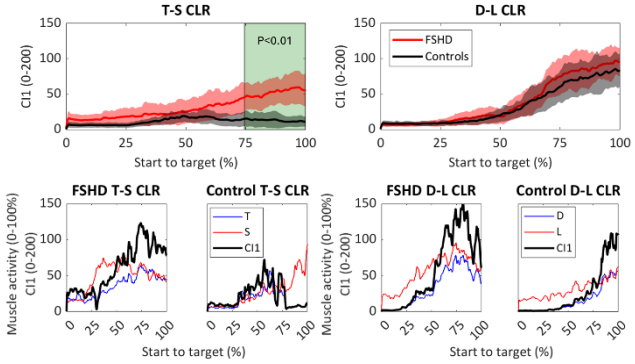


**Figure 1**: $CI_1$ as group mean±SD (top) and for two representative individuals (bottom) in T-S (left) and D-L (right) pairs during CLR. Significant differences FSHDs-controls are shown in green (top).

## Conclusions

Co-contraction was higher in FSHD and differed over time in the T-S muscle pair during CLR in FSHDs vs. controls. Changes in joint forces and the effect of co-contraction on energy expenditure should be further investigated.

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## References

[1] Pandya S et al. (2008). Phys. Ther., **88(1)**: 105–113.
[2] Rudolph KS et al. (2000). Knee Surg., Sports Traum. Arthr., **8(5)**: 262–269.