Muscular Activity while Sitting on a Novel Dynamic Office Chair

Kuster R P (1,2), Oetiker S (2), Baumgartner D (1), and Kool J (2)

(1) ZHAW Zurich University of Applied Sciences, Institute of Mechanical Systems
(2) ZHAW Zurich University of Applied Sciences, Institute of Physiotherapy

Background
Long-lasting static sitting significantly increases the risk of all-cause-mortality(1,2). Even low back pain is discussed as negative health consequence of prolonged static sitting periods(3) (>4 hours a day). Science therefore generally recommends that continuous postural changes should be supported by the chair to reduce negative health effects. Since no dynamic office chair was identified that significantly changes trunk muscle activity (4), a novel dynamic office chair was developed. The additional degree of freedom of the chair is enabled by a circular motion of the seat in the frontal plane around a center of rotation within the chair user’s body.

Method
Ten office workers laterally flexed their spine in self-selected comfortable range during a standardized reading task. Maximum spine-flexion and thorax-inclination and -translation were measured with infrared cameras during dynamic sitting for five minutes. Muscular activity of back muscles (left and right longissimus (L-/R-LONG), left iliocostalis (L-ILIO), right multifidus (R-MULT)) and thigh muscles (right vastus medialis (R-VASTM) and lateralis (R-VASTL)) were recorded by surface EMG while dynamic and static sitting and expressed as % of maximum EMG activity during gait.

Results
Subjects laterally flexed their spine 6.1±1.5° while the thorax was moved 0.9±0.7° and 7±5mm, respectively. Muscular activity of the back muscles while dynamic sitting varied between 21±7% to 71±25% compared to 21±11% to 100% in walking (see tab 1), while constant mean activity in static sitting was between 25±8% and 50±18%. Thigh muscle activity varied between 9±2% to 22±24% compared to walking (9±2% to 100%).
Muscular activity of the back was lower for dynamic compared to static sitting while 17±19% up to 47±25% of the time, and lower muscular activity of the leg was found between 9±2% and 22±24% of the time.

Discussion
On the novel office chair, subjects are able to laterally flex their spine during a reading task although the thorax remains stable. The low thigh activity indicates that the movement is performed mainly by the upper body muscles. The activity variation of back muscles while normal dynamic sitting is comparable to walking, but substantial smaller maximum values of about -30 to -60% were observed.

Conclusion
According to current literature(4), the novel office chair is the first scientifically investigated chair that significantly change trunk muscle activity, applying not only additional load, but also cyclic relief of the relevant back muscles during 17 to 47% of dynamic sitting time.

References:
3. Lis et al. 2007, Eur Spine J 
4. O’Sullivan et al. 2013, Appl Ergon