

Muscular Activity while Sitting on a Novel Dynamic Office Chair

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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 $6.1 \pm 1.5^\circ$ while the thorax was moved $0.9 \pm 0.7^\circ$ and $7 \pm 5\text{mm}$, respectively. Muscular activity of the back muscles while dynamic sitting varied between $21 \pm 7\%$ to $71 \pm 25\%$ compared to $21 \pm 11\%$ to 100% in walking (see tab 1), while constant mean activity in static sitting was between $25 \pm 8\%$ and $50 \pm 18\%$. Thigh muscle activity varied between $9 \pm 2\%$ to $22 \pm 24\%$ compared to walking ($9 \pm 2\%$ to 100%).

Muscular activity of the back was lower for dynamic compared to static sitting while $17 \pm 19\%$ up to $47 \pm 25\%$ of the time, and lower muscular activity of the leg was found between $9 \pm 2\%$ and $22 \pm 24\%$ of the time.



Fig 1: Novel dynamic office chair
For comparison to static sitting, the seat was locked in the middle position.

muscle	min dynamic sitting	max dynamic sitting	time dyn. < stat. sitting	static sitting	min walking
left longissimus	24.7±12.2 (7.9-51.6)	46±15.2 (26.4-71.4)	45.1±25.8 (2.5-83.5)	32.7±14.5 (16.2-60.3)	20.9±10.6 (6.8-39.2)
right longissimus	27.7±9.4 (16.1-41.5)	51.5±13.2 (35.8-69.5)	47.1±25.1 (10.5-78)	37.2±9.1 (25.2-47.9)	37.5±23.6 (11.7-86.1)
left iliocostalis	47.0±13.4 (28.4-65.7)	70.6±25.4 (44.1-112.5)	16.9±19.4 (0-46.0)	49.9±17.8 (28.7-82.0)	40.4±15.8 (10.2-58.3)
right multifidus	21.3±7.4 (8.6-32.3)	39.4±12.3 (16.1-54.8)	29.9±27.4 (0-89.5)	25.2±8.4 (13.7-39.1)	23.8±10.8 (8.8-44.2)
right vastus medialis	8.8±2.3 (6.5-11.2)	10.7±3.6 (7.7-15.3)	31.8±17.8 (7.0-47.0)	9.3±2.6 (6.7-12.2)	8.9±2.3 (6.2-11.8)
right vastus lateralis	15.4±14.1 (5.7-36.1)	21.8±24.1 (6.8-57.6)	52.5±31.1 (6.0-70.0)	17.4±17.3 (6.1-43.1)	16.0±14.1 (6.9-40.7)

Tab 1: Muscular activity while dynamic and static sitting and walking in self-selected lateral flexion of the spine

Muscular activity in % of walking of 4 back and 2 thigh muscles. Data of dynamic sitting are indicated at minimum and maximum activity (mean ± standard deviation and full range in brackets), data of static sitting at mean activity, data of walking at minimum activity (maximum activity corresponds to 100%). Time in which the muscular activity in dynamic sitting was below muscular activity of static sitting (time dyn. < stat. sitting) is expressed as % of sitting 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.

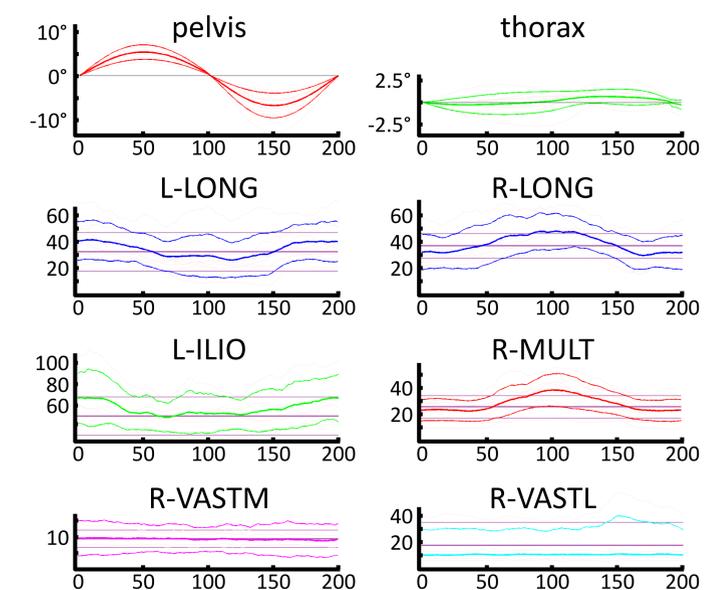


Fig 2: Laboratory Data

Data of the motion to the left (1-100) and right (101-200) are time-normalized. In the first row, angular orientation of the pelvis and the thorax is shown. In row 2 to 4, muscular activity are shown in % of maximum activity measured while walking. Thick line indicates the mean, thin line above and below standard deviation (sd). Straight shaded line in violet reflects muscular activity during static sitting (mean and sd). Muscular activity of individual subjects are plotted in the background.

References:

¹ Katzmarzyk et al. 2009, *Med Sci Sports Exerc*

² Dunstan et al. 2012, *Diabetes Res Clin Pract*

³ Lis et al. 2007, *Eur Spine J*

⁴ O'Sullivan et al. 2013, *Appl Ergon*



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