Biomechanical effects of spinal orthoses on the trunk during a sit-to-stand-to-sit task

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Summary

The overall evidence of efficacy for spinal braces, and their effect on movement and muscle activity, remains uncertain. This study was the first to employ markerless technology and surface electromyography to explore biomechanical effects of two spinal orthoses amongst asymptomatic individuals on the trunk compared to no brace. The braces did not restrict RoM, and assisted during movement into extension, alongside reductions in muscle activity of the latissimus dorsi. These findings, if present in a clinical population suggest that use of these braces may promote, or ease participation in simple activities of daily living. Further clinical studies are now warranted to explore this further, using similar methodological approaches.

Introduction

Though spinal orthoses are widely available and used in the management of a variety of spinal disorders [1], the overall evidence of efficacy and effect on movement and muscle activity remains uncertain [2]. This pre-clinical study used a novel markerless motion capture technology to explore the immediate biomechanical effects of two semi-rigid spinal orthoses on trunk muscle activity and kinematics compared to no brace, amongst asymptomatic individuals.

Methods

Twenty healthy participants (13 males, 7 females, mean age 30±9 years, height 1.7±0.1 m, mass 76.5± 17.2 kg, BMI 26.0±4.7 kg/m^2) consented to performing a sit-to-stand-to-sit task (Figure 1) under three conditions: No Brace (*NB*), *Brace A* (Medi Spinomed®, Bayreuth, Germany) and *Brace B* (DonJoy® Osteostrap, Enovis, UK). Data was collected using markerless motion capture (Qualisys, SB, Sweden) and 4 EMG wireless sensors (Delsys Inc, MA, USA) applied bilaterally to the latissimus dorsi and thoracic erector spinae, with peak and average rectified signal for each muscle assessed. Thorax angle was calculated as the thorax segment relative to the laboratory coordinate system. Sagittal, coronal and transverse plane Range of Motion (RoM) throughout both phases of the task was assessed, and in the sagittal plane, minimum and maximum flexion angle was also investigated. Repeated measures ANOVA tests were performed to explore differences between conditions. Where a main effect of brace was seen, post-hoc pairwise comparisons with a Bonferroni correction were performed.

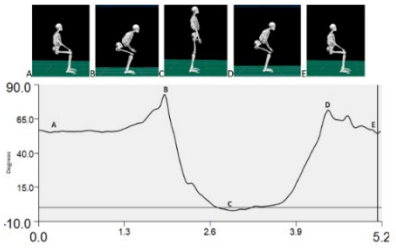

Figure 1: Change in hip angle throughout the task to determine task components: A-C is Sit-to-stand, C-E is Stand-to-sit

Results and Discussion

During sit-to-stand, average muscle activity of the dominant latissimus dorsi was significantly reduced in Brace A compared to NB (Table 1 & 2). During standing and sitting components of the task, participants were significantly more forwardly flexed in Brace A compared to NB and Brace B. During stand-to-sit, peak extension angular velocity significantly increased in Brace A and Brace B compared to NB.

Table 1: Mean (SD) and significant main effects for trunk kinematic variables. * Indicates statistical significance ($p<0.05$)

Variable	NB	Brace A	Brace B	Sig.
Sit-to-Stand				
Dominant side LD (average)	0.678 (0.18)	0.554 (0.16)	0.635 (0.20)	0.026*
Trunk min flexion angle	5.21 (3.77)	7.44 (3.10)	5.89 (4.10)	<0.001*
Stand-to-Sit				
Trunk min flexion angle	5.80 (3.51)	7.45 (2.92)	5.99 (4.09)	0.014*
Peak extension AV (°/sec)	-55.21 (12.96)	-60.96 (11.74)	-61.89 (14.22)	0.017*

NB *- No brace* ***LD*** *– Latissimus Dorsi* ***MIN*** *- Minimum* ***AV*** *– Angular Velocity*

Table 2: Mean Difference (MD) and significant pairwise comparisons ($p<0.05$) for all variables with significant main effect.*

	Condition		MD	p-value
Dominant side LD (average)	NB	Brace A	0.13	0.019*
Trunk min flexion angle (°)	NB	Brace A	-2.2	<0.001*
	Brace A	Brace B	1.5	0.012*
	NB	Brace B	-1.17	0.019*
Trunk min flexion angle (°)	NB	Brace A	-1.65	0.015*
	Brace A	Brace B	1.46	0.040*
Peak extension AV (°/sec)	NB	Brace A	5.74	0.011*
	NB	Brace B	6.68	0.046*

MD *– Mean Difference* ***NB*** *- No brace* ***LD*** *– Latissimus Dorsi* ***MIN*** *- Minimum* ***AV*** *– Angular Velocity*

Conclusions

The braces did not restrict trunk RoM, and assisted movement into extension, alongside small but significant reductions in muscle activity of latissimus dorsi. If the same findings are present within a clinical population, the use of these braces may promote, or ease participation in simple activities of daily living. Further work is now warranted, recruiting a population with pathology, embedding an intervention period that reflects clinical practice, making use of this pre-clinical groundwork as a methodological approach.

References

[1] Cerillo J et al. (2023) *Biomechanics*. **3**(1),136-154.

[2] Pieroh P et al. (2023) *Global Spine J*. **13**(1),59S-72S.