GROUND REACTION FORCE DIFFERENCES IN THE SQUAT AND THE STOOP LIFTING TECHNIQUES

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Introduction

The biomechanics of the squat and stoop lifting techniques, the two techniques which are widely used in daily activities, provide administrative control to prevent low back pain [van Dieen et al, 1999]. With regards to low back pain prevention the ground reaction force (GRF) bilateral asymmetries during lifting [Maines et al, 2006] as well as the influence of trunk motion on spinal loading [Davis & Marras, 2000] are of particular interest. The aim of the study was to exmamine the GRF differences between the squat and the stoop lifting techniques in young and middle-aged healthy subjects.

Methods

Ten (10) young (YM: 21.9 ± 0.5 yrs και six (6) middle-aged subjects (M-AM: 53.3 ± 2.0 yrs) participated in the study. They had similar ($p > 0.05$) anthropometric dimensions of body height (YM: 172.7 ± 10.2 cm, M-AM: 174.9 ± 4.2 cm), shoulder height (YM: 140.6 ± 10.6 cm, M-AM: 142.6 ± 4.6 cm) hip height (YM: 92.2 ± 6.7 cm, M-AM: 93.4 ± 3.7 cm), and knee height (YM: 51.1 ± 5.6 cm, M-AM: 48.7 ± 2.2 cm) with a significant difference in body mass (YM: 70.8 ± 14.3 kg, M-AM: 87,7 ± 9,3 kg, $p < 0.05$). They performed 5 squat and 5 stoop lifting trials [Lindbeck et al, 2001] standing on a forceplate (Kistler 9286AA, Bioware software, 500 Hz). They lifted an object weighted at 14.6 ± 2.9% of their body weight for the YM group and at 11.5 ± 1.2 % of their body weight for the M-AM group. The GRF data analysis was performed with Bioware software (Kistler). Data analysis included the parameters of the total movement duration and the minimum value, the maximum value and the force range of the resultant GRF (F_R) as well as its three components; the vertical (Fz), the anterior-posterior (Fx), and the lateral (Fy) GRF. Statistical analysis of variance was applied for the significance of the differences between the YM and the M-AM group separately for each lifting technique as well as between the two lifting techniques ($p<0.05$, SPSS 19.0).

Results

No significant difference was found between the YM and the M-AM groups ($p > 0.05$). The comparison between the squat and the stoop technique revealed no significant difference in the total movement duration ($p > 0.05$). There were significant differences in the resultant GRF as well as in the vertical and the anterior-posterior GRF components (F_R: $p = 0.000$, Fz: $p = 0.000$, Fx: $p = 0.006$ and Fy: $p = 0.212$). In specific, the squat technique presented higher forces than the stoop technique that ranged from 69.0 to 69.8% for F_R and Fz and from 40.1 to 60.2 % for Fx.

Discussion

The ground reaction force comparison of the squat and the stoop lifting techniques reveals their kinetic differences. These differences are associated with the particular segmental configuration of each technique. The lower GRF developed in the stoop technique may be attributed to the smaller downwards and upwards displacement of the center of mass compared to the squat technique. Despite, the lower work demands associated to the smaller displacement of the center of mass the stoop technique is considered to produce greater lumbar forces and greater trunk loads [Faber *et al*, 2009] which are considered critical parameters for excessive lumbar stress [Dickey et al, 2003] and may lead to the occurrence of low back pain.

References

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