Optoelectronic evaluation of squat and stoop lifting techniques related to induced restrictions in range of motion of the knee joint: a pilot study

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Summary

Optoelectronic motion capture analysis to investigate the impact of knee joint restrictions on lumbar kinematics during lifting tasks, focusing also on EMG activation pathways of posterior kinetic chain muscles. By simulating real-world conditions, such as knee osteoarthritis, this research aims to enhance rehabilitation strategies for both knee osteoarthritis and LBP, contributing to improved clinical outcomes and global healthcare practices

Introduction

A debate around lumbar spine kinematics and its role in low back pain is still ongoing [1]. This pilot study explored the effect of knee Range of Motion (ROM) restrictions on lumbar spine kinematics and posterior chain muscle activity during squat and stoop lifting tasks [2]. This relationship reflects the concept of regional interdependence [3], where impairments in one anatomical area may influence others, a key principle in rehabilitation strategies

Methods

Fifteen healthy adults performed squat and stoop lifting tasks under three knee ROM conditions (squat: free/0-60°/0-90°; stoop: free/0°/0-30°) using optoelectronic motion capture and EMG systems. ANOVA one-way was applied to analyze lumbar spine angles in flexion/extension, side bending and rotation, and to assess muscle activation patterns for five posterior chain muscles.

Results and Discussion

No significant effects of knee ROM restrictions were observed for lumbar flexion/extension or side bending ($p > 0.15$), but pelvic rotation differed significantly ($p = 0.0103$). EMG analysis showed increased activation of the Gastrocnemius Lateralis (GL) and Biceps Femoris (BF) ($p < 0.001$), while Gluteus Maximus and Latissimus Dorsi activation remained unchanged.

Table 1. Data from motion analysis and EMG. Rotation angles AP - angles of the pelvis in the global reference frame. GL = Gastrocnemius Lateralis; BF = Biceps Femoris.

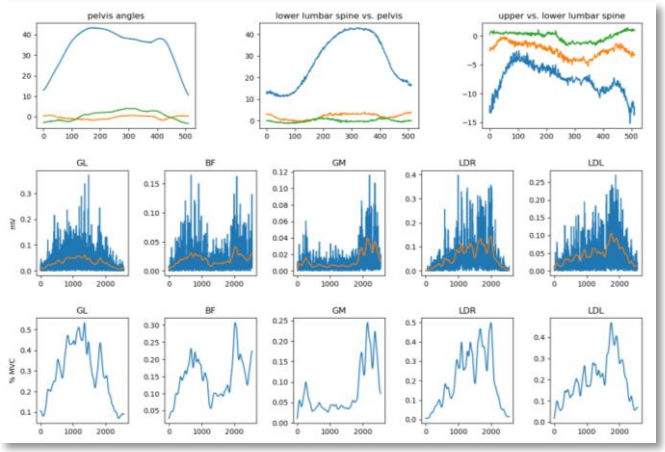

Figure 1. Plotted graphs for a typical subject

Knee ROM restrictions influenced muscle activation in distal posterior chain muscles and altered pelvic rotation, suggesting localized compensatory mechanisms, underpinning the role of regional interdependence in lifting biomechanics.

Conclusions

Knee ROM restrictions lead to significant changes in muscle activation patterns, especially for GL and BF. These muscles may play a compensatory role during restricted movements, showing interesting insights for rehabilitation strategies of individuals with knee ROM deficits, osteoarthritis or low back pain.

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References

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Results	df	sumsq	mean	f.value	p.value
Squat_AP	2	111.5	55.75	4.67	0.0103
GL	4	0.00626	0.00157	7.37	0.00000934
BF	4	0.0899	0.0225	6.15	0.0000798