Lumbar Forces during Load Lifting of construction workers: A Comparative Study between Brick and Bag Lifting

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Summary

Lifting heavy weights repetitively may yield low back pain and injuries in construction workers. We analyzed lumbar loads in four healthy subjects using motion capture and musculoskeletal (MS) analysis during two lifting activities: floor-to-shoulder lift with knee flexion, rightward trunk rotation, and load placement; and lateral mid-level to shoulder load transfer and placement. Motions were captured using infrared cameras and two force plates. The OpenSim Lifting Full-Body model served to estimate joint reaction forces at L4-L5 joint. Results showed peak compressive forces occurring during weight reception and unloading, identifying these as critical instants for injury risk. This analysis will serve to make recommendations on the technique used by construction workers aiming to reduce the risk of injuries like IVD herniation.

Introduction

Manual handling of loads is a common practice in the construction industry and a major cause of low back pain. In Colombia, this condition accounts for over 60% of work-related disabilities [1]. Therefore, it is essential to study the forces generated in the lumbosacral region during lifting activities to assess injury risks in this population. In recent years, motion simulation tools such as OpenSim have proven effective for analyzing lumbar forces [2]. However, no study has been devoted to analyzing Colombian workers, who possess a distinct anthropometry. Thus, OpenSim was used to estimate shear forces and moments at L4-L5 in four subjects with average Colombian weight and height, during two lifting tasks, typically performed by Colombian construction workers.

Methods

In this outgoing study, four subjects with anthropometric measurements within the medium range for Colombians were selected from a pool of forty uninjured participants who had been previously recruited and categorized based on height and weight. We recorded the locations of 39 reflective markers and ground reaction forces during two lifting activities**:** floor-to-shoulder lift with knee flexion, rightward trunk rotation; and load placement and lateral mid-level to shoulder load transfer and placement (Figure 1). The OpenSim Lifting Full-Body model augmented with actuators was used [3],[4] for the analysis. We applied model scaling, inverse kinematics, inverse dynamics, and static optimization to obtain the anterior-posterior and medio-lateral shear forces, as well as the compressive forces in the L4-L5 segment for each lifting task and subject. The weight of the external load was included in the analysis.

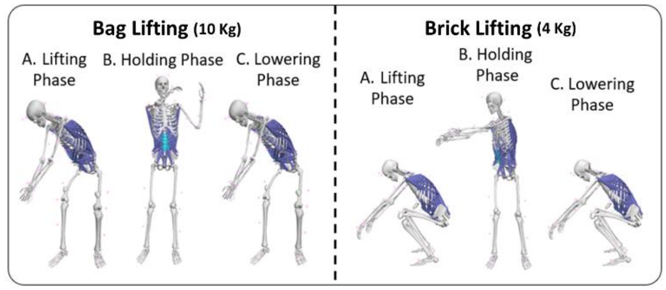

Figure 1: Analyzed lifting activities

Results and Discussion

The peak magnitudes of compressive forces and anterior-posterior shear forces were about 3300 N and 3200 N and 480 N and 540 N for bag and brick lifting, respectively (Figure 2). Both lifting activities yielded compressive forces near the allowable limit of 3400 N [5].

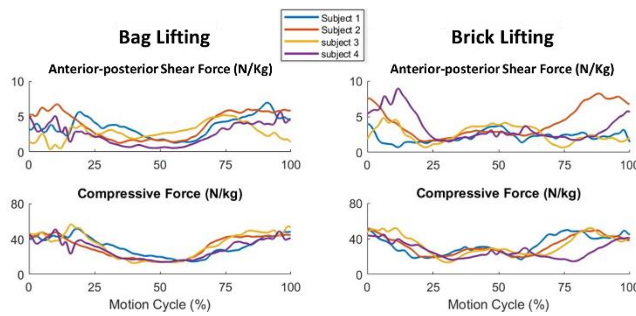

Figure 2: Normalized anterior-posterior shear force and compressive force in L4-L5 in two lifting activities of four subjects

Conclusions

The forces during load, support, and discharge phases follow similar patterns in both lifting types but differ in peak magnitudes. Compressive forces peak during the most critical moments of reception and discharge, reaching values near 3400 N, which is considered the injury threshold [5]. Although lower than compressive loads, shear forces remain significant and could contribute to spinal instability. In the next steps of this research, we will assess intervertebral disc injury risk by the finite element simulation of the 40 participants performing the described lifting tasks.

References

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