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COMPARATIVE ANALYSIS OF LUMBAR SPINE STRESS: CONVENTIONAL DEADLIFT VS. STRAIGHT-LEG DEADLIFT

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1. Introduction

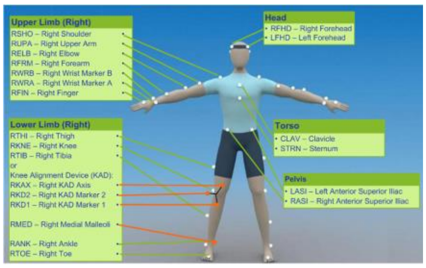
In modern workplaces and homes, lifting is a common yet critical activity, especially in jobs like delivery, production, construction, and for tasks at home, notably for parents and guardians. Repetitive lifting makes learning proper techniques essential to prevent musculoskeletal injuries, particularly in the lower back. [1]. The Bureau of Labor Statistics reports that 38.5% of all work-related injuries are back-related musculoskeletal disorders, largely due to improper lifting methods and a lack of proper training.

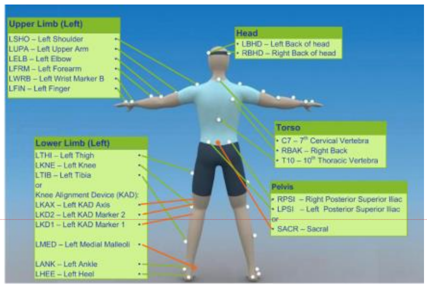
This study examines the biomechanics of lifting by analyzing straight leg and conventional deadlifts, which are key strength training exercises targeting back extensors and hamstrings. We focus on stress points at critical joints, specifically the L4-L5 segment in the lower spine and the hip joint, during these exercises. The aim is to provide biomechanical insights and practical, evidence-based recommendations for selecting the most appropriate deadlift technique. This guidance is intended to align with specific occupational requirements and everyday tasks, enhancing safe lifting practices across various settings and contributing to overall well-being.

2. Materials and Methods

Kinematic and kinetic data obtained from two deadlift trials with a marker error less than 0.009 ucm were recorded using VICON motion capture system and an AMTI force plate. This data was then applied to a modified computational musculoskeletal model. A static equilibrium problem was then solved at each instant during the deadlift cycle. The primary outcome measured was the peak compressive and shear forces on the L4-L5 vertebrea and hip joint during the lifts. This case study utilized an experienced lifter performing both deadlift styles in a controlled laboratory environment (24-059).

This study employed a marker placement strategy using 46 markers, aligning with VICON's Plug-in Gait model. These markers are strategically attached to key anatomical landmarks, including the head, shoulders, pelvis, and lower extremities as seen in the figure below.





Commented [MP1]: Update . RN, its 0.236 and I've gotta trim it down

A healthy male (83.5 kg and 1.8 m tall) free of any known musculoskeletal disorders, volunteered to participate in the current case stud. On the day of testing, the subject executed both the straight leg and conventional deadlifting forms. Each trial comprised 3 repetitions performed at a consistent cadence determined by the subject. A five-minute rest period was implemented between trials to mitigate the influence of fatigue. The motion capture analysis system employed (VICON Nexus, version 2.7; Oxford Metrics Ltd.) comprised eight [TYPE OF CAMERA] placed strategically around the subject area. All cameras underwent calibration, utilizing the lower of the two available frame rates (420 Hz, 330 Hz; V5, V2.2). A total of 49 reflective markers were affixed to the subject in positions depicted in Figure X. Concurrently, ground reaction forces (GRFs) were recorded using 2 AMTI force plates situated beneath the subject's left and right feet (OR6 2000 series; 1000 Hz; Advanced Medical Technologies Inc.).

Insert static optimization equation?
Static calibration uses a single frame of data. The subject is captured in a single
pose (body position). Regression equations are used to estimate / calibrate:
The location of a Virtual Joint Center point (relative to a segment)
A line defining the axis of rotation for the Joint
Vicon's Plug-In Gait model uses static joint calibration.

What is functional joint calibration?
Functional joint calibration uses multiple frames of data where the joint of
interest is moving (dynamic).
Using Range Of Motion (ROM) data from a joint enables functional joint
calibration to better estimate the true center and axis of a joint.

$$x = \sum_{i=1}^{4} x_i \cdot \varphi_i^g(\xi, \eta) \qquad (1)$$

3. Results

The study identified key biomechanical differences between conventional and straight-leg deadlifts. In the conventional deadlift, increased spinal shear forces were observed at the lift's start, indicating higher initial stress on the spine. Conversely, straight-leg deadlifts showed greater hip shear forces at full lockout, suggesting more strain on the hip joints towards the end of the lift. Muscle activation patterns varied significantly; the conventional deadlift engaged the erector spinae muscles more intensively, highlighting its utility in strengthening spinal muscles.

4. Discussion and Conclusions

These findings have important implications for both injury prevention and muscle strengthening. The increased spinal stress observed in conventional deadlifts underlines the need for caution and proper technique to prevent spinal injuries, especially in occupations and daily activities involving similar movements. On the other hand, the greater hip stress in straight-leg deadlifts points to the importance of strengthening hip muscles to prevent hip-related injuries. Understanding these distinct muscle activation patterns can guide individuals in choosing the right deadlift technique, whether the goal is to strengthen specific muscle groups or to minimize injury risk. This study emphasizes the importance of tailored exercise routines for balanced muscular development and injury prevention.

5. References

1. Brodland GW, Veldhuis JH. PLoS One. 2012;7(9):e44281 (2012).

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