Analyzing the effects of lifting speed for different lifting techniques on the load of the lumbar spine

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Summary

Joint loads are often investigated for different lifting techniques. However, lifting speed was rarely included in those studies. We investigated lumbar joint loading in ten participants lifting at three self-selected speeds (slow, moderate, fast) with three different lifting techniques (freestyle, squat, stoop). Results revealed significant increases in lumbar joint loads for increasing lifting speed, irrespective of the technique. Therefore, speed should be taken into account in future research. When controlling for speed, it seems like stoop lifting produces the lowest joint loads, but further research is needed.

Introduction

Even among medical professionals, there is a predominant belief that a round back should be avoided when lifting [1]. However, intervention studies have failed to show any effects of lifting techniques on musculoskeletal health [2]. Meanwhile, the effect of lifting speed has seldom been included nor investigated in studies on lifting techniques [3]. The aim of this study is to use an inverse dynamics model to analyze joint loads on the lumbar spine during three lifting techniques performed at three different speeds.

Methods

Ten subjects lifted a 10 kg-box using freestyle, squat and stoop lifting techniques at three self-selected speeds (slow, moderate, fast). Joint kinematics were obtained using an IMU based suit (MVN Link, Movella Inc., Enschede, Netherlands, 240 Hz) and ground reaction forces were obtained via force plates (Kistler Instrumentation, Winterthur, Switzerland). This data was then used as input for the validated inverse dynamic musculoskeletal model Myonardo® [4] to calculate the joint contact forces. The lumbar spine was modelled as one compound joint. True lifting speed was calculated as the maximum vertical speed of the right wrist. Peak joint force values and speed were used for statistical analysis via ANOVA and a multiple regression.

Results and Discussion

The total joint load of the lumbar joint increases significantly with lifting speed for each lifting technique (freestyle ($F(1,28) = 112.6$, $p < .001$, adjusted $R^2 = 0.79$), squat ($F(1,28) = 46.68$, $p < .001$, adjusted $R^2 = 0.61$), stoop ($F(1,28) = 70.06$, $p < .001$, adjusted $R^2 = 0.7$), see Figure 1). Stoop technique had the lowest average lifting speed ($\bar{v}_{Freestyle}$= 0.85m/s, $\bar{v}_{Squat}$ = 0.87m/s, $\bar{v}_{Stoop}$ = 0.57m/s) and led to the lowest lumbar joint load. However, figure 2 indicates that, even when considering this, stoop seems to lead to the lowest lumbar loads. Still, further investigation is needed. This study only took into account peak forces, but shear forces are also known to contribute to injury risk and should be addressed in future research.

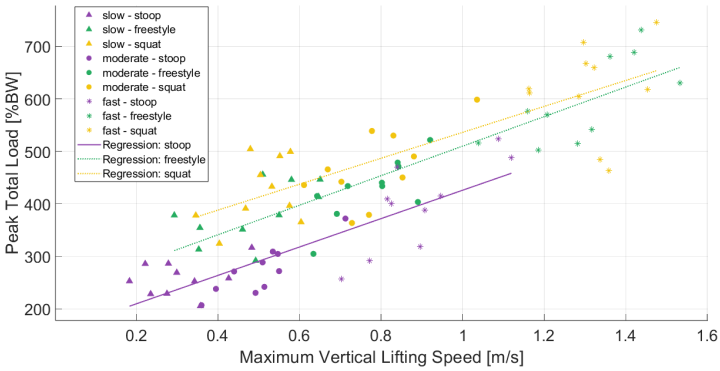

Figure 1: Relationship between actual lifting speed and peak lumbar joint loads for each lifting technique

Conclusions

Lifting speed proved to be a crucial factor influencing lumbar spine load. Therefore, it needs to be taken into account when analyzing lifting movements, especially when various lifting techniques are being compared. For similar lifting speeds, it seems like stoop lifting produces the lowest lumbar joint loads, challenging pre-existing notions of correct lifting techniques.

Acknowledgments

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References

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