Relation between trunk acceleration and trunk isometric strength in people with and without neuromusculoskeletal impairment

Lund Ohlsson M.[1,2], Rosén J.[1], Moorgat F. [3], Verdume L. [3], Westerlund H.[1], Janssens L. [1,3], Vanlandewijck Y. [1,3], Bjerkefors A.[1,4]
[1]BMC Laboratory, The Swedish School of Sport and Health Sciences, Stockholm, Sweden
[2]Swedish Winter Sports Research Centre, Mid Sweden University, Östersund, Sweden
[3] Department of Rehabilitation Sciences, Katholieke Universiteit (KU) Leuven, Leuven, Belgium
[4] Department of Neuroscience, Karolinska Institutet, Stockholm, Sweden
Email: marie.ohlsson@gih.se

Summary

Current measurements of trunk strength require equipment that is rarely available in the rehabilitation clinic or in sports. This study examined the relationship between maximal trunk accelerations measured with IMUs during seated trunk tasks and maximal isometric trunk strength in people with and without neuromusculoskeletal impairment (NMSI). The results showed good correlations between acceleration and strength, indicating that measurements of maximal trunk acceleration can potentially be used as an objective assessment in rehabilitation or sports to understand trunk strength in people with NMSI.

Introduction

Trunk strength is important in people with neuromusculoskeletal impairment (NMSI) for wheelchair mobility skills in daily activities and in sports. Trunk strength has been shown to be related to top speed and acceleration in wheelchair racing [1,2] and wheelchair court sports [3]. Measurements of trunk strength need equipment that is rarely available in the rehabilitation clinic or sports setting. Following Newton's law of motion (F=m*a), could trunk acceleration reflect the trunk muscle force produced? This study examined the relationship between maximal trunk accelerations during seated trunk tasks and maximal isometric trunk strength in people with and without NMSI.

Methods

Data was collected from 20 manual wheelchair users with NMSI (mean 49 years ±13.1 std, 12 males/8 females) and 20 able-bodied (AB) participants (35.1 ± 13.1 years, 9 males/11 females). The participants with NMSI had reduced hip and/or trunk muscle function, which was evaluated with manual muscle tests. Trunk movements, including flexion, extension, rotation, and lateral flexion, were performed with maximal acceleration in a seated position. The setup included a low backrest, a footrest, and strapping around the pelvis, legs, and feet to ensure stability. The trunk accelerations were measured with inertial measurement units (IMUs) (Xsens Technologies BV). Maximal isometric trunk strength was measured during flexion, extension, rotation and lateral flexion in a strength rig using a S-type one-dimensional force transducer (Sure Torque Europe Ltd).

Results and Discussion

There was a significant ($p < 0.05$) positive correlation (Pearsons' r) between maximal trunk angular acceleration and maximal isometric trunk strength for flexion $r = 0.48$, extension $r = 0.66$, rotation $r = 0.61$ and lateral flexion $r = 0.69$. AB participants demonstrated significantly higher ($p < 0.05$) trunk accelerations and isometric trunk strength in all directions (except for isometric strength in flexion) compared to the NMSI group.

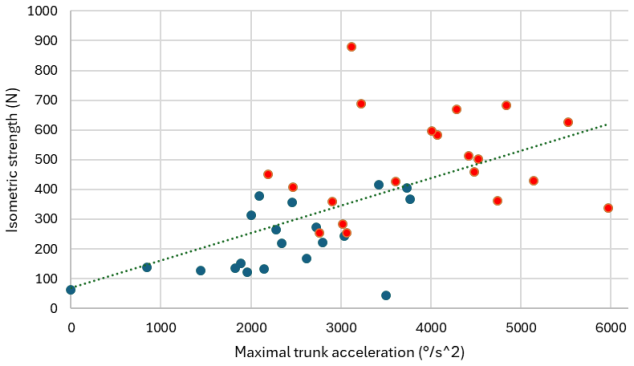

Figure 1: Plot of trunk rotational strength and acceleration for all participants (NMSI blue and AB red).

Conclusions

Measurements of maximal trunk accelerations can potentially be used as an objective assessment in rehabilitation or sports to understand trunk strength in people with NMSI. As measurement techniques are progressing fast, IMUs [4] or markerless motion capture in mobile phones or tablets could be feasible methods to measure acceleration and predict strength in the future**.**

Acknowledgments

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References

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