Validation of the Movesense Flash Sensor to Assess Soft-Tissue Vibrations in Running

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Summary

This study aims to validate the use of the Movesense Flash sensor for measuring accurately and reliably Soft-Tissue Vibrations (STV) when running at different running speeds by comparing it to a gold standard accelerometer. The results showed a good agreement between the two sensors, with a strong correlation between the measurements. These findings suggest that the Movesense Flash sensor could be a reliable tool for practically assessing STV when running.

Introduction

Vibration is a mechanical phenomenon that corresponds to variations in the speed of a physical body oscillating around its rest position. Vibration is mainly quantified using accelerometers and is characterized by its amplitude, oscillation frequency and damping coefficient. Recent studies used accelerometers (Dytran 3273A4, Dytran Instrument) with a high acquisition frequency and a wide measurement range [1]. However, these sensors suffer from a number of limitations inherent in the presence of a cable and time-consuming implementation. Newer wireless sensors (Movesense Flash, Movesense Ltd), provide easier usability but lower acquisition frequencies. This study aims to assess the ability of these sensors to measure STV accurately and reliably when running at different running speeds.

Methods

Two healthy, physically active adult volunteers participated in this study. Following a 5-minute standardized warm-up, participants completed five 1-minute running bouts at speeds of 8, 10, 12, 14, and 16 km/h on a treadmill, in a randomized order, with a 1-minute rest period between each interval. STV were recorded using both Movesense sensors and Dytran triaxial accelerometers taped to the muscle bellies of the Vastus Lateralis and Gastrocnemius Medius of one randomly selected leg. Movesense sensors were positioned adjacent to the corresponding Dytran accelerometers. The accelerometers were also attached to the heel cup of the shoe. STV parameters, including total magnitude, amplitude, median frequency, settling time, and damping, were estimated using Continuous Wavelet Transform.

Results and Discussion

Pearson correlation coefficients were calculated between the data obtained from the D and M accelerometers. The results demonstrated moderate to strong correlations between the two sensor types for the majority of the analyzed parameters. The correlations are strong for the median frequency ($r = 0.867$, $p < 0.001$), total magnitude ($r = 0.596$, $p < 0.001$), settling time ($r = 0.587$, $p < 0.001$), but slightly weaker for peak acceleration ($r = 0.495$, $p < 0.01$) and damping ($r = 0.509$, $p < 0.01$). Bland-Altmann plots illustrate a good agreement without systematic bias between the two methods (Figure 1). The agreement limits indicate a moderate spread of differences. The majority of points fall within the confidence limits suggesting reasonable agreement, though some bias may be present at higher running speed. These findings suggest acceptable inter-sensor reliability and support the validity of the data collected using the Movesense sensors.

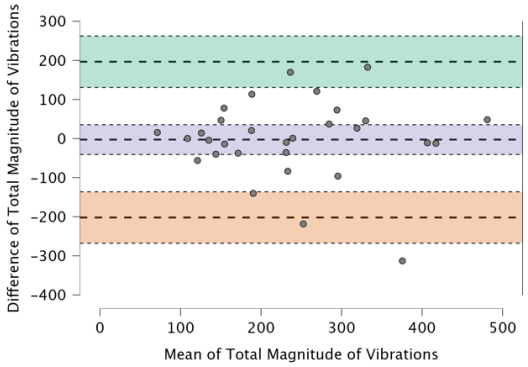

Figure 1: Bland–Altman plots of limits of agreement comparing the total magnitude of vibrations ($m.s^{-2}/Hz/s$) measured with the Movesense Flash and Dytran sensors.

Conclusions

This study aimed to investigate the validity of Movesense sensors for measuring STV in comparison to established Dytran accelerometers during running. Results demonstrated moderate to strong correlations between STV parameters recorded by both sensor types. We can hypothesize that the lower correlation for the peak acceleration is due to the limited range of Movesense (16g) compared to Dytran (100g) accelerometers. These findings suggest that Movesense sensors can provide reliable estimates of STV during dynamic activities, such as running. The compact size and wireless capabilities of Movesense sensors offer several advantages over traditional wired accelerometers and simplified data collection procedures. Further research with larger sample sizes is warranted to further validate the use of Movesense sensors for STV assessment.

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References

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