

Validation of an IMU wearable for treadmill walking

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1. Introduction

Total knee arthroplasty is an effective surgery in decreasing morbidity linked to osteoarthritis and restoring knee functionality and range of motion (ROM) [1, 2]. Successful outcomes depends on post-operative rehabilitation. In addition to clinical sessions, home or community-based rehabilitation may improve outcomes, however, outcome monitoring and compliance is poor [3]. Wearable technologies present a solution, by remotely monitoring and assessing patient progress.

Stryker have developed a wearable device, called MotionSense™ which remotely supports post-operative knee replacement rehabilitation, providing personalised rehabilitation, tracking of home exercises, and enabling healthcare professionals to continuously monitor rehabilitative progress remotely.

2. Research Aim

The aim of this study therefore was to validate the accuracy of MotionSense™ against a clinical motion capture standard.

4. Results

Treadmill walking was compared between 20 healthy younger participants (age 24 ± 4 years, mean \pm SD) and 14 healthy older participants (71 ± 5 years). Root mean square error (RMSE) data demonstrated excellent agreement between the devices with a pooled RMSE $< 3.5^\circ$ (Table 1 and Figure 2).

Participants	RMSE (°)	Pooled RMSE (°)
Younger	4.02 ± 0.99	3.37 ± 0.61
Older	2.44 ± 0.21	

Table 1. RMSE between Vicon and MotionSense for treadmill walking between older and younger participants.

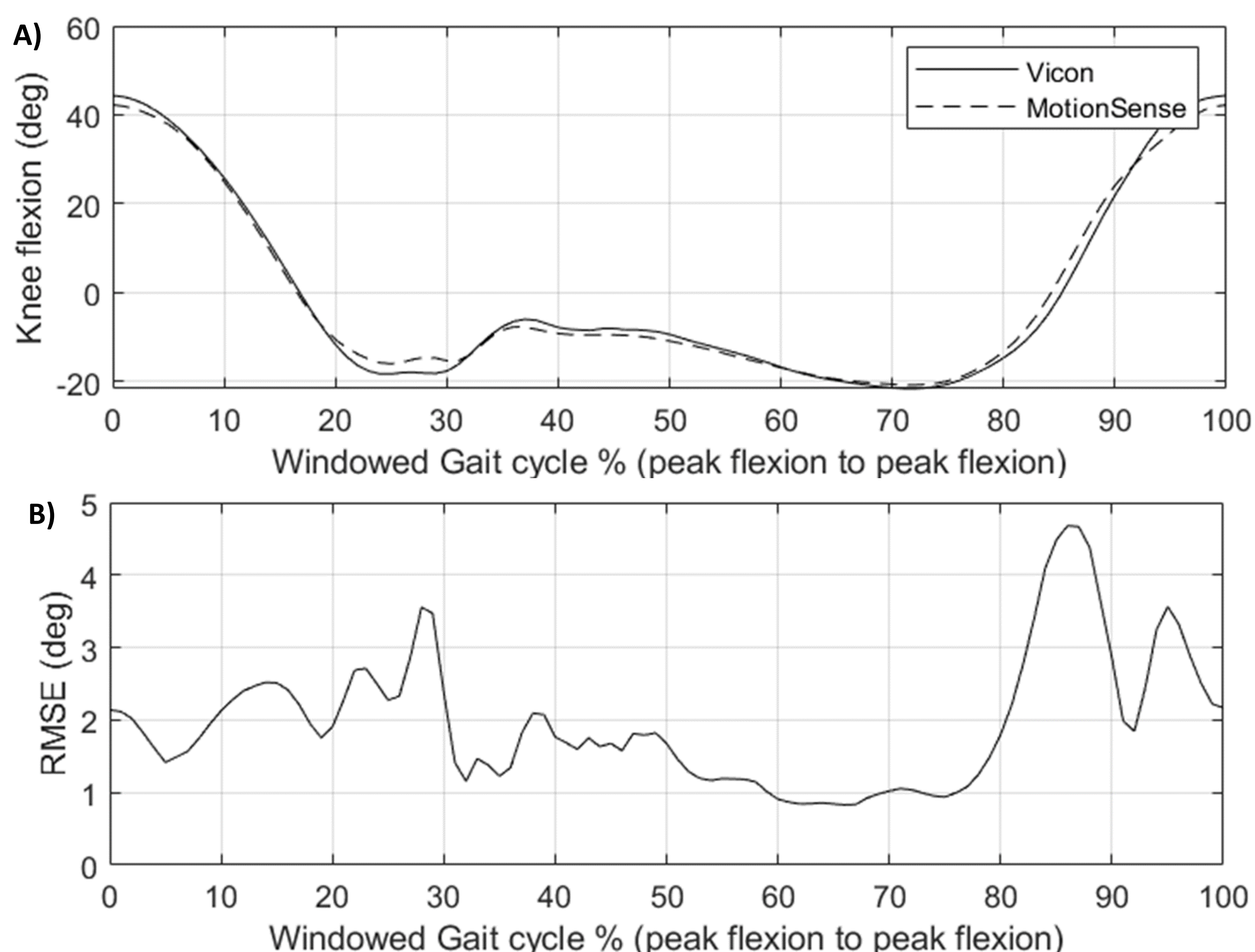


Figure 2. A) Comparison between Vicon and MotionSense™ from peak flexion to peak flexion for one older participant, B) RMSE between the two technologies.

3. Methods

Method	Description
Participants	20 younger individuals (24 ± 4 years, mean \pm SD). 14 older participants (71 ± 5 years).
Experimental Methodology	Retro-reflective markers and MotionSense™ attached to lower limb according to plug-in-gait (Figure 1). 5 min walking on a treadmill.
Data Processing	Data up-sampled 1000Hz. Cross-correlation used to time synchronise the measurements in gait cycle windows (peak flexion to peak flexion).
Analysis	RMSE was calculated between the MotionSense™ and Vicon. T-tests compared the populations (5% significance level).

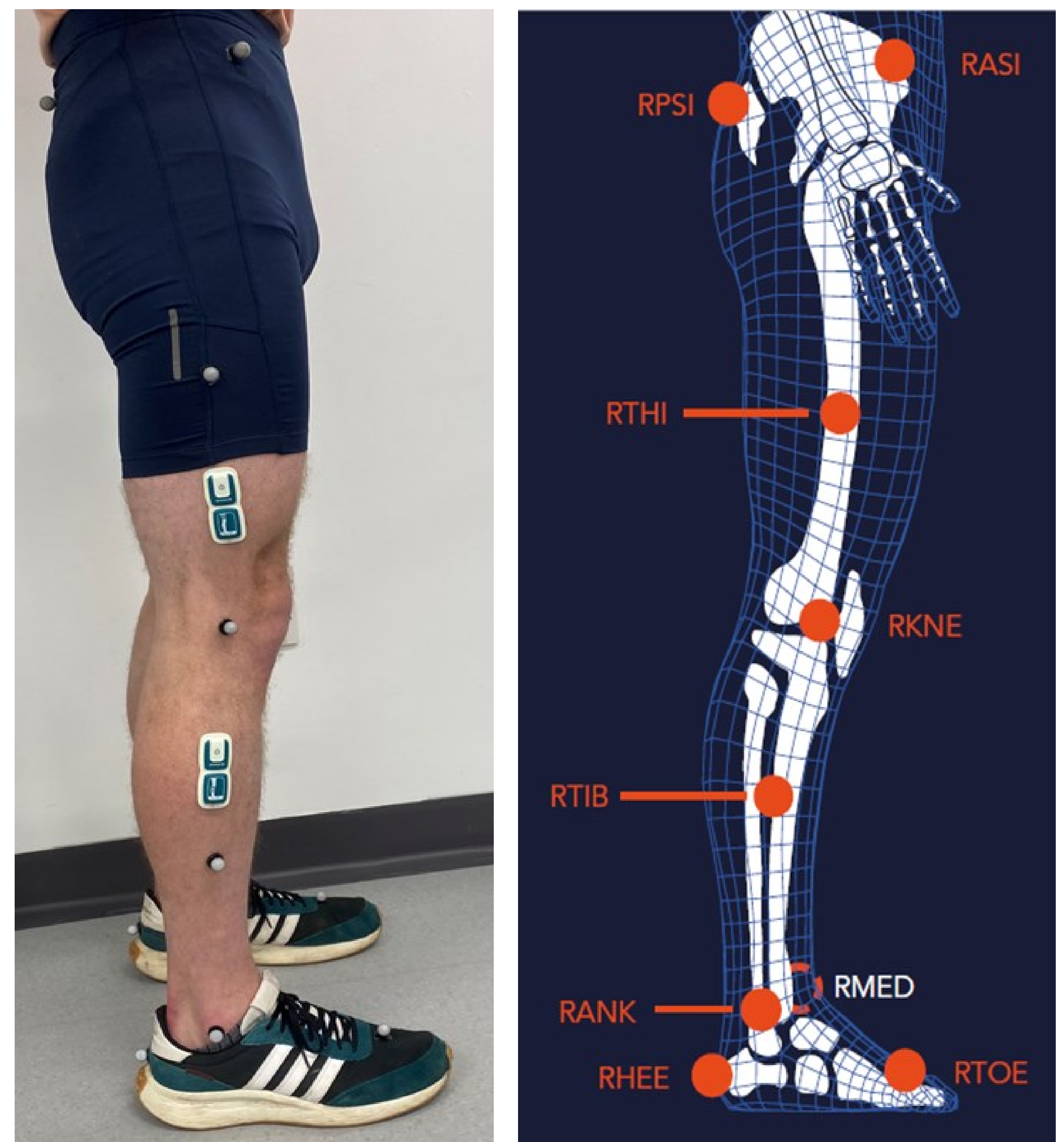


Figure 1. MotionSense wearable sensor attached above and below the knee joint, with the lower-limb plug-in-gait marker model.

5. Discussion and Conclusion

MotionSense™ performed accurately during treadmill walking in both older and young populations. The difference between the technologies may be considered clinically negligible given the inherent variation in such analyses.

6. References

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- [3] D. F. Hamilton *et al.*, "Targeting rehabilitation to improve outcomes after total knee arthroplasty in patients at risk of poor outcomes: Randomised controlled trial," *BMJ*, vol. 371, Oct. 2020, doi: 10.1136/bmj.m3576.