Can an inner disposable glove be used under an electro-goniometric glove for measuring finger movement without loss of accuracy?

J. Connolly¹, J. Condell³, K. Curran³, D. Small², P.V. Gardiner²

¹Letterkenny Institute of Technology, Letterkenny, Co Donegal, Ireland

²Altnagelvin hospital, Western Health and Social Care Trust, Londonderry, U.K.

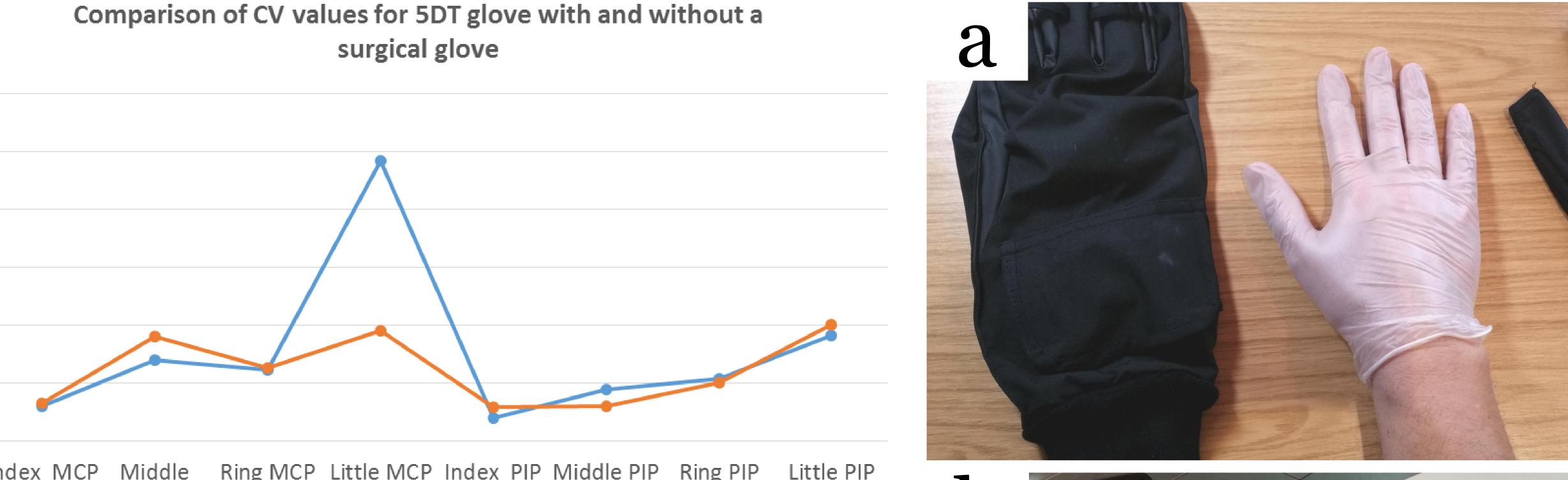
³ Intelligent Systems Research Centre, Ulster University, Londonderry, UK

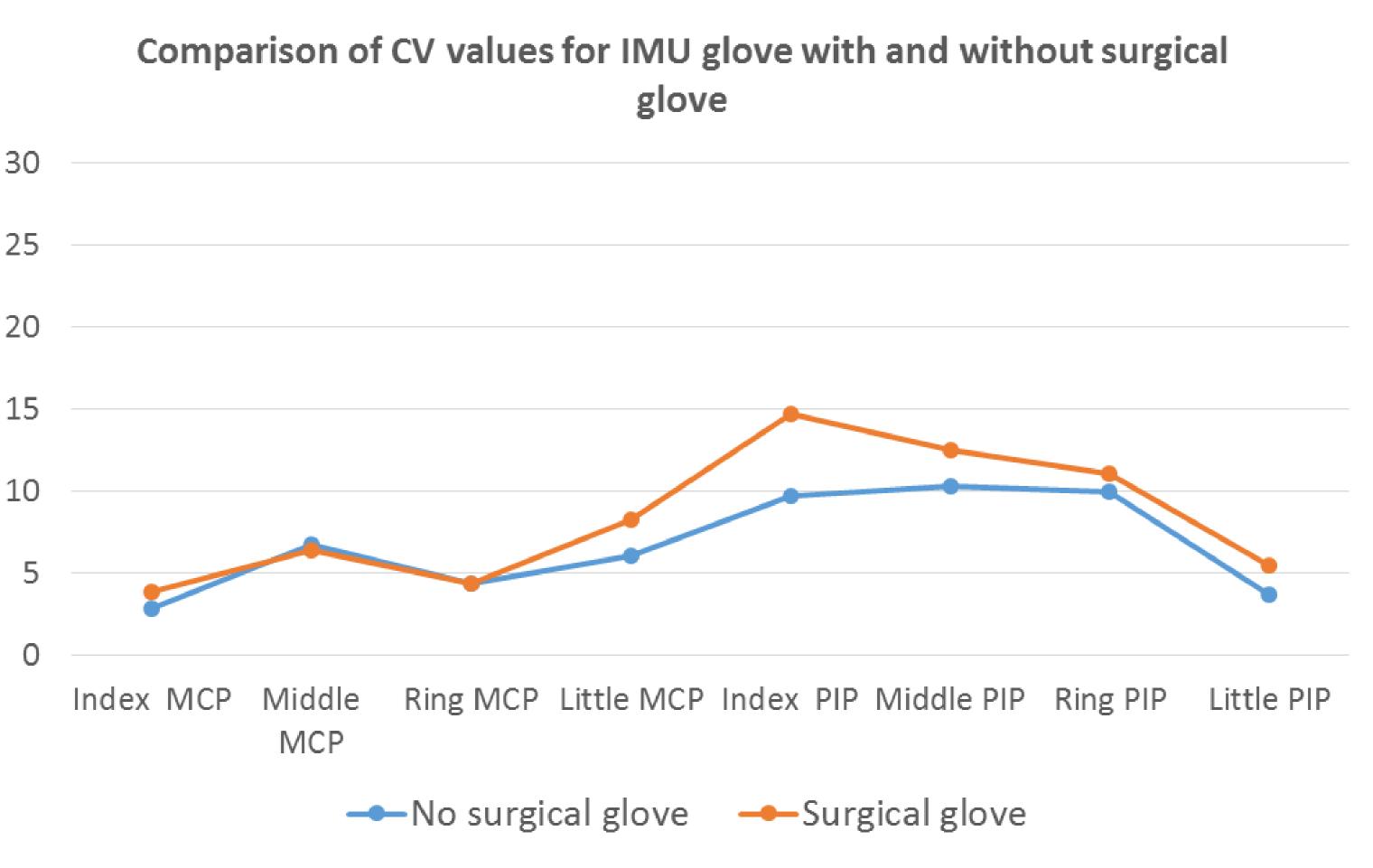
Introduction

Improving joint mobility is an important outcome for patients with arthritis, but finger joint range of motion is rarely measured in clinic. Electronic gloves with movement sensors have been developed to measure joint movement accurately and it is now possible to assess dynamic mobility of the finger joints. However these gloves are expensive and it is likely that when carrying out measurements in the patient population they would be used with inner disposable gloves to avoid nonsocomical infection. Establishing accuracy and usability of electronic gloves whilst wearing disposable inner gloves is therefore an important pre-requisite for studies in patients with arthritis.

Methods

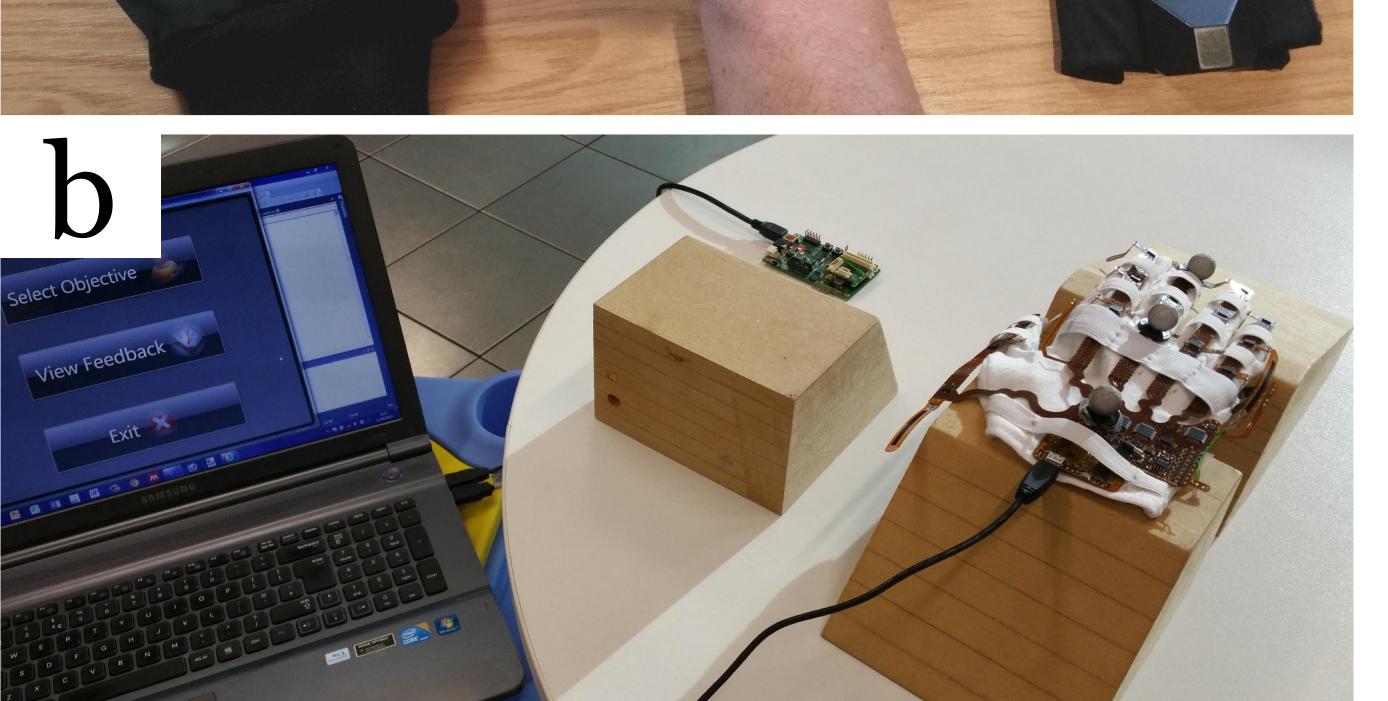
This validation study was performed on a subject with normal range of movement and no visible signs of Rheumatoid Arthritis. We used two different types of electrogoniometric glove for the purpose of this study. One is the commercially available 5DT dataglove 14 Ultra (5DT, 2011) and the other was produced to our specifications by Tyndall National Institute, University College Cork (shown in Fig. 2a). We called this the "IMU glove". We developed a graphical interface for both devices to facilitate detailed evaluation of joint movement in each finger (shown in Fig. 2b and 2d). Both gloves were tested using a protocol adapted from Dipietro, Sabatini, & Dario, (2003) (shown in Fig. 2c).





→ No surgical glove → Surgical glove

Figure 1: Comparison of Coefficient of Variation (CV) values for mean angular readings for both data gloves, with and without a surgical glove worn underneath.



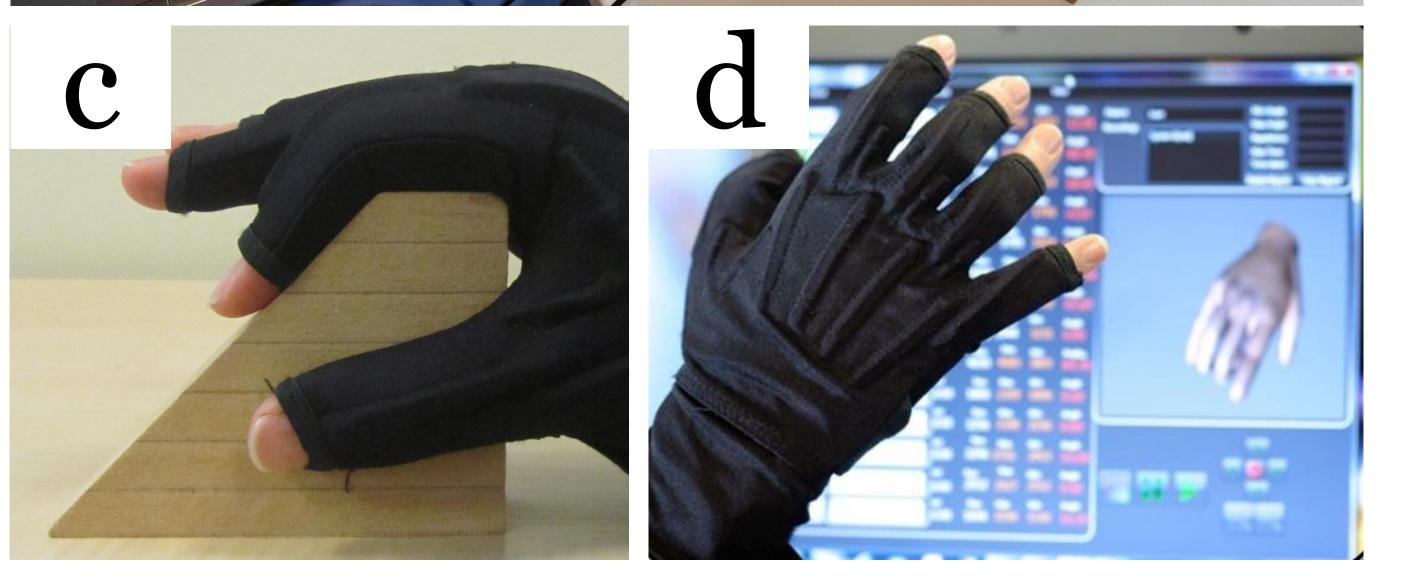


Figure 2: (a) two electrogoniometric gloves used for this study. (b) Vicon Motion capture testing procedures used for each glove. (c) Examining angular readings using blocks of wood. (d) Data glove with controlling software.

References

5DT, 2011. 5DT Data Glove 14 Ultra [WWW Document]. URL http://www.5dt.com/products/pdataglove14.html (accessed 1.10.12).

Dipietro, L., Sabatini, A.M., Dario, P., 2003. Evaluation of an instrumented glove for hand-movement acquisition. J. Rehabil. Res. Dev. 40, 179–89.

Dipietro, L., Sabatini, A. M., & Dario, P. (2003). Evaluation of an instrumented glove for hand-movement acquisition. Journal of Rehabilitation Research and Development, 40(2), 179–89.

Conclusion

The results of our study show that the use of a disposable glove worn under an electro-goniometric glove does not impair accuracy, especially at the MCP joint. A minor degree of variability was detected at the PIP joint. This study demonstrates that wearing disposable gloves under electrogoniometric gloves is feasible without significant loss of accuracy

Table 1: Comparison of Coefficient of Variation (CV) readings for both data gloves, with and without a surgical glove worn underneath.

	No surgical glove		Surgical glove underneath	
Sensor	5DT	IMU	5DT	IMU
Index MCP	2.97	2.86	3.22	3.88
Middle MCP	7.01	6.77	9.02	6.39
Ring MCP	6.10	4.37	6.28	4.32
Little MCP	24.17	6.07	9.55	8.25
Index PIP	1.96	9.72	2.92	14.69
Middle PIP	4.40	10.29	2.98	12.53
Ring PIP	5.38	9.95	5.00	11.03
Little PIP	9.11	3.71	10.07	5.46

Results

Table 1 displays comparison of Coefficient of Variation (CV) readings for both data gloves. Fig. 1 shows this information graphically. Results show no significant change for 5DT angular readings with and without a surgical glove worn underneath the data glove. Results for PIP sensors show improvement in repeatability with a surgical glove. CV variance was smaller for MCP sensors with a surgical glove worn underneath the data glove compared with no surgical glove. CV for the IMU data glove show negligible changes in MCP readings when a surgical glove is worn underneath. PIP readings show small changes when using a surgical glove.