AN INTELLIGENT ALGORITHM TO PREDICT MOVEMENTS AND POSTURES IN SPINAL CORD INJURED PATIENTS

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Introduction

During prolonged lying and sitting postures, the interaction between an individual and the underlying support surface can lead to damage of the skin and soft tissues, in the form of chronic wounds, such as pressure ulcers (PUs). Pressure monitoring systems have been used to evaluate this biomechanical interaction and determine the optimum postures and pressure relief strategies [1]. However, the short-term nature of this measure provides limited indicators of posture and mobility, which represent one of the primary interventions for PU prevention [2]. Our recent studies demonstrated the performance of selected biomechanical parameters derived from continuous pressure monitoring (CPM) [3,4] and an intelligent data processing involving convolutional neural network (CNN) was developed to detect both the frequency and type of postures. The aim of this study was to translate the CPM and algorithms to spinal cord injured (SCI) patients, deemed at risk of developing PUs [5,6].

Methods

Pressure data were acquired from twelve SCI patients, who were continuously monitored in phase 3 of their hospital rehabilitation. The study was approval by the Health Research Authority (IRAS-244580) and informed consent was provided from each patient. They were assessed on their allocated support surface, e.g., foam or air, using a CPM system (ForeSitePT, Xsensor, Canada) during prolonged periods of lying and sitting (48-72 h). Data was analyzed from pressure parameters and an intelligent algorithm was used to detect both the frequency and type of postures [5]. This involved a subject-specific threshold-based spatial derivative signal for detection of movements that offloaded vulnerable areas (MOVAs) and CNN for prediction of postures [4] (Figure 1). An independent clinical interpretation of movements and postures was retrospectively performed by a research nurse (SF). This information provided a subjective means to verify the events as predicted by the algorithm. The frequency of distribution of movement was correlated with spinal cord injury level and incidence of hospital acquired PU.

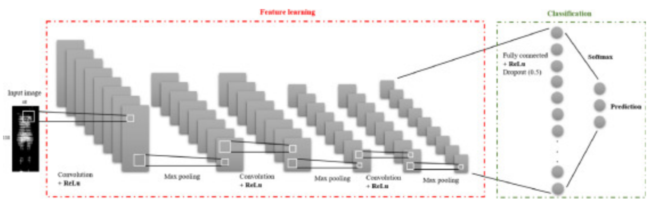

Figure 1. Illustration of CNN algorithm.

Results

The algorithm had an ~80% accuracy in detecting MOVAs when compared to clinical observations. Data revealed that higher SCI injury levels resulted in lower frequency of movement and larger gaps between MOVA (Figure 2). These had a corresponding high rate of PU, when compared to low level injuries e.g., lumbar.

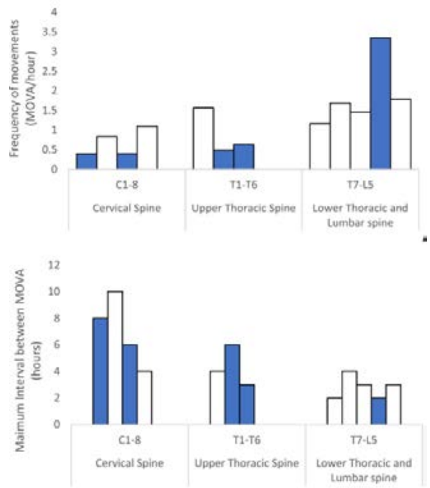

Figure 2. Frequency (top) and interval (bottom) of MOVAs in the SCI patients predicted with the algorithm.

Discussion

Prediction of posture and mobility can be achieved by combining continuous pressure monitoring and intelligent algorithms. The study demonstrated the robustness of both the derivative and CNN in detecting MOVAs. This was successfully translated to a vulnerable cohort of individuals with SCI, revealing distinct trends in movement dependent on injury level with some tentative trends with PU incidence.

References

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Acknowledgements

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