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Chapter VI

Visualisation of Clinical Gait Data Using a Self-Organising Artificial Neural Network

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ABSTRACT

The decision-making performance of gait experts varies depending on their background, training and experience. They have to analyse large quantities of complex gait data and this gives rise to an unbalanced use of the available information. These limitations inevitably lead to a biased interpretation. In this study, self-organising artificial neural networks were used to reduce the complexity of joint kinematic and kinetic data which form part of a typical instrumented gait assessment. Three dimensional joint angles, moments and powers during the gait cycle were projected from the multi-dimensional data space onto a topological neural map which thereby identified gait stem-patterns. Patients were positioned on the map in relation to each other and this enabled them to be compared on the basis of their gait patterns. The visualisation of large amounts of complex data in a two-dimensional map labelled with gait patterns is an enabling step towards more objective analysis protocols which will better inform decision making.

INTRODUCTION

The use of clinical gait analysis (CGA) in medical decision making is a controversial topic even today when it is widely recognised as a means to provide information about a patient's gait problems. On one hand, gait analysis is seen as a successful application of biomechanical concepts and methodologies applied to answer clinical questions related to the management of patients suffering from gait problems. The process of gait analysis is regarded as a collection of inter-linked methods that provide quantitative data about gait which are unavailable by any other means. Medical professionals can exercise evidence-based practices on the basis of objective information about their patients gained from performing gait analysis. The inter-disciplinary nature of CGA makes it possible to move beyond the pure mechanistic approach of the human body towards a movement disorder oriented view which leads to a pathology centred assessment of movement function thereby linking the biomechanical findings to medical interventions in a natural way.

On the other hand, it is well recognised that CGA has its limitations. As of today there are no widely accepted standards available in Europe that determine the technical, clinical and educational aspects of gait analysis, although there are some strong initiatives which move towards defining such essential measures. One of the most successful pioneering efforts is the standards laid down by the Clinical Movement Analysis Society of UK and Ireland (http://cmasuki.org). One would expect that certain gait abnormalities could be clearly defined through gait analysis, but even the sharing of a database on normal gait turned out to be problematic as witnessed by the participants of the Clinical Gait Analysis Web site in 1999 (http://www.univie.ac.at/cga/faq/norms.html). When it comes to purchasing the expensive services of a gait analysis laboratory then the customer looks for independent evaluations. One such report was published by the Technology Evaluation Centre on Gait Analysis for Pediatric Cerebral Palsy (Technology Evaluation Center, 2002) which concluded that such a service does not meet their criteria.

The benefits of CGA are shadowed by its limitations because the specific contribution of instrumented gait analysis to clinical decision making is not well known (Fuller et al.,2002). There is currently no clear evidence that medical intervention guided by CGA has better outcomes than intervention without CGA. Although there is insufficient evidence to support the claim that the use of gait analysis improves outcomes (Hailey and Tomie, 2000), there is evidence to suggest that gait analysis alters decision making in cerebral palsy (DeLuca et al.,1997; Kay et al.,2000; Cook et al.,2003) and it can promote higher agreement between surgeons in surgical planning (Fuller et al.,2002).

The outcome of the decision-making process is largely dependent on a number of factors. Perhaps the two main limitations of CGA are: (a) the subjectivity of interpretation due to varied levels of expertise, and (b) the inherent difficulty in comprehending large amounts of information. With regard to the first limitation, a gait analysis report is interpreted by different experts in various ways (Watts, 1994; Skaggs et al.,2000). Neurologists, specialists in physical and rehabilitation medicine, and physiotherapists adopted distinctly different strategies when analysing gait by focusing on the anatomical localisation of lesions, biomechanical findings and describing details of gait deviations, respectively (Watelain et al.,2003). Inconsistent interpretation of gait analysis data

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