Investigating the Use of Visualisations of Biomechanics in Physical Rehabilitation

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Abstract. Biomechanical analysis can be used to scientifically assess the causes of movement problems, measure progress and validate outcomes. However, the complexity of the data produced and the training required to use the available biomechanical analysis tools prevents the widespread understanding of this form of analysis beyond those with a background in biomechanics. This paper reports on multidisciplinary research, funded by the MRC’s LLHW programme, into the generation of three-dimensional, dynamic visualisations of biomechanical data and investigation of their use during functional rehabilitation trials, e.g., post-stroke, knee-joint replacement, and older adult exercise. The research will test the hypothesis that increased understanding of biomechanical concepts and measurements through this method of visualisation by both patients and clinicians will result in better patient outcomes.

Keywords: Visualisation, Biomechanics, Rehabilitation.

1 Introduction

Biomechanical analysis can be used to scientifically assess the causes of movement problems and to measure rehabilitation progress and outcomes. However, at present biomechanics is only explicitly used in a small number of specialist rehabilitation scenarios. This paper reports on multidisciplinary research investigating the use of visualisation software to enable the application of biomechanical data and analysis in a wider range of rehabilitation settings.

The paper begins with a discussion of the benefits which biomechanical analysis can provide for rehabilitation, and the factors which currently limit its widespread use. The approach taken in the research to overcoming these limitations is then introduced: firstly, the potential for visualisation techniques to communicate complex, dynamic biomechanical data in an accessible way to those without biomechanics training; secondly, the investigation of the application of the visualisation software to five different rehabilitation scenarios, which cover a range of different rehabilitation settings and complexity of patient condition. In the last section, the implications of the different rehabilitation settings are discussed: hospital, community and home.
2 Biomechanics in Rehabilitation: Current Limitations and Potential Benefits

The aim of physical rehabilitation is to work the musculoskeletal system in the most effective way to restore function and quality of life following injury or illness e.g. to rebuild soft tissue which has been damaged or underused; or enable relearning of motor control of muscles following brain injury.

Rehabilitation professionals therefore need to (a) assess the difficulties the patient is having with movement, and (b) determine and discuss with the patient realistic rehabilitation goals, and a programme of rehabilitation tasks which could restore their function to meet those targets.

Human movement is complex and dynamic. If you ask several people to perform the same functional task, each will achieve it by moving their body in a different way – these differences are often subtle and therefore difficult to see by eye. Biomechanics can provide highly accurate data on human movement beyond the immediately observable. However, to date biomechanical data measurement and analysis have only been used in a small number of rehabilitation scenarios. The most common clinical application for biomechanics is in gait analysis. Due to current biomechanical analysis systems, these are specialist sessions which are expensive both in terms of the equipment required and the number of staff needed to collect and interpret the results.

The following sections describe the limitations of current biomechanical analysis systems and software, and the potential benefits which could be provided for patients if these limitations could be overcome.

2.1 Limiting Factors to Widespread Use of Biomechanics in Rehabilitation

The biomechanical analysis systems currently available are highly accurate, and provide dedicated software to analyse the kinematic and kinetic parameters of movement. While the tools offer flexibility for specialists, there are a number of limitations to the systems which make them unsuitable for general clinical use.

- The analysis software is tightly integrated with expensive laboratory equipment limiting its use to only a small number of hospital facilities. The majority of therapists in the UK rarely have access to motion analysis equipment [1].
- Most therapists do not have training in biomechanics to the level required to collect motion analysis data and then use the software to perform an analysis.
- Interpretation of the data collected by motion analysis, particularly with clinical gait data, is also considered to be problematic [2]. “Interpretation of biomechanical data is complex, time consuming and not readily understood by most therapists” [3].
- Biomechanical analysis tools are designed to be general purpose, and are not tied to any particular rehabilitation application. This is beneficial in terms of the flexibility of the tools. However as a result, they provide all the data measurements from a motion without any guidance on which parameters are important or how they relate to each other.