

on 20 consecutive workdays. Members of the robotic group received thirty-minute-long robotic therapeutic events for addition. The clinical status of each patient was assessed before the first therapeutic session and at the end of the programme. The measured parameters were as follows: modified Ashworth score of shoulder adductors and elbow flexors; range of motion of shoulder and elbow; the Fugl-Meyer scale – shoulder and elbow subsection; Rivermead Motor Assessment – arm score; Functional Independence Measure and Barthel score. The assessment was made by a blinded physiotherapist. SPSS software (package 14.0) was used to perform the statistical data analysis. The differences in the scores between the initial and final assessments were statistically evaluated by the Mann Whitney test.

### Results

The shoulder-elbow subsection of the Fugl-Meyer score increased from an average of 21,73 to 24,33 in the control and from 17,67 to 23,07 in the robotic group ( $p < 0,001$ ). The modified Ashworth score of the shoulder adductors decreased more considerably in the robotic group ( $p = 0,056$ ). Most of the other measured parameters also improved to a higher degree in the robot mediated therapy group, although the difference was statistically non-significant. Nevertheless, these positive changes did not appear in the functional outcome. Subjects received altogether 150 hours of robot mediated therapy. No adverse events occurred.

### Conclusion

The aim of this study was to investigate the usefulness of the physiotherapy executed by the REHAROB Therapeutic System. The results suggest that it could be useful to supplement traditional physiotherapy with robot mediated one.

### Future plans, work in progress

The first prototype of the REHAROB Therapeutic System completed altogether 15 months successfully with exercising hemiparetic patients. The system is about to be upgraded with a new controller from ABB: a single IRC5 Multimove control unit will replace the two S4C Plus controllers that will improve the system performance by reducing the resistance against the teaching-in movement of the physiotherapist. The next task will be to obtain medical certification from the Hungarian authority, ORKI, which will allow the system's use in regular daily robotic therapy in the National Institute for Medical Rehabilitation. Depending on the outcome of a second controlled trial on higher number of patients, the system will be optimized. The REHAROB Therapeutic System offers the potential for biomechanical and physiotherapist-administered upper-limb treatments based on intelligent physiotherapy. The role of the robot is not to replace the physiotherapist, but rather to widen the treatment options. Research will investigate the use of the system with enhanced impedance control

and virtual reality based User Interface spreading from the passive to active motion therapies. The robots also help to monitor patients' progress by keeping detailed records of exercise regimes and patient responses. This helps to refine treatment programs and could be used to develop rehabilitation strategies for other neuro-motor impairments. The development of new treatments will be the focus of future work, once medical certification has been obtained and the REHAROB Therapeutic System is in regular clinical use.

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## The development and clinical application of a new, small hand joint, functional 3D motion analysis assessment system for rheumatology and musculoskeletal rehabilitation research.

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### Background

In hand and upper limb rehabilitation, the assessment of therapy outcome needs to be valid and reliable. In rheumatology, accurate measurement of the impact of therapy on hand function is challenging. Free arm goniometers are traditionally used to measure hand joint motion. In the rheumatoid patient, accurate placement of goniometer arms is difficult when small hand joints may be swollen, deformed or subluxed<sup>1</sup>. Furthermore the intra and inter-rater repeatability coefficient for distal hand joints has been reported to be as much as 6 and 10 degrees<sup>2</sup>. The lack of responsiveness of such measurement has also been highlighted<sup>3</sup>. New motion analysis assessments techniques have been designed<sup>4,5</sup> but these are not designed for small joint hand assessment. This paper describes the development and application of a novel 3D motion and functional hand analysis technique that has been developed and clinically applied by biomedical engineers and clinical therapists.

## Objectives

- 1 To describe the development of an accurate method for assessing small joint ROM in the rheumatoid wrist and hand using a 3D motion analysis system
- 2 To discuss the clinical application of a functional hand assessment used in conjunction with 3D motion analysis
- 3 To illustrate the clinical applicability of a novel method of 3D motion analysis using the Vicon motion analysis system

## Methods

A review of upper limb assessments was carried out to identify the most appropriate hand function assessment to use with the Vicon 3D motion analysis system<sup>6</sup>. The Southampton Hand Assessment Procedure (SHAP) was chosen for both its psychometric properties and design. The SHAP tests a range of daily functional hand grips using 12 abstract object tasks and 14 functional tasks, combining 6 classical grip postures. Each SHAP task is timed allowing for direct comparison to the kinematic data collected by the Vicon system. The Vicon is an infrared 6-camera system, which uses 3mm hemispherical markers placed dorsally and proximal to each joint. A validated standardised protocol for the positioning of markers on the wrist and hand was developed<sup>7</sup>.

## Results

The SHAP generates a Functionality Profile, which is a score for each grip posture and a summary Index of Function score both of which have been seen to be applicable to quantifying rheumatoid hand function. Assessment accuracy was improved by incorporating a patient activated start/stop timer synchronised with the Vicon system via an analogue input, removing the potential for assessor subjectivity in measurement. This synchronised timer allowed for a defined movement cycle for objective comparison between patients, impairments, interventions and repeated efforts.

Inter and intra-rater reliability for the 3mm wrist and hand marker placement for the kinematic model was seen to be excellent ( $r = 0.946$ )<sup>7</sup>. The use of marker placement proximal to the joint should assist in decreasing potential measurement error influenced by any rheumatological joint synovitis.

## Conclusion

The Vicon 3D motion analysis and the SHAP have been seen to be an appropriate tool to assess hand impairment and hand function in a rheumatoid population. To improve the clinical significance of results generated from 3D functional motion analysis patients' own perceptions of their functional ability should be reported alongside kinematic data.

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## Weight bearing training with SmartStep biofeedback system - a pilot study on stroke patients

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### Background

Gait and pre-functional activities are the most frequent performed physiotherapy activities (Jette 2005). A part of gait training is postural awareness training with which physiotherapists try to improve awareness of the alignment and the position of the body and achieve as symmetrical weight bearing as possible. The training mainly depends on the physiotherapist's observation and patients' sensations.

SmartStep is a simple biofeedback device which gives patients and therapists feedback information on the amount of weight put on an impaired limb.

### Objectives

The aim of the study was to find out whether weight bearing and gait could be improved by using the SmartStep biofeedback system which gave the patients a sound signal when they put enough weight on the impaired lower limb.

### Methods and subjects

Fifteen stroke patients (14 men and 1 woman) who had been admitted for primary rehabilitation after stroke to the Institute for rehabilitation and were able to walk, were included into the study. They were randomly divided into control (8 patients) and SmartStep groups (7 patients).

The SmartStep system is composed of a flexible air-inflated insole, a control unit which is fixed at the patient's ankle and software.

During gait training, all the subjects used the SmartStep system. The subjects in the control group had the system switched off, while those in the study group had it switched on. Each day before physiotherapy, the therapist in the training group measured the weight bearing and adjusted the sound signal to be triggered when the weight bearing would be greater than the initial level increased by ten percent of the patient's body weight. Before starting, weight bearing and timed walking