

A study of the activity of patients treated with Ilizarov fixator using the physical activity monitor (PAM)

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Abstract: Fractures are common orthopaedic problems, and the Ilizarov technique of distraction osteogenesis is becoming a more common way of treating complicated fractures. Mechanical load plays a vital part in the healing of musculoskeletal system. The Ilizarov frame allows the fracture segments to have micro movement within the fracture gap and to bear weight on the fractured limb, while the fracture segments are still held relatively stable. The technique and data reported here are part of a larger study of patients being treated with the Ilizarov technique. This study is investigating whether the loading applied to the bone varies between individuals and how this might modulate the healing process. The range of methods used in this study include questionnaires (assessing activity, pain and psychological parameters), radiographs, IRS, and blood sampling. In addition, we have developed an array of displacement transducers, together with an algorithm to analyse the data, which we intend to use to assess actual loading in the fracture area. The data obtained from the Human Activity Profile (HAP) questionnaire and PAMs will therefore be fitted into this mosaic of techniques, to provide a detailed picture of the inter-relationship of these various aspects of fracture healing in vivo, when the Ilizarov fixator is applied.

Monitoring the patient's daily activity will provide vital critical information for research and for clinical diagnosis. Obviously it is very difficult to monitor the fracture patients' routine mobility for a continuous 24 hour period. In this study, we used the Physical Activity Monitor (PAM) to study the patients' continuous ambulatory activity over 24 hours.

The Physical Activity Monitor (PAM) is a TriTrac acceleration monitor which can be used to record data for 24 hours. It weighs 55 grams, with dimension of 64x62x13 mm, which allows us to track a patient's daily activities without affecting his normal activity and life pattern. PAM has been used to study Obstructive Pulmonary Disease¹, Rheumatoid Arthritis², knee problems³⁻⁶ and also chronic disease, back surgery and tumor surgery of the leg. It is presumed that the fracture site will bear some loading during the action period, e.g. walking, stair climbing etc.

In order to prevent extraneous movement during use, the PAM is firmly secured to back with a backpack belt. The PAM was taken home by the patient and it is suggested that he switches it on when he feels that he is undertaking normal activities. The very large amount of recorded data obtained was analyzed using Matlab to identify the acting and non-acting duration. This entailed writing a novel program to analyze the mass of data.

The HAP is a self-reporting questionnaire. It consists of a list of 94 activities ranked in ascending order of level of energy required to perform each activity. The questionnaire is calculated using the Maximum Activity Score⁷ and the Average Activity Score (AAS). MAS gives the maximum activity the patient can still do, while AAS gives a better assessment of the range of activities performed and of the presence of impairment. These scores will be compared with the PAM result to study the patient's activity times in each study period and throughout the fracture healing process.

We have previously validated this approach by giving the HAP questionnaire to 12 Ilizarov patients over the distraction period. The data obtained showed that, as healing progressed, the HAP score for an individual increased. We report here on the relationship between the HAP score and actual activity, measured using the PAM.

A limb lengthening patient, with 41mm distraction length, was studied for the whole lengthening period of 113 days. The average acting time, as measured by the PAM, was 4277 seconds over a 24 hours period. The AAS was 47, and the correlation coefficient *r* between the two results was 0.611. This result suggests that the activity as measured by PAM recording and the HAP score have a strong positive correlation, with high-levels of PAM results associated with high-levels of HAP scores. It also found that the patient's time of activity had just slightly increased during the limb lengthening. This could be attributed to less new bone formation during the lengthening phase. We have recently

In conclusion, these preliminary data demonstrate that it is feasible in the clinical situation to use both the patient-reported activity (the HAP) and real-time activity measurement techniques (the PAM) for assessing the actual activity of patients treated by the Ilizarov technique.

REFERENCES:

- ¹F. Pitta et al. (2005) *Am J Respir Crit Care Med.* **171**: 972-7.
- ²M. Munneke et al. (2001) *J Rheumatol.* **28**: 745-50.
- ³D. J. Walker et al (1998) *Br J Rheumatol.* **37**: 969-71.
- ⁴L.B. Mokkink (2005) *Arthritis Rheum.* **53**: 357-363.
- ⁵N. van den Dikkenberg et al (2005) *Osteoarthritis Cartilage*
- ⁶N. van den Dikkenberg et al (2002) *Knee Surg Sports Traumatol Arthrosc.* **10**: 204-12
- ⁷P.S. Freedson et al (1998) *Med Sci Sports Exerc.* **30**: 777-81

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