Physical Activity Monitoring in Patients with Peripheral Arterial Disease: Validation of an Activity Monitor

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WHAT THIS PAPER ADDS

The aim of the study was to validate a tri-axial activity monitor to measure daily activities and walking steps (physical activity) in patients with intermittent claudication. A clear call in vascular research for alternative tests to determine walking capacity or walking behaviour in patients with peripheral arterial disease (PAD) has been made. This study validated an activity monitor to measure these types of outcome variables, which may offer a valuable contribution to the research armamentarium of PAD and could therefore support future PAD research.

Objectives: The daily life physical activity (PA) of patients with peripheral arterial disease (PAD) may be severely hampered by intermittent claudication (IC). From a therapeutic, as well as research, point of view, it may be more relevant to determine improvement in PA as an outcome measure in IC. The aim of this study was to validate daily activities using a novel type of tri-axial accelerometer (Dynaport MoveMonitor) in patients with IC.
Methods: Patients with IC were studied during a hospital visit. Standard activities (locomotion, lying, sitting, standing, shuffling, number of steps and "not worn" detection) were video recorded and compared with activities scored by the MoveMonitor. Inter-rater reliability (expressed in intraclass correlation coefficients [ICC]), sensitivity, specificity, and positive predictive values (PPV) were calculated for each activity.
Results: Twenty-eight hours of video observation were analysed ($n = 21$). Our video annotation method (the gold standard method) appeared to be accurate for most postures (ICC > 0.97), except for shuffling (ICC $= 0.38$). The MoveMonitor showed a high sensitivity (>86%), specificity (>91%), and PPV (>88%) for locomotion, lying, sitting, and "not worn" detection. Moderate accuracy was found for standing (46%), while shuffling appeared to be undetectable (18%). A strong correlation was found between video recordings and the MoveMonitor with regard to the calculation of the "number of steps" (ICC $= 0.90$).
Conclusions: The MoveMonitor provides accurate information on a diverse set of postures, daily activities, and number of steps in IC patients. However, the detection of low amplitude movements, such as shuffling and "sitting to standing" transfers, is a matter of concern. This tool is useful in assessing the role of PA as a novel, clinically relevant outcome parameter in IC.

Article history: Received 24 December 2013, Accepted 8 April 2014, Available online 28 May 2014
Keywords: Activity monitor, Ambulatory activities, Intermittent claudication, Physical activity

INTRODUCTION

In daily life, patients with symptomatic peripheral arterial disease (PAD) may be severely limited owing to symptoms of intermittent claudication (IC). Disease severity and the effect of treatment modalities are often assessed by outcome measures such as maximum and pain-free walking distance. However, a large discrepancy and variability has been reported between walking ability and claudication walking distances as measured on a treadmill, suggesting that treadmill assessments may not be representative of daily life walking ability.[1–3] Assessment of IC using patient-reported outcomes is subjective and insensitive, and a poorly reproducible tool for determining the severity of symptoms.[4–6] Objective clinical measurements such as Doppler ultrasonography and angiography only provide information on vessel patency and lesion severity. These imaging techniques are registered under standardised

DOI of original article: http://dx.doi.org/10.1016/j.ejvs.2014.04.008
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1078-5884/$ – see front matter
http://dx.doi.org/10.1016/j.ejvs.2014.04.003

conditions and do not take the patients' coherent daily ambulatory limitations into account.

A clear call has been made for alternative tests to determine walking capacity over a prolonged period of time.[1,2] Moreover, despite the fact that patients with IC have an increased risk of cardiovascular or cerebrovascular events,[7] current treatment for PAD is mainly focused on the limitation of walking distance. However, an increased walking capacity does not automatically imply a change in a patient's exercise behaviour. From a therapeutic, as well as a research, point of view, it may be more relevant to determine physical activity (PA) as an outcome measure for treatment modalities of IC. Improved levels of PA might be indicative of an increased exercise behaviour resulting in a reduction in the risk of cardiovascular events and an improvement in quality of life in the long term.[8,9] In the past, habitual PA was frequently ascertained using questionnaires or diaries, but patients are known to report inaccurately, and results tend to be biased owing to socially desirable answers.[4–6] Therefore, it seems necessary to obtain an objective measure of a patient's PA over a prolonged period of time.

Nowadays, PA levels can be measured with activity monitors. Tri-axial accelerometers measure acceleration in three dimensions that can be converted to intensities and metabolic equivalents (METs), which enables quantification of overall PA. The Dynaport (DP) MoveMonitor (McRoberts, The Hague, the Netherlands) is such an activity monitor and is easily applicable in a daily life setting and optimised for clinical research assessments. The DP has previously been validated in an elderly population,[10] in Parkinson disease,[11,12] and patients with chronic obstructive pulmonary disease (COPD).[13–15] To our knowledge, studies validating the DP in detecting daily activities in a PAD population have not previously been reported. However, symptoms of IC may significantly influence the outcomes of the DP owing to altered walking patterns which may have an impact on the detection of gait and postures.[16–18] Furthermore, all previous studies were performed in a laboratory setting with patients walking a specific trajectory.[10–13] Moreover, the number of observation hours has been rather limited and obtained from small groups.[10,11,13,15] One study excluded patients with walking impairments and two other studies used outdated accelerometer technology.[13–15] Overall, most studies have suffered from substantial methodological shortcomings when using the DP for assessing daily life ambulatory activities in patients with walking impairment due to IC.

The aim of this study was to validate the DP MoveMonitor in symptomatic patients with IC in a near-real life setting. If valid, the accelerometer can be used for the assessment of PA as a potential outcome measure in these populations.

METHODS

Recruitment

Patients with IC (PAD stage 2–3 according to the Rutherford classification) and visiting the vascular outpatient clinic of Catharina Hospital between August and November 2012 were eligible for this study. The study was conducted with the approval of the local medical ethics committee.

Inclusion criteria

The inclusion criteria were >3 months of symptoms of IC, and an ankle-brachial index (ABI) <0.9 at rest or a fall in systolic ankle pressure by >20% after treadmill testing. A treadmill protocol with a fixed inclination of 8% at 3.2 km/h for a maximum of 5 minutes was used.

Exclusion criteria

Patients with walking difficulties other than those due to IC were excluded (e.g., prior amputation, severe arthritis, COPD Global Initiative for Chronic Obstructive Lung Disease score 3–4, congestive heart failure [>New York Heart Association class II]), as was the use of walking aids. Patients with recent (<12 months) vascular surgical intervention prior to the study were also excluded, as were patients who were unable to understand all the specifics of the study protocol or that had insufficient knowledge of the Dutch language.

Video observation and activity monitoring

Patients' medical and surgical histories were obtained, followed by physical examination and a check of inclusion and exclusion criteria. After signing informed consent, a DP attached to a neoprene belt was strapped around the patient's waist at the level of the mid-lower back (Fig. 1). The patient's hospital visit (e.g., waiting room, doctor's visit, vascular laboratory assessments, treadmill testing, etc.) was then continuously recorded on video (GZ-HM335BE; JVC, Yokohama, Japan). Subsequently, patients were asked to walk around the hospital's car parking lot, as abnormal walking due to IC could possibly occur during this effort. Patients were instructed to act and move as they normally would. Patients were filmed anonymously. Two observers were randomly assigned to perform all video recordings.

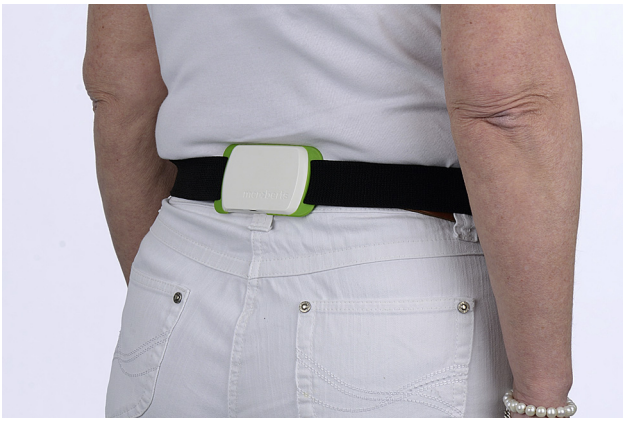

Figure 1. A patient wearing the DynaPort MoveMonitor (McRoberts, The Hague, the Netherlands).