A correlation study of objective functionality and WOMAC in total knee arthroplasty

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Abstract. Function studies after total knee arthroplasty (TKA) generally use either self-reported instruments or objective quantitative measurements of walking activities, but it is unclear how objective factors influence self-reports. This retrospective multicenter study assessed the impact of objective variables on subjective self-reported functional outcome after TKA in 128 patients at a mean of 41 months after TKA. Self-reported disability was measured by the Western Ontario and McMaster University (WOMAC) scale, and the quality of walking and representative daily activities were determined objectively by the DynaPort knee test. Objective assessment was found to be a poor predictor of WOMAC abnormality, with correlations of 0.343, 0.246, and 0.269 with WOMAC function, stiffness, and pain, respectively. The results of WOMAC are thus strongly influenced by factors other than quantitative parameters of the lower extremity. These findings provide support for including an objective assessment of activities of daily living together with a subjective self-report.

Keywords. Total knee arthroplasty · Western Ontario and McMaster University scale · Objective measurement · Functional outcome · Dynaport knee test

Introduction

Total knee arthroplasty (TKA) is performed as an end-stage procedure for patients with degenerative arthritis to eliminate pain and improve function [5, 8]. The surgical techniques and prosthetic engineering developments associated with these elective procedures have been highly refined over the past 20 years and have resulted in high success and survival rates [4, 23]. During the past decade the technology and design of joint implant systems have progressed considerably, and a great variety of systems are now on the market. From the patient’s perspective the goals of knee joint replacement are pain relief and restoration of function and mobility [5]. The surgeon has the same objectives, and additionally aims to improve range of motion, stability, walking distance, and stair climbing. Most of these variables are addressed in the various knee scoring scales [7, 8]. Therefore most previous studies of function after TKA have used these self-report instruments to obtain an understanding of the patients’ functional ability. However, the results of these self-report instruments have recently been shown to reflect psychological and constitutional status as well as regional lower limb abnormalities [22].

To our knowledge, no study has examined the extent to which objective locomotive factors influence the data obtained by these self-report instruments. Therefore the goal
of this study was to assess the correlation between quantitative performance with the results of self-report instruments.

Materials and methods

This retrospective multicenter study examined the results of 128 total knee arthroplasties (94 men, 34 women). Only patients with a unilateral total knee prosthesis, implanted for primary osteoarthritis at least 1 year previously were included in this study. Patients with posttraumatic, postinfectious, or rheumatoid arthritis were excluded. All patients were evaluated by the same independent observer using the Western Ontario and McMaster Universities (WOMAC) function subscale OA index, and the DynaPort knee test. This WOMAC index is a well-validated scale [1] designed to reflect the problems experienced by individuals with lower limb deficiencies. It assesses pain (five items), stiffness (two items), and physical function (17 items) related to the hip or knee, with higher scores indicating greater difficulty.

The DynaPort knee test is a short standardized test to assess the quality of movement of patients with knee dysfunction. It is suitable for clinical applications, and takes only 15–20 min to administer. No further equipment or specialized laboratory is required. Scores reflect the level of disability in daily living; a higher score indicates a better function. The test uses sensors which are fixed to the patient’s body, while the patient performs predetermined tasks (Fig. 1). The patient is asked to perform 14 selected activities, using 29 easy-to-measure test items that are often problematic for the patients. These tasks can be categorized under locomotion (walking), rising and descending (stairs, slopes, and wooden blocks), lifting and moving (carrying a tray or a bag, picking up a weight, and walking with a shopping trolley), and transfers (going to sit or lie down and then standing up again, as well as bending forwards to pick up a weight and returning to the upright position). To standardize the test a standard package with all equipment is included in the test material (such as wooden blocks, stairs of three steps, and a slope). The sensors are sensitive to both slow and fast changes in acceleration; they are small and of low weight. The sensors react to gravity and movement acceleration, thus giving information about posture and movement of the test person [21]. A portable recorder worn around the waist allows easy and stable data acquisition. The whole system is fixed to the patient with elastic straps over his daily clothing (Fig. 1). In total six sensors are fixed to the chest, the pelvis (two), the left thigh, and the left and right shanks. The raw signals are stored in a portable recorder and are analyzed with special software which extracts movement features. All signal properties are derived from the original accelerometer signals, while several movement features are calculated in terms of angle, duration (time), frequency, or a dimensionless number [6].

Before the Dynaport knee test was used in the present investigation it was deemed necessary to obtain preliminary information on its reliability and validity (responsiveness). In a test-retest study with 37 healthy subjects, measured twice at an interval of 1 week the reliability of the device was found to be high, with an overall intraclass correlation of 0.81 (95% confidence interval 0.69–0.93) and values for the cluster ranging from 0.73 (95% CI 0.58–0.89) to 0.84 (95% CI 0.73–0.94). To test the validity of the Dynaport knee test its responsiveness was tested on 244 TKA patients. These patients were tested before the procedure and 3, 6, 12, and 24 months thereafter. This study [6] showed a clear trend to improvement, with an average extent of effect after 24 months (mean improvement) of 0.7 (when expressed in preoperative SD of TKA patients) or 1.5 (SD of the healthy group). Such responsiveness is satisfactory.

In addition to the reliability and validity (responsiveness) of the Dynaport Knee Test, it is imperative to know whether it discriminates between injured and uninjured persons. In a previous study [6] 140 persons with knee problems (most of them diagnosed with osteoarthritis of the knee while waiting for TKA) and 32 matched persons without knee pain underwent a Dynaport knee test. The results of this study showed that the majority of item X movement feature combination discriminated significantly between the healthy subjects and TKA patients. The number of significant differences per item ranged from 10 to 24 (out of 30) and per movement feature from 1 to 29 (out of 29).

The mean follow-up period of the patients in this study was 41 months (SD 22.6). All patients in our study signed an informed consent statement. All the ethics committees of the various cooperating hospitals approved this study.

Data were analyzed using the SPSS software version 10.0. Correlations between the different assessment scores were evaluated in bivariate analyses with Spearman’s rank order correlation. To explore multivariate relationships we performed multiple regression with WOMAC function, pain, and stiffness as the dependent variables and Dynaport score as the independent variable. Statistical significance was accepted at the level of $P<0.05$.

Results

Mean and standard deviations of the anthropometric variables of the 128 patients are given in Table 1. Table 2 illustrates the results of the Dynaport knee test and the WOMAC score. The relationship between the Dynaport knee test and the WOMAC scores (Fig. 2) shows that the two are inversely: the higher the Dynaport score, the less the disability. However, the correlation between Dynaport score and WOMAC pain score was poor ($r=0.359$; Fig. 2). Similarly, there was a poor correlation between Dynaport score and the results of the WOMAC function and stiffness scores ($r=0.342$ and $r=0.216$, respectively). The $R^2$