Technically, total knee replacement (TKR) has developed into one of the most successful procedures in modern medicine [6, 17, 21, 23]. Not surprisingly therefore [14, 19, 20, 26] attention in the TKR community is shifting towards quality of life issues. After TKR a majority of patients continue to have problems with everyday movements such as climbing stairs and getting in and out of cars [11]. Thus monitoring functional abilities is currently turning into an important research topic in the field of TKR.

Functional abilities of patients in performing activities of daily living (ADL) can be assessed either subjectively or objectively. Subjective measurement usually relies on visual analogue scales or on questionnaires filled-in by the patient or by the physician. Given the possibility of physician bias and the time demands on the medical system, most
authors prefer patient-based assessment [10, 13, 18, 30]. Still, the patients’ own reports may also be biased, for instance, when their report on the actual situation is influenced by their expectations [34]. Moreover, patients may confuse the dimensions in question. In the Western Ontario MacMasters Osteoarthritis Index patients with both pain and functional problems were unable to distinguish between the two [27]. Finally, patients’ self-reports may be unreliable, for example, in the cognitively impaired [1, 12].

Thus, in addition to patients’ self-reports, objective data in monitoring patients’ functional abilities [24, 28] is also needed. Current objective measurement systems (such as electromyography, force platforms, optokinematic systems), however, are time consuming and require sophisticated laboratories. In view of this problem an accelerometer-based, user-friendly system was developed, the DynaPort knee test, which objectively assesses functional abilities in a standardized set of tasks, closely related to ADL. In principle the knee test can be used for all kinds of patients with knee problems. Since the test may prove important for clinical practice and research, especially in TKR, the present contribution summarizes the rationale behind and the design of the DynaPort knee test.

The DynaPort knee test

The DynaPort knee test (McRoberts, The Hague, The Netherlands) was developed to objectively assess knee-related functional abilities in an unobtrusive, user-friendly way. Test persons wear five belts around their trunk and legs (Fig. 1), over their clothing. The belts contain sensors (accelerometers), the signals of which are stored in a recorder, embedded in one of the belts. The whole system can easily be transported, and measurement can take place anywhere.

The belts consist of neoprene straps that can be fixed with Velcro. The data recorder (125×95×34 mm, 295 g) has a 10 Mb PC card on which data are stored at a sample frequency of 32 Hz. There are three penlight batteries. The accelerometers are uniaxial, piezoresistive (IC sensors 3031) with a frequency range of 0–400 Hz and are able to measure up to ±5 g (g being 9.8m/s²). Interpretation of the accelerometer signals [32] must consider gravitational acceleration (given the position, that is, the inclination of the sensor).

In the DynaPort knee test the recorder box is stored ventrally in a belt around the waist. User instructions are digitally displayed on the box. There are six accelerometers connected with the recorder through wires. Two of the accelerometers are located in the recorder box; when the test person is standing upright, one of these sensors registers vertical acceleration and the other sagittal acceleration. The remaining four sensors, which in upright stance all register vertical acceleration, are attached over the sternum, around the left thigh and around the two shanks.

Fig. 1 Test person carrying the measurement system for the DynaPort knee test. The belts contain accelerometers

A standardized set of 29 test items

Tasks were selected for the DynaPort knee test with the following rationale: The tasks should match as closely as possible ADL that are problematic for patients with knee complaints, or in which the knee plays a central role, while the whole set of tasks should be easy to perform routinely (excluding, for instance, getting in and out of the bath, or in and out of a car). To give one example of how this rationale was used, getting into a bus was “translated” into stepping onto a wooden block 40 cm high.

Based on the literature [2, 25], and using common sense, a list of 29 test items was constructed, grouped into 14 tasks (Table 1). 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, a slope, etc.).

The DynaPort knee test, which takes about 30 min to perform, is carried out under supervision, usually by a physical therapist. The supervisor is responsible for proper attachment of the belts, gives the instructions, and com-