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Impact of Functional Capacity Evaluation on Patient-Reported Functional Ability: An Exploratory Diagnostic Before–After Study

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Abstract

Introduction Work capacity in patients with orthopedic trauma and long-lasting inactivity is significantly reduced. Functional capacity evaluation (FCE) is a diagnostic approach for developing recommendations for a return to work and further occupational rehabilitation when the ability to carry out previous job demands is uncertain. However, FCE may also have direct effects on the patients' appraisal of their functional ability. Our study therefore evaluated the change in patient-reported functional ability after the performance of an FCE. *Methods* We performed a diagnostic before–after study in 161 consecutively recruited patients with trauma who were referred for FCE at the end of an interdisciplinary inpatient rehabilitation program in Austria. Patients completed the Spinal Function Sort to assess patient-reported functional ability both prior to the FCE and after completing it. *Results* Patient-reported functional ability (0–200 points) improved by 14.8 points (95% CI 11.3–18.2). The number of participants who rated their functional ability below their functional capacity as observed by the FCE decreased from 82.6 to 64.6% by about 18 percentage points. *Conclusions* The performance of the FCE in patients with trauma was associated with an improvement of patient-reported functional ability. The performance of an FCE in trauma rehabilitation may possibly have a direct therapeutic effect on the patient by allowing a more realistic appraisal of the ability to perform relevant work activities.

Keywords Injuries · Rehabilitation · Diagnostic techniques and procedures · Work capacity evaluation

Background

Orthopedic trauma is a main reason for work disability and causes substantial health care and societal costs [1–4]. In Austria, a country with roughly 8.8 million inhabitants, there are 790,000 accidents leading to approximately 1 million days of inpatient trauma care. The direct costs for inpatient acute trauma care are estimated to be roughly 841 million euros per annum [5]. Patients with injuries, as well as their families, consider returning to work to be an important marker in coping with the event and regaining normality. Work assures income, supports social contacts, provides respect and recognition, and enables the experience of self-efficacy [6]. The role as a worker may replace, at least partially, the role as a patient if the return to work succeeds. While most people return to work after an injury within a few weeks, about one-third to one-half of injured persons fail to return to work within 12 months of their injury [1, 7–9].

The care of patients with an orthopedic injury is a complex challenge and rehabilitation usually involves a multiprofessional team. At the level of body structure and body function, trauma rehabilitation aims to restore or improve joint mobility/stability, an increase in muscle strength and endurance, and recovery of functional abilities (e.g. walking or dexterity). At the level of participation, the key issue of trauma rehabilitation is a return to work, and in most European countries, a return to work is the main measure of the effectiveness of rehabilitation programs and injury compensation systems. This implies that in-depth knowledge of the individual patient's workplace and workload as well as the patient's work ability is required.

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Functional capacity evaluation (FCE) is therefore a crucial component of rehabilitation programs following traumatic injuries [10–12]. FCE is performed in order to assess whether workers are able to return to their former job, to give recommendations for adapting work tasks and the work environment, and to plan occupational rehabilitation. While FCE is primarily used as a diagnostic and prognostic tool, FCE may also directly affect patients. Supervised performance of tasks that are similar to the job demands allows a better appraisal of the patient's abilities and help to challenge fear-avoidance beliefs. It has been demonstrated in psychological stress research that the appraisal that a situation is manageable is a crucial determinant for coping with stressors such as health problems [13–15]. Therefore, supervised performance of work tasks as part of an FCE may promote self-efficacy and readiness for return to work. This again may support return to work [2, 16]. A systematic synthesis of inception cohort studies indicates that self-efficacy indeed affects the time off work following orthopedic trauma [17]. However, while a body of studies deals with the prognostic value added by an FCE to predict a return to work [18–24] and the relevance of FCE in shaping a physician's appraisal of the patient's readiness for a return to work [25–27], the potential impact of FCE on patient-reported functional ability has been studied less thoroughly so far.

An exploratory approach to clarify this issue is the diagnostic before–after study [28]. This is attractive as it obviously fits in with the clinical process. The general design comprises a pretest assessment, a diagnostic test and a posttest assessment. The performance of the diagnostic test, for example an FCE, is the determinant of interest and the change between the pretest and posttest assessment is deemed to be induced by the performance of the diagnostic test. While this design is mostly used to evaluate changes in the doctor's assessment of a clinical problem it is also useful for describing immediate changes in the patient's health perception due to the performance of a diagnostic test. Diagnostic before–after studies can therefore provide important insights into a diagnostic procedure beyond diagnostic accuracy [28].

We thus aimed to estimate the influence of a 2-day FCE on patient-reported functional ability in a diagnostic before–after study. When broken down into more detail, our objectives were threefold: first, to describe the immediate change in patient-reported functional ability following an FCE in patients with orthopedic trauma; second, to describe any change in discrepancies between functional capacity as assessed by the FCE and patient-reported functional ability; and third, to determine the change in discrepancies between job demands and patient-reported functional ability.

Methods

Study Design

A diagnostic before–after study was performed using data from a 2 day FCE test procedure. The time between pretest and posttest assessment was short in order to minimize the risk of interfering factors influencing the patients' perception of their functional ability, e.g. changes due to the spontaneous course or effects of an intervention. The study protocol was approved by the ethics committee of the province of Lower Austria (GS1-EK-4/502-2017).

Participants and Setting

Patients were assigned to our inpatient rehabilitation center located in the eastern part of Austria following a non-work or work accident (monotrauma or polytrauma, burns, amputation, and spinal cord injury). In 2016, approximately 1200 patients were treated in our unit. While the rehabilitation program is a multi-professional one, work-related functional capacity training and other work-related treatment components are not routinely used in these programs. Patients were referred to FCE if, at the end of the inpatient rehabilitation program, the rehabilitation team was uncertain as to whether the patient was able to perform the work demands of their previous job. If the team considered a return to work was likely, patients were not referred for FCE. Patients who were referred for FCE were eligible for the study. A rehabilitation physician checked the inclusion and exclusion criteria including medical stability status and the ability to read and understand German.

Measures

We assessed descriptive data, physical work demands and patient-reported functional ability first. This data formed the basis of the pretest assessment. The FCE was performed after this pretest assessment. The posttest assessment comprised a second assessment of patient-reported functional ability and was carried out after the FCE. The data collection procedure is shown in Fig. 1.

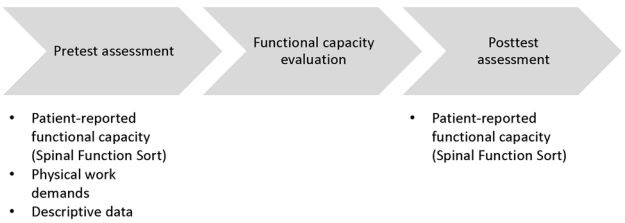

Fig. 1 Data collection procedure

Descriptive Data

We assessed age, sex, time between injury and FCE, and employment status to describe the sample.

Functional Capacity Evaluation

The WorkWell Systems (WWS) FCE was developed by Susan Isernhagen in the 1990s as a systematic method for observing the ability to perform work-related tasks [29–33]. The complete test battery consists of 29 items in five performance categories (weight handling and strength, posture and mobility, locomotion, balance, and hand coordination). For the six weight handling tests, the tasks must be repeatedly performed as the load is gradually increased to the level of maximal safe performance. In some tests, capacity is directly assessed and compared with norms (e.g. grip strength or distance walked within 6 min). There are tests with a time ceiling, like the working overhead test that is performed for 5 min. If this ceiling it is not achieved the time to test termination is documented. Other tests have certain criterion to fulfil like pushing a weighted cart (20 kg for men, 15 kg for women) over a distance of 18 meters. In these tests mainly qualitative descriptors such as movement patterns, base of support, posture, and order of muscle recruitment are rated.

The FCE was performed on two consecutive half-days with a therapy-free afternoon between the two test days. The FCE was administered by either a physiotherapist or an occupational therapist experienced in the FCE procedure. All of them had conducted at least ten FCEs per year over the previous 5 years. The final report was then cross-checked and signed by one of two rehabilitation physicians with 5–10 years of experience in performing FCEs. Both had supervised approximately 50–80 FCEs per year during the previous 5 years. All therapists and rehabilitation physicians were trained and certified to perform the WWS FCE. The observed functional capacity was determined based on the maximum weight during one of the six lifting tasks (mostly carrying horizontal). If patients did not show maximal effort, the demonstrated capacity was used for analysis. The lifted weight was rated in line with the physical demand levels as defined by the Dictionary of Occupational Titles as 1 = "sedentary" (< 5 kg), 2 = "light" (5 to < 10 kg), 3 = "medium" (10 to < 25 kg), 4 = "heavy" (25–45 kg), and 5 = "very heavy" (> 45 kg) [34].

Physical Work Demands

Before the FCE, all patients were asked to describe their work demands in their last work environment prior to the trauma. The maximum physical workload of material handling tasks in their previous job was also categorized as described above. In case of uncertainty of correctness of the patients' estimation, additional information was collected from expert interviews or from the hospital's database of prior job descriptions.

Patient-Reported Functional Ability

The Spinal Function Sort (SFS) is a picture-based questionnaire, including 50 items that assess the patient's ability to perform various work tasks (e.g., picking up a small tool, lifting a 10 kg tool box, or climbing a ladder) [34, 35]. The reliability of the SFS is excellent [34, 36]. Items are rated on a five-point scale from "unable" to "able". A total score was calculated ranging from 0 to 200 points with higher scores indicating better perceived functional ability. Additionally, the scores were categorized into categories of work demands as described in the SFS examiner's manual [34]. Scores were therefore recoded as followed: 100–110 points as 1 = "sedentary"; 125–135 points as 2 = "light"; 165–175 points as 3 = "medium"; 180–190 points as 4 = "heavy"; and 196–200 points as 5 = "very heavy" [34]. SFS scores outside these categories were assigned to the nearest category, for example, a score of 114 was categorized as "sedentary" and a score of 120 as "light". In line with Oesch et al. [35], we added another category and coded 0–99 points with 0 = "minimum". We merged the categories of "minimum" and "sedentary" into one category when comparing patient-reported functional ability with functional capacity as observed in the FCE and previous job demands, as the latter do not distinguish between these categories. The SFS was completed by the patient before testing and a second time after the FCE was finalized on the second day.

Statistical Analysis

Descriptive statistics were used to report sample characteristics. The change in patient-reported functional ability before and after the FCE was tested by a Wilcoxon matched-pairs signed-ranks test for the continuous SFS score. We calculated the standardized effect size by dividing the mean difference of the posttest and pretest assessment of patient-reported functional ability by the baseline standard deviation, and graded a standardized effect size of 0.2 as small, 0.5 as moderate, and 0.8 or greater as large [37].

To compare measurements of patient-reported functional ability, observed functional capacity by an FCE and job demands, we used the categorized scores which had a common metric format. Wilcoxon matched-pairs signed-ranks tests were used to test the change in discrepancies between observed functional capacity and the categorized SFS score and between job demands and the categorized SFS score. We used absolute discrepancies for this purpose. Additionally, we cross-tabulated patient-reported functional ability and observed functional capacity to describe the extent of

underestimating and overestimating patient-reported functional ability compared to observed functional capacity. The diagonal in this cross table identified concordant measures of patient-reported functional ability and observed functional capacity. Statistical differences were regarded as significant if the two-sided P value of a test was less than 0.05. Data analyses were conducted using R version 3.4.2.

Results

Descriptive Statistics of the Study Population

A total number of 161 patients (143 men and 18 women) were referred for an FCE in 2016 (Table 1). This represented 12% of all patients undergoing inpatient rehabilitation during the year 2016. The mean age was 42.6 years (SD = 11.1), the mean duration from accident to FCE testing was 13.3 months (SD = 21.4), and the median duration was 7.7 months. Eighty-two patients were employed at the time of the FCE and 70 were unemployed. The employment status of the others was not known (n = 9).

Table 1 Sample characteristics and spinal function sort measurements

Characteristic	n	% or mean (SD)
Sex		
Men	143	88.8
Women	18	11.2
Age in years	161	42.6 (11.1)
Time since accident in months	161	13.3 (21.4)
Employment		
Employed	82	50.9
Unemployed	70	43.5
Unknown	9	5.6
SFS before FCE	161	135.5 (39.8)
SFS after FCE	161	150.3 (36.2)

SFS spinal function sort, *FCE* functional capacity evaluation

Physical job demands were reported to be heavy or very heavy by 76% of the patients (Table 2). Functional capacity observed by FCE was on average lower. In 95% of the patients, the observed functional capacity was medium or heavy. During FCE, only two patients were able to handle very heavy weights. Two patients did not show maximal effort, and their demonstrated capacity was used for analysis. Both patients handled weights that at least allowed for medium job demands. Functional capacity observed by FCE was below the demands of previous activities in 56.9% of the patients. The median of functional capacity observed by FCE was one category below the median of demands of the previous activities.

Change in Patient-Reported Functional Ability

Patient-reported functional ability as assessed by the SFS increased from 135.5 (SD = 39.8) to 150.3 (SD = 36.2) points after completing the WWS FCE (n = 161; $p < 0.001$; Fig. 2). The mean change was 14.8 points (95% CI 11.3–18.4). This corresponded to a standardized effect size of 0.37 (i.e. the difference was nearly 40% of the standard deviation of the first SFS measurement). The categorized SFS score before performing the FCE corresponded to mainly sedentary or light functional ability. The proportion of sedentary or light ratings decreased from 52.8 to 46.0%, and the proportion of patients with minimal functional ability decreased from 18.6 to 11.2%.

Discrepancies Between Patient-Reported Functional Ability and Observed Functional Capacity

The number of participants who met exactly their observed functional capacity category increased from 21 patients (13.0%) prior to testing to 47 patients (29.2%); after completing the FCE, i.e. the proportion of concordant measures

Table 2 Work demands, observed functional capacity and patient-reported functional ability in patients with orthopedic trauma

	n	Level of actual/feasible work demands					
		Minimum	Sedentary < 5 kg	Light 5 to < 10 kg	Medium 10 to < 25 kg	Heavy 25 to < 45 kg	Very heavy ≥ 45 kg
Physical work demands[a]	151	Not applicable	0 (0.0%)	2 (1.3%)	34 (22.5%)	63 (41.7%)	52 (34.4%)
Functional capacity based on FCE	161	Not applicable	0 (0.0%)	6 (3.7%)	87 (54.0%)	66 (41.0%)	2 (1.2%)
Patient-reported functional ability based on the SFS before FCE	161	30 (18.6%)	24 (14.9%)	61 (37.9%)	22 (13.7%)	21 (13.0%)	3 (1.9%)
Patient-reported functional ability based on the SFS after FCE	161	18 (11.2%)	13 (8.1%)	61 (37.9%)	26 (16.1%)	37 (23.0%)	6 (3.7%)

SFS spinal function sort, *FCE* functional capacity evaluation

[a]Ten patients had missing values

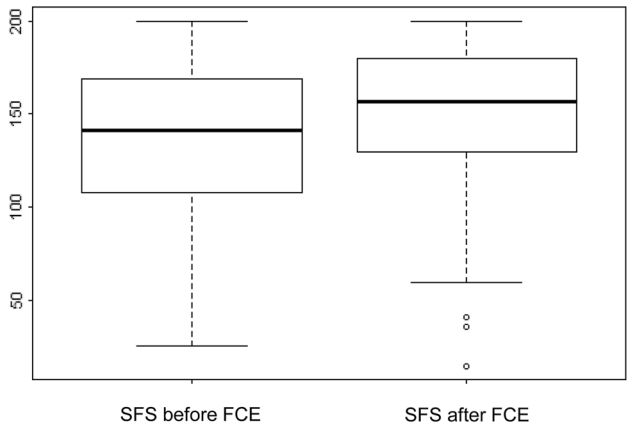

Fig. 2 Patient-reported functional ability before and after functional capacity evaluation. *SFS* spinal function sort, *FCE* functional capacity evaluation

doubled. The number of participants who rated their functional ability below their observed functional capacity decreased by 18 percentage points from 133 (82.6%) to 104 (64.6%), and the number of participants who rated above their observed functional capacity increased from seven (4.3%) to ten participants (6.2%) (Fig. 3). There was a significant reduction in the difference between patient-reported functional ability and observed functional capacity prior to and after the FCE testing procedure by roughly 0.5 categories (n = 161; 95% CI 0.3–0.6; p < 0.001).

Discrepancies Between Patient-Reported Functional Ability and Job Demands

Major discrepancies between patient-reported functional ability and the demands of the previous job were observed before and after FCE with job demands clearly exceeding patient-reported functional ability. Discrepancies were significantly reduced after the FCE testing procedure by roughly 0.4 categories (n = 151; 95% CI 0.2–0.5; p < 0.001).

Discussion

Patients with trauma in this study had significant impairments even after completion of a comprehensive multi-professional inpatient rehabilitation program. The functional capacity observed by the WWS FCE was clearly below previous job demands. Patient-reported functional ability was even lower, and most of the patients rated their functional ability below their functional capacity as observed in the following FCE. The findings of our diagnostic before–after study indicate a small to moderate improvement of patient-reported functional ability following the performance of the WWS FCE. Moreover, the number of patients who underestimated their functional capacity was significantly reduced. The number of participants who rated their functional ability as being consistent with the functional capacity as observed when performing the FCE doubled. In summary, the FCE may well have a positive effect on patients' perceived functional ability.

Though effects of diagnostic assessments and tests are mainly driven by their impact on patient management and are therefore primarily indirect, direct effects of FCE are well-known and have been previously described. Several authors have described pain aggravation after the first day of the WWS FCE [38–40]. Besides such minor temporary negative side effects, there were also direct positive effects reported for the WWS FCE. These effects can be attributed to a placebo effect and an effect of the experience when handling the weights during the FCE.

There are at least three studies reporting findings consistent with our study. Büschel et al. [38] reported a similar improvement of the SFS score in rehabilitation patients with musculoskeletal disorders, mainly back pain, after

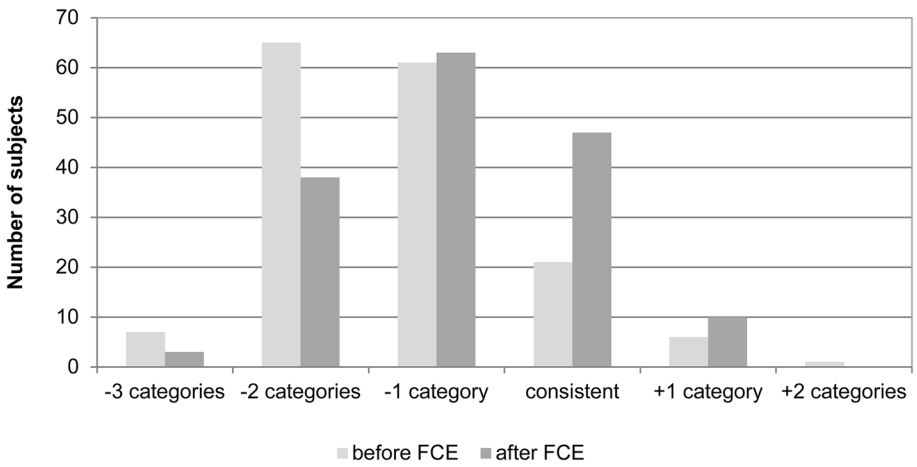

Fig. 3 Change in discrepancies between observed functional capacity und patient-reported functional ability before and after functional capacity evaluation. *FCE* functional capacity evaluation; Negative discrepancy indicated that patient-reported functional ability was below functional capacity as observed when performing functional capacity evaluation

performing the WWS FCE. Oesch et al. [35] also showed an improvement in SFS scores in back pain patients participating in a function-centered rehabilitation program including elements of the WWS FCE. In addition, Oesch et al. [35] also demonstrated that the correlation between the SFS and FCE measurement was stronger for the second SFS assessment. This indicates, as do our findings, that the patient-reported functional ability and observed functional capacity converge as a result of performing an FCE. Finally, Bühne et al. [41] reported increased SFS scores, by about 11 points, using an FCE though not the WWS FCE. Performing an FCE seems to provide important information to the patients, which changes their perception of their functional ability. However, it is not clear how lasting this effect is, and how much of the improvement is due to undergoing an elaborate procedure regardless of the information that results from the FCE. While researchers are aware of such a placebo effect in intervention studies, this is also a possibility when performing diagnostic procedures [28]. Interestingly, an improvement in our study was observed, although the FCE was performed at the end of comprehensive rehabilitation. The additional effect of the FCE may be due the fact that the FCE is much closer to work reality than the less work-related content of the general rehabilitation program that was performed prior to the FCE. An appropriate appraisal of the ability to meet work activities seems to be very difficult for patients, probably due to the long time off work and the lack of opportunities to experience their recovered and restored abilities in real-life situations.

A critical appraisal of our findings needs to consider the following limitations. First, we conducted a diagnostic before–after study. The best choice when studying the health effects of a diagnostic test is a randomized controlled trial [28, 42]. Second, all tests were provided in the same rehabilitation center and were performed by a team of very experienced physicians and therapists. This may affect the external validity of our observations. Third, the immediate follow-up assessment of the SFS on the second day of the WWS FCE does not provide information as to whether there is any lasting effect on patient-reported functional ability. Fourth, several variables, such as type of injury, may affect the change of the SFS, but this was not examined in this study.

Strengths of the present study are firstly, that patients were consecutively recruited, thus minimizing the risk of selection bias. Second, the immediate assessment of the SFS after completing the WWS FCE reduced the impact of confounding variables such as the spontaneous course of the complaints and the effect of treatment, which could possibly affect the clinical course in the long-term. Third, the change of the SFS score is unlikely to be due to lack of reliability as the reliability of the SFS was shown to be excellent in previous studies [34, 36]. Trippolini et al. [36] recently reported a change of 0.2 points in a test–retest reliability study of the SFS. Fourth, the sample size was appropriate for a diagnostic before–after study and had sufficient power to evaluate changes in SFS scores in this study. Fifth, the performance of the WWS FCE and the SFS was done in a conventional rehabilitation setting and within routine rehabilitation care. This supports the external validity and replicability of our findings in comparable settings.

In conclusion, even after completion of a comprehensive inpatient rehabilitation stay, experiencing the maximal work-related capacity during FCE improved patient-reported functional ability. Performance of an FCE may have a direct therapeutic effect on the patient by allowing a realistic appraisal of the ability to perform relevant work activities. We recommend a randomized controlled trial to directly test the potential therapeutic effect of FCE on patient-reported functional ability.

Compliance with Ethical Standards

Conflict of interest Martin Schindl declares that none of the authors have any potential conflict of interest, since the procedures described in the current study are part of the clinical routine.

Ethical Approval The study protocol was approved by the ethics committee of the province of Lower Austria (GS1-EK-4/502-2017).

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