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Reliability of a test measuring transversus abdominis muscle recruitment with a pressure biofeedback unit

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Abstract

Background There are indications that segmental stabilising exercises (SSEs) are effective in the treatment of low back pain. The evaluation of successful training in SSE performance in patients requires a reliable outcome measure. The PRONE test gives an indication of the activity of the transversus abdominis muscle. Performed in prone lying using a pressure biofeedback unit, it has been used as an aid to training and to assess the subject's ability to perform SSEs correctly.
Objectives To evaluate inter-observer and test–retest reliability of the PRONE test.
Design Repeated measures by three observers on 2 days.
Setting Department of Physical Medicine and Rehabilitation, Ludwig-Maximilian University, Munich, Germany.
Participants Forty nurses (39 females and one male), aged between 24 and 62 years, with at least one episode of low back pain.
Main outcome measures During the test, movement of the abdominal wall was monitored by measuring a change in pressure during muscle contraction termed 'abdominal hollowing'. Defined observation and palpation criteria were verified by the observers to ensure correct execution of the test.
Methods Participants were tested on two separate days. On the first day, Observer A performed two similar test sets, each with four exercises. On the second test day, Observers B and C conducted one test set each.
Results This study found an intra-class correlation coefficient (ICC) of 0.47 [95% confidence interval (CI) 0.20 to 0.67] for inter-observer reliability, and an ICC of 0.81 (95% CI 0.67 to 0.90) for test–retest reliability. Kappa values and the limits of agreement were also calculated with similar results.
Conclusions For this subject group, the PRONE test had relatively low inter-observer reliability but, as may be expected, higher test–retest reliability. It is suggested that by providing visual feedback, the PRONE test may enhance patients' insight into their deep abdominal muscle recruitment and thereby increase their motivation to exercise.

Keywords: Low back pain; Pressure biofeedback; Transversus abdominis; Reliability

Introduction

Segmental stabilising exercises (SSEs) have shown some efficacy in the treatment of back pain [1–3]. Using this technique, it is suggested that the patient can relearn a precise co-contraction pattern of the deep local trunk muscles involving the transversus abdominis and the multifidus muscles. First described by Richardson and Jull [4], recent studies have shown the effectiveness of SSEs. A systematic review of seven studies reported that, in the treatment of acute low back pain, SSEs are effective for the reduction of short-term disability as well as pain, and are a particularly effective method for the reduction of long-term recurrence of low back pain,

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producing better results than treatment by a general practitioner [5]. For chronic low back pain, SSEs have been shown to be more effective in the short and long term than treatment by a general practitioner, and can be as effective as other physiotherapy treatments in the reduction of disability and pain [5].

Some patients experience difficulties with learning how to execute SSEs correctly [6]. This may be influenced by the exercise protocol, the instruction given [7] and the correct execution of the exercise. Measuring the ability of a person to contract the local muscles involved in SSEs is particularly difficult because, in contrast to global muscles, deep muscular layers are difficult to palpate [8]. One of the main muscles involved in SSEs is the transversus abdominis muscle, which, in this group, is also the easiest to palpate. Therefore, the ability of a person to contract the transversus abdominis muscle may be used as an indicator of the proper execution of SSEs in the low back area. The abdominal hollowing technique is often used to teach SSEs and to give an indication of the subjects' ability to contract the transversus abdominis muscle.

Recent articles have described various tools to provide feedback about local low back muscle recruitment and to measure a person's ability to contract the transversus abdominis muscle. These have included ultrasound, electromyography and pressure biofeedback units [1,9–12]. Pressure biofeedback units consist of a combined inflation bulb connected to a pressure cell.

Pressure biofeedback units have been used to indicate correct contraction of the transversus abdominis muscle during abdominal hollowing in a prone position, referred to as the 'PRONE test' in this study. A change in pressure in the inflation bulb indicates contraction or relaxation of the muscles [13]. This test is used clinically both for the assessment of deep local trunk muscles [2] and as an aid in the re-education of stabilisation [14]. Comparatively, it is a relatively inexpensive test which is easily applied in the clinical situation.

Previous research has been inconclusive about intra-observer (hereafter referred to as test–retest) reliability. Storheim *et al.* [8] reported low test–retest reliability (coefficient of variance 21%), Moseley [15,16] described test–retest reliability with an intra-class correlation coefficient (ICC) of 0.91 [95% confidence interval (CI) 0.71 to 0.99], and Costa *et al.* [17] reported a test–retest ICC of 0.58 (95% CI 0.28 to 0.78). However, these studies were carried out on healthy subjects or subjects with undefined health status, and the ICC is dependent on the variability of the parameter measured in the sample used. Furthermore, the studies used various test procedures and criteria, which may have led to the differences in their results.

To the authors' knowledge, no studies of inter-observer reliability of the PRONE test have been reported to date. There is also a dearth of research on the reliability of the PRONE test in subjects with a history of low back pain.

The main objective of the present study was to provide an estimate of the reliability of the PRONE test using a pressure biofeedback unit, specifically inter-observer reliability between two observers and test–retest reliability. Both of these aims were investigated using observation and palpation criteria, a pressure criterion and the complete criterion (a combination of the observation and palpation criteria and the pressure criterion).

Methods

Participants

Forty nurses were recruited (39 females and one male), all of whom had previously participated in a separate randomised controlled trial conducted at Ludwig-Maximilian University, Munich between October 2003 and May 2005, comparing an exercise programme with a multidisciplinary prevention programme. There was a 13-week interval between the studies (for further information, see von Garnier *et al.* [18]). The interventions in this study included SSEs which took place in seven sessions (one single and six group interventions) over 8 weeks.

The participants were included if they had experienced at least one episode of low back pain in the 2 years prior to the study. Participants were initially contacted by letter and subsequently by telephone. To be eligible for inclusion, they had to give written informed consent. Exclusion criteria included acute back pain, abdominal pain or stomach pain on the test days; inability to lie in a prone position for 30 minutes; pregnancy; surgery in the lower back or abdomen; or intake of medication on one of the test days which they felt affected their coordination or concentration. Before testing, each participant received standardised information about the test procedure. All subjects were remunerated with 10€ per test day for their participation.

Observers

Observers A and C were physiotherapists and Observer B was an occupational therapist. Prior to conducting the tests, all three observers had had experience with teaching and measuring SSEs, and had attended a special training course taught by one instructor. The correct use of pressure biofeedback units was important [4,14]; therefore, all three observers were trained to test and instruct in a standardised way before the beginning of the test phase. None of the observers had instructed SSEs in the randomised controlled trial.

Measures

To ensure that participants met the inclusion and exclusion criteria, a structured interview was conducted using a screening questionnaire designed for this study. This included demographic information and general health questions on