Physiotherapy 96 (2010) 130–136

Effect of the abdominal draw-in manoeuvre in combination with ankle dorsiflexion in strengthening the transverse abdominal muscle in healthy young adults: A preliminary, randomised, controlled study

Seung-Chul Chon [a], Ki-Yeon Chang [a], Joshua (Sung) H. You [b,*]

[a] *Department of Occupational Therapy, College of Health and Welfare, Woosong University, Daejeon, South Korea*
[b] *Department of Physical Therapy, Graduate School of Rehabilitation Science, Yonsei University, Wonju City, South Korea*

Abstract

Objectives To compare the effect of the abdominal draw-in manoeuvre with the abdominal draw-in manoeuvre in combination with ankle dorsiflexion on changes in muscle thickness and associated muscle activity in abdominal muscles.
Design A preliminary, randomised, controlled study.
Setting University laboratory.
Participants Forty healthy adults (18 males, 22 females) were allocated at random to the experimental group [mean age (SD) 24 (1.6) years, $n = 20$] or the control group [mean age (SD) 24 (1.9) years, $n = 20$]. The experimental group performed the abdominal draw-in manoeuvre in combination with ankle dorsiflexion, and the control group performed the abdominal draw-in manoeuvre alone, five times a day.
Main outcome measures Ultrasonography and electromyography were used to determine the intervention-related changes in muscle activity and the thickness of abdominal muscles during the abdominal draw-in manoeuvre or the abdominal draw-in manoeuvre in combination with ankle dorsiflexion.
Results A significant difference was found in the thickness of the transverse abdominal muscle between the groups [mean difference 0.24 cm, 95% confidence interval (CI) 0.08 to 0.40, $P = 0.005$. On electromyography, a significant difference was demonstrated in the amplitude of the transverse abdominal muscle contraction between the two techniques in the experimental group (mean difference 68.76 mV, 95% CI 53.16 to 84.36, $P = 0.000$. The intra-class correlation coefficient ($ICC_{2,1}$) showed excellent test–retest reliability of ultrasound measurement of the abdominal muscles: 0.96 (95% CI 0.85 to 0.99) for the transverse abdominal muscle, 0.87 (95% CI 0.62 to 0.98) for the internal oblique muscle and 0.77 (95% CI 0.44 to 0.96) for the external oblique muscle.
Conclusions This is the first study to demonstrate the additive effect of ankle dorsiflexion on deep core muscle thickness and activity, thus contributing to existing knowledge about therapeutic exercise for the effective management of low back pain.

Keywords: Ultrasonography; Reliability; Abdominal draw-in manoeuvre; Irradiation; Transverse abdominis

Introduction

The abdominal draw-in manoeuvre (ADIM) is commonly used during core stabilisation techniques to restore neuromuscular control in the core stabilisation musculature of athletes with sports injuries. The manoeuvre has also recently gained widespread acceptance in reducing symptoms in patients with low back pain [1,2]. Recent evidence on the conservative management of low back pain suggests that the restoration of neuromuscular control in the transverse abdominal (TrA) muscle, together with minimal contraction of other superficial oblique, internal and external abdominal muscles, is essential for effective treatment during the early stages of rehabilitation [3–5]. Previous studies have demonstrated that the use of the ADIM, in particular, is far more effective than the use of general core stabilisation techniques in improving the cross-sectional area of the TrA muscle [3,6,7]. Thus, core stabilisation techniques that incorporate the selective motor recruitment of the central core stabiliser, such as the TrA muscle, may be beneficial in the effective management of low back pain.

* Corresponding author. Tel.: +82 33 760 2476; fax: +82 33 760 2496.
E-mail address: neurorehab@yonsei.ac.kr (J.H. You).

0031-9406/$ – see front matter © 2009 Chartered Society of Physiotherapy. Published by Elsevier Ltd. All rights reserved.
doi:10.1016/j.physio.2009.09.007

A variety of core stabilisation techniques, including abdominal bracing, curl-ups, lateral bridges, wall squats and stabilisation exercises using a ball [7,8], are used in conjunction with or without ultrasound imaging [9–11], although outcome studies have failed to provide clinical evidence for the superiority of any particular technique. In addition, despite the fact that all of these stabilisation exercises have been used in the management of individuals with low back pain, it is difficult to reach a clinical decision about adopting any one of them because their therapeutic efficacy has yet to be demonstrated. For example, ascertaining the exact or underpinning therapeutic effect of core stabilisation techniques poses a significant challenge because these techniques are often incorporated into static and dynamic neuromuscular or strengthening regimens [3,5,12]. Such combinations can potentially confound the results about which type of core stabilisation technique is more effective for the selective recruitment of core stabilisers.

The irradiation technique, a form of proprioceptive neuromuscular facilitation, has been conventionally used to selectively increase the number of active motor unit recruitments involved or weakened in the neuromuscular response [13,14]. Irradiation is defined as the increasing spread and strength of the response to the stimulation (resistance) [13–16], and possibly results from stimulus (resistance)-induced temporal or spatial summation [17]. It is also possible that the irradiation technique may empower or stimulate the deep target TrA muscle selectively through the application of resistance to the relatively stronger ankle dorsiflexors when used in combination with the ADIM, thus further augmenting lumbar spinal stability. Research is needed to determine the motor control mechanisms underpinning the therapeutic effects of the irradiation technique, which has important clinical ramifications for the prevention and management of lumbar spinal instability. This study was undertaken to determine the additive effect of a combination of ankle dorsiflexion and the ADIM on lumbar stabilisation and abdominal muscle motor control patterns in healthy young adults. Lumbar stabilisation and the motor control patterns in abdominal muscles were determined by measuring muscle thickness and muscle activity using ultrasound and electromyography (EMG), respectively, in experimental and control groups. The basic hypothesis was that the selective increase in size and amplitude in the TrA muscle would be greater in the experimental group (which performed both the ADIM and ankle dorsiflexion) compared with the control group (which performed the ADIM alone).

Methods

Design

The participants were allocated at random into the experimental group or the control group. The investigators responsible for assessing the outcomes were unaware of an individual's group assignment. Random allocation was implemented using the conventional randomisation directory method in which a random number table was used to produce one code card for each participant, who then picked a card to receive his or her group assignment. Experimenter blinding success was evaluated by asking the outcome assessors which intervention they thought had been provided.

Table 1
Demographic data of participants ($n = 40$), expressed as mean (standard deviation).

	Experimental ($n = 20$)	Control ($n = 20$)
Age (years)	24 (1.6)	24 (1.9)
Height (cm)	168 (8.9)	169 (7.9)
Weight (kg)	61 (12.0)	59 (9.1)

Participants

A convenience sample of 40 healthy young adults was recruited from a local university. All of the participants gave their informed consent, and the study protocol was approved by the university ethics and institutional review board. The participants, all of whom were free from any known medical problems, were allocated at random into the experimental group ($n = 20$) or the control group ($n = 20$). Those with any neuromusculoskeletal pathology or history of spinal surgery were excluded. The target sample size was estimated based on a power of 87% at $\alpha = 0.05$ to detect large differences in effect size between the groups [18]. Table 1 presents the demographic characteristics of the participants.

Intervention

Both groups performed an ultrasound-guided (visual feedback) ADIM for 30 minutes per day, 5 days per week over a 2-week period, with ankle dorsiflexion added in the experimental group. The success of the ADIM was assessed by monitoring muscle thickness using ultrasound, and irradiation was evaluated by monitoring the recruitment sequence of activation of the tibialis anterior, rectus femoris and TrA muscles of the right lower extremity.

During the ADIM, participants were asked to adopt a crook-lying position, and a pressure biofeedback unit set to range from 40 to 70 mmHg [19,20] was placed beneath their fifth lumbar vertebra to monitor lumbar movement during the measurement of ADIM performance. Participants were instructed to draw in their lower abdomen below the navel gently and gradually without moving their upper abdomen or spine, while maintaining a neutral pelvic position to attempt to keep the target pressure range (40 to 70 mmHg). They were then asked to dorsiflex their ankle joint against the resistance [with 50% maximal voluntary isometric contraction (MVIC) of the tibialis anterior] provided by a fixed-strap band. The irradiation or propagation order of muscle recruitment or the sequential activation of the tibialis anterior, rectus femoris