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Original Research

The Effect of Distractive Function on Volitional Preemptive Abdominal Contraction During a Loaded Forward Reach in Normal Subjects

Marwan A. Kublawi, PT, ScD, FAAOMPT, Troy L. Hooper, PT, ATC, LAT, Vittal R. Nagar, MD, Mark P. Wilhelm, PT, DPT, Kevin L. Browne, PT, ScD, Jean-Michel Brismée, PT, ScD, FAAOMPT, Phillip S. Sizer, PT, PhD, FAAOMPT

Abstract

Background: Volitional preemptive abdominal contraction (VPAC) is used to protect the spine and prevent injury. No published studies to data have examined the effect of distraction on VPAC use during function.
Objective: To examine the effect of an auditory distraction ("Stroop task") on healthy subjects' ability to sustain VPAC by use of the abdominal drawing-in maneuver during loaded forward reach.
Design: Within-subjects, repeated-measure cohort design.
Setting: Clinical laboratory setting.
Participants: Convenience sample of 42 healthy individuals (ages 20-57 years).
Methods: Transversus abdominis (TrA) thickness was measured with M-mode ultrasound imaging. Each subject performed Stroop versus no Stroop during 4 conditions: (1) without VPAC, quiet standing; (2) with VPAC, quiet standing; (3) without VPAC, forward reach; and (4) with VPAC, forward reach. An investigator blinded to the conditions measured the first 10 subjects to establish intratester reliability of probe/transducer placement and TrA measurement.
Data Reduction: TrA thickness (mm) change represented VPAC performance. A single investigator measured onscreen TrA thickness twice at each second from second-6 through -10 on a recorded ultrasound imaging sequence.
Results: A 2 (Stroop) $\times$ 4 (Activity) repeated-measures analysis of variance found no significant Stroop $\times$ Activity interaction [$F(3, 93) = 0.345$, $P = .793$] and no main effect for Stroop [$F(1,31) = 1.324$, $P = .259$] but found a significant main effect for activity [$F(3,93) = 17.729$, $P < .001$]. Tukey post-hoc pairwise comparisons demonstrated significant differences between VPAC versus no-VPAC conditions, except between quiet standing/yes-VPAC and loaded forward reach/no-VPAC conditions ($P = .051$). The interclass correlation coefficient (3,2) for probe/transducer placement reliability was 0.87, 0.91, 0.92, and 0.93 for conditions 1-4, respectively. The interclass correlation coefficient (3,2) for TrA measurement reliability was 0.96, 0.99, 0.99, and 0.99 for conditions 1-4, respectively.
Conclusion: A distracting executive function (Stroop task) did not produce a significant negative impact on normal individuals' ability to sustain a VPAC during quiet standing or loaded forward reach activities.

Introduction

In the United States, low back pain (LBP) is the second-leading cause for visits to the physician, the third most common cause for surgical procedures, and the fifth most common cause for hospitalization [1]. Approximately 85% of this population will experience at least 1 episode of LBP during their lifetime [1]. Up to 44% will experience another episode of LBP within 1 year, whereas 80% will experience a second episode within 10 years [1].

Clinicians use muscle-activation strategies that aim to protect the spine for LBP treatment and prevention. Muscle activation can either automatically or volitionally assist muscle cocontraction that promotes lumbar stiffness and control during functional tasks [2-4].

Volitional preemptive abdominal contraction (VPAC) can be used to support spine control and stability. A

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VPAC strategy can activate the transversus abdominis (TrA) in individuals with and without LBP [5-7]. Furthermore, LBP sufferers can engage their TrA in various functional positions [6].

Individuals without LBP can produce a VPAC during functional positions such as standing [8-10] and loaded forward reach [11]. Similar responses have been recorded in individuals with a history of LBP but no present symptoms [6]. The TrA and internal obliques promote lumbopelvic stability by enhancing intra-abdominal pressure [12-14]. In addition, studies have shown that VPAC strategies suppress spinal perturbations and movements during lower limb activities [15-17]. These responses elucidate the capacity of a VPAC to stabilize the trunk during functional movements. It is not known, however, how cognitive distraction affects an individual's ability to use such a protective strategy.

Previous investigators found that a distracting executive function (EF, or "Stroop" task) decreases performance during functional activities (such as posture and gait) in healthy subjects [18-20]. Two studies reported that EF alters postural control in patients with LBP [21,22]. These reports merit further examination of the effect of a distracting EF on individuals' trunk control during a functional task.

At this time, no studies have examined how distracting EF influences one's ability to sustain VPAC during a dynamic postural control activity. We hypothesized that incorporating a distracting EF would decrease a subject's ability to sustain a VPAC during quiet standing and a loaded functional reach activity. The effect of using a distracting EF on VPAC during a loaded forward reach could represent using the strategy during real-life activities in which spine protection and injury prevention are paramount.

Methods

Research Design and Variables

This study incorporated a 2 (Stroop) × 4 (Activity) within-subjects design with repeated measures for all factors. The Stroop variable included 2 levels: yes-Stroop versus no-Stroop. The Activity variable included 4 levels: (1) Quiet standing, no-VPAC; (2) quiet standing, yes-VPAC using the abdominal drawing in maneuver (ADIM); (3) loaded forward reach, no-VPAC; and (4) loaded forward reach, yes-VPAC using the ADIM. The dependent variable was change in TrA muscle thickness (representing a contractile response) as measured by ultrasound imaging (USI) motion mode (M-mode) during each condition over second-6 through second-10 of each 10-second trial.

Sampling and Subjects

Forty-two subjects (both male and female) between ages 20 and 57 years were recruited from: (1) students, faculty, and staff from the local university; and (2) the investigators' acquaintances. Inclusion and exclusion criteria can be found in Table 1. Subjects with a body mass index (BMI) greater than or equal to 30 were excluded because of the challenges in USI data collection as per previous investigators [6,11,23].

Instrumentation and Materials

A LOGIQ P5 ultrasound system with a 4C-RS 2.0-5.5 MHz curvilinear probe (GE Healthcare, Milwaukee, WI) was incorporated. A water-based hypoallergenic gel was used for USI coupling. Ultrasound is a reliable, valid, and noninvasive tool for studying abdominal muscle performance [24,25] during loaded functional activities [11,20,26]. The M-mode USI provides instantaneous, visualized feedback and optimizes TrA measurement across time, which may best represent a contractile response during function [24,27,28]. The M-mode USI performs these measures reliably when subjects are positioned in supine lying, standing, and walking [8,29-33].

Preparatory Procedures

After subjects signed an approved informed consent at Texas Tech University Health Sciences Center, they completed a demographics and medical history questionnaire. Then, subjects watched an instructional video regarding experimental procedures [34,35].

The subjects stood upright with feet positioned shoulder width apart. An investigator (P.S.) who is a physical therapist with extensive experience in VPAC implementation assessed the subject's ability to achieve a proper ADIM according to previous investigators

Table 1
Subject inclusion and exclusion criteria

Inclusion criteria
Age 18-65 years
Ability to activate TrA during a loaded forward reach activity
Ability to stand at least 60 minutes independently
Ability to follow instructions.
Exclusion criteria
Existing active spinal pain
History of diagnosed LBP that required professional health care management
Diagnosed and presently active abdominal, respiratory, or gastrointestinal condition
Pregnancy, based on subject report
Diagnosed spinal conditions to include: scoliosis, spina bifida, spinal pathologies, tumors, present fractures, and/or rheumatologic disorders
Known neurologic or joint disease affecting the trunk
Current urinary tract infection
Hearing loss
Cognitive disorders that hinder understanding simple directions
Body mass index greater than or equal to 30.

TrA = transversus abdominis; LBP = low back pain.