Manual Therapy 20 (2015) 194–199

Contents lists available at ScienceDirect

Manual Therapy

journal homepage: www.elsevier.com/math

Original article

Reversal time of postprandial changes of the thickness of abdominal muscles employing ultrasound measurements

Pardis Noormohammadpour [a, b], Majid Ansari [a, c], Mohammad Ali Mansournia [d], Mohsen Rostami [a, c], Ruhollah Nourian [a, c], Ramin Kordi [a, c, *]

[a] Sports Medicine Research Center, Tehran University of Medical Sciences, No 7, Al-e Ahmad St., Tehran, Iran
[b] Department of Sports and Exercise Medicine, School of Medicine, Tehran University of Medical Sciences, Imam Khomeini Hospital, Bagher Khan St., Chamran Highway, Tehran, Iran
[c] Spine Division, Noorafshar Rehabilitation & Sports Medicine Hospital, 17th St., Khodaverdi St., Niavaran, Tehran, Iran
[d] Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences, Poursina St., Shanzdah-e Azar St., Tehran, Iran

ARTICLE INFO

Article history:
Received 15 June 2014
Received in revised form
21 August 2014
Accepted 28 August 2014

Keywords:
Ultrasonography
Confounding factor
Food intake
Outcome measurement errors
Transversus Abdominis
Internal oblique

ABSTRACT

Objectives: Low thickness of Transversus Abdominis, Internal Oblique and External Oblique muscles may play a role in development of low back pain. Ultrasonography is increasingly utilized to measure the thickness of these muscles. Prandial state has recently been proposed as a confounding factor in such measurements. We aimed to compare the reversal time of the postprandial thickness of these muscles with preprandial values. The measurement errors of ultrasonographic values were also assessed in both immediate preprandial and postprandial states.
Design: Interventional cross-sectional study.
Methods: The ultrasonographic thickness of lateral abdominal muscles was measured at rest and during abdominal drawing-in maneuver in 20 healthy participants before and after consumption of a specific meal. Postprandial ultrasound measurements continued every 15 min until their thickness reached 95% of their preprandial values.
Results: There was a statistically significant reduction in postprandial thickness of these muscles (all p-values <0.001 on both sides). The reversal times were 1.5, 1.3 and 1.2 h for Transversus Abdominis, Internal Oblique, and External Oblique muscles, respectively. Standard Error of Measurement and Smallest Detectable Change were in the range of 0.007–0.013 mm and 0.020–0.035 mm, respectively.
Conclusions: To limit the effects of prandial state on the sonographic thickness of lateral abdominal muscles, we recommend measuring these values at least 1.5–2 h after food consumption. For the future studies, controlling the participants according to their prandial state is recommended.

1. Introduction

As a common clinical diagnosis with a rapidly growing prevalence, low-back pain is a major problem for healthcare systems throughout the world (Dagenais et al., 2008). Lumbopelvic stabilizing exercises (also known as core-stability exercises) are increasingly utilized as a part of low-back pain treatment in both the athletes, and the general population (Willardson, 2007; Clark et al., 2011). These exercises have been proposed to improve muscular strength, endurance and neuromuscular coordination in lumbopelvic-hip complex (Clark et al., 2011). As a part of core-stability rehabilitative approach to low-back pain, ultrasonography (US) has become popular for research, diagnostic and biofeedback treatment purposes (Hebert et al., 2009; Teyhen et al., 2009).

One application of medical ultrasound imaging is Rehabilitative Ultrasound Imaging (RUSI) (Teyhen, 2006; Whittaker et al., 2007). RUSI has been shown to be a valid method for measurement of the trunk muscle size and activation (Koppenhaver et al., 2009). While its reliability has been shown to be good to excellent for single measurements (Costa et al., 2009), methodological confounding factors such as diurnal, between-day, inter-observer, and intra-observer variations may cause measurement errors which influence the reliability of such a method over time (Mannion et al., 2008a; Costa et al., 2009). Part of such variations in ultrasound

* Corresponding author. Sports Medicine Research Center, No 7, Al-e Ahmad St., Tehran, Iran. Tel.: +98 21 88630227.
E-mail address: ramin_kordi@tums.ac.ir (R. Kordi).

http://dx.doi.org/10.1016/j.math.2014.08.012
1356-689X/

measurement of these muscles may be due to the prandial state (Kordi et al., 2011). In this study, Kordi et al. have proposed that food consumption may decrease the thickness of lateral abdominal muscles due to the stretching effect of stomach fullness on these muscles. Therefore, the effect of food consumption on muscle thickness might be a source of error in the repeated measurements of abdominal muscle thickness in different situations. Considering that ultrasound is commonly used for assessment of lateral abdominal muscles thickness and function (Hides et al., 2011; Pinto et al., 2011; Sitilertpisan et al., 2011), standardization of the time of such sonographic evaluations in relation to the time of meal-consumption seems to be necessary in both research and clinical settings. Accordingly, our goal is to determine the time required for the thickness of lateral abdominal muscles to reach the preprandial values after consuming a specific solid meal in healthy participants.

2. Methods

2.1. Design

Finding the reversal time of the thickness of lateral abdominal muscles, including external oblique (EO), internal oblique (IO) and Transversus Abdominis (TrA), was the main objective of this study. To evaluate changes in the thickness of lateral abdominal muscles, we performed ultrasonography before and after consumption of a specific solid meal in healthy participants. Afterwards, these measurements were repeated every 15 min until the measured values returned to 95% of their baseline preprandial values. The time at which this return to baseline was recorded, and is referred to as “reversal time”.

2.2. Participants

The study was carried out on 20 healthy adult (20–45 years old) male volunteers. Our exclusion criteria included history of low-back pain during the past 6 months, systemic disease affecting the musculoskeletal functions, musculoskeletal deformity or abnormality with possible influence on the thickness of lateral abdominal muscles, conditions or medications influencing gastric emptying time, prior history of specific lumbopelvic stabilizing exercises, complaint of abdominal distension and bloating after meals.

The study was announced by placing flyers in public areas. The study was approved by the ethical committee board of Tehran University of Medical Sciences. All participants were orally informed regarding the aim and process of study and also received a written information sheet. In addition, a written consent form was signed by all participants.

2.3. Measurements

Before and after food consumption, the following measurements were made on all participants by two examiners: one conducting the ultrasound measurements, and the other performing the rest of the tests.

All subjects were requested to empty their bladders and defecate (if desired) 30 min prior to preprandial evaluations. They also did not eat any food, drink, or beverages within 4 h before the first measurements.

Ultrasonographic thickness of lateral abdominal muscles, weight, and height of recruited volunteers were measured immediately before and after meal utilizing standard protocols. With shoes removed and heels together, participants stood straight up, took a deep breath, and held it. The height of participant was then recorded in centimeters, while they were looking straight ahead (Swain and Brawner, 2014). Using a calibrated digital scale, the body weight of participants was measured to the nearest 0.02 kg. In addition, participants were weighted wearing only underwear.

The thickness of lateral abdominal muscles was measured at rest and during the abdominal drawing-in maneuver (ADiM) with participants in a hook-lying position (hips flexed to ~30°). We positioned the transducer 25 mm antero-medial to the midpoint between the last rib and ilium on the mid-axillary line where the fascial margins between TrA, OI and OE are parallel (Critchley, 2002; McMeeken et al., 2004; Mannion et al., 2008b; Kordi et al., 2011). This point was marked on the skin of participants during the first preprandial measurement, and was used for the rest of measurements.

Prior to the assessment of lateral abdominal muscles in ADiM, all subjects were taught to activate their TrA muscle via the drawing-in maneuver. They were instructed to draw in their lower abdominal muscles gently toward their spine as they exhaled and held for 10 s, while maintaining a neutral posture of the lumbar spine and continuing to breathe normally. Then the subjects were asked to repeat 5 contraction attempts on each side for training, while ultrasound was used for feedback and monitoring the drawing-in maneuver before obtaining ultrasound measurements (Springer et al., 2006; Hides et al., 2007). An ultrasound machine (Micromaxx®, Sonosite Inc., Bothell, WA, USA) with a 6–13 MHz linear transducer was used to measure the thickness of abdominal muscles in B mode format. The thickness of these muscles was measured on both sides at the end of normal expiration. The ultrasound transducer was aligned perpendicular to the anterolateral abdominal wall based on previous studies (Hides et al., 2007; Teyhen et al., 2009) and in a few subjects, the transducer was slightly angled until a clear image of the abdominal muscles was observed (Springer et al., 2006; Teyhen et al., 2008). Furthermore, the image depth was manipulated until the muscle layers filled approximately 40–50% of the ultrasound display while all three muscle layers could be seen clearly and measurement of muscle thickness was made at the center point of the image using caliper of the machine (Kordi et al., 2011). For preventing inadequate inward probe pressure, a sufficient amount of ultrasound gel was used between the transducer head and the skin to increase the contact area.

The distance between the inferior and superior fascial layers was recorded as the thickness of each muscle (Mannion et al., 2008a). Also reliability of measurements at rest and during the abdominal drawing-in maneuver (ADiM) was achieved in a pilot study by the assessor.

The same amount of a specific solid meal was offered to all participants and they were requested to eat as much as they desired. The meal was a traditional Persian cuisine, and all participants were familiar with the taste of the food. Postprandially, the participants reclined supine on the examination table for a few hours and the measurements were repeated every 15 min until all lateral abdominal muscles thickness reached equal or more than 95% of their preprandial state. The participants did not drink or eat, nor did they urinate or defecate until the end of the final measurements.

2.4. Statistical analysis

Generally, due to variations in the participant, measurement process, and assessors, repeated measurements of a single variable may lead to non-uniform results. In measurement of a single variable in a participant, the results will usually vary around a *true average value*, which is the primary result of the measurement process. However, due to practical reasons, reaching this true average can be unrealistic (Bland and Altman, 1996). The standard