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Original research

The effect of transversus abdominis activation on exercise-related transient abdominal pain

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ABSTRACT

Objectives: Exercise-related transient abdominal pain (ETAP) affects 40–60% of the physically active population, is detrimental to performance but of unknown aetiology. Excessive movement of abdominal peritoneum is one proposed mechanism. Transversus abdominis (TrA) function may play a role reducing in the incidence of Exercise-related transient abdominal pain via the tensioning of the thoracolumbar fascia or increasing intra-abdominal pressure. The aim of this study is to identify any relationship between transversus abdominis function and exercise-related transient abdominal pain, hypothesing that those with stronger transversus abdominis will have lower incidence of exercise-related transient abdominal pain.
Design: Observational study design.
Methods: Trunk muscle strength was measured clinically using the functional Sahrmann test. Contraction of transversus abdominis was measured by ultrasound imaging of resting muscle size and calculating the change in thickness with a voluntary contraction. Participants completed questionnaires describing any exercise-related transient abdominal pain symptoms, and were divided into four groups dependent upon frequency of any symptoms (never, yearly, monthly and weekly). Between group differences were analysed using analysis of covariance, with Bonferroni correction adjusting for age and training of participants using STATA. Poisson regression determined incident rate ratios for relevant variables.
Results: Data was obtained from fifty runners (28 male, 25.8 ± 7.0 years). Sahrmann test score and frequency of Exercise-related transient abdominal pain were significantly different between groups ($p = 0.002$) with asymptomatic runners having significantly higher Sahrmann test scores (stronger muscles) than weekly and yearly Exercise-related transient abdominal pain groups ($p = 0.001$, $p = 0.02$). There were significant between group differences for resting transversus abdominis thickness ($p = 0.034$) but not for transversus abdominis thickness change ($p = 0.555$).
Conclusions: Participants who had stronger trunk muscles and larger resting Transversus abdominis size experienced Exercise-related transient abdominal pain less.

1. Introduction

Approximately 40–60% of runners at some time experience the performance-diminishing condition of exercise-related transient abdominal pain (ETAP),[1–3] more commonly referred to as the running or side stitch. Although ETAP incidence increases with consumption of foods,[4–6] and is reduced with age and training volume,[1–3] the precise cause of ETAP symptoms remains unclear. Recent literature has proposed several different aetiologies of ETAP, including irritation of the parietal peritoneum, cramping of the abdominal musculature, diaphragmatic ischaemia and stress of the peritoneal and sub-diaphragmatic ligaments.[3,4,7] Morton and colleagues observed that in those who regularly experience ETAP the most common locations for pain is the left and right lumbar regions of the torso and this location is consistent with pain from the intercostal nerves, which also service the parietal peritoneum.[8]

ETAP is regularly provoked when participating in activities that have a significant amount of force transmission through the trunk, for example running and horse riding, and appears less commonly in cycling.[3] During activities involving large displacements of the abdomen (running/horse riding) or rotation (swimming) it is thought that there is excessive movement of the abdominal contents, which stresses the surrounding somatic anatomical structures.[2,9] The local stabilising muscles of the spine, including transversus abdominis (TrA), internal obliques, lumbar multifidus, quadratus lumborum, pelvic floor muscles and the diaphragm,[10] are involved in providing protection of the spinal column while stationary and during functional movements.[11] Their role in providing protection against posterior trunk musculoskeletal pain has

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previously been established, with Hodges and colleagues reporting evidence that a loss or delay of feed-forward activation of TrA is associated with chronic and recurrent low back pain.[12–14] The role of these muscles in controlling the more anterior trunk pain associated with ETAP has not been established.

Contraction of the TrA leads to decreased abdominal circumference via increased tension of the thoracolumbar fascia.[15] This decreased abdominal circumference along with the co-contraction of the diaphragm and pelvic floor muscles produces an increase in intra-abdominal pressure.[16–18] Either or both of these variables may be influencing factors on the mobility of the abdominal contents. Therefore, we hypothesise that better TrA function may reduce abdominal content mobility and contribute to a reduced incidence of ETAP. Consequently, this study investigated TrA function in relation to frequency of ETAP experienced by the physically active population to determine if TrA contraction and strength is greater in those who are asymptomatic of ETAP in comparison to those who are symptomatic of ETAP.

2. Methods

Participants between the ages of 18 and 40 years were included in the study if they ran for 20 min or more at least twice per week. Sixty-six eligible recreational and competitive endurance and sprint runners were recruited to participate in the study through advertising at medical centres and fitness centres.

Participants were excluded if they

- Had a current severe injury, particularly acute or chronic low back pain.
- Were currently pregnant or had been pregnant in the last two years.
- Could not assume the correct leg positions involved in the Sahrmann test.
- Had known cardiovascular disease, cancer, pre-/diabetes, coronary artery disease, moderate/severe angina, intermittent claudication, moderate/severe dyspnoea or any other injury or illness which results in abnormal fatigue or muscle weakness.

Informed consent was given by each participant preceding any testing. This study was approved by the Human Research Ethics Committee (Tasmania) Network (H0011312).

Anthropometric measurements of height and weight were recorded and body mass index (BMI) was calculated. Participants performed a functional measure of anterior trunk muscle strength and then had diagnostic ultrasound image measurements of the TrA taken. Participants then completed a questionnaire regarding frequency of ETAP symptoms. This was administered last to ensure blinding of the researcher collecting ultrasound and strength information to the frequency of ETAP in the participants.

The Sahrmann test is a functional graded exercise test used to assess the abdominal musculature, particularly TrA,[10] giving a score from zero to five, with a higher score indicating stronger muscles. The Sahrmann test was described and demonstrated to the participants before practice attempt was performed. A stabiliser biofeedback unit (Chatanooga group of Encore Medical, TX, USA) was placed in the natural lordotic curve of the lumbar region and the participant instructed to perform the abdominal drawing-in manoeuvre which consisted of the verbal cue from the investigator 'gently draw in your navel to your spine'. The biofeedback unit was then inflated to a pressure of 40 mmHg. Verbal cues for the correct procedure of all five stages were given during the test. If the pressure on the biofeedback unit increased or decreased by more than 10 mmHg at any time during the test the previous successful movement was recorded as their score. However, all five stages of the Sahrmann test were attempted and the test ceased after the participants had finished all movements or could not progress to the next level. The participant was given a 2-min rest period in between trials to account for fatigue.

A pilot study was initially conducted to assess the reliability of ultrasound measurements. Nine participants aged between 18 and 50 had two repeated snapshot images of resting and contracted TrA conducted twice on the same day. The reliability of the operator testing techniques was established through determination of intra-class correlation coefficient and typical error.

Changes in TrA thickness during activation using ultrasound (GE LOGIQ BOOK, Jiangsu, China), were recorded with the linear transducer transversely-orientated 3 cm medial to a line half way between the 11th costal cartilage and the iliac crest.[19] The participant was positioned in supine (crook lying) with arms beside the body. TrA contraction was performed using the abdominal drawing-in manoeuvre. This manoeuvre has been shown to significantly increase the thickness of the TrA muscle.[20] Participants were given the opportunity to practice this manoeuvre prior to two ultrasound snapshots being taken immediately after each other with the participant in a relaxed position and then two snapshots during contraction of TrA. This procedure was repeated on the other side of the body. All images were taken at the end of normal inspiration, by the same investigator. Left and right measurements (in cm) were summed and averaged for both resting and contracted states, with thickness change calculated using the equation TrA thickness change = TrA thickness (contracted) – TrA thickness (resting). Contraction ratios were also calculated by dividing the contracted thickness by resting thickness. The reliability of these measures is reported in the results section.

Participants then completed a questionnaire that recorded information regarding the severity (using a 10 cm visual analogue scale), frequency (recorded as incidence) and location of all ETAP experiences using an A4 sized body map of the abdomen, delineated into 9 zones. Training volume for the total amount of physical activity performed (including running and other exercise sessions) was recorded as a weekly amount in hours and number of sessions. Four groups were established based on their rating of frequency of ETAP; weekly, monthly, yearly or never. The groups were coded 1 for weekly incidence of ETAP, 2 for monthly, 3 for yearly and 4 for never experiencing ETAP.

Data is presented as mean and standard deviation. An analysis of variance (ANOVA) was used to compare the physical characteristics of the participants in the different frequency of ETAP groups using STATA (STATA 12, College Texas). Chi-squared analysis was used to compare gender frequencies between the groups. Analysis of covariance (ANCOVA) using age and training as a covariates and Bonferroni post hoc test was completed to identify between-group differences for muscle outcome variables (size and strength). Cohen's d effect sizes were calculated on the differences between groups when significant differences were identified. The relative impact of the variables of strength, age and training on the outcome of ETAP frequency were assessed using mixed method Poisson regression to determine incident rate ratios (IRR) on z score values of the relevant variables. Pairwise correlation between the Sahrmann test and TrA thickness change was performed. The minimum significant difference was determined by a p value <0.05.

Based on the dependent variable of TrA thickness from previous research,[21] detection of a difference in muscle thickness change of 0.08 cm between the groups would require group sizes of 13 per group to provide a power of 0.8. Hence 66 participants were initially recruited to account for potential attrition.