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Original article

Effect of pilates mat exercises and conventional exercise programmes on transversus abdominis and obliquus internus abdominis activity: Pilot randomised trial

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ABSTRACT

Pilates training is said to increase Transversus abdominis (TrA) and Obliquus internus (OI) activation during exercise and functional activities.

34 Pain-free health club members with no Pilates experience, mean (SD) age 30(7) years, were randomised to Pilates mat exercises or strength training. Participants exercised unsupervised twice-weekly for eight weeks. TrA and OI thickness (a proxy for muscle activity at the low-medium efforts of our exercises) were measured with ultrasound pre- and post-training during Pilates exercises 'Imprint' (an abdominal drawing-in manoeuvre) and 'Hundreds A' (lying supine, arms slightly raised, hips and knees flexed to 90°) and 'Hundreds B' (as A, with neck flexion) and functional postures sitting and standing.

Pilates participants had increased TrA thickness in Hundreds A [all values mean (SD) mm]: 3.7(1.3) pre-intervention, 4.7(1.1) post-intervention ($P = 0.007$); and decreased OI muscle thickness during Imprint: 11.7(2.8) pre-intervention, 10.8(3.5) post-intervention ($P = 0.008$). Strength training participants had greater OI thickness during Imprint ($P = 0.014$), Hundreds A ($P = 0.018$) and Hundreds B ($P = 0.004$) than Pilates participants post-intervention. There were no changes in muscle thickness at rest or during functional postures.

Pilates training appears to increase TrA activity but only when performing Pilates exercises. Further research is required into Pilates in clinical populations and how to increase deep abdominal activation during functional activities.

1. Introduction

Pilates has become a popular form of exercise for conditioning and rehabilitation. Pilates has similarities with spinal stabilization training, both aiming to normalise spinal motor control and emphasizing Transversus abdominis (TrA) and Obliquus internus abdominis (OI) recruitment (Richardson et al., 2004; Rydeard et al., 2006). Transversus abdominis and OI are activated during Pilates exercises when performed by experienced practitioners (Endleman and Critchley, 2008). Pilates training is claimed to increase activation of TrA and OI during athletic or daily living activities, which is said to improve sporting performance and reduce back pain (Muscolino and Cipriani, 2004). Despite minimal formal investigation of these claims, Pilates is popular in dance and sports conditioning (Latey, 2002; Muscolino and Cipriani, 2004) and advocated for patients with lumbo-pelvic pain (Comerford and Mottram, 2001).

Herrington and Davies (2005) reported participants who had had six months of Pilates training were more able to maintain a neutral spine under load, claiming this represented increased TrA activity. The effect of Pilates training on TrA or OI has not been evaluated prospectively or with more direct measures of muscle activity.

Real-time ultrasound imaging has been used to measure abdominal muscle thickness change during abdominal muscle exercises (Critchley, 2002; Teyhen et al., 2007). Thickness change in TrA and OI correlated well with electromyographic activity in static contractions at less than 50% of maximum voluntary contraction (Hodges et al., 2003; McMeeken et al., 2004), suggesting that thickness change is a valid measure of activity in these muscles at moderate levels of effort (Koppenhaver et al., 2009). The relationship in obliquus externus abdominis is much weaker and ultrasound-

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measured thickness change cannot be confidently used as a gauge of activity in this muscle (Hodges et al., 2003; John and Beith, 2007).

The aim of this study was to compare the effects of Pilates mat exercises and a conventional strength training programme on the activity of TrA and OI. We used ultrasound measures of muscle thickness as a proxy of muscle activity. Our hypotheses were Pilates mat exercises would result in greater voluntary (during exercises) and automatic (during functional postures) TrA activity than a conventional strength training programme.

2. Methods

See Fig. 1. for study design flow chart.

2.1. Participants

Following ethical approval by King's College London Research Ethics Committee (ref CREC/07/08-172) and having provided written informed consent, 28 women and 6 men were recruited via posters from a health club. Potential participants were excluded if they were under eighteen years old, had had spinal or abdominal surgery at any time, low back pain in the last two years, visible scoliosis, neuromuscular disorders, were pregnant or had ever had Pilates training.

2.2. Data collection

Demographic data were recorded and height and weight measured prior to randomisation. Ultrasound measurements were made prior to randomisation and at eight weeks. Allocation was concealed from the researcher collecting data (ZP); security of concealment was evaluated by the researcher nominating which intervention she thought participants had received at reassessment. All testing took place at Fitness First health club, Balham, UK.

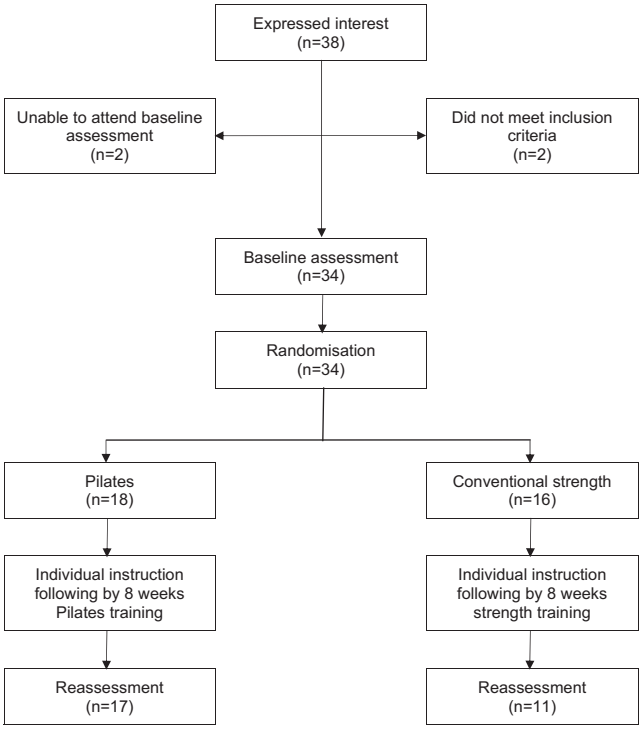

Fig. 1. Study design flow chart.

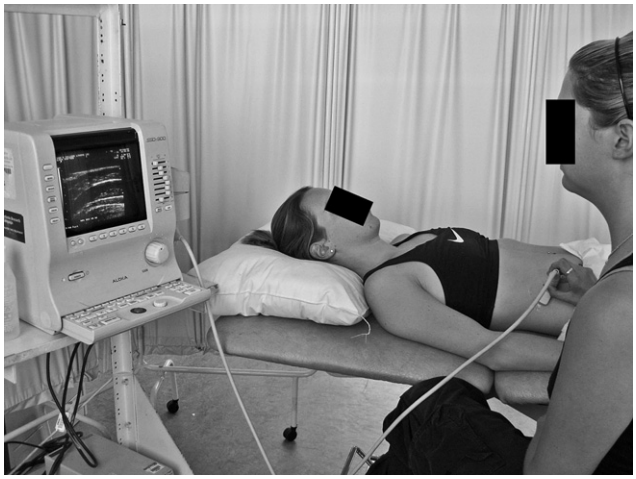

Fig. 2. Ultrasound scanning point.

2.2.1. Ultrasound measurement

A portable ultrasound scanner (Aloka 55D-900, Aloka Co.Ltd., Toyko, Japan) and 7.5 MHz linear transducer was used in B mode. The scanner was calibrated before data collection by comparing with metal phantoms of known dimensions. All measured images were from the right abdomen with transducer orientated antero-laterally, centred on the anterior axillary line midway between iliac crest and lowest rib (Fig. 2) where middle fibres of TrA and middle fibres of OI can be imaged simultaneously (Misuri et al., 1997). The transducer was placed perpendicular to the abdominal wall for optimal accuracy and image clarity. Static views were stored using the freeze facility of the scanner at end of exhalation (Ainscough-Potts et al., 2006); muscle thickness was measured in real-time using the automatic callipers software of the scanner (Fig. 3).

2.2.2. Test exercises and positions for all participants

Following standardised instructions, muscle thickness measurements were taken first in resting supine, then (in random order) standing, sitting and during Pilates exercises known as Imprint (Fig. 4), Hundreds A and Hundreds B (Fig. 5). For Pilates exercise Imprint, participants were instructed to lie supine with their head resting on one pillow. Before Imprint, participants were

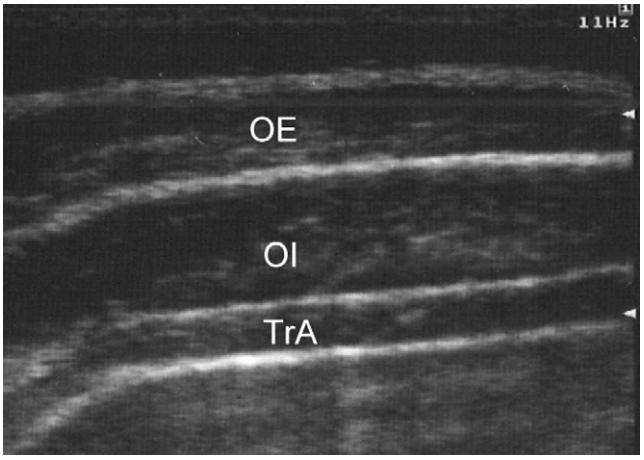

Fig. 3. Example ultrasound image of the antro-lateral abdominal wall. The lighter shade fascia planes separate obliquus externus (OE), obliquus internus (OI) and transversus abdominis (TrA).