Clinical Biomechanics 35 (2016) 49–55

Contents lists available at ScienceDirect

Clinical Biomechanics

journal homepage: www.elsevier.com/locate/clinbiomech

Response of the muscles in the pelvic floor and the lower lateral abdominal wall during the Active Straight Leg Raise in women with and without pelvic girdle pain: An experimental study

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ARTICLE INFO

Article history:
Received 27 October 2015
Accepted 12 April 2016

Keywords:
Chronic pelvic pain
Electromyography
Joint instability
Low back pain
Pelvic pain
Post-partum

ABSTRACT

Background: The relationship between activation of the stabilizing muscles of the lumbopelvic region during the Active Straight Leg Raise test and pelvic girdle pain remains unknown. Therefore, the aim was to examine automatic contractions in relation to pre-activation in the muscles of the pelvic floor and the lower lateral abdominal wall during leg lifts, performed as the Active Straight Leg Raise test, in women with and without persistent postpartum pelvic girdle pain.
Methods: Sixteen women with pelvic girdle pain and eleven pain-free women performed contralateral and ipsilateral leg lifts, while surface electromyographic activity was recorded from the pelvic floor and unilaterally from the lower lateral abdominal wall. As participants performed leg lifts onset time was calculated as the time from increased muscle activity to leg lift initiation.
Findings: No significant differences were observed between the groups during the contralateral leg lift. During the subsequent ipsilateral leg lift, pre-activation in the pelvic floor muscles was observed in 36% of women with pelvic girdle pain and in 91% of pain-free women ($P = 0.01$). Compared to pain-free women, women with pelvic girdle pain also showed significantly later onset time in both the pelvic floor muscles ($P = 0.01$) and the muscles of the lower lateral abdominal wall ($P < 0.01$).
Interpretation: We suggest that disturbed motor activation patterns influence women's ability to stabilize the pelvis during leg lifts. This could be linked to provocation of pain during repeated movements.

1. Introduction

Pelvic girdle pain (PGP) is a common complaint for women during pregnancy. While PGP prevalence declines shortly after delivery (Gutke et al., 2008), a substantial number of women still report persistent pain at three months postpartum (Wu et al., 2004) and even after two years (Albert et al., 2006). Retrospective studies show that up to 20% of women with recurrent lumbopelvic pain experienced their first episode of pain during pregnancy (Biering-Sorensen, 1983; Svensson et al., 1990). Thus, pregnancy seems to represent a risk factor for long-term lumbopelvic pain.

Pelvic instability is defined as an impaired capacity of the pelvic ring to transfer load between the trunk and the legs (Snijders et al., 1993). The Active Straight Leg Raise (ASLR) test is reportedly suitable for examining the ability to transfer load between the trunk and the legs, and a positive result is assumed to indicate insufficient load transfer due to pelvic ring stability loss (Mens et al., 1999). In most cases of PGP no specific underlying mechanism can be identified. It has been proposed that insufficient motor control gives rise to pain from impaired load transfer throughout the pelvic girdle (Beales et al., 2009a) and the pelvic floor muscles (PFM) are a part of the stabilization system for the pelvis (Hu et al., 2012). It is well known that coordination of different muscle groups is essential for maintaining stabilization in the lumbopelvic area (Richardsson et al., 2002; Snijders et al., 1993; Stuge et al., 2006). The ligaments in the pelvic region have been identified as sources of pain among women with long-lasting PGP, supporting the concept that instability during loading can trigger pain symptoms from these structures (Torstensson et al., 2013; van Wingerden et al., 1993; Vleeming et al., 2002).

While biomechanical models support the role of the PFM in providing pelvic stability claiming that the activation of the PFM might be important for PGP (Pool-Goudzwaard et al., 2004; Snijders et al., 1993), little

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http://dx.doi.org/10.1016/j.clinbiomech.2016.04.007
0268-0033/

is presently known about automatic contractions and the timing of the contractions in the PFM. It is thought that PFM contribute to pelvic ring stiffness by force closure, and that impaired force closure may hamper load transfer throughout the lumbopelvic region (Pool-Goudzwaard et al., 2004; Snijders et al., 1993). Compared to healthy controls, women with pregnancy-related lumbopelvic pain show increased electromyographic (EMG) activity of the PFM during endurance contraction, coughing, and pushing (Pool-Goudzwaard et al., 2005). In contrast Stuge et al. (2013) suggest that the activation of the PFM is not important for PGP. With ultrasound they showed that there is an automatic response in the PFM with respect to the level of activation when performing an ASLR in both women with and without PGP. However, since difficulties with performing the ASLR could possibly be due to failing to perform optimal force closure, not only activation level but also the timing of the automatic contraction of the PFM, the trunk muscles and diaphragm can be essential. There is still a knowledge gap concerning the timing of the activation of the PFM in women with PGP.

The present study aimed to examine automatic contractions in relation to pre-activation in the PFM and the muscles of the lower lateral abdominal wall during leg lifts, performed as the ASLR test, among women with and without persistent postpartum PGP.

2. Methods

2.1. Participants and clinical examinations

Women with persistent postpartum PGP and pain-free women were recruited by physiotherapists at a women's health care clinic, as well as through advertisements posted in waiting rooms of children's health care clinics. Inclusion criteria were age between 20 and 40 years and vaginal delivery no less than three months earlier. Exclusion criteria were insufficient Swedish language skills; ongoing pregnancy; diagnosed neurologic or rheumatic disease; fracture, operation, or neoplasm of the femur, pelvis, or spine; and history of gynecological operation. Additionally, pain-free women were excluded if they had experienced recurrent lumbopelvic pain within the previous 12 months and/or during their most recent pregnancy. We aimed to recruit an equal number of women in both groups; however, this was prevented by the low number of women with no pain who were willing to participate in the study. This study was approved by the Regional Ethical Review Board in Linköping, Sweden, and all participants gave informed consent to participate in the study (Dnr M81-06; Dnr 2012/193-31).

All participants completed a questionnaire evaluating demographic data, number of children, urinary leakage (yes/no), and lumbopelvic pain during pregnancy (yes/no). Women with PGP also answered additional questions; their disability was evaluated on a scale of 0–100% using the Oswestry Disability Index (ODI) (Fairbank et al., 1980), and health-related quality of life was assessed on a scale of −0.594 to 1 using the EuroQol instrument (Rabin and de Charro, 2001). Women with PGP rated their symptom satisfaction as "delighted to mostly satisfied" or "mixed to terrible feelings" (Cherkin et al., 1996). They also assessed their pain frequency as "always, day and night to several times per week," or "occasionally to never," and rated their pain intensity at the moment and their average pain for the previous week using a visual analog scale (VAS) ranging from 0 to 100 mm.

PGP classification was based on an examination described in detail by Gutke et al. (2010) with the modification that ≥1 positive pelvic pain provocation test was sufficient. The women also performed the ASLR test, the results of which were used to describe the severity of the problem but not considered as an inclusion criterion. The ASLR was scored on a 4-point Likert scale, ranging from 0 (the patient feels no restriction) to 3 (inability to raise the leg) (Mens et al., 1999). The scores on both sides were summed, and a sum score of ≥1 was defined as positive.

2.2. Protocol

The test movements consisted of leg lifts performed as ASLRs (Fig. 1). The participants performed a total of ten repetitions (5 with each leg) of ASLR at a comfortable (i.e. self-paced) speed with an approximately 40-second rest between each repetition. The test leader issued a verbal command to the participants to indicate when to start each repetition. A switch was placed under the woman's foot to indicate when the lift was initiated. The ASLR was first performed using the contralateral leg with respect to the electrodes placed on the abdominal wall, and then with the ipsilateral leg. Notably, the first two women with PGP performed only contralateral leg lifts. However, since PGP often was bilateral, this procedure was changed such that all subsequent women were tested during both contralateral and ipsilateral leg lifts. Throughout the article, the ASLRs will be referred to as the contralateral ASLR and the ipsilateral ASLR.

2.3. EMG recordings

Surface EMG activity was recorded from the PFM, and unilaterally from muscles over the lower lateral abdominal wall at ~2 cm medially from the spina iliaca anterior superior. A Periform™ vaginal probe (Neen HealthCare, Dereham, UK) was used to record EMG activity of the PFM and disposable pre-gelled Ag/AgCl surface electrodes (Blue Sensor, M-00-S, Medicotest, Denmark, diameter of active part 10 mm) were used to record activity from the abdominal wall. Skin preparations were performed according to the recommendations from Surface EMG for Non-Invasive Assessment of Muscles (SENIAM). EMG activity was recorded with a 1000-Hz sampling frequency (bandwidth of 8–500 Hz) using a ME6000 EMG eight-channel unit system (MEGA Electronics Ltd., Kuopio, Finland) with a 14-bit analog-to-digital converter and Butterworth filter.

2.4. Algorithm for detecting onset time

The raw data were edited to remove the offset using MegaWin software, version 2.3.4 (MEGA Electronics Ltd., Kuopio, Finland). The onset time was detected through data processing using MATLAB, version 8.1.0.604 (R2013a) with the Microsoft Windows 7, version 6.1 operating system. The power spectrum of the surface EMG was within the frequency range of 10–500 Hz with the most power in 20–200 Hz, and the normal electrocardiography (ECG) signal showed a frequency content of up to 100 Hz with the fundamental frequencies falling below 35 Hz (Drake and Callaghan, 2006). Accordingly, the ECG mainly distorted the lower end of the EMG spectrum. A high-pass Butterworth

Fig. 1. The test movement performed as an Active Straight Leg Raise (ASLR) test.