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TRUNK MUSCLE ACTIVITY IS INDEPENDENT OF ANGLE ACHIEVED IN POSTERIOR PELVIC TILT

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SUMMARY

Posterior pelvic tilt (PPT) exercises are frequently used in back rehabilitation, although the immediate effect of PPT in people not educated in this exercise is unknown. This study evaluated the effect of PPT in healthy participants on pelvic angle and muscle activity compared to normal standing. Reflective markers were attached to the left and right Anterior Superior Iliac Spine (ASIS) and Posterior Superior Iliac Spine (PSIS) in ten healthy participants without back pain. Kinematic data were collected using 10 high speed cameras. Surface electromyography (EMG) electrodes were attached to rectus abdominis (RA), gluteus maximus (GM), erector spinae (ES), external oblique (EO) and internal oblique (IO) muscles (left and right sides). EMG signals were transmitted via telemetry and synchronised with the kinematic data collected during stance and PPT (3 trials, 10s). PPT was achieved by verbal and manual facilitation at the start of each PPT trial. EMG data were full-wave rectified and the integrated EMG (iEMG) calculated. The angle between the left PSIS, ASIS and vertical, significant angle and iEMG differences between stance and PPT, and correlations between angle and iEMG were calculated. There was a significant angle reduction from stance (102°) to PPT (93°) and a significant iEMG increase for GM left, RA left, OE left and OI right. Angle or change in angle was not correlated to any muscle or change in muscle activity. Therefore PPT causes a significant increase in muscle activation, but is independent of the magnitude of the position change.

INTRODUCTION

Pelvic alignment is commonly assessed in physiotherapy due to its relation to musculoskeletal pathologies of the spine and lower limb [1]. Many people stand with an anteriorly tilted pelvis during stance, which may have undesirable effects on muscle recruitment around the pelvis and the trunk. Therefore, a posterior pelvic tilt exercise is frequently used as part of a rehabilitation programme for the treatment of low back pain [2]. This exercise is also used during lower limb exercises and activities of daily living to support the spine with the aim to prevent injury [3]. To our knowledge, the immediate effects of a posterior pelvic tilt exercise on pelvic angle and muscle activity of the pelvis and trunk in people not educated in this exercise is not known. The aim of this study was to evaluate the effect of an initial verbal and manual posterior pelvic tilt in healthy participants on pelvic angle and muscle activity during a sustained posterior pelvic tilt whilst standing, compared to normal relaxed standing.

METHODS

Ten asymptomatic participants were recruited as part of another larger study. Exclusion criteria included back pain in the last 12 months, previous spinal surgery or fracture, neurological conditions, abdominal surgery, a Body Mass Index (BMI) in excess of 25, or people who had done pelvic tilt exercises regularly under educated instruction. Normal range of thoracolumbar movement was assessed in each participant, to ensure that all movements were within physiological limits and pain free. All participants except one were right handed and right footed. Ethical approval was granted from the ethics commission at the Medical University of Vienna and all participants signed a consent form. For this study, reflective markers attached to the left and right Anterior Superior Iliac Spine (ASIS) and Posterior Superior Iliac Spine (PSIS) on each participant were included for data analysis. Three-dimensional kinematic data were collected using 10 high speed cameras (Eagle Digital Real Time System, Motion Analysis Corp., Santa Rosa, CA, USA) recording at 120Hz using kinematic software (Cortex 3.6.1). After skin preparation with sandpaper and alcohol, surface Electromyography (EMG) electrodes (Delsys Trigno, Boston, MA, USA) were attached to the left and right side of the rectus abdominis (RA), gluteus maximus (GM), erector spinae (ES), external oblique (EO) and internal oblique (IO) muscles and data were collected at a sample rate of 1200Hz. EMG signals were transmitted via telemetry and synchronised with the kinematic data collection. Data were collected during normal relaxed standing (stance condition) and during posterior pelvic tilt (pelvic tilt condition) at stance. For both conditions, three trials of 10s were collected for each participant. The posterior pelvic tilt was achieved by verbal and manual facilitation by a person experienced in educating correct pelvic posture before the start of each posterior pelvic tilt trial. As soon as the pelvic tilt posture was achieved, the facilitator discontinued manual and verbal facilitation and data collection began immediately whilst the participant maintained the posterior pelvic tilt independently for the duration of the measurement trial. Surface EMG data were full-wave rectified and the integrated EMG (iEMG) was calculated using the cumulative summation function in MATLAB (2008b). The two-dimensional angle between the left PSIS, ASIS and the vertical were calculated from the kinematic data. Data were statistically analysed using IBM SPSS 19. Descriptive statistics (including the mean and standard deviations) were calculated for angle and iEMG data during the stance and pelvic tilt conditions, as well as the change in angle and iEMG between the stance and pelvic tilt conditions. The normal distribution of data was tested using the Shapiro-Wilk test. Differences between the stance and pelvic tilt conditions were tested for angle and for iEMG values using a paired t-test or Wilcoxon Signed Rank Test. Correlations between angle and iEMG for the stance condition, the pelvic tilt condition and for the difference between stance and pelvic tilt condition were calculated using a Pearson's or Spearman's correlation.

RESULTS AND DISCUSSION

All data from the ten participants were reported (female n=4, male n=6, age 22.5 ± 1.35 years, body mass 69.7 ± 16.9 kg, height 176.6 ± 14.2 cm, and BMI 22.0 ± 2.2). There was a significant reduction (p=0.000) in mean angle from stance (102°) to posterior pelvic tilt (93°). There was an increase in mean iEMG for each muscle from stance to pelvic tilt, although only significant iEMG increases were found for GM left (p=0.011), RA left (p=0.013), OE left (p=0.013) and OI right (p=0.009). Out of all the correlation calculations between muscle activities during stance and pelvic tilt, 15 correlations were significant. Six of these were highly significant, these being left RA during stance and pelvic tilt (r=0.938, p=0.000), right ES and left RA during stance (r=0.855, p=0.002), right ES during stance and right RA during pelvic tilt (r=0.794, p=0.006), right OI and left OI during stance (r=0.879, p=0.001), right OI during stance and left OI during pelvic tilt (r=0.830, p=0.003), and right OI and left OE during pelvic tilt (r=0.903, p=0.000). Pelvic angle during stance, pelvic tilt or the change in angle was not correlated to any muscle or change in muscle activity.

In the present study, an increase in abdominal muscle activity was shown during the posterior pelvic tilt condition compared to the stance condition. This finding is similar to other literature, where it has been shown that abdominal hollowing exercises, performed to increase activity of the IO and transverse abdominis muscles, increase the amount of posterior tilt of the pelvis [4]. Significant differences in trunk muscle activation have also been shown when comparing normal stance with more relaxed postures of sway-back at stance and slumped sitting, with the relaxed postures showing a reduction in muscle activity except for RA during a sway-back posture [5]. A change of pelvic position in the posterior tilt direction causes a significant increase in muscle activation, but this increase is independent of the magnitude of the position change. Apparently, leaving the habitual non-conscious relaxed pelvic alignment during stance and assuming a non-habitual conscious posture creates the need for additional muscle activity to achieve muscular stability, potentially relieving the passive structures from their tensions and stresses. If the aim of physiotherapy in some patients is therefore the reduction of excess stress on passive structures, then it seems important to train the posterior pelvic tilt posture until it becomes non-conscious and habitual. The effect of postural training programmes has shown variable results which may not be sustained. A 10-week Pilates-based exercise programme aimed at enhancing standing and sitting posture in older adults, showed a significant reduction in thoracic kyphosis during stance, although this was not sustained on short-term follow-up [6]. However, a 10-week home exercise programme aimed to improve head-neck posture showed a significant change in head-neck posture on completion of the exercise programme compared to a control population [7]. Therefore, muscle activation during a posterior pelvic tilt in people at different stages of habituation to an efficient pelvic alignment as part of a postural training programme should be investigated in the future. It is conceivable, that once the new posture has again become non-conscious and habitual, muscle activities would gradually decrease. If the aim of physiotherapy in some patients is the activation of trunk musculature, then it seems important to introduce new postures or more challenging postural stability exercises at frequent intervals. These findings could then be applied in clinical practice to best educate back pain patients in this exercise or as a preventative exercise.

CONCLUSION

Verbal and manual facilitation of a posterior pelvic tilt leads to a significant reduction of pelvic angle and increase in abdominal trunk muscle activity in young people not educated in the posterior pelvic tilt exercise, although muscle activation was not correlated to the change in pelvic angle.

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