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2D ULTRASOUND IMAGING AND MOTION TRACKING OF PELVIC FLOOR MUSCLE (PFM) ACTIVITY DURING ABDOMINAL MANOEUVRES IN STRESS URINARY INCONTINENT (SUI) WOMEN

Hypothesis / aims of study

To describe the response of the PFM of continent women during abdominal manoeuvres as measured by motion tracking of the ano-rectal angle (ARA) using 2D ultrasound and compare this response to women with self reported SUI.

Study design, materials and methods

Data were obtained from 22 controls, age 40.1±2.3 yr, (parity 0.5±0.2) and 9 SUI subjects age 52.1±5.9 yr, (parity 1.4 ± 0.2), recruited according to an IRB approved protocol. Investigators were blinded to the continence state of the volunteers. A preliminary digital vaginal examination assessed the ability of the volunteers to elicit a voluntary PFM contraction and a low abdominal hollowing manoeuvre, that produces a voluntary Transversus Abdominis (TrA) contraction, was taught and verified by both palpation and with Transabdominal ultrasound. Volunteers were imaged using a Hitatshi EUB-52 scanner (Hitachi, Japan) connected to a 128 element high definition linear array operating at 3.4-5.0 MHz.

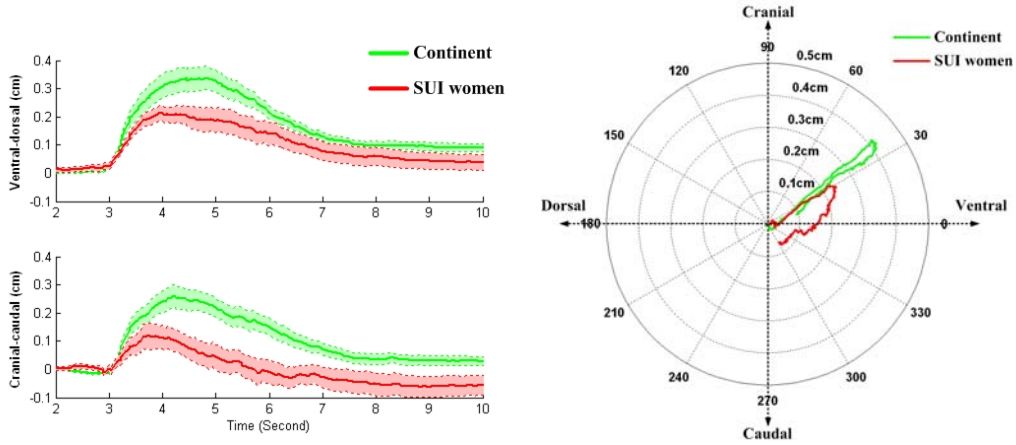
The ultrasound transducer was placed on the perineum in a mid sagittal orientation. All volunteers performed, whilst breathing normally, in crook lying and in standing, a voluntary TrA contraction without instruction to contract their PFM. Simultaneous digital palpation of the low abdominal muscles verified activation of TrA.

Video recordings of the imaging were recorded on a PC using in AVI format for off line analysis. An orthogonal coordinate system fixed on the symphysis pubis was established to map the trajectory of the Ano-rectal angle (ARA) in response to a voluntary TrA contraction. The motion artefact of the symphysis pubis was tracked and re-indexed. Statistical comparisons, using the T-test, were performed to evaluate the level of significant differences of the trajectory of displacement during a TrA manoeuvre and also to compare the effects of a change, between standing to supine within each group. Values are quoted as mean and Standard Error (SE)

Results

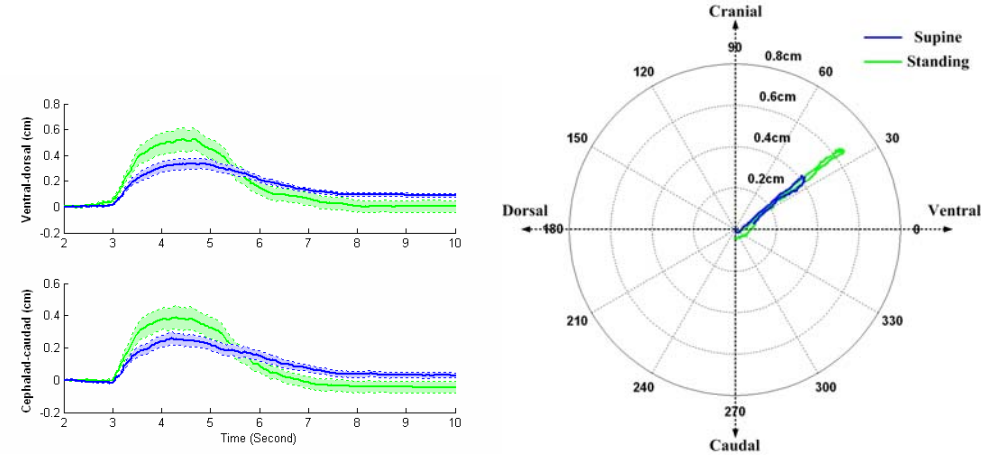
In both groups, it was found that there was an automatic response of the PFM to a TrA manoeuvre] as indicated by the cranio-ventral displacement of the ARA. (Figure 1) In the continent group, in the supine position, there was a significantly higher mean ventral displacement when compared to that of the incontinent group P=0.0116. Furthermore after the completion of the contraction, the ARA of the SUI women was more caudal (lower) than the starting position whereas in the continent women there was still a positive cranial displacement.

In the standing position the results of the 18 continent and 3 SUI women are given by Figure 2. A TrA contraction in standing also displaced the ARA in a ventral-cranial direction. In continent women, there was greater displacement in a standing position compared to supine in both the cranial P=0.0443 and ventral P=0.0197 directions (Figure 2).



(a) (b)

Figure 1 (a) Mean and SE of the ventral-dorsal and cranio-ventral movement of ARA in supine. The STEs of the movement are marked by the coloured areas. (b) The trajectory of the ARA movements in supine.



(a) (b)

Figure 2 (a) Mean and SE of the ventral-dorsal and cranio-ventral movement of ARA in supine (green) and standing (blue). (b) The trajectory of the ARA movements of the continent women in supine and standing (blue).

Interpretation of results

It is normal for the PFM to contract and displace the ARA in a cranio-ventral direction in response to a voluntary lower abdominal hollowing manoeuvre that activates the TrA. A ventral displacement of urogenital structures will produce compression against the symphysis pubis, and this may help to increase urethral closure pressure.

It is known that co-activation of the PFM, the diaphragm and the abdominal muscles are necessary to generate intra-abdominal pressure (IAP). The automatic ventral displacement of the urogenital structures during abdominal muscle activity is reduced in incontinent women. This could be another mechanism by which the IAP exceeds urethral pressure producing leakage in incontinent women.

When the continent group finish the contraction of the TrA, there is still an overall ventral-cranial displacement of the ARA, providing further support of the urogenital structures up and towards the pubic symphysis. This suggests that the PFM in healthy women, do not fully return to their resting state, even though there has been a conscious cessation of the contraction. In the incontinent group, however, at the end of the contraction, there is greater dorsal caudal displacement than at the beginning of the manoeuvre, providing less support of the urogenital structures towards the symphysis pubis.

In continent women, in standing, there is greater displacement of the ARA following a TrA contraction, compared to supine. Analysis of pilot data of 3 SUI women in standing, suggest that this difference does not occur, however this should be interpreted with caution, give the small number within our SUI group. Preliminary thoughts are that in standing, in normal subjects, the vaginal force pressure increases due to greater IAP and greater resistance in the PFM (1) so there is easier recruitment of both the TrA and PFM, creating more displacement of the ARA. However in the SUI women they are less able to overcome the increased resistance created by higher levels of IAP.

Concluding message

It is not appropriate to discourage the activation of the lower abdominal muscles when rehabilitating the PFM. Furthermore, if the patient is unable to voluntarily activate the PFM, the reflex co-contraction of TrA and the PFM justifies the clinical use of facilitation of the PFM via the TrA.

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