17
Shishido K[1], Jones R[2], Peng Q[3], Constantinou C E[3]
1. Department of Urology, Fukushima Medical University School of Medicine, Fukushima, Japan, 2. School of Health Professions and Rehabilitation Sciences, Southampton University, UK, 3. Department of Urology, Stanford University School of Medicine, CA, USA

PASSIVE RESPONSE OF THE PELVIC FLOOR TO THE INCREASE OF THE INTRA-ABDOMINAL PRESSURE DURING A VALSALVA

Hypothesis / aims of study

Anatomically, hypermobility of the urethra is thought to be one of the main causes of female stress urinary incontinence (SUI). From our clinical experiences, however, urethral hypermobility is not only seen in patients with SUI, it is also evident in many continent women. On the other hand, the pelvic floor (PF) is considered to play an important role on the continent mechanism by supporting the bladder and urethra against increasing intra-abdominal pressures (IAP). It is suggested that the difference between continent women and SUI patients may be found in the differences of tissue characteristics of the PF, located beneath the bladder and urethra and moves simultaneously with urethral movement. In this study, we evaluated the passive properties of the PF in normal continent women and SUI patients by measuring the movement of Ano-Rectal Angle (ARA) relative to the urethra as well as the pressure of anterior vaginal wall during Valsalva maneuver.

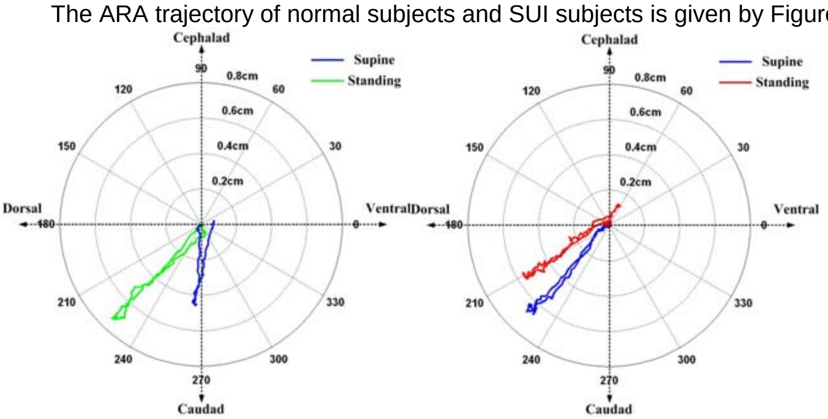
Study design, materials and methods

31 female volunteers were recruited and divided on the basis of history and self reported symptoms to normal controls (N=22, age; 39.0±2.3 y.o, parity; 0.5±0.2) and to those with SUI (N=9, age; 52.1±5.9 y.o, parity; 1.4±0.2). The vaginal probe was used to measure the contact pressure on the middle of the anterior vaginal wall in Valsalva. Three consecutive Valsalva maneuvers were elicited. Volunteers were imaged using a HITACHI EUB-52 ultrasound scanner (Hitachi, Japan) connected to a 128 element high definition linear array operating at 3.4-5.0 MHz. All volunteers were asked to Valsalva on command while imaging, in the supine position and also while standing. Three consecutive Valsalva maneuvers were also elicited.

An orthogonal coordinate system fixed on the symphysis pubis was established to map the trajectory of the ARA in response to Valsalva. An adaptive motion tracking algorithm based on matching template was developed to measure the movement of the symphysis pubis and the ARA, and then the motion artifact of the symphysis pubis was tracked and subtracted from the motion of the ARA. The two axes of the coordinate system are parallel and vertical to the urethra at rest respectively. The coordinate system is fixed during the maneuver, so when the subject deforms the bladder and urethra, the coordinate system will maintain its original position and the ensuing trajectory of ARA can be measured relative to this fixed axis. Values are given as mean value ± standard error and statistical comparisons were made by using T-test or one way ANOVA.

Results

The ARA trajectory of normal subjects and SUI subjects is given by Figure 1.



(a) Normal subjects (b) SUI patients

Figure 1: Trajectory of ARA in response to Valsalva while supine and standing in normal and SUI subjects.

Table 1 shows the numerical values of the trajectory of the ARA in response to Valsalva pressures. There are significant differences between Normal and SUI subjects primarily in the supine position. As shown in Table 2, to define the maximum displacements of the ARA, the numerical values of a range of action of the ARA in response to Valsalva pressures were calculated.

Table 1: The directional angle (degree) of the trajectory of the ARA

Posture	Supine	Standing	P value
Normal subjects	-110.9±2.0	-130.0±2.8	<0.001
SUI patients	-127.5±3.1	-149.4±4.7	<0.01
P value	<0.001	<0.01	

Table 2: The range (cm) of action of the ARA in response to Valsalva

Posture	Supine	Standing	P value
Normal subjects	0.63±0.05	0.94±0.08	<0.01

SUI patients	0.90±0.09	0.69±0.12	>0.05
P value	>0.05	>0.05	

Maximum anterior Valsalva pressures, as measured in the vagina, 1.02±0.19 (N/cm^2) in Normal subjects were higher than SUI subjects 0.90±0.26 (N/cm^2) but not statistically different.

Interpretation of results

Because the maximum anterior vaginal wall pressure of SUI patients generated by increasing IAP was similar to that of normal subjects, we could compare passive movements of the ARA in two groups directly. We consider the ARA as an important landmark in our present analysis because the central sling component of the PF, puborectalis and puboccoccygeus, wrap around the anorectal junction, and its displacement is closely associated with a movement of the PF.

As shown by the data, there is difference of the trajectories of ARA between SUI patients and normal subjects. The directional angle of the trajectory of SUI patients was significantly greater than that of normal subjects in both postures (Table 1) whereas there was no significant difference in the range of action between two groups (Table 2), indicating that, comparing with normal subjects, the ARA of SUI patients is more likely to move away relatively from the urethra during IAP increase.

In the normal subjects' ARA movements, the range of action in standing position was significantly greater than that in supine (Table 2). This difference may occur by not only an influence of gravity and the direction of force created by the increase in IAP but also due to the stiffness of the PF which can keep holding its position against the IAP at rest. In SUI patients, however, the range of action in standing was smaller than that in supine (not significant); suggesting that the PF can not hold its position against the resting pressure and had already sagged. Therefore, the range may be getting smaller when the load increases.

It therefore appears that, in normal subjects, the PF has elastic and firm properties. These may not only be the histological characteristics, but also be derived from reflexive contraction of the PF muscles according to the increasing of IAP which recently has been observed by an EMG study (1). In contrast, The PF of SUI patients lacks these properties.

Concluding message

Analysis of the displacement and trajectory of the ARA movement in supine and standing demonstrate that the PF properties of normal women are significantly different from those of the patients with SUI.

Reference

1. Neurourology and Urodynamics 2006, 25: 148 – 155

FUNDING: NIH 1 R21 EB001654
DISCLOSURES: NONE
HUMAN SUBJECTS: This study was approved by the IRB committee of Stanford University and followed the Declaration of Helsinki Informed consent was obtained from the patients.