ORIGINAL ARTICLE

Can wearing high heels influence anal canal pressure and the severity of fecal incontinence?

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Abstract

Introduction and hypothesis Wearing high heels may not only produce deleterious effects on the musculoskeletal system and on the general posture, but also on the activity of pelvic floor muscles. However, no data are currently available concerning the link between fecal incontinence and wearing high heels. Our aim was to determine whether wearing high-heeled shoes could influence anal canal pressure values in patients suffering from fecal incontinence.

Methods In this retrospective monocentric study, 338 female patients were included. Clinical data, including the Wexner score, and manometric data were recorded (using 3D high-resolution anorectal manometry). Wearing high heels was defined by the use of high-heeled shoes at least four times a week for 4 consecutive hours with at least 1 year of usage time and heels ≥3 cm. Two sub-groups were defined: "high heels" vs "no high heels."

Results The two subgroups were comparable for clinical data, including Wexner score, except for a higher age, menopause and hormone replacement therapy, and urinary incontinence in the group with "high heels." No statistical difference was observed concerning the anal canal pressure. Using analysis by logistic regression, only age was related to a significantly lower resting pressure.

Conclusions In this retrospective cohort of women with fecal incontinence, no clinical or manometric differences were observed between women who wore high heels versus those who did not. Because there is limited knowledge on this potential link and because the pelvic tilt may vary according to age and the habit of walking with high heels, further studies are necessary.

Keywords High-heeled shoes · Fecal incontinence · 3D high-resolution anorectal manometry

Introduction

Wearing high heels is a common habit in women to appear slender and taller. Data from the literature show that this use is increasing and that about 59% of women wear high-heeled shoes for 1 to 8 h per day [1, 2]. However, wearing high heels

may produce deleterious effects on the musculoskeletal system and on the general posture [3]. These effects may not only cause foot problems [4], but may also increase lumbar lordosis [5] and may affect the activity of the pelvic floor muscle [6]. Indeed, some data have demonstrated that the ankle position influences pelvic floor muscle activity [6]. In particular, Chen et al. have studied the changes in the pelvic floor muscle activity in three different positions (horizontal standing, ankle dorsiflexion, or plantar flexion of an angle of 15° in women suffering from stress urinary incontinence. They have demonstrated that the resting contraction and the mean maximal contraction were significantly lower during the plantar flexion position than during the horizontal standing or the dorsiflexion position [6]. These data may be of particular interest to try to improve the success rate of pelvic floor muscle training using various ankle positions. Moreover, the impact forces created from the feet during walking, and providing information to the pelvic floor muscle, are lower in subjects in the plantar flexion position [6]. These data suggest that the

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ankle position induced by wearing high-heeled shoes may have an impact on pelvic floor muscle activity due not only to the posterior pelvic tilt but also to the higher impact force transmitted to the pelvic floor muscle, as was previously described in high level sport practice [7]. However, the impact of wearing high-heeled shoes on pelvic floor activity has been poorly studied and no data are currently available concerning ano-rectal function and use of high heels. The aim of our study was to determine whether wearing high-heeled shoes could influence anal canal pressure values measured by 3D high-resolution anorectal manometry (3DHRAM) in patients suffering from fecal incontinence (FI).

Materials and methods

Materials

This retrospective study was conducted between 1 October 2012 and 1 October 2014. All patients suffering from FI who underwent 3DHRAM and an endoanal ultrasound (EUS) were eligible. The exclusion criteria were as follows: age ≤18 years, previous anorectal surgery, an active anal lesion, neurological disease, or systemic disease.

Clinical data were systematically recorded. The Wexner Fecal Continence Scale was used to rate the severity of the symptoms [8]. The Wexner scale provides a score ranging from 0 to 20, with a higher score reflecting a greater severity of symptoms.

Wearing high-heeled shoes was defined by the use of high heels at least four times a week for 4 consecutive hours with at least 1 year of usage time and heels measuring ≥3 cm (= 1.18 in.) [1]. Two sub-groups were thus defined: "high heels" vs "no high heels."

The women were asked the following questions:

1. In your current habits, what is the height of the heels you mainly wear: < or ≥ 3 cm (= 1.18 in.)?
2. If you used to wear heels ≥3 cm (= 1.18 in.), did you wear them at least four times a week for 4 consecutive hours for at least 1 year? Yes or no (all patients who answered "no" were considered "no high heels")

Patients were also asked about their main position during the day (> 50%): upright, sitting or both.

Procedures

In our center, the recording of clinical data and the two following procedures are carried out on the same day.

Three-dimensional high-resolution anorectal manometry

The 3D high-resolution probe used in this study has a diameter of 10.75 mm and a length of 64 mm. It has 256 pressure sensors arranged in 16 rows of 16 circumferential sensors each. The probe has a central lumen for inflation and a disposable sheath that is covered by a balloon that is 3.3 cm long and has a capacity of 400 cc. The manometric data were analyzed using specific ManoView™ analysis software (Sierra Scientific Instruments, Los Angeles, CA, USA) [9]. The data analyzed were the mean resting pressure, the mean voluntary contraction, and the mean high-pressure zone length. All of the patients underwent 3DHRAM in the left lateral decubitus position without previous enema.

Endo-anal ultrasound

Endo-anal ultrasound (EUS) was performed on patients in the left lateral decubitus position. We used a rigid biplanar transrectal probe with a frequency of 7 MHz (model EUP-U533; Hitachi, Japan). By slowly and manually rotating the linear probe 360°, the various layers of the anal wall (mucosa, internal anal sphincter, external anal sphincter), the rectal wall, and the perirectal tissues (*m. puborectalis*, bladder, vagina, or prostate) could be successively visualized. A defect of the internal anal sphincter was defined as an echogenic interruption of the muscular ring, whereas an external anal sphincter defect was defined as a hypoechogenic interruption [10].

During the dynamic analysis with EUS, pelvic floor disorders (rectocele, enterocele, bladder descent) were assessed according to the technique previously described by Vitton et al. after instillation of 50 ml of water into the rectum [11, 12].

Regulatory aspects

This is a retrospective study and according to current French legislation on clinical trials, there was no need for patient consent. The data used were anonymized and collected from the Assistance Publique Hôpitaux de Marseilles computer file, which is declared to the Commission Nationale Informatique et Liberté (French National Commission for Data Protection).

Statistical analysis

Descriptive data were provided for the whole sample and per group. Comparisons were performed between the no high heels group and the high heels group, according to the definition provided: Chi-squared tests or Fisher's exact tests for binary variables, Student's t tests or Mann–Whitney test for quantitative variables. To determine the role of the high heels in resting pressure, logistic models were performed including heel group, age, BMI, duration of symptoms, vaginal delivery,

and menopause. Results were presented as odds ratios and their 95% confidence intervals.

Results

A total of 338 women with a mean age of 55 ± 15 years were included in this study. Their clinical characteristics are presented in Table 1.

There was no significant difference for clinical data between the two sub-groups except for age (significantly higher in the "high heels" group), menopause. and hormone replace therapy (more frequent in the sub-group heels ≥ 3 cm). There were no significant differences in the duration of symptoms and the Wexner score between the two sub-groups.

Urinary incontinence was significantly more frequent in the sub-group heels ≥ 3 cm.

There were no significant differences in the parameters measured by 3DHRAM were not significantly different between the 2 sub-groups. Moreover, there was no significant difference in the EUS data between the two sub-groups. The values of 3DHRAM and EUS are presented in Table 2.

By multivariate analysis (including heel height, age, BMI, duration of symptoms, vaginal delivery, menopause), only age was related to a significant lower resting pressure and FI.

Discussion

To our knowledge, this study is the first one to assess a link between wearing high heels and the severity of FI. In this work, no significant link was identified among wearing high heels, anal canal pressure values, and the severity of FI assessed by the Wexner scale.

Currently, the main identified risk factors for FI are obstetric perineal lesions (anal sphincter tears and stretch-induced neuropathy), inflammatory bowel diseases, general pathological conditions (neurological, metabolic, systemic diseases), and the side effects of radiotherapy [13]. However, in some cases, FI is considered to be idiopathic and new risk factors need to be identified. In this way, in a previous work, we demonstrated that, in young women, high-level sport practice is an independent risk factor for FI [7]. In the same way, we tried to identify a link between wearing high heels and the severity of FI. Indeed, this habit is currently increasing in women, data from the literature showing that about 59% of women wear high-heeled shoes for 1 to 8 h per day [1, 2]. To date, data from the literature have mainly studied the impact of wearing high heels on lumbar and dorsal statics. However, the way in which wearing high heels influences lumbar lordosis remains controversial. Indeed, although some authors have demonstrated that high-heeled shoes induce an increase in lumbar lordosis, other studies have

Table 1 Patients' clinical data

	Total	No high heels	High heels	
Patients, n (%)	338	164 (48.5)	174 (51.5)	
Mean age $\pm$ SD (years)	55 ± 15	52 ± 16	57 ± 14	$p = 0.001$
Mean BMI $\pm$ SD	25 ± 5	25 ± 5	25 ± 5	NS
French shoe size <38, n (%)	115	52 (32)	63 (36)	NS
French shoe size $\geq$38	223	112 (68)	111 (64)	NS
Mean vaginal delivery (n)	2 ± 1	2 ± 1	2 ± 1	NS
Mean Cesarean (n)	0.2 ± 0.5	0.2 ± 0.6	0.2 ± 0.5	NS
Mean use of instrumental maneuvers during vaginal delivery, (%)n	66	29 (22)	37 (25)	NS
Episiotomy, n (%)	122	58 (44)	64 (42)	NS
Perineal tear, n (%)	123	60 (45)	63 (58)	NS
Hysterectomy, n (%)	45	17 (11)	28 (16)	NS
Diabetes, n (%)	15	7 (4)	8 (5)	NS
Menopause, n (%)	212	90 (62)	122 (75)	$p = 0.01$
Hormone replacement therapy, n (%)	73	26 (22)	47 (34)	$p = 0.04$
Mean duration of fecal incontinence (months $\pm$ SD)	74 ± 99	83 ± 112	65 ± 86	NS
Mean Wexner scale $\pm$ SD	11 ± 5	11 ± 5	12 ± 6	NS
Urinary incontinence, n (%)	195	82 (52)	113 (67)	0.006
Main standing position during the day	129	72	57	NS
Main sitting position during the day	109	46	63	NS
Both positions during the day	82	36	46	NS

Table 2 High-resolution anorectal manometry values and endo anal ultrasound data

	No high heels	High heels	
Mean resting pressure (mmHg)	68 ± 28	68 ± 29	NS
Mean voluntary contraction (squeeze increment; mmHg)	151 ± 64	144 ± 64	NS
Mean high pressure zone length (mm)	3.5 ± 1	3.4 ± 1	NS
Internal anal sphincter defect (n)	53	58	NS
External anal sphincter defect (n)	52	62	NS
Rectocele (n)	22	26	NS
Cystocele (n)	6	8	NS
Enterocele (n)	4	2	NS

found a decrease or no effect [14]. These various results may be due to the fact that the studies included 5–60 patients, mainly young women, whereas, as suggested by Mika et al., age may have an influence on the effect of high heels on pelvic range of motion (being lower with advanced age, probably because the lumbopelvic tissues become more rigid) [3]. Moreover, the way in which the lumbar lordosis was assessed in these studies was heterogeneous and was sometimes only a visual assessment, whereas it is known that, with high heels, the pelvis tilts more posteriorly, inducing a compensatory posture with a gluteal contraction and a visual prominence of these muscles that can distort the visual assessment of the lumbar lordosis.

Although wearing high heels may produce deleterious effects on the musculoskeletal system, the general posture, and the lumbar lordosis, it may also affect the activity of the pelvic floor muscle [3, 5, 6]. Appropriate posture can be defined as the body position in which the center of gravity of each body segment is placed vertically above the lower segments. The proper alignment allows the body to use ligament and bone structures to provide stability instead of excessive muscular activity [15]. Thus, posture may be considered as a relative arrangement of the various parts of the body such as lumbar curvature, vertebral, paravertebral and abdominal tone, and ankle position. Some data have demonstrated that the lumbopelvic posture and the ankle position influence pelvic tilt and thus pelvic floor muscle activity [6, 16]. Indeed, Chen et al. have studied, in 39 women with stress urinary incontinence, the influence of the ankle position (neutral position, dorsiflexion, plantar flexion) on pelvic floor activity [6]. They have demonstrated that patients with ankle dorsiflexion had greater resting pelvic floor muscle activity than those with plantar flexion. In another study on 31 women, Chen et al. studied the influence of the ankle position on pelvic floor muscle activity assessed by electromyography during exercises with EMG biofeedback [17]. They demonstrated that, although every ankle position induced greater pelvic floor activity than the

horizontal foot position, greater muscle activity was observed with ankles in the plantar position with raised arms. These results confirm that pelvic floor muscle activity is greater in active ankle positions than in passive positions. Pelvic floor muscle contractions in active ankle positions result in simultaneous use of abdominal, back, thigh, and leg muscles to maintain posture. The co-activation of abdominal muscles and the pelvic floor is of particular importance in pelvic floor dysfunction and should be considered in rehabilitation programs. However, although a link among pelvic tilt, pelvic floor muscle activity, and abdominal muscle strength may be suspected, the way in which they are linked remains contradictory because of the heterogeneity of the studies. Thus, no solid data can be retained and rehabilitation programs should be adapted to each individual according to age and postural habits [6, 18–20]. However, although few studies have assessed the effect of high-heeled shoes and thus of ankle angulation on urinary continence, no study has assessed the link between wearing high-heeled shoes and FI. Moreover, our study has included a large number of patients, whereas studies on the subject usually have small samples. The mean age of our population was 55 ± 15 years, which is in accordance with the mean age of patients suffering from FI [21, 22]. The choice of the cut-off for the heels was made in accordance with literature data, although the definition of "high heels" is not clear among available studies [1, 23]. Indeed, we chose a definition from the literature that appeared to us not only simple to apply and to understand for patients, but also clinically relevant. However, further studies using other definitions are needed to improve the robustness of our findings. Moreover, our study is retrospective and measurements have been made whatever the height of the heels worn the day on which they were performed. In other studies, some authors have assessed the immediate/acute effect of high heels on general posture, lumbar lordosis, and activity of the pelvic floor muscles. However, in our study, we aimed to assess the influence of the regular wear of high heels on clinical and manometric

parameters and to assess whether these effects may be chronic.

In our study, the two subgroups were comparable for clinical data, including Wexner score, except for a higher age, menopause and hormone replacement therapy, and urinary incontinence in the group with heels ≥3 cm. No statistical difference was observed between the two subgroups concerning the anal canal pressures measured by 3DHRAM. To date, no other data are available to compare with our results. The only data available have compared vaginal, bladder, and anal resting pressures in supine versus in the standing position and have demonstrated that they all increase in the standing position, probably because of the higher intra-abdominal pressure [16, 24–26]. However, according to multivariable analysis (including heel height, age, BMI, duration of symptoms, vaginal delivery, menopause), only age was related to a significantly lower resting pressure.

Our study has several strengths:

1. It is the first to study the link between wearing high heels and FI (clinical and manometric data).
2. The sample is large.
3. It has studied the long-term effect (and not an acute effect) of wearing high heels in a population concerned by FI.

 Its limitation may be the absence of clinical and radiological evaluation of dorsal and lumbar statics.

In conclusion, in this retrospective cohort of women with FI, no clinical or manometric differences were observed between women who wore high heels and those who did not. Because there is limited knowledge on this potential link and because pelvic tilt may vary according to age and the habit of walking with high heels, further studies are necessary.

Compliance with ethical standards

Conflicts of interest None.

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