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ORIGINAL ARTICLE

Influence of Body Position on Defecation in Humans

Ryuji SAKAKIBARA,[1]* Kuniko TSUNOYAMA,[2] Hiroyasu HOSOI,[3] Osamu TAKAHASHI,[4] Megumi SUGIYAMA,[4] Masahiko KISHI,[1] Emina OGAWA,[1] Hitoshi TERADA,[5] Tomoyuki UCHIYAMA,[6] and Tomonori YAMANISHI[7]

[1]Department of Internal Medicine, Division of Neurology, Sakura Medical Center, Toho University, Sakura, Japan, [2]Department of Urology, Tokyo Women's Medical University, Tokyo, Japan, [3]Aishin Seiki Inc., Tokyo, Japan, [4]Clinical Physiology Unit, Sakura Medical Center, Toho University, Sakura, Japan, [5]Department of Radiology, Sakura Medical Center, Toho University, Sakura, Japan, [6]Department of Neurology, Chiba University, Chiba, Japan, and [7]Department of Urology, Dokkyo Medical College, Tochigi, Japan

Objectives: To compare three positions for defecation by measuring abdominal pressure and the anorectal angle simultaneously.

Methods: We recruited six healthy volunteers. The videomanometric measures included simultaneous fluoroscopic images, abdominal pressures, subtracted rectal pressures and anal sphincter pressures. Three positions were used: sitting, sitting with the hip flexing at 60 ° with respect to the rest of the body, and squatting with the hip flexing at 22.5 ° with respect to the rest of the body.

Results: Basal abdominal pressure before defecation on hip-flex sitting was lower than that with normal sitting, although the difference did not reach statistical significance. Basal abdominal pressure before defecation on squatting (26 cmH_2O) was lower than that with normal sitting ($P < 0.01$). Abdominal pressure increase (strain) on hip-flex sitting was lower than that with normal sitting, although this difference did not reach statistical significance. Similarly, the abdominal pressure increase on squatting was smaller than that with normal sitting, and yet the difference did not reach statistical significance. The rectoanal angle on defecation on hip-flex sitting did not differ from that with normal sitting. The rectoanal angle on defecation on squatting (126 °) was larger than that with normal sitting (100 °) ($P < 0.05$), and was also larger than that with hip-flex sitting (99 °) ($P < 0.01$).

Conclusion: The results of the present study suggest that the greater the hip flexion achieved by squatting, the straighter the rectoanal canal will be, and accordingly, less strain will be required for defecation.

Key words constipation, defecation, manometry, squatting

1. INTRODUCTION

Normal defecation is thought to necessitate three components: spontaneous phasic rectal contraction that starts during storage (autonomic component);[1–3] relaxation of the anal canal with an enlarged anorectal angle (mostly a somatic component);[4,5] and straining (somatic component).[6,7] Among these, straining is most significant in the etiology of pathological conditions.[8] While squatting for defecation continues to be the traditional position in populations of Asia (including Japan, Korea and China) and Africa, Western populations have become accustomed to sitting on toilet seats. In contrast to general assumptions that squatting is a non-physiological position for defecation, little is known about the influence of body position on defecation in humans. Recently in a study from Israel, Sikirov compared three positions (sitting, sitting on a low chair [hip flexing] and squatting [hip most flexed]) for defecation, and he found that squatting for defecation required the shortest amount of time and the least subjective effort for defecation.[9] Previously, Lam and colleagues in Australia compared three positions (left-sided lying with the hip straight, sitting and squatting) for defecation; they found that the perineum decent was larger with sitting and squatting than with lying.[10] These observations suggest that defecation could be more easily achieved by squatting than by sitting, which was then followed by the straight-hip position. However, the mechanisms underlying the effects of differences between body positions on defecation remain unclear. The aim of this study was to compare three positions (sitting, sitting with the hip flexed and squatting) for defecation by measuring abdominal pressure and the anorectal angle simultaneously using anorectal videomanometry.

*__Correspondence:__ Ryuji Sakakibara, MD, PhD, Associate Professor, Neurology, Internal Medicine, Sakura Medical Center, Toho University, 564-1 Shimoshizu, Sakura, 285-8741 Japan. Tel: +81-43-462-8811 ext. 2323; Fax: +81-43-487-4246. Email: sakakibara@sakura.med.toho-u.ac.jp

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2. METHODS

2.1. Subjects

Six healthy volunteers (one male, five females; age range: 36–44 years; mean age: 41 years old) with apparently normal bowel function agreed to take part in the study. Standard neurological examination showed normal findings in all subjects including in the perineal area. Individuals who were unable to assume a squatting posture for any reason were excluded, as were those who had less than three bowel movements per week, or had fecal incontinence or diarrhea. Similarly, individuals were excluded who had marked urinary dysfunction that would suggest pelvic organ dysfunction. None of the subjects had a previous history of abdominal-pelvic surgery, anal fissure, pain or infections. All subjects gave written informed consent before participating in the study. This study was approved by the Ethics Committee in Sakura Medical Center, Toho University, Sakura, Japan.

2.2. Methods

The volunteers were instructed to have evacuated their rectum in the morning before the study, and all had eaten their usual breakfast. All measurements were obtained by an urodynamic computer (Urovision, Lifetech Inc., Houston, TX).[3,11] A triple-lumen 9F catheter (for use with liquid contrast medium infusion into the rectum, for recording naïve rectal pressure and anal pressure) was inserted into the anus. An 8F catheter (used to measure abdominal [bladder] pressure) was inserted into the bladder. We also obtained fluoroscopic images of the sigmoid colon, rectum and anus.

We first performed anal manometry once (data not shown) in order to locate the anal catheter by pulling the catheter from inside the rectum (2 cm/min) throughout the anal canal under infusion of sterile water at a rate of 1 mL/min. The anal pressure showed a maximum value at the external sphincter, where the radiopaque marker attached to the anal luminal orifice was visualized (i.e. 2.0–3.0 cm below the rectal base under an X-ray fluoroscope). We then performed filling phase videomanometry once (data not shown). In normal subjects the radiopaque infusant tended to exceed the rectosigmoid junction. Normal subjects can evacuate their rectum, while they are unable to evacuate their sigmoid colon completely. By this reason, whereas we could not repeat measuring filling phase function precisely, we could repeat measuring evacuating phase function.

Evacuating phase videomanometry was performed as follows. After filling the subjects' anorectum with contrast medium (20% amidotrizoic acid), we asked subjects to defecate (if they need straining, they can do so) with the subjects sitting on a regular toilet seat (Fig. 1a). We checked the intraluminal content to be evacuated. If not, visible liquid postvoid residuals are catheterized and measured. Again, after filling the subjects' anorectum the second time, we asked subjects to defecate with the subjects sitting on a regular toilet seat, but with the hip flexed at 60 ° with respect to the rest of the body by placement of the feet on a height-adjustable step (Fig. 1b). We checked the intraluminal content to be evacuated. Again, after filling the subjects' anorectum a third time, we asked subjects to defecate with the subjects assuming a squatting position and with the hip flexed at circa 22.5 ° with respect to the rest of the body while standing on a flat plane (Fig. 1c). During these procedures, we measured abdominal pressure, rectal pressure and anal sphincter pressure at the largest value. The anorectal angle was measured radiographically in a lateral view using two central longitudinal axes of the rectum and the anal canal, respectively, which lie in the center of two wall lines[12,13] (Fig. 1d–f).

2.3. Statistical analysis

Comparison of the averages of measured manometric pressures and the anorectal angle in defecating in different postures was carried out using the paired Student's *t*-test.

3. RESULTS

Basal abdominal pressure before defecation on hip-flex sitting (29 cmH_2O) was lower than that with normal sitting (53 cmH_2O), although the difference did not reach statistical significance ($P = 0.056$) (Table 1). Basal abdominal pressure before defecation on squatting (26 cmH_2O) was lower than that with normal sitting ($P < 0.01$). Abdominal pressure increase on voluntary straining on hip-flex sitting posture (53 cmH_2O) was lower than that with normal sitting posture (65 cmH_2O), although the difference did not reach statistical significance ($P = 0.056$) (Fig. 2). Similarly, the abdominal pressure increase on voluntary straining on squatting posture (52 cmH_2O) was lower than that with normal sitting posture, although this difference also did not reach statistical significance ($P = 0.21$). The rectoanal angle on defecation with hip-flex sitting (99 cmH_2O) did not differ from that with normal sitting (100 cmH_2O). The rectoanal angle on defecation with squatting (126 cmH_2O) was larger than that with sitting (100 cmH_2O) ($P < 0.05$), and the rectoanal angle on defecation with normal sitting was not significantly different from that with hip-flexing sitting (99 cmH_2O). Other videomanometric variables on defecation did not differ significantly, that is, rectal pressure increase on sitting (mean 2.7 cmH_2O), hip-flex sitting (2.3 cmH_2O) or squatting (0 cmH_2O); anal sphincter pressure on sitting (15.8 cmH_2O), hip-flex sitting (1.5 cmH_2O), or squatting (0.8 cmH_2O); and post-defecation residual on sitting (18.3 mL), hip-flex sitting (15.8 mL), or squatting (15.0 mL).

4. DISCUSSION

Previous reports[9,10] have suggested that defecation could be more easily achieved by squatting than by sitting, followed by use of a straight-hip position. However, the mechanisms underlying the potentially different effects of these positions on defecation have remained unclear. To the best of our knowledge, this is the first report to measure the rectoanal angle and abdominal pressure on

Fig. 1 Three positions on defecation and video imaging. A typical recording of a subject (case 1) is shown. Left column shows body positions (a, sitting; b, sitting with the hip flexed; c, squatting with the hip most flexed). Right column indicates the anorectal angle on defecation according to the body position in the left column. The anorectal angle was measured radiographically in a lateral view using two central longitudinal axes of the rectum and the anal canal, respectively, which lie in the center of two wall lines. The anorectal angle on defecation became larger with squatting (c,f) than with sitting (a,d), and also larger than with sitting with the hip flexed (b,e). Pressure values are not indicated here.

defecation simultaneously using anorectal videomanometry in six healthy volunteers. Here, demonstrated that the rectoanal angle was larger and abdominal pressure lower with squatting as compared to the corresponding values obtained for defecation while sitting.

In order to simultaneously measure the rectoanal angle and abdominal pressure on defecation, we chose to administer a slow rectal infusion of liquid contrast medium, [1–3] an approach that has been regarded as provisional until recently.[14] There are known differences between the balloon method and the present method (indirect infusion in a closed bag versus direct infusion into the rectum), as well as between defecography and the present method (half solid content for visualizing alone versus liquid content for both visualizing and manometry). However, using a sitting position, most liquid infusants remained in the rectum and we were able to fill the rectum and generate proper sensation without leakage

TABLE 1. Results of videomanometry

Position			Sitting	Sitting with the hip flexing	Squatting with the hip most flexing
Patient			Basal abdominal pressure (cmH_2O)		
Number	Age	Sex			
1	42	F	25	18	18
2	39	F	42	15	13
3	40	F	66	11	24
4	44	F	67	91	29
5	43	F	46	24	41
6	36	M	73	16	32
Average			53 $P = 0.056$ $P = 0.0056$	29 $P = 0.41$	26
Patient			Abdominal pressure increase (cmH_2O)		
Number	Age	Sex			
1	42	F	65	39	19
2	39	F	50	55	45
3	40	F	45	29	28
4	44	F	48	49	52
5	43	F	91	90	67
6	36	M	93	58	88
Average			65 $P = 0.065$ $P = 0.21$	53 $P = 0.43$	52
Patient			Anorectal angle (degree)		
Number	Age	Sex			
1	42	F	109	97	122
2	39	F	73	68	127
3	40	F	117	133	141
4	44	F	77	80	103
5	43	F	98	98	121
6	36	M	125	120	142
Average			100 $P = 0.45$ $P = 0.042$	99 $P = 0.0061$	126

in all subjects.[3] All of the present subjects were able to defecate properly with little residual matter remaining, which thereby allowed us to examine the radiographical and manometric parameters simultaneously.

Among the factors affecting defecation, the angle between the rectum and the anal canal (the rectoanal angle) is a major physiological factor in the continence of rectal content.[12,13] Previously, Tagart[15] radiographically showed that the rectoanal angle straightens with fully flexed hips–corresponding to the squatting position in the present study–and converts the rectoanal outlet into a straight canal, thereby facilitating rectal emptying. Although we did not measure perineal decent in the present study, Lam and colleagues reported that decent of the perineum was greater with sitting and squatting than upon lying (hip straight).[10] The larger rectoanal angle achieved with squatting is most probably brought about by relaxation of the puborectal and pelvic floor muscles. This line of reasoning agrees with the finding by Altomare and colleagues in Italy who compared two hip positions (lying with hip flexion [Sims position] and straight-hip, in addition to sitting and standing) for defecation.[16] They found that the anorectal angle was larger with sitting or hip flexion, although it should be noted that the effects of squatting were not studied.[16]

Another finding of the present study was that the abdominal pressure was lower with squatting than sitting. This lower abdominal pressure may well reflect reduction in effort upon defecation in these subjects. These findings are consistent with the observation by Sikirov that squatting required the shortest time and the least subjective amount of effort for defecation.[9] However, Lamb and colleagues also reported that the amount of straining did not differ in sitting and squatting subjects.[10] Similarly, using bag manometry, Rao and colleagues in the United States compared two positions (lying with the hip straight and sitting) for defecation.[17] They found a dyssynergic pattern in 24–36% of subjects when the hip was straight, while this pattern was seen in 8–20% of sitting subjects.

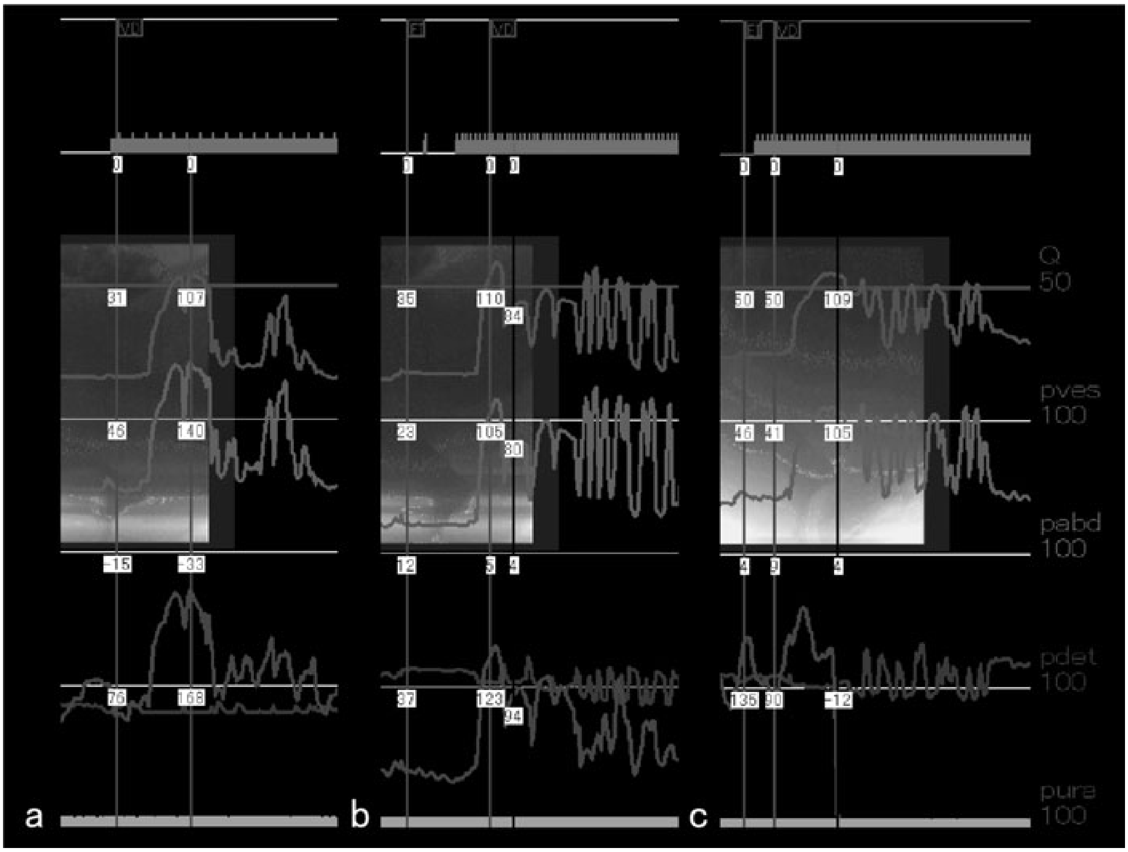

Fig. 2 Effect of three positions on defecation and videomanometric recording. A typical recording of a subject (case 5) is shown. (a, sitting; b, sitting with the hip flexed; c, squatting with the hip most flexed). In this subject, abdominal pressure increase on defecation became lower with (c) squatting than with (a) sitting or (b) sitting with the hip flexed. padb, abdominal (bladder) pressure; pdet, differential rectal pressure; pura, anal sphincter pressure; pves, naïve rectal pressure.

Similarly, 44–60% of subjects were unable to expel the balloon or deformable device when the hip was straight, while 4–16% of subjects were unable to do so while sitting, and squatting was not studied.[17]

We acknowledge that our sample size was small and that our results will require confirmation with a larger study. However, our findings draw attention to the potential significance of the squatting posture in defecation. Historically, man has squatted in order to defecate.[9,18] In Western countries, the dissemination of the sitting toilet took place during the 19th century when sewage systems were developed to improve sanitation.[19] In contrast to Western countries, in Asian and African countries, their dietary habits and use of a squatting posture might contribute to the very low incidence of hemorrhoids, constipation and diverticulosis.[9,20] In addition, lower abdominal pressure on squatting defecation might reduce the risk of defecation syncope,[21] deep vein thrombosis,[22] and stroke.[23] Therefore, a new toiletry commode incorporating both Western and Eastern approaches is anticipated.

5. CONCLUSION

The results of the present study, taken together with earlier findings, suggest that the greater the hip flexion achieved by squatting the straighter the rectoanal canal will be, and accordingly, less strain will be required for defecation.

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