

Effect of Bladder Distention Following Water Ingestion on Cardiac Autonomic Balance in Healthy Young Men

S. Mehran Hosseini¹, Hamid Sepehri*¹

1. Neuroscience Research Center, Department of Physiology, Faculty of Medicine, Golestan University of Medical Sciences, Gorgan, Iran

ABSTRACT

Background and objectives: Bladder filling and severe urgency to urinate may affect the cardiovascular system through viscerovisceral reflexes. In the cardiovascular system, post-micturition syncope is a well-known and clinically important consequence of this phenomenon. Despite the importance of such reflexes, limited numbers of studies have investigated the in vivo effects of bladder filling on the heart. The purpose of this study was to determine the effects of bladder filling through water ingestion on heart rate and the autonomic nervous system in healthy young men.

Methods: This was a descriptive-analytical study performed on 20 healthy male volunteer students. Five minutes after voluntary bladder emptying, the electrodes were attached and heart rate was recorded in the sitting position in a controlled environment. After five minutes of adjustment, data collection was started at 1 KHz sampling frequency. Then, the participants continued drinking water until developing severe urgency to urinate. Heart rate was recorded at the peak of urgency and the data were compared with baseline values. All data were expressed as mean \pm standard deviation. Statistical analyses of data were performed using SPSS 16 at significance level of 0.05.

Results: Mean age, weight and height of the participants were 22.3 ± 3.466 years, 75.55 ± 15.5 kg and 175.8 ± 11.28 cm, respectively. Mean heart rate was 74 ± 12.23 after the initial urination, 68.55 ± 10.53 when feeling severe urgency to urinate and 66.3 ± 10.87 after the second urination. The heart rate differed significantly between the three tested conditions ($P < 0.05$). There was no significant difference in other parameters of heart rate variation including SDNN, RMSSD, RRM, PNN50, absolute and relative (normalized) low frequency and high frequency and their ratio (LF/HF).

Conclusion: Bladder distension secondary to drinking water has no effect on the heart autonomic balance.

Keywords: Bladder distension, Heart, Autonomic nervous system

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*Correspondence: Hamid Sepehri, Neuroscience Research Center, Department of Physiology, Faculty of Medicine, Golestan University of Medical Sciences, Gorgan, Iran

Tel: +98-1732453515

Email: hamsep49@yahoo.com

INTRODUCTION

Bladder dilation affects cardiac functioning through the autonomic nervous system (ANS), which is also the most important factor in maintaining heart rate. Although factors such as heat and stretching also directly affect the heart rate, different stimuli by a variety of visceral neural reflexes (compressive, volumetric and chemical) affect the heart rate (1). Visceral sensory afferents indirectly influence the cardiac autonomic balance (CAB). During bladder filling, various impulses are sent through the sensory and visceral sensory receptors to the spinal cord and other parts of the central nervous system, causing void sensation and autonomic nerve reflexes, thus altering the activity of somatic nervous system and neuromuscular mechanisms of bladder emptying. The extent of this sensory and motor activity may affect other organs through the visceral-visceral reflexes. In the cardiovascular system, post-micturition syncope is a well-known and clinically important consequence of this phenomenon. Despite the importance of such reflexes, reports about the effect of bladder filling on the heart under normal conditions are limited and require evaluating distention of hollow visceral organs such as the stomach (3), small intestine (4), rectum (5) and gallbladder (6). Bladder volume changes also have a major impact on cardiovascular functioning (7-9). Studies on the direct impact of bladder distention on blood pressure and its relationship with RR intervals in humans have demonstrated that bladder distention can increase the baroreceptor reflex in people with primary hypertension, thereby increasing the probability of post-micturition syncope (10). In a study on healthy young people, bladder distention via drinking fluids increased systolic and diastolic blood pressure with no impact on the heart rate (7). Increased blood pressure following severe urinary retention has been also reported in other studies on healthy individuals. Moreover, urinary retention also increases blood pressure in middle-aged individuals with hypertension (8). Electrophysiological studies have shown

that bladder distention increases the activity of efferent fibers of the pelvic and hypogastric nerves (9). The bladder sensory neurons located in the subepithelial network contain granular vesicles containing norepinephrine. Bladder stretches and stimulation of the efferent fibers increases sympathetic activity and decreases vagal tone that can affect the cardiovascular system (10). In a study on the effect of bladder distention on cardiovascular reflexes in dogs, it was found that bladder distention elevates blood pressure and stimulates carotid sinusoidal receptors, thus leading to bradycardia, hypotension and vasodilatation in the legs. In addition, concomitant distention and carotid receptor stimulation produced similar cardiovascular reflexes and hypotension, while the degree of vasodilatation in the legs decreased (12). Evaluation of heart rate variability (HRV) as the variation of interval between two consecutive heartbeats allows non-invasive in vivo assessment of the balance between the sympathetic and parasympathetic branches of the ANS. The objective of this study was to determine the effects of bladder filling by drinking water on activity of the cardiac ANS in healthy individuals based on HRV indices.

MATERIALS AND METHODS

The study was performed on 20 eligible healthy male volunteer students (age range: 19-24 years) from the Golestan University of Medical Sciences, Iran. The participants had no history of disease, medication, smoking and physical activity. The subjects were enrolled in the study after fully explaining the research objectives and written consent was obtained from all participants. This clinical trial was approved by the Ethics Committee of the Golestan University of Medical Sciences, Iran. All tests were performed in the morning, in a silent room and at 22 ± 2 °C. Following voluntary bladder emptying, electrodes of were attached and heart rate was monitored in sitting position under a controlled environment. After five minutes of

adjustment to the test conditions, blood pressure and ECG were recorded for five minutes, with a sampling frequency of 1 kHz to convert analog data to digital. Subsequently, the volunteers continued to drink water until developing a severe urgency to urinate. Then, heart's electrical activity and blood pressure were recorded once again. Oscillometric blood pressure was measured from the brachial artery and in the sitting position using a blood pressure monitor (OMRON, made in China). The heart's electrical activity was recorded continuously in the sitting position using electrodes of an ADInstrument device (Powerlab).

Statistical analyses

After performing the necessary calculations in the Chart 5 software, the collected data were expressed as mean value and standard deviation. All statistical analyses were performed in SPSS 16 using paired t-test and at significance level of 0.05.

RESULTS

Table 1 presents the mean height, age and weight of the study subjects.

Table 1. Mean height, age and weight of the study subjects

Variable	Age (year)	Weight (kg)	Height (cm)
Mean	22.30	75.5500	175.8000
Standard deviation	3.466	15.50373	11.28856
Minimum	18	48.00	147.00
Maximum	30	100.00	190.00

Mean amount of water intake and urine volume were 1971±651.5 ml (range: 1080 to 2880 ml) and 455±177.6 ml (range: 100 to 750 ml), respectively. The time interval between water intake and urination was 1.38±0.19 hours (range: 1 to 1.5 hours). Mean heart rate was 74±12.23 after the initial urination, 68.55±10.53 when feeling severe urgency to urinate and 66.3±10.87 after the

second urination. The heart rate differed significantly between the three tested conditions. There was no significant difference in other parameters of HRV over time. Tables 2, 3 and 4 present the mean values of the studied parameters at the three test conditions.

Table 2. Mean value of time interval indicators and HRV frequencies at baseline

Parameter	LF (ms ²)	HF (ms ²)	LF/HF	SDNN (ms)	RMSSD	RRM (ms)	PNN50 (%)
Mean value	26934.7518	37426.1782	.7855	83.3485	9.9400	1151.2000	21.3500
Standard deviation	13656.15969	20074.48099	.34772	59.50146	6.54092	801.97287	16.90305

LF: low frequency; HF: high frequency; LF/HF: LF to HF ratio; RMSSD: the square root of the mean of the squares of the successive differences between adjacent NNs; RRM: RR intervals mean; PNN50: the proportion of NN50 divided by total number of NNs.

Table 3. Mean value of time interval indicators and HRV frequencies when feeling the urgency to urinate after drinking water

Parameter	IF2 (ms ²)	HF2 (ms ²)	IF/HF2	SDNN2 (ms)	RMSSD2	RRM2 (ms)	PNN502 (%)
Mean value	29126.5245	43456.8817	.7255	107.7227	11.7700	893.5500	27.4000
Standard deviation	12425.65831	22284.58855	.20874	90.65389	9.58069	127.80968	16.67459

LF: low frequency; HF: high frequency; LF/HF: LF to HF ratio; RMSSD: the square root of the mean of the squares of the successive differences between adjacent NNs; RRM: RR intervals mean; PNN50: the proportion of NN50 divided by total number of NNs.

Table 4. Mean value of time interval indicators and HRV frequencies after complete bladder emptying

Parameter	IF3 (ms ²)	HF3 (ms ²)	IF/HF3	SDNN3 (ms)	RMSSD3	RRM3 (ms)	PNN503 (%)
Mean value	26995.5628	44038.4190	.6460	84.7976	8.9050	927.7500	30.3000
Standard deviation	11150.57715	25031.82357	.18503	44.18157	4.27138	142.73600	16.60089

LF: low frequency; HF: high frequency; LF/HF: LF to HF ratio; RMSSD: the square root of the mean of the squares of the successive differences between adjacent NNs; RRM: RR intervals mean; PNN50: the proportion of NN50 divided by total number of NNs.

DISCUSSION

Bladder filling and a severe urinary urgency may affect the cardiovascular system through autonomic reflexes. We utilized HRV as a valuable tool for assessing the ANS variation in response to bladder distention. As mentioned, the heart rate decreased significantly after bladder distention and restored to baseline value after the bladder was emptied. This finding is in line with findings of a study by Yamaguchi et al. that showed excessive bladder distention increases vagal tone and reduces heart rate via vagovagal reflexes (13). Similarly, Daly et al. reported that increased pressure and stimulation of carotid sinusoidal receptors leads to bradycardia and hypotension and concluded that reducing the activity of parasympathetic afferents can decrease heart rate during bladder distention (14). Inconsistent with these findings, Hassan et al. reported that bladder distention by hot water ingestion in anesthetized dogs can increase heart rate by decreasing the parasympathetic activity and increasing the sympathetic activity (15).

In our study, despite the increase in heart rate, we observed no significant difference in parameters of HRV over time and frequency range including low frequency (LF), high frequency (HF) and their ratio (LF/HF). However, a study claimed that bladder distention could change HRV variables in anesthetized individuals (16). Furthermore, bladder distention has been thought to stimulate vagovagal reflexes, thereby

decreasing HF activity (13). There are also reports of sympathetic activation and increase in Lf via stimulation of viscerovascular reflexes (17).

Guttmann et al. (1947) studied the effect of bladder distention on cardiovascular functioning in a group of World War II patients with spinal cord injury. Surprisingly, they found that bladder distention could raise blood pressure while there was no neural pathway to transmit impulses from the bladder to the brain. They suggested that accessory neural pathways within the viscera may transmit impulses to areas above the damaged spinal cord, thus inducing bladder-cardiovascular reflexes (18). On the other hand, it has been observed that bladder distention can increase the level of circulating catecholamines (19). Since bladder distention can induce cardiovascular reflexes, it is essential to gain a better understanding of the causes of HRV consistency in our study by evaluating hormonal responses including variation of angiotensin.

CONCLUSION

Bladder distention by drinking water does not affect the CAB. Other mechanisms such as change in the blood pressure and hormones might compensate for the autonomic response.

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DECLARATIONS

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Ethics approvals and consent to participate:

The study was approved by the ethics committee of the Golestan University of Medical Sciences, Iran. A written informed consent was taken from all participants prior to participation.

Conflict of interest

The authors declare no conflict of interest.

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