Original Article

Is There a Clinically Meaningful Change in the Blood Pressure of Osteoarthritis Patients with Comorbid Hypertension During the Course of Balneotherapy?

Emrullah Hayta, Mehmet Birhan Yılmaz[1], İlker Yayıkçı, Zafer Özer[2], Özlem Şahin

Departments of Physical Medicine and Rehabilitation and [1]Cardiology, Cumhuriyet University, [2]Department of Physical Medicine and Rehabilitation, Sivas Numune State Hospital, Sivas, Turkey

Abstract

Background: Balneotherapy (BT) is a treatment modality that uses the physical and chemical effects of water, including thermomineral, acratothermal, and acratopegal waters. It has many effects on cardiovascular system. **Aim:** The aim of the study is to investigate the effects of 3-week BT on blood pressure of osteoarthritis (OA) patients with no hypertension (HT), and controlled or uncontrolled HT. **Materials and Methods:** The OA patients ($n = 270$) were divided into three groups: No HT, controlled HT, and uncontrolled HT. All the groups received BT in the facilities of our university hospital at the same time every day (10:00-11:30 AM) for 10 min per day, 5 days per week, for a total duration of 15 days in a 3-week period. Systolic and diastolic blood pressures and pulse rates were measured before and after BT on daily basis. **Results:** Overall, (1) the pulse rates of study groups measured after BT were significantly increased compared to before BT; (2) the systolic blood pressures of study groups measured before and after BT were found as comparable; and (3) the diastolic blood pressures of no HT and controlled HT groups measured before and after BT were not statistically significant ($P > 0.05$); however, in the uncontrolled HT group, the diastolic blood pressure showed a decreasing trend after BT ($P < 0.05$). **Conclusions:** In patients with OA, BT can be safely used without resulting in any meaningful changes in systolic and diastolic blood pressures in patients with normal and controlled HT but a decrease in diastolic blood pressure of patients with uncontrolled HT. This may be an advantage in OA patients having HT as comorbid disease.

Keywords: Balneotherapy (BT), hypertension (HT), osteoarthritis (OA)

Address for correspondence: Dr. Emrullah Hayta, Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Cumhuriyet University, Sivas - 58140, Turkey. E-mail: dremay@gmail.com

Introduction

Osteoarthritis (OA) is one of the most frequent joint diseases and is a major cause of pain and locomotor disability for people in advanced age. The common treatment of OA includes nonpharmacological, pharmacological, and surgical therapies.[1] Balneotherapy (BT) is one of the most commonly used nonpharmacological approaches for OA.[2]

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BT, in its most general sense, is used for bathing in thermal or mineral water. However, the exact definitions BT and spa therapy are frequently confused and the terms are generally used interchangeably. BT employs thermal mineral water from natural springs but also natural gases (CO_2, H_2S, and Rn), peloids for prevention, treatment, and rehabilitation. BT is usually practiced in

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spas with their special therapeutic atmosphere as part of a complex therapy program.[3,4] While the physical properties of water are on the forefront in hydrotherapy, which is one of the most significant components of BT, the chemical properties of water also play a role in BT applications.[5,6] The types of water used in BT are classified as being low mineralized (0.6-2 g/L), mildly mineralized (>2-10 g/L), or highly mineralized (>10 g/L). Also, water temperature is defined as cold (<20˚C), hypothermal (20-30˚C), thermal (>30-40˚C), and or hyperthermal (>40˚C).[7]

BT influences many systems in the body, particularly the cardiovascular system. The effect of BT on the cardiovascular system depends fundamentally on its hydrostatic pressure and heat effect. BT increases the hydrostatical pressure by means of significantly rising venous circulation; this, in turn, increases the stroke volume and heart rate.[8,9] Some clinical studies indicate that BT results in acute and remarkable changes in body temperature, pulse rate, and diastolic and systolic blood pressures.[10,11]

There are various comorbidities associated with BT applications, the most common of which is hypertension (HT). In a study conducted with a Turkish population, it was found that the prevalence of HT among those aged 35-64 years was 42.3%, with the incidence increasing with advanced age, similar to OA.[12] The common presence of comorbid HT in people with OA is one of the most significant factors in designing a treatment plan targeting OA. No matter how safe BT seems in OA treatment, some studies have indicated some controversial findings revealing cardiovascular complications. The presence of these findings has resulted in discussions pertaining to the safety of BT treatment for patients with OA.[13,14] In the related literature, the number of clinical studies focusing on the effects of BT on the cardiovascular system is relatively limited. Although there are some studies investigating the acute effects of BT, there is no study evaluating the effects of long-term BT treatment. Revealing the effect of long-term BT treatment on the cardiovascular system during the treatment course will be valuable information for physicians administering BT. The aim of the present study is to investigate the effects of 3-week BT on the blood pressure of patients with no HT and controlled or uncontrolled HT.

Materials and Methods

Case selection

The approval of the Human Ethics Committee of our university and informed consent were obtained from all the participants. For the present study, the patients with OA of the lumbosacral region, hip, and knee were enrolled in the period from October 2012 to July 2013.

At the beginning of the study, 270 consecutive patients who had a diagnosis of OA according to the American College of Rheumatology criteria[15,16] of both the sexes were included in the study. All patients underwent a general medical evaluation and rheumatologic examination by the same physician before the beginning of the treatment. Patients with OA were further categorized into subgroups according to the region, that is, lumbosacral, hip and knee. The study included patients with HT who reported being on a regular diet consisting of 6 g and less salt consumption and complied with Dietary Approaches to Stop Hypertension, and who had also used antihypertensive medications for at least a 1-year prior to hospitalization. These patients with HT received antihypertensive medications at the same dose in intervals throughout the physical therapy for OA after admission to the research team’s institution.

Exclusion criteria were the presence of severe comorbidity of cardiovascular diseases (aortic stenosis, unstable angina, severe orthostatic hypotension, or any history of recent myocardial infraction, pacemaker), lung, liver, cerebrum, hypo- or hyperthyroidism, acute illness, systemic blood diseases, neoplasms, and pregnancy or nursing.

The patients were divided into three groups. The three groups comprised patients with OA nonaccompanied by HT, patients with OA accompanied by controlled HT, and patients with OA accompanied by uncontrolled HT. While systolic blood pressure was <140 mmHg and diastolic blood pressure was <90 mmHg in patients taking medication were defined as controlled HT,[17] systolic blood pressure >150 mmHg and/or diastolic blood pressure >90 mmHg in HT patients without diabetes mellitus (DM) or chronic kidney disease (CKD), and systolic blood pressures >140 mmHg and/or diastolic blood pressure greater than 90 mmHg in those with DM or CKD were defined as uncontrolled HT.[18] All the groups received BT in the therapy facilities of our university hospital at the same time every day (10:00-11:30 AM) for 10 min per day, 5 days per week, for a total duration of 15 days. The patients in all the groups of BT therapy immersed their bodies in the xiphoid process during the treatment. All patients in all groups stayed in the water (received BT) for exactly 10 min. The thermomineral water, the threshold value of which was not above acceptable levels for any mineral, was at 40 ± 1°C, with 623 mg/L concentration.[4]

Assessments

Blood pressure measurements

The blood pressure and pulse rates of the patients were measured and recorded on a daily basis for a period of 15 days, 5 min before and after the BT in a sitting position. Following the therapy sessions, prior to the measurements, the patients were dried, and then they spent 10 min in a sitting position at normal room temperature. The measurements of the blood pressure were recorded by means of Erkameter 3,000 desktop mercury sphygmomanometer (Erka, Bad Tölz, Germany). The measurements were obtained from the average of the last two measurements from both arms in the form of three measurements with two minutes intervals after a 5-min resting in the upright sitting position with back support without allowing the patients to speak. The patients were not allowed to take any form of caffeine and nicotine in the last 1 h prior to the measurements.

Statistical analysis

All the results were expressed as mean ± standard deviation (SD). For parameters with normal distribution, comparisons between the groups were performed using two-way analysis of variance (ANOVA) followed by Tukey's test or *t*-test for *post hoc* pairwise comparisons. Data analysis was performed with International Business Machines (IBM) Statistical Package for the Social Sciences (SPSS) Statistics, Version 22 (IBM Corp., Armonk, NY, USA). $P < 0.05$ was considered significant.

Results

The selected clinical data of no HT, controlled HT, and uncontrolled HT groups can be seen in Table 1. The ages of patients in the controlled HT group and uncontrolled HT group were significantly higher compared to the no HT group [$P < 0.05$ Table 1]. In all the study groups, there were more female patients and overall, there were more patients with lumbar OA. The study groups were found comparable to the rate of history of smoking ($P > 0.05$).

Figures 1-3 present the systolic and diastolic blood pressures and pulse rates of the three groups as measured before and after BT. We compared the systolic and diastolic blood pressures and pulse rates with the repeated measures ANOVA test with Tukey's test as *post hoc* test after the study group (no HT, controlled HT, and uncontrolled HT) and measurement time (before and after) were given as two factors.

Considering the systolic blood pressure and pulse rate, the factor of the study group presented a significant effect on the systolic blood pressure ($P < 0.05$) but not the measurement time ($P < 0.05$). Considering diastolic blood pressure, the factor of the study group and measurement time presented a significant effect on the diastolic blood pressure ($P < 0.05$). The pulse rates of the study groups measured after BT were significantly increased compared to before BT ($P < 0.05$).

Overall, the systolic and diastolic blood pressures and pulse rate of the uncontrolled HT group were significantly higher than those of the no HT and controlled HT groups ($P < 0.05$); and the systolic and diastolic blood pressures and pulse rates of the no HT and controlled HT groups were found to be similar ($P > 0.05$).

Overall, in all the study groups, after comparison of systolic and diastolic blood pressures and pulse rates measured both before and after BT, we found that the systolic and diastolic blood pressures and pulse rates measured from day 1 to day 15 did not present a meaningful change as increase or decrease although there were some fluctuations, especially in the uncontrolled HT group.

Overall, the systolic blood pressures of the study groups measured before and after BT were found to be comparable ($P > 0.05$). Overall, the diastolic blood pressures of the no HT and controlled HT groups measured before and after BT were not statistically significant although after BT diastolic blood pressure presented a decrease in some days throughout the study period ($P > 0.05$); however, in the uncontrolled HT group, the diastolic blood pressure showed a decreasing trend after BT ($P < 0.05$).

Discussion

In the present study, we compared the pulse rate, systolic and diastolic blood pressure of the patients with no HT, controlled HT, and uncontrolled HT before and after BT administration for 15 days. Although the systolic and diastolic blood pressures and pulse rate in the uncontrolled HT group were higher compared to the other groups, overall, we did not observe any meaningful change in the systolic blood pressure measured before and after BT during the study period. In the uncontrolled HT group, overall, the diastolic blood pressure had a

Table 1: Selected clinical data of study groups

	No HT (n = 126)	Controlled HT (n = 97)	Uncontrolled HT (n = 47)
Age, years	59.0±8.2	61.9±7.0	61.4±8.5
Gender (female/male)	73/53	74/23	26/21
Smoking, n (%)	111 (88%)	85 (88%)	41 (87%)
Region of OA (lumbar, hip, knee)	71/11/14	41/11/15	23/10/14

HT = Hypertension, OA = Osteoarthritis, Data are expressed as mean + SD

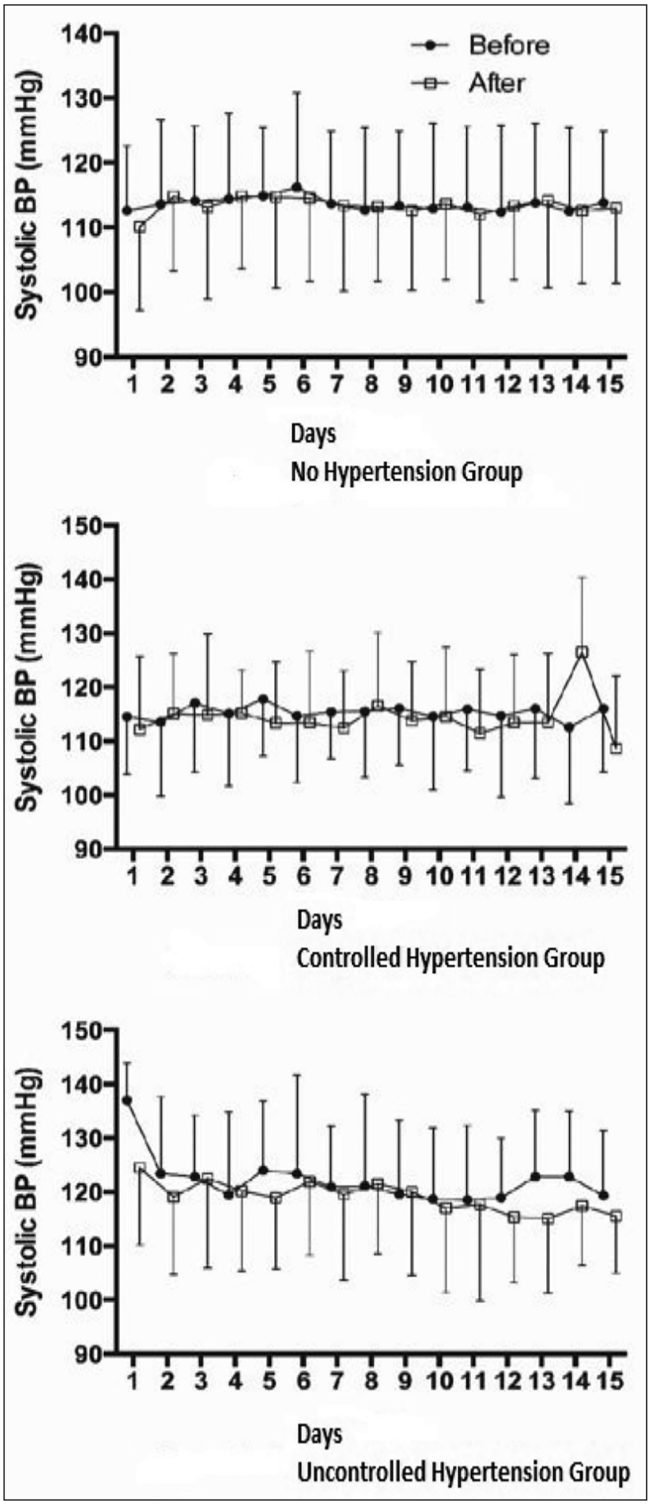

Figure 1: Systolic blood pressures of study groups as measured before and after balneotherapy. Data are expressed as mean + SD

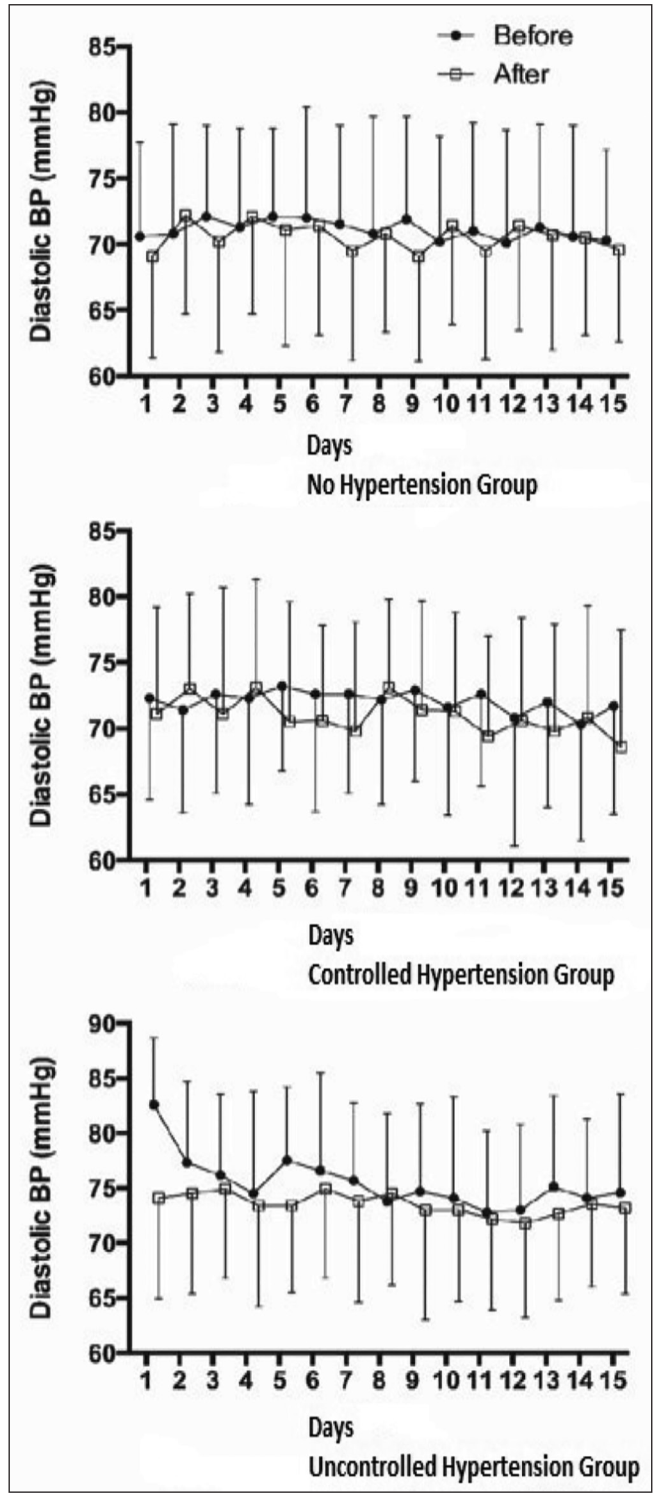

Figure 2: Diastolic blood pressures of study groups as measured before and after balneotherapy. Data are expressed as mean + SD

decreasing trend after BT although this was not a very significant finding in the measurements of systolic blood pressure. Although we found that the pulse rates after BT increased in all the study groups compared to those before BT, these differences did not signify an important characteristic for these patients. There were fluctuations in the measurements of systolic and diastolic blood pressures and pulse rates before and after BT from day 1 to day 15.

For years, BT has been successfully used in the treatment of various diseases such as disorders of musculoskeletal system, dermatologic diseases, and

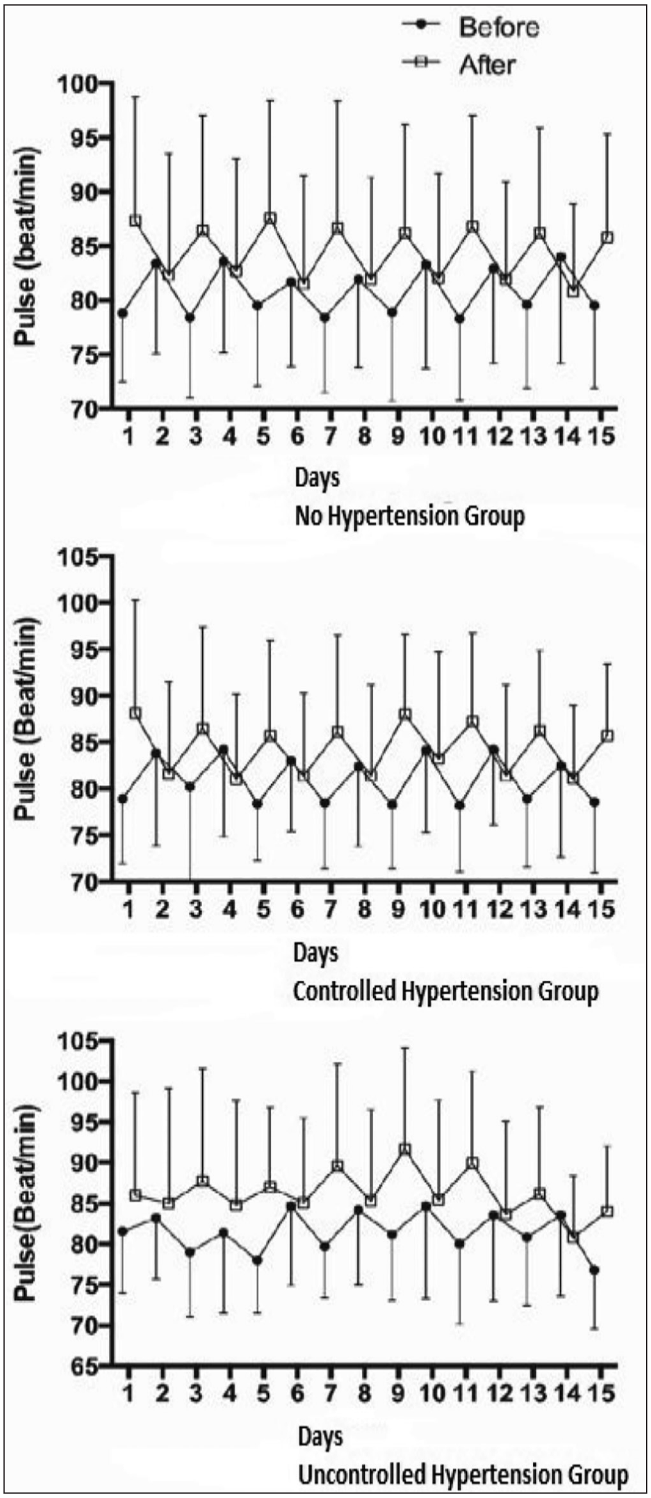

Figure 3: Pulse rates of study groups as measured before and after balneotherapy. Data are expressed as mean + SD

cardiovascular diseases.[19] Cardiovascular load is intense, if hyperthermal pools are used in the BT; and the cardiovascular load tends to decrease comparatively if thermo indifferent and hypothermal pools are used. A more positive cardiovascular effect can be attained in BT through the use of CO_2 gas pools in comparison to CO_2 liquid pools.[9,20,21] Some studies demonstrated that hydrotherapy and BT decrease blood pressure and provide positive effects on cardiac functions.[22] However, there are also a few case reports noting that BT increases cardiovascular risk particularly in patients with HT.[23,24]

Until recently, the number of studies investigating the acute effects of BT is relatively limited and the findings emerging from these studies show variations in connection to temperature of the water in BT and the immersion level of the patients.[25] In a study conducted in 1998, Paran *et al*.[26] applied BT to two groups of OA patients, one with HT and the other who were normotensive for a 2-week period in thermomineral water. They recorded a significant reduction in systolic and diastolic blood pressures in the normotensive group. Moreover, thermomineral water had an additional lowering effect on the blood pressure of the patients who were normotensive but the systolic blood pressure of hypertensive patients increased, which tended to decrease within 10 days after the beginning of the treatment. However, the findings of the Paran study turn out to be have some inconsistency with the findings of the present study because we found that the increase in the systolic blood pressure did not show any decreases during the 15-day treatment period. The use of hyperthermal water in BT may have resulted in the absence of decrease in systolic blood pressure in the present study. In a study conducted on OA patients in thermomineral water, Cimbiz *et al*.[27] recorded an increase in heart rate and a decrease in diastolic blood pressure after treatment and reported no significant changes in systolic blood pressure, which is consistent with the findings of the present study. In a retrospective study on 2,090 OA patients receiving thermal therapy, Umay *et al*.,[28] found that while there were decreases in the systolic and diastolic blood pressure in patients with HT and who were normotensive, the decrease in the diastolic blood pressure in patients with HT was recorded to be greater and more significant.

Shani *et al*.,[29] in a study on the diastolic and systolic blood pressures of 1,366 samples consisting of hypertensive and normotensive psoriatic patients treated at the Dead Sea for a period of 4 weeks found that both diastolic and systolic blood pressures of both the groups significantly decreased. The drop was evident 2 days after the beginning of the treatment. The differences in blood pressure measurements between the findings of the different studies might be related to the immersion level of the patients. While most trials report about the head being out of water during immersion, in the present study, the patients were immersed to the xiphoid. So it may well be that the cardiovascular response to immersion was so small in the present study because of the immersion level of the patients.

The most common cardiovascular complication in rheumatic disease accompanying comorbid disease is HT.[30] It has been known for a long time that the presence of HT as a comorbid factor in rheumatic disease may alter the options of treatment. For these patients, BT has still been used as a safe and effective treatment method.[31,32] The fact that BT decreases the diastolic blood pressure effectively might be seen as a positive factor in the decrease of the comorbid load of the patients with OA. It has been thought that the decreasing effect in blood pressure might be related to the effect of thermal water on the vasodilation of the venous system, the decrease in peripheral resistance, the antioxidant effect of thermal water, and cardiovagal baroreflex effect. The cardiovagal baroreflex is one of the autonomic functions regulating blood pressure. Hyperthermia triggered by bathing may decrease carotid arterial stiffness. thus increasing the cardiovagal baroreflex, which naturally results in a decrease in blood pressure.[33-35]

The limitation of the present study is the fact that the cardiovascular hemodynamic variables were not measured during the immersion process of BT. The measurement of blood pressure during the immersion process of BT might yield more objective results. Another limitation of the present study is that the HT follow-ups of the patients were not conducted in 24-h intervals after BT.

Conclusion

In summary, BT for OA can be safely used without resulting in any meaningful fluctuation in systolic and diastolic blood pressures in patients with normal and controlled HT except for a decrease in the diastolic blood pressure of patients with uncontrolled HT. This may be an advantage in OA patients having HT as comorbid disease. Even so, there is a need for further clinical studies investigating the effects of BT on blood pressure during the immersion process of BT.

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Conflicts of interest

There are no conflicts of interest.

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