

# Comparison of the effects of sodium bicarbonate jet prophylaxis on blood pressure in normotensive individuals and patients with controlled hypertension: a controlled clinical trial

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This study assessed the blood pressure (BP) of normotensive subjects and subjects with pharmacologically controlled hypertension after sodium bicarbonate jet prophylaxis. Forty subjects were divided into 2 groups: a normotensive control group (n = 20) and a hypertensive group (n = 20). Blood pressure measurements were conducted at 4 timepoints: prior to the dental prophylaxis (T0), immediately after treatment (Ti), 15 minutes after treatment (T15), and 30 minutes after treatment (T30). The systolic BP (SBP) values for both groups were significantly increased at Ti ( $P < 0.05$ ) and returned to their initial state at T15. Both groups also showed a significant increase in diastolic BP (DBP) values at Ti ( $P < 0.05$ ); however, the basal conditions in hypertensive subjects were not restored until T30, whereas the values for normotensive subjects were restored at T15. The results indicated that systemic BP changed significantly after sodium bicarbonate jet prophylaxis in both study groups; while initial SBP values were restored by 15 minutes in both groups, the return to initial DBP values took longer in the hypertensive group than in the normotensive group.

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**GENERAL DENTISTRY  
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There is extensive literature demonstrating that the accumulation of a bacterial biofilm is directly related to the pathogenesis of gingivitis and periodontitis and that removal and control of this biofilm are necessary to treat such diseases.<sup>1,2</sup> Until the 1970s, methods for biofilm and calculus control were limited to use of rubber cups and/or brushes with abrasives in low-speed handpieces, dental tapes, ultrasonic devices, and manual devices. At the end of that decade, a new prophylaxis system was introduced. The device released a controlled jet of air, water, and sodium bicarbonate particles to remove nonmineralized, supragingival biofilm. This method has proven to be efficient and less time-consuming than other methods of prophylaxis—up to 3 times shorter than rotational instruments and rubber cups.<sup>3,4</sup>

Sodium bicarbonate is regarded as an ideal abrasive for intraoral use due to its nontoxic features and water solubility.<sup>4</sup> Sodium bicarbonate jet prophylaxis can be used for basic periodontal treatment as well as periodontal and peri-implant maintenance. Several studies have examined the effects of sodium bicarbonate jets on the surfaces of enamel, dentin, cement, restorations, and soft tissue.<sup>5-7</sup> However, little attention has been given to the systemic effects of the use of these jets, particularly concerning their contraindication in hypertensive patients.

With the aging of the general population, some chronic systemic diseases have become more evident, including hypertension. In 2008, approximately 40% of adults aged 25 years and older worldwide had been diagnosed with hypertension. The number of people suffering from this condition increased from 600 million in 1980 to 1 billion in 2008, and it is expected that the number of hypertensive adults in 2025 will be approximately 1.56 billion.<sup>8-10</sup> The increased prevalence of hypertension is generally attributed to the growth and aging of the population; however, other risk factors also need to be considered, such as unhealthy diet, alcohol abuse, lack of physical activity, obesity, and excessive stress levels.<sup>11</sup>

In a study conducted with dogs, the pH level and the serum levels of sodium, potassium, bicarbonate, and other electrolytes were analyzed after bicarbonate jet use.<sup>12</sup> The results showed minor, yet significant, changes in these parameters. However, the authors conceded that this was an animal study and recommended that possible systemic transitional changes arising from the use of sodium bicarbonate jet be

**Table.** Mean (SD) systolic and diastolic blood pressure (in mm Hg) of normotensive and hypertensive subjects before and after sodium bicarbonate jet prophylaxis.

Timepoint	Systolic blood pressure		Diastolic blood pressure	
	Normotensive	Hypertensive	Normotensive	Hypertensive
T0	123.2 (6.13) <sup>Aa</sup>	144.20 (11.10) <sup>Ab</sup>	83.25 (6.34) <sup>Aa</sup>	96.20 (10.18) <sup>Ab</sup>
Ti	134.75 (11.64) <sup>Ba</sup>	153.90 (13.21) <sup>Bb</sup>	93.25 (10.92) <sup>Ba</sup>	103.00 (9.56) <sup>Bb</sup>
T15	127.50 (8.81) <sup>Aa</sup>	148.40 (14.08) <sup>Ab</sup>	87.50 (7.52) <sup>Aa</sup>	99.35 (12.67) <sup>Bb</sup>
T30	125.75 (6.74) <sup>Aa</sup>	148.40 (13.80) <sup>Ab</sup>	85.00 (6.07) <sup>Aa</sup>	96.75 (8.91) <sup>Ab</sup>

**Abbreviations:** T0, prior to prophylaxis; Ti, immediately after prophylaxis; T15, 15 minutes after prophylaxis; T30, 30 minutes after prophylaxis.

Statistically significant *intergroup* differences are indicated by different superscript lowercase letters within rows (2-factor repeated-measures analysis of variance;  $P < 0.05$ ). Statistically significant *intragroup* differences are indicated by different superscript uppercase letters within columns (2-factor repeated-measures analysis of variance;  $P < 0.05$ ).

investigated further.<sup>12,13</sup> Recently, a clinical study conducted with young patients reported that there was some variability in diastolic blood pressure (DBP) immediately after the procedure with sodium bicarbonate jet in comparison with conventional prophylaxes.<sup>14</sup>

Thus, the main aim of this study was to evaluate the effect of treatment with a sodium bicarbonate jet on the blood pressure (BP) of 45- to 65-year-old normotensive and controlled hypertensive patients. In addition, the comfort and anxiety levels of the patients during the procedure were assessed.

## Materials and methods

This study received approval from the Ethics and Research Committee, São José dos Campos Dental School, Institute of Science and Technology, São Paulo State University (ICT-UNESP; No. 754.623). The study was in full accordance with the World Medical Association's Declaration of Helsinki.<sup>15</sup>

Forty patients from the Periodontics Clinic of the ICT-UNESP, 21 women and 19 men, were recruited from August 2014 to June 2015. Inclusion criteria were patients 45-65 years of age who needed dental biofilm removal prophylaxis and had agreed to participate by signing an informed consent form. Exclusion criteria were any of the following conditions: dentitions with fewer than 20 teeth; uncontrolled hypertension; diabetes; and kidney, respiratory, or lung problems.

According to the patient's systemic condition, patients were allocated either to the normotensive control group ( $n = 20$ ) or to a test group of individuals with pharmacologically controlled hypertension ( $n = 20$ ); both groups received sodium bicarbonate jet prophylaxis.

### Sodium bicarbonate jet prophylaxis

The prophylaxis consisted of a sodium bicarbonate jet, which contained 15 g of sodium bicarbonate powder within each dental unit reservoir and was applied for 10 uninterrupted minutes. The directions for the prophylaxis were to direct the air/water/sodium bicarbonate jet spray from the cervical toward the incisal tooth region at approximately 5 mm distance, angled from 40 to 90 degrees toward the long axis of the tooth, while avoiding contact with the soft tissues.

## Parameters tested

### Blood pressure

The BP measurements were performed by a single trained individual using a mercury column sphygmomanometer (0-300 mm Hg) with a stethoscope. The readings were carried out prior to prophylaxis (T0), immediately after the procedure (Ti), 15 minutes after the procedure (T15), and 30 minutes after the procedure (T30).

### Patient comfort

The patients' level of comfort was assessed by a visual analog scale (VAS) after the end of the prophylaxis procedure. The modified VAS had written categories that identified the minimum level (0) as "very uncomfortable" and the maximum level (10) as "nothing uncomfortable."

### Patient anxiety

The anxiety levels of the patients were assessed via the State-Trait Anxiety Inventory (STAI). The STAI is a 20-statement questionnaire from which each patient gave a reply of 1-4, 1 indicating low anxiety and 4 indicating high anxiety. Thus, the final assessment score ranges from 20 to 80 points; the sum of 20-40 points is considered a low anxiety level, 41-60 points is considered a moderate anxiety level, and 61-80 points indicates a high anxiety level.<sup>16</sup>

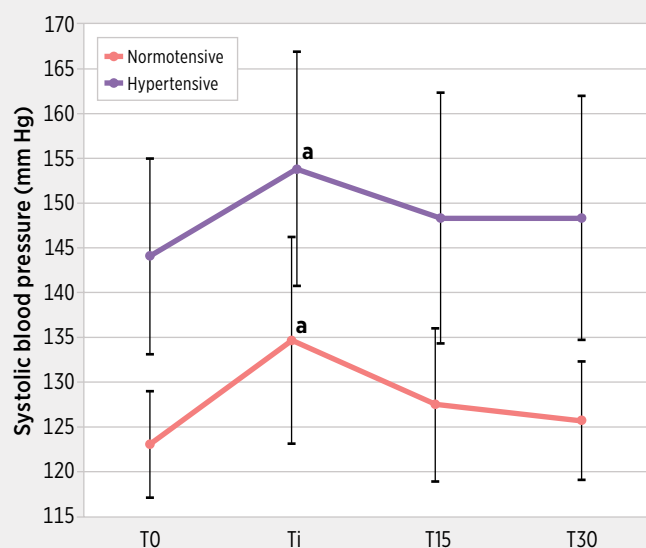
### Sample size

A difference of 1 mm Hg between the groups was considered to be clinically relevant for the primary variable of arterial pressure. With a power of 80%,  $\alpha = 0.05$ , and an expected standard deviation of 0.8 mm Hg, a sample of 14 subjects per group would be necessary to achieve this purpose, using the analysis of variance (ANOVA). With a sample of 20 subjects per group, the study had a greater than 80% power to detect a difference of 1 mm Hg in arterial pressure variation between the groups.

### Statistical methods

The descriptive data analysis was performed by mean and standard deviation. The sample arrangement was verified by the Shapiro-Wilk test. The data were analyzed with a 2-factor ANOVA for repeated measures at a significance level of 0.05.

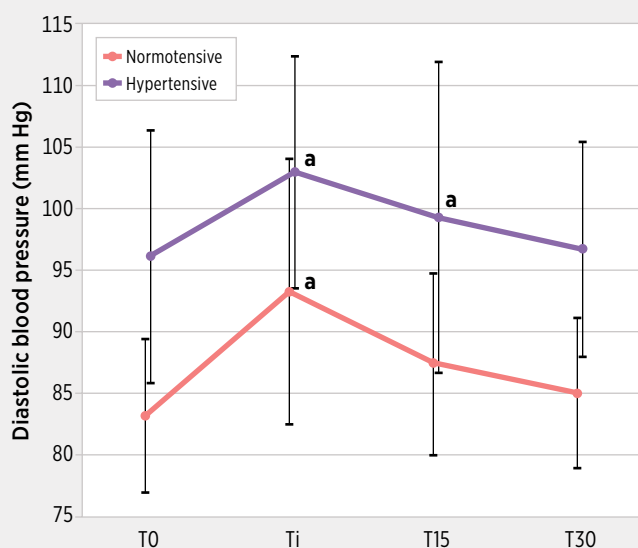
**Chart 1.** Systolic blood pressure.



**Abbreviations:** T0, prior to prophylaxis; Ti, immediately after prophylaxis; T15, 15 minutes after prophylaxis; T30, 30 minutes after prophylaxis.

<sup>a</sup>Statistically significant difference in the intragroup analysis (2-factor repeated-measures analysis of variance;  $P < 0.05$ ).

**Chart 2.** Diastolic blood pressure.



**Abbreviations:** T0, prior to prophylaxis; Ti, immediately after prophylaxis; T15, 15 minutes after prophylaxis; T30, 30 minutes after prophylaxis.

<sup>a</sup>Statistically significant difference in the intragroup analysis (2-factor repeated-measures analysis of variance;  $P < 0.05$ ).

## Results

There were no statistically significant differences between groups regarding the sex or age of patients. The normotensive group, with 10 men and 10 women, had a mean age of 47.7 (SD, 6.71) years. The hypertensive group included 8 men and 12 women with a mean age of 53.0 (SD, 7.43) years.

Analysis of the VAS results showed that there was no statistically significant difference between groups in reported comfort level. The mean VAS score was 6.95 (SD, 1.57) in the normotensive group and 8.22 (SD, 1.60) in the hypertensive group. Both groups had a mean STAI score of 41.50 (SD, 6.39).

Intergroup analysis revealed that there were statistically significant differences in both the systolic BP (SBP) and the DBP at all times (Table). In the intragroup analysis, there was a statistically significant difference in SBP and DBP values in both groups immediately after the prophylaxis ( $P < 0.05$ ). In normotensive patients, both the SBP and DBP were higher at Ti and returned to the initial values at T15 (Charts 1 and 2). In hypertensive patients, the same increase at Ti and return to normal values at T15 was observed in the SBP. However, the DBP values that increased in Ti remained high at T15, only returning to normal levels at T30.

## Discussion

Studies have indicated the highly variable prevalence of periodontal disease worldwide, which is affected by such factors as region, age, and ethnicity.<sup>17-19</sup> Through a study conducted with Swedish subjects for 30 years, Hugoson et al demonstrated that there would be a significant improvement in periodontal and oral health conditions if dental preventive measures were

adopted.<sup>19</sup> Both preventive measures and periodontal supportive treatment are essential for maintaining good dental health throughout a patient's lifetime. Furthermore, in many cases, professional prophylaxes—either conventional treatment or with a sodium bicarbonate jet—are recommended.

Sodium bicarbonate jet prophylaxis is effective at removing plaque and extrinsic stains and is faster than other prophylactic measures.<sup>3,4,6</sup> It is considered advantageous for plaque removal in areas of difficult access, such as furcation regions, as it uses jets propelled under controlled pressure, which are more effective in reaching depths.<sup>20</sup> The sodium bicarbonate jet is also recommended for the pretreatment of teeth that require pit and fissure sealants.<sup>21,22</sup>

Information on the potential effect of the sodium bicarbonate jet on blood pressure is scarce in the literature. Gutmann warned about the use of sodium bicarbonate in patients with respiratory diseases, infectious diseases, kidney disease, hypertension, and other systemic problems but emphasized the lack of scientific data on the systemic effects of the absorption of sodium bicarbonate from this type of prophylaxis.<sup>6</sup> Thus, the present study evaluated the effect that this type of prophylaxis exerts on the blood pressure of normotensive and controlled hypertensive subjects, in an attempt to confirm or refute its contraindication.

According to the results, although there was a significant increase in SBP for both normotensive and hypertensive subjects between the intervals of T0 and Ti, the SBP returned to initial values by T15. On the other hand, there was a difference in DBP values in hypertensive and normotensive subjects; the DBP values in hypertensive subjects remained unchanged at T15, taking longer to return to the initial values.

*Systolic blood pressure* has been defined as “aortic pressure at its maximum value during the period of ventricular ejection, being generated by the cardiac systole,” so it represents the highest pressure condition in the arteries, closely associated with ventricular systole.<sup>23,24</sup> The increase in SBP in the present study can be partially explained by the fact that dental procedures can generate anxiety, excitability, and fear in many patients.<sup>25</sup> It has also been proven that when an individual is submitted to stress, there is an increase in neurotransmitters (such as norepinephrine and dopamine) that can increase arterial BP.<sup>26</sup> Hall stated that a sympathetic stimulation in situations of stress (such as fear and anxiety) sharply increases heart activity.<sup>27</sup> Under a strong sympathetic stimulation, the heart can pump at least twice as much blood as in normal conditions, contributing to increased BP. In situations of fear and anxiety, the sympathetic system is overstimulated, generating peripheral vasoconstriction and resulting in an increase in arterial BP.<sup>27</sup>

The DBP represents the lowest pressure in the arteries, which occurs during ventricular diastole, when the blood is filling the ventricular cavities.<sup>23</sup> The fluid volume can be increased with excess intake of sodium (which passively retains water) and chloride, increasing the venous return.<sup>28</sup> As previously noted, the DBP in hypertensive individuals had a significant increase from T0 and remained at high levels for a longer period of time than the DBP in the normotensive group. In order to explain such an effect, it is theorized that a hypertensive patient suffers from left ventricular hypertrophy as a structural adaptation of the heart to increased afterload, which occurs in arterial hypertension. Concentric hypertrophy is a result of thickening of the arterial walls and leads to a subsequent reduction of ventricular dimensions. The systolic function is still preserved, but the diastolic function is impaired.<sup>29</sup>

Campagnole-Santos & Haibara also cited vascular and ventricular hypertrophy as a cardiovascular change caused by arterial hypertension.<sup>30</sup> Research has shown an association between diastolic dysfunction and an increased volume of collagen in the heart; in this type of ventricular hypertrophy, there is a deposition of collagen fibers that are responsible for increased myocardial stiffness associated with a reduction of ventricular distensibility.<sup>29</sup> Thus, it is suggested that the increase in BP found in both groups may have occurred as a result of a patient's anxiety when facing dental treatment, associated with the slight absorption and intake of sodium from the prophylaxis system. However, when a hypertensive individual experienced these cardiovascular changes, his or her DBP might have taken longer to be restored to its initial state.

The VAS and STAI assessments of the degree of comfort and anxiety level of patients indicated that the sodium bicarbonate jet was a relatively comfortable procedure, with patients in both groups experiencing an average level of anxiety. The STAI is a commonly used tool to quantify subjective components related to anxiety. It presents one scale that assesses anxiety as a state (STAI-S) and another that evaluates the anxiety as a trait (STAI-T).<sup>31</sup> In the present study, only the STAI-S was used, as this scale relates to a transitory emotional condition constituted of consciously perceived feelings of tension, apprehension, and hyperactivity of the autonomous nervous system.<sup>32</sup>

## Conclusion

Within the limitations of this study, it can be concluded that there was a significant change in the blood pressure of patients after sodium bicarbonate jet prophylaxis. The SBP values of both groups were restored relatively quickly, while the DBP values in the hypertensive group were restored more slowly than those in the normotensive group. The procedure was relatively comfortable, and the patients reported an average level of anxiety.

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## Disclaimer

The authors have no financial, economic, commercial, or professional interests related to topics presented in this manuscript.

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