

Original Article

Does Hypertension affect your Saliva Properties?

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KEY WORDS

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ABSTRACT

Statement of the Problem: Systemic conditions can affect the salivary glands and oral health. Hypertension induces xerostomia. Because the function of saliva is related to its quality and quantity, therefore, any changes in saliva can lead to diminished quality of patient's life.

Purpose: The purpose of this study was to evaluate the relationship between hypertension and pH and viscosity of cumulative saliva in adults with hypertension.

Materials and Method: This cross sectional study took place on patients referred to oral medicine faculty of Shahid Sadoughi University of Medical Science. The patients' blood pressure was measured and the 135 patients fitting the inclusion criteria participated in the study. Their unstimulated cumulative saliva was collected by spitting method and pH of the samples was measured by digital pH-meter set. Viscosity of the samples was measured by comparing the amount of saliva displacement in the thistle tube with control fluids at mm/10 seconds. The data was analyzed by Spss 20 software and ANOVA Tests and Tukey multiple comparison and their nonparametric equivalent ($p \leq 0.005$).

Results: This study showed that a significant relationship exists between pH and also viscosity of unstimulated saliva of normotensive and borderline hypertensive patients ($p < .0001$ and $p < .005$, respectively) and also between normotensive and stage I hypertensive patients ($p < .0001$, $p < 0.000$). So, there is a direct and significant relationship between saliva viscosity and hypertensive patients and this relationship is reverse between saliva pH and hypertension.

Conclusion: Hypertension can cause an increase in viscosity and a decrease in pH of saliva in hypertensive patients that leads to salivary quantitative and qualitative changes and influences the oral health and quality of the patient's life.

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Introduction

Hypertension is one of the most common recognized diseases and currently, most of older adults are suffering from hypertension and are under treatment by anti-hypertensive drugs. In adults, hypertension is defined as a stabled systolic blood pressure ≥ 140 mmHg and/or a stabled diastolic blood pressure ≥ 90 mmHg. Hypertension and prehypertension can lead to significant

prevalence in mortality and morbidity due to cardiovascular disease that follow them [1].

Although it has an unappealing appearance saliva is the most important oral fluid. Many properties of saliva have been studied but it seems that pH and viscosity are among the most important features. Many systemic diseases and medications can cause disturbances in the quality and quantity of saliva and there-

fore influencing the patient's quality of life extremely [2-5].

Viscosity of saliva is dependent on various factors including protein content; inorganic component and any change in the viscosity of saliva can reflect major changes in the content of saliva and its remarkable impact on the oral mucosa. Also saliva pH is one of the most important features of saliva and is directly correlated to the buffering capacity of secreted saliva and its significance rule in maintaining oral dental health and dental integrity [6-7].

Due to increasing prevalence of hypertension by aging [1] many studies has been conducted on this disease but there is little information about the influence of hypertension and its treatment on the salivary gland function and their secreted saliva and because hypertension affects body fluids its effect on saliva needs to be determined [2, 8]. Thus, the aim of this study was to evaluate the relationship between hypertension and pH and viscosity of cumulative saliva in adults with hypertension.

Materials and Method

This cross sectional study was conducted on patients referred to Oral Medicine Faculty of Shahid Sadoughi University of Medical Sciences. Their medical history was obtained by interview and recorded in their files. 135 patients were included in this study using sequential sampling and according to their blood pressure were divided in to 3 groups with 45 participates. All the groups were matched for age and gender.

The inclusion criteria for participants was just hypertensive individuals with no other systemic disease, taking no other drugs (except antihypertensive drugs such as losartan, beta blockers and etc.) and no history of smoking or alcohol use. Patients who were taking diuretics for their hypertension or taking drugs which are known to induce xerostomia such as antidepressants were excluded from the study. Patients who were taking antihypertention drugs were all in group 3.

A total of 135 saliva samples were collected from participants with the mean age of 45.86 years (range of 30-79 years) and analyzed.

Blood pressure was taken twice (by 5 minutes intervals) after each individual was seated comfortably on the chair for at least 5 minutes, by SANA automatic

Sphygmomanometer (model HL868RT, made by Health and life Company in Taiwan). To reduce inter-examiner error automatic Sphygmomanometer was used.

Hypertension was defined as systolic blood pressure more than 140 mmHg and diastolic blood pressure more than 90 mmHg. Individuals were divided into 3 groups each with 45 members, group 1 consisted of 45 normotensive individuals (BP less than 120/80 mmHg, not taking drugs), group 2 consisted of 45 borderline hypertensive individuals (Systolic BP in range of 120-139 or Diastolic BP in range of 80-89 mmHg, not taking drugs), and group 3 consisted of 45 Stage I hypertensive individuals (Systolic BP in range of 140-159 or Diastolic BP in range of 90-99 mmHg). Spitting method was used to collect the unstimulated whole saliva. All of the saliva samples were collected at 25 degrees C. at 9-11 A.M. Individuals were forbidden to eat, drink, smoke or brush their teeth, at least 90 minutes before sampling in order to decrease the influence of daily changes on the composition of saliva.

Before sampling, individuals remained seated on the chair and were asked to swallow all the saliva existing in their mouth. Then, they were prevented to swallow for 5 minutes and spit the collected saliva into the sterilized cups provided by the investigators.

Immediately after sampling, pH of the saliva samples were measured by Pen-type digital pH-meter set (Taiwan AZ Company www.azinstrument.com.tw). Also, the viscosity of samples was immediately measured by comparing the amount of displacement of saliva in the calibrated thistle tube to that of control fluids. Control fluids were glycerin (Viscosity=830 mm²/s (cSt)) and water (Viscosity=1 mm²/s (cSt)) and the amount of displacement of the fluid in the thistle tube was compared to of control fluids within 10 seconds (mm/10 s) in this study.

According to Shipro Test, data distribution was normal and ANOVA Test was used to compare the groups. When the differences were significant, Tukey multiple comparisons and/or nonparametric equivalent of them and was used to compare groups pairwise.

This study was approved by Ethical Committee of Shahid Sadoughy University of Medical Sciences of Yazd (no ir.ssu.rec.1395.128) after receiving a written consent form from all participants.

Results

In this study 51% of individuals were male and 49% were females. Also, 16% of individuals were taking antihypertensive drugs including 82% took Losartan and 18% propranolol. Furthermore, 76% of individuals took only one drug and 24% took two. All groups were matched regarding gender and age. The mean ages of the 3 groups were 45.59 years for group 1 (SD:12.08), 45.53 years for group 2 (SD:9.91) and 46.56 years (SD:13.40) for group 3. Also $p < 0.05$ was regarded significant.

The mean and standard deviation of salivary pH of 3 groups are compared in Table 1. As shown in Table 1 and Table 2, the average pH was higher in group 1 (BP less than 120/80 mmHg) than in group 2 (Systolic BP in range of 10-139 or Diastolic BP in range of 80-89 mmHg) ($p=.0001$) and it was higher in group 2 than in group 3 (Systolic BP in range of 140-159 or Diastolic BP in range of 90-99 mmHg) ($p=.005$). These differences were statistically significant.

As shown in Tables 3 and 4, the average of displacement of saliva in the thistle tube at mm/10s in group1 was more than group 2 ($p=.005$) and greater in group 2 than group 3 ($p=.0001$). These differences were also significant ($p < .05$).

Table 1: The mean and standard deviation of salivary pH in 3 groups (n = 135)

Groups	Std. Deviation	Mean	Number
Group 1 (Normal BP)	0.42628	6.487	45
Group 2 (Prehypertension)	0.50526	6.060	45
Group 3 (Stage I BP)	0.56959	5.851	45

ANOVA Test $p = 0.000$

Table 2: Multiple comparisons of salivary pH in 3 groups

Groups	Mean Difference	p Value
Group 1 (Normal BP)	0.426 Group 2	0.0001
	0.636 Group 3	0.0001
Group 2 (Prehypertension)	0.426 Group 1	0.0001
	0.209 Group 3	0.151
Group 3 (Stage I BP)	0.636 Group 1	0.0001
	0.209 Group 2	0.151

Table 3: The mean and standard deviation of saliva displacement in thistle tube (mm/10s) amongst 3 groups

Groups	Std. Deviation	Mean	Number
Group 1 (Normal BP)	2.6310	4.678	45
Group 2 (Prehypertension)	1.9932	3.233	45
Group 3 (Stage I BP)	1.6963	2.556	45

ANOVA Test, $p = 0.0001$

Table 4: Multiple comparisons of the saliva displacement in thistle tube amongst 3 groups

Groups	Mean Difference	p Value
Group 1 (Normal BP)	1.444 Group 2	0.005
	2.122 Group3	0.0001
Group 2 (Prehypertension)	1.444 Group1	0.005
	0.677 Group3	0.408
Group 3 (Stage I BP)	2.122 Group1	0.0001
	0.677 Group2	0.408

Discussion

The results of this study demonstrated the relationship between hypertension, antihypertensive drugs, and their influence on saliva properties, since individuals involved in this study were only hypertensive individuals without any other systemic disease and a few of them took only antihypertensive drugs (e.g. Losartan, beta blockers, ... and not diuretics because it has been shown that diuretics cause xerostomia).

Blood pressure was measured twice for a more powerful prediction. To remove the difference among examiners, an automatic sphygmomanometer, (SANA) model HL868RT, made by Health and life Company in Taiwan was used.

Unfortunately, a few studies have been done on the effects of hypertension on saliva. In a study, R. Kagawa *et al.* [1] found that pH of unstimulated saliva is significantly lower in hypertensive individuals [1]. In fact, they demonstrated that pH of unstimulated saliva tends to decrease simultaneously by an increase in both systolic and diastolic blood pressures [1]. As seen in this study hypertension is related to the decrease of pH which is similar to R. Kagawa's [1] results. Our results showed that pH of unstimulated saliva in borderline and stage I hypertensive individuals was lower than normotensive individuals so that a decrease in pH leads to changes of physical and chemical properties of saliva resulting in the destructive influences of hypertension on the oral health [9-10].

Preteasa *et al.* [11] expressed that viscosity and pH of saliva are both independent parameters and their changes are not related to each other (while pH decreases, viscosity tends to increase) [11]. This is consistent with our results as we also did not find any relationship between saliva viscosity and pH in the participants in our study.

Viscosity of samples was measured just immediately after collection due to the possibility of its rapid

changes by time. Because of the reverse relationship between viscosity and temperature, the amount of sample displacements in thistle tube (mm/s) were measured at 25 degrees so that the temperature changes wouldn't affect the results in our study [12]. Statistical analysis showed that, the amount of salivary displacement in the thistle tube in stage I and pre hypertensive groups was significantly lower than normotensive group; therefore, viscosity is higher in hypertensive groups and because of higher viscosity saliva travels less in the thistle tube in the hypertensive groups and it can be concluded that by an increase in blood pressure, viscosity of unstimulated saliva also increases resulting in lower salivary flow and the reduction of the cleansing effect of saliva on the teeth and mucosa resulting in impaired oral health in these individuals [14].

Also, pH of samples was measured immediately after collection because pH of saliva increases while it is exposed to the air due to constant losing of CO₂ [4]. In statistical analysis, pH of unstimulated saliva in stage I hypertensive and prehypertensive groups was significantly lower than in normotensive group.

It may be suggested that the reduction of pH in hypertensive patients could be related to a decrease in unstimulated salivary flow rate in hypertensive patients (before taking drugs) in comparison to normotensive individuals due to disturbances in autonomic pathways and higher activity in the sympathetic pathways and lower activity in the parasympathic pathways which controls the salivary secretion which results in lower flow rate [5] and because bicarbonate which is the most important oral buffer is effective only in high salivary flow rates and its concentration greatly decreases by lower flow rate there for resulting in lower pH and buffering capacity of the saliva [2]. In other words, pH of saliva is greatly dependent to the amount of saliva secretion and also the speed of secretion affects the salivary composition therefore due to the reduction of saliva secretion in hypertension patients pH and buffering capacity is also compromised [11, 15-16]. The cause of this increase in bicarbonate concentration is the elevation of saliva secretion rate, and in general, bicarbonate concentration is low in all salivary glands; However, by an increase in their metabolic activities, CO₂ is produced and hydrat-

ed by carbonic anhydrase enzyme therefore lower saliva secretion results in lower bicarbonate concentrations [17]. Salivary buffering capacity has a great influence on pH of plaque surrounding the enamel and prevention of dental caries progression [18]. Therefore, in hypertensive individuals, the buffering capacity and concentration of bicarbonate diminishes due to a decrease in unstimulated saliva flow rate and also the pH of saliva decreases too.

If decreased pH in oral environment lasts for too long, it can cause colonization of cariogenic bacteria instead of useful ones and this leads to more caries and jeopardizes individuals oral health which can lead to compromised oral health in patients with chronic hypertension [19].

In a study, Taguchi and et al. [20] showed that treatment of hypertension in lower ages leads to more success in the maintenance of teeth [20]. Also, it has been shown that viscosity of saliva has a direct relationship with its protein content [8]; therefore, any protein secretion into saliva causes changes in viscosity and its properties and these changes lead to irreversible complications in oral health [13].

Lubrication of mouth, larynx, and other soft and hard tissues is one of the most important roles of saliva which is made by elastic resistance between surfaces, and viscosity is the most important indicator of saliva lubricating role [14]. Consequently, increased viscosity irritates mucosa, causes inflammation, and diminishes salivary elution activity resulting in rampant caries, oral mucositis, difficulty in swallowing, and halitosis that influence the quality of hypertensive individuals' life [20].

It seems reasonable to monitor chronic hypertensive patients taking antihypertensive drugs who are disposed to caries or have a history of root caries or periodontal diseases more frequently [16].

This study showed that hypertension can decrease pH and increase viscosity both of which are risk factors of caries and oral inflammation.

According to our findings, it seems that a decrease in pH and an increase in viscosity in chronic hypertensive patients are absolutely obvious. Increased viscosity results in rampant caries, oral mucositis, difficulty in swallowing and halitosis that influence the quality of hypertensive individuals' life [21]. Also, it leads to

lower salivary flow rate and decreased salivary elution activity that cause irreversible complications in oral health. On the other hand, decreased pH of unstimulated saliva is harmful for oral health, the early tooth loss due to caries; therefore, hypertension can be a risk factor for tooth loss [22-23].

Conclusion

In conclusion, we should take into consideration the influences of hypertension on oral health more seriously and must consider more regular dental appointments for these patients.

Suggestions

In this study one of our limitations were a few individuals who were taking medication in stage I hypertension after sampling therefore we could not compare subjects taking medication and those who did not but for reducing the effect of medication, individuals taking drugs with known effects on blood pressure were excluded. It is suggested that another study be done only on patients with stage II hypertension who are taking the same medication and their pH and saliva viscosity be evaluated for better results.

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Authors Contribution

Azra Mohiti supervised the study and was the main author. Faeze Eslami collected the data and Mohammad Dehestani provided the patients who participated in the study. Ethical approval: The study was approved by ethical committee of Shahid Sadoughy University of Yazd (no ir.ssu.rec.1395.128).

Conflict of Interest

The authors declare that they have no conflict of interests.

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