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## Evaluation of impact of hypertension on salivary pH, salivary flow and buffering capacity: A retrospective analysis

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### Abstract

**Background:** Hypertension is defined as systolic and diastolic blood pressures with values  $>140\text{mmHg}$  and  $>90\text{mmHg}$  respectively. The purpose of the present study is to evaluate the impact of hypertension on salivary pH, salivary flow and buffering capacity.

**Methodology:** This study is a retrospective observational study that included 200 patients. The subjects were categorized into the four groups: Group 1- Patients with normal blood pressure (SBP of  $<140\text{ mmHg}$ , DBP of  $<90\text{ mmHg}$ ) without medication, Group 2- Patients with normal blood pressure with antihypertensive medication, Group 3- Hypertensive patients (SBP of  $\geq 140\text{ mmHg}$  and/or DBP of  $\leq 90\text{ mmHg}$ ) without medication and Group 4- Hypertensive patients with antihypertensive medication. Unstimulated and stimulated salivary flow rates (USSFR and SSFR), pH and buffering capacity of saliva was recorded.

**Results:** There were no statistically significant differences in the sex, mean age among the all four groups. Although there was no significant difference in the USSFR, SSFR, or Stimulated saliva pH among the groups. There was a significant difference observed in unstimulated saliva pH ( $p=0.001$ ).

**Conclusion:** The contributory factors in maintaining the integrity of oral cavity is salivary flow rate, pH and the buffering action of the saliva. Use of anti-hypertensive medications effects pH of unstimulated saliva which can be lead to many oral detrimental changes.

**Keywords:** hypertension, saliva buffering capacity, salivary pH

### Introduction

Saliva is healthy for your teeth and gums. Saliva has a variety of activities, including lubricating oral tissues, enabling oral functions like as speaking, mastication, and deglutition, and preserving teeth and oral mucosal surfaces in various ways. Resting saliva is primarily responsible for the lubricating and antibacterial effects of saliva. When salivary flow is stimulated, it causes a flushing effect and the removal of oral detritus and unpleasant substances.

Saliva quality and quantity are crucial factors in maintaining oral balance <sup>[1]</sup>. Specific adjustments, such as higher pH, buffer capacity, and flow rate, may help to reduce tooth caries susceptibility. Severe caries and mucosal inflammations can be caused by a decrease in salivary flow rate and the resulting decline in mouth defence mechanisms <sup>[2, 3]</sup>.

Unstimulated flow rate is  $0.3\text{ mL/min}$  on average, while stimulated flow rate is  $7\text{ mL/min}$  at most; any unstimulated flow rate less than  $0.1\text{ mL/min}$  is called hypofunction. Hypofunction of stimulated salivary flow is not a common occurrence as people get older. Reduced flow can be caused by a variety of factors, including dehydration, Sjogren's syndrome, diabetes mellitus, neurological and cognitive impairments, and taking several drugs <sup>[4]</sup>.

Hypertension is a common cardiovascular disease that affects over 1 billion people around the world. Despite the fact that more than 70% of hypertensive patients are aware of their condition, only 23.49 percent are treated, and even fewer (20%) achieve control. Hypertension is defined as systolic and diastolic blood pressures of greater than  $140\text{mmHg}$  and greater than  $90\text{mmHg}$ , respectively, with prevalence varying by age, race, and education <sup>[5]</sup>. Hypertension and the use of anti-hypertensive drugs have a significant impact on the pH of stimulated saliva, which can lead to a variety of oral complications. As a result, blood pressure must be monitored in order to reconstruct and maintain oral health.

Because of its ease of collection, non-invasiveness, and low cost, saliva is becoming more popular as a diagnostic tool for evaluating physiologic and pathologic disorders [6, 7]. The current retrospective study's goal is to see how hypertension affects salivary pH, salivary flow, and buffering capacity.

### Methodology

This study is a retrospective observational study that included 200 patients. The subjects in this study were patients who visited outpatient department for dental treatment. The patients that have recorded blood pressure and the use of antihypertensive drugs which they were taking at the time of visit were only included in the study. The subjects were categorized into the four groups:

Group 1- Patients with normal blood pressure (SBP of < 140 mmHg, DBP of < 90 mmHg) without medication

Group 2- Patients with normal blood pressure with antihypertensive medication

Group 3- Hypertensive patients (SBP of  $\geq$ 140 mmHg and/or DBP of  $\leq$ 90 mmHg) without medication

Group 4- Hypertensive patients with antihypertensive medication.

### Inclusion criteria

1. Patients with recorded Blood pressure, saliva related parameters
2. Patient with no other co morbidity
3. Patients with recorded history of all medications

### Exclusion criteria

1. Patients with diabetes mellitus, any other systemic diseases.
2. Patients on radiotherapy and chemotherapy dosages

Subjects with either an SBP of 140 mmHg or DBP of >90 were defined as having hypertension according to the ACC/AHA Guidelines -2017. The details of collection of saliva was recorded.

### Method of collection of saliva

Unstimulated whole saliva (USS) was collected by the spitting method (Matsuda *et al.*, 2009). Salivary samples were collected between 10 AM and 3 PM. Patient was advised to not smoke, drink alcohol, brush their teeth, and eat for 2 hrs. before saliva collection to reduce the effects of diurnal variability in salivary composition. The subjects were asked to swallow the saliva in their mouths before collection of sample. The subjects were asked to stop swallowing for 5 min and then to spit the accumulated saliva into a collection cup.

Stimulated saliva (SS) was collected by the mastication method (Ikebe *et al.*, 2006). The subjects were asked to collect all of the saliva in their mouths, chew a measured amount of paraffin wax for 30 secs, and then spit into a collection cup. Subjects were asked to continue chewing the wax for an additional 5 minutes, expectorating every 15 - 20 seconds in the collection cup.

Unstimulated and stimulated salivary flow rates (USSFR and SSFR) were expressed in ml/min. The recorded pH and buffering capacity was tabulated. For pH evaluation, a pH test strip was immersed in the saliva for 10 seconds and compared for colour change with a testing chart.

### Statistical analysis

Data analyses were performed using SPSS Version 13.0 for Windows (SPSS, Inc., Chicago, IL, USA). The categorical data is presented as frequency distribution. The continuous data is represented in means. The percentages were compared using the Chi square test. The continuous data is compared using student T test. The  $P < 0.05$  was considered significant.

### Results

The demographic characteristic of the study population is discussed in Table 1. 200 subjects were recruited in the study. 80 males and 120 females were enrolled for the present study. SBP, DBP and USSFR were higher in men than women.

110 of analyzed subjects comprised individuals with normal blood pressure who took no medications. 11 patients were the ones who took medications but had normal blood pressure. 59 patients were those who had hypertension but were not taking medications. 20 patients were those who were hypertensive but were taking medications.

17.1% (Group 1, 2, 3 & 4) of all the subjects included individuals taking antihypertensive medication. Seventy-four percentage (75%) of subjects were on calcium channel blocker ie amlodipine antihypertensive medication, 21% were on angiotensin II receptor blockers and 7% were on angiotensin converting enzyme inhibitor. 74% were on only one antihypertensive medication and 28% were on two medications, out of the subjects taking antihypertensive medication.

When the subjects were categorized into four groups by blood pressure and medication, there were no statistically significant differences in the sex, mean age among the all four groups. Although there was no significant difference in the USSFR, SSFR, or Stimulated saliva pH among the groups. There was a significant difference observed in unstimulated saliva pH ( $p=0.001$ ). (Table 2).

### Discussion

The study evaluates adults who were hypertensive and were either on no medication or only antihypertensive medication. Few antihypertensive drugs such as diuretics and hydrochlorothiazide majorly acts on the ion channels for reduction of the blood pressure. Diuretics also shows an action on the small mucous glands, reducing the production of mucous, that is an important protector to the oral mucosa. In the present study subjects were mainly under stage 1-2 of hypertension and were taking calcium channel blocker, ACE inhibitor and Angiotensin –II inhibitors. Ship *et al.*, [6] conducted a study which stated that the stimulated parotid gland salivary flow rates in the Hydrochlorothiazide medicated group were lower than in the normotensive and hypertensive groups with no medicines, but were still within the normal ranges of saliva production. The results in our study showed that salivary flow rate had no significant association with hypertension or antihypertensive medication which is in accordance with the study done by Sankar *et al.* [8] De Matos *et al.* [9] reported a significant reduction in the salivary flow rate as a side effect to medicines. But no clarification has been justified between salivary flow rate and antihypertensive medications. A reason for this could be that most of the people taking antihypertensive are unaware of their decreased salivary flow as saliva is usually neglected body fluid thus very little

data has been reported till date.

In the present study, the pH of unstimulated saliva was significantly lower in the group with hypertension than in the group with normal blood pressure regardless of the use of anti-hypertensive medications. With an increase in blood pressure both systolic and diastolic, the pH of unstimulated saliva was found to be more acidic. The cause effect relationship can thus be established between increase in blood pressure and the acidic salivary ph. A similar study was performed by Wong et al. [10] where he revealed that the blood pressure influences the general circumstances in several ways. The most important buffering system of saliva is bicarbonate which maintains the neutrality of the salivary ph. Dawes et al. [11] revealed that bicarbonate concentration and the salivary pH has a directly proportional relationship, as the bicarbonate concentration reduced with the reduction

in flow, and the pH of saliva is also reduced. There was no statistically significant difference in salivary flow rate between each group in the present study. The cleansing action of saliva on tooth surface minimizes caries. Prashanthi B et al. [12] reported that patients on diuretic medication have a higher prevalence of xerostomia, periodontitis, dental caries and mucosal lesions comparing with that in the control group individuals. Reduction in pH can be an important risk factor for dental/oral health. Johansson I et al. and Saelbröm A-K et al. [12] concluded that the decreased buffering capacity due to more acidic pH resulted increased incidence of dental caries which supports the present study which is similar to our study. Prashanth K et al. [14] demonstrated that there was an association of gingival and periodontal pathology in hypertensive patients.

**Table 1:** Distribution of the characteristics recorded from the study population

Parameters	Male (80)	Female (120)	Total (200)	P value
Age	59.3±7.2	58.07±8.3	58.56±8.12	0.31
Systolic BP	139.5±12.4	140.01±13.2	139.68±13.1	0.769
Diastolic BP	83.4±5.66	83.02±6.3	83.24±6.2	0.54
Buffering capacity	9.83±1.2	9.21±1.3	9.54±1.5	0.07
USSFR (ml/min)	1.61±0.39	1.60±0.38	1.61±0.37	0.89
pH of unstimulated saliva	6.4±0.49	6.4±0.52	6.4±0.5	0.91
pH stimulated saliva	7.65±0.2	7.64±0.38	7.62±0.29	0.22
SSFR (ml/min)	0.29±0.28	0.29±0.25	0.29±0.24	0.865

\*p value of <0.05 is considered statistically significant

**Table 2:** Distribution of variable in each group

	Group I (110)	Group II (11)	Group III (59)	Group IV (20)	P value
Age	58.6±8.12	55.3±6.1	58.89±8.1	58.17±8.2	0.664
Systolic BP	126.5±6.8	125.5±5.62	151.2±4.98	151.4.85	<0.001*
Diastolic BP	81.69±5.65	81.31±5.45	87.15±0.94	89.22±5.1	<0.001*
Buffering capacity	9.95±1.51	9.7±1.52	9.92±1.45	9.78±1.59	0.53
USSFR (ml/min)	0.35±0.33	0.32±0.07	0.32±0.23	0.32±0.36	0.77
pH of unstimulated saliva	6.65±0.46	6.53±0.55	6.39±0.51	6.71±0.53	<0.001*
pH of stimulated saliva	7.95±0.33	7.71±0.31	7.84±0.50	7.85±0.33	0.334
SSFR (ml/min)	1.58±0.46	1.56±0.08	1.50±0.38	1.52±0.48	0.07

\*p value of <0.05 is considered statistically significant

**Conclusion**

In conclusion, the contributory factors in maintaining the integrity of oral cavity is salivary flow rate, pH and the buffering action of the saliva. Use of anti-hypertensive medications effects pH of un-stimulated saliva which can be lead to many detrimental changes in oral cavity. In older adults, monitoring of blood pressure is required for maintenance of oral health. There was no significant association of either hypertension or antihypertensive medication with salivary flow rate in this study. Diminished pH of unstimulated saliva and thus acidity of the oral cavity was related to hypertension rather than antihypertensive medication. More research would be needed for confirming the flow rate alterations in hypertensive patients.

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