EVALUATION OF THE SALIVARY FLOW RATE AND SALIVARY pH AMONG CHRONIC SMOKERS: A CROSS SECTIONAL STUDY

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Introduction

INTRODUCTION

Salivary glands are exocrine glands in mammals that secrete saliva, which functionally lubricate and solubilize food before digestion, they are divided into major and minor glands of which parotid, submandibular and sublingual glands are the paired major salivary glands and numerous minor salivary glands which are scattered throughout the oral cavity[1].

Saliva is essential for oral health and it is an important biofluid which plays a significant role in protection, lubrication, remineralization of teeth, and alimentation, normaly healthy humans produce 0.5–1.5 liters of saliva each day whereas in hyposalivation, the salivary flow rate is < 0.1 mL/min at rest or < 0.7 mL/min under stimulation and there are many factors have been associated with hyposalivation they are medications, smoking, old age, psychological conditions, such as stress and anxiety, sjögren's syndrome, head and neck radiotherapy [2,3].

The saliva can be obtained by two ways one is stimulated and the other one is unstimulated (resting) whole saliva. Paraffin and citric acid are used to stimulate the salivary secretion whereas unstimulated salivary secretion is obtained in the absence of any stimulus. In case of resting condition, the parotid, submandibular, sublingual and minor mucous glands contribute about 25%, 60% and 7–8% respectively and when it is stimulated, the salivary flow is increased by at least 10% [3,4,13].

The pH in the saliva plays an important role in the life, growth and multiplication of oral bacteria, the normal range of salivary pH is 6.2-7.6 with 6.7 being the average

pH[4]. While in resting, pH of mouth does not fall below 6.3 and there are two mechanisms involved to maintain the pH, first one eliminates carbohydrates that could be metabolized by bacteria and removes acids produced by bacteria because of salivary secretion[5] and the Second one is acidity from drinks and foods, as well as from bacterial activity, is neutralized by the buffering activity of saliva.

The number of acidophilic bacteria is increased when the pH in the saliva is very low, whereas the number of the acid sensitive bacteria is decreased. The increased number of acidophilic bacteria in the dental plaque and saliva above 10^5 colony forming unit's colonies, as well as a low pH and low buffer capacity of the saliva indicate a high risk of dental caries[5,6].

Saliva plays an important role in oral homeostasis, as it modulates the ecosystem in the oral cavity. Alterations in salivary flow rate (SFR) and pH have a significant impact on oral and dental health and can be used for the diagnosis of a wide range of diseases such as dental caries, oral mucositis, dysphagia, oral infections and altered taste has been reported in individuals with reduced salivary flow and the pH[6,7].

Saliva is the first biological fluid that is exposed to cigarette smoke, which contains numerous toxic compositions responsible for structural and functional changes in saliva[8]. Normally cigarette smoke contains nicotine, tar, carbon-monoxide, formaldehyde, ammonia etc[2]in which nicotine plays a vital role which increases the flow of saliva in the mouth in the beginning and the later doses decrease the salivary

flow[3,7] also it acts on certain cholinergic receptors in the brain and other organs causing neural activation leading to altered salivary secretion[9].

The effects of cigarette smoking upon oral health are numerous and vary among individuals. The adverse effects include those involving gingival tissue, mucosal tissue, dental tissues, as well as non-cancer oral lesions associated with the use of smoke, such as tooth staining, increased susceptibility to periodontal diseases, reduced response to both surgical and non-surgical periodontal therapies, an increased risk of dental implant failure[10] and finally chronic smoking leads to cancer.

The smoke of tobacco during smoking is spread to all parts of the oral cavity and therefore, the taste receptors, a primary receptor site for salivary secretion, are constantly exposed. Generally, it is accepted that long term use of tobacco decreases the salivary pH and also the sensitivity of taste receptors which in turn leads to depressed salivary reflex. Presumably, this might lead to altered taste receptors response and hence to changes in salivary flow rate[11].

Aims and Objectives

AIM

To evaluate the salivary flow rate (SFR) and salivary pH among smokers and non-smokers.

OBJECTIVES

1. The purpose of the study is to compare the difference in Salivary flow rate by using salivary flow rate method and pH meter.

2. To evaluate the effect of long-term use of smoking significance between chronic smokers and non-smokers.

Review of Literature

REVIEW OF LITERATURE

M. Navazesh et al (1982)[12] stated that there are 4 methods of saliva collection and stimulation. Whole mouth saliva was collected and compared. They concluded that Gustatory and masticatory stimuli induced significantly higher salivary flow compared with resting levels of above methods.

Philip C (1987)[13] conducted study to evaluate Subjective examination of xerostomia and objective Measurements of salivary gland performance. Questionnaire was used to identify patients for further evaluation of oral and dental care. Saliva was collected separately from the major salivary glands without stimulation and after stimulation with citric acid. They concluded that Salivary impairment was found distributed equally between the groups and there was lack of significant differences between the groups.

Irw in D. Mandel (1989)[14] described Saliva is important in maintaining a relatively neutral oral pH, possesses a number of effective mechanisms for regulating, plaque pH, and helps neutralize reflux acids in the esophagus. Role of saliva is maintaining tooth integrity is a reflection of: mechanical cleaning and carbohydrate clearance, post eruptive maturation of enamel.

Bruce. Baum (1989)[15] described that older people are, however, more likely to experience salivary disorders due to disease or its treatment. For many patients with remaining salivary gland parenchymal tissue, improved function may result from pharmacological therapy.

Atkinson JC (1994)[16] described that there are three most common known causes of salivary gland dysfunction are medication usage, radiation therapy and Sjogren's syndrome. Current therapeutic options to treat salivary dysfunction are limited.

Axelsson et al (1998)[17] presented the study to examine the dental status and smoking habits in randomized samples of 35-, 50-, 65-, and 75-year-old subjects. Questionnaire based study, they concluded that the number of missing surfaces was higher in 50-, 65- and 75-year-old smokers than in non-smokers. In addition, 35- year-old smokers exhibited a significantly larger number of decayed and filled tooth surfaces (DFS) than non-smokers. Male smokers had significantly higher than non-smoking males.

B. Zappacosta et al (1999)[18] Investigated the concentrations of glutathione, uric acid and total antioxidant activity, expressed as Trolox (a water-soluble vitamin E analogue) equivalent, were measured in the saliva of two group healthy non-smokers and smokers. It is found that there was no statistically significant difference between smokers and non-smokers in uric acid concentrations and total radical-trapping antioxidant capacity, but glutathione concentration was significantly higher in smokers.

Ghezzi et al (2000)[19] described the Salivary hypofunction is associated with oral and pharyngeal disorders. Differences in salivary flow rates within and between individuals has been reported, concluded that there were no significant age or gender differences in variability between and within salivary flow rates at all collection time periods.

M. Bergdahl (2000)[20] study was to evaluate the association of medication, anxiety, depression, stress and subjective oral dryness. It is concluded that the medication plays an important role in reducing unstimulated salivary flow, while psychological factors such as depression, anxiety and stress for subjective oral dryness.

Hanna Pajukoski (2001)[21] conducted a study to investigate the prevalence of self-reported symptoms of dry mouth and burning mouth in elderly patients. They examined 175 home-living elderly patients and 252 elderly out patients of the same community were studied. They concluded hospitalized patients mostly complained of dry mouth, which was associated with the number of their concomitant medications. whereas, the elderly patients seldom complained of dry mouth and burning mouth. At the same time patients with burning mouth often had low salivary flow rates and there was no significant results.

Poul Erik Petersen (2003)[22] described The WHO Oral Health Programme gives priority to tobacco control in many ways through the development of national and community programmes which incorporates oral health and tobacco issues,

tobacco prevention through schools, tobacco risk assessment in countries, and design of modern surveillance systems on risk factors and oral health.

Khan GJ et al (2003)[23] described Secretion of calcium in saliva depends upon salivary flow rates in non-tobacco users and greater is the rate, lower is the concentration and vice versa. In tobacco users the taste receptors, a primary site for salivary secretion, are constantly exposed to tobacco for long time thus presumably affecting the salivary reflex. They concluded that higher levels of calcium are present in the saliva of long-term tobacco users than non-users.

Fenoll-palomares et al (2004)[24] to assess the salivary flow rate, pH and buffer capacity of healthy volunteers. Salivary flow rate, pH and bicarbonate concentration (mmol/l) were measured using a Radiometer ABL 520. The 5 percentage of salivary flow rate and bicarbonate solution concentration was considered the lower limit of normality. He reported the presence of obesity, smoking and alcohol consumption did not influence salivary parameters.

Muhammad Asif Jaleel et al (2005)[25] study was carried out on 3200 subjects. Questionnaire based study, regarding their personal and specific information about smoking was filled by the individual. The use of tobacco in any form by human being has proved to be a health hazard and its harmful effects on human health cannot be ignored. So he concluded smoking is quite common in Haripur. Smokers should quit smoking to avoid financial losses and harmful physical effects.

Athra M. Al-Weheb (2005)[26] study was to investigate the effect of cigarettes smoking on count of lactobacilli, the dental caries and salivary factors. smokers and non-smokers aged (24-29) years were chosen from post graduate students in College of Dentistry, they were interviewed about smoking behaviour. Stimulated salivary sample was analysed for lactobacilli count, salivary flow rate and salivary pH was determined. Results were analysed which states that there was a significant relation between lactobacilli and DMFT/DMFS in smokers group at but there was no significant differences concerning salivary flow rate and salivary pH between the two groups.

Ebru Olgun Erdemir (2006)[27] comparatively assessed cigarette smoking and the serum levels of folic acid, vitamin B12 and some haematological variables in patients with periodontal disease. They checked the clinical parameters of plaque index, gingival index, bleeding on probing, probing depth and clinical attachment loss. From the results of the study it is clear that patients with periodontal disease, the serum folic acid concentration is lower in smokers compared to non-smokers.

Al-Shammari KF (2006)[28] this study was to examine differences in dental patient knowledge and awareness of the effects of smoking on oral health between smokers and non-smokers. To assess any Significant associations between oral health knowledge, smoking status, and sociodemographic variables were examined. Concluded that Smoking dental patients are significantly less aware of the oral health effects of smoking than non-smokers.

Wayne J. Millar (2007)[29] stated that smokers have a higher than average risk of periodontal disease and poor oral health status. Current smokers and former smokers had higher odds of reporting orofacial pain than people who had never smoked. It is concluded that prevention of smoking and support for cessation could contribute to improve oral health.

Ebru Olgun Erdemir (2008)[30] conducted study to investigate the effect of cigarette smoking and signs of anemia in chronic periodontitis patients. Study base consisted of 88 patients with chronic periodontitis including 45 volunteer current smokers and 43 volunteer are non-smokers. The clinical parameters including plaque index, gingival index, bleeding on probing, probing depth, clinical attachment loss were recorded and several red blood cell parameters were determined from peripheral blood samples. In smokers, Plaque index, probing depth and Clinical attachment loss were significantly higher than non-smokers. They concluded that cigarette smoking may be effective on the signs of anemia of chronic disease in patients with chronic periodontitis.

Ghulam Jillani Khan et al (2008)[31] described the effect of changes in salivary concentration in chronic tobacco users. Subjects were divided into smokers, pan chewers, niswar dippers and non-tobacco users as controls. The saliva of each subject was collected under resting condition and following by application of citric acid solutions to the tip of the tongue. Results were concluding that there was no change in salivary flow rates in long-term tobacco users, salivary reflex is not adversely affected by long-term use of tobacco.

Colin Dawes (2008)[32] stated that Saliva in the mouth forms a thin film, the velocity of which varies greatly at different sites. This variation appears to account for the site specificity of smooth surface caries and supra gingival calculus deposition. Saliva protects against dental caries, erosion, attrition, abrasion, candidiasis and the abrasive mucosal lesions seen commonly in patients with hyposalivation.

De Almeida et al (2008)[33] study was to perform a literature review about the composition and functions of saliva as well as describe the factors that influence salivary flow (SF) and its biochemical composition. This review provides the information about the salivary system functions.

Ghulam Jillani Khan, et al (2010)[34] performed a study to assess and evaluate effect of smoking on salivary flow rate. Subjects of the study were divided into smokers group and control group. The saliva of each subject was collected under resting condition and also in stimulated condition by using citric acid solution. Regarding salivary flow rates of smokers there was no significant difference. They concluded Long-term smoking does not adversely affect the taste receptors response and salivary flow rate.

Maryam Rad et al (2010)[35] conducted a study in which one-hundred smokers and 100 non-tobacco subjects were selected. A questionnaire based study was conducted, was used to collect the demographic data and smoking habits. A careful oral examination was also performed for all patients and whole saliva was

collected in the resting condition, the SFR was measured. The difference was statistically significant whereas the prevalence of oral lesions in the smokers were more than that of non-smokers and the difference was not significant.

Bakianian Vaziri et al (2010)[36] study was to evaluate the differences between salivary IgA, glucose and salivary flow rate in diabetic patients compared with healthy controls. Concluded that there were no significant differences in diabetic patients and control group. And also stated salivary constituents may be useful in the description and management of oral findings in diabetic patients.

Kumar et al (2011)[37] conducted a study to evaluate the effect of the presence of plaque on the salivary clearance of sucrose and also to study the effect of the presence of plaque on salivary pH. Concluded that caries occur preferentially in the dentition sites characterized by high exposure to carbohydrate and diminished salivary effect.

Tharun Varghese Jacob (2011)[38] described the field of salivary diagnostics is now becoming a broad, complex and crosscutting area of scientific research with enormous potential to impact the practicing dentist and health care in general.

Nair et al (2012)[39] stated that discovery of salivary biomarkers and its validation had broadened the use of salivary diagnostics from assessment of dental caries to the diagnosis of cardiac diseases and malignancies remote from the oral cavity.

Kanwar Alphana et al (2013)[40] conducted study comprised of 60 healthy adults, divided into 3 groups (20 each). Smoked form, Smokeless form and Healthy control, Subjects should be consumer of the tobacco for more than 10 years. Saliva of each subject was collected under resting condition, the SFR and pH was determined. Salivary flow rate was assessed in 3 groups and there was no significant relation. Lower salivary pH was observed in smoked and smokeless form.

Prathibha KM (2013)[41] conducted a study to assess the salivary parameters in diabetic and non-diabetic subjects. They compared the salivary flow rates and the salivary physical and biochemical parameters such as salivary pH, flow rate, organic and inorganic constituents in diabetic and non-diabetic subjects. The results regarding the salivary pH, flow rate and salivary amylase were significantly lower in diabetics. Whereas salivary glucose, and total proteins, sodium, and potassium were significantly higher in diabetics and lower levels of calcium in comparison to those in the non-diabetic group. They concluded that evaluation of salivary parameters can be used as a non- invasive alternative to serum parameters for screening, diagnosis and monitoring of diabetes mellitus.

Smith et al (2013)[42] described that saliva production was identified for age, in that the young and older participants and the middle-aged and older participants differed significantly from each other, but no difference was found between the young and middle-aged participants.

Dhivyalakshmi et al (2014)[43] explained the significance of Lactate dehydrogenase, Alkaline phosphatase in salivary samples of oral leukoplakia, oral squamous cell carcinoma cases and control groups and to ensure the estimation of these markers in leukoplakia is valuable in diagnosing the malignant risk potential. Statistical analysis proved that Lactate dehydrogenase could be more reliable marker in detection of oral carcinoma in comparison with Alkaline phosphatase.

Braimoh Omoigberai Bashiru (2015)[44] conducted a study to determine the prevalence of cigarette smoking and awareness of oral health problems of tobacco use among university students in Nigeria. Totally 360 young adults. Participants answered questions regarding demography, smoking behaviour, attitude and on oral effect of smoking. Though majority of the students were aware of the negative impact of smoking on general health, most of them were ignorant of the effect on oral health.

Sabarni Chakrabarty et al (2015)[45] conducted a study to determine the effects of long term use of tobacco on SFR, salivary pH, the oral and dental health among tobacco chewers, smokers, and control group. Resting whole mouth saliva was collected from every patient; SFR was calculated and then salivary pH was assessed using the salivary pH strips. There was a significant result obtained on comparison between these three groups.

Singh M et al (2015)[46] conducted a study which was divided into 35 smokers and 35 non-smokers. The saliva was collected under resting conditions. Salivary pH and Salivary flow rate was measured. Which results that there was a significant difference found in long term smokers.

Pandey et al (2015)[47] study was conducted to evaluate salivary flow rate, pH, buffering capacity, calcium, total protein content and total antioxidant capacity in relation to dental caries, age and gender. Stated that total protein and total antioxidants in saliva were increased with caries activity. Calcium content of saliva was found to be more in caries-free group and increased with age.

Rajesh et al (2015)[48] conducted to estimate and compare inorganic salivary calcium, phosphate, magnesium, salivary flow rate, pH of unstimulated saliva and oral hygiene status of healthy subjects. Which was divided into 3 groups: healthy, periodontitis, and dental caries. Oral hygiene index, probing pocket depth, clinical attachment level, the number of intact teeth, and active carious lesions were recorded. Estimation of salivary calcium, phosphate, and magnesium was performed. Spectrophotometrically using Vitros 5.1 FS. From his study it was stated Subjects with increased inorganic salivary calcium, phosphate, pH, flow rate, and poor oral hygiene are at a higher risk of developing periodontitis. Results were statistically significant.

Onur Ozturk et al (2016)[49] described Cigarette smoke renders oral mucosa epithelium to be susceptible for colonization of pathogens. These pathogens can cause systemic diseases such as diabetes and obesity. Also smoking is carcinogenic agents that can lead to cancers.

Archana PS (2016)[50] evaluated serum glucose, serum calcium, serum potassium, serum sodium, along with salivary pH, salivary flow rate, salivary glucose in type 2 diabetic and control group. concluded that there was decrease in salivary electrolyte and salivary calcium in uncontrolled diabetes when compared to controlled diabetes and control group. There was no significant difference between salivary pH and flow rate among the groups similarly no significant difference in serum sodium and potassium among the groups.

Materials and Methods

MATERIALS AND METHODS

STUDY TYPE: Observational study

STUDY DESIGN: Cross-sectional study

STUDY DURATION: January 2017 –September 2018

SOURCE OF DATA COLLECTION

The size of sample study consist of 120 patients and were divided equally in two groups such as smokers and non-smokers Subjects were only male, who were 25-80 years of smoking and normal healthy patients were attending as outpatients in K.S.R dental college, Tamil Nadu, India, between January 2017 to September 2018

METHODOLOGY

The selection of the subjects would be based on their past deleterious habit and medical history. All the subjects were clinically examined to assess the oral hygiene and to exclude the possibility of any other oral disease or systemic disease with oral manifestation. Subjects of both the study and control groups were informed about the procedure and a written consent was obtained.

INCLUSION CRITERIA:

- The subjects comprised individuals who had smoked cigarettes daily for more than 3 years.

- The subjects who smoked 10–15 cigarettes daily or 1–2bundles of bidi per day were considered in smokers group and those who do not smoke tobacco were considered in non-smokers group.

- This study will be done in three groups, one is between 25 – 40 years next one is 40-60 years and other group is above 60 years.

EXCLUSION CRITERIA

- Patients who had the history of any other a systemic disease were excluded
- Patients who were under medications for a systemic disease were excluded.
- Patients who had the history of alcohol consumption or those who consumed smokeless tobacco in any form were excluded.
- Patients who had undergone surgery of the salivary glands were excluded.
- Patients who had been exposed to radiation of the head and neck region were excluded.
- Patients who refused to participate were excluded.

SALIVA COLLECTION BY TWO METHODS

UNSTIMULATED METHOD

Saliva collection was done between 9:00 am and 12:00 noon to avoid diurnal variation. To avoid this effect, it is advised to collect all saliva sample at the same, fixed time of the day. The patients were advised not to eat, drink, smoke or to chew 1 hour before and during the entire procedure. Unstimulated whole salivary samples were collected by spitting method. Subjects were comfortably seated in the dental chair and a few minutes of relaxation for the procedure of collecting saliva in a graduated test tube through a glass funnel every 1 min for 5 min.(figure 1,2,4,6) During saliva collection, subjects were instructed not to speak or swallow. After the collection, the SFR was measured and expressed in ml / min.

STIMULATED METHOD

After unstimulated saliva collection, stimulated saliva was collected by placing few drops of 2% of citric acid on the patients tip of the tongue at regular intervals ranging from 15 to 60 sec. After 60 secs patient was asked to spit into another sterile container. During saliva collection subjects were instructed not to speak or swallow. SFR was measured.(figure 5,8,9)

ANALYSIS OF SALIVARY FLOW RATE

Flow rate (ml/min) of saliva will be determined by allowing the saliva to flow into a graduated fiber container, in which graduated marks starts from 1ml to 20 ml. Graduated container is cylindrical in shape. The container was labelled as stimulated and unstimulated saliva. Collected saliva was measured approximately by seeing the graduated container and expressed in mL/min for 10 min.

ANALYSIS OF SALIVARY pH BY pH METER:

The pH values for all salivary characteristics were assessed with the help of ECO TESTER pH meter (OAKTON PH1 TESTER). The pH meter was standardized using a standard protocol, using pH calibration solutions ranging from pH 4, 7 and 10. Following the manufacturer guidelines the head of the pH bulb was immersed in the calibration solution (pH 4, 7, 10), until the pH of the solution was determined correctly in all the three ranges. The pH meter is dipped into the container containing saliva and placed for 10 seconds, then the reading was noted for both stimulated and unstimulated saliva. Tip of the PH meter should rest on the bottom of the container and should be immersed completely in saliva. Readings are comparatively reliable. (figure 3,5, 10,11)

ARMAMENTARIUM:

SAMPLE COLLECTION

Disposable sterile graduated container
Disposable gloves and mouth masks
2% of Citric acid solutions
Disposable sterile Filler
pH meter
Stop watch

Figure 1: **Armamentarium for collecting saliva**

Figure 2: Sterile container for saliva collection

Figure 3 : pH meter used for SFR and salivary pH analysis

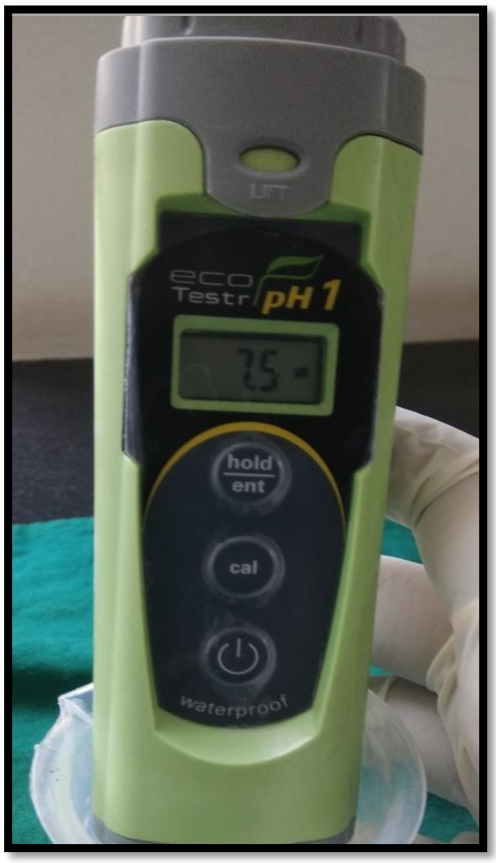


Figure 4: Stop watch

Figure 5: Disposable sterile filler

Figure 6: Unstimulated saliva sample collection by spitting method

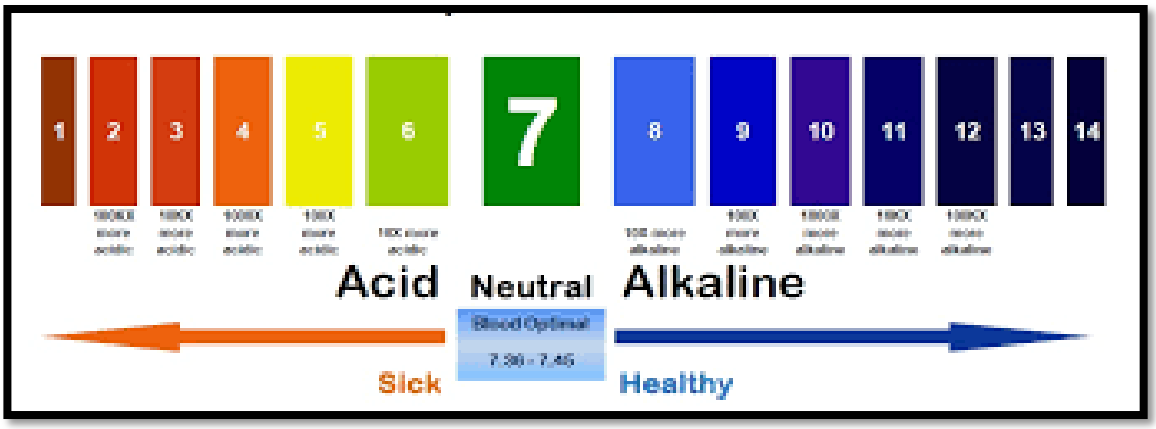
Figure 7: Citric acid solution in a filler

Figure 8: 2% citric acid solution placed on the tip of the tongue for stimulation

Figure 9: Stimulated saliva sample collection by spitting method

Figure 10: The tip of the pH bulb was immersed in the calibrated cup containing salivary solution

Figure 11: PH chart



Statistical Analysis

STATISTICAL ANALYSIS

The data obtained from the study was entered in Microsoft Excel and statistical analysis was done. The data was analysed using Statistical Package for Social Sciences (SPSS) software version 16.0 (Windows version 17.0 SPSS Inc.,Chicago,IL,USA).The level of significance (α) was fixed at 5% ($p \leq 0.05$). Statistical analysis was done using the t-test and ANOVA.

t TEST:

Statistical analysis was done using *t*-test. A *t*-test is most commonly applied when the test statistics would follow a normal distribution if the value of a scaling term in the test statistic were known.

ANALYSIS OF VARIANCE (ANOVA) :

ANOVA provides a statistical test of whether the population means of several groups are equal, and therefore generalizes the *t*-test to more than two groups. ANOVA is useful for comparing (testing) three or more group means for statistical significance.

Results

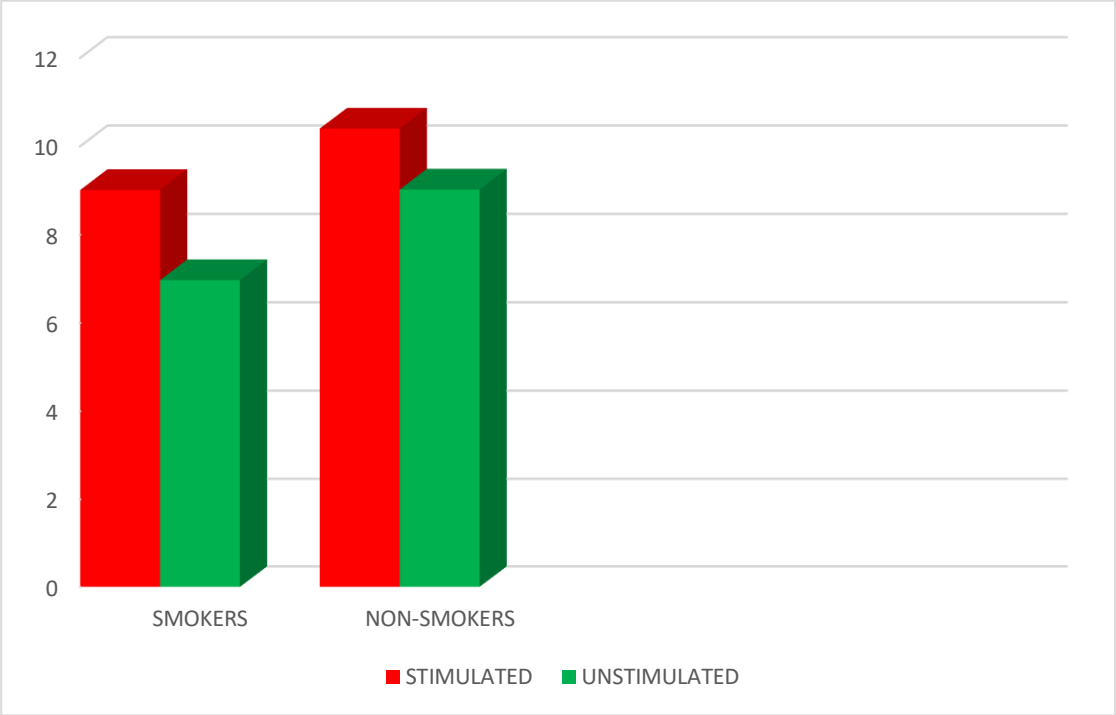
RESULTS

Table 1: Comparing the mean score of stimulated and unstimulated salivary flow rate between smokers and non-smokers group

GROUP	NUMBER	SFR STIMULATED Mean± SD	SFR UNSTIMULATED Mean± SD	P-VALUE
SMOKERS (group I)	60	9.01±1.56	6.97±1.35	P=0.00
NON-SMOKERS (group II)	60	10.4 ±1.06	9.02±1.06	P=0.00

A group of 120 samples were collected in our study, which are divided equally 60 samples, considered as group I who are smokers and group II who are non- smokers. By using t'test, mean value for these two groups were calculated. The mean value of SFR of stimulated saliva in group I is 9.01, whereas in group II is 10.4. And the mean value of SFR of unstimulated saliva in group I is 6.97 and the later group is 9.2.

Graph 1: Comparing the mean score of stimulated and unstimulated salivary flow rate between smokers and non-smokers group



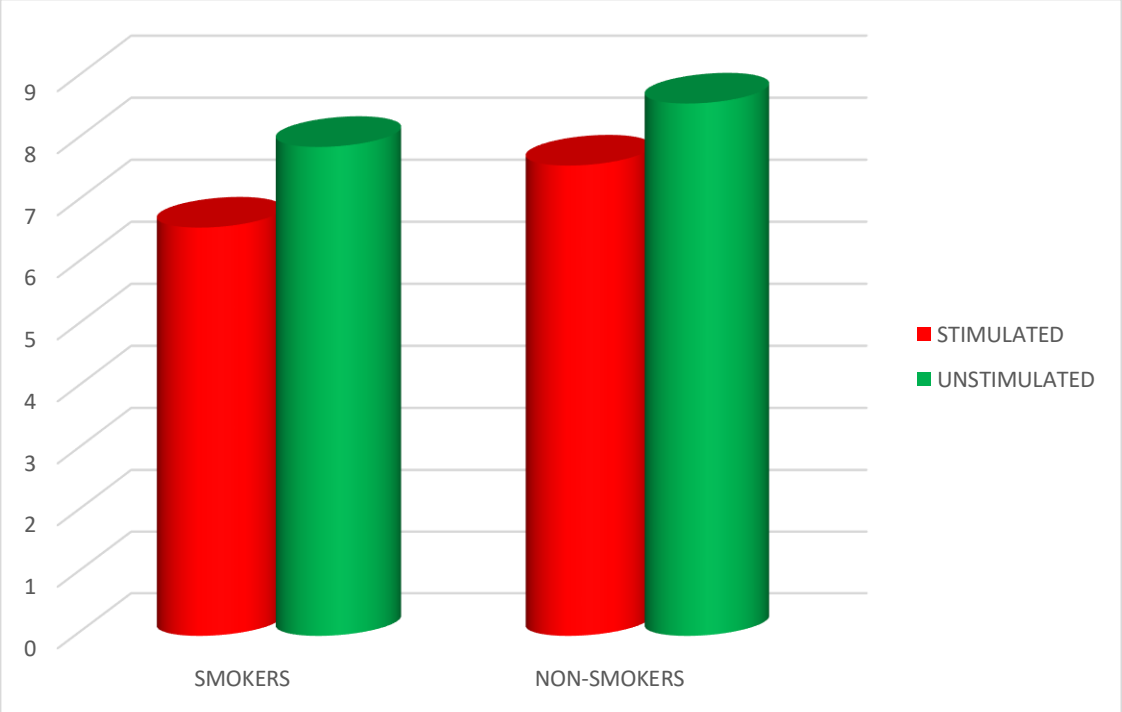
The bar diagram shows clearly that the SFR of stimulated saliva in group II is higher than that of the group I and similar results were also being obtained using unstimulated saliva. The P- values are statistically significant.

Table 2: Comparing the mean score of stimulated and unstimulated salivary pH between smokers and non- smokers group

GROUP	NUMBER	pH METER STIMULATED Mean± SD	pH METER UNSTIMULATED Mean± SD	P-VALUE
SMOKERS (group I)	60	6.6 ± 0.68	7.9 ± 0.75	P=0.00
NON-SMOKERS (Group II)	60	7.6 ± 0.62	8.6 ± 0.61	P=0.00

When pH meter is used to calculate the mean value, stimulated salivary pH in group I is 6.6 and stimulated salivary pH in group II is 7.6. And In case of unstimulated salivary pH in group I, it is 7.9 and unstimulated salivary PH in group II, it is 8.6.

Graph 2: Comparing the mean score of stimulated and unstimulated salivary pH between smokers and non- smokers group



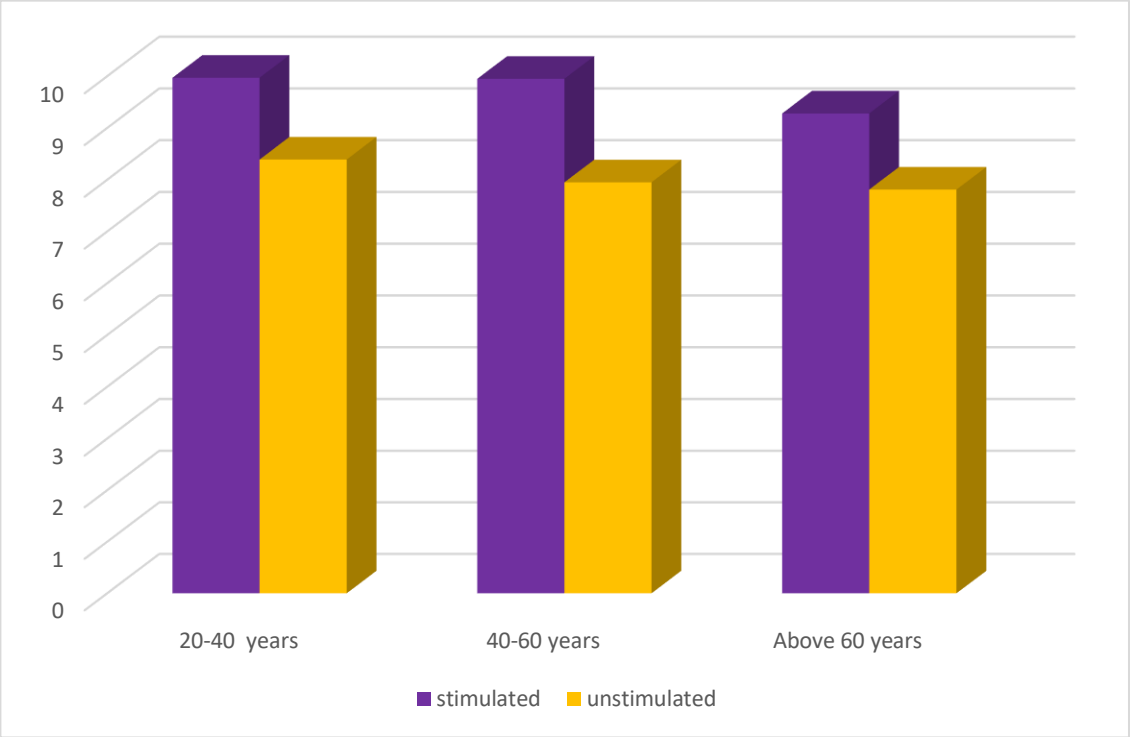
The bar diagram shows the difference clearly, that is unstimulated salivary pH in group II is comparatively higher than in group I. Comparatively similar values were found in stimulated saliva of group I and group II. Here the P-Value is statistically significant.

Table 3: Tabulating the mean scores of salivary flow rate with regard to age

	AGE	NUMBER	MEAN	STD. DEVIATION	P- VALUE
SALIVARY FLOW RATE (Stimulated)	20-40 Years	26	9.97	1.25	0.017
	40-60 years	46	9.95	1.11	
	Above 60 Years	48	9.28	1.38	
SALIVARY FLOW RATE (Unstimulated)	20-40 years	26	8.39	1.50	0.325
	40-60 years	46	7.95	1.81	
	Above 60 Years	48	7.81	1.39	

The participants were divided into 3 groups according to their ages viz. 20-40, 40-60 and above 60 years. Among them 26 were under group I, 46 were in group II, 48 were in group III. Mean value of SFR of stimulated saliva are 9.97, 9.95 and 9.28 respectively. And the mean value of SFR of unstimulated saliva are 8.39, 7.95 and 7.81 respectively.

Graph 3: Tabulating the mean scores of salivary flow rate with regard to age



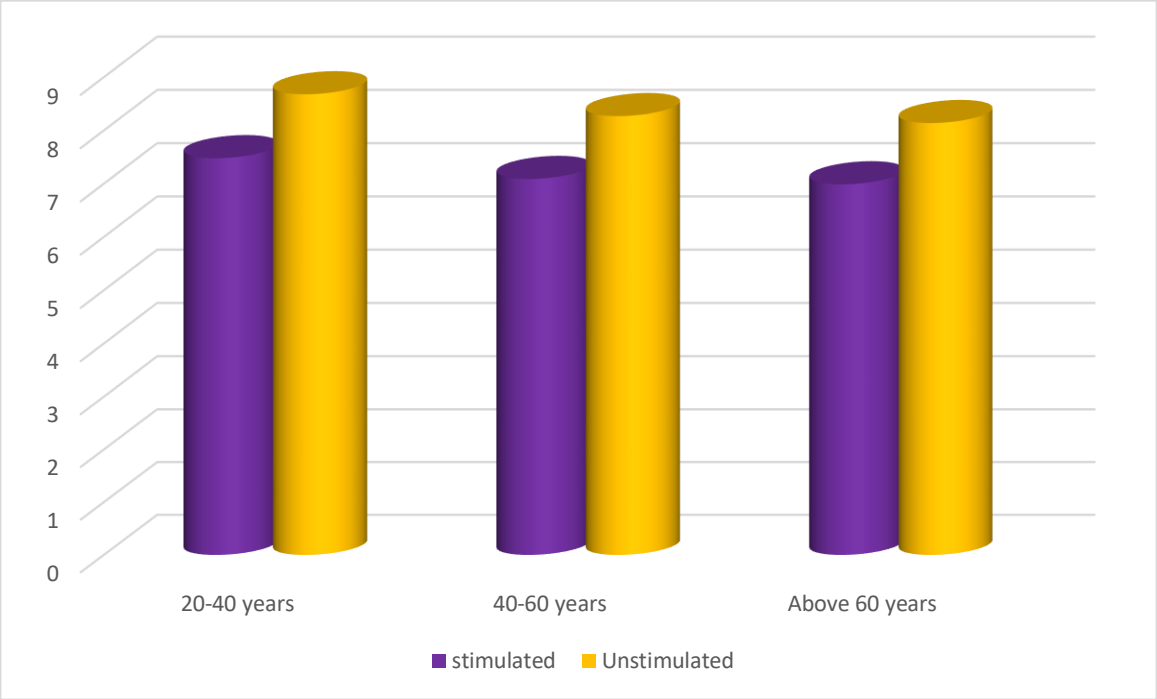
Bar diagram shows persons of stimulated and unstimulated saliva were classified according to ages. In group I and group II difference in mean values of stimulated saliva can't be appreciable. But in group III mean values of stimulated saliva is less. On comparison of mean values of unstimulated saliva persons in group I have higher mean value but in group II and group III it seems more or less similar values.

Table 4: Tabulating the mean scores of salivary pH with regard to age

	AGE	NUMBER	MEAN	STD. DEVIATION	P- VALUE
PH METER (Stimulated)	20-40 Years	26	7.48	0.74	0.053
	40-60 years	46	7.09	0.88	
	Above 60 Years	48	6.99	0.80	
PH METER (Unstimulated)	20-40 years	26	8.68	0.70	0.016
	40-60 years	46	8.27	0.75	
	Above 60 Years	48	8.14	0.79	

Table shows that the mean value of stimulated salivary pH is 7.48 in group I, 7.09 in group II, and 6.99 in group III, whereas the mean value of unstimulated salivary pH is 8.68 in group I, 8.27 in group II, 8.14 in group III. P- value is statistically significant in stimulated SFR.

Graph 4: Tabulating the mean scores of salivary pH with regard to age



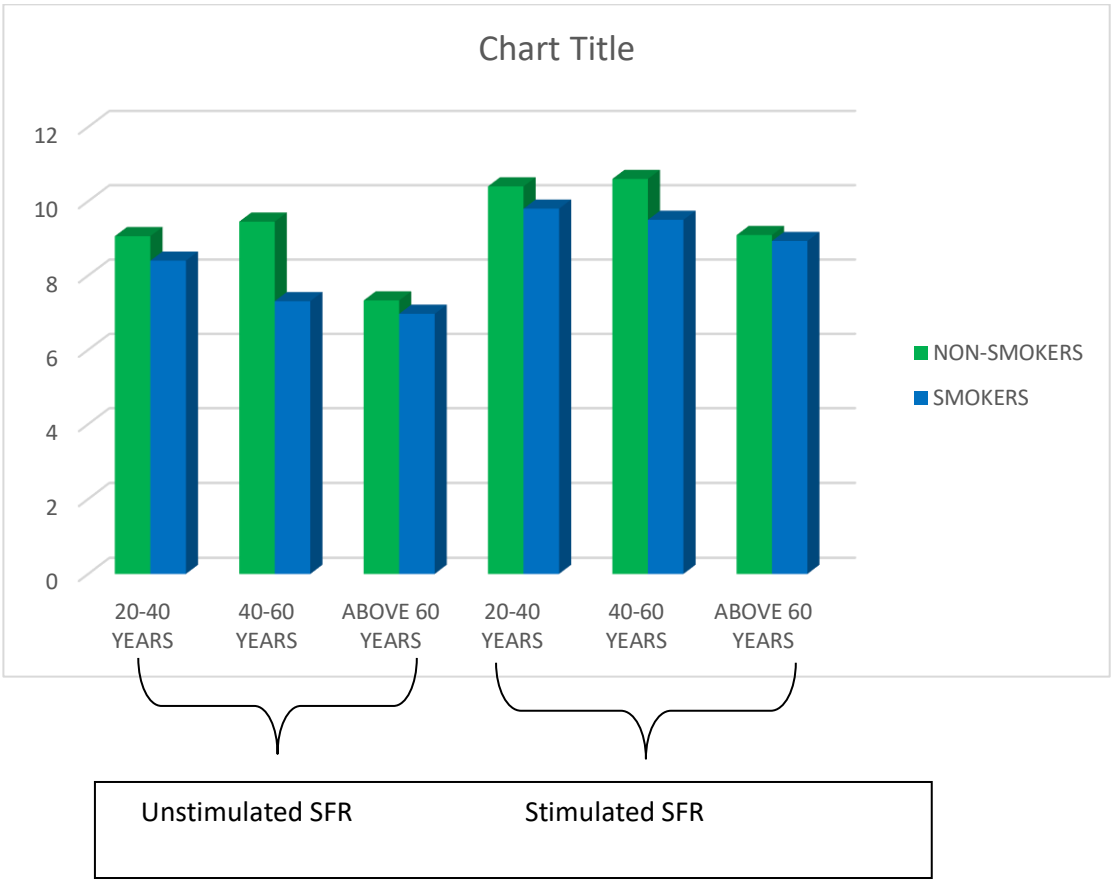
Bar diagram shows, in both simulated and unstimulated salivary pH values are gradually decreasing according to their increase in age.

Table 5: Indexing the mean score of SFR of smokers and non-smokers corresponding to age

GROUP	AGE	SFR STIMULATED MEAN± SD	SFR UNSTIMULATED MEAN± SD	P-VALUE
SMOKERS	20-40 years	10.4±1.15	9.06±1.23	0.18
	40-60 years	10.6±0.9	9.4±0.8	0.01
	Above 60 years	9.09 ± 1.4	7.33±1.2	0.00
NON-SMOKERS	20-40 years	9.8±1.13	8.40±1.17	0.45
	40-60 years	9.5±0.8	7.31±1.5	0.00
	Above 60 years	8.93±0.9	6.97±1.3	0.04

Table 5 shows stimulated and unstimulated SFR value of smokers and non-smokers classified according to age. It shows significant p-value for the patients who are under 40-60 and above 60 years. 20-40 years showed no significant difference in both group (smokers and non-smokers)

Graph 5: Indexing the mean score of SFR of smokers and non-smokers corresponding to age



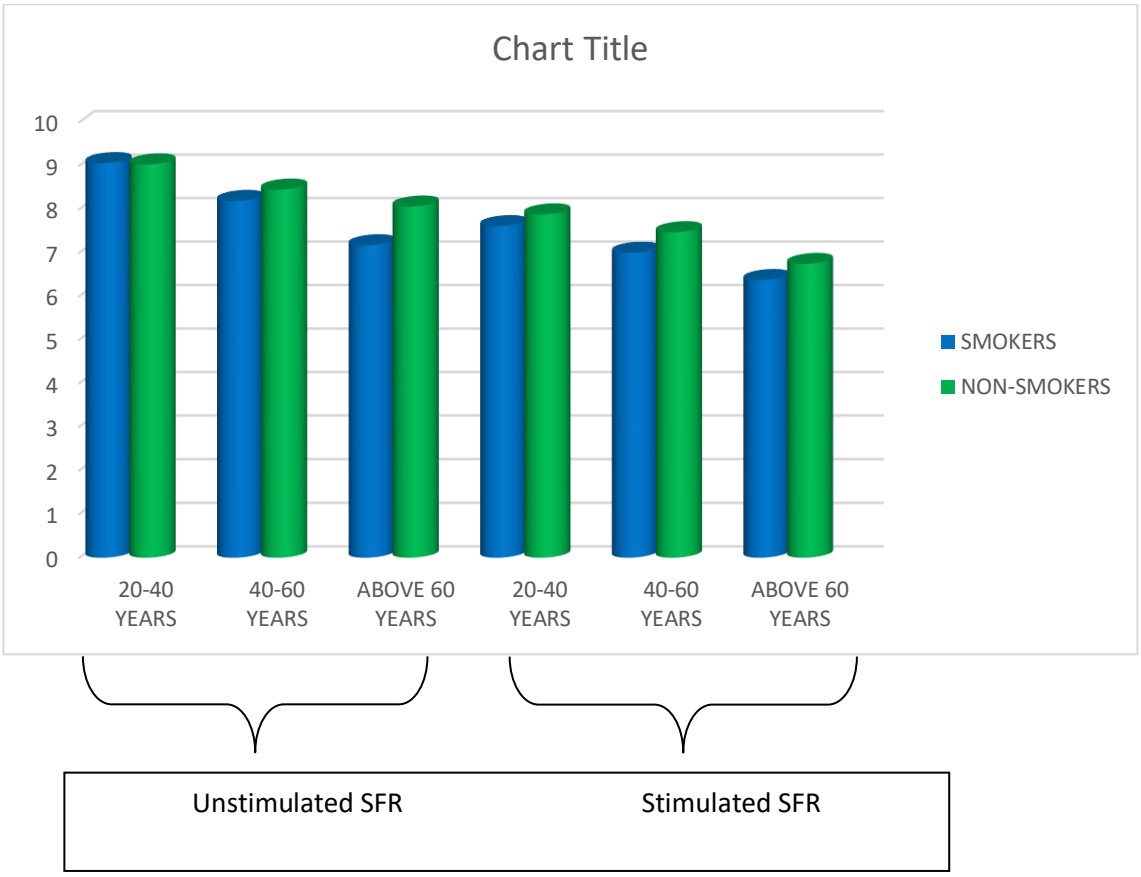
Bar diagram shows stimulated and unstimulated SFR value of smokers and non-smokers classified according to age. It shows significant p-value for the patients who are under 40-60 and above 60 years.

Table 6: Indexing the mean score of salivary PH of smokers and non-smokers corresponding to age

GROUP	AGE	STIMULATED PH MEAN± SD	UNSTIMULATED PH MEAN± SD	P-VALUE
SMOKERS	20-40 years	7.61±0.6	9.06±0.5	0.88
	40-60 years	7.00±0.4	8.19±0.35	0.04
	Above 60 years	6.37±0.6	7.17±0.8	0.05
NON-SMOKERS	20-40 years	7.88±0.6	9.03±0.7	0.23
	40-60 years	7.47±0.7	8.45±0.5	0.00
	Above 60 years	6.74±0.5	8.06±0.5	0.01

Table 6 shows pH values of smokers and non-smokers classified according to age. It shows significant p-value for the patients who are under 40-60 and above 60 years. 20-40 years showed no significant difference in both group (smokers and non-smokers)

Graph 6: Indexing the mean score of Salivary pH of smokers and non-smokers corresponding to age



Bar diagram shows pH values of smokers and non-smokers classified according to age. It shows significant p-value for the patients who are under 40-60 and above 60 years.

Table 7: Showing the p-value for SFR and salivary pH between chronic smokers and non- smokers

GROUP	VARIENCE	METHODS	P-VALUE
SMOKERS	STIMULATED	SFR	< 0.001
	UNSTIMULATED		
NON-SMOKERS	STIMULATED	PH	
	UNSTIMULATED		

Table 8: Showing the p-value evaluation in different age group

AGE	SALIVARY SECRETION	METHODS	P- VALUE
20-40 Years	STIMULATED	SFR	0.017
40-60 years		PH	0.053
	UNSTIMULATED	SFR	0.325
Above 60 Years		PH	0.016

Table 9: Showing the p-value evaluation smokers and non-smokers in different age group

GROUP	AGE	P-VALUE
SMOKERS	20-40 years	>0.05
	40-60 years	<0.05
	Above 60 years	<0.05
NON-SMOKERS	20-40 years	>0.05
	40-60 years	<0.05
	Above 60 years	<0.05

Discussion

DISCUSSION

Saliva is recently being used for the diagnosis of a wide range of disease, as it has been proven to be an easily available, reliable and a non-invasive method which is easy to collect without causing much discomfort to the patients, now-a-days there is increasing inclination towards using saliva samples[34], for the diagnosis of oral and systemic diseases and the salivary secretion is a complex process, its flow and composition vary greatly under different conditions[51,52].

Saliva is necessary for the growth and maturation of taste buds, protection and lubrication of the oral mucosa, maintenance of integrity of enamel by tooth remineralization, stimulation, dilution, cleaning, pH balance, and phonation[53]. Various drugs such as antihypertensives, anticholinergics, diuretics, psychoactive substances, antihistaminics, and conditions such as nutritional, metabolic, neurological abnormalities, and post-surgery alter the salivary constituents, thereby altering the salivary parameters like salivary flow rate (SFR)[52]. Early diagnosis and intervention are required in various oral, pharyngeal, and esophageal disorders; neoplastic, metabolic, nutritional, inflammatory, genetic, autoimmune conditions and disorders of the nervous system which can affect the salivary gland function[54,55].

The salivary flow measurement is frequently used in the evaluation of oral and systemic diseases (1),The main objective of this procedure is to investigate the presence of hyposalivation (Xerostomia) is usually the clinical expression of decreased salivary secretion which can be caused by various etiologic factors such as:

head and neck radiotherapy (2), intake of medications (3), schizophrenia (4), Sjögren's syndrome (5) and diabetes mellitus[56]. Besides the reduction in salivary flow causing dry mouth, burning mouth and taste disturbance (8), the quality of saliva shows a shift towards a more acidogenic microflora[57,58]. And the unstimulated flow of whole saliva is depends on the sizes of the parotid and submandibular glands, i.e. larger the size of the gland, faster will be the salivary flow[59]. Unstimulated whole saliva is a mixture of secretions that enters the mouth without any exogenous stimuli[60]. Unstimulated whole SFRs were found to be about 0.3–0.5 ml/min in healthy individuals, whereas stimulated SFR can be as high as 10 ml/min. Usually, the SFRs are 0.3 ml/min when unstimulated, but rise to 1.5–2.0 ml/min when stimulated, and the flow rate is negligible during night time[61,62].

Measurement of salivary secretion can be calculated by different methods such as (i) Resting or unstimulated whole saliva secretion (ii) Stimulated whole saliva secretion and (iii) Glandular saliva collection (mainly from parotid glands) with or without stimulation. In which the unstimulated salivary secretion is an accurate method to analyse salivary gland status, whereas stimulated saliva is useful method for the study of the functional reserve. In case of unstimulated whole saliva, reflects basal salivary flow rate which is present in our mouth for about 14 hours a day and that provides protection to oral tissues and the secretions are due to fluctuation in intensity and frequency of internal stimulation[63].

The stimulated saliva represents the secretion during food intake i.e. physiologic stimulation, and is present in our mouth for up to 2 hours in a day for which the secretion of saliva from the salivary glands is generally elicited only in response to stimulation of the autonomic innervations to the gland. Artificially, stimulation of saliva is done by giving drugs (pilocarpine, cevimeline) and different chemical compounds (nicotine, chewing paraffin wax and citric acid), which activate lingual sensory neurons.

It is suggested that oral mucosal wetness and minor salivary gland secretion could be influenced by various factors differently according to mucosal sites. The most common site to stimulate saliva is lingual apex, application of nicotine and citric acid was associated with a rise in salivary secretion rate but the salivation response to citric acid was abrupt and more pronounced as compared to nicotine proving that citric acid is more potent and quicker in its action[64].

The pH in the saliva plays an important role in the life, growth and multiplication of oral bacteria[24]. The number of acidophilic bacteria is increased when the pH of saliva is low, whereas the number of the acid sensitive bacteria is decreased. The increased number of acidophilic bacteria in the dental plaque and indicate a high risk of caries[65,66]. Therefore, altered salivary pH have an important role in the causation of various oral changes and conditions[67].

A number of studies shows that while cigarette smoking would typically cause a noticeable short term increases in SFR because it increases the activity of salivary glands in anyone who begins smoking, but in long term use it is observed that some individuals develop tolerance to the salivary effect of smoking so it reduces SFR.

Further there are clinical and epidemiological evidences stated by[40] **Borhan Mojabi et al 2007**, regarding the adverse effects of cigarette smoking and other forms of tobacco are numerous, the usage of tobacco has been associated with staining of the teeth, gingival disease, oral mucosal changes to serious diseases such as oral cancer and in addition to the salivary microbes count are affected by smoking, moreover smoking is strongly associated with higher presence of Candida species[68,69] which leads to oral candidiasis that can manifest itself as erythema, white plaque, thrush, median rhomboid glossitis, and angular cheilitis[70].

The main ingredient of tobacco is nicotine, which acts on certain cholinergic receptors in the brain and other organs causing neural activation leading to altered salivary secretion[8]. It is now well established that the epidemiologic evidence of cigarette smoking is the major preventable risk factor in the incidence progression of periodontal disease[71]. It is suggested that periodontitis is associated with an increased risk for systemic diseases like cardiovascular diseases, cerebrovascular ischemia and atherosclerosis stated in **Ebru Olgun et al study (2006)**[72]. Smoking condition of the patients was calculated as: number of cigarettes per day/number of years smoked. In this study patients who have been smoking for a period of

15-30 years were included. The mean age of chronic smokers and non-smokers are 9.01 ± 1.56 and 10.4 ± 1.06, respectively[72].

Obviously age-related reductions in salivary gland secretion would be significant concern to the middle-aged and geriatrician, hence majority of the hyposalivation conditions are iatrogenic, notably pharmaceuticals or radiation induced xerostomia[73]. Nevertheless, to say in older patients xerostomia may develop in the absence of any disease[17], which may be explained by an ageing-related decrease in salivary secretion, It has been suggested that ageing leads to a decrease in salivary flow rate as a consequence of parenchymal atrophy[75].

This study both stimulated and unstimulated saliva between chronic smokers and non-smokers and there was a difference in the secretion rate of saliva between smokers and non-smokers, however the effect of immediate smoking did not cause any significant change in salivary flow rate. Generally, it was accepted that long term use of tobacco decreased salivary reflex and hence reduced the salivary flow rates and variation in pH (which is in of more acidic). Therefore, the present study was conducted to find if there is any change in long term effect of smoking.

However, studies have shown that long term consumption of tobacco in any form, especially smoke form, is one of the risk factor for reducing saliva. As per in this study it is noted that the mean value of SFR of stimulated saliva in group I is 9.01, whereas in group II is 10.4. And the mean value of SFR of unstimulated saliva in

group I is 6.97 and the later group is 9.2. When compared with smokers and non-smokers, the mean value of resting SFR is high in non- smoker than that of smoker and it is same in case of stimulated SFR and the result is statistically significant. These findings were also consistence with the finding of **Rad et al (2010) and Khan, et al(2008,2010)**[34,35](Table 1, Graph 1).

This study revealed that the mean salivary pH was 6.6 ± 0.68 in smokers and 7.6 ± 0.62 in non-smokers and the difference was statistically significant (P = 0.00) (Table 2, Graph 2). Which is in accordance to the study of **Fenoll Palomares et al (2004)**[24] in which the mean salivary pH was lower in smokers that is, 6.7 ± 0.27 as compared to non-smokers that is, 6.8 ± 0.29. Similarly, Rooban et al (2006)[76] also observed a lower salivary pH in smokers that is, 6.48 ± 0.36 in comparison to 6.59 ± 0.56 in non-smokers.

Earlier studies show there was diminished salivary secretion rate with age, which was consistent with this study, the participants were divided into 3 groups according to their ages viz. 20-40, 40-60 and above 60 years. Among them 26 were under group I, 46 were in group II, 48 were in group III. Mean value of SFR of stimulated saliva are 9.97, 9.95 and 9.28 respectively whereas the mean value of SFR of unstimulated saliva are 8.39, 7.95 and 7.81 respectively (Figure 3, Graph 3). From the above values, the SFR and salivary pH in both simulated and unstimulated saliva are gradually decreasing according to increase in age and the significant results were obtained (Table 4, Graph 4).

Based on the classification of age, in the age group of 20-40 years, the mean value of stimulated and unstimulated SFR among smokers were 10.4, 9.06 respectively but in case of 40-60 years the mean values were noted as 10.6, 9.4 and considering the age group of above 60 years it was 9.09, 7.33 respectively. From this study it was clearly identified that the p-values of two groups (40-60years, above 60 years) were having statistically significant results. In case of non-smoker group the mean values were found as 9.8, 8.40 in 20-40 years group and the other groups (40-60yeras, above 60 years) were having 9.5, 7.31 and 8.93, 6.97 respectively and regarding the P-values the later two groups were having statistically significant results (Table 5, graph 5).

The PH values of smokers and non-smokers classified according to age, the mean value of stimulated and unstimulated PH among smokers were 7.61, 9.06 respectively but in case of 40-60 years mean values were noted as 7.0, 8.19 and considering the age group of above 60 years it was 6.37, 7.17 respectively. From this study it was clearly identified that the p-value (<0.05) for two groups (40-60 and above 60 years) were having statistically significant. In case of non-smoker groups the mean values were found as 7.88, 9.03 in 20-40 years group and the other groups (40-60yeras, above 60 years) were having 9.47, 8.45 and 6.74, 8.06 respectively and regarding the P-values the later two groups were having statistically significant results (Table 6, Graph 6). **R.M. Nagler et al (2005)** showed comparison between younger and elder group revealed that they were decreased salivary secretion in elderly patients and the significant results were found[77].

Summary and Conclusion

SUMMARY

We started our study with an aim to evaluate the salivary flow rate (SFR) and salivary pH among smokers, and non-smokers. The patients were selected for the study from the Oral Medicine and Radiology department and 120 patients were included in the study according to the inclusion and exclusion criteria only after obtaining their informed consent. The saliva was collected using spitting method and the patients were advised not to eat, drink, or rinse their mouth or smoke or to chew 1 hour before and during the entire procedure. Unstimulated saliva was collected by asking the patients to spit in a cup and the SFR was measured. At the same time the stimulated saliva was collected by placing few drops of 2% of citric acid on the patients tongue at regular intervals ranging from 15 to 60 sec. After 60 secs patient was asked to spit in a cup and SFR was measured and followed by Salivary pH was also measured, using the pH meter. The results were analysed by using t'test, ANOVA and it was found that the mean value of SFR and salivary pH in smoker group has lower value than that of non-smoker group in both stimulated and unstimulated saliva and the results were statistically significant.

CONCLUSION

The role of salivary flow rate and salivary pH is to maintain oral and dental health. Based on the results of this study we concluded that the long term smoking significantly reduces the SFR and salivary pH. These alterations in long term smoker can render oral mucosa vulnerable to various oral and dental diseases such as dry mouth, cervical caries, gingivitis, tooth mobility, calculus and halitosis. Due to low pH, there is risk for demineralization and cavities in teeth. Considering the importance and numerous roles of saliva in the oral cavity, the patients should be educated about ill effects of smoking on the oral cavity and importance in maintenance of proper oral hygiene by the use of proper brushing techniques and regular dental check-ups to monitor and prevent the development of dental and oral mucosal lesions.

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Annexures

ANNEXURE-I

INFORMED CONSENT FORM

KSR INSTITUTE OF DENTAL SCIENCE & RESEARCH

EVALUATION OF THE SALIVARY FLOW RATE AND SALIVAR PH AMONG CHRONIC SMOKERS: A CROSS SECTIONAL STUDY

I ……. hereby declare that I clearly understood the procedures of the study. Also, I declare that I give permission for the above mentioned individual/organization/hospital to do the procedure to the individual/organization listed above.

Signature ……. Date……..

I have explained the above and answered all questions asked by the participant.

Signature…….. Date……..

ANNEXURE-II

ஒப்புகை வாக்குமூலம்

..... ஆகிய நான் மேற்கூறிய ஆராய்ச்சி படிப்பின் வழிமுறைகளைத் தெளிவாகப் புரிந்து கொண்டேன். மேலும் நான் இந்த ஆராய்ச்சிப் படிப்புக்கான வழிமுறைகளை மேற்கொள்வதற்கும். அதன் பரிசோதனை முடிவுகளை தெரிந்து கொள்ளவும் முழுமையாக அனுமதிக்கிறேன்.

.....

நோயாளியின் கையொப்பம் தேதி.....

நான் மேற்கூறிய ஆராய்ச்சிப் படிப்பிற்கான விதிமுறைகள் மற்றும் அது குறித்த நோயாளியின் சந்தேகங்களையும் தெளிவாக விளக்கியுள்ளேன்.

.....

மருத்துவரின் கையொப்பம் தேதி.....

ANEXURE III

A.THE VALUE OF STIMULATED AND UNSTIMULATED SALIVARY FLOW RATE AND SALIVARY PH IN SMOKERS GROUP

S.NO	UNSTIMULATED SFR	STIMULATED SFR	UNSTIMULATED PH	STIMULATED PH
1	8ml/min	8ml/min	8.5	7.2
2	10ml/min	9ml/min	9.4	8.4
3	10ml/min	11ml/min	8.8	7.3
4	8ml/min	12ml/min	9.3	8.1
5	9ml/min	9ml/min	9.4	8.4
6	8ml/min	10ml/min	9.7	8.8
7	8ml/min	10ml/min	9.4	8.5
8	9ml/min	9ml/min	8.3	7.3
9	8ml/min	10ml/min	8.2	7.1
10	10ml/min	10ml/min	8.8	7.7
11	11ml/min	11ml/min	9.9	7.6
12	8ml/min	12ml/min	9.1	8.9
13	9ml/min	9ml/min	8.2	8.5
14	7ml/min	10ml/min	8.8	7.5
15	10ml/min	8ml/min	9.5	7.4
16	11ml/min	11ml/min	8.8	7.5
17	8ml/min	12ml/min	9.7	7.8
18	8ml/min	10ml/min	9.9	9.1
19	8ml/min	11ml/min	8.3	8.2
20	10ml/min	10ml/min	10.1	8.3
21	10ml/min	11ml/min	9.7	9.4
22	8ml/min	12ml/min	9.3	7.8
23	10ml/min	10ml/min	9.5	7.3
24	8ml/min	11ml/min	7.3	8
25	9ml/min	9ml/min	8.1	7.1
26	10ml/min	10ml/min	9.3	7.6
27	10ml/min	12ml/min	8.7	8.3
28	8ml/min	10ml/min	8.3	7.7
29	8ml/min	9ml/min	7.5	7.9
30	10ml/min	9ml/min	8.3	6.5

B.THE VALUE OF STIMULATED AND UNSTIMULATED SALIVARY FLOW RATE AND SALIVARY PH IN SMOKERS GROUP (*Continue…)*

S.NO	UNSTIMULATED SFR	STIMULATED SFR	UNSTIMULATED PH	STIMULATED PH
31	10ml/min	11ml/min	8.4	7.5
32	9ml/min	12ml/min	8.5	8.1
33	10ml/min	10ml/min	8.8	6.8
34	10ml/min	11ml/min	8.4	7.3
35	10ml/min	12ml/min	8.1	7
36	10ml/min	11ml/min	8.7	7.9
37	10ml/min	10ml/min	8.4	7.3
38	9ml/min	11ml/min	8.7	7.9
39	10ml/min	10ml/min	8.8	8
40	10ml/min	11ml/min	8.8	7.8
41	11ml/min	10ml/min	8.5	7.4
42	9ml/min	12ml/min	8.3	7.7
43	10ml/min	10ml/min	8.2	6.8
44	8ml/min	11ml/min	8.8	7.8
45	10ml/min	10ml/min	8.8	8
46	8ml/min	11ml/min	8.5	7.3
47	8ml/min	9ml/min	8.4	6.9
48	10ml/min	10ml/min	8.1	7.3
49	9ml/min	12ml/min	8	7.2
50	8ml/min	10ml/min	8.3	7.1
51	8ml/min	10ml/min	7.9	6.5
52	8ml/min	9ml/min	8.2	7.7
53	8ml/min	9ml/min	8.8	7.6
54	8ml/min	10ml/min	8.1	7.4
55	10ml/min	11ml/min	8.3	7.9
56	9ml/min	12ml/min	7.9	6.3
57	9ml/min	11ml/min	8.4	7.9
58	9ml/min	10ml/min	8.8	7.4
59	9ml/min	10ml/min	8.9	6.8
60	8ml/min	10ml/min	8.1	7.8
MEAN /SD	**9.02±1.06**	**10.4 ±1.06**	**8.6 ± 0.61**	**7.6 ± 0.62**

C.THE VALUE OF STIMULATED AND UNSTIMULATED SALIVARY FLOW RATE AND SALIVARY PH IN NON-SMOKERS GROUP(*Continue…)*

S.NO	UNSTIMULATED SFR	STIMULATED SFR	UNSTIMULATED PH	STIMULATED PH
1	5ml/min	10ml/min	8.3	6.2
2	5ml/min	10ml/min	9.7	6.1
3	6.5ml/min	8ml/min	7.2	6.1
4	5ml/min	6.5ml/min	7.2	6.2
5	6ml/min	9.5ml/min	8.3	6.2
6	5.5ml/min	8.8ml/min	8.2	6.3
7	8.5ml/min	10ml/min	8.7	6.9
8	5ml/min	8ml/min	7.9	7.3
9	8.8ml/min	10ml/min	8.7	8.3
10	5.8ml/min	9.1ml/min	7.6	6.6
11	6.2ml/min	7.8ml/min	7.6	6.2
12	8ml/min	9.8ml/min	8.1	6.8
13	8ml/min	10ml/min	7.5	6.5
14	8.5ml/min	10ml/min	7.9	6.8
15	9ml/min	11ml/min	8.8	7.3
16	8ml/min	8.5ml/min	9.1	7.7
17	8ml/min	9ml/min	9.3	7.4
18	7ml/min	8.8ml/min	7.8	6.5
19	9ml/min	10ml/min	9.7	7.8
20	5ml/min	8ml/min	7.6	6.1
21	6ml/min	10ml/min	7.5	6.3
22	8ml/min	9ml/min	8	7.3
23	7ml/min	8ml/min	7.3	6.9
24	5ml/min	9ml/min	8.1	6.8
25	7.8ml/min	8ml/min	6.3	6.5
26	8ml/min	9ml/min	9.1	7.8
27	8ml/min	9ml/min	9.7	7.9
28	8ml/min	10ml/min	6.3	5.5
29	7ml/min	9ml/min	8.9	7.3
30	6ml/min	8ml/min	7.5	6.3

D.THE VALUE OF STIMULATED AND UNSTIMULATED SALIVARY FLOW RATE AND SALIVARY PH IN NON-SMOKERS GROUP (Continue..)

S.NO	UNSTIMULATED SFR	STIMULATED SFR	UNSTIMULATED PH	STIMULATED PH
31	5ml/min	10ml/min	8.3	6.2
32	7ml/min	8ml/min	8.2	6.2
33	5ml/min	9ml/min	7.2	5.5
34	5ml/min	9ml/min	8.2	6.2
35	6ml/min	8ml/min	8.1	7.4
36	6ml/min	10ml/min	7.6	6.1
37	8ml/min	9ml/min	7.6	6.6
38	6ml/min	7ml/min	7.6	6.2
39	8ml/min	9ml/min	8.1	6.8
40	8ml/min	10ml/min	7.5	6.5
41	8ml/min	10ml/min	7.9	6.8
42	8ml/min	9ml/min	7.8	6.2
43	7ml/min	8ml/min	7.2	5.8
44	8ml/min	8ml/min	7.2	5.5
45	6ml/min	7ml/min	7.5	6.2
46	7ml/min	8ml/min	6.3	5.7
47	8ml/min	11ml/min	7.6	6.7
48	7ml/min	10ml/min	7.5	6.3
49	8ml/min	10ml/min	8.4	6.8
50	8ml/min	10ml/min	8.1	7.1
51	10ml/min	12ml/min	8.1	7.5
52	9ml/min	10ml/min	6.8	6.2
53	5ml/min	6ml/min	7.2	6.1
54	5ml/min	8ml/min	8.1	6.3
55	8ml/min	8ml/min	8.2	6.8
56	8ml/min	10ml/min	8.1	6.2
57	6ml/min	8ml/min	8.2	7
58	6ml/min	10ml/min	8.1	6.8
59	8ml/min	10ml/min	8.1	6.2
60	6ml/min	8ml/min	7.2	5.1
MEAN/ SD	**6.97±1.35**	**9.01±1.56**	**7.9 ± 0.75**	**6.6 ± 0.68**

ANEXURE IV

INSTITUTIONAL ETHICAL COMMITTEE

KSR INSTITUTE OF DENTAL SCIENCE & RESEARCH

KSR Kalvi Nagar, Tiruchengode-637 215, Tamilnadu.
Phone : 04288-274981, Fax : 04288-274761,
email : ksrdentalcollege@yahoo.com

Chairman
Dr. PHILIP ROBINSON, Ph.D
Prof. & Head Dept. of Biotechnology
KSR College of Technology,
KSR Kalvi Nagar, Tiruchengode.

Member Secretary
Dr. G.S. KUMAR, MDS.,
Principal,
KSR Institute of Dental Science & Research,
KSR Kalvi Nagar, Tiruchengode.

Members

Dr.G.Ayppadasan,Ph.D.,
Biotechnologist

Mr.A.Thirumoorthi,M.A.B.L.,
Human Activist

Dr.R.Renuka,M.D.S.,(Perio),M.Sc.,
Family Counsellor

Dr.M.Rajmohan, MDS, (Oral Path)

Dr.R.Prakash, MDS, (PHD)

Dr.Suman, M.D.S.,(OMDR)

Dr.Sharath Ashokan,MDS.,(Pedo)

Dr.G.Rajeswari,Ph.D.,(Biochemistry)

Dr.K.Karthick,MDS.,(Cons.Dent.)

Mr.V.Mohan,M.Sc.,M.Phil.,(Physicist)

Mr.A.P.S.Raja,B.A.,
(Layperson)

Ref.: 158/KSRIDSR/EC/2016 **Date : 19.12.2016**

To

Dr.J.Sri Jaya Ranjitha,
Postgraduate Student,
Dept. of Oral Medicine & Radiology,
KSR Institute of Dental Science & Research,

*****

Your dissertational study titled "EVALUATION OF THE SALIVARY FLOW RATE AND SALIVARY PH AMONG CHRONIC SMOKERS – A CROSS SECTIONAL STUDY" presented before the ethical committee on 16th Dec. 2016 has been discussed by the committee members and has been approved.

You are requested to adhere to the ICMR guidelines on Biomedical Research and follow good clinical practice. You are requested to inform the progress of work from time to time and submit a final report on the completion of study.

Signature of Member Secretary
(Dr.G.S.Kumar)