Original Article

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SALIVARY GLUCOSE LEVELS AND ORAL CANDIDAL CARRIAGE IN TYPE II DIABETICS

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ABSTRACT:

Background: Saliva is a ubiquitous, non invasive bio-fluid with a large number of inorganic and organic compounds . These substances can be reliably measured in saliva during various disease processes which makes saliva, diagnostic fluid of choice in recent times. Diabetes mellitus the most common endocrine disorder, has been consistently documented to be associated with altered salivary composition and function, thus altering oral haemostasis.

Objectives: To detect salivary glucose in type II diabetics and to study its relationship with Candidal carriage. To determine if salivary glucose levels can be used as a non invasive tool to monitor glycemic status

Materials and methods: The subjects were divided into group - I with 100 diabetic , group - II 100 non diabetic subjects. Non-fasting plasma glucose levels, stimulated and unstimulated , salivary glucose level were assessed using glucose oxidase method. Candidal colonization was done and Candidal colonies were counted using digital colony counter .

Results: Salivary glucose levels were higher in diabetics and with a significant positive correlation plasma glucose levels. Candidal forming units showed a significant positive correlation with salivary glucose levels in diabetic group.

Conclusion: Salivary glucose levels is a potentially non-inasive diagnostic tool to monitor glycemic status in diabetic individuals.

Key words: Diabetes Mellitus, Stimulated Salivary Glucose, Unstimulated Salivary Glucose, Candidal Colonisation, Random Non Fasting Plasma Glucose Level .

INTRODUCTION:

Saliva is a highly complex secretary product of major and minor salivary glands dispersed throughout the oral cavity. Whole saliva is derived predominantly from three pairs of major salivary glands: the parotid, the submandibular, and the sublingual glands. The whole saliva contains gingival crevicular fluid (GCF), mucosal transudate, expectorated bronchial and nasal secretions, serum and blood derivatives from oral wounds and, oral microbial inhabitants. [1]

Serum constituents are found in whole saliva as a result of GCF outflow. Depending on the degree of the inflammation in the gingiva, GCF is either a serum transudate or, more commonly,

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an inflammatory exudate that contains serum constituents. Serum constituents that are not part of the normal salivary constituents (i.e., drugs and hormones) can reach saliva by several ways: intracellular through passive transfer by diffusion and extracellular by ultrafiltration. [1]

Various organic and inorganic substances can be reliably measured in saliva during various disease processes, which make saliva, the diagnostic fluid of choice in recent times.[2] As a diagnostic fluid, saliva has attracted attention of numerous investigators owing to its non-invasive nature and relative simplicity in collection. [1,2,3]

Diabetes mellitus is the most common endocrine disorder, characterized by an inability of the body's cells to utilize glucose. The cardinal feature of this condition is an increased blood glucose level, resulting from decreased production of insulin, insulin dysfunction or lack of insulin receptor responsiveness at target organs. Diabetes is commonly categorized as type-I or type-II. More than 10% of the diabetics has a type-I process of autoimmune origin.[4,5,6] Type-II diabetes mellitus accounts for 90% to 95% of all diagnosed cases of diabetes mellitus and is often associated with obesity and is characterized by slow onset of symptoms. [4,5,6,7]

Diabetic mellitus is frequently associated with alterations in salivary flow rate and composition. It is widely believed that diabetic patients are more susceptible to infections [8] and frequent occurrence of Candidal infections in diabetic patients has been recognized for many years. [9,10] Many researchers have found a greater prevalence of Candida in the oral cavity of diabetics than normal subjects.[10,11,12,13] In contrary, some studies have found no significant difference in the occurrence of oral Candidal organisms between diabetics and non-diabetics. [14,15,16]

Literature shows controversies in identifying the correlation between blood and salivary glucose levels. Several studies show that an increase in the concentration of salivary glucose correlates with capillary glycemia.[17,18,19] However, this relationship is not confirmed in other studies. [20,21] In addition, very few studies correlating the association between salivary glucose levels and Candidal colonisation have been identified in diabetics. In this regard, the purpose of the present study is to determine salivary glucose levels in type-II diabetics and identify its association with oral Candidiasis. The present study also aims at substantiating the use of saliva as a non-invasive diagnostic technique in monitoring glycemic control in type-II diabetic patients.

AIMS AND OBJECTIVES:

The study aims at investigating salivary glucose levels and oral Candidal carriage in type-II diabetics with the following objectives:

1. To detect salivary glucose both at stimulated and unstimulated levels in Type-II diabetics.
2. To study the relationship between salivary glucose levels and Candidal carriage.
3. To determine if salivary glucose levels can be used as a non-invasive tool to monitor glycemic control in diabetic patients.

MATERIALS AND METHODS:

A study was conducted to estimate salivary glucose levels and oral Candidal carriage in type-II diabetics .The study protocol was approved by the institutional ethical review board.

STUDY SAMPLE: A total of 200 subjects were included and divided into two groups :

Group-I was a study group of 100 type-II diabetic patients between the age group of 30 and 80 years. These patients were being treated for diabetes and had random non-fasting plasma glucose values of >120 mg/dl and <=200mg/dl. Group II was a Control group of 100 non diabetic patients.

Inclusion criteria: For diabetic patients : All the diabetic patients in this study had to be diagnosed and managed for diabetes at the private diabetic clinic using established criteria for diagnosis of diabetes by The Expert Committee On The Diagnosis and Classification of Diabetes mellitus,1998.

For control subjects: No history of any systemic diseases or any medication.

Exclusion criteria for diabetic patients and controls:

- Patients on topical or systemic antifungal therapy
- Patients on medications for salivary gland pathology
- Patients with salivary gland pathology
- patients on corticosteroid therapy

Methodology:

A specially designed proforma was used for the collection of data which consisted of general information, medical condition, duration of diabetes history and drugs being used. After obtaining the consent, the study protocol was explained to the participants. In the very beginning, the participants were asked to refrain from eating for at least 2 hours before the investigation.

Method for unstimulated saliva collection:

Patients were asked to have their breakfast and abstain from eating for 2 hours before the sample collection. Unstimulated saliva was to be collected using a spit technique .The patients were asked to sit on a chair with head tilted forward and was instructed not to speak, or move the head during the procedure. The patient was instructed to spit saliva in a sterile graduated

container every minute for 10 minutes.[22] [figure 1]

Method for stimulated saliva collection:

Stimulated saliva was collected using 2 % food grade citric acid that would be applied to the dorso lateral surface and the tip of tongue every 30 sec. The patient was asked to spit the saliva as and when it pooled up in the mouth, into a sterile container without swallowing for 3 minutes.[22]

Estimation of salivary glucose levels:

Glucose levels of stimulated and unstimulated saliva were measured using the glucose oxidase method in a semi-automated analyser. The saliva sample of 100 µL was mixed with the reagent in a 1:3 ratio and incubated for 5 minutes at 37 ^{0} C. The absorbance values of the standard and the sample against reagent blank were measured. The glucose standard was diluted 10 times for the estimation of salivary glucose levels. The method was standardised and used for measurement of both stimulated and unstimulated salivary glucose levels.

Estimation of random non-fasting plasma glucose levels:

Standardised technique for estimation of blood glucose levels was used using glucose oxidase method .

Saliva sampling and assessment of salivary Candidal count:

Saliva sampling for estimation of colony forming units was performed using oral rinse technique. All the subjects were asked to rinse the mouth thoroughly with 10 ml sterile phosphate buffer saline for 1 minute and to drop the rinse into the sterile container .The rinse was concentrated immediately by centrifuging it at 1,700 rpm for 10 minutes. The supernatant was discarded and 0.001µL inoculating loop was used to spread the sample onto sabouraud dextrose agar plates supplemented with chloramphenicol of 10mg/mL. These agar plates were incubated for 48 hours in an incubator and the CFUs were counted manually and the number was multipled by 1,000 and expressed as CFU/ mL. To confirm Candidal colonisation, the colony forming units from random plates were stained with PAS stain and Candidal growth was identified as positive .[22]

Data analysis:

Data entry, database management, and all statistical analysis were performed with stastical package for the social sciences software in SPSS version-2. Differences in median between groups were assessed using Mann–Whitney U test . Relationships between variables were evaluated by Pearson Correlation coefficient. Linear regression analysis was performed to determine factors independently associated with continuous data, such as salivary and blood glucose. A p- value of <0.05 was considered to be statistically significant.

RESULT:

Results between diabetics and non-diabetics in relation to age, blood glucose, salivary glucose levels and candidal colonisation showed the mean age for both diabetics and non diabetics were equal .Mean age was much closer to 51.7 yrs in diabetics and 51.09 in non diabetics. Random non-fasting plasma glucose level in diabetics was high with 198.7±51.8 mg/dl compared to non diabetics with glucose level of 84±13.2mg/dl. Comparison between Unstimulated and stimulated salivary glucose levels showed that the USSG level was much higher in diabetics with 11.5±3.17 mg/dl when compared to non diabetics with glucose level of 1.9±0.16 mg/dl. The stimulated salivary level did not show much difference between diabetic with 1.8±0.76 mg/dl and non diabetics with 0.83±0.13 mg/dl

Comparison between the median unstimulated and stimulated salivary glucose levels in both diabetics and non diabetics showed that the median USSG in diabetic group with 10.9mg/dL was significantly higher when compared to non diabetic group with 2mg/dL. Also the median stimulated salivary glucose level for diabetic patients was 1.7mg/dL which was between 0.8 and 5.3 mg/dL. This was significantly higher than non diabetic individuals with 0.8 mg/dL, which in turn was between 0.5 and 1.2 mg/dL. The difference between USSG and SSG within the groups of diabetics and non diabetics was also significant

USSG and SSG were compared to RNFG among the diabetics (scatter plot Graph 1A and 1B). A significant positive correlation existed between both USSG and SSG with RNFPG in the diabetic group with p value < 0.001 between USSF and RNFPG and p value = 0.001 between SSG and RNFPG.

Scatter plot 2 A & B show that USSG and SSG are compared to RNFG among the non diabetics. There is a significant positive correlation existed between USSG and RNFPG and there is no statistically significant correlation between SSG and RNFPG.

Median colony forming units in group-I (diabetics) are double than that of group-II (non diabetics). Diabetic patients have a 23,710 ±5731 mean Candidal forming units which are significantly higher than those of non diabetics with mean 9310 ± 4384. Pearson correlation analysis of CFU with USSG and SSG in the study groups shows that there is a significant correlation between CFU of Candida and USSG in diabetics (r=0.229 , p=0.022).

Multivariate regression analysis confirms the statistically significant linear relationship between USSG, SSG and RNFPG with p value for USSG- 0.002 and SSG - 0.039. No such linear correlation exists between Candidal forming units with either stimulated or unstimulated salivary glucose levels (table 3).

DISCUSSION:

Oral fluid or whole saliva is a complex chemical mileu of teeth and oral soft tissues consisting mainly of water, essential electrolytes, glycoproteins ,

antimicrobial enzymes and other important constituents like glucose and amylase.[23] Diabetes mellitus is the most common endocrine disorder, characterized by an inability of the body's cells to utilize glucose. Glucose level is importantly altered in DM. Glucose is a small molecule that diffuses easily through membrane of blood vessels, passing through blood and serum to gingival fluid by way of gingival sulcus and making its way in to saliva. [24] DM has been consistently documented to be associated with altered salivary composition and function.[23] Thus, altering oral haemostasis.

Normal salivary glucose levels do not significantly affect oral health or support the growth of microorganisms. However, higher salivary glucose favour, the proliferation of microorganisms enhances their colonisation on teeth and oral mucous membranes. Glucose serves as nutrient for Candidal colonisation and suppresses phagocytic activity of neutrophils which further accentuates colonisation and likely consequences can be proposed as a result of the elevated salivary glucose levels in diabetes. [23]

Particularly in India, very few studies have been performed on salivary composition and function in diabetes and thus, the data to date is limited. Furthermore, study results that have been reported are contradictory in several aspects and this suggests further investigation.

Recently, interest has been increasing in non-invasive diagnostic testing. Monitoring diabetic patients require repeated estimations of plasma glucose either by finger pricks or by IV blood sampling, hence, a non invasive procedure for glucose measurements would be most welcome under these circumstances. It has become increasingly apparent to investigators and clinicians in a variety of disciplines that saliva has become a non-invasive diagnostic tool. The highly sensitive test procedures that are now commonplace, make it practical to quantitate large number of substances despite their very low concentrations in saliva. Considering these facts, this study was designed to estimate glucose levels in saliva in order to determine their relation to random non-fasting plasma glucose levels and also to determine if salivary glucose levels could be used as a non-invasive tool in monitoring glycemic control in diabetics.

The study consisted of 200 individuals who were divided in to two groups as group-I diabetics and group-II non diabetics with an age range from 20 to 80 years. The mean age for both diabetic and non diabetic individuals was 51.4 ± 8.9yrs. In our analysis the Random non-fasting plasma glucose level in diabetics were high with 198.7±51.8 mg/dl when compared to non diabetics with 84±13.2mg/dl glucose level.

In the present study, Glucose was detected in both unstimulated and stimulated saliva of non diabetic subjects. The mean salivary glucose

levels in unstimulated saliva of non diabetic patients was 1.9 ± 0.16 mg/dl while the stimulated saliva was 0.83 ± 0.13 mg/dL. This observation was in close correlation with the study conducted by Arati Panchai etal [23] , but did not correlate with the findings of Radhika etal [22] , Carman Carda. [25] The possible reason for this difference was due to difference in the study populations and variations in dietary patterns. [26]

In this study, the mean salivary glucose levels both stimulated and unstimulated were higher in diabetic with USSG – 11.5 mg / dL and SSG 1.8 mg / dL than those of in non diabetic with USSG – 1.9 mg / dL and SSG 0.83 mg / dL, which was in accordance with studies conducted by various authors.[23,26] This finding suggested that salivary glucose levels followed a threshold mechanism which was suggested by Rueterring. [23] According to this, a threshold mechanism for salivary glucose was similar to that of urine at blood glucose concentration of about 10-15 mmol/L. Another possible explanation for higher salivary levels in diabetes patients was that basement membrane permeability of parotid gland was reported to be higher in diabetic mellitus. This result gave rise to raised percolation of components such as glucose, amylase and protein from blood thus raising their levels in saliva. [23] Salivary samples collected for the present study represented whole mouth fluid and therefore, reflected glucose levels not only due to leakage across basement membrane of major and minor salivary glands but also potentially from gingival crevicular fluid .

In the present analysis, Scatter plot of both USSG and SSG levels showed a significant positive correlation with RNFPG in diabetes but it was not with non diabetics. A Similar finding was observed in other studies. [17,1823,22] This positive correlation can be attributed to the threshold mechanism proposed by Rueterring [23] and leakage of basement membrane of parotid gland in diabetics. However, this finding is contrary to other studies . [21,27] The factors for this poor correlation include oral retention of alimentary carbohydrate, glucose utilisation by bacteria, release of carbohydrate from salivary glycoproteins and contamination of saliva by large out flow of crevicular fluid in patient with poor gingival status . In view of these findings, whether correlation between plasma glucose and salivary glucose levels observed in this study reflects the sensitivity of test used or else other factors need to be further investigated.

In this study, Blood glucose (RNFPG – random non fasting plasma glucose level) was considered to be an indicator of diabetes control rather than glycosalated Hb level, since patients with NIDDM typically have less rapid changes in blood glucose, which make non fasting plasma glucose level as a reliable measure for long term glycemic control. [20]

In the present analysis, Multivariate regression analysis between USSG and

SSG with RNFPG and CFU showed that RNFPG significantly correlated with USSG and SSG. However, other factors such as salivary flow rate, and medications which were associated and the influencing factor were not taken into consideration in this study. This would prove to be the basis for further research. Thus , from this study it can be inferred that salivary glucose levels correlate with blood glucose levels and can be used as reliable non-invasive to monitor glycemic control in diabetic subjects .

In this study, median candidal colony forming units between study and control groups were compared using Mann–Whitney U test. It was identified that median CFU was significantly higher and double to that of non diabetics in group-I - diabetics having 6000 CFU with a range of 0-3,70,000, when compared to non diabetics having 3000 CFU with a range of 0-58,000 . This was similar to findings of other studies. [8,9,26,29]

Pearson correlation analysis of CFU with USSG and SSG in the study groups showed that there was significant correlation between USSG and CFU in diabetics. This conferred the relation that increased candida would reflect increased salivary glucose levels. This finding was similar to earlier studies.[8,10,25,29] Candidal adhesion to oral mucosal cells generally recognised as first step in the process of colonisation and subsequent infection. It is true that high levels of salivary glucose increases Candidal adhesion to buccal epithelial cells. Salivary glucose forms chemical reversible glycosalation products with proteins in tissue during hyperglycaemic episodes, and this leads to accumulation of glycosalation products on buccal epithelial cells which in turn, may increase the number of available receptors for candida. [26]

Other factors that play a role in diabetes mellitus are neutrophil dysfunction, decreased salivary flow rate and lower pH [55] . Also decreased phagocytosis , intracellular bactercidial activity , chemotaxsis have been associated with poorly controlled diabetes . These neutrophil deficiencies have been shown to enhance the presence of glucose which support the documentation of increased Candidal carriage in diabetic patients . [10]

In this study microbial colonisation of Candida was considered to be Candida which can be counted microbiologically without manifesting clinically. [20]

CONCLUSION:

Type-II diabetes mellitus patients may have altered salivary composition and one manifestation of this may be the increased susceptibility to oral candidal carriage. This may be due to increased levels of salivary glucose, decreased flow rates that has been observed in previous investigations. The observations and associations made from our study are salivary glucose levels, both stimulated and unstimulated, which show a significant positive correlation with

blood glucose levels in diabetic patients. Salivary glucose levels can be a potentially non-innasive diagnostic tool to monitor glycemic status in diabetic individuals. Candidal colony forming units are significantly higher in diabetic patients and have showed a significant positive correlation with salivary glucose levels. The increased salivary glucose levels likely contributes to increased Candidal colonisation and the potential for increased susceptibility to oral candidiasis .

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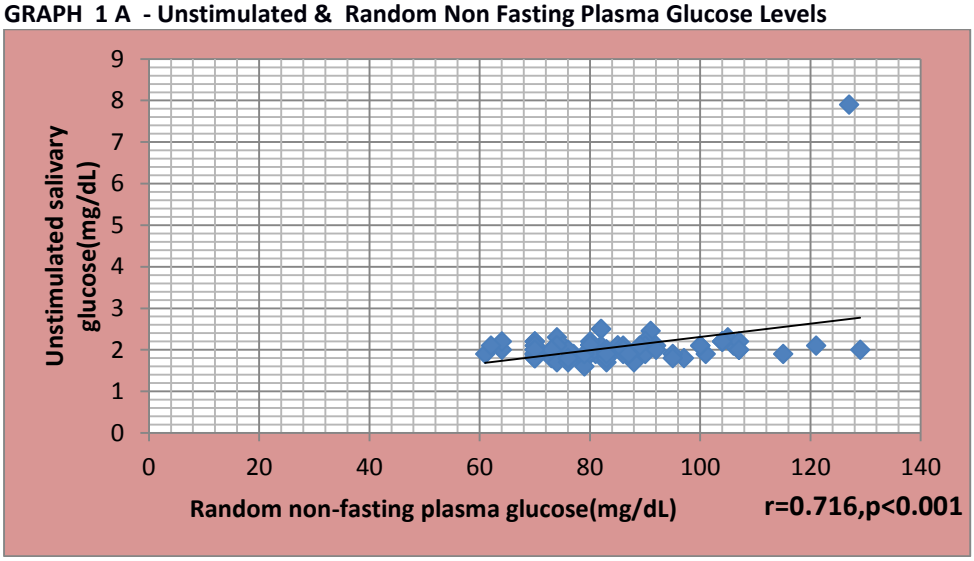
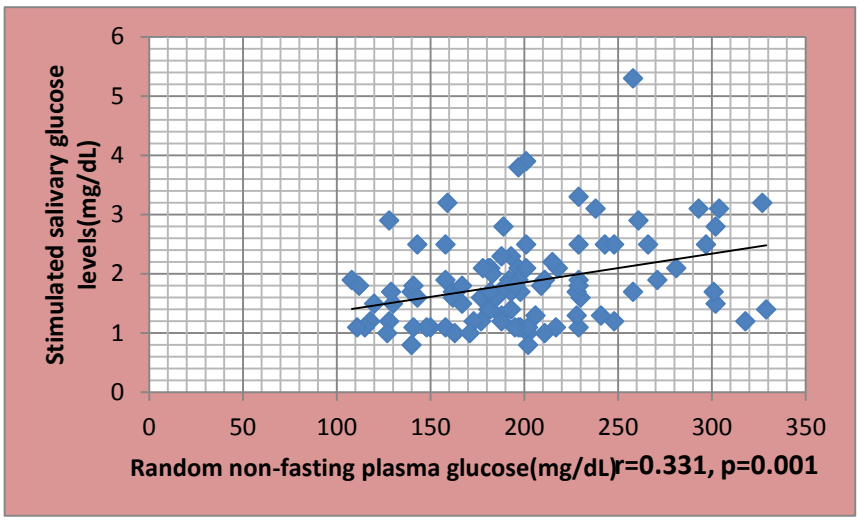
GRAPHS:

GRAPH 1A, 1B – Scatter plot of salivary glucose levels (unstimulated and stimulated) and random non fasting plasma glucose levels in group I subjects (diabetics)

GRAPH 1 A - Unstimulated & Random Non Fasting Plasma Glucose Levels



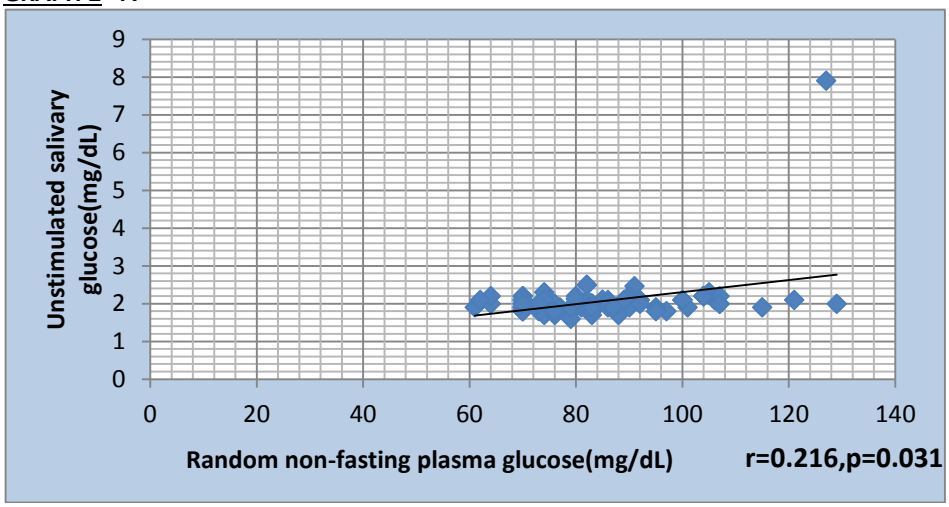
GRAPH 1– B



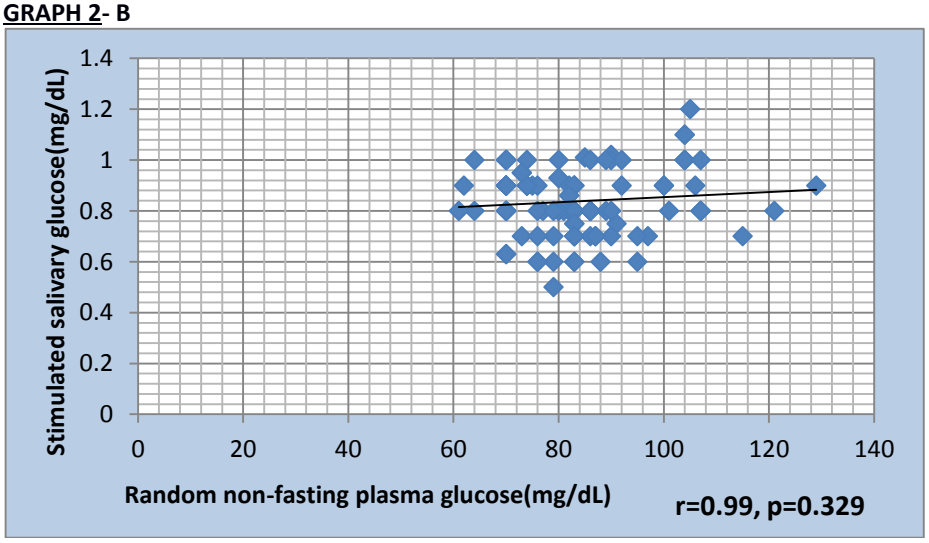
USSG and SSG were compared to RNFG among the diabetics in Graph 1A and 1B. There was a significant positive correlation existed between both USSG and SSG with RNFPG in the diabetic group with p value < 0.001 between USSF and RNFPG and p value = 0.001 between SSG and RNFPG

GRAPH 2A, 2B – Scatter plot of salivary glucose levels (unstimulated and stimulated) and random non fasting plasma glucose levels in group II subjects (non diabetics)

GRAPH 2 –A



GRAPH 2- B



GRAPH 5 A, B – Shows USSG and SSG were compared to RNFG among the non diabetics . There was a significant positive correlation existed between USSG and RNFPG and no statistically significant correlation existed between SSG and RNFPG .

Table –3 -Multivariate linear regression for salivary glucose (USSG and SSG)

Variable	Slope		P value	
	USSG	SSG	USSG	SSG
RBS	0.0043	0.001	0.002**	0.039*
CFU	0.000043	0.0000016	0.322	0.262

FIGURES:

FIGURE 1: COLLECTION OF UNSTIMULATED AND STIMULATED SALIVA

FIGURE 2: CANDIDAL COLONISATION OBTAINED AFTER 48 HRS OF INCUBATION

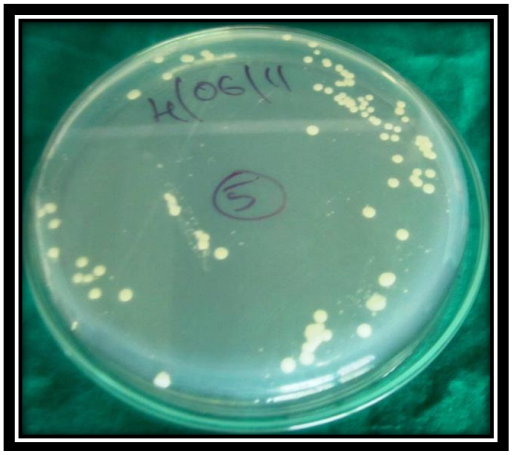


FIGURE 3: IDENTIFICATION OF CANDIDAL COLONISATION USING PAS STAIN