Prediction of type 2 diabetes mellitus with saliva- A pilot study

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Abstract
Aim: To validate the usage salivary glucose levels to monitor type 2 diabetes.
Materials and Methods: 100 type 2 diabetes mellitus patients were included in the study. The fasting whole saliva and serum was collected and were analyzed for glucose by using autoanalyzer. The results were analyzed statistically.
Results: A Significant correlation was obtained between salivary and serum glucose levels in type 2 diabetic patients and in control group.
Conclusion: Salivary glucose levels can serve as a marker in diagnosing and monitoring type 2 diabetes mellitus.

Keywords: Diabetes mellitus, Salivary glucose, Serum glucose.

Introduction
The Type 2 Diabetes mellitus is the most routinely encountered disease these days. Diabetes mellitus (DM) is a metabolic disorder characterized by a insufficiency of insulin secretion.[1] Diabetes mellitus (DM) has been classified into Type1 DM, Type 2 DM, Other specific types and gestational DM.[2] 5-10% of population have Type 1 diabetes and 90-95% of population have type 2 diabetes mellitus.[3]

Diabetes mellitus affects approximately 14 million people in United States and majority are often undiagnosed.[4] 19.4 million individuals in India are affected with this deadly disease, which is likely to go up to 57.2 million by the year 2025.[4] DM may lead to potential complications like the diabetic retinopathy, nephropathy, peripheral peripheral neuropathy, macroangiopathies, etc.[5]

Hence the investigative procedures must be routinely employed to diagnose and monitor the diabetes. The most routinely employed procedures are blood investigations. These procedures are invasive and offer much discomfort to the patient. So, there is a pressing need for the development of non-invasive procedure method for diagnosing and monitoring diabetes.

Changes in the basement membrane of salivary glands in diabetes enhances increased permeability of glucose molecules in saliva thus enabling detection of salivary glucose levels[6] which is helpful in detecting DM. Saliva has added benefits over blood that the whole saliva can be collected non-invasively. No special equipment is needed and is less complicated than collecting serum glucose. For larger populations saliva also serves as a cost effective approach.

This study is undertaken to validate the usage of the salivary glucose levels for monitoring type 2 diabetes mellitus. The salivary glucose correlation with serum glucose levels has got advantage of being a non-invasive method of monitoring diabetes mellitus.

Materials and Methods
The type 2 diabetes mellitus patients who were already diagnosed and under the treatment reporting to reporting to Osmania general hospitals, Hyderabad, were considered under study group.

A total of 100 patients diagnosed with type 2 diabetes mellitus age between 35-72 years comprising of 53 males and 47 females.

The control group were matched with age and sex of type 2 diabetes mellitus patients, comprised of 53 males and 47 females. Fasting blood and saliva samples from both study and control groups were collected between 6-8am.

The blood is collected into 2ml test-tube containing 20 µl of fluoride oxalate which prevents clotting of blood and degradation of glucose.[2] The unstimulated whole saliva was analyzed in this study. 1ml of saliva was collected in draining method in a plastic container which is placed over icepack containing 0.1ml of sodium fluoride is added to prevent degradation of glucose.[3] The plastic containers with saliva are stored in ice until analysis of glucose is performed. Glucose levels in saliva and serum samples were analyzed using glucose oxidase/peroxidase reagent in Biolis 4i autoanalyzer and the results were recorded.

Results
The correlation of the salivary glucose and serum glucose levels type 2 diabetics and controls. Pearson correlation test was used and the value was 0.99 and for control group was 0.89 which can be interpreted that with increase in the serum glucose levels the salivary glucose levels also increases. The ‘P’ value for both serum and salivary glucose levels was < 0.01 which was statistically significant (Table 1).

Table 1: Correlation of serum and salivary glucose levels in type 2 diabetics and controls

	Type II	Sample Size	Range mg %	Mean mg %	Standard Deviation	Pearson correlation value 'r'	P Value
Diabetics	Serum Glucose Levels	100	100 – 247	191.2	52.464	0.99	< 0. 01
	Salivary Glucose Levels	100	9.9 - 29.67	19.13	5.1857		
Controls	Serum Glucose Levels	100	73 – 120	93.68	12.305	0.89	< 0.01
	Salivary Glucose Levels	100	7.4 - 12.9	9.713	1.2369		

Unpaired 't' test

Discussion

DM is the 5th most common metabolic disorder routinely encountered in the world. Due to the modified lifestyle habits the prevalence of DM has drastically increased. The number of people with diabetes had rised to 366 million in 2030.[8] The largest number of diabetic patients are diagnosed in India and the number is estimated to increase to 79.4 million by 2030.[9]

This metabolic disease is a potential burden on both patients and society because of the high morbidity and mortality associated with infections and its renal, retinal and vascular complications. Thus, it is essential to take necessary steps for the early detection and control of DM with regular monitoring over glycemic control.

The routinely employed investigative procedures for glucose monitoring are invasive, but saliva can best serve as a valuable non invasive diagnostic aid. Thus the salivary and serum glucose levels correlation would be helpful in monitoring diabetes non-invasively. There is paucity on the data regarding its correlation, hence this study was undertaken to estimate and correlate salivary glucose concentration and serum glucose concentration in diabetic patients, and also to explore the potential validity of using saliva for diagnosing and monitoring DM.

Hyderabad ranks first in India with having 4.1% of prevalence in type 1 DM. The probable etiology for higher prevalence in Andhra Pradesh would be because of more consumption of polished rice, where as in other states wheat, jowar and bajra are consumed more.[10]

DM can be detected by measuring salivary glucose levels. The glucose molecule easily diffuses into salivary gland through the semi permeable membrane. Thus, large when blood glucose levels increases salivary glucose levels are also increase in diabetes. Other explanations are alterations in the permeability of basement membrane of salivary glands which leads to leakage of glucose in saliva.[11] The alterations in the basement membrane of blood vessels leads to increased transport of glucose from blood into saliva according to Harrison and Bowen.[12] The salivary glands act as filters of blood glucose that is influenced by hormonal regulation according to Lopez ME et al. Glucose also makes it way from the gingival crevicular fluid into the saliva.[13] Under pathologic conditions like the infections and inflammations of salivary glands raised glucose levels can be detected.

In this study the salivary glucose are higher in type-2 diabetics than in controls and was statistically highly significant (P<0.01). This is in accordance with the findings of Mehrotra KK and Chawla TN.[14]

In the present study between serum and salivary glucose levels in type-2 DM and also in healthy controls a significant correlation was seen. Hence, salivary glucose serves as a reliable indicator of serum glucose concentrations in diabetes. The same correlation was noticed by Sreedevi et al,[7] Yamaguchi et al.[15]

A correlation was found both in fasting and after glucose load according to a study.[16] This correlation was in contrary to Borg A and Birkhed D, whose observations show that the correlation was higher after than before the carbohydrate intake,[17] Anderson AB et al. showed that the glucose concentration in parotid saliva is increased after 2 hrs after glucose intake in individuals with both IGT and DM of short duration.[18] In certain studies correlation was seen only in fasting serum and salivary glucose levels.[19]

As the time duration of the entry of glucose into salivary glands is not determined precisely and in order to avoid biased results in this study only fasting glucose levels are considered.

As variation in the correlation was observed in various studies while using gland specific saliva, in the present study resting unstimulated whole saliva is considered and in order to standardize the salivary measures all the samples are collected between 6-8 am.

For a given salivary glucose level by using the regression equation the serum glucose level can also be predicted [Serum glucose = 10.07 (salivary glucose) – 1.505], for type 2 diabetes.

It is observed in the study that if the salivary glucose levels are greater than 11.5 mg% the patient is considered as diabetic and if the values are less than 11.5% the patient is considered as non diabetic. The overall accuracy of the study is 95.6%, sensitivity is 95.5% and specificity is 95.9%. Positive predictive value is 96.4% and 95.2% is the negative predictive value.

Although statistically salivary glucose is proved to be a good indicator of presence or absence of diabetes, attention must once again be drawn to the fact that glucose in whole saliva may not be entirely derived from salivary glands.

Our study showed a good correlation between serum and salivary glucose levels in type 2 diabetes patients. Hence salivary glucose levels may be used diagnose diabetes mellitus as has got profound advantage of being a

non invasive method and is potentially valuable. Detailed information on the possible influences of the glucose levels in saliva and further studies which include random and post prandial glucose comparison would further help in inculcating salivary glucose levels as a promosing source to monitor and detect DM.

Conclusion

Diabetes mellitus is the most prevailing chronic disease that requires long-term medical attention to limit the development of its devastating complications. The routinely employed investigative procedures are invasive whereas salivary glucose levels can serve as a non invasive diagnostic modality for diagnosing and monitoring salivary glucose levels.

Good correlation was found between salivary and serum glucose in type 2 DM patients. A patient can be diagnosed as diabetic or non diabetic and also monitor the disease based on salivary glucose levels. In the near future further research must be carried to recommend salivary glucose levels to monitor DM.

Source of Funding

None.

Conflict of Interest

None.

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