Original Article

# The role of salivary gland scintigraphy in detection of salivary gland dysfunction in type 2 diabetic patients

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ABSTRACT

**Objective:** The aim of the study was to evaluate the salivary gland dysfunction in a patient with uncontrolled type 2 diabetes using salivary gland scintigraphy. **Materials and Methods:** patients included in the study were 32 uncontrolled type 2 diabetic and 30 normal healthy individuals. Patients having any other systemic(or) nervous illness(or) taking medications that could affect the normal functioning of the salivary gland were excluded from the study. The salivary gland scintigraphy was performed, with radioactivity measured at 1st, 20th, and 40th minutes. Twenty minutes after the injection, vitamin C chewable tablet was given to stimulate the secretion and continued until the end of the study period (40min).The data were replayed and regions of interest were chosen over four salivary glands to obtain the uptake ratio (UR) and excretory ratio(ER) of the salivary glands. Result: The scintigraphic total URand ER in diabetic and control groups was compared. The values in these two categories showed decrease in both UR and ER in diabetic patients, when compared to control patients. **Conclusion and Significance:** The result of this study suggests that salivary gland scintigraphy plays a significant role in the evaluation of salivary gland dysfunction in type 2 diabetic patients.

**Keywords:** Salivary gland dysfunction, scintigraphy, type 2 diabetes

## INTRODUCTION

There are various body fluids, of which saliva is the most valuable oral fluid that can aid in the diagnosis of various diseases such as HIV, hepatitis, renal disease, and detection of apoptotic cells in saliva of patients with oral carcinoma. Saliva has also become useful as a non-invasive systemic sampling measure for medical diagnosis and research, so this valuable oral fluid is critical to the preservation and maintenance of oral health, yet it receives little attention until its quality or quantity is diminished. There has been much recent research on the topic of salivary glandular dysfunction as it relates to disease or as a side effect of certain medications.[1]

In the salivary gland dysfunction, it can present as either hypersalivation or hyposalivation. Hyposalivation can occur in localized disease, systemic disease (diabetes mellitus and Parkinson's disease), cystic fibrosis, and sarcoidosis of which diabetes is the most commonly reported disease in daily medical and dental practice.[2] Although hypersalivation usually caused by physiological factors such as mensuration or early pregnancy, local factors such as inflammatory lesions, food, or medication are also responsible.[1]

Diabetes mellitus is characterized by increased levels of glucose in the blood and abnormalities in the metabolism of lipid, protein induced by diminished levels, or total absence of insulin. The incidence of diabetes is increasing at an alarming rate and the risk of diabetes has increased as people move away from their traditional lifestyle.[3]

Patients with diabetes can present with various oral manifestations such as gingivitis, periodontitis, candidiasis, burning mouth syndrome, delayed wound healing, and those who have poor glycemic control are more likely to complain of xerostomia and may have decreased salivary flow up to 82.5%.[4] The cause of salivary dysfunction may be related to polyuria (or)

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to alterations in the basement membrane of salivary glands, an investigation revealed parotid gland basement membrane abnormalities in all diabetic subjects as indicated by the binding of immunoglobulins (IgG) albumin and polyvalent IgG to ductal and acinar basement membranes. So variation in parotid diabetic basement membranes evidenced that membranopathy in this disease is systemic in nature.[5,6]

There are various imaging techniques used for salivary gland, e.g., sialograms, computed tomography, magnetic resonance imaging, ultrasound, and scintigraphy. Scintigraphy is the only method available that can provide qualitative and quantitative functional assessments of the major salivary glands.[7] So various studies have been carried out in diabetic patients to detect salivary gland function, but only few studies in the past have used scintigraphy for assessing the salivary gland function in diabetic patients. Scintigraphy is a valuable tool as it provides dynamic, objective, and quantitative measurement of the major salivary gland function and allows for differentiation of abnormalities in saliva production as uptake ratios (URs) and secretion as excretory ratios (ERs).[8]

The isotopes used for salivary gland is Technetium-99m pertechnetate, which paves way for excellent images with sharp contrast.[9]

### Objective

The aim of this study was to evaluate the salivary gland dysfunction in patients with uncontrolled type 2 diabetes using salivary gland scintigraphy.

To determine whether salivary gland scintigraphy can be used in diabetic patients to detect salivary gland dysfunction.

## MATERIALS AND METHODS

Patients were randomly selected in the Department of Oral Medicine and the study comprised of 32 uncontrolled type 2 diabetic patients (20 females and 12 males) and 30 (16 females and 14 males) age- and sex-matched normal healthy individuals. Age group ranges from 40 to 60 years. Patients having any other systemic or nervous illness or taking any medications or having suffered in the past with any type of illness or treatment that could have an effect on the normal functioning of the salivary gland were excluded from the study. All the studies were done with the patient consent.

The diabetic and normal healthy patients were selected according to American Diabetes Association expert committee.[10] Fasting plasma glucose <126 mg/dl, post-prandial glucose <160 mg/dl, and HbA1C <6% were considered controlled diabetes. Diabetic status was considered uncontrolled when patients had fasting plasma glucose >160 mg/dl, post-prandial >200 mg/dl, and HbA1C >8%.

The salivary gland scintigraphy was performed in the Department of Nuclear Medicine using gamma camera (Diacam, Seimens, Germany) equipped with a low energy all-purpose collimator. The patient was placed in supine position with the gamma camera close to the face to record activity in the major salivary glands and the surrounding tissues. Technetium-99m about 5 mCi (135 MBq) was injected intravenously into antecubital vein. The activity was measured at 1st, 20th, and 40th min [Figure 1]. Twenty minutes after the injection, vitamin C chewable tablet was given to stimulate the secretion and continued until the end of the study period (40 min). The data were replayed and regions of interest were chosen over four salivary glands to obtain the uptake and ER of the salivary glands.[11,12]

Statistical analyses were done from the obtained data; mean and standard deviation were estimated using the formula:

$$\text{Mean: } X = \sum \frac{xi}{N}, \quad (1)$$

where $xi$ is the individual observation in the group.

$$\text{Standard deviation (SD): } S = \sqrt{\frac{xi - \bar{x}}{N}}$$

The mean UR between diabetic and normal patients was compared and the $P$ value was calculated using Mann–Whitney $U$-test.

The formula used was:

$$u - n_1 n_2 + \tfrac{1}{2} n_1 (n_1 + 1) - T \quad (2)$$

$T$ is the sum of the ranks in the smaller group. $n_1$ and $n_2$ are the sample sizes in each study group.

## RESULT

The results are depicted in Tables 1 and 2. Figure 1 shows scintigraphic images at different time intervals. The scintigraphic total uptake and ER showed a decrease in both uptake and the ER in diabetic patients, when compared to control patients [Table 2, Figure 2]. When it was subjected to statistical analysis, it was found to be non-significant.

## DISCUSSION

This study was carried out to detect whether diabetic patients have salivary gland dysfunction using salivary gland scintigraphy. Various literature studies have reported that diabetic patients have diminished salivary dysfunction,[5,13-18] of which the xerostomia is seen in uncontrolled diabetic patients up to 82.5%.[4]

The cause of salivary dysfunction may be related to polyuria (or) alteration in the basement membrane of salivary glands, and lot of literature studies have reported the parotid gland basement membrane abnormalities in all diabetic patients.[4-6] Previous studies have included diabetic patients with age group of 50-60 years and another study has evaluated in diabetic patients

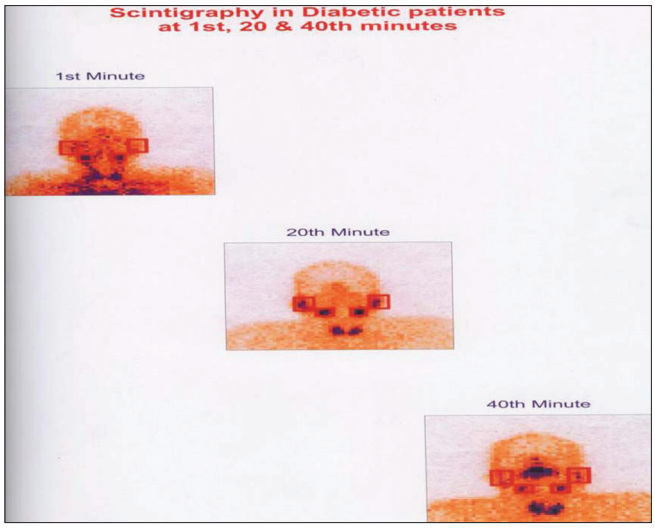


**Figure 1:** Scintigraphy in diabetic patients at 1st, 20th, and 40th min

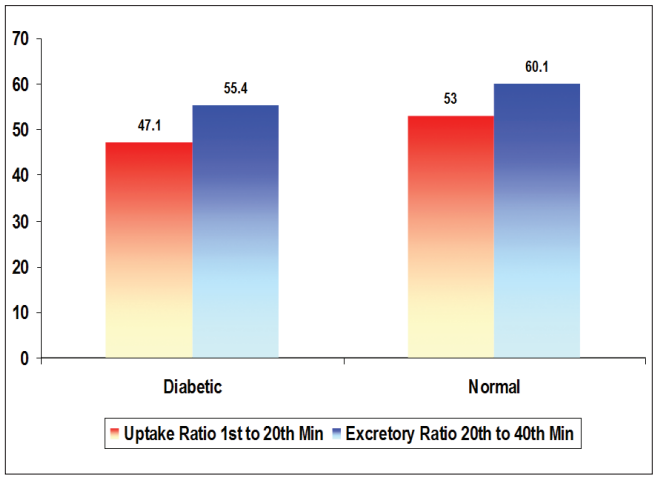


**Figure 2:** Comparison of mean uptake ratios between diabetic and control group. Graph I shows a decrease in the mean uptake and excretory ratios in diabetic group as compared to control group

**Table 1: Total uptake and excretory ratio of the major salivary glands in diabetic and control patients between 1st-20th and 20th-40th min**

| UR and ER in percentage | | | |
|---|---|---|---|
| Diabetic | | Control | |
| 1st-20th min (%) | 20th-40th min (%) | 1st-20th min (%) | 20th-40th min (%) |
| 53.3 | 47.0 | 38.1 | 51.9 |
| 80.1 | 51.2 | 43.4 | 60.4 |
| 61.2 | 50.3 | 55.9 | 60.1 |
| 56.9 | 53.6 | 43.2 | 64.8 |
| 13.0 | 52.1 | 48.4 | 64.7 |
| 52.9 | 52.3 | 65.6 | 70.3 |
| 48.9 | 45.5 | 42.8 | 66.8 |
| 48.8 | 43.3 | 42.2 | 67.6 |
| 47.7 | 45.1 | 68.1 | 73.1 |
| 39.5 | 35.0 | 48.0 | 70.7 |
| 27.6 | 21.0 | 40.0 | 69.0 |
| 45.2 | 92.8 | 51.7 | 78.0 |
| 42.6 | 48.0 | 47.9 | 67.5 |
| 60.2 | 63.2 | 44.1 | 64.0 |
| 41.6 | 72.5 | 48.7 | 58.4 |
| 36.1 | 47.5 | 38.8 | 41.6 |
| 30.9 | 50.7 | 52.5 | 58.6 |
| 52.5 | 57.8 | 42.8 | 58.6 |
| 40.1 | 60.1 | 56.6 | 60.8 |
| 40.4 | 47.9 | 49.1 | 56.5 |
| 42.7 | 64.8 | 52.1 | 75.7 |
| 31.6 | 46.4 | 67.3 | 53.1 |
| 43.1 | 62.6 | 52.1 | 48.1 |
| 44.5 | 68.7 | 62.1 | 50.1 |
| 63.5 | 73.5 | 84.0 | 63.5 |
| 46.0 | 50.6 | 58.4 | 56.2 |
| 45.8 | 76.2 | 91.9 | 72.9 |
| 47.2 | 49.0 | 51.7 | 35.9 |
| 34.8 | 55.2 | 50.5 | 40.1 |
| 49.7 | 66.2 | 52.5 | 45.4 |
| 46.1 | 70.3 | | |
| 50.3 | 51.9 | | |

UR: Uptake ratio, ER: Excretory ratio

**Table 2: Comparison of mean uptake and excretory ratios between diabetic and control patients**

| Variable | Diabetic Mean±SD | Control Mean±SD | *P* value |
|---|---|---|---|
| Uptake ratio 1st-20th min (%) | 47.1±10.5 | 53.0±12.5 | 0.07 |
| Excretory ratio 20th-40th min (%) | 55.4±13.5 | 60.1±10.8 | 0.07 |

*Mann–Whitney *U*-test was used to calculate the *P* value, Inference: The result of Table 2 shows that there is decrease in the uptake ratio of 1st-20th and excretory ratio of 20th-40th min in the major salivary glands of diabetic patients as compared to control patients. However, there was no statistically significant difference between the diabetic and control. *P* value of (<0.05) was considered significant

with age group of 50-90 years.[19,20] This study was performed in 62 patients (32 diabetic and 30 controls) with age range between 40 and 60 years, which is similar to the age range employed in other studies evaluating salivary gland dysfunction.[4,12,20] Both the diabetic and normal patients were excluded, if they had any other systemic illness (or) were on any medication that could have an affect on salivary gland function.

A lot of studies in the past have been carried out in diabetic patients to detect salivary dysfunction,[13,15,20] but only few studies in the past have used scintigraphy for assessing the salivary dysfunction in diabetic patients.[12] The imaging techniques used for visualizing salivary gland include sialography, computed tomography, magnetic resonance imaging ultrasound, and scintigraphy. Scintigraphy is the widely used method that can provide functional assessment of salivary glands.[7] Number of studies in the past had used scintigraphy to detect the glandular dysfunction in diabetic patients, chronic renal failure, parenchymal damage after treatment with radio-iodine, and in patients with xerostomia due to aging and medications.[11,12,19,21-23] Hence, scintigraphy was chosen as a choice in this study.

A number of studies have used Technetium-99m pertechnetate for imaging of salivary dysfunction.[12,19,21-23] Technetium-99m pertechnetate with its monochromatic energy of 140 kW is physically the ideal isotope for imaging. Because of their short half-life, these isotopes can be used in very large amounts

of order of millicuries, without causing radiation hazards to patients. This paves for excellent images with sharp contrast.[10] Technetium-99m pertechnetate was injected in millicuries and about 5 mCi (135 MBq) was injected into antecubital vein and the activity was recorded with a low energy all-purpose collimator for data analysis.[11]

The scintigraphic total UR and ER in diabetic and control groups were compared [Table 1]. The values in these two categories showed a decrease in both UR and the ER in diabetic patients, when compared to control patients [Table 2, Figure 2]. When it was subjected to statistical analysis, it was found to be non-significant as this could be due to smaller sample size of 32 numbers and marginal difference between diabetic and control groups.

Scintigraphy has its limitations of free availability of equipment, cost factor, and patient's acceptance for a long procedure. This study did not encounter any limitations except the patient acceptance for long procedure.

## CONCLUSION

The result of this study leads to the conclusion that salivary gland scintigraphy plays a significant role in the evaluation of salivary gland dysfunction. However, its role as an independent investigative procedure in the evaluation of salivary gland dysfunction requires a study with larger sample size, which may yield a statistical significant result.

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