Salivary gland function in continuous ambulatory peritoneal dialysis patients by ^{99m}Tc-pertechnetate scintigraphy

Mustafa Keles[1] MD,
Bedri Seven[2] MD,
Erhan Varoglu[2] MD,
Abdullah Uyanik[1] MD,
Kerim Cayir[3] MD,
Arif Kursad Ayan[2] MD,
Ebru Orsal[2] MD,
Habib Emre[3] MD,
Ramazan Cetinkaya[1] MD

1. *Division of Nephrology, Department of Internal Medicine*
2. *Department of Nuclear Medicine and*
3. *Department of Internal Medicine, Ataturk University, Medical School, Erzurum, Turkey*

Keywords:
– Chronic renal failure
– Continuous ambulatory peritoneal dialysis
– Salivary function
– Salivary gland scintigraphy

Correspondence address:
Assistant Professor
Bedri Seven, M.D.
Ataturk University,
Medical School,
Department of Nuclear Medicine
25240 Erzurum, Turkey
Phone: +90.442.2360900
Fax: +90.442.2312766
E-mail: bedriseven@yahoo.com, bedirhan@atauni.edu.tr

Received:
28 August 2009
Accepted revised:
15 November 2009

Abstract

The purpose of this study was to evaluate the alterations in salivary gland function in patients who receiving continuous ambulatory peritoneal dialysis (CAPD) for chronic renal failure (CRF) using technetium-99m pertechnetate (^{99m}Tc-P) salivary gland scintigraphy. *The study population consisted* of 36 CAPD patients (16 males and 20 females, ranging in age from 19 to 73 years, mean age 44.94±15.01 years) and 20 healthy controls (11 males and 9 females, ranging in age from 31 to 51 years, mean age 41.25±5.62 years). All patients and healthy controls underwent salivary gland scintigraphy. After the intravenous administration of 185MBq of ^{99m}Tc-P, dynamic salivary gland scintigraphy was performed for 25min. On the basis of the time-activity curves, the following glandular function parameters were calculated for the parotid and submandibular salivary glands: uptake ratio, maximum accumulation, and ejection fraction. *Our results showed:* All functional parameters obtained for CAPD patients were significantly lower than for healthy controls ($P<0.05$). *In conclusion*, this study demonstrated that salivary gland function, an important determinant of oral health, is impaired among the CRF patients treated with CAPD compared with healthy controls, as evaluated by ^{99m}Tc-P salivary gland scintigraphy.

Hell J Nucl Med 2010; 13(1): 26-29 • Published on line: 10 April 2010

Introduction

Chronic renal failure (CRF) is a process that expresses a loss of functional capacity of the nephrons, independently of its aetiology. Although acute renal failure is reversible in the majority of cases, CRF presents a progressive course towards terminal renal failure, even if the cause of the initial nephropathy disappears [1, 2].

When the function of the kidneys is severely impaired, either haemodialysis or peritoneal dialysis treatment or renal transplantation may be applied [3]. Haemodialysis leads to variations in the flow and composition of the saliva [1, 4-6]. It has been shown that the parenchymatous and excretory functions of salivary glands were decreased in dialysis patients [7, 8].

Salivary gland scintigraphy with ^{99m}Tc-P is a routine test with low dosimetry and does not interfere with normal physiology [8-11]. In addition, by using this method, quantitative data about the major functions of salivary glands can be obtained [12-15].

We found no report in the literature about the evaluation of salivary function using ^{99m}Tc-P salivary gland scintigraphy, in patients receiving CAPD for CRF.

Subjects and methods

Patients

The study population consisted of 36 patients with CRF (16 males and 20 females, ranging in age from 19 to 73 years, mean age 44.94±15.01 years) and 20 healthy controls (11 males and 9 females, ranging in age from 31 to 51 years, mean age 41.25±5.62 years) (Table 1). All patients with CRF have received CAPD routinely since 5 to 84 months, mean 22.39±20.37 months. The duration of CRF was 30.11±21.83 months (range 6-86 months). The levels of serum creatinine and 24h urine volume of patients were 9.33±3.18 mg/dL (range 2.30-14.70mg/dL) and 616.67±328.19mL (range 200-1500mL), respectively. No patient or healthy control had a history of head or neck surgery or radiation treatment, a connective tissue or other systemic disease. All patients and healthy controls gave informed consent for the study, which was approved by the ethical committee of your university.

Table 1. *Characteristics of patients and healthy controls groups*

Groups	*N*	Sex (male/ female)	Mean age ± SD (range in years)
CAPD patients	36	16 / 20	44.94 ± 15.01 (19-73)
Healthy controls	20	11 / 9	41.25 ± 5.62 (31-51)

CAPD, continuous ambulatory peritoneal dialysis.

Salivary gland scintigraphy

Dynamic salivary gland scintigraphy was performed after intravenous administration of 185MBq of ^{99m}Tc-P using a single-head gamma camera with a parallel-hole, low-energy, high-resolution collimator (GE-Starcam 4000 XR/T, St Albans, Hertfordshire, UK). The photopeak was centered at 140keV with a 20% window. A total of 25 frames of 60s each were acquired in the anterior position of the head and neck during the 25min study with a zoom 1.33 and matrix of 128×128 (Fig. 1). Salivary gland secretion was stimulated with 3mL concentrated lemon juice instilled orally with a syringe at 20min. Similar protocols have been used by others [11, 12, 14, 15]. All patients and healthy controls tolerated the study well.

Semi-quantitative analysis

For semi-quantitative analysis, regions of interest (ROI) were drawn around the right and left parotid glands and the right and left submandibular glands on summation images of dynamic scintigraphy (Fig. 2). A background ROI was placed in the temporal region. A time-activity curve of each salivary gland was created (Fig. 3A and 3B). As shown in Fig. 4, the following points were designated on the time-activity curve: a) vascular perfusion, at 1 min; b) the maximum count before stimulation; c) the background count at the time of peak activity; d) the minimum count after stimulation.

The following glandular function parameters were calculated using the time-activity curves for each salivary gland:

$$\textit{Uptake ratio (UR)} = b/c,$$

$$\textit{Maximum accumulation (MA\%)} = (b - a) / b \times 100,$$

$$\textit{Ejection fraction (EF\%)} = (b - d) / b \times 100.$$

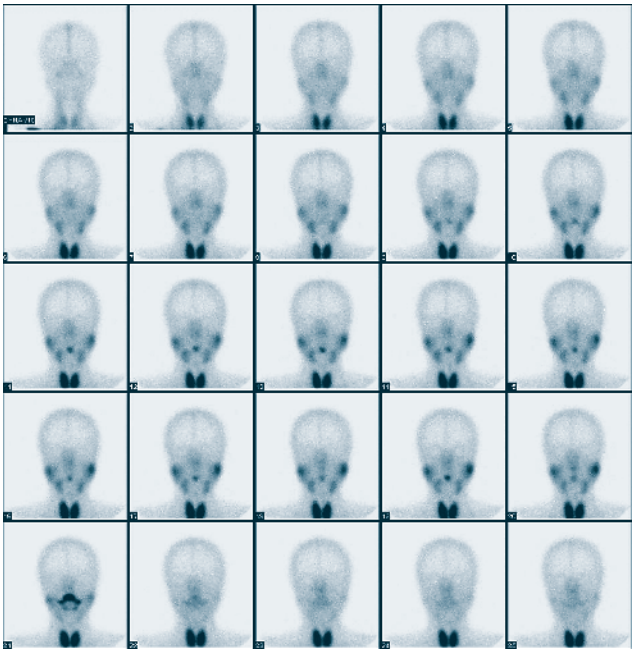

Figure 1. Dynamic salivary gland ^{99m}Tc-P scintigraphy study showing a normal distribution of radiotracer in a healthy control group subject. Dynamic imaging over a 25min period is shown.

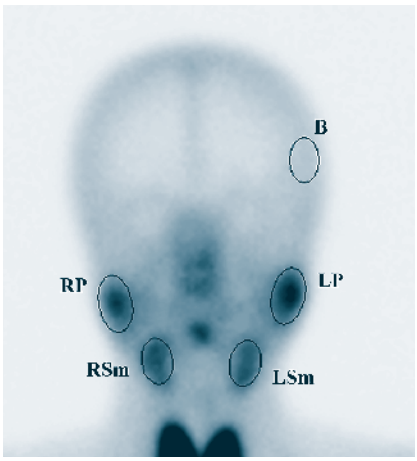

Figure 2. Regions of interest on the summation image obtained by dynamic scintigraphy. RP, right parotid; LP, left parotid; RSm, right submandibular gland; LSm, left submandibular gland; B, background.

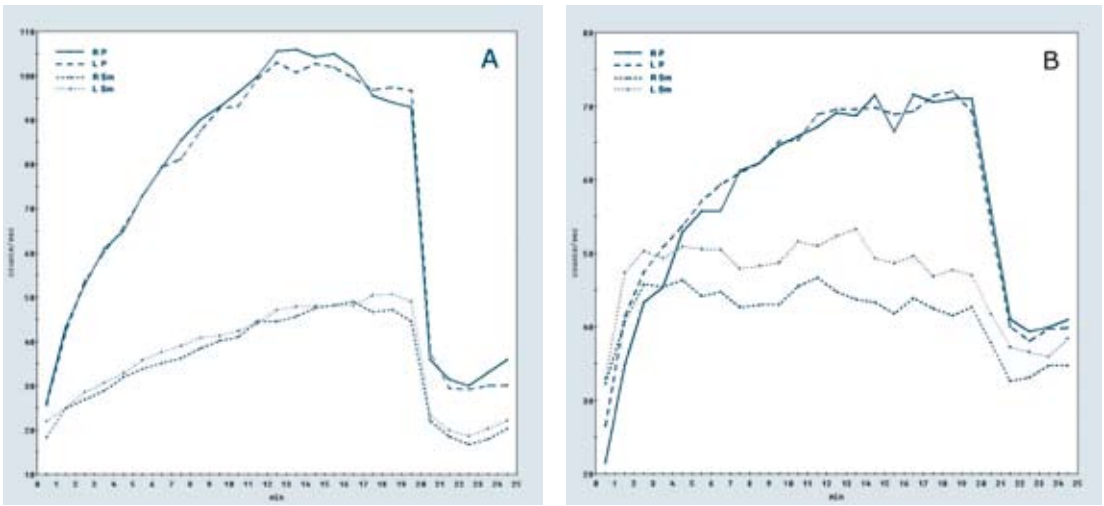

Figure 3. Time-activity curves of healthy control (A) and patient (B). RP, right parotid; LP, left parotid; RSm, right submandibular gland; LSm, left submandibular gland.

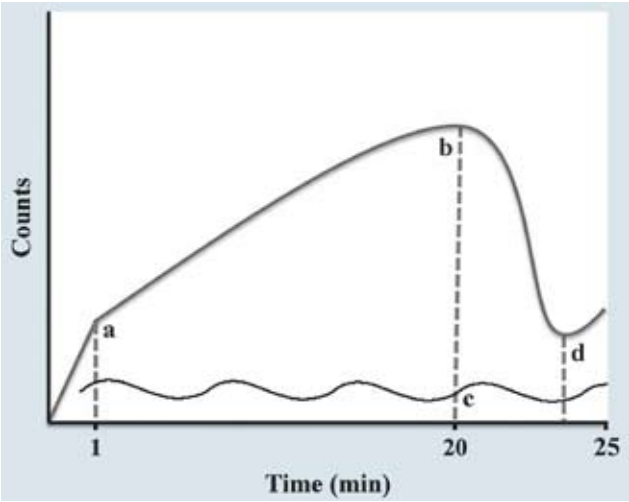

Figure 4. Schematic presentation of a time-activity curve in a normal pattern of salivary gland scintigraphy. Points: a, representing a vascular perfusion at 1min; b, the maximum count before stimulation; c, the background count at the time of peak activity; point d, the minimum count after stimulation.

Table 2. *Comparison of scintigraphic parameters in CAPD patients and healthy controls groups*

Parameter	Gland	CAPD patients (n = 36)	Healthy controls (n = 20)
UR	RP	7.58 ± 3.21	9.84 ± 2.71
	LP	7.40 ± 2.13	9.07 ± 2.14
	RSm	4.72 ± 1.10	6.51 ± 1.82
	LSm	4.83 ± 1.29	6.14 ± 1.93
%MA	RP	59.97 ± 4.09	65.38 ± 7.59
	LP	58.77 ± 6.45	64.98 ± 8.47
	RSm	35.82 ± 6.72	41.35 ± 8.43
	LSm	39.11 ± 8.04	42.82 ± 9.24
%EF	RP	58.52 ± 13.38	65.96 ± 10.32
	LP	60.19 ± 6.26	66.35 ± 8.12
	RSm	43.90 ± 12.44	51.87 ± 10.43
	LSm	42.82 ± 13.28	50.72 ± 9.46

CAPD, continuous ambulatory peritoneal dialysis; UR, uptake ratio; %MA, maximum accumulation; %EF, ejection fraction; RP, right parotid; LP, left parotid; RSm, right submandibular; LSm, left submandibular. Data are expressed as mean ± SD.

Statistical analysis

The Kolmogorov-Smirnov test of the normality of the distribution led to the use of the nonparametric method. The Mann-Whitney U test was used for comparison of scintigraphic parameters between CAPD patients and healthy controls. Differences with a *P* value less than 0.05 were accepted as significant. Data are presented as means ± standard deviation (SD). The SPSS version 11.5 (SPSS Inc., Chicago, IL) software program was used for statistical analysis.

Results

In Table 2, the values for the UR, MA% and EF% calculated from parotid and submandibular glands are presented. Statistical analysis revealed that the UR, MA% and EF% values for bilateral parotids and submandibular glands obtained in CAPD patients were significantly lower than those of healthy controls ($P < 0.05$).

Discussion

Normal salivary function is important for the metabolic health of the mouth as a whole, by providing an antimicrobial activity and lubrication for oral mucosa [7, 16]. Salivary function including maintenance of tooth integrity, antibacterial activity, taste and digestion may by disturbed by saliva flow and biochemical alterations. Patients with CRF undergoing dialysis often have a decreased salivary flow rate and oral problems such as dry mouth, oral infection and dental problems. Others have analysed saliva alterations in patients with CRF [3, 7, 8, 17, 18]. Furthermore patients with end-stage renal disease requiring hemodialysis and peritoneal dialysis had lower flow rates of salivary glands [7, 17, 18] and lower salivary secretion than healthy controls [8]. There is only one study with sialoscintigraphy in CRF [8]. Our study evaluated salivary function in patients with CRF undergoing hemodialysis not CAPD**.** In our study, a lower salivary flow rate was found in CAPD patients compared with healthy controls and the differences were statistically significant.

The salivary glands can also be evaluated through computerized tomography (CT) and sialography. We found no other papers studing patients with CRF tested with CT or scintigraphy. However, neither CT nor sialography allow quantification of the salivary gland function and obstruction [14]. Furthermore, in the diagnosis of functional obstruction by sialography, cannulization of all four salivary gland ducts is difficult and often painful for the patients [14]. On the other hand, salivary gland scintigraphy is easy, non invasive and enables a functional evaluation of the salivary glands, making it a valuable diagnostic tool. It is also well tolerated by patients, has a low dosimetry and does not interfere with normal physiology [8-11, 15]. A review of previous reports on quantitation of salivary gland function showed that most functional indices such as percent uptake, concentration and excretion fractions were derived from individual salivary gland time-activity curves generated from a dynamic study [12-14, 19].

In conclusion, results of our study indicate that salivary gland function, an important determinant of oral health, is impaired among the CRF patients treated with CAPD compared with healthy controls, as evaluated by ^{99m}Tc-P salivary gland scintigraphy. Further studies involving larger cohorts of patients should be performed to confirm these findings.

Bibliography

1. Tomás I, Marinho JS, Limeres J et al. Changes in salivary composition in patients with renal failure. *Arch Oral Biol* 2008; 53: 528-532.

2. National Kidney Foundation. Clinical practice guidelines for chronic kidney disease: evaluation, classification, and, stratification. *Am J Kidney Dis* 2002; 39: 1-266.
3. Bots CP, Brand HS, Poorterman JH et al. Oral and salivary changes in patients with end stage renal disease (ESRD): a two year follow-up study. *Br Dent J* 2007; 202: E3.
4. Epstein SR, Mandel I, Scopp IW. Salivary composition and calculus formation in patients undergoing hemodialysis. *J Periodontol* 1980; 51: 336-338.
5. Roskerr AR. Update on renal disease for the dental practitioner. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2001; 92: 9-16.
6. Humphrey SP, Williamson RT. A review of saliva: normal composition, flow, and function. *J Prosthet Dent* 2001; 85: 162-169.
7. Bayraktar G, Kazancioglu R, Bozfakioglu S et al. Stimulated salivary flow rate in chronic hemodialysis patients. *Nephron* 2002; 91: 210-214.
8. Kaya M, Cermik TF, Ustün F et al. Salivary function in patients with chronic renal failure undergoing hemodialysis. *Ann Nucl Med* 2002; 16: 117-120.
9. Mishkin FS. Radionuclide salivary gland imaging. *Semin Nucl Med* 1981; 11: 258-265.
10. Kohn WG, Ship JA, Atkinson JC et al. Salivary gland ^{99m}Tc-scintigraphy: a grading scale and correlation with major salivary gland flow rates. *J Oral Pathol Med* 1992; 21: 70-74.
11. Firat F, Cermik TF, Sarikaya A, Berkarda S. Effects of gender and age on the quantitative parameters of [99mTc]pertechnetate salivary gland scintigraphy in normal subjects. *Nucl Med Commun* 2006; 27: 447-453.
12. Anjos DA, Etchebehere EC, Santos AO et al. Normal values of ^{99m}Tc-P uptake and excretion fraction by major salivary glands. *Nucl Med Commun* 2006; 27: 395-403.
13. De Rossi G, Focacci C. A computer-assisted method for semi-quantitative assessment of salivary gland diseases. *Eur J Nucl Med* 1980; 5: 499-503.
14. Klutmann S, Bohuslavizki KH, Kröger S et al. Quantitative salivary gland scintigraphy. *J Nucl Med Technol* 1999; 27: 20-26.
15. Seven B, Yoruk O, Varoglu E et al. Evaluation by ^{99m}Tc-pertechnetate scintigraphy of the effect of levocetirizine on salivary glands function, in allergic rhinitis patients. *Hell J Nucl Med* 2009; 12: 119-122.
16. Ferguson DB. Salivary glands and saliva. In Lavelle CLB Ed. *Applied Physiology of the Mouth*. John Wright, Bristol 1975; 145–179.
17. Bayraktar G, Kazancioglu R, Bozfakioglu S et al. Evaluation of salivary parameters and dental status in adult hemodialysis patients. *Clin Nephrol* 2004; 62: 380-383.
18. Bayraktar G, Kurtulus I, Kazancioglu R et al. Oral health and inflammation in patients with end-stage renal failure. *Perit Dial Int* 2009; 29: 472-479.
19. Booker J, Howarth D, Taylor L et al. Appropriate utilization of semi-quantitative analysis in salivary scintigraphy. *Nucl Med Commun* 2004; 25: 1203-1210.