Oral Diseases (2006) 12, 176–180. doi: 10.1111/j.1601-0825.2005.01183.x

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ORIGINAL ARTICLE

The oral health status of dentate patients with chronic renal failure undergoing dialysis therapy

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OBJECTIVE: The aim of this study was to compare the oral health status of chronic renal failure (CRF) patients on renal replacement therapy with a matched reference population.

DESIGN: Cross-sectional study.

SUBJECTS: Forty-two dentate CRF patients – aged 25–52 years old – were matched with a reference group of 808 dentate subjects.

METHODS: The oral health was assessed using decayed missing filled (DMF) indices, simplified oral hygiene index and periodontal status. An oral health questionnaire was used to assess self-reported dental problems. Student *t*-tests and chi-square tests were performed to compare the CRF patients with the controls.

RESULTS: All index-scores in the CRF patients were comparable with the controls except for number of teeth covered with calculus that was significantly higher ($P < 0.05$) in CRF patients (4.1 ± 2.6) than in controls (3.0 ± 2.9). The self-reported oral health questionnaire revealed a trend for increased temporomandibular complaints in CRF patients (16.7% *vs* 5.7% in controls; $P = 0.06$) as well as bad taste (31.0% *vs* 6.8% in controls, $P = 0.08$)

CONCLUSIONS: For most dental aspects, the oral health of CRF patients is comparable with controls.

Oral Diseases (2006) **12**, 176–180

Keywords: calculus; dental; end-stage renal disease; hemodialysis; kidney; oral health; peritoneal dialysis

Introduction

The major function of the kidneys is removal of metabolic waste products, electrolytes and water. When this function is impaired towards 5–10% of the original capacity, end-stage renal disease (ESRD) can lead rapidly to death, unless renal replacement therapy is started. Chronic dialysis therapies, such as hemodialysis (HD) and peritoneal dialysis (PD) have proven to be successful in replacing the major functions of the kidney. In HD treatment, an artificial extra-corporal device is used to clear the blood of waste products and excess fluid. Access to the circulatory system is obtained through a surgically created arteriovenous shunt, and anticoagulants are administered during dialysis. HD treatment must be performed every 2–3 days for 4–5 h. In PD treatment, the patients' peritoneal membrane is used as an artificial kidney. Sterile dialysis fluid is introduced into the abdominal cavity for several hours, drained and refreshed several times during the day (Continuous Ambulatory Peritoneal Dialysis, CAPD) or continuously at night (Continuous Cycler-Assisted Peritoneal Dialysis, CCPD).

Both HD and PD treatment cause systemic changes, oral complications and alterations in salivary composition and output (Epstein *et al*, 1980; Proctor *et al*, 2005). In addition, vomiting and reduced oral (self) care could also negatively affect the oral health in chronic dialysis patients resulting in more caries, periodontitis and oral lesions (Epstein *et al*, 1980; Atassi, 2002; Proctor *et al*, 2005). However, conflicting data exist on the effect of chronic dialysis therapy on oral health status (Naugle *et al*, 1998; Gavalda *et al*, 1999; Marakoglu *et al*, 2003). Gavalda *et al* (1999), in a study with 53 HD patients, reported that the number of decayed missing and filled teeth (DMFT) and the level of periodontal attachment did not differ from a matched control group. Increased salivary urea levels could induce calculus formation, but on the contrary also contribute to the remineralization of dental enamel, leading towards a lower caries experience in children (Peterson *et al*, 1985). No differences were found for the caries variables between adult HD patients and controls (Bayraktar *et al*, 2004). On the contrary, another study

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Received 10 May 2005; revised 10 June 2005; accepted 26 June 2005

reported that the prevalence of periodontitis and caries experience was high in dialysis patients, but this study lacked a control group (Naugle *et al*, 1998).

Therefore, the aim of this cross-sectional study was to compare the oral health status of chronic renal failure (CRF) patients on renal replacement therapy with a matched reference population.

Materials and methods

Patients

The CRF patients undergoing kidney replacement therapy for at least 3 months were asked to participate. One hundred and twenty-six dialysis patients (HD, $n = 95$; (C)APD, $n = 31$) gave informed consent to participate in this study, which was approved by the Medical Ethical Committee of the Vrije Universiteit Medical Centre, Amsterdam, The Netherlands. Twenty-nine patients (23.0%) were edentulous and 13 participants (10%) were physically not able to participate in the clinical dental investigation. This resulted in 84 dentate CRF patients available for matching with a control group of 808 dentate subjects from a dental epidemiological study among subjects aged 25–54 years old (Kalsbeek *et al*, 2003). The CRF patients were matched with the control group with regard to age [excluded < 25 years ($n = 3$); > 54 years ($n = 39$)] and educational level. Finally, this resulted in 42 dentate patients aged 25–54 years old, who matched with the reference group.

Age, gender and level of education were assessed with a questionnaire and the clinical data were retrieved from patient files. The main pathologies causing CRF, classified according to the EDTA-ERA and WHO diagnostic codes (1993), were IgA nephropathy (9.5%), glomerulonephritis (9.5%), polycystic kidney disease – adult type – (7.1%) and renal vascular diseases (7.1%).

Oral health assessment

The oral health assessment of the dialysis patients took place at a dental clinic nearby one of the dialysis centers. Two dentists examined each patient, subsequently. One dentist (JP) was involved in the assessment of both the oral health in the ESRD patients and the Dutch epidemiological caries study, which was carried out in the same year (2002). The data presented are based on the consensus reached after the two inspections. The intraclass correlation coefficient for the DMFT and plaque index was 0.99 and 0.86 respectively, indicating a good intratest reliability for these variables (Streiner and Norman, 2002).

The teeth were dried with air and inspected with a standard dental mirror and assessed according to the same protocol as used in the reference group (Kalsbeek *et al*, 2003). This protocol consists of several generally accepted oral health indices, such as the DMFT and DMFS, in addition the amount of dental plaque was assessed (Greene and Vermillion, 1964; World Health Organisation, 1987; Marks *et al*, 1993). The periodontal status including pocket depth, bleeding on probing (none, minor, moderate and on probing) and presence of calculus was assessed using a split mouth model (first to third quadrant or second to fourth quadrant), to which the patients were randomly allocated. A questionnaire was used to assess specific dental issues such as problems with 'caries', 'gingiva', 'jaw pain', 'ulcerations', 'bad breath' or 'pain', during the preceding year.

Statistics

Data are presented as percentages, mean ± s.d. and the 95% confidence interval (CI) of the mean difference. The mean values of quantitative oral health data from the dialysis patients were compared with the matched reference population using independent Student *t*-tests, chi-square tests or Fisher's exact tests when appropriate. All levels of significance were set at $P < 0.05$.

Results

After matching by age and educational level with a control group of 808 patients (326 men and 482 women; mean age 41.3 ± 8.4 years) from a dental epidemiological study, the total sample of CRF patients comprised 42 patients (30 men and 12 women; mean age 42.6 ± 9.2 years). Twenty-eight CRF patients were on HD, eight on CAPD and six on CCPD, see Table 1.

Seven percent had one or more bridges in the maxilla and/or mandible. The amount of CRF patients' wearing a partial denture in the maxilla was comparable with the control group (data not shown).

Table 2 shows the data regarding the DMF indices. Both the DMFT and DMFS scores were comparable in CRF patients (DMFT: 13.3 ± 7.5; DMFS: 37.2 ± 23.7) and controls (DMFT: 14.7 ± 6.4; DMFS: 39.1 ± 22.0). No statistically significant differences were observed for any of the DMF-indices.

Both CRF patients and matched controls had the same amount of surfaces covered with dental plaque (2.4 ± 1.6 *vs* 2.6 ± 1.4, respectively), see Table 3. CRF patients had significantly more teeth covered with calculus (4.1 ± 2.6) than controls (3.0 ± 2.9; $P < 0.05$). The percentage of supra- and subgingival calculus was slightly higher in CRF patients (34.4%) than in controls (24.6%). A statistically significant association was found between the number of teeth

Table 1 Clinical and demographical data of patients with chronic renal failure (CRF) on dialysis, ($n = 42$)

Age (years ± s.d.)	42.6 (9.2)
Male gender (%)	71.4% ($n = 30$)
Educational level	
Primary school	33.3% ($n = 14$)
Secondary school	35.7% ($n = 15$)
High school or higher	31.0% ($n = 13$)
Months on dialysis	28.6 (16.9)
Therapy	
Hemodialysis	66.7% ($n = 28$)
CAPD	19.0% ($n = 8$)
CCPD	14.3% ($n = 6$)

Percentages and numbers of clinical and demographic variables. Mean values (s.d.) are given for continuous variables.
CAPD, continuous ambulatory peritoneal dialysis; CCPD, continuous cycler-assisted peritoneal dialysis.

Table 2 Decayed missing filled index values (mean ± s.d.) of patients with chronic renal failure (CRF) on dialysis compared to a matched reference group

	CRF ($n = 42$)	*Controls* ($n = 808$)	*95% CI mean difference*
Decayed teeth (DT)	1.4 (1.9)	1.3 (1.8)	−0.5–0.7
Missing teeth (MT)	3.7 (5.2)	3.7 (5.6)	−1.8–1.8
Filled teeth (FT)	8.1 (5.8)	9.7 (5.6)	−0.2–3.4
Decayed missing filled teeth (DMFT)	13.3 (7.5)	14.7 (6.4)	−0.6–3.4
Decayed surfaces (DS)	1.6 (2.6)	1.6 (2.9)	−0.9–0.9
Missing surfaces (MS)	14.3 (18.7)	14.3 (20.1)	−6.3–6.3
Filled surfaces (FS)	21.3 (16.5)	23.3 (16.3)	−3.1–7.1
Decayed missing filled surfaces (DMFS)	37.2 (23.7)	39.1 (22.0)	−5.0–8.8

No significant differences were found between the two groups.

Table 3 Dental plaque, calculus and periodontal health in patients with chronic renal failure (CRF) on dialysis compared to a matched reference group

	CRF ($n = 42$)	*Control* ($n = 808$)	*P*-value
Dental plaque (>2 teeth assessed)			
Number of surfaces assessed	5.4 ± 1.0	5.7 ± 0.8	n.s.
Number of surfaces with dental plaque	2.4 ± 1.6	2.5 ± 1.4	n.s.
Score dental plaque (% surfaces)			
0	54.1	56.3	n.s.
1	32.6	31.6	n.s.
2, 3	13.3	12.2	n.s.
Calculus (>4 teeth assessed)			
Number of teeth assessed	12.3 ± 2.1	12.2 ± 2.2	n.s.
Number of teeth *with* calculus	4.1 ± 2.6	3.0 ± 2.9	<0.05
Calculus (% teeth)			
No	65.6	75.4	n.s.
Supra or subgingival	34.4	24.6	n.s.
Pockets (>4 teeth assessed)			
Number of teeth assessed	12.3 ± 2.1	12.2 ± 2.2	n.s.
Number of teeth *with* pocket (≥4 mm)	1.8 ± 2.0	1.6 ± 2.3	n.s.
Pockets (% teeth)			
≤3.5 mm	95.8	86.9	n.s.
>3.5 and ≤5.5 mm	3.3	11.5	n.s.
>5.5 mm	1.0	1.6	n.s.
Bleeding on probing (>4 teeth assessed)			
Number of teeth assessed	11.6 ± 3.3	12.2 ± 2.2	n.s.
Number of teeth *with* bleeding	2.8 ± 2.2	3.0 ± 3.0	n.s.
Bleeding (% teeth)			
No bleeding	62.1	66.0	n.s.
Minor	12.4	9.4	n.s.
Moderate	1.9	16.4	n.s.
Immediately on probing	21.2	8.2	n.s.

t-tests and chi-square tests were performed.
n.s., No statistical significant difference.

covered with dental plaque or calculus and the number of elements with bleeding on probing ($r = 0.543$, $P < 0.001$ and $r = 0.568$, $P < 0.001$, respectively).

The periodontal pocket status did not differ between CRF patients and controls. Also, the total number of elements with bleeding on probing did not differ. Although the percentage of teeth bleeding immediately after probing in CRF patients was higher (21.2%) than in controls (8.2%), and no statistically significant differences were observed. The majority of the CRF patients (97.6%) brushed daily (28.6% once a day, 64.3% twice a day, 19.0% more than twice a day) which does not differ from of the controls (96.6% brushing daily). During the preceding year, 81% of the CRF patients ($n = 34$) had received professional oral care at least once, which is comparable with the reference group.

Table 4 Self-reported oral health during the preceding year in chronic renal failure (CRF) patients on dialysis compared with healthy controls

	CRF% ($n = 42$)	*Controls%* ($n = 808$)	*P*-value
Caries lesions	41 ($n = 17$)	25 ($n = 203$)	0.25
Gingival problems	36 ($n = 15$)	28 ($n = 226$)	0.28
Temporomandibular complaints	17 ($n = 7$)	6 ($n = 46$)	0.06
Ulcerations	21 ($n = 9$)	12 ($n = 95$)	0.12
Problems with eating and drinking	10 ($n = 4$)	21 ($n = 172$)	0.19
Missing, moving or broken teeth	17 ($n = 7$)	21 ($n = 166$)	0.21
Distortion of teeth position	7 ($n = 3$)	11 ($n = 88$)	0.11
Bad breath	24 ($n = 10$)	12 ($n = 96$)	0.12
Sharp edges of the teeth	24 ($n = 10$)	14 ($n = 111$)	0.14
Bad taste	31 ($n = 13$)	7 ($n = 55$)	0.08
Discoloration of the teeth	21 ($n = 9$)	26 ($n = 211$)	0.26
Pain	14 ($n = 6$)	15 ($n = 118$)	0.15

Chi-square or Fisher's exact tests were performed. No significant differences were found.

The association between duration of hemo- or peritoneal dialysis and the various oral health variables was investigated, however, no significant associations were found for any of these variables.

The self-reported oral health questionnaire revealed that CRF patients did not differ from the control group (Table 4). However, trends were observed for the increased frequency of temporomandibular complaints in CRF patients (16.7% *vs* 5.7% in controls; $P = 0.06$) and bad taste (31.0% *vs* 6.8% in controls; $P = 0.08$).

Discussion

In this study, the oral health of 42 dentate CRF patients was assessed and compared to a matched reference group of 808 healthy subjects. The DMFT and DMFS scores tended to be higher in the control group than in the patient group, but the difference was not statistically significant. These observations are in accordance with previous studies (Naugle *et al*, 1998; Gavalda *et al*, 1999; Marakoglu *et al*, 2003). Gavalda *et al* (1999) also found no statistically significant difference between the number of carious, absent and obturated teeth (CAO) in 105 renal patients on HD treatment (CAO = 14.9 ± 8.7) compared with 53 gender matched controls (13.3 ± 7.9).

It has been suggested by others that the caries activity in patients on dialysis is lower, as an increased urea concentration in saliva leads to higher pH levels (Epstein *et al*, 1980; Jaffe *et al*, 1986). Higher salivary urea levels

could potentially protect the teeth from demineralization but on the contrary enhance calculus formation in dialysis patients (Obry *et al*, 1987). The higher prevalence of calculus we found, suggest that CRF patients received less oral care. This seems not feasible, as almost every participant had visited an oral healthcare worker during the preceding year. It should be taken into account that in general, almost everyone (86%) in the Netherlands visits the dentist once or twice a year (Kalsbeek *et al*, 2003).

It might be possible that the effect of a relatively short period of dialysis treatment (28.6 ± 16.9 months) may not be reflected in the DMFT index, which is a measure for the life-long caries experience. Long-term dialysis treatment might affect the carious component of the DMFT (Peterson *et al*, 1985; Obry *et al*, 1987; Al Nowaiser *et al*, 2003), although studies focusing on the duration of dialysis treatment in relation to oral health did not show a substantial effect (Naugle *et al*, 1998; Marakoglu *et al*, 2003).

Our results potentially could have been biased as only relatively healthy and mobile CRF patients were able to participate in this study, thus missing those in a very poor physical condition.

We found that the number of teeth with calculus was significantly higher in the patient group than in controls. This is in accordance with the study by Gavalda *et al* (1999) who found a significantly higher calculus index in HD patients compared with controls. However, in contrast to their study, we found no differences between CRF patients and controls with respect to the amount of dental plaque. As in our study the frequency of dental hygiene procedures and dental plaque levels were comparable in both groups, it seems feasible that other factors such as salivary changes might have contributed to higher calculus deposition.

A strong correlation between the number of teeth with bleeding and the number of teeth covered with dental plaque and calculus was found. This is in agreement with previous studies on healthy individuals (Oshrain *et al*, 1979; Breuer and Cosgrove, 1989). An improvement in oral hygiene might reduce the amount of dental plaque and calculus, resulting in a reduction of the number of elements with bleeding. However, it should be taken into account that medication of HD patients, such as anti-coagulant therapy, might mask the effect of an improvement of oral health measures. We found support of this concept in our data as the increased prevalence of calculus and the higher number of bleeding on probing was not reflected in the severity and number of pocket depths (Table 3). This finding also indicates that the increased bleeding on probing does not directly reflect the level of inflammation (gingivitis or periodontitis) in CRF patients, which is in accordance with findings from Marakoglu *et al* (2003).

In our study, the data of the self-reported oral health questionnaire suggested a trend towards an increase of taste disturbances in CRF patients. (Dick and Jones, 1973; Nilsson, 1984; Astback *et al*, 1999; Middleton and Allman-Farinelli, 1999). Thirty-one percent of the CRF patients in our study reported to have had a bad taste, in the preceding year. This is in accordance with another study that showed that 31.7% of HD patients had taste changes (Kho *et al*, 1999). These taste disturbances could be caused by metabolic disturbances, the use of medication, a diminished number of taste buds and changes in salivary flow rate and composition (Epstein *et al*, 1980; Astback *et al*, 1999; Middleton and Allman-Farinelli, 1999; Bots *et al*, 2004).

Also, the number of temporomandibular complaints showed a tendency to be higher in CRF patients than in the control group. This finding might be related to renal osteodystrophy, caused by increased parathyroid functions associated with inappropriate vitamin D, calcium and phosphorus metabolism in dialysis patients (Phelps *et al*, 1994; Damm *et al*, 1997).

To conclude, we have shown that most dental aspects of oral health in CRF patients are comparable with a well-matched control group. In CRF patients, the number of teeth covered with calculus was significantly higher. However, many CRF patients are candidates for renal transplantation and need to be kept foci free. Therefore, maintaining good oral health is of major importance as oral pathologies or -infections could jeopardize the opportunity to receive a successful kidney transplant (De Rossi and Glick, 1996).

Acknowledgements

The authors would like to thank the nephrologists P.M. ter Wee, R.M. Valentijn, P.F. Vos and J.A. Bijlsma for providing access to the patients. We are also indebted to A.W. van de Beld, J.C. Boom, L. Snel, J. van de Brink, G. Meijer and. A. Bijkerk for providing the dental clinics at the different locations. We would also like to thank P.D. Bezemer for methodological advice in the set-up phase of this study.

This study was financially supported by grants from the Dutch Kidney Foundation and The Netherlands Institute for Dental Sciences (IOT).

References

Al Nowaiser A, Roberts GJ, Trompeter RS *et al* (2003). Oral health in children with chronic renal failure. *Pediatr Nephrol* **18:** 39–45.

Astback J, Fernstrom A, Hylander B *et al* (1999). Taste buds and neuronal markers in patients with chronic renal failure. *Perit Dial Int* **19**(Suppl. 2)**:** S315–S323.

Atassi F (2002). Oral home care and the reasons for seeking dental care by individuals on renal dialysis. *J Contemp Dent Pract* **3:** 31–41.

Bayraktar G, Kazancioglu R, Bozfakioglu S *et al* (2004). Evaluation of salivary parameters and dental status in adult hemodialysis patients. *Clin Nephrol* **62:** 380–383.

Bots CP, Brand HS, Veerman ECI *et al* (2004). Interdialytic weight gain in patients on hemodialysis is associated with dry mouth and thirst. *Kidney Int* **66:** 1662–1668.

Breuer MM, Cosgrove RS (1989). The relationship between gingivitis and plaque levels. *J Periodontol* **60:** 172–175.

Damm DD, Neville BW, McKenna S *et al* (1997). Macrognathia of renal osteodystrophy in dialysis patients. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* **83:** 489–495.

De Rossi SS, Glick M (1996). Dental considerations for the patient with renal disease receiving hemodialysis. *J Am Dent Assoc* **127:** 211–219.

Dick R, Jones DN (1973). Temporo-mandibular joint changes in patients undergoing chronic haemodialysis. *Clin Radiol* **24:** 72–76.

EDTA-ERA and WHO diagnostic codes (1993). *Nephrol Dial Transplant* **6:** 524–525.

Epstein SR, Mandel I, Scopp IW (1980). Salivary composition and calculus formation in patients undergoing hemodialysis. *J Periodontol* **51:** 336–338.

Gavalda C, Bagan J, Scully C *et al* (1999). Renal hemodialysis patients: oral, salivary, dental and periodontal findings in 105 adult cases. *Oral Dis* **5:** 299–302.

Greene JC, Vermillion JR (1964). The simplified oral hygiene index: a method for classifying oral hygiene status. *J Am Dent Assoc* **68:** 7–13.

Jaffe EC, Roberts GJ, Chantler C *et al* (1986). Dental findings in chronic renal failure. *Br Dent J* **160:** 18–20.

Kalsbeek H, Poorterman JHG, Kivit MM (2003). *Tandheelkundige Verzorging Volwassen Ziekenfondsverzekerden 1995–2002*. Leiden, The Netherlands: TNO Preventie en Gezondheid, rapport: PG/JGD/03.219.

Kho HS, Lee SW, Chung SC *et al* (1999). Oral manifestations and salivary flow rate, pH, and buffer capacity in patients with end-stage renal disease undergoing hemodialysis. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* **88:** 316–319.

Marakoglu I, Gursoy UK, Demirer S *et al* (2003). Periodontal status of chronic renal failure patients receiving hemodialysis. *Yonsei Med J* **44:** 648–652.

Marks RG, Magnusson I, Taylor M *et al* (1993). Evaluation of reliability and reproducibility of dental indices. *J Clin Periodontol* **20:** 54–58.

Middleton RA, Allman-Farinelli MA (1999). Taste sensitivity is altered in patients with chronic renal failure receiving continuous ambulatory peritoneal dialysis. *J Nutr* **129:** 122–125.

Naugle K, Darby ML, Bauman DB *et al* (1998). The oral health status of individuals on renal dialysis. *Ann Periodontol* **3:** 197–205.

Nilsson P (1984). Bone disease in renal failure. Clinical and histomorphometric studies. *Scand J Urol Nephrol Suppl* **84:** 1–68.

Obry F, Belcourt AB, Frank RM *et al* (1987). Biochemical study of whole saliva from children with chronic renal failure. *ASDC J Dent Child* **54:** 429–432.

Oshrain HI, Mender S, Mandel ID (1979). Periodontal status of patients with reduced immunocapacity. *J Periodontol* **50:** 185–188.

Peterson S, Woodhead J, Crall J (1985). Caries resistance in children with chronic renal failure: plaque pH, salivary pH, and salivary composition. *Pediatr Res* **19:** 796–799.

Phelps KR, Bansal M, Twersky J (1994). Jaw enlargement complicating secondary hyperparathyroidism in three hemodialysis patients. *Clin Nephrol* **41:** 173–179.

Proctor R, Kumar N, Stein A *et al* (2005). Oral and dental aspects of chronic renal failure. *J Dent Res* **84:** 199–208.

Streiner DL, Norman GR (2002). *Health measurement scales: a practical guide to their development and use*. Oxford University Press: Oxford.

World Health Organisation (1987). *Oral health surveys. Basic methods*. WHO: Geneva.