The oral health status of children undergoing hemodialysis treatment

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In this study, we investigated the oral status of children suffering from end-stage renal disease (ESRD) with the aim of determining the causes of low caries prevalence in this population (using the CRT® bacteria and buffer test), and compared results with a control group (n=38). In the study group, there were 38 children (aged 4-17 years) who were being treated in pediatric nephrology units at three different hospitals in İzmir, Turkey.

The study and control groups did not significantly differ in daily tooth brushing frequency and periodic dental check-up frequency. Severe enamel hypoplasia was present in the study group. Dmft, DMFT, gingival and plaque indices were compared statistically in mixed dentition stage with the control group and dmft and gingival status showed a statistically significant difference ($p<0.05$). The differences among groups for DMFT and plaque indices were not statistically significant.

In the study group, high salivary buffer capacity was found in 89.5% of patients. Salivary levels of cariogenic streptococcus mutans and lactobacilli in the study group were significantly lower than in the control group.

In conclusion, probably due to increased concentrations of antibacterial chemicals such as urea in the saliva of children with ESRD, decreased levels of cariogenic microorganisms were detected. Therefore, although dental treatment need is not high, these children should receive dental health education, including oral hygiene instruction, in order to improve their overall oral health.

Advances in pediatric nephrology during the last two decades have resulted in a marked increase in the number of children surviving with chronic renal failure (CRF). Although many complications of chronic renal diseases can now be prevented or treated effectively, these therapeutic advances have introduced new problems, including concerns of oral health. The prevalence of chronic renal impairment in Turkey is 390 Prevalence Million Population (PMP-0.039%) according to the 2001 report of the Turkish Society of Nephrology. Patients with CRF who could not be treated need to follow renal replacement therapy by dialysis or transplantation, and the disease is then referred to as end-stage renal disease (ESRD). At present, the number of patients on renal dialysis is 14,086, and 142 (1.008%) of them are under 15 years of age[1].

There are a number of reports on the oral changes in patients with CRF and ESRD. Among these are enamel hypoplasia, enamel opacities, uremic stomatitis, oral bleeding, decreased periodontal disease, reduced salivary flow, xerostomia, and an increased tendency for calculus deposition[2-5]. Bone disease is a complication of CRF in the developing child. Dental age of these children is delayed, but to a lesser extent than bone age[6]. The effects of CRF on the developing dentition are related to the time of onset of the disease[4]. Renal failure is also associated with a reduced prevalence of caries, and its early intraoral symptoms include bad metallic taste and ammonia odor. Loss of lamina dura, loosening of teeth, bony fractures, bone tumors, radiolucent cyst-like lesions, malocclusion, narrow pulp chamber, and thick pre-dentin may also be seen in these

patients[7,8].

Because of the oral health concerns for children with CRF and ESRD, this study was designed to gain further insight into some of the oral changes seen in ESRD patients. The aims of the present study were to monitor the oral health of children with ESRD, and to investigate the cariogenic microflora in comparison with the healthy control group.

Material and Methods

The subjects of this study were 38 children (16 girls and 22 boys) between the ages of 4 and 17 years (12.868±3.793) who were undergoing hemodialysis treatment in pediatric nephrology units at three different hospitals in İzmir, Turkey. Primary kidney disorders are listed in Table I. The fluoride concentration in the public water supply in İzmir is known as 0.3-0.5 ppm[9].

Table I. Primary Kidney Disorders in Children with End-Stage Renal Disease

Primary diagnosis	Number of subjects
Glomerulonephritis	9
Postinfectious renal failure	8
Vesicoureteric reflux	5
Obstructive uropathy	4
Unknown etiology	4
Amyloidosis	3
Nephrotic syndrome, steroid resistant	1
Renal hypoplasia	1
Nephrocalcinosis	1
Hyperoxaluria	1
Hemolytic uremic syndrome	1

In order to form the control group, we examined the primary school students whose socio-economic status and oral hygiene habits resembled the study group. Subjects in the control group consisted of 38 normal children (21 girls and 17 boys) ranging in ages between 7 and 12 years (9.316±1.662).

Information related to the blood chemistry of each child was obtained from the patient's records before and after the hemodialysis, specifically blood levels of urea, creatinine, sodium (Na), potassium (K), calcium (Ca), and phosphorus (P). CRF is defined here in pediatric nephrology units as a glomerular filtration rate (GFR) of 25 ml/min. The patients had been placed on a 1 g/kg/day protein; low-Na, P, and K; and high carbohydrate diet.

One examiner carried out clinical examinations using a mouth mirror and a probe according to the criteria of the World Health Organization (WHO)[10]. Each subject was assessed for daily tooth brushing frequency, periodic dental check-up frequency, and ammonia odor. Following a general appraisal of the mouth, the teeth were examined in both study and control groups for hypoplasia, discolorations, gingival status and plaque indices. Patients without any antibiotic therapy in the last week before the sample collection were included in the investigation.

Caries status was determined by recording the number of decayed (d, D), missing (m, M), and filled (f, F) teeth in the primary and permanent dentitions per patient and were referred to as dmft and DMFT scores, respectively. The gum status and deposits were assessed using the gingival and plaque indices[11]. Enamel hypoplasia was assessed using the criteria determined by Alaluusa et al.[12]. The CRT Buffer Test [CRT® Bacteria and Buffer Test (Vivadent Ets., Lichtenstein)] was used to determine the buffer capacity of saliva using a colorimetric test strip. The CRT Bacteria Test measured the Streptococcus mutans (S. mutans) and lactobacilli count in saliva by means of selective culture media.

Before collecting saliva for the CRT Buffer and Bacteria Test, the patients were asked not to eat or drink for at least an hour. Salivation was stimulated by having the children chew a paraffin pellet for 5 minutes. The saliva from each patient was collected in a calibrated container. CRT Buffer Test was stripped from the package without touching the yellow test field. The entire yellow test field was wetted with saliva using a pipette. To determine the buffer capacity of saliva, the color of the test field was compared with the color samples after exactly 5 minutes of reaction time. High, medium, and low salivary buffer capacities are indicated by blue, green, and yellow test fields, respectively. The saliva collected for the CRT Buffer Test was also used for the CRT Bacteria Test. The agar carrier was removed from the test vial, and a $NaHCO_{3-}$ tablet was placed at the bottom of the vial. The protective foils were removed carefully from the two agar surfaces. Using a pipette, both agar surfaces were wetted with saliva and excess was allowed to drip off. The agar carrier was placed back into the vial, which was closed tightly. The vials were incubated at 37°C for 48 hours. The density of S. mutans and lactobacilli colonies was

assessed using the corresponding evaluation pictures provided with the kit.

Children who needed dental treatment in both groups were referred to the University's Pedodontics Clinic.

Comparisons between control and ESRD children were made using chi-square, Mann-Whitney U and Wilcoxon tests for oral hygiene parameters.

Results

Pre-and post-dialysis laboratory findings of children with ESRD revealed a considerable improvement (Table II).

The number of children with enamel hypoplasia, according to the age of onset and duration of the renal disease is seen in Table III.

Table IV shows that the ESRD group had significantly more tooth discoloration and increased incidence and severity of enamel hypoplasia. In the ESRD group, five children had intrinsic staining, whereas extrinsic stains were found in 24 patients. Only one patient in the control group had intrinsic stain, and none had extrinsic stain. Of 38 children with ESRD, 21.1% had mild, 23.7% had moderate and 2.6% had severe enamel hypoplasia. The data obtained from the groups were statistically significant ($p<0.001$).

The caries status, and gingival and plaque indices of the ESRD group are seen in Table V. The control group consisted of 38 children between 7-12 years dmft, DMFT, and gingival plaque indices of the control group were 2.078, 1.078, 1.158±0.437 and 1.368±0.541, respectively.

Table II. Laboratory Findings in End-Stage Renal Disease Children (Mean±Standard Deviation)

	Pre-dialysis laboratory values	Post-dialysis laboratory values
Urea (mg/dl)	142.076±82.218	51.769±31.622
Creatinine (mg/dl)	7.786±2.718	3.327±1.275
Sodium (mEq/L)	138.481±5.280	139.777±4.300
Potassium (mEq/L)	4.900±0.898	3.946±2.032
Calcium (mg/dl)	7.829±2.520	8.515±2.315
Phosphorus (mg/dl)	5.912±1.946	2.976±1.013

Table III. Number of Children with Enamel Hypoplasia, According to the Age of Onset and Duration of the Renal Disease

	Age of onset of renal disease					
	Number of children			Number of children with hypoplasia		
Duration in years	1-4 years	5-9 years	10-13 years	1-4 years	5-9 years	10-13 years
<1 year	2	3	3	0	0	0
1-3 years	1	5	3	1	1	3
>4 years	3	9	9	3	6	4
Total	6	17	15	4	7	7

Table IV. Frequency of Tooth Discolaration and Enamel Hypoplasia in Study and Control Groups (%)

		Discoloration (%)		Hypoplasia (%)				
	n	None	Intrinsic	Extrinsic	None	Mild	Moderate	Severe
Patients	38	23.6	13.2	63.2	52.6	21.1	23.7	2.6
Control	38	97.4	2.6	–	94.7	2.6	2.6	–
p			<0.05			<0.05		

The statistical analysis revealed that dmft and gingival status showed significant difference among groups ($p<0.05$). Although DMFT and plaque indices were lower for the study group, there was no statistical significance between the groups. Thirty-four CRF patients (89.5%), but only seven normal patients (18.4%) had high salivary buffer capacity (Table VI). None of the children in the study group had low salivary buffer capacity. Salivary S. mutans and lactobacilli counts in normal children were significantly higher than in the study group (Table VI).

Daily tooth brushing frequency and periodic dental check-up frequency were not significantly different in the study and control groups ($p>0.05$). None of the patients in the study group had ever visited the dentist, and 92.1% did not brush their teeth (Table VII).

Discussion

In the present study, the 38 children with ESRD clearly differed from a normal childhood population in most of the dental parameters such as enamel hypoplasia, tooth discoloration, dmft, S. mutans and lactobacilli counts, and buffer capacity of saliva.

Enamel hypoplasia is the result of a defect in the appositon and mineralization of the enamel due to either hereditary, mechanical

Table V. dmft, DMFT, and Gingival (GI) and Plaque (PI) Indices in End-Stage Renal Disease Children

Dentition	n	dmft	DMFT	GI (mean±SD)	PI (mean±SD)
Primary (4-6 years)	2	3.5	–	0±0	1±0
Mixed (7-12 years)	15	0.4	0.533	0.800±0.414	1.267±0.458
Permanent (13-17 years)	21	–	1.571	1.619±0.740	1.952±0.669

d : decayed.
m : missing.
f : filled, primary teeth.
D : decayed.
M : missing.
F : filled, permanent teeth.

Table VI. Buffer Capacity of Saliva and S. mutans and Lactobacilli Counts in Saliva of CRF Patients Compared to Healthy Children

		Buffer capacity of saliva			S. mutans			Lactobacilli	
	n	High	Medium	Low	$<10^5$	$>10^5$		$<10^5$	$>10^5$
Patients	38	89.5	10.5	–	97.4	2.6		60.5	39.5
Control	38	18.4	68.4	13.2	28.9	71.1		7.9	92.1
p			<0.05		<0.05		<0.05		

CRF: chronic renal failure.

Table VII. Daily Tooth-Brushing Frequency and Periodic Dental Check-up Frequency in Study and Control Groups (%)

	Daily tooth-brushing frequency (%)			Periodic dental check-up frequency (%)			
	n	None	Once a day	2-3 times a day	None	Rare	Regular
Patients	38	92.1	7.9	–	100	–	–
Control	38	86.8	13.2	–	92.1	7.9	–
p			>0.05			>0.05	

or metabolic factors. Disturbances occurring during intrauterine life or in early infancy generally affect the primary teeth, while damage caused later in life will mainly be manifested in the permanent denitition[13,14]. The enamel hypoplasia noted in CRF was typical of that seen in patients with calcium deficiency. Calcium depletion with renal impairment during mineralization of the developing dentition, often resulting in enamel hypoplasia, is a likely sequela[4,6]. Nunn et al.[5] reported 83% of their renal patients had enamel defects.

Koch et al.[14] investigated the exfoliated primary teeth of CRF or ESRD patients microscopically and showed that enamel hypoplasia was limited to postnatal enamel.

Of our patients, 47.4% demonstrated various degrees of enamel defects, in the form of hypoplasia. This increased prevalence was probably due to abnormal calcium and phosphate metabolism. There was an evident correlation between the location on the teeth of hypoplastic changes and the age of onset of severe renal failure that was similar to the findings of Wolff et al.[4]. Table III shows that the prevalence of hypoplasia increases with the duration of the disease and the early onset.

Intrinsic staining is generally a result of adsorption of pathological pigments onto the dentine matrix. Brown discoloration can be seen when uremia is present during development of the dentitions[15]. Intrinsic stains are also seen in some hemodialysis patients resulting from the use of tetracycline to treat infection during the period of calcification of the primary and permanent teeth. Intrinsic stains in our study group were not related to tetracycline use since the patients' physicians were aware that tetracycline could stain developing teeth and did not prescribe it. Our findings of intrinsic brown staining in 13.2% of patients are in agreement with previous reports[4,15].

Extrinsic staining was found in 63.2% of the pediatric patients with ESRD in our study. The children were being treated for anemia with ferrous sulfate in syrup form, which caused the black-brown extrinsic staining on the teeth. Chow et al.[16] reported similar findings. Ferrous sulfate medications in capsular rather than syrup form can be used to avoid extrinsic staining of teeth. Extrinsic stain can be readily removed from the surface of the teeth with an abrasive prophylactic material.

Children in both groups did not brush their teeth regularly, consistent with findings from other studies[4,6,17]. All children in the study group and 92.1% of those in the control group had never visited the dentist. Among the early symptoms of renal diseases are metallic taste and ammonium odor[2,3], and 71.1% of our patients had these symptoms.

Children with CRF and ESRD usually consume cariogenic foods such as cakes, soft drinks, and sweets to compensate for the reduction in protein intake. The low caries prevalence in ESRD pediatric patients was the most interesting finding of this study, in spite of the fact that the patients had poor oral hygiene, and were maintained on high-carbohydrate diets[5,6,16]. The patients' low caries rate could have been related to elevated urea levels in the saliva that raise salivary pH.

In many reports, there is a positive correlation between dental caries and S. mutans and lactobacilli counts18-20. Salivary urea elevated pH, possibly negating the effect of any acid formation by these cariogenic bacteria resulting from sugar intake. This mechanism also inhibits caries because of its antibacterial properties and its inhibitory effect on plaque formation. In addition, high salivary phosphate concentrations found in patients with uremia may facilitate remineralization of incipient carious lesions[17,21,22].

We found reduced caries prevalence despite poor oral hygiene in uremic children. Eighteen patients (47.4%) in our study group had never experienced dental caries, similar to the results of Nunn et al.[5]. The results of the 1990 Oral Health in Turkey Report[23], using equivalent diagnostic criteria, indicated that caries prevalence was over 90% for the 5-6 year age group and approximately 80% for 6 to 12 years olds. According to the report, dmft and DMFT values increase with age. The 15-19 year olds had DMFT of 4.3, which is higher than the findings of this study group of permanent dentition.

Similar to findings of Jaffe et al.[6], plaque amounts were similar in both groups, but the gingival status was lower for the ESRD patients in our study. Jaffe et al.[6] reported that this may be due to inadequate inflammatory response in the gingival tissue or to decreased level of hemoglobin that leads to paleness of

the gingivae despite the presence of marked inflammation. It is likely that this is related to the patients' level of education and low socioeconomic status. These findings indicate that there is a need for dental health education for all children and their families in İzmir. These findings also showed that there is a relatively less restorative and dental treatment need than that seen in the normal childhood population due to the presence of less dental caries. Dental and medical care should be closely integrated for children with renal disease to avoid conditions such as gingival overgrowth or problems in treating enamel hypoplasia, despite a low incidence of caries in children with CRF. Their bad oral hygiene habits and the resultant gingival changes suggest a need for dental advice and supervision. The oral hygiene habits of these children should be improved and monitored closely through periodic dental check-ups. The prescription of additional fluorides (other than that received from fluoridated water and toothpastes) for these patients is contraindicated because of their renal impairment. In conclusion, regular brushing is necessary for a favourable long-term oral health condition of children with CRF and ESRD.

REFERENCES

1. Registry of the Nephrology Dialysis and Transplantation in Turkey. Published by the Turkish Society of Nephrology, 2001: 7-15.
2. Sonis ST, Fazio RC, Fang L. Principles and Practice of Oral Medicine (2nd ed). Philadelphia, London, Toronto, Montreal, Sydney, Tokyo: WB Saunders Company; 1995: 293-304.
3. Lynch MA, Brightman VJ, Greenberg MS. In: Cohen SG (ed) Burket's Oral Medicine Diagnosis (8th ed) Philadelphia, London, Mexico City, New York, Sydney: JB Lippincott Company; 1984: 705-726.
4. Wolff A, Stark H, Starnat H, Binderman I, Eisenstein B, Drukker A. The dental status of children with chronic renal failure. Int J Pediatr Nephrol 1985; 6: 127-132.
5. Nunn JH, Sharp J, Lambert HJ, et al. Oral health in children with renal disease. Pediatr Nephrol 2000; 14: 997-1001.
6. Jaffe EC, Chantler Carter JE. Dental findings in chronic renal failure. Br Dent J 1986; 160: 18-21.
7. Wysocki GP, Daley TD, Ulan RA. Predentin changes in patients with chronic renal failure. Oral Surg Oral Med Oral Pathol 1983; 56: 167-173.
8. Nasström K, Forsberg B, Petersson A, Westesson PL. Narrowing of the dental pulp chamber in patients with renal diseases. Oral Surg Oral Med Oral Pathol 1985; 59: 242-246.
9. Ertuğrul F, Koparal E. İzmir ilinde içme sularının flor düzeyleri ve ağız-diş sağlığı yönünden önemi. Ege Pediatri Bülteni 1999; 6: 1-5.
10. World Health Organization. Oral Health Surveys: Basic Methods (3rd ed). Geneva, 1987: 334-335.
11. Loe H. The gingival index, the plaque index and the retention index systems. J Periodontol 1967; 38: 610-616.
12. Alaluusa S, Lukinmaa PL, Koskimies M, et al. Developmental dental defects associated with long breast feeding. Eur J Oral Sci 1996; 104: 493-497.
13. Oliver WJ, Owings CL, Brown WE, Shapiro BA. Hypolastic enamel associated with the nephritic syndrome. Pediatrics 1963; 32: 399-406.
14. Koch MJ, Buhrer R, Pioch T, Scharer K. Enamel hypoplasia of primary teeth in chronic renal failure. Pediatr Nephrol 1999; 13: 68-72.
15. Sowell SB. Dental care for patients with renal failure and renal transplants. JADA 1982; 104: 171-177.
16. Chow MH, Peterson DS. Dental management for children with chronic renal failure undergoing hemodialysis therapy. Oral Surg 1979; 48: 34-38.
17. Epstein SR, Mandel I, Scopp IW. Salivary composition and calculus formation in patients undergoing hemodialysis. J Periodontol 1980; 51: 336-338.
18. Alaluusua S. Salivary counts of mutans streptococci and lactobacilli and past caries experience in caries prediction. Caries Res 1993; 27: 68-71.
19. Beighton D. A simplified procedure for estimating the level of Streptococcus mutans in the mouth. Br Dent J 1986; 160: 329-330.