https://doi.org/10.35845/kmuj.2025.23565

ORIGINAL ARTICLE

Cytopathological changes of oral mucosa in dialysis-dependent chronic kidney disease: association with KDIGO staging

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Date Submitted: February 07, 2023
Date Revised: December 06, 2025
Date Accepted: December 15, 2025

ABSTRACT

Objective: To determine cytopathological changes in the oral mucosa of patients with chronic kidney disease (CKD) undergoing dialysis and to assess their association with Kidney Disease: Improving Global Outcomes (KDIGO) staging.

Methods: This cross-sectional study was conducted at University of Health Sciences, Lahore, from January to November 2019, after institutional ethical approval. One hundred CKD patients on dialysis were recruited from tertiary care hospitals in Lahore using predefined criteria. Socio-demographic data, oral hygiene status, clinical oral manifestations and relevant laboratory parameters were documented. CKD staging was performed according to KDIGO-2013 guidelines, and renal ultrasound grading was assessed. Oral mucosal smears were evaluated for inflammatory changes and cytological atypia. Associations between clinical, cytological, and KDIGO variables were analyzed through SPSS version-23.

Results: Mean age of participants was 50.09±14.98 years, with a male predominance. Xerostomia (86%), metallic taste (48%), and uremic fetor (45%) were the most frequent oral manifestations. Cytologically, reactive- and non-reactive atypia were identified in 29% and 40% cases respectively. Significant associations were found between inflammatory atypia and thickened mucosa, and between non-reactive atypia and angular cheilitis. Prominent nucleoli were significantly associated with metallic taste and higher KDIGO stages. Grades 3b and 4 CKD showed significant associations with duration of dialysis, xerostomia, periodontitis, and prominent nucleoli.

Conclusion: Oral cytopathological alterations are common in CKD patients undergoing dialysis and show significant associations with disease severity as per KDIGO staging. Oral cytology may serve as a useful adjunctive tool for early detection and monitoring of mucosal changes in patients with advanced CKD.

Keywords: Kidney Diseases (MeSH); Chronic Kidney Disease (MeSH); Renal Insufficiency, Chronic (MeSH); Hemodialysis (MeSH); Mouth Mucosa (MeSH); Cytology (MeSH); Oral Cytology (Non-MeSH); Epithelial Atypia (Non-MeSH); Micronuclei (MeSH); Oral Manifestations (MeSH).

THIS ARTICLE MAY BE CITED AS: Khan UJ, Anjum R, Bugvi NA, Naseem N, Nagi AH. Cytopathological changes of oral mucosa in dialysis-dependent chronic kidney disease: association with KDIGO staging. Khyber Med Univ J 2025;17(4):408-16. https://doi.org/10.35845/kmuj.2025.23565

INTRODUCTION

Chronic kidney disease (CKD) is a progressive condition characterized by persistent structural and functional abnormalities of the kidneys and affects an estimated 700 million individuals worldwide.[1] Clinically, CKD is defined by a glomerular filtration rate (GFR) below 60 mL/min/1.73 m^2, or by evidence of kidney damage, including micro- or macroalbuminuria, persistent hematuria, or radiological abnormalities, present for more than three months.[2] The disease is categorized into five stages based on estimated glomerular filtration rate (eGFR) and the degree of proteinuria, reflecting progressive loss of renal function.[3]

Given the kidneys' central role in maintaining metabolic and fluid homeostasis, CKD contributes substantially to global morbidity and mortality.[4] Beyond its systemic associations with conditions such as diabetes mellitus, coronary artery disease, and graft-versus-host disease, CKD is also linked to characteristic oral manifestations. These oral changes may serve as clinically useful indicators of disease severity and provide insight into the overall systemic health of affected individuals.[5]

Oral alterations in patients with CKD may arise from the underlying renal pathology, therapeutic interventions, or a combination of both. When left untreated, these lesions can adversely affect the patient's clinical course and overall prognosis.[6] Individuals undergoing dialysis commonly exhibit a spectrum of oral manifestations, including mucosal pallor, xerostomia, dysgeusia, gingivitis, and parotitis.[7] In addition, impaired immune function in CKD predisposes patients to opportunistic infections such as oral candidiasis and herpes simplex virus infection.[8]

Despite the recognized burden of oral manifestations in chronic kidney disease, there remains a paucity of data on cytopathological changes of the oral mucosa in patients with CKD, particularly those undergoing dialysis, in regional and local settings. Most available studies have focused on clinical oral findings, with limited attention to cellular-level alterations and their relationship with disease severity. To address this gap, the present study aimed to evaluate cytopathological changes in the oral mucosa of patients with chronic kidney disease undergoing dialysis using exfoliative cytology, and to explore their association with disease severity.

METHODS

This study was conducted in the Department of Morbid Anatomy and Histopathology/Oral Pathology at the

University of Health Sciences, Lahore, Pakistan, from January to November 2019, following approval from the Institutional Ethics Review Committee (UHS/REG-18/ERC/456).

A minimum sample size of 100 participants was calculated using a 95% confidence level, a 10% margin of error, and an expected prevalence of oral epithelial atypia of approximately 30% among patients with chronic kidney disease, as reported in previous studies.[6-8]

Participants were recruited from the Departments of Nephrology at Fatima Memorial Hospital and Sheikh Zayed Hospital, Lahore. Patients with controlled hypertension or diabetes, without any other chronic medical illness or concurrent malignancy, were included after obtaining written informed consent. Individuals with a history of tobacco use, other addictions, or denture use were excluded. Socio-demographic data and relevant clinical information were recorded, including oral hygiene status, periodontitis, and xerostomia. Oral assessments were performed by dental surgeons using periodontal probing to assess pocket depth for periodontitis, and clinical evaluation of mouth dryness, oral burning, swallowing difficulty, and altered or reduced taste for xerostomia.

Laboratory investigations, including blood urea nitrogen, serum albumin, and hemoglobin levels, were obtained for all participants. Chronic kidney disease was classified according to glomerular filtration rate using Kidney Disease: Improving Global Outcomes (KDIGO) 2013 guidelines (Table I).[9]

Grading of CKD on ultrasound was carried out based on renal length, cortical thickness, cortical echogenicity and cortico-medullary differentiation. Standard B Mode grey scale ultrasound with sector curved array transducer of 3.5-5 MHz was used for ultrasound. The echogenic parenchyma of kidney was assessed by applying low tissue harmonic and speckle reduction imaging to reduce the interobserver bias. For cytological evaluation, participants were instructed to rinse the oral cavity prior to smear collection. Exfoliative smears were obtained from the oral mucosa using a wooden spatula, transferred onto clean glass slides, and fixed in ethyl alcohol for 30 seconds. The smears were subsequently stained with Giemsa and Papanicolaou stains. Periodic acid-Schiff (PAS) and Grocott-Gomori's methenamine silver (GMS) stains were applied to smears with suspected fungal infection. Smear adequacy was assessed based on cellularity and graded as 0 (no cells), 1 (scant cells), or 2 (adequate cells).[10]

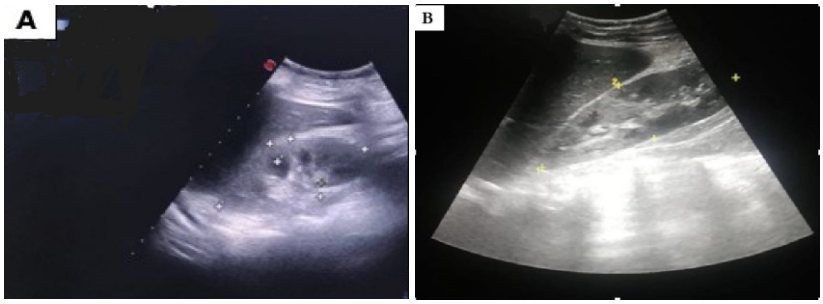

Figure 1: (**A**) shows the normal renal length and cortical thickness with preserved corticomedullary demarcation (**B**) increased renal parenchymal echogenicity with grade-3 changes.

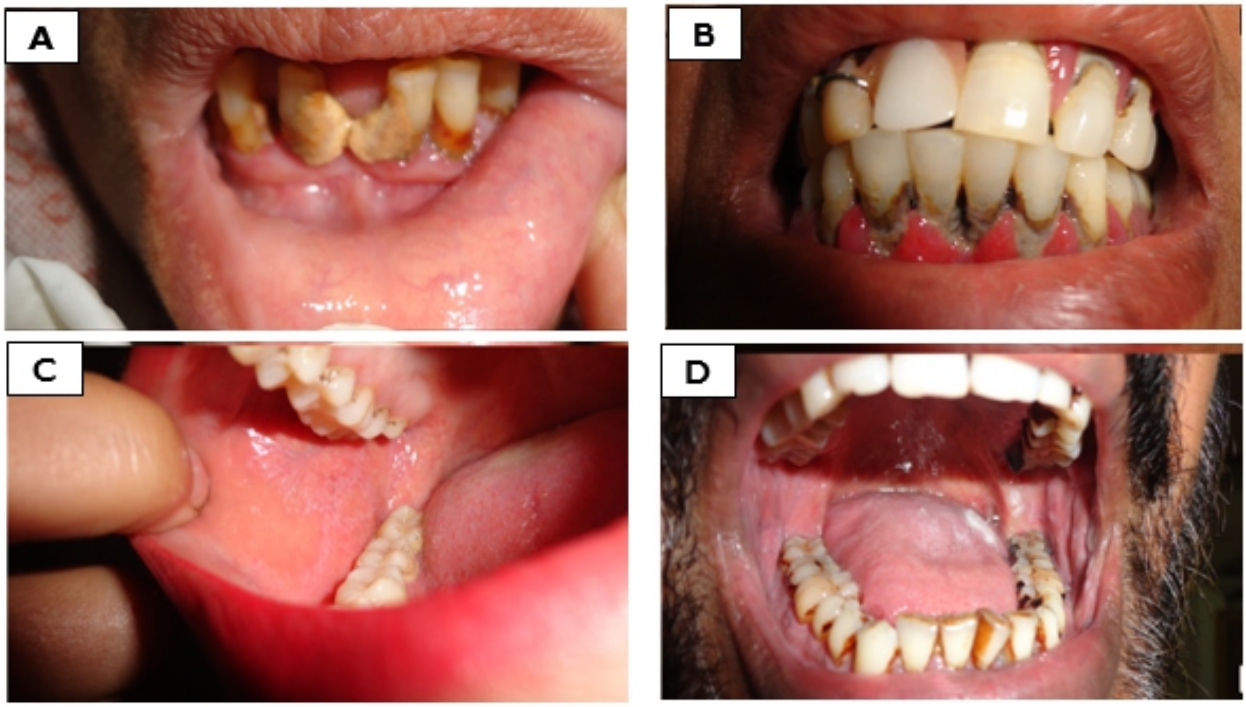

Figure 2: (**A**) is showing Poor oral hygiene with periodontitis, (**B**) inflamed and swollen gingiva showing gingivitis (**C**) discolored buccal mucosa and (**D**) whitish tongue coatingin patients with CKD.

Data were entered and analyzed using IBM SPSS (Statistical Package for the Social Sciences) version 23.0. Descriptive variables were expressed as frequencies and percentages. Associations between clinical and cytological findings were assessed using the Pearson chi-square test and Fisher's exact test, as appropriate. Regression analysis was performed to further evaluate relationships between independent and dependent variables. A p value≤0.05 was considered statistically significant.

RESULTS

This cross-sectional study was conducted at the Departments of Morbid Anatomy and Histopathology/Oral Pathology, University of Health Sciences, Lahore, from January to November 2019, following institutional ethical approval. One hundred patients with chronic kidney disease undergoing dialysis were recruited from tertiary care hospitals in Lahore. Socio-demographic characteristics, oral hygiene status, and clinical oral findings were recorded, along with laboratory parameters including blood urea nitrogen, albumin, and hemoglobin. Chronic kidney disease was staged according to KDIGO 2013 guidelines, with additional renal ultrasound grading. Oral mucosal smears were obtained, stained with Papanicolaou and Giemsa stains, and assessed for inflammatory and cytological atypia. Associations among clinical, cytological, and KDIGO variables were evaluated using Chi-square and Fisher's exact tests, with logistic regression analysis. The mean age of the participants was 50.09±14.98 years (range: 22-83 years). The study cohort comprised 57 males and 43 females, yielding a male-to-female ratio of 1.3:1. Mean serum creatinine, blood urea nitrogen, albumin, and hemoglobin levels were 9.81±2.66 mg/dL, 47.67±13.36 mg/dL, 3.67±0.54 mg/dL, and 9.36±1.78 g/dL, respectively. According to KDIGO staging, the highest proportion of patients were classified as stage 4 (28%), followed by stage 5 (21%), stage 3b (19%), and stage 3 (17%), while the smallest proportion of patients were in stage 1 (9%).

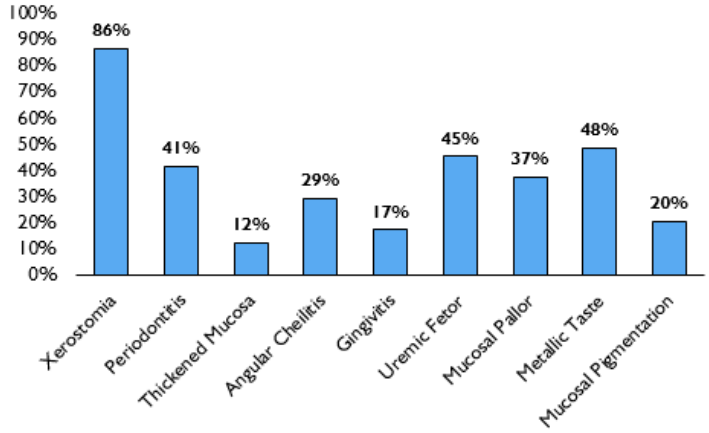

Figure 3: Frequency of oral mucosal lesions in (n=100) CKD patients on dialysis

Of the 100 participants, 54% belonged to a low socioeconomic group. The duration of dialysis was 3-4 years in 35% of patients, 5-6 years in 27%, and 7-8 years in 38%. Clinically, although most patients demonstrated adequate oral hygiene, 47% were noted to have poor oral hygiene. Among oral manifestations, xerostomia was the most frequent finding (86%), followed by periodontitis (41%) and gingivitis, as illustrated in Figures 2 and 3. Additionally, 48% of patients reported a metallic taste, followed by uremic fetor (45%) and periodontitis (41%).

All cytological smears were adequate and representative of the sampled sites and lesions. Microscopically, inflammatory changes were observed in 33% of cases, with acute inflammation in 2% and chronic inflammation in 31%, based on the predominant inflammatory cell types. According to severity, inflammation was classified as

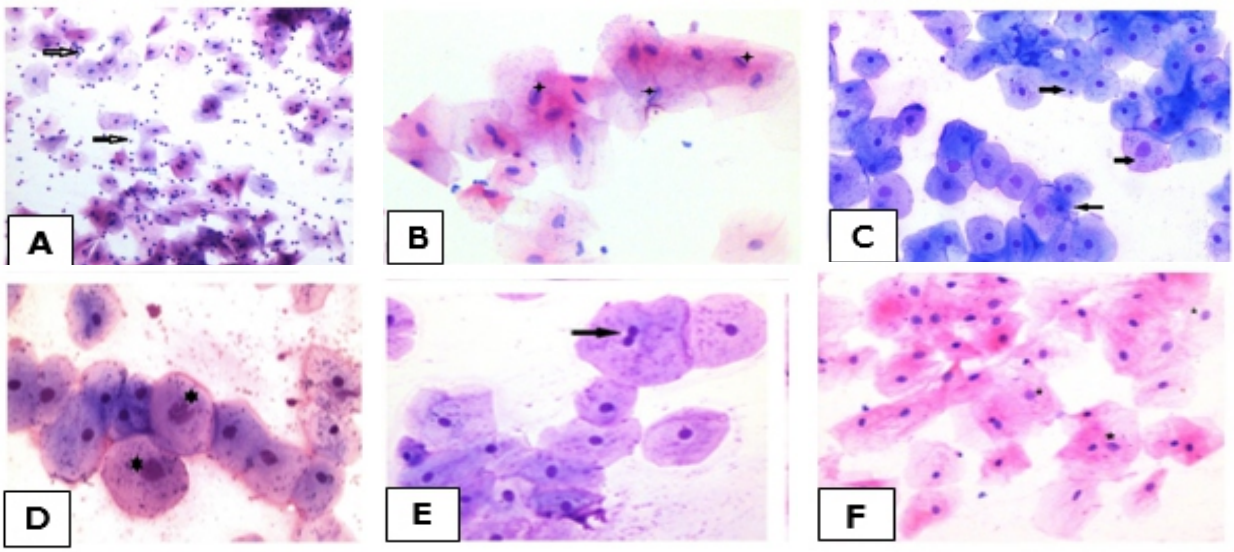

Figure 4: (**A**) shows inflammatory infiltrate obscuring epithelial cells (→) (B) mitotic activity (**C**)cellular pleomorphism (→) (**D**) nuclear changes (Karyorrhexis) (**E**) bi-nucleation (→) and (**F**) prominent nucleoli (H&E, A=100X, B-F=200X)

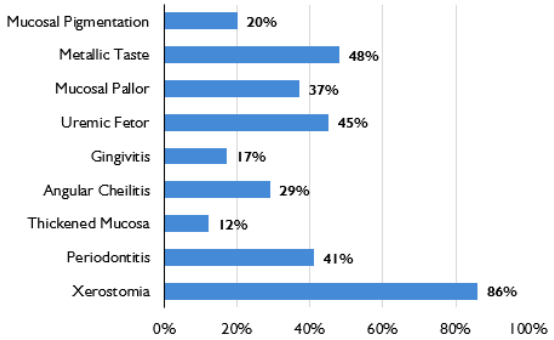

Figure 5: Distribution of nuclear changes amongchronic kidney disease patients (n=100)

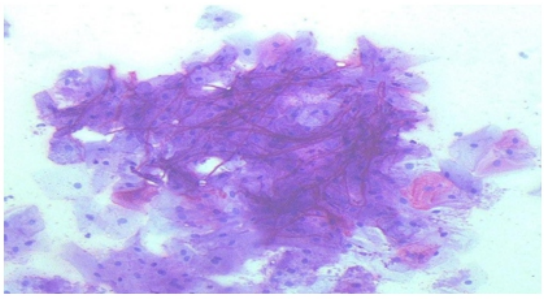

Figure 6: Oral mucosal smear showing aggregates of fungal hyphae obscuring the otherwise benign epithelial cells (stained with PAS 200X)

Table I: Stages of chronic kidney disease according to KDIGO classification system based on glomerular filtration rates[9]

GFR stages	GFR (mL/min/1.73 m^2)	Terms
G1	≥90	Normal or high
G2	60 to 89	Mildly decreased
G3a	45 to 59	Mildly to moderately decreased
G3b	30 to 44	Moderately to severely decreased
G4	15 to 29	Severely decreased
G5	<15	Kidney failure (add D if treated by dialysis)

GFR: Glomerular Filtration Rates

mild in 26% of cases, moderate in 4%, and severe in 3%. Reactive atypia secondary to inflammation, characterized by nuclear pleo-morphism, altered nuclear-to-cytoplasmic ratio, increased mitotic activity, and prominent nucleoli, was identified in 29% of cases. In contrast, 40% of smears demonstrated atypical cytological features in the absence of inflammation (Figure 4; Table II).

Regarding nuclear changes, hyperchromatic nuclei and prominent nucleoli were seen in 2% and 37% smears respectively as shown in Figure 5.

Two patients presented with whitish tongue surface with burning sensation. The smears showed benign cellular morphology with fungal hyphae confirmed on PAS as seen in Figure 6.

Microscopically, cytopathological changes were most frequently observed in patients presenting with xerostomia, metallic taste, angular cheilitis, periodontitis, and uremic fetor. Chi-square and Fisher's exact tests demonstrated a significant association between inflammatory (reactive) atypia and thickened mucosa (p=0.038), while non-reactive atypia showed a significant association with angular cheilitis (p =0.003). Prominent nucleoli were also significantly associated with the presence of metallic taste. Other clinicopathological variables did not show statistically significant associations. Logistic regression analysis further identified significant relationships between selected demographic variables and clinical features, as detailed in Table III.

Regression analysis revealed significant association of thickened mucosa with inflammation (P=.04), gingivitis with karyorrhexis (P=0.05) and multinucleation (P=0.02), tongue coating with pyknosis (P=.02), thickened mucosa, periodontitis and xerostomia with cell surface keratinization (P=.03; P=.001) and metallic taste with prominent nucleoli (P=.03) [Table IV]. The KDIGO grading revealed a significant association of grade 3b and 4 with the duration of dialysis (P=0.03) and prominent nucleoli (P=0.04), periodontitis (P=0.025) and xerostomia (P=.028). The likelihood of presence of micronuleolei was significantly higher in subjects with CKD compared with controls (Odds ratio 153.3, 95% C.I (40.1-584.8), p 0.001). Age and gender did not have a significant relationship with the likelihood of developing oral lesions.

DISCUSSION

The present study demonstrates that patients with CKD undergoing dialysis exhibit a wide spectrum of cytopathological alterations in the oral mucosa, many of which show meaningful associations with clinical oral manifestations and disease severity as defined by KDIGO staging. Inflammatory and non-reactive atypia, along with specific nuclear changes such as prominent nucleoli and karyorrhexis, were frequently observed and appeared to correlate with both local oral findings and systemic disease burden. These results highlight the impact of chronic renal dysfunction and dialysis-related metabolic stress on oral epithelial integrity and highlight the potential utility of exfoliative cytology as a non-invasive adjunct for assessing oral mucosal changes in patients with advanced CKD.

In this study, oral cytopathological alterations in patients with chronic kidney disease on dialysis were evaluated using exfoliative cytology. While previous studies from India, Poland, and Thailand have primarily focused on the clinical assessment of oral health in patients with renal disease, data on cytological changes of the oral mucosa in dialysis-dependent CKD patients remain scarce. To the best of our knowledge, this study represents one of the first attempts to systematically document oral cytological alterations in this patient population.

Table II: Distribution of atypical changes in reactive and non-reactive atypia

Variables	Status	Reactive Atypia [n = 29 (29%)]	P-value*	Non-reactive Atypia [n=40 (40%)]	P-value*
Pleomorphism	Present	27 (93.1%)	.085	39 (97.5%)	.000*
	Absent	02 (6.9%)		01 (2.5%)	
Bi-nucleation	Present	26 (89.6%)	.719	37 (92.5%)	.738
	Absent	03 (10.3%)		03 (7.5%)	
Multi-nucleation	Present	0	1.00	0	1.00
	Absent	29 (100%)		40 (100%)	
Hyper-chromatism	Present	01 (3.5%)	.502	01 (3.5%)	1.00
	Absent	28 (96.5%)		39 (96.5%)	
Prominent nucleoli	Present	14 (48.2%)	.149	18 (45%)	.176
	Absent	15 (51.7%)		22 (5%)	
Micro-nucleolei	Present	05 (17.2%)	.761	10 (25%)	.042*
	Absent	24 (83%)		30 (75%)	
Pyknosis	Present	0	1.00	01 (2.5%)	0.40
	Absent	29 (100%)		39 (97.5%)	
Karyorrhexis	Present	22 (75.8%)	.212	32 (80%)	.024*
	Absent	07 (24.1%)		08 (20%)	
Karyolysis	Present	14 (48.2%)	.001*	10 (25%)	.852
	Absent	15 (51.7%)		30 (75%)	
Mitotic Activity	Present	78 (78%)	0.75	86 (86%)	
	Absent	22 (22%)		14 (14%)	.000*

Clinically, oral manifestations in advanced uremia involve both hard and soft tissues of the oral cavity. These changes may result from multiple factors, including therapeutic interventions such as fluid restriction, dietary modifications, adverse effects of systemic medications, and the cumulative impact of dialysis and/or kidney transplantation. Beyond overt clinical findings, alterations in the oral microflora have also been reported, characterized by increased colonization by yeasts, changes in species distribution, and variable antifungal susceptibility patterns.[11]

Oral candidiasis is more prevalent among patients with CKD, largely attributable to immune suppression related to malnutrition, dietary restrictions, anemia, psychological stress, and the use of immunosuppressive medications.[12] Oyetola et al. further demonstrated a significant association between declining glomerular filtration rate and oral symptoms such as burning mouth, altered taste, bleeding gums, xerostomia, and aphthous ulceration, highlighting the influence of disease severity on oral health manifestations.[12]

In this context, oral diseases represent a potentially preventable contributor to adverse health outcomes in individuals with end-stage renal disease (ESRD), owing to their association with infection, chronic inflammation, and malnutrition. Patients with advanced chronic kidney disease (stages 4-5) require special considerations during routine dental care, whereas those in stages 1-3 generally do not present contraindications. Key clinical considerations include hypertension, anemia, bleeding and infection risks, medication-related effects, and disease- or hemodialysis-associated oral manifestations. Consequently, individuals with advanced renal dysfunction are particularly vulnerable to oral diseases because of the systemic effects of impaired kidney function.[13]

In the present study, xerostomia emerged as the most frequent clinical manifestation among patients with chronic kidney disease. Similarly, previous reports have documented xerostomia in 28–59% of individuals with end-stage renal disease, largely attributed to polyuria and the impaired renal ability to reabsorb sodium.14 However, xerostomia in CKD should be carefully distinguished from true salivary gland hypofunction, which may result from reduced salivary flow in this population. Clinical features such as glossitis, cervical caries, stomatitis, angular cheilitis, oral candidiasis, and pale, corrugated, or dry buccal mucosa are commonly associated with decreased salivary flow and should be systematically assessed.[15]

Hyposalivation can substantially impair quality of life by altering taste perception and increasing salivary urea concentration.[16] In patients with CKD, factors such as fluid restriction, electrolyte imbalance, and the use of medications including furosemide and hydrochlorothiazide further contribute to the development of dry mouth. In the present study, xerostomia was observed in 12.22% of patients, whereas a comparable study from Germany involving 44 dialysis patients reported a markedly higher prevalence of 59.1%.[17]

In addition to xerostomia and metallic taste, a strong association exists between chronic kidney disease and periodontitis, highlighting the need for early diagnosis and preventive periodontal care to improve outcomes in CKD patients.[18] A meta-analysis by Ruospo et al., including 88 studies across 125 populations, reported higher Decayed, Missing, and Filled Teeth (DMFT) scores in patients with CKD stage 5D (mean 14.5; 95% CI: 12.7-16.3) and a periodontitis prevalence of 31.6% in CKD stages 1-5, increasing to 58% in stage 5D. Female sex and longer

Table III: Association of demographic variables with clinical features in chronic kidney disease patients (n=100)

Demographic variables	Thickened Mucosa	Xerostomia	Angular Cheilitis	Gingivitis	Periodontitis	Metallic Taste	Tongue Coating	Mucosal Pallor
Patient Age	.581	.016*	.052*	.007*	.001*	.001*	.74	.000*
Patient Gender	.402	.136	.454	.025	.279	.86	.930	.246
KDIGO Grade	0.94	0.02*	0.88	0.35	0.02*	.04	0.25	0.91
Duration of dialysis	.528	.21	.71	.67	.25	.03	.25	.95

*p<0.05 considered as significant; KDIGO: Kidney Disease: Improving Global Outcomes

dialysis duration, but not age, were identified as significant contributors.[19]

Oral mucosal pallor, primarily attributable to anemia resulting from reduced erythropoietin production, is commonly observed in patients with CKD.[20] Altered platelet function and renal anemia further predispose these patients to bleeding tendencies, while hemodialysis may contribute to ecchymoses, petechiae, and oral hemorrhage.[21,22] In patients with CKD stage 5D, ulceration and candidiasis have been reported in 8.6% and 22.2% of cases, respectively, whereas xerostomia affects up to 48.4% of patients.[19]

Cytologically, atypical changes in oral mucosal epithelial cells are broadly classified as inflammatory (reactive) or non-reactive atypia. Persistent non-reactive atypia may predispose to progressive cellular damage and potential dysplastic transformation 23 Features of non-reactive atypia include cellular and nuclear pleomorphism, nuclear budding, prominent nucleoli, and micronuclei, whereas inflammatory atypia is characterized by inflammatory cell infiltrates, intracytoplasmic bacterial colonies, perinuclear halos, free nuclei, and the presence of micronuclei.[23]

Exfoliative cytology serves both as a diagnostic and a potential screening tool for oral mucosal disorders through microscopic evaluation of epithelial cells.[24] Cytological features such as cellular keratinization, nuclear hyperchromasia, and altered nuclear-to-cytoplasmic ratios are indicative of neoplastic transformation and are therefore critical for the early detection of oral malignancies.[25] Despite the high prevalence of oral lesions among patients with CKD, oral health care remains inadequately addressed, particularly in developing countries where the burden of renal disease is substantial. Evidence also suggests that improved oral hygiene practices are associated with a reduced risk of chronic kidney disease.[26]

Micronuclei are extranuclear bodies formed from whole chromosomes or chromosomal fragments that fail to incorporate into daughter nuclei during mitosis and are widely used as early biomarkers of genetic damage.[11] Oxidative stress associated with dialysis can induce DNA damage, including point mutations, single- and double-strand breaks, impaired DNA repair, and genomic instability.[27] Such damage may manifest cytologically as micronuclei. In the present study, micronuclei were observed in 15% of smears, reflecting epithelial injury likely resulting from mutagenic or genotoxic stress.[28]

Other nuclear abnormalities observed in the present study, including binucleation, karyorrhexis, karyolysis, and pyknosis, may similarly reflect oxidative stress-induced DNA damage in patients undergoing dialysis. These nuclear changes were most frequently noted in individuals with xerostomia, followed by periodontitis, uremic fetor, and metallic taste.[29-31]

Nuclear pleomorphism, characterized by irregularities in nuclear size, shape, and chromatin distribution, is commonly associated with inflammatory atypia and is particularly prevalent in immunocompromised states. The clinical significance of reactive atypia lies in the need to distinguish it from preneoplastic and dysplastic lesions, as cytological atypia in squamous epithelium may represent a continuum from reactive to premalignant change.[32,33] These findings highlight the importance of regular cytological screening, along with targeted health education and awareness programs, as components of primary and secondary prevention in patients with CKD on dialysis. Improved oral hygiene, early diagnosis, and timely multidisciplinary intervention may help reduce subclinical pathology and limit the need for extensive dental treatment.

CONCLUSION

The overall oral and dental health of individuals with CKD undergoing dialysis is markedly compromised, reflecting the combined impact of systemic disease burden and treatment-related effects. The detection of atypical cellular alterations on microscopic examination, often in the absence of obvious clinical lesions, indicates the presence of subclinical pathological changes within the oral mucosa. These observations emphasize the need to incorporate regular cytological screening into routine patient care to facilitate early detection, enable timely intervention, and potentially improve clinical outcomes.

ACKNOWLEDGEMENT

The authors acknowledge and appreciate the cooperation and logistical support provided by the staff of the Nephrology Units at Fatima Memorial Hospital and Sheikh Zayed Hospital, Lahore, Pakistan.

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Table IV: Association of cytological variables with clinical features in chronic kidney disease patients (n=100)

	Cytological Variables									
Clinical Variables	**Inflammation**	**Bi-nucleation**	**Multi nucleation**	**Hyper-chromasia**	**Prominent Nucleolei**	**karyolysis**	**karyorrhexis**	**Micro-nucleoli**	**Pyknosis**	**Surface Keratinization**
Thickened Mucosa	.05 OD: 3.33 CI: .97-11.48	.32 OD:.43 CI: .079-2.37	.99**	.99**	.32 OD: 1.44 CI: .62-3.45	.93 OD: .94 CI: .235-3.78	.97 OD:.98 CI: .273-3.5	.30 OD: .474 CI: .112-2.002	.99**	.59 OD: 1.4 CI: .389-5.13
Xerostomia	.70 OD:1.2 CI: .367-4.4	.79 OD:1.3 CI: .154-11.5	.99**	.99**	.62 OD:.625 CI: .423-4.18	.29 OD: .431 CI: .09-2.06	.39 OD:.610 CI: .193-1.93	.13 OD:2.72 CI: .728-10.2	.99**	.04 OD:.0303 CI: .095-.968
Angular Cheilitis	.25 OD:1.68 CI:.685-4.124	.63 OD:1.47 CI:.288-7.5	.98**	.98**	.56 OD:1.29 CI:.536-3.147	.08 OD:2.28; CI:.889-5.82	.84 OD .910; CI; .36-2.268	.16 OD .330 CI; .70 - 1.568	.98**	.17 OD: 2.1 CI; .727-6.39
Periodontitis	.83 OD:96; CI:.393-2.13	.82 OD:1.16; CI: 0.294-4.6	.98**	.99**	.69 OD: 1.2 CI: .426-3.58	.79 OD: .853 CI: .251-2.89	.06 OD: .362 CI: .125-1.048	.68 OD: .718 CI: .146-3.52	.99**	.04 OD.334 CI; .113-.985
Uremic Fetor	.35 OD: 1.48 CI: .64-3.42)	.46 OD: 1.7 CI: .404-7.27	.99**	.99**	.57 OD: 1.26 CI: .559-2.85	.89 OD: 1.06 CI: .434-2.61	.62 OD: .811 CI: .351-1.87	.88 OD: 1.08 CI: .360-3.25	.99**	.40 OD.685 CI; .283-1.66
Metallic Taste	.35 OD: 1.48 CI: .64-3.4	.82 OD: 1.17 CI: .295-4.64	.99**	.99**	.03 OD: 2.49 CI: 1.08-5.75	.26 OD: .592 CI: .238-1.47	.18 OD: .562 CI: .242-1.30	.22 OD: .488 CI: .154-1.55	.99**	.98 OD: .992 CI: .410-2.4
Tongue Coating	.43 OD: 1.53 CI: .526-4.48	.66 OD: 0.69 CI: .131-3.65	.99**	.99**	.69 OD: 1.2 CI: .42-3.5	.16 OD: 1.7 CI: .56-5.23	.73 OD: 1.7 CI: .56-5.23	.28 OD: 1.2 CI: .39-3.8	.99**	.72 OD: 1.2 CI: .368-4.21
Mucosal Pallor	.59 OD: 0.788 CI: .329-1.89	.62 OD: 0.71 CI: .178-2.83	.99**	.70 OD: 1.72 CI: .105-28.3	.46 OD: .73 CI: .311-1.71	.55 OD: 1.3 CI: .543-3.37	.33 OD: 1.5 CI: .63-3.77	.75 OD:.82 CI: .26-2.64	.99**	.64 OD: 1.2 CI: .56-5.23
Pigmentation	45 OD: 1.47 CI: .533-4.03	.86 OD: 0.86 CI: .165-4.51	.99**	.99**	.75 OD: 1.17 CI: .43-3.2	.25 OD: .47 CI: .117-1.6	.75 OD: 1.18 CI: .411-3.4	1.0 OD: 1.0 CI: .254-3.9	.99**	.03 OD: 9.1 CI: 1.16-72.10

*P<0.05 considered as significant.**The odds ratio could not be computed due to lack of variability in the predictor variable. OD: ODDS Ratio; CI: Confidence Interval

the need for extensive dental treatment.

CONCLUSION

The overall oral and dental health of individuals with CKD undergoing dialysis is markedly compromised, reflecting the combined impact of systemic disease burden and treatment-related effects. The detection of atypical cellular alterations on microscopic examination, often in the absence of obvious clinical lesions, indicates the presence of subclinical pathological changes within the oral mucosa. These observations emphasize the need to incorporate regular cytological screening into routine patient care to facilitate early detection, enable timely intervention, and potentially improve clinical outcomes.

ACKNOWLEDGEMENT

The authors acknowledge and appreciate the cooperation and logistical support provided by the staff of the Nephrology Units at Fatima Memorial Hospital and Sheikh Zayed Hospital, Lahore, Pakistan.

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AUTHORS' CONTRIBUTION

The Following authors have made substantial contributions to the manuscript as under:

UJK: Acquisition, analysis and interpretation of data, drafting the manuscript, approval of the final version to be published

RA: Analysis and interpretation of data, drafting the manuscript, critical review, approval of the final version to be published

NAB: Acquisition of data, drafting the manuscript, approval of the final version to be published

NN & AHN: Conception and study design, critical review, approval of the final version to be published

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST

Authors declared no conflict of interest, whether financial or otherwise, that could influence the integrity, objectivity, or validity of their research work.

GRANT SUPPORT AND FINANCIAL DISCLOSURE

This manuscript was extracted from MPhil research project funded by the University of Health Sciences, Lahore, Pakistan

DATA SHARING STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request