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Our kidneys and teeth may be closer than we think: relationship between dental calculi and renal stone burden grading in a patient series from Somalia

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Abstract. – OBJECTIVE: This study investigated the correlation between dental calculi grading and renal stone burden grading.

PATIENTS AND METHODS: This study was designed as an observational single-center study and included consecutive patients with radiologically confirmed renal stones at our center between January 2022 and July 2022. These patients were referred to the dentistry clinic for a dental examination to assess dental calculi and oral hygiene. Investigated parameters included demographic characteristics, renal stone location and diameter, urine pH, and dental evaluation findings (teeth brushing habits, oral hygiene, and dental calculi). Renal stone burden grade and dental calculi grade were calculated, and Spearman's rank-order correlation analysis was used for correlation analyses.

RESULTS: Overall, 204 patients were included. The mean patient age was 36.3±15.2. Approximately half of the patients (49.2%) had multiple stones. About 36% of the participants had high-grade dental calculi, while 29.4% had intermediate low-grade dental calculi. Oral hygiene was significantly associated with dental calculi grade (p<0.001). The dental calculi grade was positively and moderately correlated with the renal stone diameter (Spearman's rho=0.493, p<0.001). Among patients with a renal stone diameter greater than 20 mm, intermediate to high-grade dental calculi were found in 88.4%. This proportion was 49.1% for those with a renal stone diameter smaller than 20 mm.

CONCLUSIONS: Dentists should consider the presence of undiagnosed kidney stones in patients with especially intermediate or high-grade dental calculi. Urologists should know that patients with large and multiple kidney stones may have dental calculi.

Key Words:
Renal stone, Dental calculi, Grading, Correlation.

Introduction

Renal stones are part of a multifactorial disease that affects 12-15% of the population and are more common in males, with an increased prevalence in recent decades[1-3]. The lifetime risk of developing renal stones ranges between 10-15% in developed countries and 20-25% in developing countries.

Several emerging data[4] suggest that the rising incidence of renal stones is due to increased rates of metabolic syndrome, diabetes mellitus, obesity, and obesity-related comorbidities. In addition, bidirectional associations have been documented[5] between renal stones and hypertension, and patients with renal calculi were found to have an increased risk of cardiovascular events and ischemic strokes. Furthermore, it was reported[5] that diverse systemic metabolic factors might impact the function of the gastrointestinal tract, renal absorption, and excretion and alter the risk of renal stones.

The most widely accepted mechanism of nephrolithiasis is urinary supersaturation with constituents such as calcium, oxalate, or uric acid. However, its pathogenesis and risk factors still need to be fully comprehended[6].

Dental calculi are calcified dental plaques that can lead to dental complications, including gingivitis, periodontitis, tooth decay, and tooth loss[7]. The prevalence of dental calculi ranges from 8% to 95%. Several potential risk factors for dental calculi formation, including advanced age, systemic diseases, caries, dental restorations, pulpal irritations, periodontal disease, epithelial rests in the pulpal tissue, and orthodontic movements of the teeth, were previously investigated[8]. Although many systemic diseases were found to be associat-

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ed with renal stone formation, controversies exist on the relationship between dental calculi and renal stones. However, they are believed[9] to share a similar formation process, as most of these stones primarily contain calcium. Furthermore, several studies in literature have demonstrated that dental calculi might be a harbinger of undiagnosed renal stones. Therefore, this study investigated the correlation between dental calculi grading and renal stone burden grading.

Patients and Methods

This study was approved by the Institutional Ethical Review Board of Somalia Turkiye Training and Research Hospital (MSTH/9581). The research objective was explained to the participants; all patients given oral and written informed consent for the study participation. Patients who presented to the urology outpatient clinic between January 2022 and July 2022 and were diagnosed with nephrolithiasis constituted the target population of this study. Patients with systemic disease and those with a stone location other than the kidney (i.e., ureter or bladder) were excluded. Ultrasound (US) was the initial radiological diagnostic modality to detect renal stones. In addition, non-contrast computerized tomography (NCCT) was performed if needed. The results of NCCT and US were used to evaluate the stone size and localization. Stone location was documented as the upper, middle, lower poles, renal pelvis, or multiple poles. The stone diameters were measured on the radiological images, and the patients were categorized according to the stone diameter as a diameter smaller than 10 mm, a diameter between 11-20 mm or 21-30 mm, and a diameter larger than 30 mm. The cumulative stone diameter was calculated in cases of multiple stones.

Patients with radiologically confirmed renal stones were referred to the dentistry clinic for a dental examination to assess dental calculi and oral hygiene. All dental examinations were performed by the same dentist (I.M.M.), who was blinded to the urological assessment results. The dentist asked the study participants questions about their teeth brushing habits and assessed their oral hygiene through an oral and dental examination. In addition, the dentist examined the patient and took a radiograph specifically for diagnosing and grading the dental calculi.

Patients were divided into three categories based on dental calculi grades using a previously reported grading system[10]. According to this system, patients with dental calculus levels below 25% were graded as low-grade, while those between 25-75% and 75-100% were graded as medium-grade and high-grade, respectively.

Thus, during the urological and dental assessments, data regarding demographic characteristics (age and gender), history of renal stone surgery, teeth brushing habits (regular *vs.* irregular), renal stone features (location and size), number (single *vs.* multiple), and laterality (right or left) of the stones, urine pH values, oral hygiene (good, intermediate or poor) renal stone and dental calculi grades were collected and recorded into a database.

Statistical Analysis

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS v. 23, IBM Corp., Armonk, NY, USA) software. The data were analyzed using univariate descriptive statistics. Frequencies, percentages, and means±standard deviations (SDs) were presented where appropriate. Cross-tabulations and the Chi-square test were used to determine the association between renal stone and dental calculi grades. Correlations were conducted to explore the associations of interest. The Shapiro-Wilk test was used to test the normal distribution of the data. Spearman's rank-order correlation analysis was used for all correlation analyses. A p-value lower than 0.05 was considered statistically significant.

Results

Overall, 204 patients were included in this study (Table I). The mean patient age was 36.3±15.2; males had a significantly higher mean age than females (37.0±15.5 *vs.* 34.7±14.9 years, p=0.02). Approximately two-thirds of renal stone patients (n=138, 67.6%) were males, while 32.4% (n=66) were females. All patients underwent US as the initial radiological imaging modality, while 119 (58.3%) patients necessitated NCCT as an adjuvant investigation to further delineate the stone features and the surrounding anatomy. Nearly 37% (n=75) of the patients had a history of renal stone surgery. The mean urine pH was 5.3±0.3.

Among all patients, 40% had a right kidney, 33.3% had a left kidney, and 26.4% had bilateral renal involvement. Approximately half of the patients (n=98, 48%) had multiple stones. The

Table I. Baseline demographic characteristics and renal stone features.

Variable	Number of patients (n)	Percentage (%)
Age		
<18-year	10	4.9%
19-39-year	120	58.8%
40-59-year	50	25.5%
>60-year	24	11.8%
Gender		
Male	138	67.6%
Female	66	32.4%
Comorbidities		
No	170	83.3%
Yes	34	16.7%
Number of stones		
Single	106	52%
Multiple	98	48%
Laterality		
Right	82	40.2%
Left	68	33.3%
Bilateral	54	26.5%
Location		
Upper pole	30	14.7%
Middle pole	22	10.8%
Lower pole	44	21.6%
Renal pelvis	54	26.5%
More than one pole	54	26.5%
Staghorn stone		
Yes	64	31.4%
No	140	68.6%
Renal stone diameter		
<10 mm	66	32.4%
11-20 mm	52	25.5%
21-30 mm	56	27.5%
>30 mm	30	14.7%

most common stone location was the renal pelvis (26.4%, n=54), and a similar percentage of the patients had multiple stones occupying more than one kidney pole. Among all study participants, 32.5% (n=66) had a stone size smaller than 10 mm, while 25.5% (n=52) had 11-20 mm, and 27.5% (n=56) had 21-30 mm. On the other hand, 14.7% (n=30) of the patients had a stone size larger than 30 mm.

More than half of the participants (n=120, 58.8%) brushed their teeth irregularly (Table II). Our analysis also revealed that 36.2% of the participants had high-grade dental calculi, while 34.3% and 29.4% had intermediate-grade and low-grade dental calculi, respectively.

Table II. Dental evaluation findings.

Dental evaluation	Number of patients (n)	Percentage (%)
Brushing teeth		
Regularly	84	41.2%
Irregularly	120	58.8%
Oral hygiene		
Poor	82	40.2%
Intermediate	120	54.9%
Good	10	4.9%
Dental calculi grading		
Low	70	34.3%
Intermediate	60	29.4%
High	74	36.3%

There was a statistically significant association between age and dental calculus grading (p<0.001). Intermediate to high-grade dental calculi were detected in 83.7% (n=62/74) of the patients older than 40. In contrast, 55.3% (n=72/130) of those younger than 40 had intermediate to high-grade dental calculi. On the other hand, there was no statistically significant association between gender and dental calculus grading (p=0.13). Approximately 90% (66 of 74) of patients with high-grade dental calculi had irregular teeth brushing habits compared to those with regular ones in 9.5% (8/84) (p<0.001).

Among all participants, 54.9% had intermediate oral hygiene. Oral hygiene was significantly associated with dental calculi grade: 72,9% (54 of 74) of patients with high-grade and 20% (14 of 70) of the patients with low-grade dental calculi had poor oral hygiene (p<0.001).

The correlation analysis revealed that dental calculi grade was positively and moderately correlated with the renal stone diameter (Spearman's rho=0.493, p<0.001) (Table III).

Among patients with a renal stone diameter greater than 20 mm, intermediate to high-grade dental calculi were found in 88.4% (n=76/86) (Figure 1). On the other hand, this proportion was 49.1% (n=58/118) for patients with a renal stone diameter lower than 20 mm.

Discussion

Although they are formed in different body parts, renal and dental calculi share the same biological system, and most of them primarily contain calcium[10,11]. A systematic review by Gabardo

Table III. Correlation of dental calculi grading and renal stone burden grading.

Renal stone diameter	Dental calculi grade			Spearman's rho	*p*-value
	Low	Intermediate	High		
<10 mm	44 (66.6%)	10 (15.2%)	12 (18.2%)	0.493	<0.001
11-20 mm	16 (30.8%)	18 (34.6%)	18 (34.6%)		
21-30 mm	10 (17.9%)	28 (50%)	18 (32.1%)		
>30 mm	0 (0%)	4 (13.3%)	26 (86.7%)		

et al[12] evaluated the association between renal stones and dental calculi, and they found a significant association between them [1.97 (95% confidence interval, 1.21-3.18); $p<0.05$]. Therefore, these authors suggested that dental calculi could be indicators of undiagnosed kidney stones.

Movahhedian et al[13] worked on 154 patients, 77 with and 77 without renal stones. They investigated the correlation between dental and kidney stones with the expectation of developing an early detection method for kidney stones. They reported that the risk of having kidney stones is 5.78 times greater in patients with three teeth containing dental calculi. To the best of our knowledge, our study is the first to investigate the relationship between dental calculi grading and renal stone burden. This investigation revealed that the dental calculi grading was positively and moderately correlated with the renal stone burden.

In recent decades, researchers[14,15] increased their interest in the associations between oral diseases and other disorders such as renal stones, cardiovascular disease (CVD), and diabetes mellitus (DM). According to these studies, dental calculi may serve as an early diagnostic indicator for patients with previously undiagnosed systemic diseases. A systematic review by Almadhoon et al[14] included 19 studies investigating the association of dental calculi with CVD and renal stones. The authors found a significant association between dental calculi and CVD (OR: 3.35; 95% CI, 1.91-5.89; $p<0.001$). They also reported a positive correlation between dental calculi and CVD in patients older than 40 (OR: 8.78; 95% CI, 3.64-21.17; $p<0.001$). Srivastava et al[15] noted that patients with CVD and DM had a 2.94-fold and 1.81-fold higher risk of having dental calculi in comparison to healthy subjects (CI, 1.54-3.10, $p<0.001$; CI, 0.48-2.06, $p<0.01$).

Figure 1. Photograph demonstrating high-grade dental calculi in a patient who had a renal stone with a diameter of 35 mm.

According to the current literature, coronary artery disease (CAD) patients are highly likely to develop dental calculi[16]. It was stated that the detection of dental calculi in multiple teeth might necessitate the exclusion of CAD, particularly in the presence of other risk factors.

Although studies[17] analyzing the relationship of dental calculi with the patients' demographic variables, such as age and gender, reported that aging was a risk factor for the formation of dental calculi, they did not present sufficient evidence regarding the association between dental calculi and gender. However, they suggested that women might have a higher incidence of dental calculi. Our study found intermediate to high-grade dental calculi in more than two-thirds of patients older than 40, which supports the hypothesis that dental calculi correlate with age. On the other hand, patient gender did not significantly impact the dental calculus grade.

Renal stones are part of a multifactorial disease, and the current literature reports a rising incidence of kidney stone disease globally[1,18,19]. According to these reports[1], 12-15% of the population is currently affected by renal stone disease, and the lifetime risk of developing this disease is 10-25%. Furthermore, it is also known that kidney stone formers are at increased risk of developing end-stage renal disease (ESRD), and the risks of comorbidities, such as dyslipidemia, met-

abolic syndrome, DM, CVD, and hypertension, are higher in this patient population[19]. Therefore, a higher mortality rate may be anticipated due to these comorbid conditions, and prompt assessment and treatment are mandatory[20].

Limitations

This study has some limitations that must be considered while evaluating its findings. First, it has no control group. Second, stone analysis and metabolic workup results were not included due to the lack of equipment to perform these tests. Besides these limitations, to the best of our knowledge, the present study is the first to examine the relationship between dental calculi grading and renal stone burden. This analysis revealed a positive moderate correlation between dental calculi grade and renal stone burden. This finding is significant concerning its contribution to the ongoing debate regarding the association between dental and renal stones.

Conclusions

Clinicians working in dental practice should consider the presence of undiagnosed kidney stones, particularly in patients with intermediate to high-grade dental calculi, and refer them to urology clinics for a check-up. Urologists should be aware that patients with large and multiple kidney stones may have dental calculi that may lead to gingivitis, periodontitis, tooth decay, and tooth loss.

Conflicts of Interest

The authors declared no competing interest.

Ethics Approval

This study was approved by the Institutional Ethical Review Board of Somalia Turkiye Training and Research Hospital.(MSTH 29.08.2021/7132).

Informed Consent

The research objective was explained to the participants; all patients given oral and written informed consent for participation in this study.

Availability of Data and Materials

All study data and materials can be obtained from the corresponding author.

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Authors' Contribution

Sertac Cimen: Data collection, Supervision, Writing original draft. Abdikarim Hussein Mohamed: Data collection, Data analysis. Ibrahim Mohamed Mohamud: Investigation, Supervision, Visualization. Asir Eraslan: Data analysis, Data interpretation. Metin Gur: Data collection, Methodology. Alihan Kokurcan: Data curation, Data analysis. Fahrettin Samil Uysal: Methodology, Data analysis. Serafettin Kaymak: Conceptualization, Methodology. Ahmet Emin Dogan: Study design, Data curation. Burhan Baylan: Data analysis, Data interpretation. Mehmet Emin Sirin: Investigation, Project administration, Revision of the original draft.

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