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Dental Calculus Formation among Recurrent Renal Calculi Formers

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Citation: Ahmed Tawfig et al. (2017), Dental Calculus Formation among Recurrent Renal Calculi Formers. Int J Dent & Oral Heal. 3:1, 7-12. DOI: [10.25141/2471-657X-2017-1.0007](https://doi.org/10.25141/2471-657X-2017-1.0007)

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Received: December 18, 2016; **Accepted:** December 29, 2016; **Published:** January 19, 2017

Abstract

Background: Dental calculus is a form of hardened dental plaque of both inorganic (mineral) and organic (cellular and extracellular matrix) components. Whereas kidney (renal) calculi is a solid concentration or crystal aggregation formed in the kidneys from dietary minerals present in urine.

Aim & Objective: The study aimed to investigate and explore the relationship between dental calculus formations among recurrent renal calculi formers. The objective was instigated due to the multiple shared features and the high prevalence of formation factors and the calcification process of dental calculus and renal calculi.

Methods & Materials: The study was comprised of 65 patients of the lithotripsy clinic participated in the study; all volunteered after reviewing and accepting the study's proposal. The control group consisted of 31 participants whilst the study group had 34 participants. Oral examination was carried out for both groups using the gingival index, plaque index, and oral hygiene index--calculus index, debris index. Saliva and urine samples were obtained to measure the levels of Calcium (Ca), phosphate (P), magnesium (Mg) and pH.

Results: Plaque, Calculus and Gingival Indices showed High mean values among study group with significant differences compared to control group.

Saliva and urinary samples resulted lower magnesium ions in the study group but not statistically difference compared to the control one, while high scores of calcium and phosphorus ions were found in the study group.

Conclusion: After laboratory investigations and bio statistical analysis a relation has been found linking both conditions. In light of this result, urologist are advised to refer these patients to have follow up sessions in dental clinic to maintain their oral health.

Keywords: Dental Calculus, Kidney Calculi, Mineralization, Saliva, Urine

INTRODUCTION

The mouth like all other surfaces in the body is a natural community of microorganisms, which exist as structurally-organized, multispecies, complex biofilms [1,2]. Precipitation of minerals from saliva and gingival crevicular fluid in plaque on the teeth formed dental calculus. Calculus is composed of both inorganic (mineral) and organic (cellular and extracellular matrix) components. The mineral proportion of calculus ranges from approximately 40–60% [3]. As the concepts of etiopathogenesis of periodontal diseases have changed over time, dental plaque took the entire spotlight and calculus was almost ignored. Currently, dental plaque remains the mainstay in the etiology of periodontal

diseases [4,5]. The periodontopathic potential of dental calculus stems largely from unmineralized disease-associated bacterial biofilms coating its outer surfaces [6]. Chronic inflammatory periodontal diseases are one of most common pathologies found in the oral cavity worldwide. [7,8].

Kidney stones (renal calculi) is a worldwide problem, sparing no geographical, cultural, or racial groups [9], affecting between 12-15% of the global population during their lifetime [10], with a predicted increase in its prevalence [11].

About 60,000 persons annually lose their lives due to kidney-related diseases. Glomerulonephritis constitutes 54.7% of kidney diseases, pyelonephritis accounts for 12.3% of renal failures and

others about 33% [12].

Calcium oxalate stones are now identified as the main type of urinary calculi in most countries throughout the world [13]. The probability of recurrence Ca renal stone approximately 10-50% within a period of 1-5 years from the first renal stone formation [14]. Most of the renal stones are idiopathic [15].

In Saudi Arabia it has been estimated that the expected life time risk of a renal stone episode is at least 50% higher than in the west countries, Reflecting the hot weather and dehydration that occur in these areas [16]. Renal calculi are formed when the urine is supersaturated with salt and minerals such as calcium oxalate and uric acid [15]. It has been estimated that up to 90% of renal patients will show oral symptoms [17].

Since the formation factors and the process of calcification of dental calculus and renal calculi share multiple features[18,19] and also due to their high prevalence and recurrence rate, furthermore dental calculus and its correlation with recurrent renal calculi formation has not been adequately reported in the literature, It thus thought pertinent to conduct this study to investigate the relationship between dental calculus formations among recurrent renal calculi formers.

MATERIALS AND METHODS

This was a retrospective study conducted on patients attended the lithotripsy clinic, of the urology department, King Saud Medical City between January, August 2015 to study the possible relation between dental calculus formation and recurrent kidney (renal) calculi formation.

Informed consent was obtained from all subjects who accepted the study proposal prior to participation in this study to achieve ethical clearance.

The study sample size was determined by the number of the patient whom attended the urology clinic within the period of the study, ending to a total of 65 participants both genders whose age ranged between 18 to 60 years. The participants were divided into two groups; one group represented the study group which included 34 participants and a control group which included 31 participants matched for sex and age.

For the control group, the selection was made from the consecutive list of patients who were to be given an appointment for a routine check-up in the urology department whom were medically fit patients with no history of renal calculi, who had recent clear ultrasound in the last three months, and contacted them to have their saliva and urine samples. While the study group included Subjects with kidneys that suffer only from recurrent renal calculi formation at least (twice in the last 5 years) and has no other conditions or diseases that may alter the normal calcium levels nor affect any vital organs. While the exclusion criteria included medically compromised patients, patients with endocrine disease, bone disease, blood related disorders or alcoholic patients, patients using calcium or vitamin D supplements participants who underwent periodontal procedures within the past 6 months.

The null hypothesis of this study claim that the recurrent kidney (renal) calculi patients do not correlate with dental calculus status.

Oral examination was carried out for both groups using the gingival index, plaque index [20], and oral hygiene index (calculus index,

debris index) [21].

The periodontal parameters of each participant were evaluated at 6 sites using the Ramfjord teeth (16, 21, 24, 36, 41 and 44) [22]. If an index tooth was absent, the tooth nearest in the sextant was examined. If all the teeth of the sextant were missing, the sextant was excluded. Teeth exhibiting extensively crown destruction or which were not fully erupted were also excluded from the examination procedure.

A 'pre-study' reliability test was conducted by performing a pilot study on ten participants, selected from the patients attending the Department of Periodontics, at the Riyadh Dental Colleges. The re-examinations to evaluate reproducibility 'during the study' were performed two hours after the end of the initial examination on the participants.

The glomerular filtration rate (GFR); which is the best overall index of kidney function [23], was obtained from the patients' records, which was calculated from the serum Creatinine [Cr] to exclude any renal impairment.

Calcium (Ca), phosphate (P), magnesium (Mg) and pH concentrations were measured in both the saliva and urine from non-fasting participants. Stimulated whole saliva was collected prior to the oral examination with the aid of paraffin pellets which was chewed for one minute [24]. The collected saliva was immediately delivered to the lab along with the urine samples. At the end of the examination all the participants were informed whether any dental treatment was necessary and oral hygiene instructions were given individually.

Material used included Reagent kits for Calcium, Phosphorus, Magnesium and Creatinine, a spectrophotometer, a pH meter, pH standards, pipetting devices (multi-pipette, single pipette), timing device, disposable cuvettes, tips, dilution tubes and racks, saline and deionized water, water bath, vortex mixer.

Procedure (Manual): All frozen saliva samples were allowed to thaw to ambient temperature and were analyzed using locally available automated clinical chemistry kits ⁽¹⁾ and PD303D spectrophotometer ⁽²⁾. A slight modification was made to estimate the level of phosphorus by diluting the saliva twenty times with saline before the analysis. One ml of respective reagent what respective agent was pipette into a sterile and dry disposable dilution tube ⁽³⁾. The required amount of standard solution and sample were added to the dilution tube and mixed thoroughly with in a vortex mixer ⁽⁴⁾, and allowed to stand. The standard and sample mixture were transferred into a disposable cuvettes ⁽⁵⁾, the absorbance of standard and sample were recorded by spectrophotometer and the wavelength (nm) was recorded against a blank.

Similarly, the Calcium and Magnesium levels in the urine samples were analyzed. Slight modifications were made to in the estimation of phosphorus and creatine in urine by diluting the urine twenty times with normal saline before the analysis and calculate the amount accordingly. The pH of the samples was measured by using a pH128 GroPro pH meter ⁽⁶⁾.

Statistical Analysis

Data processing and analysis were carried out using SPSS version 20 (Statistical Package for Social Sciences) which provided the followings:

Calculation and presentation of statistical parameters, means and standard deviation of

the means for the clinical and biochemical variables examined in the study.

The statistical tests that were used in this study:

-Student's t-test.

- Person's correlation coefficient.

* The level of significance was accepted at $P < 0.05$, and highly significance when $P < 0.01$.

RESULTS

Table 1 represents the mean values in addition to standard deviations of Plaque, Calculus and Gingival indices among the study and control groups. The null hypothesis for this test stated that the populations' means for study and control groups are statistically same, where the alternative hypothesis stated that they are statistically different.

Comparing the total mean values (male and female participants) for the gingival index, between the study group and the control group was found to be statistically significant.

For Plaque Index, T-test was carried three times. First row, the test result was significant which means the two means are statistically different. Moreover, the P-value for one tailed test can be computed by dividing 0.0001 by 2. Clearly, the one tailed test is significant which provide enough evidence that males in the population of the study groups have higher scores in plaque index than males in the population of the control group. For females in study and control groups (second row), the test was significant which provide an evidence that the female populations of the study and control groups are statistically different where the population of the study group has higher score of Plaque index than the population of the control group with $P\text{-value} = 0.004/2 = 0.002$. Third row, T-test was significant with $P\text{-value} = 0.000$ which provide enough evidence that they are statistically different. In addition, the population of the study group has higher scores of Plaque index than the population of the control group.

For calculus Index, First row the test result was significant which means the two means are statistically different. Moreover, the P-value for one tailed test can be computed by dividing 0.0001 by 2. Clearly, the one tailed test is significant which provide enough evidence that males in the population of the study groups have higher scores in calculus index than males in the population of the control group. For females in study and control groups (second row), the test was significant which provide an evidence that the female populations of the study and control groups are statistically

different where the population of the study group has higher score of calculus index than the population of the control group with $P\text{-value} = 0.002/2 = 0.001$. Third row, T-test was significant with $P\text{-value} = 0.000$ which provide enough evidence that they are statistically different. In addition, the population of the study group has higher scores of calculus index than the population of the control group.

Table 2 illustrates the correlation coefficient between calculus index and plaque index among study and control groups. In case of study group, the related P-value was not significant and clearly it can be notice from $r = -0.0679$ which is a small value (close to 0). Usually for strong correlation (positive or negative), r should be close to minus ± 1 . In case of control group, $r = 0.2$ is still small value and close to zero which is not a sign of significant correlation.

T-test for two samples was carried out in Table 3. Showing the concentration of inorganic salivary constituents, The null hypothesis for this test stated that the populations' means for study and control groups are statistically same, where the alternative hypothesis stated that they are statistically different. The statistical tests were not significant which provide evidence that the gender is not a significant factor in inorganic salivary constituents.

Table 4. illustrates Inorganic urinary constituents (calcium, phosphorous and magnesium) (mean and standard deviation) among study and control groups The null hypothesis for this test stated that the populations' means for study and control groups are statistically same, where the alternative hypothesis stated that they are statistically different.

The statistical tests were not significant which provide evidence that the gender is not a significant factor in inorganic urinary constituents. while for concentration of magnesium ions, it was found higher in control group in comparing to study group but with no statistical significance. Table 5 demonstrates the correlation coefficient of Calculus Index in relation to urinary constituents among study and control groups. The statistical result revealed a positive highly significant correlation ($P < 0.01$) found between dental calculus accumulation and the mean value of urinary phosphorous/creatinine, calcium/creatinine and magnesium/creatinine.

DISCUSSION

The high score of gingival index indicating a significant gingival inflammation caused by calculus formation which provides an excellent surface for plaque adherence which in return irritates the gingival integrity which came in agreement with previous studies

Comparing with previous studies reporting presence of a positive highly significant correlation between dental calculus accumulation with dental plaque accumulation, in our study the oral examination recorded high dental calculus mean values among calcium stone formers which showed high significant difference than the non-stone formers, this could be due to several justifications, such as high scores of plaque accumulation, which came in agreement

Presence of higher values of salivary pH and buffer capacity among study group, the high salivary pH and buffer capacity may permit the saliva to be more supersaturated with calcium phosphates, which might promote calculus deposition in dental plaque

As with the other factors in our study, the the Higher levels of

1-United Diagnostic Industries, KSA
2-APEL, Japan
3-Sarstedt, Germany
4-Rotamixer Deluxer, UK
5-Brand GMBH, Germany
6-Hanna, USA

Table 1: Gingival, Plaque and Calculus indices (mean and standard deviation) among study and control groups

Parameter	Gender	Study	Control	Statistical test	
		Mean $\pm$ SD	Mean $\pm$ SD	t-test	p-value
Gingival Index	M	1.714 $\pm$ 0.43	0.90 $\pm$ 0.37	8.252	0.0001**
	F	1.29 $\pm$ 0.37	0.75 $\pm$ 0.44	1.306	ns
	T	1.585 $\pm$ 0.45	0.835 $\pm$ 0.409	6.372	0.000**
Plaque Index	M	1.828 $\pm$ 0.542	0.72 $\pm$ 0.31	9.038	0.0001**
	F	1.29 $\pm$ 0.23	0.48 $\pm$ 0.28	3.830	0.004**
	T	1.664 $\pm$ 0.53	0.615 $\pm$ 0.32	8.716	0.000**
Calculus Index	M	1.72 $\pm$ 1.15	0.348 $\pm$ 0.257	5.157	0.0001**
	F	1.344 $\pm$ 0.57	0.282 $\pm$ 0.258	4.719	0.002**
	T	1.607 $\pm$ 1.02	0.318 $\pm$ 0.255	6.721	0.000**

Table 2: Correlation coefficient (r) between calculus index with plaque index among study and control groups

Groups	Parameter	Plaque Index	
		r	p-value
Study	Calculus Index	-0.0679	ns
Control	Calculus Index	0.2004	ns

Table 3: Inorganic salivary constituents (calcium, phosphorous and magnesium) (mean and standard deviation) among study and control groups

Elements (mmol/L)	Gender	Study	Control	Statistical test	
		Mean $\pm$ SD	Mean $\pm$ SD	t-test	p-value
Calcium	M	2.897 $\pm$ 1.515	2.60 $\pm$ 1.04	0.0632	ns
	F	2.889 $\pm$ 1.60	2.83 $\pm$ 1.84	0.0704	ns
	T	2.895 $\pm$ 1.51	2.710 $\pm$ 1.45	0.2360	ns
Phosphorus	M	30.13 $\pm$ 21.69	20.55 $\pm$ 12.66	1.088	ns
	F	27.31 $\pm$ 13.87	22.13 $\pm$ 13.44	1.306	ns
	T	29.27 $\pm$ 19.38	21.28 $\pm$ 12.81	1.825	ns
Magnesium	M	0.414 $\pm$ 0.357	0.453 $\pm$ 0.36	0.7870	ns
	F	0.38 $\pm$ 0.180	0.47 $\pm$ 0.59	0.9650	ns
	T	0.403 $\pm$ 0.312	0.461 $\pm$ 0.477	0.6620	ns

Table 4: Inorganic urinary constituents (calcium, phosphorous and magnesium) (mean and standard deviation) among study and control groups

Elements (mmol/L)	Gender	Study	Control	Statistical test	
		Mean $\pm$ SD	Mean $\pm$ SD	t-test	p-value
Calcium	M	6.37 $\pm$ 6.02	7.09 $\pm$ 7.34	0.2649	ns
	F	4.43 $\pm$ 4.2	4.63 $\pm$ 3.42	0.3390	ns
	T	5.773 $\pm$ 5.52	5.98 $\pm$ 5.95	0.3559	ns
Phosphorus	M	88.72 $\pm$ 75.27	80.53 $\pm$ 52.91	0.7953	ns
	F	41.65 $\pm$ 19.64	76.54 $\pm$ 35.81	2.116	ns
	T	74.24 $\pm$ 66.72	78.73 $\pm$ 45.31	0.5691	ns
Magnesium	M	3.47 $\pm$ 2.78	4.53 $\pm$ 2.77	1.007	ns
	F	2.165 $\pm$ 2.165	3.897 $\pm$ 2.24	0.952	ns
	T	3.07 $\pm$ 2.64	4.246 $\pm$ 2.53	1.545	ns

Table 5: Correlation coefficient (r) between urinary constituents among study and control groups

Groups	parameter	Calcium/Creatinine (mmol/g)		Phosphorus/ Creatinine (mmol/g)		Magnesium/ Creatinine (mmol/g)	
		r	p	r	P	r	P
Study	calculus	0.793	0.000**	0.536	.002**	0.551	.001**
Control	calculus	0.167	ns	.020	ns	.204	ns

phosphorus were found in the saliva of study group compared to the control group (table 3), and this could be in agreement with the role of phosphorus ions in the development of heavy calculus. The early plaque of heavy calculus formers contains more calcium and three times more phosphorus than that of non-calculus formers, suggesting that phosphorus may be more critical than calcium in plaque mineralization. Table 4 shows the low levels of magnesium found in study group indicates higher chances of calcium oxalate formation as magnesium considered an inhibitor of calcium renal stone that's why found in higher concentration in the control group in convenient [25,26]

Since most evidence suggests that a bi-directional relationship exists between periodontitis, oral hygiene status and systemic diseases in general [27] to implement the routine scaling and oral hygiene maintenance to all patients of kidney diseases.

Also to focus on the Dentist-physician communication as it is of extreme importance to assure efficient health care of the patient and avoid complications. The limitation of this study is the small sample size.

Conclusion

This retrospective study was conducted through careful samples collection and laboratory analysis resulting in significant data supporting the hypothesis. Future wise, sample size increase is advisable for further strengthening of the research.

The knowledge of the dental and medical teams should be evaluated regarding the bi-relation of oral and periodontal status

with the kidney diseases.

Future studies are needed to corroborate these preliminary findings.

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