

Saliva as an Alternative Fluid for Kidney Diseases Assessment

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ABSTRACT

Background

The prevalence of kidney diseases are increasing by increasing of chronic debilitating diseases and progressing age of population. Many medical and scientific studies increasingly encourage to use saliva fluid as an alternative fluid for diagnostic methods. Thus, the aim of the present study is to determine the diagnostic efficacy of saliva in kidney disease patients.

Materials and methods

A cross-sectional study included 59 patients with renal disease and 20- matched healthy controls were studied. Serum and saliva were collected and Serum and saliva were used for biochemical analysis of urea, creatinine, uric acid, total protein, albumin, sodium, potassium, calcium, and chloride, using the suitable demonstrated methods, which were statistically compared and analyzed by using SPSS version 22, student T-test.

Results

In the comparison of serum to salivary creatinine, uric acid, urea, albumin, total protein, sodium, potassium, calcium, chloride, the results showed a statically significance ($p < 0.05$) in renal failure, nephritis and kidney stones patients comparing with the control subjects.

Conclusion

Saliva can be applied as a diagnostic fluid instead of using blood, because it is noninvasive and has an easy collection procedure, for biochemical diagnostic of renal & kidney diseases.

Key words: Saliva, creatinine, urea, uric acid, T. protein, Albumin, Sodium, Potassium, Calcium & Chloride, Renal Diseases

اللعاب كسائل بديل لتقييم أمراض الكلى

الملخص

خلفية: يتزايد انتشار أمراض الكلى بسبب زيادة الأمراض المزمنة المنهكة وتقدم عمر السكان. تشجع العديد من الدراسات الطبية والعلمية بشكل متزايد على استخدام سائل اللعاب كسائل بديل لطرق التشخيص. وبالتالي فإن الهدف من هذه الدراسة هو تحديد مدى فعالية اللعاب في تشخيص مرضى الكلى.

المواد والأساليب

شملت دراسة مقطعية 59 مريضاً يعانون من مرض كلوي وتمت دراسة 20 مريضاً من الأصحاء المتطابقين. تم جمع مصل الدم واللعاب واستخدام المصل واللعاب للتحليل الكيميائي الحيوي لليوريا والكرياتينين وحمض البولييك والبروتين الكلي والألبومين والصوديوم والبوتاسيوم والكالسيوم والكلوريد، وذلك باستخدام الطرق المثبتة المناسبة والتي تمت مقارنتها وتحليلها إحصائياً باستخدام استخدام SPSS الإصدار 22، اختبار الطالب T.

النتائج

وفي مقارنة المصل مع الكرياتينين اللعابي وحمض البولييك واليوريا والألبومين والبروتين الكلي والصوديوم والبوتاسيوم والكالسيوم والكلوريد أظهرت النتائج وجود دلالة إحصائية ($P < 0.05$) في مرضى الفشل الكلوي والتهاب الكلية وحصول الكلى مقارنة مع مرضى الفشل الكلوي والتهاب الكلية وحصول الكلى. موضوعات التحكم.

خاتمة

يمكن استخدام اللعاب كسائل تشخيصي بدلاً من استخدام الدم، لأنه غير جراحي وله إجراء تجميع سهل، للتشخيص الكيميائي الحيوي لأمراض الكلى والكلى.

الكلمات المفتاحية: اللعاب، الكرياتينين، اليوريا، حمض البولييك، بروتين T، الألبومين، الصوديوم، البوتاسيوم، الكالسيوم والكلوريد، أمراض الكلى

Introduction

Kidney diseases are increasing global problems with a significant economic impact, especially in the developed world(1). About 60000 people annually lose their lives due to kidney related diseases, while the incidence of the kidney stones in the United States is 11% (2). Moreover, the incidence of pyelonephritis is 25% . Also kidney diseases are caused by many reasons either pre renal or renal and post renal(2). Pre-renal causes are (cardiac failure, hypovolemia and hypotension(2,3), while renal causes include (glomerulonephritis or nephrotoxins as aminoglycosides, heavy metals, etc.,). Post-renal causes are composed of either bilateral obstruction (unless there is only one functioning kidney) of urinary drainage or prostate, cervical, urinary bladder or retroperitoneal tumors, or bilateral nephrolithiasis and inflammation(3).

Acute kidney failure (AKF), is a rapidly loss of renal function, generally characterized by decreased urine production, less than 400 mL per day in adults, less than 2 mL/kg/h in children, or less than 1 mL/kg/h in infants); causing fluid and electrolyte imbalance(4).

Chronic Kidney Failure (CKF), is also named chronic renal failure (CRF), is defined as kidney damage or decreased kidney function for three or more months, (It can be caused by many reasons as: renal circulatory diseases, primary glomerular diseases, renal sequelae to metabolic disease, inflammatory diseases, renal obstructions, congenital renal deformity, and miscellaneous conditions, as well(5).

The main function of the kidney, is the excretory function which can be evaluated by assessing serum levels of materials excreted by the kidney, as (urea and creatinine), which are important indicators of renal function alterations and also to illustrate the constancy

of body fluids, by maintaining and regulating urine compositions and volume (3) . The level of serum electrolytes such as Ca^{2+} , Na^{+} , K^{+} and P^{3+} found to be as an investigatory tool to diagnose renal diseases, and evaluation the degree of renal impairment as well as assessing diseases progressing(3,6,7,8).

In the world kidney diseases are considered to be the most common diseases, especially in Yemen due to lack of awareness, and due to the difficulty of repeated blood sampling from kidney diseases patients and the difficulties faced during blood sampling such as difficulty obtaining veins, stiffness of veins and the occurrence of complications associated with blood drawing, such as pain, discomfort, anemia and serious diseases acquired from the patient during the dialysis process and transferred to the medical staff during the collection of blood sample. Therefore, saliva sample was used as a safe and non-surgical alternative sample which is easy to obtain and is considered less dangerous than the blood sample(1).

Therefore, the aim of research is to evaluate the chance and efficacy of using saliva fluid instead of blood to assess of kidney function.

Saliva and its use in kidney function tests

The average of daily secretion of saliva is ranging from ~ 800 ml to 1500 ml(4, 8), reaching its maximum peak at around 12 a.m. but falls considerably at night, during sleeping time(26,12). Saliva secretion is a complex mixture of an extracellular fluid that is produced and secreted by salivary glands, parotid, submandibular, sublingual, and by numerous minor salivary glands (7). It is composed of more than 99% water and less than 1% solids including (Na^{+} , K^{+} , Ca^{2+} , ...), protein that is represented by hormones, enzymes, immunoglobulins and trace amount of albumin, glucose, uric acids and metabolic

products as urea and creatinine (8) . Saliva components get from blood components by either passive diffusion, active transport or by ultrafiltration of extracellular fluids, by the action of hydrostatic pressure, so saliva is considered as blood filtrate (9,10,12,13) . Saliva is sterile when it leaves salivary glands but it is contaminated with bacteria and other product directly when it enters the oral cavity(12). As saliva is a filtrate of blood, it will have the same type of biochemical markers inside(12,16).

Saliva is an accessible fluid that can easily be collected from the patients, that is neither painful or traumatic, therefore, saliva becomes credible for early detection of certain systemic diseases, monitoring and treatment of addictive drugs(11). These properties support the possibility to diagnose, monitor in infants, and in many personal status in which blood and urine sampling is not obtainable(16,18).

Due to kidneys damage, they will not be able to filtrate blood perfectly, so it causes many changes in blood biochemical composition. As a result of the difficulties that are faced while withdrawing blood samples, like blood, saliva can work as "a mirror of health" and because saliva components are similar to blood, it can be affected by kidney diseases. These biomarkers include urea, creatinine, uric acids, proteins, albumin, and minerals as, sodium, potassium, calcium and chloride, etc.,(18,26).

Creatinine

It is a metabolite wasted product of creatine phosphate metabolism that consists of three amino Acids come from liver, pancreas and kidney(1,7,14). It is a large molecule, diffuses from various tissues into blood that is released in a constant rate to the circulation every day depending on muscular mass(5). So serum

creatinine level used as an index to renal function, Mainly, it is specific test for renal diseases because it is entirely excreted by the kidney and never reabsorbed(5,7,18,22). In consequence normal values of serum creatinine is 70-123 $\mu\text{mol/L}$, while salivary creatinine normal range is 4.42 - 17.68 $\mu\text{mol/L}$ (1,12).

Urea

Is a wasted product of protein metabolism, urea and creatinine, of plasma serve as an indicator of any changing of kidney functions. Even though, creatinine and urea levels could be altered by many reasons as many diseases other than kidney diseases, food intake, drugs or intestinal bacteria(20,22). Its normal value is 2.5 - 7.1 mmol/L, whereas normal salivary urea is 1.99 - 11.7 mmol/L(1,18).

Uric acid

It is the catabolism products of purine nucleic acids. It is filtered by the glomerulus and secreted by the distal tubules into the urine, and relatively insoluble in plasma, so it can precipitate at high concentrations, deposited in the joints and tissue, causing inflamed pain(1,21). Normal serum values are 120-400 $\mu\text{mol/L}$ while in saliva 172 -226 $\mu\text{mol/L}$.

Albumin

It is the smallest protein, globular, and has a molecular weight of 66.5 kilodaltons (KDA). It serves and maintains the osmotic, oncotic, pressure in blood, transports of bilirubin, fatty acids, drugs, hormones and enzymes. Increased levels are rarely observed, and mainly seen during dehydration, but decreased levels are seen in liver diseases (hepatitis, cirrhosis), as liver is its main synthesis site, its normally excreted in a very small amounts. The decreased concentrations of serum albumin, in renal diseases is due to its excretion of albumin with urine, kidney diseases cause excessive excretion of albumin in urine (microalbuminuria), leading to

decrease serum albumin level (hypoalbuminemia) (3,5,7,13). Its normal range in serum is 33–55 g/L.

Total protein

Albumin and globulins together are called total protein, Albumin, Kidney disease, liver disease, bone marrow as well as other metabolic or nutritional disorders and many other conditions may be reflected by evaluation of T. which is used in the diagnosis and treatment of a variety of diseases involving the liver, kidney. It is decreased in kidney diseases due to its excessive excretion with urine (proteinuria) causing a hypoproteinemia(3,14). Its normal range in serum is 60-80g/L, while in saliva is 0.5 – 2 mg/ L(17).

Sodium (Na⁺)

It is considered a famous and abundant positive charge electrolyte in the blood, representing 90% of all extracellular cations, and mostly evaluates and determines the plasma osmolality, stimulating compensatory mechanisms of kidneys to balance the body's fluid (1). Also it plays a main role in acid-base balance, and in neuromuscular functions(1,3,10).

These important roles of Na⁺ are regulated by production of certain hormones that increase (natriuretic peptides) or decrease (aldosterone) or antidiuretic hormone (ADH) to prevent water losses. Beside these, another mechanism of feeling thirst during the increase of blood sodium leads to facilitating water drink to return the water balance and blood volume to a normal level(1,3). Its normal range in serum is (135–145 mmol/L) while in saliva is(2–21 mmol/L)(5,7).

Potassium (K⁺)

Is the most intracellular electrolyte (cation) in the body. It is 20 times greater in the intracellular than the extracellular, so as a

result, only 2% of the body's total K circulates in the plasma, K⁺ roles in the body including regulation of neuromuscular excitability, contraction of the heart, maintenance of ICF volume, and [H⁺],(10,13). The excess dietary potassium intake is then excreted through the kidneys. In renal failure, plasma potassium increased causing (hyperkalaemia) which is the most significant and life-threatening complication of renal failure(15,16). Its normal range in serum is (3.5–5.0 mmol/L) while in saliva is 10– 36 mmol/L (higher than plasma),

Calcium (Ca²⁺)

Calcium is the most abundant mineral in the body because the adult (70 kg) contains about 1kilogram of calcium. About 99% of calcium present is in the bones and teeth, and 1% in the other tissues. It is also more useful for the controlling of heart and its normal function, in blood clotting, and muscle functioning, such as relaxation and contraction(16,26). The kidneys aid to keep the levels of calcium at healthy levels, but its level in kidney disease altered, as activation process of vitamin- D that is necessary for calcium absorption decreases(26).

Chloride(Cl⁻)

It is the major extracellular anion. The normal range of serum chloride is (98- 107 mmol/L), while in saliva is (5–40 mmol/L). Its precise function in the body is unclear; however, although it is involved in maintaining osmolality, blood volume, and electric neutrality. In most processes, Cl⁻ shifts secondarily to a movement of Na⁺ or HCO³⁻. Cl⁻ disorders are often a result of the same causes that disturb Na⁺ levels because Cl⁻ passively follows Na⁺(1,5,22).

Materials and methods

Type of study: Comparative cross-sectional study.

Sample size: Samples were withdrawn from the different patients of renal diseases, 59 samples were divided into groups (Renal failure RF, Renal calculi & Renal crystals RC and Nephritis). The female samples were 26, while male samples were 33 and control samples were 23 divided, as (13 femals and 10 males).

Study area: The study was carried out in Al-Torba region- Taiz.

Study duration: The study was carried out between February 2022- October 2022 .

Exclusion criteria: Patients with mouth diseases, patients that had any food before less than half an hour or still having and patients who used toothpaste before collection of the sample were excluded.

Data collection: A structured questionnaire was used to collect information from the participants during Field survey. The information collected included (age, gender, medicine and the other diseases that they have).

Equipment and Instruments: Rayto chemray 240, Cornley AFT-500 Electrolytes analyzer, Refrigerator, Centerfuge, Gloves, Marker, Alcohol prep pads, Tourniquet, Needles, Glass tubes, Gell and Ependrove.

Rayto chemray 240.

We used this device to measure the following parameters (creatinine, urea , uric acid, albumin and total protein) .

Colorimetric:

It is depending on determining how much light is reflected by a chemical material by measuring the strength of light as a light beam that travels through the sample solution. The fundamental theory is that light is absorbed or emitted over a certain wavelength spectrum by each compound.

Cornley AFT-500 Electrolytes analyzer

We used this device to measure electrolytes. It as depending on a galvanic cell. It contains a reference electrode, ion-selective membrane, and voltmeter. The transport of ions from high concentration to low concentration through the selective membrane creates a potential difference. It can be measured with respect to a standard reference electrode having a constant electrode potential.

Centrifuge

A centrifuge works by using the principle of sedimentation under the influence of gravitational force(g-force), substances separate according to their density here, particles are concentrated as a pellet at the bottom of the centrifuge tube and separated from the remaining solution, called supernatant .

Methods

Sampling method and preparation

Serum sampling method and preparation:

Aspirate of about 5ml from all patients and control subjects into gel tubes. They were separated using centrifuge at (8000 r \ m) for 10 minutes and kept in the ependrove tubes .

Saliva sampling method and preparation:

collection of about 5 ml of the unstimulated saliva into sterile container, and putting them in an ice box till the time of analysis. Then they separated directly by centrifuge at (8000 r/m) for 10 minutes and took the suspension into ependrove tubes.

Creatinine assay by Jaffe reaction

Principle:

Creatinine assay uses the "Jaffe reaction", in an alkaline medium, creatinine forms a yellow-orange-colored complex with picric acid. The rate of color formation is proportional to the concentration of creatinine present which is measured at 520 nm.

Urea assay by enzymatic method

Principle:

Urea is hydrolysed in presence of urease to produce ammonia and CO_2 , the ammonia produced combines with alfa oxoglutarate and NADH in presence of GLDH to yield glutamate and NAD^+ . The decrease in extinction due to $\text{NADH}+\text{H}^+$ in unit time is proportional to the urea concentration which is measured.

Uric acid assay by enzymatic method

Principle:

Uric acid is oxidized by the specific enzyme uricase to form allantoin and H_2O_2 . The H_2O_2 reacts with 2,4,6-tribromo-3-hydroxybenzoic acid (TBHB) and 4-aminophenazone in the presence of peroxidase to form quinone-imine dye and hydrogen bromide (HBr). The intensity of the red color is proportional to the uric acid concentration.

Results

Table (1):

Albumin assay by bromo cresol green (BCG) method

Principle:

The method is based on the protein error of indicators. Biding of a protein to an indicator changes its colour. Among serum proteins, only albumin binds to BCG. This binding produces a change in the colour of BCG , which is measured colorimetrically.

Total protein assay by Biuret's reagent

Principle:

The method is based on the protein error of indicators. Biding of a protein to an indicator changes its colour, which is measured colorimetrically.

Statistical analysis

Using SPSS Version 22, quantitative variables were analysed by using student T-test to analyse our results.

The results of serum and salivary creatinine were highly significantly increased in group patients with renal failure and nephritis when comparing with the results of the control subjects, while the serum and salivary creatinine values were slightly increased in

Table (2):

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The data of serum and salivary urea were also significantly raised in patients with renal failure and nephritis as compared to control group subjects, while the values of serum and salivary urea in group patients with renal stones were slightly increased but without

patient group of renal stones compared to control, but without statistical significant difference between the two groups. The creatinine levels showed a statistical significant difference between serum and saliva in all groups as shown in table 1.

statistical significant difference when compared to the control subjects. The urea concentration illustrated a statistical significant difference between serum and saliva in all group as shown in table 2.

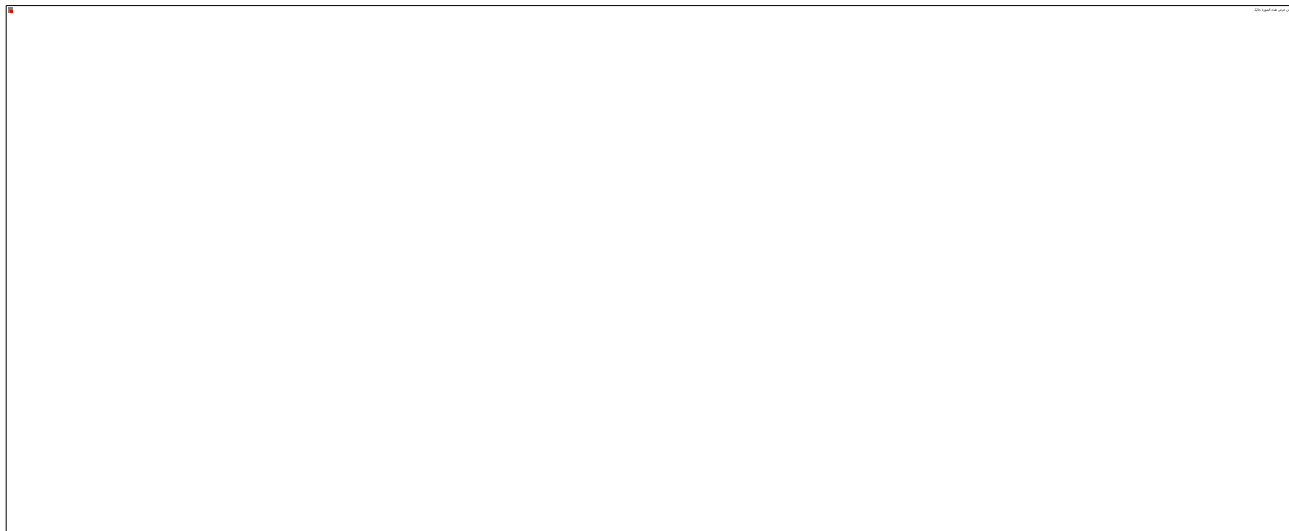
Table (3):

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The data of uric acid in serum and salivary group patients of renal failure and nephritis were significantly increased as compared to the control subjects, while the values of serum and salivary uric acid were slightly increased in patients with renal stones when compared

to the control subjects, but without statistical significant difference between the two groups. The uric acid results showed a statistical significant difference between serum and saliva in all groups as shown in table 3.

Table (4):



Serum and salivary total protein values were significantly reduced in group patients with renal failure compared to control subjects, while the values of the serum and salivary total protein of nephritis and kidney stones groups were reduced with non significance when compared to the control subjects. The total protein concentration of serum and saliva had a statistical significant difference between all groups as seen in table 4.

Table (5):

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Serum and salivary albumin values were significantly reduced in patients with renal failure compared to control subjects, while the values of the serum and salivary albumin were slightly reduced in patients with nephritis and renal stones compared to

control, but without statistical significant difference between the two groups. The albumin concentrations revealed a statistical significant difference between serum and saliva in all groups as shown in table 5.

Table (6):

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The serum and salivary sodium values were significantly increased in patients with renal failure compared to control subjects, while the serum and salivary sodium values were slightly increased in patients with nephritis

and renal stones compared to control, but without statistical significant difference between the two groups as shown. The sodium concentration showed a significant difference between values of serum and saliva in all groups as appeared in table 6.

Table (7):

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Salivary and serum chloride values were significantly increased in patients with renal failure group when compared to control subjects, while serum and salivary sodium values of patients with nephritis and renal

Table (8):

stones groups were slightly increased with non significant difference as compared to the control subjects. The chloride concentration revealed a statistical significant difference between serum and saliva in all groups as shown in table 7.

Potassium values of serum and saliva in patients with renal failure group were significantly elevated compared to control subjects, while the serum and salivary potassium values were also slightly raised in patient groups of nephritis and renal stones

as compared to control subjects, but without statistical significant difference between the two groups. The potassium concentration showed a statistically significant difference between serum and saliva in all groups as illustrated in table 8

Table (9):

Salivary calcium values were significantly reduced in the patient group of renal failure, but with non significant difference in patients of nephritis. On the other hand, there was a highly significant increase of salivary calcium in kidney stones group, as compared to the control subjects. While the serum calcium levels were slightly reduced in patients with renal failure, nephritis and kidney stones,

when compared to the control subjects without statistical significant difference. The calcium concentration showed a statistical significant difference between serum and saliva in all groups as revealed in table 9

Discussion

The study goal was to determine levels of salivary creatinine, urea, uric acid and other parameters (albumin, T.protein, & minerals as

Na, K, Ca, Cl, in patients with chronic renal failure (RF), renal calculi or renal crystals (RC) and Nephritis in comparison to healthy individuals. The role of using saliva fluid to diagnose, comparing the results with blood, as it is available, simple and non-invasive collection that can be done by individuals themselves, easy collection especially for geriatric, pediatric, obese, patients and with mental deficiency, and prisoners etc.,(15,18).

Saliva components include organic and inorganic molecules, which are found dissolved in the aqueous components. The inorganic part is composed of weak and strong ions like Na^+ , K^+ , Cl^- , Ca^{2+} , HCO_3^- , Mg^{2+} , NH_4^+ etc., and the organic parts such as urea, uric acid, creatinine, putrefaction products, etc.,... (1,16,18,20). Saliva could be used for diagnosing systemic diseases,(20). As Riis, JL. et al (2018) said: "only a thin layer of epithelial cells separates the salivary ducts from the systemic circulation which makes ultrafiltration and exchange of molecules possible between serum and saliva". Thus, many studies explore the possibility of positive correlation between serum and salivary uric acid levels(18,21). In patients with renal failure, the serum creatinine is increasing due to reduced creatinine excretion via the kidneys. Although creatinine is a large molecule with a high molecular weight, it has little secretion into the saliva in healthy individuals(22), but in renal failure, more creatinine secreted with saliva. As serum creatinine levels increased in renal failure patients causes a concentration gradient which accelerates creatinine diffusion from blood into saliva.(23). In this study, we observed increased levels of serum and salivary creatinine in patients with renal failure when compared to the control subjects. The current study also showed that there were increased concentration of salivary and serum urea in

patients with renal failure when compared with control subjects. These findings were in an agreement with **Taye Jemilat et, al., (2016)** in Nigeria and **Divya Pandya et, al., (2016)** in India, who found that "salivary levels of creatinine and urea were significantly elevated in chronic kidney disease patients ($p < 0.001$)". Also they proved that there was a positive correlation between creatinine levels in serum and saliva, and as well as urea levels (13,33,34).

In the year 2016 Divya Pandya et, al., 2016, reported that creatinine and urea in saliva levels raised in CKD group, diabetic groups, hypertensive groups and controls respectively (15,23).

The increased urea in the blood creates an elevation in gradient, so increasing the diffusion of urea from blood to saliva(17,27). These results were also observed by the study that was done by Alpdemir et, al., (2017) in Serbia(24). So our study was in consistence to those results.

Many studies reported that high levels of uric acid (hyperuricemia) are associated with chronic kidney diseases due to excretion reduction from the kidney(21). In the present study, the patients with renal failure showed elevated levels of serum and salivary uric acid than the control subjects. The reason for increasing salivary uric acid in patients with renal failure may be due to elevation of serum uric acid which make a concentration gradient that facilitate urea diffusion from blood to saliva(19,21). Our finding and the previous studies were in parallel to that study published by Riis JL et, al., (2018), where they revealed that the value of salivary uric acid was stable while assessing the validity and stability of salivary uric acid levels among 99 healthy young adults.(1,21)

Our data, found that the patients with renal failure showed reduced levels of serum and salivary total protein than that of the control subjects. The findings of the present study were in agreement to the study done by Rodrigues et, al., (2016)) in Brazil, which demonstrated high salivary albumin level in hemodialysis patients than control(26). However, on the other hand, that study results and our results were in the opposite side to the data obtained by Taye Jemilat et, al., (2016), in Nigeria, which described that the higher levels of salivary total protein in chronic kidney disease were due to increase amylase level, and attributed their reduced data of serum and salivary albumin levels of renal failure to damage of nephrons in these patients with CRF, which lead the secretion of albumin in large amounts with urine (Macroalbuminuria). Thus, low albumin level in the blood causing low salivary albumin level(25,26) .

In our data, the patients with renal failure showed elevated levels of serum and salivary sodium than control. The increased salivary sodium level might have been related to the higher serum sodium level. This finding was in consistence to that reported by Anuradha B.R et, al., (2015), who revealed a high salivary sodium level than in control (27), but disagree with Taye J. Lasisi et, al., (2018), in consequence the alterations in the results were probably because of diet, other diseases and use of multiple drugs(25). The increased salivary chloride and potassium level might have been related to the higher serum chloride and potassium levels. Our findings of chloride and potassium levels were similar to that study reported by Taye Jemilat et, al., (2018)(25). Consequently, the serum and salivary concentration of calcium in the patients with renal failure in the present study were lower than that in the control which was similar to the

previous works, which showed reduced concentration of salivary calcium in patients with CKD. This reduction in serum and salivary calcium levels may be due to the consequence of a fall in 1,25 dihydroxycholecalciferol, the active metabolite form of Vitamin D₃, which plays a main role in maintenance of calcium absorption and calcium levels in serum and saliva, these findings were also similar to Taye J. et, al., (2018)(2,25,26). Anuradha et, al., 2015 found a significant difference between control subjects and prehemodialysis patients in the salivary minerals "sodium, potassium, calcium, phosphorus and urea levels"(2,27). On the other hand, Rodrigues et, al., (2016) showed high salivary levels of Ca, P, albumin ($p < 0.05$) of the hemodialysis (HD) group exhibited(13,26).

Conclusion

- The obtained results in our study suggested that saliva can be used as an evaluation tool of serum creatinine, urea, uric acid, albumin, total protein in kidney disease patients.
- Saliva can be used as a diagnostic fluid in all renal and kidney disease patients instead of using blood sample.
- It is easy to control and monitor general health and to diagnose the early stage morbidity.
- All studies give us the promise that saliva has the potential to be used as an alternative fluid to serum.
- It might decrease the occupational risks of personnel laboratory.

Recommendations

- Making intensive studies on saliva and its role in diagnosis of different diseases.
- Providing the laboratories with all the necessary procedures for saliva samples getting.

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