ABO Blood Type in Relation to Caries Experience and Salivary Physicochemical Characteristic among College Students at Al-Diwania Governorate in Iraq

Rania F. Kadhum, B.D.S. [1]
Ban Sahib Diab, B.D.S., M.Sc., Ph.D. [2]

ABSTRACT

Background: (ABO) Blood type have an effect on general health including oral health as salivary physicochemical characteristics differ among different type of blood and as consequence these affect the severity of dental caries. The aim of the present study is to assess of the prevalence of caries experience among different blood type in relation to salivary physicochemical characteristic.

Materials and Methods: Two hundred and fifty females' college students in Al-Qadisyia University aged 18 years old were selected on random basis; they were divided to four groups according to their blood type, Dental experience was diagnosed and recorded according to DMFs Index (Mülemman, 1976), this allows recording decayed lesion by severity. A sub sample was pooled for salivary analysis.

Results: In the present study the blood type O was more common followed by B and A, whereas the less common was AB type, caries experiences (DMFs) and Ds component were found to be statistically significant among different blood types. The most sever grade of dental caries D_3 and D_4 were higher among type AB and lowest sever grade D_1 among B blood type. While salivary flow rate significantly differ among differ blood type, viscosity higher but not significant among type AB. While salivary concentration of calcium and total protein were differ but not significant, opposite to alkaline phosphatase which was highly significant among different blood types.

Conclusions: ABO blood type has an effect on salivary physical and chemical characteristic of saliva as effect on prevalence of caries.

Key words: ABO antigen, ABO blood group, Dental decay. (J Bagh Coll Dentistry 2015; 27(4):125-131).

INTRODUCTION

In spite of a knowledge explosion in cariology science, dental caries still remains a misunderstood phenomenon by the clinicians. In order to effectively use the wide range of preventive and management strategies, it is imperative to look beyond those black and white spots that manifest on the tooth surfaces. One of the most important factors which influence the development of dental caries is saliva. The physicochemical properties of saliva like pH, buffering capacity, salivary flow rate, concentration of various components like proteins, calcium and antioxidant defense system play a major role in the development of caries [1].

Dental caries is one of the most significant health problems facing all ages [2]. This could be due to the cumulative irreversible nature of dental caries [3,4]. Saliva is one of the most important factors in regulating oral health, with flow rate and composition changing throughout development and during disease. Saliva can affect incidence of dental caries in four general ways, firstly as a mechanical cleansing, secondly by reducing enamel solubility by means of calcium, phosphate and fluoride, thirdly by buffering and neutralizing the acids produced by cariogenic organisms and finally by anti-bacterial activity [5], salivary alkaline phosphatase; which may balance enamel remineralization [6], as well as buffering capacity; that may affect alkaline phosphatase function and the quantity of ion activity product for hydroxyapatite [7,8].

In 1900, Landsteiner first described the existence of serologic difference between individuals, and classified people into four groups depending on whether their RBC cell membrane contained agglutinogen (antigens). The most important blood-typing system, the ABO system, which comprises of four blood types: A, B , AB and O. Blood group O erythrocytes have no true antigen, but blood serum of O-type individuals carries antibodies to both A and B antigens. Type A and B erythrocytes carry the A and B antigens, respectively, and make antibodies to the others. Type AB erythrocytes do not manufacture antibodies to other blood types because they have both A and B antigens [9]. The distribution patterns of ABO system are complex around the world. Some variation may even occur in different areas within one small country [10]. The blood group distribution also shows variety according to races. In previous Iraqi studies [11,12], they found that the O blood type was more common followed by blood type B and A, and the least prevalent was AB.

In the last 20 years, there has been increasing evidence that blood groups have a function and play a biological role, they have been used as

(1)Master Student. Department of Pedodontics and Preventive Dentistry, College of Dentistry, University of Baghdad.
(2)Assistant Professor, Department of Pedodontics and Preventive Dentistry, College of Dentistry, University of Baghdad.

genetic markers in studies of their associations with various diseases [13,14]. This biological role often does not relate to the red cell, but to the presence of chemical moities on other cells that were initially identified as red cell antigens. Antigens, first identified on RBCs, are now known to be important as receptors and ligands for bacteria, parasites and immunologically important proteins and differences in ABO blood groups are determined by antigens in the outer carbohydrate coating (glycocalyx) of erythrocytes[15].

Immunohistochemical studies have demonstrated the presence of A/B antigens on spinous cells in the non-keratinized oral epithelium of blood group A and B persons, where basal cells express precursor structures and the more-differentiated spinous cells express the A or B antigens. Blood group O persons who do not have the A and B gene-coded glycosyl transferase express a fucosylated variant (Ley) of the precursor structure[16,17]. Because these antigens are present in most tissues, differences in the glycocalyx expressed by cells might elicit differing responses in biomedical phenomena in other diseases or disorders [18-20].

Anthropologists have used the ABO blood types as a guide to the development of modern humans. Many diseases, particularly digestive disorders, cancer, and infection, show preferences among the ABO blood types [21-23]. The history of investigations regarding the relationship between blood groups and dental diseases goes back to 1930 [24].

Early investigation by Aitchison and Carmichael [25] studied the distribution of blood groups within two groups, one of whom were the random patients attending the dental hospital and the other consisting of cases with rampant caries they found that people with O blood type have higher dental caries experiences, while people with A blood type was the lowest, also O'Rark and Lyschon [26] found a statistical significance regarding the relation blood type and caries history. While Janghorbani [27] showed that dental caries prevalence of 427 soldiers of military base in Kerman with 19 years, the mean value for DMF index was the lowest in B blood group and the highest in AB blood group. Also, secretors of blood group A had the lowest numbers of cavities [25-28]. On the contrary, Barros and Witkop, on a large group of Chileans, found no association between the D.M.F scores for caries and ABO Blood groups [29].

To the best of our knowledge, no previous study has been performed yet in Iraq to evaluate the relationship between the physic-chemical characteristic of saliva and caries experience among different blood group; therefore, this study was conducted.

MATERIALS AND METHODS

Study Population:

In the present study, 250 female students of first grade in Al-Qadisyia University at Al – Diwania governorate with age 18 years old were selected randomly and participated in the present study. Respecting the previous studies [8,30], those who had positive history of illnesses or treatments which could cause alteration in salivary rate and composition, were excluded from the study.

Informed consent was obtained from each individual, before any data collection and examination of the oral health status then the blood samples were taken by a sterile finger prick with a disposable needle. The blood grouping examination was done by the slide method [13].

Dental Examination:

An examiner was trained and informed with WHO instructions on oral examination, the examination was done while the students sitting on the dental unit, Plain mouth-dental mirrors (No.4). Sickle-shaped dental explorers were used. Teeth lost or restored due to trauma, orthodontic treatment or aesthetic reasons were not considered as missed or filled teeth. Decayed (D), missed (M) and filled (F) teeth index were detected following the criteria described by Mülemman (1976), this allows recording decayed lesion by severity [31].

Collection of Saliva Samples:

The stimulated whole saliva was collected under standard conditions, following the instructions cited by Tenovuo and Lagerlöf[32]. To reduce circadian effect, saliva collection was done between 9 and 11am after 2 hours with subjects being prevented of eating, drinking or brushing. Each individual was asked to chew apiece of Arabic gum (0.5-0.7gm) for one minute, then removed all saliva by expectoration, after that chewing was continued for five minutes with the same piece of gum and saliva collected in a sterile screw capped bottle.

The flow rate of the saliva was determined according to Jensen et al. [33]. Flow rate (ml/min) = Volume (ml)\ Time (min). Then each salivary sample was separated in two parts, one for the measurements of viscosity of saliva, which was done by measuring the volume rate of flow through a tube of viscometer is known Ostwald viscometer as cited by Stokes and Davies [34]. Other part was centrifuged at 3000 r.p.m for 10 minutes then the clear supernatants was separated

by micropipette and then stored at (-20°C) in a deep freeze till the time of biochemical analysis.

Biochemical Analysis of Saliva:

Target salivary elements were alkaline phosphatase, calcium and total protein analyzed at private licensed laboratory Salivary alkaline phosphatase, calcium and total protein analyzed by flame atomic, using SP-300 spectrophotometer (Optima, Japan), following standardized procedure. Instrumental settings were performed according to instrumental manufacture's specifications. Frozen saliva samples were allowed to thaw and come to room temperature. Thereafter, they were subjected to biochemical analysis.

Alkaline phosphatase in saliva was estimated by using alkaline phosphatase kit, which functions on the basis of Modified Kind & King's method[35]. The measurement of calcium in the sample is based on formation of color complex between calcium and o-cresolphtaleir in alkaline mediurn [36]. Determination of total proteins in saliva was done by using human total protein liquicolor kit (SPECTRUM-S.A.E) [37].

Statistical Analyses:

A computerized program, the statistical package for social science (SPSS), version (13) was used to calculate the statistics. The analysis of data included, tests for normal distribution**,** statistical tests: non-parametric Kolmogorov-Smirnov test.

The collected data was tabulated and statistically analyzed by: Descriptive data analysis Frequencies, percentages, mean, standard deviation for normally distributed data and Median, mean rank for not normally distributed data, tests for differences applied were ANOVA test significant difference (LSD) test for normally distributed data. Kruskal-Wallis H and Mann-Whitney U- test for not normally distribution.

RESULTS

In the present study the O blood type was found to be more common (36.8%), followed by B type (28%) and A type (26%) whereas the less common was AB type (9.2%) as shown in (Table-1). Results revealed that DMFs (median and mean rank) was statistically significant different among blood type (Chi-square =8.091, P–value = .044), further analysis showed that the students with type B had significantly lower DMFs value than students with other blood types.

The same result shown concerning decayed Ds component of DMFs as the result illustrates a significant differences among students with different types. Further analysis showed that the students with type B had significantly lower Ds value than students with type AB (Z= 2.424, P-value= 0.015) and type O (Z=2.306,P-value = 0.012). The severity of the dental caries represent by grades of decayed fraction D_1-D_4(median and mean rank) among students with different blood type are illustrated in Table-3 that shows the higher mean rank was D_2 grade among students with AB and O types while among students with A and B types the higher mean rank was grades $D_3$and D_1 respectively.

However concerning differences among different blood types the data of the present study showed that the only statistically significant difference was concerning D_2 (Chi-square=14.423,P-value= 0.002) and D_3 (Chi-square=10.739,P-value= 0.013).Further analysis showed that the students with type B had significantly lower D_2 value than students with type AB (Z=2.424,P-value= .015) and type O(Z= 2.306, P-value= .021). On the other hand although the mean rank value of most sever grade of dental caries D_3 and D_4 were higher among students with type AB and lowest sever grade D_1 among students with B blood type all these differences were not significant.

Salivary flow rate (ml\min) and viscosity (poise) among students with different blood type (mean± S.D) are shown in Table -4. This table shows that the mean value of salivary flow rate was found to be higher among students with type B and the lower among students with type AB; however the data of present study showed that the mean salivary flow rate was highly statistically significant differ (F= 9.805, P-value= .000) among different blood type, further analysis showed that the mean salivary flow rate among students with blood type AB were significantly lower than other blood types.

The viscosity was found to be higher among students with type AB and lower among students with type A and B, however this differences was statistically not significant. Table 5 illustrates the concentration of calcium (mg/dl), alkaline phosphatase (U/l) and total protein (g/l) in saliva among students with different blood type. The present study found that the mean concentration of calcium (mg/dl) higher but not significant among type AB (4.18 ± .655) than other blood types. The same figure found concerning the salivary concentration of total protein (g/l) as the concentration was higher but not significant among students with type A (1.22± .284) than students with other blood types.

On the other hand other picture found concerning alkaline phosphatase as the differences among students with different blood types was

highly significant (F=6.495, P-value =.001). Further analysis showed that the mean salivary concentration of alkaline phosphatase was significantly higher among students with type AB than type A (mean difference=.943*,P-value = .000) and type B (mean difference=.1.004*,P-value = .000) as well as type O (mean difference=.561*,P-value = .32).

Table 1: Frequency distribution of ABO blood type among students

Blood group	No	%
A	65	26
B	70	28
AB	23	9.2
O	92	36.8

Table (2): Dental Caries Experience Represented by (DMFs) among Students with Different Blood Type (Median and Mean Rank)

Blood type		Dental caries experience			
		Ds	Ms	Fs	DMFs
A	Median	5.000	0.000	0.000	6.000
	Mean Rank	129.2	124.8	116.6	122.7
B	Median	3.000	0.000	0.000	5.000
	Mean Rank	106.3	125.1	123.8	108.0
AB	Median	7.000	.000	.000	9.000
	Mean Rank	148.7	124.7	128.3	147.6
O	Median	5.000	0.000	0.000	7.000
	Mean Rank	131.7	126.5	132.3	135.2
Test statistics	Chi-square	8.265	.083	3.834	8.091
	P -value	0.041	0.994	0.280	0.044

Table (3): Severity of Dental Caries Represented by Grades of D_1-D_4 (Median& Mean Rank) among Students with Different Blood Types

Blood Type		Dental caries experience and severity			
		D1	D2	D3	D4
A	Median	0.000	2.000	0.000	0.000
	Mean Rank	119.59	129.92	132.54	123.06
B	Median	1.500	2.000	0.000	0.000
	Mean Rank	135.67	99.26	120.46	125.06
AB	Median	1.0000	4.0000	0.000	0.000
	Mean Rank	130.30	148.87	138.54	132.43
O	Median	0.000	4.000	0.000	0.000
	Mean Rank	120.73	136.49	121.10	125.82
Statistical difference	Chi-square	2.745	14.423	10.739	0.712
	P -value	0.433	0.002	0.013	0.870

Table (4): Salivary Flow Rate (ml\min) and Viscosity (Poise) among Students with Different Blood Type.

Blood type		Saliva physical proprieties	
		Flow rate	Viscosity
A	Mean	1.67	0.02
	±SD	0.52	0.01
B	Mean	1.79	0.02
	±SD	0.36	0.01
AB	Mean	1.19	.044
	±SD	0.25	0.03
O	Mean	1.35	0.04
	±SD	0.42	0.11
Statistical difference	F	9.81	1.81
	Sig	0.00	0.15

Table (5): Salivary Concentration of Calcium (mg/dl), Alkaline Phosphatase (U/l) and Total Protein (g/l) among Students with Different Blood Type.

Blood type		Salivary constituents		
		Calcium (mg/dl)	Alkaline phosphatase (U/l)	Total protein (g/l)
A	Mean	4.02	3.52	1.22
	±SD	0.73	1.02	0.28
B	Mean	3.93	3.46	1.16
	±SD	0.85	0.89	0.19
AB	Mean	4.18	4.46	1.14
	±SD	0.66	0.59	0.20
O	Mean	3.66	3.89	1.17
	±SD	0.49	0.65	0.19
Statistical difference	F	1.940	6.49	0.54
	Sig	0.13	0.001	0.66

DISCUSSION

The present study aims to find the effect of many variables and elements on the grades of caries severity among different blood type, however the data revealed that the DMFs (median and mean rank) was statistically significantly differ among blood type; this association can be due to that various blood group antigens acting as receptors for infectious agents associated with dental disease. This broad correlation between oral disease and ABO blood group also points toward susceptibility of the subjects with certain blood groups to oral disease [38], further analysis the data of present study showed that the students with type B had significantly lower DMFs value than students with other blood type and this in agreement with previous study that found DMF index was the lowest in B blood type and the highest in AB blood type, however no statistically significant difference was observed [27]. While disagree with earlier study, that found the individual of blood group A had the lowest numbers of cavities [28]. This difference may be attributed to variation in sample size and variation in the methods of measuring dental caries in addition to that geographical, racial and ethnic condition which effected on blood type distribution [13]. Other researchers failed to find this increased risk [29].

The decreased caries experience among student with blood type B and the increase among type AB could be attributed to many findings that illustrated by the data of the present study, these include: Significantly increase in salivary flow rate among students with type B and significantly decreased among students with type AB than other types. The salivary flow rate plays an important role in relation to dental caries because the washing action of saliva as well as its protective constituents increased with increase flow rate [39,40].

The protective factor of salivary flow rate was also found in the present study by the negative relation between flow rate and caries experience as well as in the previous studies [41,42], however others found opposite [43-45]. While viscosity was found to be higher among students with type AB and the lower among students with type A and B, however this differences was statistically not significant, that a positive correlation was detected between the viscosity of saliva and the number of decayed, missing, and filled teeth.

Patients with thick, ropy saliva invariably had poor oral hygiene and the teeth appear to be covered by stain or plaque, and the rate of dental caries ranged from greater than average to rampant caries [46]. Other explanation could be the significantly increase concentration of salivary alkaline phosphatase among students with type AB than other types, higher alkaline phosphatase activity was found to be associated with increase caries experience because variations in alkaline phosphatase levels causes changes in phosphate levels which lead to initiation and progress of caries[47,48], this positive association was also found in the present study. While the decreased of salivary total protein among students with type AB, this may explain the anti-caries effect of total protein as increased concentration may give a protective role. In humans, after eruption of teeth there is no direct effect of protein on tooth susceptibility to caries, theoretically protein adsorbs on tooth surface and could decreases dental caries risk, but precise evidence is lacking[48] and this disagree with other studies[50,51]. While Leone and Oppenheim in 2001 reported that fourteen studies examined the correlation between caries and salivary proteins and found no correlation between them [52].

As conclusions; ABO blood types may constitute a risk factor on the development of dental disease. By affecting the physicochemical

characteristics of saliva, however long-term studies are needed to make a more comprehensive assessment of the effects of ABO group on dental disease.

REFERENCES

1- Preethi B, Reshma D, Anand P, et al. Evaluation of Flow Rate, pH, Buffering Capacity, Calcium, Total Proteins and Total Antioxidant Capacity Levels of Saliva in Caries Free and Caries Active Children: An In Vivo Study. Indian J Clin Biochem 2010; 25(4): 425–8.
2- Saunders R, Meyerowitz C. Dental caries in older adults. Dent Clin North Am 2005; 49: 293–308.
3- Madléna M, Farago R, Lukacs P, et al.Various aspects of dental prevention in the elderly. J Dent Res 2007; 100(6): 289-93.
4- Aguilar-Zinser V, Irigoyen M, Rivera G, et al. Cigarette smoking and dental caries among professional Truck drivers in Mexico. Caries Res 2008; 21: 56-9.
5- Shahrabi M, Nikfarjam J, Alikhani A, Akhoundi N, Ashtiani M, Seraj B. A comparison of salivary calcium, phosphate, and alkaline phosphatase in children with severe, moderate caries, and caries free in Tehran's kindergartens. J Indian Soc Pedod Prev Dent 2008; 26: 74-7.
6- Harada M, Udagawa N, Fukasawa K, Hiraoka BY, Mogi M. Inorganic pyrophosphatase activity of purified bovine pulp alkaline phosphatase at physiological pH. J Dent Res 1986; 65: 125-7.
7- Gandhy M, Damle SG. Relation of salivary inorganic phosphorus and alkaline phosphatase to the dental caries status in children. J Indian Soc Pedod Prev Dent 2003; 21: 135-8.
8- Damle SG, Vidya I, Yadav R, Bhattal H, Loomba A. Quantitative determination of inorganic constituents in saliva and their relationship with dental caries experience in children. Dentistry 2012; 2:131.
9- Skripal IG. ABO system of blood groups in people and their resistance to certain infectious diseases (prognosis). Mikrobiol Z 1996; 58(2): 102-8.
10- Kolmakova GN, Kononova LL. The prevalence of ABO blood groups among persons of native nationality in Buryatia. Sud Med Ekspert 1999; 42:15-6.
11- Salih HALM. Frequency Distribution of ABO blood groups and Rh phenotypes of blood donors in Babylon governorate-Iraq. A thesis. Deptartment of Community Medicine, College of Medicine, University of Babylon, 2007.
12- Taha JY. Frequency of various Rh antigens in Basrah province, Iraq. The Medical J Basrah University. 2005; 23(1): 53-5.
13- Kaya H, Gündoğdu M, Akarsu E, Kiki I, Tekin B. The distribution of blood groups in Erzurum. Medical J Atatürk University 1999; 31: 20–2.
14- Turkish Red crescent Society. www.kizilay.org.tr. 2006.
15- Lowe JB. Carbohydrate-associated blood group antigens: The ABO, H/Se and Lewis loci. In G. Garratty (ed.): Immunobiology of Transfusion Medicine. New York: Marcel Dekker, Inc.; 1994. p. 3-36.
16- Campi C, Escovich L, Valdés V, GarcvaBorrás S, Racca L, Racca A, et al. Secretor status and ABH antigens expression in patients with oral lesions. Med Oral Patol Oral Cir Bucal 2007; 12: E431-4.
17- Mahajan NM, Kohad RM. Association between ABO blood groups and periodontal diseases. JISP 1998; 1: 62-3.
18- Oriol R, Le Pendu J, Sparkes RS, Sparkes MC, Crist M, Gale RP, et al. Insights into the expression of ABH and Lewis antigens through human bone marrow transplantation. American J Human Genetics 1981; 33(4): 551-60.
19- Oriol R, Le Pendu J, Mollicone, R. Genetics of ABO, H, Lewis, X and related antigens. Vox Sang 1986; 51(3): 161-71.
20- Trickett LP, Evans PR, MacIver AG, Smith JL, Slapak M. Variable localization of blood group antigen in group A kidneys. Bri J Experimental Pathol 1983; 64(2): 137-43.
21- Suadicani P, Hein HO, Gyntelberg F. Airborne occupational exposure, ABO phenotype, and risk of obesity. Int J Obes (Lond) 2005; 29(6): 689-96.
22- Liumbruno GM, Franchini M. Beyond immunohaematology. The role of the ABO blood group in human diseases. Blood Transfus 2013; 11(4): 491–9.
23- Moon TC. An Examination of the relationship of ABO blood group and lifespan in a hospitalized population in the southeastern united states. Doctoral thesis, Virginia Commonwealth University, 2014.
24- Ishikawa I. Host responses in periodontal diseases: A preview. Periodontol 2007; 43: 9–13.
25- Aitchison J, Carmichael AF. The relationship between the ABO blood mutations and dental caries. Dent PractDentRec 1962; 13: 93-5.
26- O'Roark WL, Lyeschan C. Dental caries prevalence as related to blood group. J Dent Res 1963; 42: 1530.
27- Janghorbani M, Akhavan-Mahdavi S, Masoudi HR. The relationship between ABO blood groups and Rh factor with dental caries in soldiers of a military base in Kerman. J Kerman Univ Med Sci1996; 3: 87-91.
28- Demir T, Tezel A, Orbak R, Kara A, Kavrut F. The Effect of ABO Blood Types on Periodontal Status. Eur J Dent 2007; 1(3): 139-43.
29- Witkap CJ, Barros L, Hamilton PA. Geographic and nutritional factors in dental caries. Public Health Rep 1962; 77: 928-40.
30- von Bültzingslöwen I, Sollecito TP, Fox PC, Daniels T, Jonsson R, Lockhart PB, et al. Salivary dysfunction associated with systemic diseases: systematic review and clinical management recommendations. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007; 103: 1-15.
31- Mühlemman H. Oral epidemiology-caries. In: Buch- und Zeitschriften-Verlag, Die Quintessenze (Translated in English). Introduction to oral preventive medicine, 1976: 73-100.
32- Tenovuo J, Lagerlöf F. Saliva. In: Thylstrup A, Fejerskov O. Textbook of clinical cardiology. 2nd ed. Copenhagen: Munksgaard; 1994. p. 17-43.
33- Jensen B, Mouridsen T, Bergmann J, et al. Oral mucosal lesions, microbial changes, and taste disturbances induced by adjuvant chemotherapy in breast cancer patients. Oral Surg Oral Med Oral Pathol, Oral Radiol Endodontol 2008; 106 (2): 217-26.

34- Stokes J, Davies G. Viscoelasticity of human whole saliva collected after acid and mechanical stimulation. Biorheol 2007; 44:141-160.
35- Kind PRN, King EGJ. Clin. Path 1954-7-322 BELFIELD A, GOLDBERG D.M Enzyme ;1971. 12:561.
36- Burtis A. Edward R, Ashwood MD. Tietz Textbook of clinical chemistry. 3rd ed. St. Louis: Saunders; 1999.
37- Burtis C, Bruns D. Tietz fundamentals of clinical chemistry. 2nd ed. St. Louis: Saunders; 1994. p 692.
38- Pai GP, Dayakar MM, Shaila M, Dayakar A. Correlation between "ABO" blood group phenotypes and periodontal disease: Prevalence in south Kanara district, Karnataka state, India. J Indian Soc Periodontol 2012; 16(4): 519–23.
39- Dawes C. Salivary flow patterns and the health of hard and soft oral tissues. J Am Dent Assoc 2008; 2(139): 18-24.
40- Nieves A, Blue F. Saliva of emerging importance in the medical and dental worlds. RDH 2008; 28(9): 56-60.
41- Sulaiman A. Quantitative measurment of urea content in saliva acquired pellicle and dental plaque in relation to dental caries susceptibility in human adults. A master thesis, College of Dentistry, university of Baghdad, 2000.
42- Younger H, Harrison B, Streckfus C, et al. Relationship among stimulated whole glandular salivary flow rate and root caries prevalence in an elderly population. A preliminary study. Spec Care Dent 2008; 18(4): 156-63.
43- El-Samarrai SK. Major and trace elements contents of Permanent teeth and saliva among a group of adolescents in relation to dental caries, gingivitis and mutans Streptococci, Ph.D. thesis, College Of Dentistry, University of Baghdad, 2001.
44- Farsi N. Dental caries in relation to salivary factors in Saudi population groups. J Contemp Dent Pract 2008; 9(3): 66-80.
45- Al-Rubbaey Y. Oral health status and treatment needs in relation to salivary constituents and parameters among a group of patients with thyroid dysfunction. A master thesis, College of Dentistry, University of Baghdad, 2009.
46- McDonald RE, Avery DR. Dentistry for the child and adolescent. 4th ed. St. Louis: Mosby Inc.; 2004.
47- Pandey RK, et al. Relation of salivary phosphorus and alkaline phosphatase to the incidence of dental caries in children. Paediat Dent 1990: 14(3): 144-6.
48- Gandhy M, Damle G. Relation of salivary inorganic phosphorous and alkaline phosphatase to the dental caries status in children. J Indian Soc Pedod Prev Dent 2002; 21: 135-8.
49- Hay DI, Bowen WH. The functions of salivary proteins. In: Edgar W, Mand O', Mullane DM (eds.). Saliva and oral health. 2nd ed. London: British Dental Association; 1996. p. 105-22.
50- Prakobphol A, Leffler H, Fisher SJ. The high-molecular-weight human mucin is the primary salivary carrier of ABH, Le (a), and Le(b) blood group antigens. Crit Rev Oral Biol Med 1993; 4(3-4): 325-33.
51- Ahmadi-Motamayel F, Goodarzi MT, Hendi SS, Abdolsamadi H, Rafieian N. JDOH J Dentistry and Oral Hygiene 2013; 5(4): 35-9.
52- Leone CW, Oppenheim FG. Physical and chemical aspects of saliva as indicators of risk for dental caries in humans. J Dent Educ2001; 65(10):1054-62.