



Editorial

The dental workforce in Libya: an overlooked research topic

Niroz Arhoma¹

&

Arheiam Arheiam² (Editor in chief – LJD)

¹Assistant lecturer, Department of Dental Public Health and Preventive Dentistry, Faculty of Dentistry, University of Benghazi

²Associate professor, Department of Dental Public Health and Preventive Dentistry, Faculty of Dentistry, University of Benghazi

According to American Dental Education Association (ADEA), Dentistry is one of the oldest health professions, dating back to 7000 BC, passing through Greek civilization and the Middle ages to the present day.¹ Dentistry was of interest to many ancient Arab physicians and surgeons.² However, the first book devoted entirely to dentistry was issued in 1530 by Aristotle and Hippocrates, including all diseases of mouth and teeth.³ In 1723, Pierre Fauchard, known as the Father of Modern Dentistry, published his influential book, *The Surgeon Dentist, a Treatise on Teeth*, which described a comprehensive system for dental care, including the idea of dental fillings and the use of dental prostheses, and sugary acids as part of caries process, for the first time.

The first dental college-Baltimore College of Dental Surgery- opened in 1840 in the United States, Alabama led the way by enacting the first dental practice act in 1841, and nearly 20 years later, the American Dental Association (ADA) was formed. The first university-affiliated dental institution, the Harvard University Dental School, was founded in 1867.⁴ In the UK, the first Licence of Dental surgery examinations was in March 1860, and 43 dentists were awarded the qualification.⁵ In the Arabic countries, the importance of dental education emerged early in the 19th century, as the first group of dental students were accepted into the Faculty of Medicine at Damascus University in 1921, and the first dental school was opened at the Faculty of Oral and Dental Medicine at Cairo University in 1925. The first dental school in all of the Arabian Gulf countries was established at King Saud University in Riyadh in 1975. These schools were mainly public institutions until the early nineties before private schools appeared in the 21st century in different Arab countries.^{6,7}

In Libya, there are 15 dental schools. One dental school in the southern province, five dental schools in the north-eastern province, and the rest are located

in the midlands and the North-western province.⁸ The faculty of dentistry of the University of Benghazi is the oldest dental school in Libya which was established in 1974. All dental schools follow almost the same education system in which students finish high school then enrol in a one-year pre-dental education program. This is followed by four years of dental education, including the traditional two years of pre-clinical dental education and two years of clinical dental education. All students are expected to complete a one-year internship to get a bachelor's degree in dental surgery.⁹ Most dental education in Libya is provided free by the public universities, with the increasing establishment of private dental schools.¹⁰

Libya has a significant health workforce, but there is a critical shortage of allied health workers in many health facilities. This shortage occurred due to many reasons, such as insufficient numbers and skills mix of persons being trained or maldistribution of health workforce.¹¹ Tackling this issue needs leadership, multisector collaboration, a long-term commitment and development policies at the country level to bridge the gap between providing qualified health teams with proper training to meet the current health system goals. Above all, this requires coordination between health and higher education ministries.

One of the most significant challenges facing the Libyan health care system is the increased number of dental schools that admit large numbers of students. This, in turn, overburdens the education system that suffers from insufficient teaching staff, insufficient resources and limited capacity of dental schools.¹² The faculty of dentistry of the University of the Benghazi (UoB) is not an exception, although UoB has a long-term reputation for good standards and high-quality graduates. More than 2,000 dentists in Benghazi for nearly 1.2 million inhabitants in 2019 (figure 1).

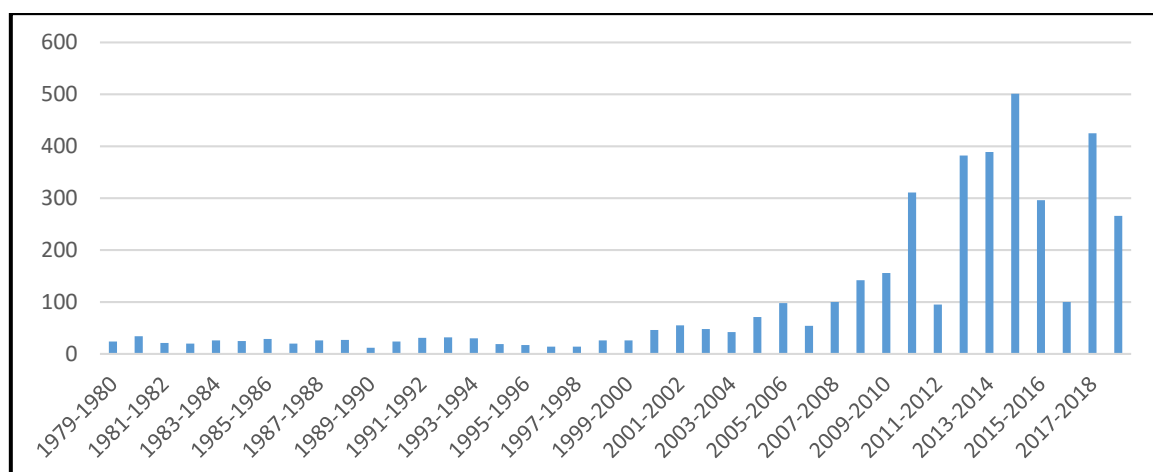


Figure 1-1: Numbers of dental graduates at the UoB between 1979 and 2019

Source: Registrar's office, faculty of Dentistry, University of Benghazi

According to this number, it can be speculated that Benghazi has a dentist-population ratio of 1 for every 400 individuals, which is way higher than the World Health Organization (WHO) recommendation (1:7,500).¹³ This figure raises concerns about the quality and postgraduate pathway of these dentists in the light of anecdotal evidence suggesting many recent dental graduates are either without a job or work in non-dental health sectors such as pharmacies or representatives of Health companies. However, it is well known that career choices are shaped by several factors such as intentions to engage in a particular activity, job positions in the community, financial factors, self-esteem and job opportunities.¹⁴ Therefore, career selection also depends mainly on career goals and varies from one person to another according to needs, self-awareness, skills, abilities, ambitions, resources, and social history.^{14,15}

Therefore, it is essential to understand the reasons for choosing dentistry as a career and what happened to this large number of dentists after graduation. So far, no previous studies have investigated the dental workforce in Libya. The available information is based on anecdotal evidence and governmental reports. Libya went through several political and economic calamities since the February uprising in 2011. Social, political, and economic transformation influence the healthcare staff, which is recognized as 'critical' for healthcare systems.¹⁶ Also, the performance of health systems is closely linked to the skills, motivation and commitment of its workforce.¹⁷ In addition, a generational effect resulting in changes in the professional expectations of the emerging workforce compared to older generations which lead the profession, is well documented.¹⁸ Therefore, researching the health workforce is crucial to provide evidence to inform health workforce planning and policy development.¹⁹

REFERENCES

1. Forshaw RJ. The practice of dentistry in ancient Egypt. *Br Dent J.* 2009;206(9):481-6.
2. Minhaj A. Ancient surgeons and dentistry. 2012.
3. Kezian SA. The History of the Dental Profession-From Ancient Origins to Modern Day. *PacJ Health.* 2020;3(1):2.
4. Hussain A, Khan FA. History of dentistry. *Arch Med Health Sci.* 2014;2(1):106.
5. Gelbier S. Dentistry and the University of London. *Med Hist.* 2005;49(4):445-62.
6. Baqain ZH, Alshalan TA, Naaman N, Faleh S. An overview of dental education in the Arab world. *Fac Dent J.* 2016;7(4):172-4.
7. Shaker RE, Babgi AA. Women in dentistry: A perspective on major universities in Saudi Arabia. Part 1: Historical background. *Saudi dent j.* 2009;21(3):103-6.
8. Ministry of higher education. [Available from: <http://mohe.gov.ly>.
9. Arheiam AA, Tantawi ME, Al-Omami M, Peeran SW, Elmisaleti W. Perceptions of Stress Among Dental Students Living in a War-Affected Zone. *J Dent Educ.* 2019;83(1):48-55.
10. Benamer HT, Bakoush O. Medical education in Libya: the challenges. *Medical teacher.* 2009;31(6):493-6.
11. Ibrahim J. The Libyan Health System: Study of Medical and Allied Health Education and Training Institutions. In: Center HIA, editor. on line: Ministry of Health; 2018.
12. Peeran SW, Altaher OB, Peeran SA, Alsaid FM, Muqrabi MH, Ahmed AM, et al. Oral health in Libya: addressing the future challenges. *Libyan J Med.* 2014;9:23564-.
13. Vundavalli S. Dental manpower planning in India: current scenario and future projections for the year 2020. *Int dent J.* 2014;64(2):62-7.

14. Bausz T. Career Expectations of Hospitality Students–A Swiss Context and Generational Effects.
15. Borchert M. Career choice factors of high school students. 2002.
16. Dal Poz MR, Quain EE, O'Neil M, McCaffery J, Elzinga G, Martineau T. Addressing the health workforce crisis: towards a common approach. BioMed Central; 2006. p. 1-4.
17. Dubois C-A, Nolte E, McKee M. Human resources for health in Europe: McGraw-Hill Education (UK); 2005.
18. Dittman M. Generational differences at work. Monitor on Psychology. 2005;36(6):54.
19. Skelly AM, Fleming GJ. Perceptions of a dental career among successful applicants for dentistry compared with those of fifth-year dental students. Prim Dent Care. 2002(2):41-6.



Original article

Fluoride Concentration in Drinking water in The Libyan City of Zliten: Dental Perspective

Muftah Swisialgdar¹, Amal Gaber², Mohammed Faraj Abogamiza³.

¹Lecturer, Department of Dental Public Health and Preventive Dentistry, Faculty of Dentistry, Alasmarya Islamic University, Zliten, Libya.

²Assistant lecturer, Department of Dental Public Health and Preventive Dentistry, Faculty of Dentistry, University of Benghazi, Benghazi, Libya.

³Assistant lecturer, Faculty of Public Health, Alasmarya Islamic University, Zliten, Libya.

ABSTRACT:

Background: Having optimally fluoridated drinkable water supply is important to reduce the prevalence of both dental decay and dental fluorosis. This research aimed to report all possible drinking water sources and their fluoride content in the Libyan city of Zliten.

Methods: This descriptive study used a convenient sampling strategy to collect 68 samples from different drinking water sources across the city. The fluoride concentration was identified using potentiometric method by means of fluoride selective ion electrode.

Results: 31 source of desalinated water and 37 ground water source have been identified as drinking water. Moreover, the fluoride content was found to be much lower than recommended by the national and international standards for the desalinated water ($0.047 \text{ ppm} \pm 0.062$) while that of ground source was found to range from 0.9 to 2.23 ppm with a mean of ($1.43 \text{ ppm} \pm 0.38$).

Conclusion: People in the city have many choices for drinkable water, however, those who drink from the desalinated water consume less water-dissolved fluoride than those who rely on the ground water as a source of drinking. This reflects the fact that the residents have no equal chances to get the sufficient amounts of fluoride necessary for healthy teeth. Accordingly, more research is needed to evaluate the actual effect of this discrepancy in fluoride consumption on the population and consequently to implement the required strategies essential to assure optimum oral health for the whole population.

Keywords: Fluoride, Drinking water, water fluoridation, dental fluorosis, Zliten

Corresponding author:

Muftah Swisialgdar: Department of Dental Public Health and Preventive Dentistry, Faculty of Dentistry, Alasmarya Islamic University, Zliten, Libya.

Email: m.swisi@asmarya.edu.ly

INTRODUCTION:

The main source of fluoride intake by human comes from drinking water, the fluoride in drinking water occurs naturally or added to water at adjusted amounts in a procedure called water fluoridation.^{1,2,3} Fluoride has both advantageous and harmful effects on human health. Regarding dental health, there is

an inverse relationship between fluoride concentration in drinking water and the prevalence of dental caries; while a dose-response relationship exists between the concentration of fluoride in drinking water and the severity of dental fluorosis.^{1,3} The most relevant adverse effects on communities, where drinking water and foodstuffs excessively high in fluoride, are dental and skeletal fluorosis. These conditions embody the fluoride adverse effect

on dental and general health.^{1,2} Therefore, the World Health Organization WHO recommended that that fluoride in drinking water should not exceed 1.5 mg/L.¹

The drinking water sources in the city of Zliten include the desalinated water either produced by the private sector in small purification projects or government operated large desalination plants, the other source is ground water including the manmade river which is a ground water extracted from outside the city.

As many other cities in Libya, small water purification projects are becoming the most popular source on which inhabitants are reliant.⁴ These are small projects that use the technology of reverse osmosis, where the desalination process will remove nearly all fluoride and other elements from the original water.⁵ The produced water is required to be reconstituted to become in line with the standard of Libyan National Centre for Standardization and Metrology LNCSM where it is stated that fluoride in drinking water is 1ppm. The other source of desalinated water in the city is that provided by the General Company for Water Desalination where the company uses the Multistage- Flash technology in its three desalination plants. The design capacity for each is 30000 m³/d. The original water source before desalination is the seawater since all the plants occur on the coast.⁵ Communal water fluoridation is recommended when there is enough financial and human resources besides the availability of a reliable supply of a fluoride containing chemical of acceptable quality and the equipment to pump the material for water fluoridation.¹

As being arid zone, ground water could be considered as a prime source for drinking, ground water is easily extracted through wells using centrifugal and submerged pumps. These wells are government-owned and run by the General Company for Water and Wastewater (GCWW). As per the hydrological cycle, ground water should contain fluoride at varying concentrations. Also, the geological rocks which are in contact with ground water are known to leach fluoride into the water.¹

The produced water either from desalination plants or that extracted from municipal wells is then distributed throughout the city via a net of pipelines, this task is allocated to GCWW, the operation and maintenance of all infrastructure water network and water treatment plants are also run by this company.⁶ However, the pipeline network does not cover the whole city and thus inhabitants in areas not covered by the network use water supply trucks and pump the water to home storage tanks. In rural areas, people depend on private water supply wells and rainwater reservoirs for domestic use.⁶

Unfortunately, there is no data on contribution of each source to the drinking water. However, there is an increase in the small water purification projects in the city what indicates that it's the most popular source.⁴ Also, there is a doubt on the quality of fresh water provided by the government as being not good enough for drinking; whereas people think that the water collected in big reservoirs is not analyzed or treated regularly, which sort as non-potable water due to it's incompatibility with the international standards and consequently people do not use it as a stable and reliable source of drinking water.

So far, there is no published research tried to investigate the mean concentration of fluoride in drinking water in the Libyan city of Zliten; accordingly, this research was conducted to fill in this gap and aimed to report all possible drinking water sources and their fluoride content in the city of Zliten which will be beneficial to evaluating whether or not the residents' fluoride intakes from drinking water fell within the international recommended ranges.

METHODS AND MATERIALS:

A descriptive study design was followed to collect 68 drinking water samples from different water sources and regions of the city of Zliten that is located on a narrow coastal plain eastern of Tripoli. A convenient

Table 1. Main water sources for the city of Zliten.

Water source	Number of provider	Delivery of water	Intended use
Small water purification projects	29	Filled in bottles of 10L to 20L	Drinking
Desalination plants	2	pipelines (GCWW) OR Transported in large volume tanks	Drinking and Domestic use
Municipal Deep wells	37 wells over 6 localities	pipelines(GCW W)	Domestic use
Manmade river	1(ground water from outside city)	pipelines(GCW W)	Domestic use and plants irrigation

sampling strategy was used, in that all the possible drinking water sources in the city were included, all non-functioning sources were excluded which were 6 deep municipal wells. The city was divided into six zones A to F, which is based on the population distribution over the six localities of the city and not on the geological nature of the city. By this, each municipal well was given a letter indicating the locality (A to F) and a number that indicates the site of the well in a locality. For example, E4 means the well in site 4 in the locality E of the city. Table 1 shows the main water sources for the city.

The guidelines for water sample collection by LNCSM were followed. The samples were collected in plastic or glass bottles. All bottles were thoroughly cleaned and rinsed with a detergent. The collected samples were representative and the volumes collected were sufficient for replicate analysis. Sample preservation was not required and samples were kept cool. After labeling, they were sent to the lab of the local Environment Sanitation Affair for determination of fluoride concentration and the results were produced in particle per million, PPM.

Potentiometric method using a fluoride selective ion electrode (ELIT 8221F- 41936) is carried out to evaluate fluoride content of the water samples.

Although many different methods available for the measurement of fluoride concentration, this method is considered reliable and has been used in many scientific research and hence utilized in this study. All data were tabulated and presented using appropriate descriptive statistics (mean and standard deviation). No comparisons were made using statistical tests.

RESULTS:

Tables 2 and 3 show the different fluoride concentrations in both Municipal deep wells and Small water purification projects respectively. Surprisingly, water produced by the government-owned two large desalination plants contain nil fluoride.

Table2. Fluoride in municipal wells

Well location	F in ppm	Well location	F in ppm
A1	1.49	D1	1.96
A2	0.95	D2	2.00
A3	1.59	D3	2.23
A4	1.86	D4	1.97
A5	1.60	D5	1.63
A6	1.20	D6	1.10
A7	2.03	D7	2.02
A8	1.03	E1	2.08
A9	1.05	E2	1.59
B1	1.64	F1	1.05
B2	1.69	F2	1.20
B3	0.90	F3	1.11
B4	1.13	F4	1.13
B5	1.32	F5	1.20
B6	0.99	F6	1.13
C1	1.77	F7	1.09
C2	1.00	F8	1.20
C3	1.18	F9	1.32
C4	1.77	M ± SD	1.43±0.38

Table3. F in ppm from small water purification projects

Project No	F in ppm	Project No	F in ppm
1	0.17	16	0
2	0.02	17	0.09
3	0	18	0.01
4	0.02	19	0
5	0.11	20	0
6	0	21	0
7	0.02	22	0.05
8	0.08	23	0
9	0.04	24	0
10	0.07	25	0.2
11	0.05	26	0.02
12	0.05	27	0.02
13	0	28	0
14	0.07	29	0.04
15	0.24	M ± SD	0.047±0.062
		Median	0.02

DISCUSSION:

This cross sectional survey aimed to measure the fluoride level in drinking water from different possible sources in the city of Zliten. This will partially help in explaining the prevalence of dental caries or fluorosis in the city and guides the dentists to make a decision on providing preventive fluoride therapy for their patients.

In Libya, it is commissioned that drinkable water should contain a level of fluoride of 1PPM, this policy is in accordance with WHO guidelines for fluoride in drinking water. One PPM fluoride in water is beneficial in reducing dental caries prevalence. However, this limit was exceeded in number of cities in Libya and what exaggerates the dilemma is lack of public awareness regarding oral health.⁷⁻⁹

The fluoride level in the natural wells of water in Zliten have been found to fluctuate from 0.9 to 2.23 ppm. This kind of variation in concentration of fluoride in the same region has been reported in other studies.^{1,10}

Amongst all collected samples of natural water, about 50% contain optimum levels of fluoride that

fall within the WHO recommendations for fluoride level in drinking water. Except for area E where fluoride level is found higher than recommended for its two wells. All other regions in the city have at least one well where the fluoride level is within the permissible amount required by LNCSM. These results indicate that dental fluorosis might be of no concern in most locations and dental caries prevention is optimized, however, it was reported that people do not use these sources for drinking.

In contrast to another region in the west of Libya, Al-Fateh University of Tripoli attributed the increased incidence of fluorosis to the dominant consumption of ground water, in which fluoride content found to be 5 ppm.¹¹ A much higher concentrations of fluoride in the ground water was found in cities of southern Libya; where the Fluoride contents documented as 8.8, 4.7, 7.2, 4.2 and 6.7 ppm. for Mourzouk, Qatron, AL-Shati – Barak, Obari, and Sebha respectively.^{12,13}

Our findings indicate a higher concentration of fluoride than that found in ground water reservoir located mainly under the center of Tripoli the capital city where the mean F was 0.51 ± 0.041 .¹⁴ It is also higher than that found in the Northeast of Libya where the mean concentration of fluoride in the ground water was 0.24 ± 0.32 .¹⁵

It is known that Fluoride occurs in natural water systems as a result of runoff from weathering of fluoride-containing rocks and soils and leaching from soil into groundwater. Atmospheric deposition of fluoride-containing emissions from coal-fired power plants and other industrial sources also contributes to amounts found in water, either by direct deposition or by deposition to soil and subsequent runoff into water, none of these contributors exist in Zliten which contributes to finding a relatively low fluoride level in its natural water.¹⁶ Moreover, lower fluoride concentrations in water are anticipated in the ground water of calcium-rich aquifers;¹⁶ Zliten is an area where calcium-rich limestone rocks occur, these bedrocks have little fluoride concentration as they are not of volcanic origin.¹⁷

In small water purification projects, desalination in most of these spots results in almost fluoride free water, table 2. The mean concentration of fluoride was 0.047 ± 0.062 and the highest reported concentration of fluoride in water was 0.24 ppm. This concentration is much lower than what is recommended in the national and international standards. These results are in accordance with what was found in another report from a western Libyan city that show a very low concentration in the produced water.¹⁸ This source of water, however, is becoming popular for drinking regardless the fact that it lacks the protective role against dental caries. Therefore, it is expected that dental caries risk would be high especially when this situation is coupled with the scarcity of other preventive dental services provided in the public or private sectors.¹⁹ producing and marketing a product with specifications less than what is required by the local standards indicates the lack of adherence of producers to the regulations and standards stipulated by the LNCSM. This lack of adherence might be attributed to weak surveillance and monitor activities of the LNCSM and the Libyan Food and Drug Control Centre.

Water from large desalination projects, although it is a government produced tap water, it lacks the optimum fluoride concentration. This is a result of the financial shortage and the absence of technical facility, material and human resources to analyze the produced water and to assure that it has all required minerals, including fluoride, in optimum concentrations.

CONCLUSION:

People in the city have many choices for drinkable water, the desalination one is not the best option since its fluoride content is very low and does not provide the protective role against dental caries. Most of the ground water sources contain optimal fluoride as recommended internationally regardless

of its safety for drinking from chemical and biological perspectives.

According to these alarming findings, it seems that there is a real chaos regarding the quality of drinkable water in the city, therefore, strict laws and regulations for drinkable water production should be implemented and mentored regularly by the responsible sectors in the country.

Clinicians are advised to consider this insufficiency of fluoride level in desalinated water when establishing preventive measures for their patients. Equally important is to guard against fluorosis whereas fluoride content is high in a number of ground water sources that might be utilized by some residents.

REFERENCES:

- 1- O Mullane DM, Baez RJ, Jones S, Lennon MA, Petersen PE, Rugg-Gunn AJ, Whelton H, Whitford GM. Fluoride and oral health. Community dent health. 2016 Jun 1;33(2):69-99.
- 2- World Health Organization. Fluorides and oral health: report of a WHO Expert Committee on Oral Health Status and Fluoride Use [meeting held in Geneva from 22 to 28 November 1993]. World Health Organization; 1994.
- 3- Demelash H, Beyene A, Abebe Z, Melese A. Fluoride concentration in ground water and prevalence of dental fluorosis in Ethiopian Rift Valley: systematic review and meta-analysis. BMC Public Health. 2019 Dec;19(1):1-9.
- 4- الأربش، جمعة سالم، الرابطي، عبدالقادر علي، الكبير، علي أحمد، الغويل، محمد خالد عبدالله. ملامح الاستراتيجية الوطنية لإدارة الموارد المائية بالجمهورية العظمى للفترة ما بين 2000 – 2050. مجلة الهندسي. 2000 العدد 44. ص 71-82.
- 5- Brika B. Water resources and desalination in Libya: A review. In Multidisciplinary Digital Publishing Institute Proceedings 2018 (Vol. 2, No. 11, p. 586).
- 6- CEDARE (2014), "Libya Water Sector M&E Rapid Assessment Report", Monitoring & Evaluation for Water In North Africa (MEWINA) Project, Water Resources Management Program, CEDARE.
- 7- Brika B. Environmental implications of Tajoura reverse osmosis desalination plant. Desalination and Water Treatment. 2016 Oct 1;57(46):21712-20.
- 8- Alraqiq H, Eddali A, Boufis R. Prevalence of dental caries and associated factors among school-aged children in Tripoli, Libya: a cross-sectional study. BMC oral health. 2021 Dec;21(1):1-2.

- 9- Arheiam A, Masoud I, Bernabé E. Perceived barriers to preventive dental care among Libyan dentists. *Libyan J Med.* 2014 May 13;9(1).
- 10- Ballo L, Arheiam A, Marhazlinda J. Determinants of caries experience and the impact on the OHRQOL of 6-year-old Libyan children: a cross-sectional survey. *BMC oral health.* 2021 Dec;21(1):1-9.
- 11- Guissouma W, Tarhouni J. Fluoride in Tunisian drinking tap water. *J water resour prot.* 2015 Jul 1;7(11):860.
- 12- Sunil Tejaswi KL, Suneeth Shetty A, Sudarshan CP, Sarveshwar Reddy P. A pioneering study of dental fluorosis in the libyan population. *JIOH.* 2013 Jun;5(3):67.
- 13- Hassan AK, Al-Bou-Saifi M, Najim ZN. Prevalence of Dental Fluorosis in Fazan (South Libya). *j Bahrain med soc.* 2002;14(3):85-90.
- 14- Nureddin AA, Shagan A. An epidemiological study of geographical mapping of fluoride levels in drinking water in the north-western region of Libya. *Libyan J Med Res.* 2014; 8(2):37-43.
- 15- Nair GA, Bohjuari JA, Al-Mariami MA, Attia FA, El-Touml FF. Groundwater quality of north-east Libya. *J environ biol.* 2006 Oct 1;27(4):695-700.
- 16- Edmunds WM, Smedley PL. Groundwater geochemistry and health: an overview. Geological Society, London, Special Publications. 1996 Jan 1;113(1):91-105.
- 17- Goudarzi, G. H. (1970). Geology and mineral resources of Libya-a reconnaissance (No. 660). US Govt. Print. Off.
- 18- أحمد كمال الكيلاني, فرج عبد الجليل المودي. تقدير نسبة عنصر الفلور في مياه الشرب المعبأة المحلية والمستوردة في السوق الليبي. مجلة القرطاس للعلوم الانسانية والتطبيقية. 10:509-15;2020 Sep





Original article

Interaction of *Candida Albicans* and *Streptococcus Mutans* with four different types of acrylic resin denture base materials Part (2)

Salma A. Elnaili¹, Elnaihoum W. A², and Saied H. Alabidi³

^{1, 2} Assistant lecturer, Department of prosthodontics, Faculty of Dentistry, University of Benghazi, Libya

³ Professor, Department of prosthodontics, Faculty of Dentistry, University of Benghazi, Libya

ABSTRACT

For denture base materials to be clinically accepted, they have to meet certain requirements such as superior mechanical and chemical properties, having a natural appearance, being easy to construct, easy to repair as well as biocompatibility and resistance to adhesion of microorganisms. Microbial adhesion to denture base materials may lead to oral diseases such as candidiasis. The present in-vitro study was aimed to assess the adherence of *Candida albicans* and *Streptococcus mutans* to four different types of acrylic dentures; Heat Cure (HC), High Impact Heat Cure (HIHC), Heat Cure Clear (HCC) and Clear Chemical Cure (CC).

Materials and Methods: 25 discs measuring 11 mm in diameter and 3 mm in thickness were fabricated for each type of acrylic resin. All samples were polished with different roughness parameters, including 600 and 1200 surface polishers. *Candida albicans* was cultured in Sabouraud dextrose broth (Sigma-Aldrich) while, *S. mutans* was cultured in a Columbia blood agar. They were then placed in an aerobic or CO₂ incubator for *Candida albicans* and *Streptococcus mutans* respectively at 37°C overnight. The absorbance of the crystal violet stain in the de-staining solution was measured. Subsequently, the samples were removed, fixed on a glass slide, and lastly viewed under the light microscope [Nikon (ECLIPS TS100)] at magnification 40x.

Results: The highest average absorbance of *C. albicans* was shown in HCC600 and HC1200. Whereas, there was no significant difference in the P-value of *C. albicans* growth on the different surfaces of acrylic resins. Regarding the adhesion of *Streptococcus mutans*, CC had much more average absorbance than the other three heat cure types. When these materials were compared by ANOVA single factor, the data statistically showed a significant difference in the capacity of attachment between heat cure and chemical cure.

Conclusion: The acrylic denture surface roughness by its nature has a large impact on the colonization of denture base, specifically by *Streptococcus mutans*.

Keywords: Microbial adhesion, *Candida albicans*, *Streptococcus mutans*, denture base, surface roughness.

Corresponding author:

Salma A. Elnaili: Department of prosthodontics,
Faculty of Dentistry, University of Benghazi, Libya
Email: salma82_2012@yahoo.com

INTRODUCTION

The demand of patients to replace their missing teeth has dramatically increased. Despite the fact that implants are now commonly used as one of the major prosthetic devices for tooth replacement, dentures are still the most common choice of teeth replacement.¹ However, for denture base materials to be clinically accepted, they have to meet some requirements such as sufficient strength to withstand

the force of mastication, adequate durability, superior mechanical and chemical properties, natural appearance, good adhesion to metal, plastic, and porcelain, easy to construct as well as biocompatibility and resistance to adhesion of microorganisms.²

The dentures' tissue surface usually has microporosities and micropit areas that allow for the accumulation of microorganisms; rather than other areas in the dentures.³ There are many factors which

may affect surface roughness such as the material utilized, the polymerization technique as well as the fiber incorporation into the material.^{4,5} Also, many types of microorganisms adhere to the denture surfaces such as bacteria like *Streptococcus mutans* and fungi such as *Candida albicans* species, and nonalbicans species such as *Candida glabrata*, *C. tropicalis*, *C. krusei*, *C. parapsilosis*, and *C. dubliniensis*.⁶ However, *Candida albicans* is considered the most common microorganism that adheres to dentures. *Candida albicans* is a fungus present in the oral cavity of a healthy individual as a normal commensal organism. Under systemic and local factors, mainly poor oral hygiene, *C. albicans* becomes pathogenic leading to oral atrophic candidosis.⁷ Despite the fact that *Candida* species are the main pathogen of denture stomatitis, bacteria such as *Streptococcus mutans*, *Actinomyces species*, and *Fusobacterium species* are also involved in the denture biofilms.^{8,9,10} *Streptococcus mutans* was first described by Clark who isolated these bacteria from the carious lesion in 1924.¹¹ *Streptococcus mutans* is a spherical Gram-positive bacterium belonging to the lactic acid and the phylum Firmicutes groups of bacteria which has eight serotypes from A to H, and the most common serotypes isolated from the human plaque was C.^{11,12} This study aimed to assess the difference in adhesion of *Candida albicans* and *Streptococcus mutans* according to materials type (four different types of acrylic denture; heat cure, high impact heat cure, clear heat cure, and clear chemical cure) and according to the surface roughness of each type (two different surface roughness for each type) to detect which type of acrylic resin has the least adhesion of oral microorganisms.

MATERIALS AND METHODS:

Materials

This study is an experimental study design. 25 samples of each different type of acrylic resins measuring 11 mm in diameter and 3mm in thickness were made. All samples were polished by p600. Then, half of each type was polished again by grinding paper p1200.¹²

Microbial growth (*Streptococcus mutans* and *Candida albicans*)

Candida albicans was cultured in Sabouraud dextrose broth (Sigma-Aldrich) while *S. mutans* was cultured in a Columbia blood agar; they were then placed in an aerobic or CO₂ incubator for *Candida albicans* and *Streptococcus mutans* respectively at 37°C overnight.

Measuring absorbance of crystal violet stain in the destaining solution

To assess the absorbance of crystal violet stain in the destaining solution, three experiments for each microorganism; *Streptococcus mutans* and *Candida albicans* were carried out. For each experiment, a couple of colonies of *S. mutans* and *C. albicans* were obtained from the Department of Microbiology, University of Sheffield, UK. They were placed in separate bottles containing Brain Heart Infusion (BHI) and yeast nutrient broth for *S. mutans* and *C. albicans* respectively, and then they were placed in an incubator for 24 hours. Furthermore, 4 samples of each type (3 for the growth of microorganisms and one as standard (blank)) were used; they were placed in an autoclave overnight to be ready for the growth of the microorganism. The samples were removed by forceps and placed in sterile plates, then one ml of the microbial suspension of (optical density) OD 0.05 was added to 3 wells, whereas the BHI was added without microorganisms to the one which was used as a standard; afterward, the plates were stored in an aerobic or CO₂ incubator for *Candida albicans* and *Streptococcus mutans* respectively at 37°C. The microbial suspension and BHI were removed, and the acrylic samples were gently transferred to a fresh plate. In the next phase, 200 µl of phosphate-buffered saline was used to wash the biofilm-coated wells of microtiter plates, then they were left to dry for 45 min. Following that, 0.4% aqueous crystal violet solution (200 µl) was added to stain each of the washed wells for 45 min. Subsequently, each well was washed three times with 350 µl of sterile distilled water and destained with 200 µl of 95% ethanol immediately. They remained there for 45 min. Afterward, 100 µl of the destaining solution was transferred to a new well and the amount of absorbance was assessed with a microtiter plate reader [FLUO Star Galaxy (2000 BMG Lab technologies)] at 570 nm.

Assessment the microbial growth by using a light microscope

After the experiment was over, the samples were removed, fixed on a glass slide, and then viewed under the light microscope [Nikon (ECLIPS TS100)] magnification 40x. In the end, pictures of 40x magnification by using (COOLPIX P5100) were taken.

Statistical analysis

For data statistical analysis, ANOVA single factor was utilized to compare the adherence of the microorganisms on four different types of acrylic denture base materials; a P-value of 0.05 or less was considered significant.

RESULTS

Assessing the adhesion of oral microorganisms in different surface roughness

To examine the growth of microorganisms (*Candida albicans* and *Streptococcus mutans*) on different types of acrylic resins, 100 µl of the destaining solution was measured with a microtiter plate reader [(FLUO Star Galaxy (2000 BMG Lab technologies))] at 570 nm.

Assessing the growth of *Candida albicans*

The average absorbance of *Candida albicans* growth (the blank was subtracted) on different types of acrylic resins are displayed on the chart Figure (1). It showed that HCC600 has the highest average absorbance of *C. albicans*, which was approximately 1.2. Chemical cure 600 (CC600) had the second-highest average, then HIHC600 came afterward whereas, HC600 had the lowest average absorbance which was about 2/3 as high as HCC600. In contrast, one can see that HCC1200 and HC1200 had the opposite average absorbance; it was as great as

HCC600 and HC600. HC1200 was about twice as high as HCC1200 while, there was no significant difference in the average absorbance of HIHC1200 and CC1200 as compared to 600 surface roughness. Furthermore, the Standard deviation of *Candida albicans* growth on four acrylic resins with different surface roughness was calculated (Table 1). In addition, the P-value of *C. albicans* growth on each type of acrylic resins that has different surface roughness was statistically analyzed (Table 1). The P-value of the different materials with the same surface roughness are compared to each other as illustrated in Tables (2). The ANOVA single factor test revealed that the P-value of the *Candida albicans* adhesion on the different surfaces of acrylic resins was not significant; this is evident when the same materials were compared with different roughness or when different materials were compared with the same roughness (Tables 1, 2)

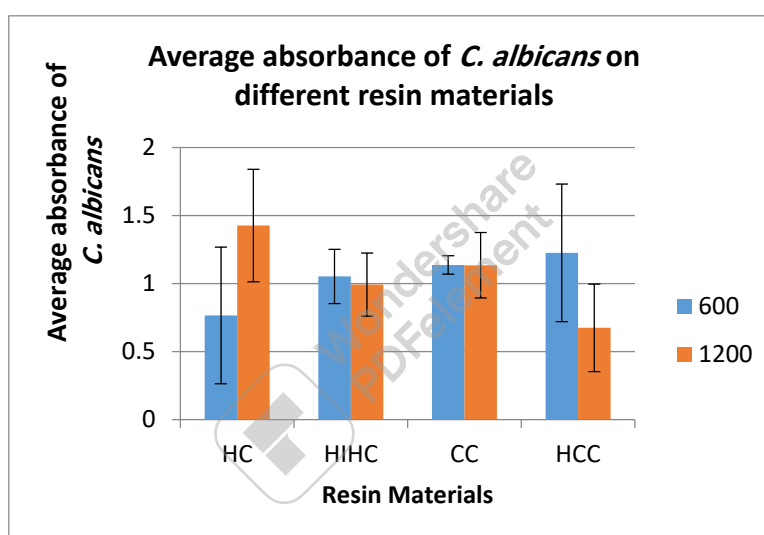


Figure (1): The chart demonstrates the average absorbance of *Candida albicans* on the different types of dentures with surface roughness 600 and 1200 as compared to the blank (the blank was subtracted).

Table (1): The Mean, Standard deviation, and P-value of *Candida albicans* growth on four acrylic resins with different surface roughness.

Materials	Surface roughness	Mean ± Standard deviation (<i>C. albicans</i>)	P-value
HC	600	0.765±0.502	0.153
	1200	1.4268±0.413	
HIHC	600	1.0527±0.1993	0.754
	1200	0.9935±0.231	
CC	600	1.137±0.067	0.989
	1200	1.135±0.240	
HCC	600	1.226±0.506	0.1869
	1200	0.675±0.3216	

Table (2): The comparison between P values of *C. albicans* growth on different acrylic dentures with surface roughness 600 and 1200

Materials at surface roughness 600	Mean $\pm$ Standard deviation	P-value	Materials at surface roughness 1200	Mean $\pm$ Standard deviation	P-value
Heat cure (HC)	0.765 $\pm$ 0.502	0.409	HC	1.4268 $\pm$ 0.413	0.188
High impact heat cure (HIHC)	1.0527 $\pm$ 0.1993	(NS)	HIHC	0.9935 $\pm$ 0.231	(NS)
Heat cure (HC)	0.765 $\pm$ 0.502	0.2734	HC	1.4268 $\pm$ 0.413	0.349
Chemical cure (CC)	1.137 $\pm$ 0.067	(NS)	CC	1.135 $\pm$ 0.240	(NS)
Heat cure (HC)	0.765 $\pm$ 0.502	0.326	HC	1.4268 $\pm$ 0.413	0.06
Heat cure clear (HCC)	1.226 $\pm$ 0.506	(NS)	HCC	0.675 $\pm$ 0.321	(NS)
High impact heat cure (HIHC)	1.0527 $\pm$ 0.1993	0.526	HIHC	0.9935 $\pm$ 0.231	0.53
Chemical cure (CC)	1.137 $\pm$ 0.067	(NS)	CC	1.135 $\pm$ 0.240	(NS)
High impact heat cure (HIHC)	1.0527 $\pm$ 0.1993	0.61	HIHC	0.9935 $\pm$ 0.231	0.236
Heat cure clear (HCC)	1.226 $\pm$ 0.506	(NS)	HCC	0.675 $\pm$ 0.321	(NS)
Chemical cure (CC)	1.137 $\pm$ 0.067	0.777	CC	1.135 $\pm$ 0.240	0.118
Heat cure clear (HCC)	1.226 $\pm$ 0.506	(NS)	HCC	0.675 $\pm$ 0.321	(NS)

Assessing the growth of *S. mutans*

The result was illustrated in Figure (2). Chemical cure acrylic resin in both CC600 and CC1200 exhibit a greater amount of average absorbance, which constituted (0.857733, 0.962867) respectively, than the heat cure (HC, HIHC, and HCC). HC and HCC reveal reverse absorbance in 600 and 1200 surface roughness. For instance, HC600 had the lowest average absorbance which was virtually 1/5 HC1200 whereas, HCC1200 had the least absorbance, which was approximately 1/3 as high as HCC 600. Furthermore, HIHC1200 has increased by double as compared with HIHC 600. In addition, the Standard

deviation of *S. mutans* growth on four types of acrylic resins which have different surface roughness was calculated in Table (3). The P-value of *S. mutans* growth on each type of acrylic resins that has different surface roughness was statistically analyzed (Table 3). The P-value of the different materials with the same surface roughness are compared to each other as illustrated in Tables (4). The ANOVA single factor test revealed that the P-value of *S. mutans* was significant solely when comparing chemical cure denture base (CC) with three other different types of heat cure in both 600 and 1200 surface roughness (Tables 4). Therefore, the Chemical cure had the highest adhesion of *Streptococcus mutans*.

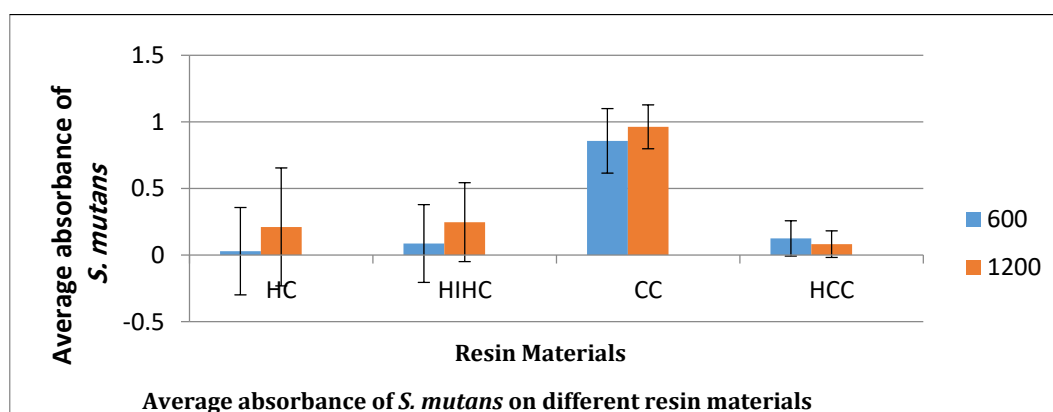
**Figure (2):** The average absorbance of *Streptococcus mutans* on different types of dentures with surface roughness 600 and 1200 as compared to the control group (blank was subtracted).

Table (3): The Mean, Standard deviation, and P-value of *Streptococcus mutans* growth on four types of acrylic resins which have different surface roughness.

Materials	Surface roughness	Mean $\pm$ Standard deviation (<i>S. mutans</i>)	P-value
HC	600	0.0294 $\pm$ 0.327	0.598
	1200	0.211 $\pm$ 0.443	
HIHC	600	0.0869 $\pm$ 0.291	0.54
	1200	0.247 $\pm$ 0.296	
CC	600	0.8577 $\pm$ 0.2422	0.567
	1200	0.96 $\pm$ 0.164	
HCC	600	0.125 $\pm$ 0.132	0.679
	1200	0.0825 $\pm$ 0.099	

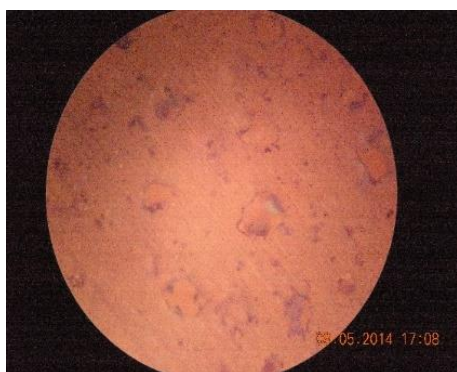
Table (4): Comparison between P-value of *S. mutans* growth on different acrylic dentures with surface roughness 600 and 1200

Materials at surface roughness 600	Mean $\pm$ Standard deviation	P-value	Materials at surface roughness 1200	Mean $\pm$ Standard deviation	P-value
Heat cure (HC)	0.0294 $\pm$ 0.327	0.831	HC	0.211 $\pm$ 0.443	0.912
High impact heat cure (HIHC)	0.0869 $\pm$ 0.291	(NS)	HIHC	0.247 $\pm$ 0.296	(NS)
Heat cure (HC)	0.0294 $\pm$ 0.327	0.024	HC	0.211 $\pm$ 0.443	0.05 (S)
Chemical cure (CC)	0.8577 $\pm$ 0.2422	(S)	CC	0.96 $\pm$ 0.164	
Heat cure (HC)	0.0294 $\pm$ 0.327	0.6638	HC	0.211 $\pm$ 0.443	0.649
Heat cure clear (HCC)	0.125 $\pm$ 0.132	(NS)	HCC	0.0825 $\pm$ 0.099	(NS)
High impact heat cure (HIHC)	0.0869 $\pm$ 0.291	0.024	HIHC	0.247 $\pm$ 0.296	0.021
Chemical cure (CC)	0.8577 $\pm$ 0.2422	(S)	CC	0.96 $\pm$ 0.164	(S)
High impact heat cure (HIHC)	0.0869 $\pm$ 0.291	0.84	HIHC	0.247 $\pm$ 0.296	0.412
Heat cure clear (HCC)	0.125 $\pm$ 0.132	(NS)	HCC	0.0825 $\pm$ 0.099	(NS)
Chemical cure (CC)	0.8577 $\pm$ 0.2422	0.010	CC	0.96 $\pm$ 0.164	0.001
Heat cure clear (HCC)	0.125 $\pm$ 0.132	(S)	HCC	0.0825 $\pm$ 0.099	(S)

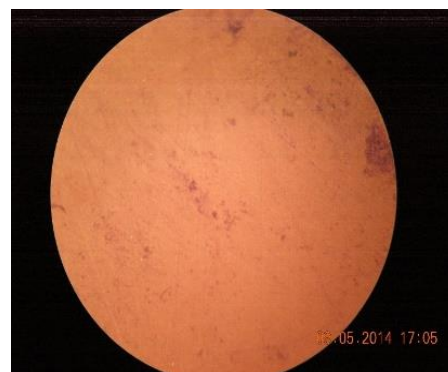
Visualizing the growth of microorganisms

The microbial growths were exhibited by using light microscopes at 40x magnifications. The growth of

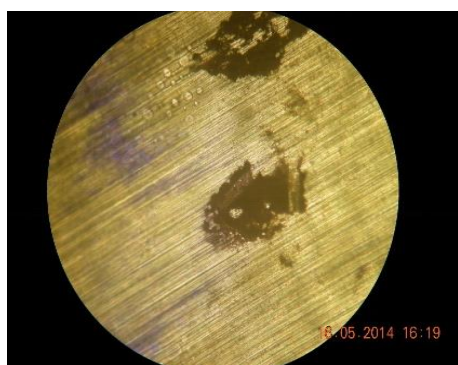
Candida albicans on both HIHC600 and HC600 and the growth of *Streptococcus mutans* which appear as clumps on chemical cure as compared to the blank were exhibited in Figure 3 (A-D).



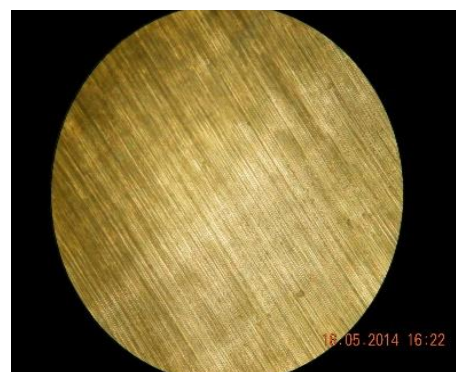
A. Growth of *candida albicans* on HC600



B. Growth of *candida albicans* on HC600



C. Growth of *streptococcus*



D. Blank chemical cure

Figure 3 (A-D): Figures (A-C) demonstrated the growth of microorganisms, whereas Figure D showed the blank surface

DISCUSSION

In several research studies concerning the *C. albicans* and *S. mutans* adhesion mechanisms to the acrylic resins denture base, the material types and surface roughness of the materials, are considered as major factors that play a major role in the direct adherence mechanism.¹³ However, understanding the exact attachment mechanism of *C. albicans* has yet to be identified.⁷ According to Anusavice (2003), the decrease in the surface roughness of the denture, results in a decrease in the friction which in turn reduces the abrasion impact on the soft tissue of the patient. Moreover, the study indicates that the high rough surface results in an increase in the stain as well as in the adhesion of the microorganisms on the surface.¹⁴ However, *C. Albicans* adherence to acrylics resins denture base, and to the subsequent formation of biofilm, is considered as a significant factor in denture-induced stomatitis development.¹⁵

Regarding the attachment of *Candida albicans* (in vitro) on acrylic resins, there was no difference between the average absorbance (optical density) of HIHC and CC in the different surface roughness (600,1200), whereas HC and HCC revealed reverse profiles. However, even though the P-value of the average surface roughness of HIHC, CC, and HCC was statistically significant, there was no difference in the adhesion of *Candida albicans* between these three materials and insignificantly, HC. In other words, the result concerning the adhesion of *C. albicans* especially to chemical cure material is contrary to what to have been expected according to the profilometry. A previous study which was undertaken by Radford et al (1999) demonstrated that fewer *C. albicans* was observed on the smooth surface rather than on the rough surfaces.¹⁶ Also, another study demonstrated the colonization of *C. albicans* on the denture surface.¹⁷ The reason for the difference between the current study and the

previous one was probably that this study was carried out under different conditions.¹⁶

The presence of *Candida* species, within the oral cavity, adhesion to the oral mucosa, and biofilms development on the surface of the denture are associated with mild to severe physio-pathological effects. *Candida*-induced stomatitis has a certain range according to the classifications of Newton.¹⁸ This infection is caused by *C. albicans*' cell attachment to the denture impression surface, which depends on the non-specific factors such as the surface charge and hydrophobicity which are related to the materials, and the specific factors (receptor-ligand binding) which are related to the microorganisms.^{19,20,21} Additionally, the chemical and physical compositions of the acrylic denture base have a positive effect on the adhesion and colonization of the yeast.

Various chemical materials may affect the *Candida* attachment level. It has been shown that the immersion of acrylic resin base in water increases *Candida* adhesion by reducing the level of residual monomer.²² Previous clinical studies have shown that there is a close relation between denture hygiene procedures frequency and the *Candida* infection.²³ Therefore, those patients are exposed to more risks concerning denture sore mouth than other people. Furthermore, as noted by Verran and Motteram (1987), *Candida albicans* cannot be attached to the denture base materials that have not been already preincubated with streptococcus.²⁴ Likewise, Branting et al (1989) outlined that *C. albicans*' adhesion to the acrylic resins was increased when *S. mutans* was incubated on the acrylic dentures.²⁵

On the other hand, the interaction of *Streptococcus mutans* on the different materials, there was no significant difference concerning the average absorbance between 600 and 1200 surface polishers. It can be seen that Chemical cure (CC) had by far the highest absorbance compared to the other three heat cure types. The findings are similar to those of the previous study which is undertaken by Morgan and Wilson (2001)²⁶ who demonstrated that the adhesion of the chemical cure was colonized by a high amount of bacteria (*Streptococcus oralis*) as compared to that of the heat cure. The reason for the difference in the attachment of *Streptococcus mutans* on the various types was probably attributed to the difference in the processing conditions used, resulting in dissimilarity in the nature and porosity of the surface of both heat cure and chemical cure materials.²⁶ Furthermore, the chemical cure denture base materials exhibit higher surface irregularities that have lower strength compared with the conventional heat cure materials because of the difference in the physical nature.^{27,28}

The formation of plaque is based on the microorganism's retention capacity, and therefore on acquired pellicle cohesive strength. The non-specific properties of substratum, especially hydrophobicity,

have the highest effect.²⁹ The non-specific adhesion of the bacteria in low shear stress environments is affected mainly by substratum hydrophobicity.³⁰ In general, hydrophilic substrata were preferred to bacteria with hydrophilic surfaces, and the hydrophobic substrata were preferred to bacteria with hydrophobic surfaces.³¹ Regarding Streptococci, the strain hydrophobicity was reduced dramatically, resulting in a loss in its properties of adhesion, when it was sub-cultured in vitro.³² Another factor that affects the attachment of Streptococci is the surface charge. Concerning surface charge, bacteria are invariably negatively charged in an aqueous environment like human saliva.³³ Even though high surface energy is usually characterized by hydrophilic bacteria, the bacteria being hydrophobic may have these properties.³⁴ In addition to the hydrophobicity and surface charge, Surface Free Energy (SFE) is another factor that affects the adhesion of bacteria. In most cases, the higher the substratum surface free energy, the more the colonization of bacteria will be.³⁵

However, it can be seen that there is a difference regarding the adherence between *C. albicans* and *S. mutans*. The reason could be that the surface characteristics of the bacterial cell are different from the fungal ones. In other words, the bacterial cell is smaller in size as compared to the yeast; therefore, they behave differently.³⁶ Also, extracellular polymers can play another key factor. In comparison, the fungal and bacterial biofilms, the bacterial biofilm extracellular polymers have lower levels of galactose and glucose and higher carbohydrate and protein content.⁷ However, this study does not simulate the oral environment (in-vitro study). Furthermore, the fitting surface of the denture is not polished; therefore, it would be better to study the adhesion of microorganisms on the surface without any polishing.

CONCLUSIONS

Within the limitation of this study, the study showed the highest average absorbance of *C. albicans* in HCC600 and HC1200 whereas there was no significant difference in the P-value of *C. albicans* growth on the different surfaces of acrylic resins. Regarding the adhesion of *Streptococcus mutans*, CC had much more average absorbance than the other three heat cure types. When these materials were compared by ANOVA single factor, the data showed a statistically significant difference in the capacity of attachment between heat cure and chemical cure. Thus, according to this study, the acrylic denture surface roughness by its nature has a large impact on the colonization of denture base by Streptococcus mutants only.

REFERENCES

- 1) Phillips RW, Anusavice KJ, Shen C, Rawls HR. Phillips' science of dental materials. Elsevier/Saunders; 2013.
- 2) Craig, R. G., Powers, J.M. Restorative Dental Materials. St. Louis: Mosby; 2002.
- 3) Charman KM, Fernandez P, Loewy Z, Middleton AM. Attachment of *Streptococcus oralis* on acrylic substrates of varying roughness. Lett appl microbiol. 2009 Apr;48(4):472-7.
- 4) Karaagaciloglu L, Can G, Yilmaz B, Ayhan N, Semiz O, Levent H. The adherence of *Candida albicans* to acrylic resin reinforced with different fibers. J Mater Sci: Mater Med. 2008 Feb;19(2):959-63.
- 5) Pereira T, Del Bel Cury AA, Cenci MS, Rodrigues-Garcia RC. In vitro *Candida* colonization on acrylic resins and denture liners: influence of surface free energy, roughness, saliva, and adhering bacteria. Int J Prosth. 2007 May 1;20(3).
- 6) Salerno C, Pascale M, Contaldo M, Esposito V, Busciolano M, Milillo L, et al. *Candida*-associated denture stomatitis. Med Oral Patol Oral Cir Bucal. 2011;16(2):e139-43.
- 7) Ebrahimi Saravi M, Zomorodian K, Vojdani M, Sattari M. Comparison of candidal and bacterial adherence to denture base acrylic resins. J Islam Dent Assoc Iran. 2013 Jul 10;25(3):169-74.
- 8) Shirtliff ME, Peters BM, Jabra-Rizk MA. Cross-kingdom interactions: *Candida albicans* and bacteria. FEMS microbiol. 2009 Oct 1;299(1):1-8.
- 9) Bamford CV, d'Mello A, Nobbs AH, Dutton LC, Vickerman MM, Jenkinson HF. *Streptococcus Gordonii* modulates *Candida albicans* biofilm formation through intergeneric communication. Infect immun. 2009 Sep;77(9):3696-704.
- 10) Hamada S, Slade HD. Biology, immunology, and cariogenicity of *Streptococcus mutans*. Microbiol. 1980 Jun;44(2):331-84.
- 11) Cohen B, Peach SL, RUSSELL RB. Immunization against dental caries. Med microbiol. 1983;2:255-94.
- 12) Salma A. Elnaili, David G. Patrick. Evaluation of the surface roughness of four different types of acrylic resin denture base materials: heat cure (HC), high impact heat cure (HIHC), heat cure clear (HCC), and clear chemical cure (CC). Part (1. Libyan J Sci & Tech. 2020;11:2 94-97.
- 13) Ozel GS, Guneser MB, Inan O, Eldeniz AU. Evaluation of *C. Albicans* and *S. Mutans* adherence on different provisional crown materials. J adv prosth. 2017 Oct 1;9(5):335-40.
- 14) Verran J, Boyd RD. The relationship between substratum surface roughness and microbiological and organic soiling: a review. Biofouling. 2001 Apr 1;17(1):59-71.
- 15) Soysa NS, Samaranayake LP, Ellepola AN. Diabetes mellitus as a contributory factor in oral candidosis. Diabet med. 2006 May;23(5):455-9.
- 16) Radford D, Challacombe SJ, Walter JD. Denture plaque and adherence of *Candida albicans* to denture-base materials in vivo and in vitro. Crit Rev Oral Biol Med. 1999 Jan;10(1):99-116.
- 17) Nevzatoglu EU, Özcan M, Kulak-Ozkan Y, Kadir T. Adherence of *Candida albicans* to denture base acrylics and silicone-based resilient liner materials with different surface finishes. Clin oral investig. 2007 Sep;11(3):231-6.
- 18) Jeganathan S, Lin CC. Denture stomatitis—a review of the etiology, diagnosis, and management. Aust dent J. 1992 Apr;37(2):107-14.
- 19) Cannon RD, Chaffin WL. Oral colonization by *Candida albicans*. Crit Rev Oral Biol Med. 1999 Jun;10(3):359-83.
- 20) Holmes AR, Cannon RD, Jenkinson HF. Interactions of *Candida albicans* with bacteria and salivary molecules in oral biofilms. J ind microbiol. 1995 Sep 1;15(3):208-13.
- 21) Millsap KW, Bos R, van der Mei HC, Busscher HJ. Adhesion and surface-aggregation of *Candida albicans* from saliva on acrylic surfaces with adhering bacteria as studied in a parallel plate flow chamber. Antonie Van Leeuwenhoek. 1999 May;75(4):351-9.
- 22) Waltimo T, Vallittu P, Haapasalo M. Adherence of *Candida* species to newly polymerized and water-stored denture base polymers. International J Prosth. 2001 Sep 1;14(5).
- 23) Webb BC, Thomas CJ, Whittle T. A 2-year study of *Candida* associated denture stomatitis treatment in aged care subjects. Gerodontology. 2005 Sep;22(3):168-76.
- 24) Verran J, Motteram KL. The effect of adherent oral streptococci on the subsequent adherence of *Candida albicans* to acrylic in vitro. J dent. 1987 Apr 1;15(2):73-6.
- 25) Branting C, Sund ML, Linder LE. The influence of *Streptococcus mutans* on adhesion of *Candida albicans* to acrylic surfaces in vitro. Arch Oral Biol. 1989 Jan 1;34(5):347-53.
- 26) Morgan TD, Wilson M. The effects of surface roughness and type of denture acrylic on biofilm formation by *Streptococcus oralis* in a constant depth film fermentor. J appl microbiol. 2001 Jul;91(1):47-53.
- 27) Faltermeier A, Rosentritt M, Müssig D. Acrylic removable appliances: Comparative evaluation of different postpolymerization methods. Am J Orthod Dentofacial Orthop. 2007 Mar 1;131(3):301-e16.
- 28) Gladwin MA, Bagby MD. Clinical Aspects of Dental Materials: Theory Practice and Cases. 2004.

- Philadelphia: Lippincott Williams and Wilkins:154-6.
- 29) Busscher HJ, Cowan MM, Van der Mei HC. On the relative importance of specific and non-specific approaches to oral microbial adhesion. *FEMS Microbiol.* 1992 Jun 1;8(3-4):199-209.
- 30) Vacheethasane K, Marchant RE. Nonspecific *Staphylococcus epidermidis* adhesion. In *Handbook of Bacterial Adhesion 2000* (pp. 73-90). Humana Press, Totowa, NJ.
- 31) An YH, Friedman RJ, editors. *Handbook of bacterial adhesion: principles, methods, and applications*. Springer Science & Business Media; 2000 Jan 21.
- 32) Olsson J, Westergren G. Hydrophobic surface properties of oral streptococci. *FEMS Microbiol.* 1982 Dec 1;15(4):319-23.
- 33) Dankert J. Biomedical polymers: bacterial adhesion, colonization, and infection. *CRC Crit Rev Biocompat.* 1986;2:219-301.
- 34) Hogt AH, Dankert J, Feijen JA. Adhesion of *Staphylococcus epidermidis* and *Staphylococcus saprophyticus* to a hydrophobic biomaterial. *J Gen Microbiol.* 1985 Sep 1;131(9):2485-91.
- 35) Quirynen M, Dierickx K, van Steenberghe D. Effects of surface roughness and free energy on oral bacterial adhesion. In *Handbook of Bacterial Adhesion 2000* (pp. 91-102). Humana Press, Totowa, NJ.
- 36) Whitehead KA, Rogers D, Colligon J, Wright C, Verran J. Use of the atomic force microscope to determine the effect of substratum surface topography on the ease of bacterial removal. *Colloids Surf B: Biointerfaces.* 2006 Aug 1;51(1):44-53.





Original article

Attitude of Dental Clinicians Towards Flexible Dentures: A Questionnaire Survey in Libya

Yusra Muftah Elfaidy¹, Warida Abdalla Elnaihoum², Aseidah Abdullah Elgotrany³.

¹ Assistant lecturer, Dental Technology Department, Faculty of Medical Technology, University of Tripoli, Tripoli, Libya.

^{2,3} Assistant lecturer, Removable Prosthodontic Department, Faculty of Dentistry, University of Benghazi, Benghazi, Libya.

ABSTRACT

Background: Management of partially edentulous patients with hard and soft tissue undercuts is complicated, and the use of flexible dentures for these cases offers dual advantages of aesthetics and flexibility. However, research shows a varying preference for flexible dentures among general dental practitioners, prosthodontists, and other dental specialties.

Objectives: The aim of this study was to survey the attitude and awareness of a sample of Libyan dental clinicians towards advantages, disadvantages, indications, and contraindications of flexible dentures.

Material and methods: A descriptive cross-sectional study was conducted among 250 dentists currently practicing in different cities of Libya. Only 218 dentists responded. Using Google form software, a self-administrable e-questionnaire consisting of thirty-one multiple choice questions with “yes,” “no” or “not sure” answers encompassing major aspects of flexible dentures was conducted through an online survey.

Results: Out of 250 Libyan dentists to whom the questionnaire was sent, only 218 dentists responded and our results revealed that the respondents were females more than males with a ratio (2:1) and more than half of them were of age group (35-60 years) work in governmental dental practice with more than ten years of experience and 34.9% of them prefer and often offer flexible dentures to their patients. The majority of respondents with a long-term success of the flexible denture were prosthodontists who had more than ten years of experience with a correct response rate of more than 50% of questions that reflected their attitude and knowledge.

Conclusions: Despite the fact that flexible dentures are not taught in Libyan universities of dentistry, about more than one-third of respondents prefer and recommend this treatment to their patients, and the long-term success of these prostheses was dependent on clinicians' education and their clinical experience.

Keywords: Flexible denture, E-questionnaire, Attitude, Libyan dental clinicians.

Corresponding author:

Yusra Muftah Elfaidy: Dental Technology Department,
Faculty of Medical Technology, University of Tripoli,
Tripoli, Libya.

E-mail: y.gumma@uot.edu.ly

INTRODUCTION

Aesthetic and functional rehabilitation of partially edentulous patients with hard and soft tissue undercuts are frequently encountered. Management of such situations with removable cast partial dentures as definitive removable prostheses is complicated and requires pre-prosthetic surgical intervention for alteration of the denture bearing area, careful planning of the path of insertion and removal, adaptation of the denture base using resilient lining material, in addition

to the problem of clasps location that may deteriorate aesthetics.

Nowadays, prosthodontic patients demanding the aesthetic aspect of their prostheses. In response to this demand, manufacturers and dental healthcare providers (dentists and dental technicians) have developed innovative, aesthetic, natural-looking materials and methods for fabricating removable dental prostheses.¹

An alternative denture prosthesis design in which optimal flange height and thickness can be achieved is by using flexible dentures.² Other commonly used

terms are "metal-free dentures" and "clasp-free dentures".³ Flexible denture base material is a nylon-based thermoplastic material that does not sacrifice function and preserves aesthetics.² Some of the commercially available products are Valplast, Sunflex, Duraflex, Flexite, Proflex, Lucitone, and Impak, whereas Valplast, Sunflex, and Lucitone are monomer free.²

The advantages of flexible dentures are that they combine flexibility with subsequent resistance to fracture and plastic deformation; insertion into undercuts is much easier compared to conventional removable dental prostheses, and the denture base is thinner than in conventional dentures. Also, there is no risk of allergic and hypersensitivity reactions (no residual monomer), besides the transparency of the material that reflects the shade of mucosa and the absence of metal clasp make the denture more aesthetic⁽⁴⁾. Free movement is allowed by the overall flexibility and can, therefore, be referred to as "a built-in stress breaker".⁵

Patients usually come to our clinics to restore their lost teeth. However, the purpose of denture construction should not be restricted to tooth replacement but should maintain the surrounding tissue health⁽⁶⁾. The flexibility of the flexible dentures acts as a tissue conditioner and therefore reduces the leverage rotational force and damaging effect on the underlying mucosa.⁷

Flexible dentures use a special flexible resin that prevents them from chafing the gums and allows the wearer to chew properly. It also provides a soft base that prevents the gums from being rubbed.²

Among the flexible denture indications are patients for whom aesthetics is a top priority, patients who refuse the preparation of abutment teeth, patients with allergy to metal, and patients whose medical history or age contraindicates a pre-prosthetic surgical intervention when needed. Good oral hygiene and sufficient interarch space are very important in case selection for flexible removable denture prosthesis.⁶

Designing flexible dentures for the management of patients particularly those facing partial edentulism in the aesthetic zone is still of non-preference by the clinicians in the Libyan ministry of health and it was not included in the curriculum of Libyan governmental universities. However, among private dental practitioners, this treatment modality is highly favourable. Therefore, this study was an effort to survey the attitude of a sample of Libyan dental clinicians towards advantages, disadvantages, indications, and contraindications of flexible dentures.

MATERIALS AND ETHODS

A descriptive cross-sectional study was conducted among 250 dentists (general dental practitioners, prosthodontists & other dental specialists) currently practicing in different cities of Libya who were

conveniently sampled and entirely volunteered to participate the study. Using Google form software,⁸ a self-administered e-questionnaire consisting of thirty-one multiple choice questions with "yes," "no" or "not sure" answers encompassing major aspects of flexible dentures was conducted through an online survey. Online reminders were sent to intended participants more than one time to increase the response rate. Only 218 dentists responded. Dentists who never provided flexible dentures to their patients were excluded.

Previous studies were used to prepare the questionnaire,^{1,4,9,10} which was validated by pre-testing on a group of dentists in the faculty of dentistry, Benghazi University, as the questionnaire was modified until - in the view of respondents- the questions measured what they are intended to measure. The final form of the questionnaire was then distributed electronically among participants and the response was no longer accepted after 7 weeks.

The questionnaire included three sections of questions, a demographic section including information about the participants such as age, gender, qualification level, work institution, and the number of years of experience. The second section included questions reflecting the attitude of Libyan dentists towards flexible dentures and whether they are using them. The third section reflected the success of flexible dentures which is revealed by the level of participants' satisfaction with their dentures one year after delivery and their need for denture replacement.

Results were evaluated using Google form software,⁸ and python programming language.¹¹ Data were analyzed and visualized using tableau VizQL (Visual Query Language).¹² Chi-square test was used to analyze the correlation among variables at a 0.05 level of significance. The conclusions were made by the results.

RESULTS:

The response rate was rather high 87.2%. A total of 218 dentists were taken as samples for the questionnaire study from different cities in Libya in which, as summarized in (Table 1), 67% (146) were female and 33% (72) were male. Most of the respondents 57.8% (126) were of (36-50 years) age group, while 6.4% (14) were of (more than 50 years), and 35.8% (78) were of (25-35 years). One hundred and thirty-two of the respondents (60.2%) were governmental dental practitioners, while 39.8% (86) were private dental practitioners. Regarding the years of work experience, 21.1% (46) of the respondents had 1-5 years, 20.2% (44) had 6-10 years, and the majority 58.7% (128) had more than ten years of work experience in the practice of removable prosthesis. The qualification level of the respondents was ranging from 31.2% (68) prosthodontists, 31.2% (68) specialists (not prosthodontists), and 37.6% (82) general dental practitioners.

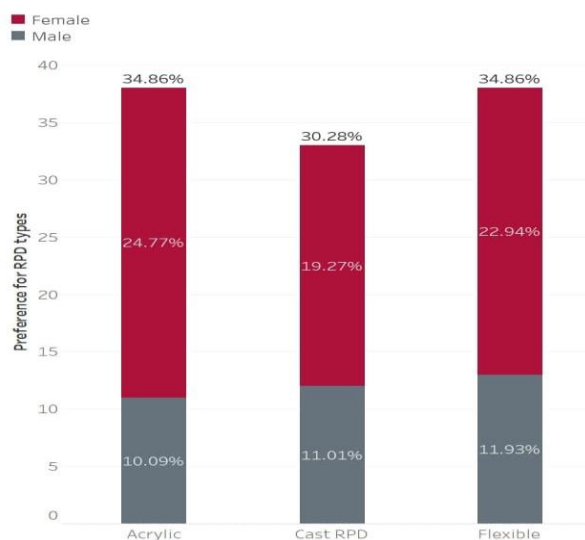
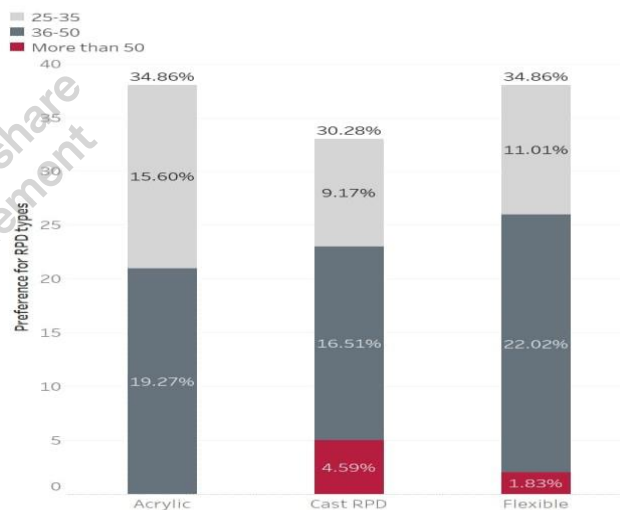
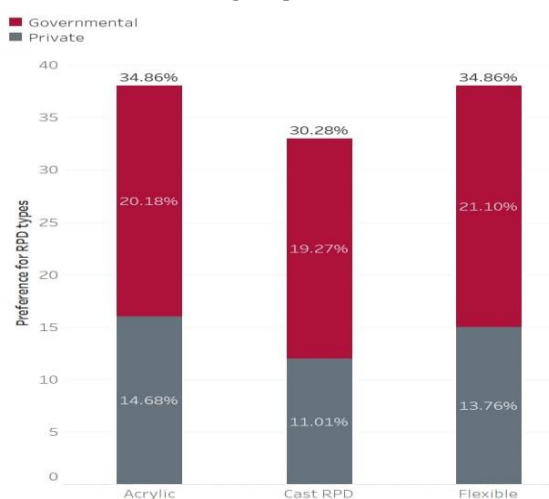
Table 1: Number & percentage of respondents' profiles

Item	Group	No.	%
Gender	Male	72	33%
	Female	146	67%
Age	25 - 35 Yrs.	78	35.8%
	36 - 50 Yrs.	126	57.8%
	> 50 Yrs.	14	6.4%
Work institution	Governmental	132	60.2%
	Private	86	39.8%
Years of work experience	1 - 5 Yrs.	46	21.1%
	6- 10 Yrs.	44	20.2%
	> 10 Yrs.	128	58.7%
Qualification level	General dental practitioner	82	37.6%
	Specialist (not prosthodontist)	68	31.2%
	Prosthodontist	68	31.2%

In correlation between demographic data using python programming language, most of the respondents of age group (35-60 years) – who were the largest population participated in the study - were females work in a governmental institution (36.84%).

In relating this age group to the qualification level, the majority had more than 10 years of experience, 13.16% of them were prosthodontists, while 28.95% were other dental specialties, and 18.42% were general dental practitioners.

Regarding the preference of the respondents to RPD types, our results revealed that more than one-third 34.9% (76) of them prefer and they often prescribe flexible dentures to their patients. In an attempt to relate their preference to age group, gender, and work institution, (Figures 1, 2, and 3) showed that most of them (22.94%) were females with (22.02%) age ranging (36-50 years) and they were (21.10%) governmental dental practitioners.

**Fig. 1:** Preference for RPD types in relation to gender**Fig. 2:** Preference for RPD types in relation to age group**Fig. 3:** Preference for RPD types in relation to work institution

The second section of questions from Q 8 to Q 29 in the questionnaire showed the difference in the acknowledgment and attitude of the respondents towards flexible denture advantages, disadvantages, indications, contraindications, and their commercial names.

Using Google form software, the frequently missed questions -which had a correct response rate of less

than 50%- were ten questions. A summary of the responses regarding these questions is shown in (Table 2). The question with the least correct response rate was (Flexible denture material is only made up from Nylon) in which only (22) 10.1% had a correct answer, while (70) 32.1% had wrong answers and (126) 57.8% were not sure.

Table 2: Distribution of the frequently missed questions, those with a correct response rate of less than 50%

Question title	Correct answer		Wrong answer		Not Sure	
	No.	%	No.	%	No.	%
Flexible denture material is only made up from Nylon	22	10.1%	70	32.1%	126	57.8%
A patient with knife-edge ridges can be indicated to use flexible dentures	46	21.1%	78	35.8%	94	43.1%
Patients with lingual tori can use flexible dentures without undergoing surgery	56	25.7%	86	39.4%	76	34.9%
Flexible dentures are indicated for patients who have limited mouth opening	60	27.5%	74	33.9%	84	38.5%
Flexible dentures displace more soft tissue due to their flexibility	68	31.2%	96	44%	54	24.8%
Staining by various ingredient of food, tea and coffee is unlikely to happen	68	31.2%	58	26.6%	92	42.2%
A flexible denture may be an option in the treatment plan of a patient with ectodermal dysplasia	80	36.7%	18	8.3%	120	55%
The technique for the insertion and adjustment of flexible dentures is the same as that used to acrylic partial ones	82	37.6%	68	31.2%	68	31.2%
Do you know the commercial names of the product you are using for the construction of flexible dentures?	84	38.5%	134	61.5%		
Flexible denture provides more stability during mastication	106	48.6%	44	20.2%	68	31.2%

On analyzing the answers to the third section of questions, the last two questions reflected the level of satisfaction with flexible dentures and the need for their replacement, our results revealed the long-term success of the flexible dentures in more than one third (78) 35.8% of the respondents those were enough satisfied, and most of them 46.15% needed acceptable range of years (5-6 years) for dentures replacement as shown in (Figure 4), and by using a python heat map 16.51% of the total sample had a long term succeed flexible dentures.

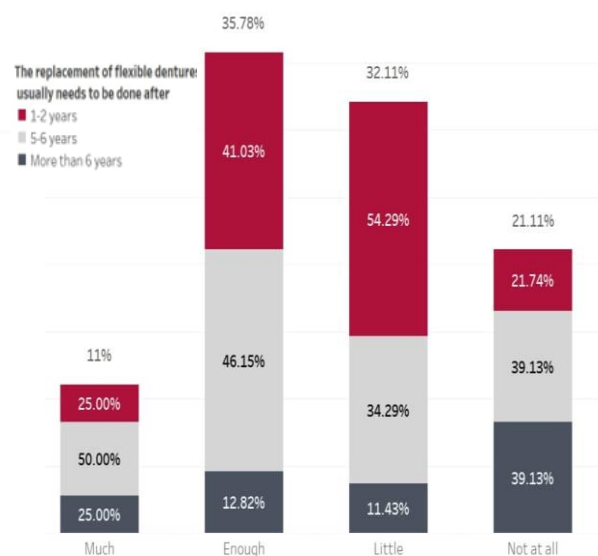


Fig.4: Distribution of years needed for replacement according to Level of satisfaction with flexible denture

In an attempt to correlate this long term success to the attitude of those respondents, their qualification level, and their years of experience, chi-square test indicated no significant association ($p>0.05$). While using tableau analyzing language, (Figures 5, 6, 7) illustrated that out of the respondents 35.8% who had a long term succeed flexible dentures, nearly three quarters 25.69% had a correct response rate of more than 50% of the attitude questions and more than one third 11.93% were prosthodontists, in addition, majority of them 23.85% had more than 10 years of experience

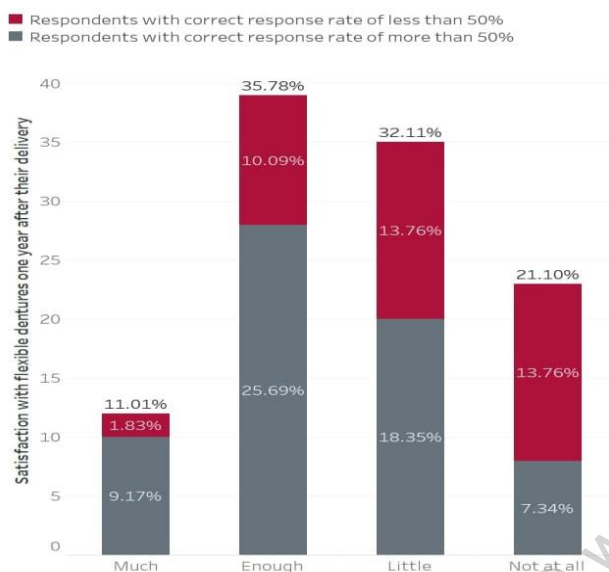


Fig.5: Distribution of satisfaction level according to correct answers rate

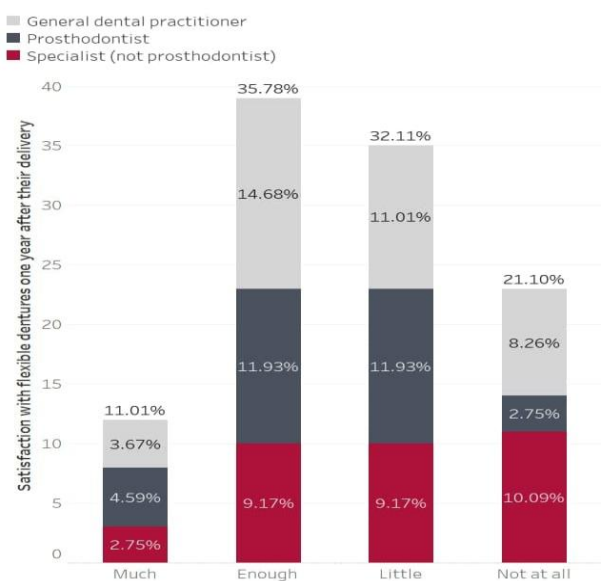


Fig.6: Distribution of satisfaction level according to qualification level

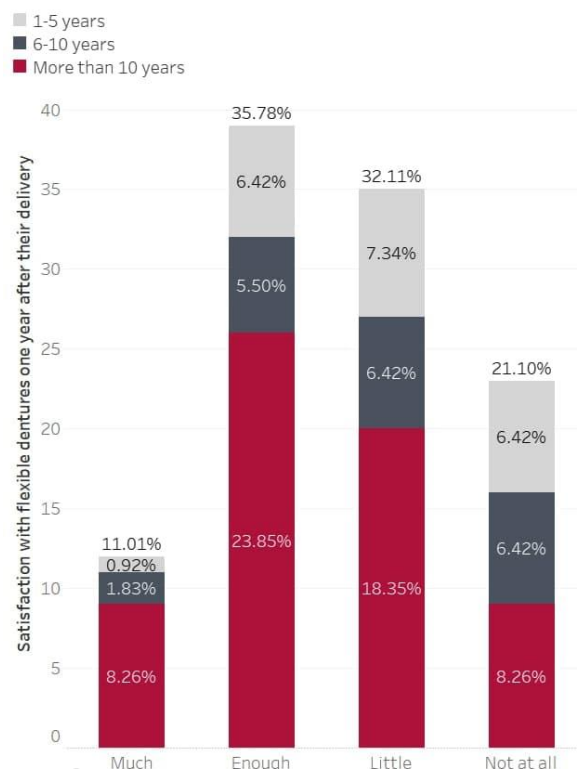


Fig. 7: Distribution of satisfaction level according to years of experience

DISCUSSION:

Denture base materials have been subjected to extensive research, advancements, and improvements. Recently, flexible dentures have gained popularity as an alternative to PMMA among dental practitioners and patients in denture construction as it gives dual advantages of aesthetic and flexibility.

Although flexible dentures are prosthetic works that are not learned during faculty, the interest of dentists and technicians in their realization is growing. Their acknowledgment is usually based on investing in oneself by taking specialized courses in the field, but also in the materials and equipment needed to make flexible partial dentures.¹³

Nowadays, there are several different flexible materials in the dental market that general dental practitioners can choose from. However, research shows a varying preference for flexible dentures among general dental practitioners, prosthodontists, and other dental specialties. Therefore, the present study is an attempt to evaluate the attitude of Libyan dental clinicians towards flexible dentures.

This study was a self-administrable e-questionnaire conducted among 250 dentists currently practicing in different cities of Libya. Only 218 dentists responded

and our results revealed that the respondents were females more than males (2:1) and the majority of them were of age group (35-60 years) work in governmental dental practice with more than ten years of experience and 34.9% of them prefer and often offer flexible dentures to their patients.

Interpretation for the preference of age group ranging (36-50 years) to prescribe flexible dentures could be that the younger practitioners tend more to use newer techniques. This was in agreement with Polyzois et al.¹ Regarding the second section of the questionnaire, twenty-two questions reflected the attitude of the respondents towards flexible denture advantages, disadvantages, indications, and contraindications, as our results revealed that eighty-six of the respondents had a correct response rate of less than 50% of questions. Also, the results illustrated that Q9 had the least response rate, which indicates the material the flexible denture made of, only 22 respondents knew that it was made of nylon.⁵

The number of respondents who correctly answered Q16, Q19, Q22 and they knew that flexible dentures are contraindicated in patients with limited mouth opening, lingual tori, and knife-edge ridges were 60, 56, and 46 respectively. While the questions Q11, Q13, Q17, Q18, Q20 reflected the awareness towards indications of the flexible denture as 80 respondents knew that it is an option in the treatment plan of patients with ectodermal dysplasia, and more than half they aware that it is indicated for patients with teeth or tissue undercuts, patients with a history of repeated denture fracture and is considered as an alternative for patients those are allergic to acrylic dentures.^{6, 14} Questions Q8, Q10, Q14, Q23, Q24, and Q25 analyzed the attitude of the respondents towards the advantages of the flexible denture, as more than half they knew that it is unbreakable, it needs minimum or no mouth preparation, it provides more stability during mastication^{4, 5, 14} as being reported by Thakral et al.¹⁵ and Sharma et al.,¹⁶ it more cosmetic and lighter in weight compared to acrylic denture¹⁴ as being agreed by Shamnur et al.¹⁷ while the number of them who aware that flexible denture doesn't displace soft tissues during function was only sixty-eight.^{4, 5, 14}

Responses to the questions Q12, Q26, Q27, Q29 revealed that more than half of the respondents were aware that good oral hygiene is very important, and as there was no addition that could be made onto nylon a flexible denture is not easy to repair.^{6, 9} While only 31.2% knew that staining of a flexible denture by various ingredients of food, tea and coffee is likely to happen, and 68.8% agreed that the cost factor plays a role in the patient's decision to make a flexible denture rather than an acrylic one.⁹

Considering the insertion and adjustment, Q21 exhibited that less than half of the respondents knew

that the technique for the insertion and adjustment of flexible denture is not the same as that used to acrylic partial ones as its trimming and polishing with rubber wheel must be done with intermittent contact to prevent material from melting.¹⁴

Despite that flexible dentures are intended for temporary applications and not to be used for the long term, our study revealed that only 17.6% knew that.⁴ In total both permanent and temporary uses of flexible denture prostheses are almost equal.⁴ In addition, as illustrated by Q28, only 38.5% of the respondents were aware of the commercial names of the product they use for the construction of flexible dentures.

In discussing the results related to respondents with a long term success of the flexible denture, our study revealed that the majority of them were prosthodontists who had more than ten years of experience with a correct response rate of more than 50% of attitude questions and it was a believable result because it is not a surprise to reveal that a prosthesis success and satisfaction is related to and affected by the clinician's attitude and experience those make the case selection for flexible denture more professional which in turn increasing its success, and our results were in consistence with Hill et al.¹⁸ as he reported that the decision of flexible denture was mostly depended on case selection and there are differences between general dentist and specialist in the use of flexible denture prostheses.

CONCLUSION:

Despite the fact that flexible dentures are not taught in Libyan Universities of dentistry, about more than one-third of them prefer and recommend this treatment to their patients and the long-term success of these prostheses was dependent on clinicians' education and their clinical experience.

Each new material or technique introduced into the field of dentistry has its pros and cons, and a thorough understanding of its advantages, disadvantages, indications, and contraindications is obligatory for a careful case selection to ensure an optimum restoration with a perfect treatment prognosis. Hence, patients' satisfaction and an enhanced quality of life can be met.

Although dental practitioners were aware of the benefits of flexible dentures to fulfill the patient's demand for a more retentive and aesthetic prosthesis, there is still a need to educate and motivate them on how to manage them on a regular academic curriculum. Seminars and workshops should also be arranged to help dentists enhance their skills to keep up with new updates in dental materials and technology.

Limitation of the study:

There were several limitations to this study that must be addressed accordingly. The distribution of respondents in private and governmental dental institutions was imbalanced. Thus, the result of this study could be affected in some way.

A representative and randomized sample is required to determine the actual awareness of dental practitioners and specialists. The primary objective of this study, however, was to assess the attitude and awareness of a selected sample of Libyan dentists as a convenience sampling was used. A questionnaire is a well-established strategy for data collection. However, it has its own limitations. For example, social desirability bias and non-response rate may affect the representativeness of the sample and the quality of the information.¹⁹ However, no personal data was collected and the participation was entirely voluntary. As a result, in the current study, these biases would have less of an impact. Furthermore, the current study's response rate was rather high (87.2%).

Ethical approval:

The study was following the ethical standards of the institutional research committee of Benghazi University and approval was obtained.

Informed consent:

In the questionnaire, an explanation of the aim of the study and a statement of agreement to participate were written. As well Using electronic surveying gives the responders the freedom either to agree or refuse to answer the questionnaire.

REFERENCES:

1. Polyzois G, Lagouvardos P, Kranjčić J, Vojvodić D. Flexible Removable Partial Denture Prosthesis: A survey of dentists' attitudes and knowledge in Greece and Croatia. *Acta Stomatol Croat* 2015;49:316-324. doi: 10.15644/asc49/4/7
2. Jain RA. Flexible denture for partially edentulous arches - case reports. *Int J Recent Adv Multidisciplinary Res* 2015;2:182-186.
3. Kamdar RS, Dhanraj M, Rakshaghan. Knowledge, awareness, and practice regarding the use of flexible dentures among dental practitioners. *Int J Curr Res* 2017;9:57081-57084.
4. Eswaran MA, Kesavan R, Subramani M, Meena M. Flexible removable partial denture prosthesis: a survey of dentist's attitudes and knowledge in Chennai region. *World J Pharm Life Sci* 2019;5:125-130.
5. Thumati P, Padmaja S, Raghavendra RK. Flexible dentures in prosthodontics - An overview. *Indian J Dent Adv* 2013;5:1380-1385. doi: 10.5866/2013.541380
6. Rostom D, Abdul Aziz M. "The impact of the flexible partial denture base on the alveolar mucosa in comparison to metallic denture: RCT and Histological Study". *Adv Dent J* 2020;2:101-107.
7. Abdel-Fdeel BM, Kabeel SM, Sanad ME. Patient satisfaction and stress distribution of flexible and cobalt chromium partial dentures. *Al-Azhar D J for Girls* 2018;5:145-151.
8. Google forms. Survey. Available: <https://docs.google.com/forms/u/0/> Last accessed 23rd Jun 2021.
9. Rozano AS, Asman N, Zubaidah ZA, Lim GS. Knowledge and perception of flexible dentures among dental private practitioners in Klang Valley, Malaysia. *ADUM, University of Malaya* 2017;24:33-38.
10. Afridi AMJI, Ehsan A. Knowledge, perception, and choice of dental implants as a treatment option for patients visiting the university college of dentistry Lahore-Pakistan. *Pak Oral & Dent J* 2014;34:560-563.
11. Ramdas N. Basic Fundamental of Python Programming Language and The Bright Future. *An Int Multi Quarterly Res J AJANTA*. 2019;8:71-76.
12. Milligan JN. *Learning Tableau, Tools for Business Intelligence, data prep, and visual analytics*. 3rd ed. Birmingham - Mumbai: Packt Publishing Ltd; 2019:1-808.
13. Malița Mădălina et al. The Technology of Obtaining Flexible Dentures in Dental Practice, Theoretical and Practical Aspects. *Acta Medica Transilvanica* 2021;26:67-69. Doi:10.2478/amtsb-2021-0018
14. Lim GS, Buzayan MM, Elkezza AH, Sekar K. The development of flexible denture materials and concept: A narrative review. *J Health & Transl Med* 2021;24:2329.
15. Thakral GK, Aeran H, Yadav B. & Thakral R. Flexible Partial Dentures-A hope for the Challenged Mouth. *Peoples J Sci Res* 2012;5:55-59.
16. Sharma A. & Shashidhara HS. A review: Flexible removable partial dentures. *J Dent Med Sci* 2014;13:58-62.
17. Shamnur SN., Jagadeesh KN., Kalavathi SD. & Kashinath KR. Flexible Dentures-An alternate for rigid dentures. *J Dent Sci Res*. 2010;1:74-79.
18. Hill ET, Rubel B, Smith JB. Flexible removable partial dentures: a basic overview. *Gen Dent*. 2014;62:32-36.

19. Edwards PJ, Roberts I, Clarke MJ. Methods to increase response to postal and electronic

questionnaires. Cochrane Collaboration: JohnWiley & Sons, Ltd.2010;1:1-533.





Original article

Effect of Staining and Bleaching on Color Change of Resin Composite Restorative Materials

Eman Z. Osman^{1*}, Naeima M. Betamar², Nagat H. Bubteina³, Rafa A. Mohamed⁴.

^{1*} Specialist in Operative Dentistry Department at Al-Gala Hospital, Benghazi, Libya.

² Associate Professor, Conservative Dentistry and Endodontics Department, Faculty of Dentistry, University of Benghazi, Libya

³ Professor, Conservative Dentistry and Endodontics Department, Faculty of Dentistry, University of Benghazi, Libya

⁴ Professor, Physics Department, Faculty of Science, University of Benghazi, Libya

ABSTRACT

Aims: To evaluate the color change of three resin composites (nanohybrid; Filtek Z250XT, microhybrid, DenFil, and nanoceram; Zenit) after exposure to tea, coffee, artificial saliva, and bleaching procedure.

Materials and Methods: A total of 162 disc-shaped specimens (12.2mm diameter, and 2.2mm thickness) from the three resin composites were prepared in a silicon mold, then divided into 3 groups according to the type of resin composite. Each group was subdivided into three experimental groups (n=18), and immersed into staining solutions; tea, coffee, and artificial saliva for 3h/day over 28 days. A bleaching agent (Opalescence 20 home bleach) was applied to previously stained specimens for 3h/day over 14 days. The color measurement for each specimen was performed according to CIE L*a*b* system using a spectrophotometer on three occasions: i) at baseline, ii) after staining, and iii) after bleaching. The color differences delta E (ΔE) between the three measurements were calculated and the obtained data was statistically analyzed.

Results: The three composites showed significant color change after immersion in tea, and coffee solutions ($P<0.05$), and after the bleaching ($P<0.05$). DenFil showed the most color change followed by Z250XT. Zenit was the least affected by staining solutions. Tea solution caused more color change than the coffee solution. Artificial saliva showed insignificant color change for all groups ($P=0.07$).

Conclusions: Exposure to drinks with staining ability such as tea and coffee can significantly affect the color stability of the tested composites. The bleaching agent was effective in removing the stains and restoring the color of all composites near or at baseline color.

Keywords: color change, resin composite, tea, coffee, staining solution, bleaching.

Corresponding author:

Eman Z. Osman, Specialist in Operative Dentistry
Department at Al-Gala Hospital, Benghazi, Libya.
E.mail: amro71032005@yahoo.com

INTRODUCTION

Resin composites are very popular and widely used restorative materials for anterior and posterior teeth, due to their esthetics and improved physical and mechanical properties.¹ However color stability which is the ability of the material to maintain its original color remains the main esthetic problem.² These restorative materials are susceptible to various degrees of discoloration due to continued exposure

and interaction with colorants ingredients in certain foods and beverages in the oral environment.³ This discoloration causes patient discomfort, dissatisfaction, and may need replacement of the restoration.⁴

The discoloration is also affected by accumulation of plaque, and oral hygiene status, daily dietary intake of food and beverages with staining ability such as tea, coffee, cola, coloring mouth rinses, and smoking

habits.^{5, 6} In this context, staining agents can penetrate the superficial layer of resin composite causing degradation and softening of the resin matrix where its ability to resist stain is reduced,⁷ and consequently lead to discoloration of the resin composite.⁸ In addition, several factors can affect the color and staining susceptibility of the resin composite leading to color change such as visible light, ultra-violet irradiation, thermal changes, vigorous finishing and polishing procedures, humidity, curing time, curing mode, aging conditions, and composition of the materials such as matrix and filler type and size.⁸⁻¹⁴

Because of the discoloration problem of the resin composite restorations, patients are looking for a bleaching procedure to remove the stains and improve the esthetic demand. Thus, various bleaching products are available in the market and become very popular and well accepted by the patients.¹⁵ Several studies were conducted to investigate the effects of those bleaching materials once they come in contact with the esthetic restorative materials, such as their influences on the physical and optical properties of the resin composite restorative materials.^{2, 15-20}

It is important to investigate the color stability of resin composite restorative materials and the efficacy and performance of bleaching materials.¹⁵ This is to assist dental clinicians to choose the proper materials that go with the diet habits of the patients, and can also help to predict the success rate of the restorations.¹⁷ It can also allow the clinician to educate and advise the patient about the effects of specific chromogenic components in the diet such as tea, coffee, and cola on the color change of the resin composites.¹⁸ This study was performed to evaluate the color change of three resin composite restorative materials (nanohybrid, microhybrid, and nanoceram) after exposure to three staining solutions; tea, coffee, artificial saliva, and bleaching procedure.

MATERIALS AND METHODS

Detailed description and composition of the resin composites materials evaluated in this in-vitro study are listed in Table 1. Research approval has been obtained by the Committee on Ethics in Research, faculty of dentistry, University of Benghazi (Certificate Reference No. 094).

Specimen preparation

A total number of 162 disc-shaped specimens were prepared from three commercially available resin composites shade A2 namely: a nanohybrid (Filtek™ Z250 XT), a microhybrid (DenFil^{TE}), and a nanoceram (Zenit) (Table1). The specimens were divided into three groups (n=54) depending on the type of composite material; C1=Z250, C2=DenFill, C3=Zenit. For each brand of resin composites; the specimens were prepared by condensing the resin composite

material into a silicone mold with circular holes measured 12.2 mm in diameter and 2.2 mm in thickness. A celluloid strip was placed over the material, and then a glass slide was pressed against the upper surface to extrude excess material and to create a flat surface.

All specimens were polymerized by a light-curing unit (Radii plus LED cordless curing light) with the same intensity and light-curing mode to standardize the specimen preparation. The specimens were placed in jars of distilled water for 24 hours at room temperature in complete darkness to allow complete polymerization. After 24 hours of water stage, the color of all specimens was measured using a Spectrophotometer (UV mini-1240 UV-VIS Spectrophotometer SHIMADZU, Germany). This measurement is considered as base-line color measurements for each type of resin composites before the staining procedure. Each group of a composite of 54 specimens was subdivided into 3 experimental groups (n=18)¹⁵ according to the staining solution into which the specimens were immersed in as following: Group1 (Gp1): artificial saliva (saliva simulating solution) and consider as a control group, group 2 (Gp2) in Tea solution, and group 3 (Gp3) Coffee solution.

Staining procedure

Tea solution was prepared by dipping two bags of (Lipton red tea) in 300 ml of boiled water for five minutes according to manufacturer recommendation (150 ml for each bag).² The teabags were removed and the solution is allowed to cool at room temperature, then sub-divided to 100 ml at each of the three jars.

Coffee solution: Two bags of Nescafé plain coffee were stirred in 300 ml of hot water until completely dissolved according to the manufacturer's recommendations (150 ml for each bag)². The prepared coffee solution is allowed to cool at room temperature and then subdivided into three portions of 100 ml each in three jars.

The specimens were placed in Tea (T) or Coffee (F) solution according to the intended sub-groups for three hours daily,^{2, 15} and then were kept in artificial saliva for the rest of day.¹⁴ The staining solutions were freshly prepared each day with the same method throughout the testing period (28 days).²⁴ The third group of specimens was kept at artificial saliva throughout the experiment period in jars completely covered to prevent evaporation of the solutions. Artificial saliva solutions were changed daily. All specimens were rinsed with tap water, plot dry, and kept into dry containers for color measurement by spectrophotometer after staining.²⁵

Bleaching Procedure

Bleaching agent Opalescence 20 home bleach (20% carbamide peroxide), (Table 1) was painted on the

top surface of the previously stained composite specimens according to the manufacturer's instructions and remains for 3 hours per day for 14 days.^{2, 14, 15, 17} After bleaching; the specimens were rinsed with tap water for 1 minute to remove the bleaching agent, plot dry, and stored in artificial

saliva.²⁵ All specimens were rinsed by tap water, plot dry, and kept in dry containers for color measurement after bleaching procedures. All the experiments were prepared at the same conditions of temperature, illumination, and relative humidity.¹⁴

Table 1: Detailed description and composition of the materials used in the study

Product name	Manufacturer	Composition ^(a)	Lot number	Expire date
Nanohybrid Composite, Filtek™ Z250 XT	3M™ ESPE™, USA ¹	Bis-GMA, UDMA, Bis-EMA, PEGMA, TEGDMA. Zirconia/silica 20 nm. Filler loading: 82% vol.	N915906 CE 0123	2021-08-28
Microhybrid Composite, DenFil™	VERICOM LTD, Korea ²	Bis-GMA, TEGDMA. Barium alumino-silicate particles. Fumed silica 0.04µm. Filler loading: 80% vol.	DF8614A2 CE 0120	2021-06-06
Nanoceram Composite, Zenit	PD President Dental, Germany ³	UDMA, Butanediol DMA, Bis-GMA. Pyrogenic silica 12nm Glass filler 0.7µm. Agglomerated nanoparticles 0.6µm. Filler loading: 70% vol.	2017006943 CE 1984	2021-04
Opalescence 20 home bleach	Ultradent, USA	20% Carbamide peroxide, Potassium nitrate, 0.11% fluoride ions Mint flavor	N915907	2021-06-07
Staining solutions:				
Artificial saliva	Gulf Inject LLC- Dubai UA	Sodium chloride 0.86gm, potassium chloride 30gm, and calcium chloride 0.33gm in each 100ml.		
Coffee, Nescafe`	Nestle\ Swiss	Instant Plain Coffee without sugar		
Tea, Lipton	Unilever\United Kingdom	Black Tea		
^(a) According to manufacturers' data: Bis-GMA: bisphenol-A-glycidyl methacrylate; UDMA: urethane dimethacrylate; Bis-EMA: ethoxylated Bisphenol-A- glycidyl methacrylate; TEGDMA: Triethylene glycol dimethacrylate; PEGMA: polyethylene-A-glycidyl methacrylate; DMA: dimethacrylate.				

Assessment of the color change (Color measurements):

A colorimetric evaluation according to the CIE L*a*b* system²⁶ was performed to record the color change of the specimens using a spectrophotometer (UV mini-1240 UV-VIS Spectrophotometer SHIMADZU, Germany),^{15, 24, 25} against a black background to simulate the absence of light in the mouth¹⁷. The spectrophotometer was calibrated regularly before starting the actual color measurement. The specimen should be clean and dry before being positioned at the determined place in the device.

All specimens were chromatically measured three times²⁴ as follows: (1) at the baseline before staining procedures (m_0), (2) after 28 days of staining period (m_1), and (3) after bleaching procedure (m_2). Where m =time. The spectrophotometric evaluation was done at the Optics laboratory in the Physics department of the Faculty of Science, University of

Benghazi. Values of color difference (ΔE) were obtained according to the equation proposed by the Commission International de l'Eclairage CIE L*a*b*:
 $\Delta E^*_{ab} = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$ where, L^* = variation of luminosity, quantified with a scale ranging from 0 to 100. The measurements of a^* and b^* corresponded to chromaticity coordinates, where, a^* =green/red axis, and b^* =yellow/blue axis.²⁷ The ΔE values at different intervals to determine the color change of the resin composite using the equations: ^{14, 15, 18, 25}

$\Delta E_0 = [(\Delta L_0)^2 + (\Delta a_0)^2 + (\Delta b_0)^2]^{1/2}$ color difference at baseline.

$\Delta E_1 = [(\Delta L_1)^2 + (\Delta a_1)^2 + (\Delta b_1)^2]^{1/2}$ color difference after immersion in staining solution.

$\Delta E_2 = [(\Delta L_2)^2 + (\Delta a_2)^2 + (\Delta b_2)^2]^{1/2}$ color difference after bleaching process.

$\Delta E_3 = [(\Delta L_1 - \Delta L_0)^2 + (\Delta a_1 - \Delta a_0)^2 + (\Delta b_1 - \Delta b_0)^2]^{1/2}$ color difference between baseline and stained composite.

$\Delta E_4 = [(\Delta L_2 - \Delta L_0)^2 + (\Delta a_2 - \Delta a_0)^2 + (\Delta b_2 - \Delta b_0)^2]^{1/2}$ color difference between baseline and bleached composite.

Statistical analysis

Statistical analysis was performed using SPSS software version 20. Means and standard deviations were attained for each group. Differences in color change (ΔE) by the immersion protocols were calculated at baseline ΔE_0 , after staining ΔE_1 , and after bleaching ΔE_2 . One-way analysis of variance test (ANOVA) was used to evaluate the effects of immersion solutions on color change after staining (ΔE_3 between baseline and stained specimens). Two-way ANOVA was performed to compare the effect of immersion solutions and bleaching agent on color change after bleaching (ΔE_4 between baseline and

bleaching). Tukey's Post hoc test was used for pairwise comparisons between the means when ANOVA tests were significant. Statistical significance was set in advance at the 95% probability level (Probability value ≤ 0.05).

RESULTS

Means and $\pm$ standard deviations of color difference delta E (ΔE) values for the three resin composites into each immersion solution, and after bleaching are summarised in Table 2.

The three types of resin composite specimens are changed in color after immersion in coffee and tea solutions for three hours per day for 28 days. Tea solution had more ability to stain the three brands of resin composites than the coffee solution. However, the color is slightly changed by immersion into artificial saliva for the same period of time (Table 2).

Table 2: Means and $\pm$ Standard Deviations of ΔE_0 (at baseline), ΔE_1 (after staining), and ΔE_2 (after bleach) of the three resin composites

Procedure	No. of specimen	Time ΔE	C1 Z250	C2 DenFil	C3 Zenit
Baseline	54	m_0 ΔE_0	26.25 $\pm$ 0.81	24.85 $\pm$ 0.47	14.74 $\pm$ 0.65
Staining with a tea solution	18	m_1 ΔE_1	33.67 $\pm$ 1.08	28.97 $\pm$ 1.53	19.54 $\pm$ 0.75
Staining with coffee solution	18		29.77 $\pm$ 0.27	28.64 $\pm$ 0.26	17.70 $\pm$ 0.50
Artificial saliva (Controls)	18		27.35 $\pm$ 0.70	25.90 $\pm$ 0.44	15.11 $\pm$ 0.96
Bleach after coffee staining	18	m_2 ΔE_2	26.25 $\pm$ 1.08	24.91 $\pm$ 0.42	14.55 $\pm$ 0.64
Bleach after tea staining	18		26.34 $\pm$ 0.84	24.77 $\pm$ 0.51	14.77 $\pm$ 0.64
Bleach after artificial saliva	18		26.51 $\pm$ 0.67	24.91 $\pm$ 0.56	13.97 $\pm$ 0.89

By immersion in tea solution; the most stained resin composite was DenFil microhybrid (C₂) $\Delta E_3=8.45$ followed by Z250 nanohybrid (C₁) $\Delta E_3=7.54$. Nanoceram (C₃) was the least affected by tea staining solution $\Delta E_3=5.18$ (Table 3). Conversely with the coffee solution; DenFil microhybrid (C₃) showed the highest change in color $\Delta E_3=5.13$ followed by Z250 (C₁) $\Delta E_3=3.64$. Nevertheless, Zenit Nanoceram was the least color change by coffee solution $\Delta E_3=3.43$ (Table 3). Artificial saliva caused a little color change for the three resin composites tested specimens after the same period of immersion. The most color changed was DenFil microhybrid (C₂) $\Delta E_3=1.82$, followed by Z250 nanohybrid (C₁) $\Delta E_3=1.46$ Zenit nanoceram (C₃) was the least affected by artificial saliva $\Delta E_3=0.76$ (Table 3).

The color of the three stained resin composites evaluated in this study was found to be changed by the bleaching agent (Opalescence 20% home bleach) and returned near or at the original color shade after two weeks. Zenit Nanoceram (C₃) was the most affected one followed by Z250 Nanohybrid (C₁), and DenFil Microhybrid (C₂) (Table 4). Zenit nanoceram performed better regarding the color stability but was found to be affected more by the bleaching agent compared to DenFil Microhybrid and Z250 nanohybrid composites (Tables 3 & 4).

Statistical analysis (One-way and Two-way ANOVA) revealed that the three tested resin composites were significantly changed in color after immersion in staining solutions ($P<0.05$). Also, there was a significant change in color of the three resin composite specimens after the application of the bleaching agent ($P<0.05$). Tukey's Post Hoc test

revealed that the three types of resin composite specimens are significantly affected by the tea ($P=0.03$), and coffee solutions ($P=0.02$). With artificial saliva, there was a little color change, which is insignificant $P=0.07$. Application of bleaching agent

to the previously stained specimens resulted in returned the color of the stained specimens near or at the baseline color. This means there was no significant difference in the color between baseline and bleached specimens ($P>0.05$).

Table 3: Mean and $\pm$ Standard Deviation of $\Delta E3$ (color difference between baseline & stain)

Resin Composite	Immersion solution	Total No. of specimens	No. of Specimens (per group)	Mean $\pm$ (SD)
Z250 C1	Tea	54	18	7.54 $\pm$ (1.34)
	Coffee		18	3.64 $\pm$ (0.82)
	Artificial Saliva		18	1.46 $\pm$ (1.07)
DenFil C2	Tea	54	18	8.45 $\pm$ (1.63)
	Coffee		18	5.13 $\pm$ (0.50)
	Artificial Saliva		18	1.82 $\pm$ (0.78)
Zenit C3	Tea	54	18	5.18 $\pm$ (0.88)
	Coffee		18	3.43 $\pm$ (0.80)
	Artificial Saliva		18	0.76 $\pm$ (1.37)

Table 4: Mean and $\pm$ Standard Deviation of $\Delta E4$ (color difference between baseline & bleach)

Resin Composite	Immersion solution	Total No. of specimens	No. of Specimens (per testing group)	Mean $\pm$ (SD)
Z250 C1	Tea	54	18	1.76 $\pm$ (0.19)
	Coffee		18	1.73 $\pm$ (0.10)
	Artificial Saliva		18	0.85 $\pm$ (0.26)
DenFil C2	Tea	54	18	1.63 $\pm$ (0.22)
	Coffee		18	1.34 $\pm$ (0.12)
	Artificial Saliva		18	0.28 $\pm$ (0.31)
Zenit C3	Tea	54	18	2.12 $\pm$ (0.24)
	Coffee		18	2.33 $\pm$ (0.44)
	Artificial Saliva		18	0.92 $\pm$ (0.27)

DISCUSSION

Resin composite restorative materials are exposed to saliva, staining foods and drinks in the oral cavity, which can affect the color stability of these aesthetic restorations leading to superficial or internal color change. Clinically several methods have been suggested to overcome the discoloration problem of composite restorations including surface polishing by polishing pastes and discs, application of bleaching

materials or even replacement of the restoration if the former procedures were not effective.^{2, 16, 24}

The current in-vitro study was conducted to investigate the color changes of three brands of resin composites of the same shade (A2), after exposure to tea, coffee solutions, and artificial saliva. The selection of the composites is based on the fact that the three resin composites have some compositional differences, they are available in the market, and used by many dentists for anterior and posterior teeth. The staining period was kept at 3 h per day because an

average person spends approximately 60–180 min per day eating and drinking thus simulating possible staining susceptibility of restorations¹¹. Lipton Black Teabags and Nescafé plain coffee were used as staining solutions because they are routinely consumed beverages by the Libyan society at home and in public cafés.

Color assessment varies from person to person and even in one individual at different time points.¹⁴ In this study, to eliminate the subjective errors of interpretation of visual color comparison⁸, the color assessment was done using a spectrophotometer. Several studies were performed using this device to determine the color difference of resin composite restorative materials after exposure to several foods and drinks with staining ability.^{11, 15, 17, 24} The color measurement was done against a black background to simulate the absence of light in the mouth.¹⁵

Results of the present study revealed that the color of all composites specimens was significantly changed after exposure to tea and coffee solutions, and also after application of the bleaching agent. However, the tea solution had a more staining effect than the coffee solution. Our findings were in agreement with some studies^{10, 25, 25, 26}. On contrary, other studies documented that coffee had the most staining effect on the color of the investigated resin composites.^{17, 25} The obtained results could be attributed to the compositional differences between the three resin composites. Dental composites are composed of three chemically-different materials: the organic matrix or organic phase; the inorganic matrix, filler or disperse phase; and the coupling agent to bond the filler to the organic resin.²⁸ These different materials can play a role in its color stability and affect esthetic properties.²⁹ Literature reported that staining susceptibility of resin composites is attributed to the degree of water sorption and hydrophilicity of the resin matrix.¹⁴ Excessive water sorption can increase the staining liability of composite restorations.⁵ Water sorption leads to expanding and plasticizing the resin component, hydrolyzing the silane, and causing microcracks formation.² These microcracks at the interface between the filler and the matrix allow stain penetration and discoloration.²

Hydrophilic materials have a higher degree of water sorption and relatively higher discoloration value with staining solutions than hydrophobic materials.⁸ This may explain why the three types of resin composite evaluated in the current study were discolored at dissimilar degrees as they have some dissimilarity in the chemical composition and proportions of their matrix (Table 1). Zenit nanoceram was the least affected by both tea and coffee solutions followed by nanohybrid Z250XT, and DenFil microhybrid resin composite which was the most affected one. Authors stated that TEGDMA diluent material increases the hydrophilicity of the resin composite,²⁹ and can affect its esthetic

properties.^{2, 8, 29} This may explain why Z250XT and DenFil stained more than Zenit as the latter doesn't contain this monomer. UDMA is more resistant to stain than Bis-GMA.^{13, 29} The absence of UDMA in DenFil may explain why it is the most affected one by tea and coffee solutions. Nasim *et al.*,¹⁴ reported that Bis-GMA- and TEGDMA-based resin composites are more hydrophilic than UDMA-based resin composites because of the presence of hydroxyl group in their chemical structure. Consequently, dental materials that contain such monomers may be more susceptible to water sorption and discoloration over time.^{2, 14} This fitted with the findings of the current study. Literature documented that microfilled resin composite showed a greater degree of staining because of their higher content of organic matrix.^{11, 30} In addition, it has been reported that a composite with large-size filler particles is more prone to water aging discoloration than a composite with small-size filler particles.^{2, 24} Thus, water and coloring solutions are absorbed easily causing hydrolytic degradation of the matrix filler interfaces.⁵ Accordingly, the staining ability and the high color change of the DenFil microhybrid resin composite evaluated in the current study could be attributed to its filler particle size as compared with Z250XT and Zenit (Table 1). As the size of the filler particles decreases they become difficult to be detached from the matrix, therefore the penetration of solutions including staining one is not easy, hereafter the material is more color stable.³¹ This may clarify why Zenit nanoceram showed the most color stability as it had a filler particle size of 12nm from pyrogenic silica. Likewise, Z250XT nanohybrid is more stable than DenFil as Z250XT had a filler size of 20nm from Zirconia. Our results were in agreement with Telang *et al.*,¹⁵ who concluded that Supranano resin composite was more color stable than Z250XT nanohybrid resin composite. However, in contrast to our results, Villalta *et al.*,² reported that Feltik supreme nanohybrid had more color change than Estht X microhybrid composite.

Furthermore, higher loading of filler particles in Zenit nanoceram (70%) (Table 1) may contribute to the color stability of this material. Although DenFil microhybrid had more filler loading (80%), the larger size of these particles may play an important role in the color change as mentioned previously. Accordingly, it can be assumed that DenFil microhybrid resin composite, in the presence of small-to-large filler particles, with a Bis-GMA and TEGDMA resin-based, is more prone to water sorption and discoloration.²⁹

In the present study, noticeable discoloration has been observed in all tested composite specimens. The addition of zirconia and ceramics in recent composite materials to improve esthetic and mechanical properties also may contribute to the resistance to discoloration^{15, 25} Farah and Elwi²⁵ stated that N-Ceram is more stable than nanohybrid Z350 resin

composite which is in agreement with our study. Our results were in agreement with observations of previous studies who found that the effect of staining solutions on color change of resin composites is material dependent and has been primarily attributed to the composition of the resin composite,^{8, 29} type of filler particles,²⁵ and filler particle size.^{2, 5, 24} Literature reported that normal saline¹⁶ or distilled water¹⁴ could be used as immersion solution in the control group. In the present study, the specimens were immersed into artificial saliva²⁵ to mimic the oral condition.¹⁵ Yet, the specimens of the control group at previous studies used any one of the previously mentioned solutions showed a little and insignificant color change.^{14, 16, 25} These results were in accordance with our findings.

Regarding staining solutions, both coffee and tea solutions showed visible discoloration of all resin composite specimens, ΔE_3 (Table 3). This is in line with the findings obtained in previous investigations.^{2, 8, 14, 16, 20} Adsorption and absorption can be the cause of tea and coffee discoloration²⁴. Both tea and coffee contained yellow colorants with different polarities, which are released and penetrated to the organic part of the materials.¹⁶ This may be due to the matching of the polymeric materials with the yellow color-causing materials in tea and coffee.²⁵ Higher polarity components (like those in tea) are eluted first, while lower polarity components (like those in coffee) are eluted at a later time.²⁹ In the same context, Poggio et al.,³¹ examined different types of coffee for 28 days and found that all coffee solutions caused a significant color change. According to previous studies, authors suggested that immersion time,^{16, 29} and type of discoloring solution³¹ are dominant factors in staining resin composite. However, long-term contact with some food dyes such as tea and coffee can considerably affect the color stability of modern esthetic restorative materials regardless of materials type and different compositions.^{24, 31}

Concerning the bleaching procedure performed in the present study, the active ingredient of Opalescent 20 home bleach was the 20% carbamide peroxide, which was found to be effective in removing stains from the stained composite specimens. Values of ΔE_4 (Table 4) revealed that the color of stained composite specimens returned near or at the original color, which is in agreement with several studies.^{16, 18, 20, 31} It has been found that after bleaching with 10% and 16% carbamide peroxide, the color of the stained specimens changed to a clinically acceptable color.²⁵ The mechanism of bleaching for the teeth is that the active agents (peroxide solutions) can flow freely through the enamel and dentin, and oxidize the pigments in the teeth². In this *in vitro* study, the bleaching agent was able to remove the stain from the surface of the three resin composite specimens. This was probably due to superficial cleansing of the

specimens, not intrinsic color change,³² because the values of ΔE_4 were near or similar to the original color value. It seemed that the bleaching agents can remove the exterior staining from the specimens but did not bleach them, whereas they can effectively bleach the natural teeth.¹⁸ Therefore, in the clinical practice after bleaching procedures, the composite restoration may not always match the surrounding bleached tooth structure.¹⁶ Further studies using teeth restored with resin composites are needed to gain more insight into the clinical relevance and color match between tooth structure and resin composites after bleaching.

CONCLUSIONS

Under restricted conditions and within the limitations of the present *in vitro* study, the following conclusions may be drawn:

- 1) The three tested resin composites; nanohybrid, microhybrid, and nanoceram showed variable color change when exposed to tea, coffee, and artificial saliva solutions for 3hrs per day for 28 days.
- 2) Tea solution had a more stainability effect on the three tested resin composites than the coffee solution.
- 3) Zenit; nanoceram composite showed the highest color stability (the least affected by staining solutions), and DenFil; microhybrid composite showed the least color stability (the most affected by staining solution).
- 4) Artificial saliva had an insignificant effect on color stability after the same staining period, although it did change the color of the three tested resin composite specimens.
- 5) Opalescence 20 home bleach (bleaching agent) was effective in removing stains from previously stained resin composite specimens and restoring the color to near baseline.

Conflicts of Interest: The authors declare no conflict of interest.

REFERENCES

1. Oliveira D. Esthetics of Dental Composites. Dental Composite Materials for Direct Restorations. J Applied Oral Science 2018;17:155-76.
2. Villalta P, Lu H, Okte Z, Garcia-Godoy F, Powers JM. Effects of staining and bleaching on color change of dental composite resins. J Prosthet Dent 2006;95(2):137-42.
3. Janda R, Roulet JF, Latta M, Steffin G, Ruttermann ST. Color stability of resin-based filling materials after aging when cured with plasma or halogen light. Eur J Oral Sci 2005;7:113-251.
4. Magne P, Woong-Seup S. Optical integration of incisoproximal restorations using the natural layering concept. Quintessence Int 2008;39(8):633-43.

5. Janda R, Roulet JF, Latta M, Kaminsky M, Ruttermann ST. Effect of exponential polymerization on color stability of resin-based filling materials. *Dent Mater J* 2007;23(6):696-704.
6. Kolbeck C, Rosentritt M, Lang R, Handel G. Discoloration of facing and restorative composites by UV-irradiation and staining food. *Dent Mater* 2006;22(1):63-8.
7. Yap AU, Low JS, Ong LF. Effect of food-simulating liquids on surface characteristics of composite and polyacidmodified composite restoratives. *Operative Dentistry* 2000;25:170-76.
8. Mundim FM, Garcia Ld-FR, Pires-de-Souza FP. Effect of staining solutions and repolishing on color stability of direct composites. *J Appl Oral Sci* 2010;18(3):249:54.
9. Barutçigil Ç, Yildiz M. Intrinsic and extrinsic discoloration of dimethacrylate and silorane based composites. *J Dent* 2012:e57-e63.
10. Reis AF, Giannini M, Lovadino JR, Ambrosano GM. Effects of various finishing systems on the surface roughness and staining susceptibility of packable composite resins *Dent Mater* 2003;19:12-18.
11. Omata Y, Uno S, Nakaoki Y, et al. Staining of Hybrid Composites with Coffee, Oolong tea, or Red wine. *Dent Mater J* 2006;25(1):125-31.
12. Vichi A, Ferrari M, Davidson CL. Color and opacity variations in three different resin-based composite products after water aging. *Dent Mater J* 2014;20:530-34.
13. Garoushi S, Lassila L, Hatem M, et al. Influence of staining solutions and whitening procedures on discoloration of hybrid composite resins. *Acta Odontologica Scandinavica* 2013;71(1):144-50.
14. Nasim I, Neelakantan P, Sujeer R, Subbarao CV. Color stability of microfilled, microhybrid and nanocomposite resins - an in vitro study. *J Dent* 2010;38 Suppl 2:e137-42.
15. Telang A, Indiresha H, Narayana K, et al. Effect of Staining and Bleaching on Color stability and Surface Roughness of Three Resin Composites. *Contem Clin Dent* 2018;9(3):452-56.
16. Poggio C, Beltrami R, Scribante A, Colombo M, Chiesa M. Surface discoloration of composite resins: Effects of staining and bleaching *Dent Res J (Isfahan)* 2012;9(5):567-73.
17. Borges A, Caneppele T, Luz M, Pucci C, Torres C. Color stability of resin used for caries infiltration after exposure to different staining solutions. *Oper Dent* 2014;39(4):433-40.
18. Canay S, Cehreli MC. The effect of current bleaching agents on the color of light-polymerized composites in vitro *Journal of Prosthetic Dentistry* 2003;89(5):474-78.
19. Pruthi G, Jain V, Kandpal HC, PrakashMathur V, Shah N. Effect of Bleaching on Color Change and Surface Topography of Composite Restorations. *International Journal of Dentistry* 2010;695748:1-7.
20. Hasani E, Baghban AA, Sheikh-Al-Eslamian SM, Sadr A. Effect of bleaching on color change of composite after immersion in chlorhexidine and coffee. *J Conserv Dent* 2019;22(6) 529-32
21. Brochure for Feltik Z250XT Msi, 3M ESPE 2014, Canada. Nanohybrid.
22. Brochure for Den Fil™ Msi, VIRICOM CO.LTD 2018, USA. Microhybrid.
23. Brochure for ZENIT Msi, president dental 2019, Germany. Nanoceram.
24. Poggio C, Vialba L, Berardengo A, et al. Color Stability of New Esthetic Restorative Materials: A Spectrophotometric Analysis. *J functional biomaterials* 2017;8(3):26.
25. Farah RI, Elwi H. Spectrophotometric Evaluation of Color Changes of Bleach-shade Resin-based Composites after Staining and Bleaching. *J Contemporary Dental Practice* 2014;15(5):587-94.
26. Commission Internationale de l'Eclairage: Recommendations on uniform color space. Color difference equations. Psychometric color terms. Suppl 2 to CIE pub 15 (E-13.1) 1971/ (TC-1.3), Paris, France: Bureau Central de la CIE; 1978.
27. Wyszecki G, Stiles WS. Color Science: Concepts & Methods, Quantitative Data & Formula. 2nd ed. New York: John Wiley; 1982.
28. Van Noort R. Introduction to Dental Materials. 3rd ed. North Carolina, USA: Mosby Inc.; 2007.
29. Malekipour MR, Sharafi A, Kazemi S, Khazaei S, Shirani F. Comparison of color stability of a composite resin in different color media. *Dental Research J (Isfahan)* 2012;9(4):441-46.
30. Malhotra N, Shenoy RP, Acharya S, Shenoy R, Mayya S. Effect of three indigenous food stains on resin-based, microhybrid-, and nanocomposites. *J Esthet Restor Dent* 2011;23(4):250-7.

31. Poggio C, Ceci M, Beltrami R, et al. Color stability of esthetic restorative materials: A spectrophotometric analysis. *Acta Biomater Odontol Scand* 2016;2(1):95-101.
32. Fay RM. Color of restorative materials after staining and bleaching. *Oper Dent* 1999;24(5):292-96.





Original article

Orthodontic Patients' Knowledge and Understanding of Orthodontic Retainers: A cross sectional study

Fatma Fenesha,¹ Sara Elhabony²

¹Assistant lecturer, Department of Orthodontics, Faculty of Dentistry, University of Benghazi.

²General dental practitioner.

ABSTRACT

Objectives: To assess the dental patients' knowledge and understanding of orthodontic retainers, and to evaluate the level of knowledge in relation to different predefined variables such as gender, onset of treatment and education level.

Materials and Methods: This is a cross sectional questionnaire-based study involving patients undergoing active orthodontic treatment. A validated and piloted questionnaire was distributed around five orthodontic clinics in Benghazi city. The paper questionnaire consisted of four sections with 20 questions covering basic demographic data, the knowledge and understanding of orthodontic retainers, and finally the mode of information provision. Descriptive statistics were carried out for frequency and proportions. In addition, the relationship between the variables was analysed using Chi-Square and Fisher exact test. A simple thematic analysis was conducted for the open-ended questions.

Results: The response rate was 95%. A total of 295 questionnaires were self-completed and collected from the five centres. The age range was between 16 - 53 years (mean age 24.3). Around 83.4% of patients were aware that they will require a set of orthodontic retainers at the end of treatment. However, only half of the patients knew what type of retainers they will require (56.9%). Regarding the understanding of retention and relapse, around 71.2% of patients understood why retainers are needed and 60% recognize what will happen if they didn't wear their retainers. However, only 34% of the respondents understand what "orthodontic relapse" means. No association was found between the onset of treatment, age and gender and the patients' level of knowledge and understanding of orthodontic retainers. Nevertheless, the level of education was the only variable shown to be associated with the level of patients' understanding.

Conclusions: The level of knowledge and understanding regarding orthodontic retainers was suboptimal among Libyan orthodontic patients. The reported lack of knowledge could potentially influence the amount of compliance with wearing orthodontic retainers. Postgraduate students and professionals seem to be more attentive to instructions and maintaining their teeth in place.

Key words: Retention, questionnaire, knowledge, orthodontic patients.

Corresponding author:

Fatma Fenesha: Department of Orthodontics,
Faculty of Dentistry, University of Benghazi
E-mail: fatma.fenesha@gmail.com

INTRODUCTION

Retention is an integral part of orthodontic treatment to maintain the teeth in their corrected position following active tooth movement. Relapse is considered one of the challenging risks in orthodontics due to the various causative factors involved in moving the teeth back into their initial position. These include periodontal, gingival, occlusal, soft tissue factors and growth.¹ Relapse is

not only the return of the original features of malocclusion, but also changes that occur as part of the ageing-process, which can be difficult to predict and vary between individuals. For these reasons, the need for lifelong retention has been widely advocated to ensure long-term stability of the treated malocclusion.² Orthodontic retainers have been investigated extensively in the literature and perhaps the best available evidence comes from an updated Cochrane systematic review which concluded there is no evidence to recommend one retainer over the other.³ Whilst there have been many studies investigating the effectiveness of different types of retainers, not much work has been done on the patients' perception of orthodontic retainers.

During the last 10 years there has been a paradigm shift in healthcare from the disease-centred approach to patient-centred approach generating many new concepts such as, evidence-based dentistry, patient reported outcome measures, and shared decision making (SDM).⁴ Patients' values and preferences form a fundamental element of evidence-based dentistry and applying SDM in orthodontics is particularly important for many reasons. First, orthodontic treatment can carry few risks such as, root resorption and demineralization and hence a good discussion with the patient is required to weigh the benefits of treatment against these risks.⁵ Secondly, a patient's perception of aesthetics is different to the orthodontist's perception and in order to meet patients' expectations, it's important to understand their views and opinions regarding their treatment. And finally, there are many treatment modalities in orthodontics and each case can be treated using different techniques and appliances. Therefore, efficient communication and information exchange can help the orthodontist formulate the best suitable treatment plan for the patient and enhance the decision-making process.⁶

The need for orthodontic retainers should be discussed with the patient from the onset of treatment as part of the informed consent process.^{7,8} Orthodontic treatment is a lengthy procedure that can take up to 20 months on average and good compliance is key for achieving a successful treatment outcome.⁹ Studies have shown that patients are more compliant when they are well-informed and engaged in the decision-making process.¹⁰⁻¹² Furthermore, compliance with orthodontic removable retainers can be a challenging task and various methods to enhance patients' compliance has been reported in several studies. Factors such as forgetfulness, negative patients' beliefs, and the lack of understanding of the importance of the retention phase have been documented.¹³ In the light of all this more research is required to assess the patients' perception and awareness regarding orthodontic retainers and the amount of information patients can actually retain during treatment. Thus, the aim of this study is to explore the patients' knowledge and understanding of orthodontic retainers and evaluate its' association to different variables such as gender, education level and onset of treatment.

MATERIAL AND METHODS:

This cross-sectional study was described according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. Ethical approval was obtained from the Dental Ethics Approval Committee at the Faculty of Dentistry - University of Benghazi (reference number 092). All patients' data and information were confidential and

accessed only by the principal investigators. No personal data was collected, and all the data was coded during the statistical analysis. A self-administered paper questionnaire was distributed at the reception area of each clinic to consecutive patients as they walked in. After a brief explanation of the nature of the study and reading the information sheet attached with the questionnaire, the participants were asked to sign the consent form. Instructions were given with the help of a dental assistant to fill the questionnaire independently and anonymously with no time restriction before or after their appointments. The questionnaire was then placed into a sealed envelope and dispensed back into a box at the waiting area by the patients themselves to ensure anonymity. The inclusion criteria included patients speaking Arabic as their first language, aged 16 years or above, receiving orthodontic treatment for the first time and willing to take part in the study. A priori sample size calculation was based on a previous study¹⁴ and the formula of survey sampling by Kish.¹⁵ A minimum sample of 278 was needed with a margin of error set at 5% and a confidence level at 95%. To compensate for an anticipated nonresponse rate of 15%, a total sample of 310 will be required to maximise the response rate. The sample was recruited using a convenient random sampling method.

Development of the questionnaire:

The process of developing the questionnaire involved 7 stages (Table 1) as described by.^{16,17} The questionnaire included four sections; section (1) included items related to the patients' demographic and sociocultural data, section (2) included items on the knowledge of orthodontic retainers, section (3) included questions on the understanding of patients on orthodontic retention and section (4) contained questions on the means of information delivery and communication including 3 pictures of three types of orthodontic retainers. The type of questions included were a mix of open and closed ended questions. Open ended questions would provide a deeper insight into the patients' understanding than yes/no questions.

Table 1: Stages of Questionnaire Development

Stage 1	Defining a research question	
Stage 2	Development of the questionnaire content	• Reviewing the literature to identify questionnaires used in previous studies (14)(18).
Stage 3	Questionnaire formatting	• Item selection by a panel of expert orthodontist (FS, MB, RA) • Questionnaire design
Stage 4	Readability test	• Gunning fog test score (75%)
Stage 5	Translation	• Questionnaire was translated by a professional translator.
Stage 6	Pre-piloting	• Testing the questionnaire on a similar group of lay people to assess face validity. • Making any amendments if required.
Stage 7	Testing and piloting	• Piloting the questionnaire on a similar group of orthodontic patients 2 weeks apart to assess validity, reliability and acceptability.

Questionnaire validation:

The questionnaire layout and questions format were evaluated with a group of orthodontists (expert panel) initially to identify any potential ambiguous questions and make sure the subjects can navigate easily through the questionnaire. Any amendments required were made before pre-piloting the questionnaire on a small group of lay people to make sure the questionnaire was clear and acceptable to the respondents.

In order to test the questionnaire for any potential problems the questionnaire was then piloted on a similar group of patients 2 weeks apart. The two sets of responses were compared using Kappa statistics for categorical data. During this, the validity, reliability and acceptability of the questionnaire was tested.

Statistical analysis:

All statistical analysis was carried out using the Statistical Package for Social Sciences (SPSS), version 20 (SPSS Inc., Chicago, Illinois, USA). The level of statistical significance was set at $p < 0.05$. Descriptive statistics were conducted for the counts and percentages of each question item. Frequencies and proportions were calculated for the basic demographic data. The association between the dependent variables (knowledge and understanding of retention) and independent variables (gender, treatment onset and educational level) was analysed using chi-square and Fisher exact test. A simple thematic analysis was carried out for the open-ended question regarding why orthodontic retention is important.

RESULTS:

The questionnaire response rate was 95%. Out of 310 questionnaires distributed, a total number of 295 were completed and returned back. The lowest kappa score was 0.8 showing good questionnaire reliability. The demographic characteristics of the respondents are presented in table 2. The age range was between 16 - 53 years (mean age 24.3) with 74.6% of the respondents being females and 25.4% males. The majority of the respondents had their appliances fitted for more than 6 months (63.4%) and 36.6% reported they started their orthodontic treatment during the past 6 months. Regarding the level of education; 65.1% of the respondents were university graduates, 31.5% were secondary school students, and only 3.4% were postgraduate students and professionals.

Table 2: Demographic Characteristics of respondents (n=295)

Characteristic	Percentage%	Frequency
Age (years)		
<21	34.5	102
21-30	49.1	145
31-40	14.5	43
>40	1.6	5
Gender		
Female	74.6	220
Male	25.4	75
Onset of treatment		
< 6 months	36.6	108
> 6 months	63.4	187
Education level		
Secondary	31.5	93
Graduate	65.1	192
Postgraduate	3.4	10

Overall, the respondents showed moderate knowledge on orthodontic retainers as 83.4% of patients were aware, they will require a set of retainers at the end of treatment. However, only half of the patients knew what type of retainers they will need (56.9%) and 45% knew how long they are required to wear their retainers for. Similarly, when asked about the number of hours, only 34.9% reported they know how many hours they need to wear their retainers during the day.

Around 71.2% of patients understood why retainers are needed. The most common answers and comments for those who responded "yes" regarding why orthodontic retainers are needed are presented in table 3. Another 60% appreciate what would happen if they stopped wearing their retainers. However, only 39% of the respondents reported they understand the meaning of "orthodontic relapse". Proportions of responses to the knowledge and understanding questions are presented in figure 1 and figure 2.

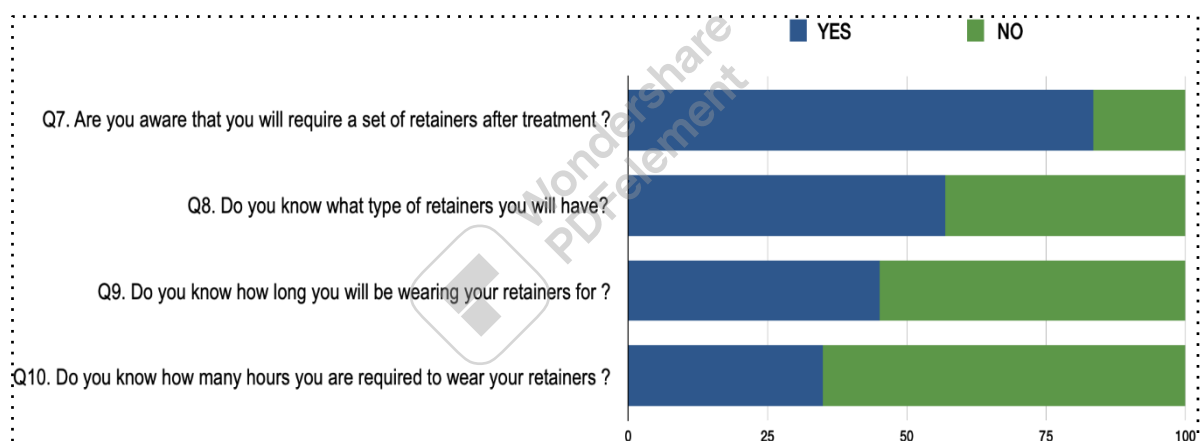
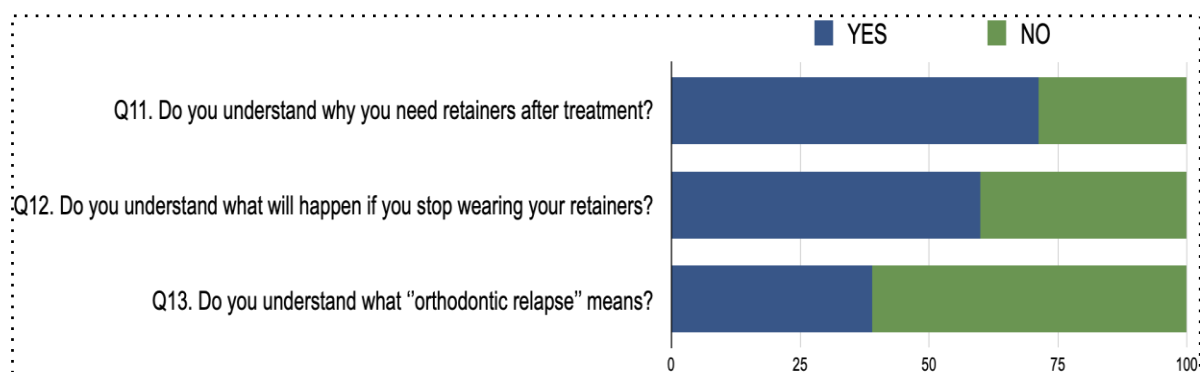
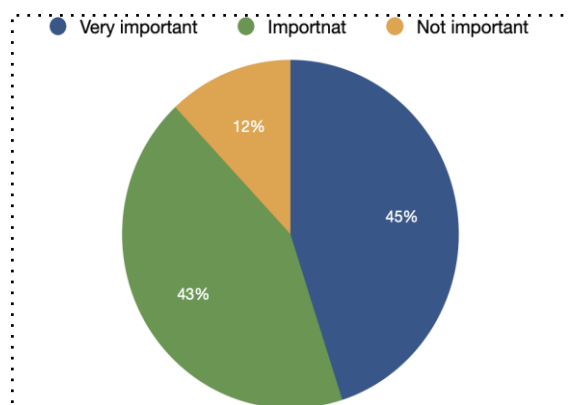
**Figure 1:** Proportion of responses to knowledge-based questions on orthodontic retainers**Figure 2:** Proportion of responses to understanding based questions on orthodontic retainers

Table 3: The effect of gender, onset of treatment and education level on the responses to knowledge-based questions.

Variable	Q 7	Q 8	Q 9	Q10
Gender	0.846 (NS)	0.153 (NS)	0.450 (NS)	0.240 (NS)
Onset of treatment	0.109 (NS)	0.067 (NS)	0.867 (NS)	0.605 (NS)
Education level	0.006 (NS)	0.036 (NS)	0.522 (NS)	0.642 (NS)
Chi-square test. Fisher exact test. P value < 0.05				

Regarding the importance of orthodontic retainers; approximately 90% of patients believed that orthodontic retainers are very important and important collectively, and only a 12% responded that retainers are not important (figure 3). Variables such as the onset of treatment, age and gender didn't seem to influence the patients' level of knowledge of orthodontic retention (Table 3). The level education was the only factor that influenced the understanding of patients on orthodontic retention (Table 4). A statistical difference was found between education and the reason why orthodontic retainers are needed ($P < 0.000$), the consequences of stop wearing retainers after treatment ($P < 0.021$), and the meaning of orthodontic relapse ($P < 0.014$). A simple thematic analysis carried for an open-ended question regarding the reasons for wearing retainers at the end of treatment is presented in table 5.

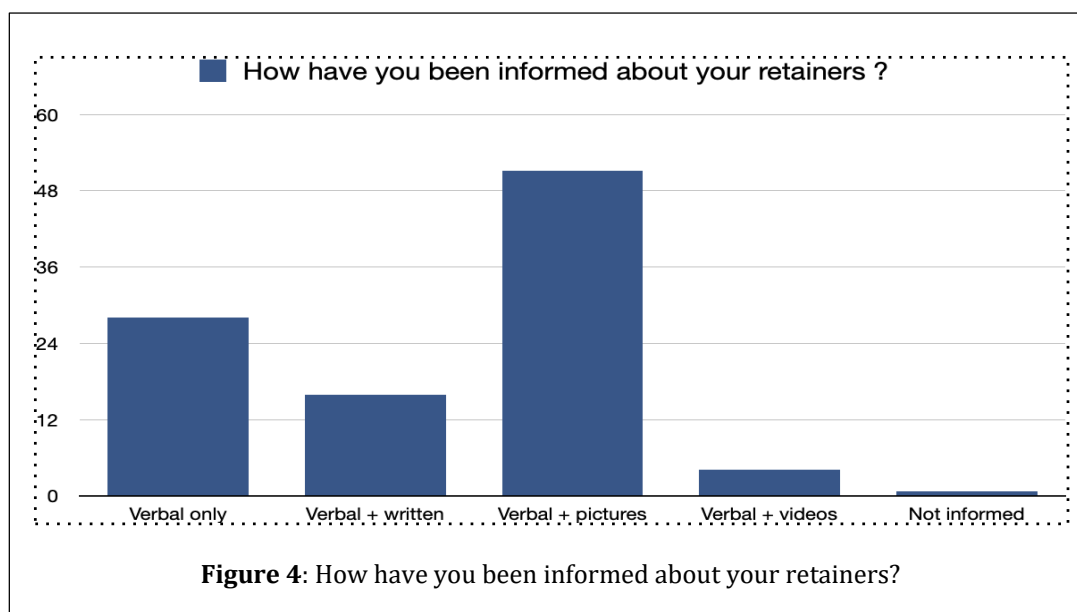
**Figure 3:** How important do you think orthodontic retainers are?**Table 4:** The effect of gender, onset of treatment and education level on the responses to understanding based questions.

Variable	Q 11	Q 12	Q 13
Gender	0.908 (NS)	0.029 (NS)	0.087 (NS)
Onset of treatment	0.193 (NS)	0.152 (NS)	0.980 (NS)
Education level	0.000 (SS)	0.021 (SS)	0.014 (SS)
Chi-square test. Fisher exact test. P value < 0.05			

Table 5: Simple themes identified from the responses to the questions:

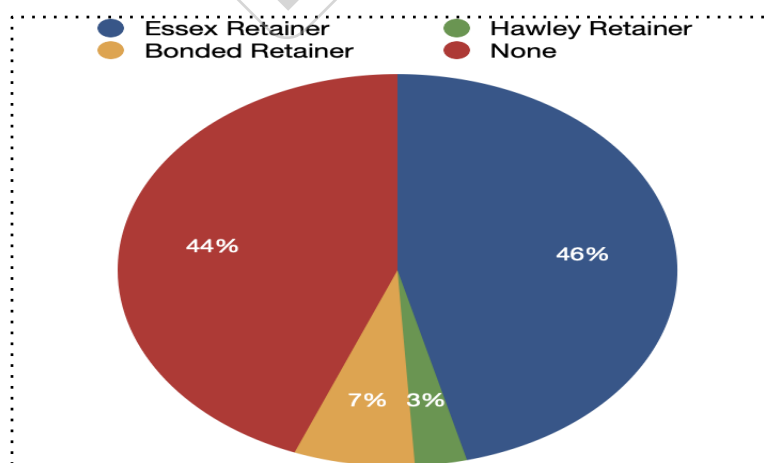
Do you understand why you need orthodontic retainers at the end of treatment?

Theme	Patients' comments
Success of treatment	"Maintaining the teeth in place will help achieve a successful outcome" "Because wearing retainers is part of the success of my brace treatment"
Teeth stability	"To prevent teeth from moving" "Because teeth can go back" "So my teeth will stay stable" "Retainers will guarantee stability" "Because I don't want my teeth to move" "To prevent relapse"
Healthy dentition	"To keep my teeth healthy" "It will maintain the shape and health of my teeth"



The majority of the patients reported that they were informed about retainers at the start of treatment (72.2%) and only 27.8% were informed about retainers during treatment. Regarding the mean of receiving information on retainers (figure 4), just over half (51.9%) of them were informed about retainers verbally and shown pictures, 28.1% reported they were informed verbally only, and 15.9% were informed verbally and written. Only 4.1% reported that they were informed using videos in addition to verbal instructions. When asked if the

patients have seen any pictures of retainers; 46% were shown pictures of Essex retainers, 7% were shown pictures of bonded retainers and only 3% were shown pictures of a Hawley retainer. No visual aids on retainers were provided to 44% of the patients suggesting they have received verbal instructions and/or written information (figure 5).



DISCUSSION:

A Questionnaire is a very useful tool to investigate patients' perspectives on different treatment approaches and appliances. As there is an increased demand to engage patients in the treatment planning and shared decision-making process, it is important to investigate their level of knowledge and understanding regarding certain appliances such as orthodontic retainers. Whereas, several studies have explored the attitudes of patients and parents towards many orthodontic appliances, not much work has been done on the perspectives of patients on orthodontic retainers. To the best of our knowledge, this is the first study to investigate the knowledge and understanding of Arab patients regarding orthodontic retainers.

Knowledge of orthodontic retainers:

In general, the majority of patients recognize that they will need a set of retainers at the end of treatment. However, reporting details such as, retainer type, length of retention and number of hours revealed suboptimal knowledge. Furthermore, characteristics such as gender, timing of treatment, and level of education had no influence on their level of knowledge. One would expect females to be more meticulous regarding their teeth as women are more demanding of aesthetics than men.^{19,20} In our study, there was no statistical difference in terms of gender. In addition, no significant difference was found between patients whose appliances were fitted less or more than 6 months. On this basis, regardless of the timing of starting treatment and presumably discussing the need for retention as part of the informed consent process, the knowledge of patients regarding retainers did not reduce over time. This in turn supports the current orthodontic practice of discussing retainers at the start of treatment and again towards debond. Similarly, there was no statistical difference in terms of knowledge between the three educational groups.

Understanding of orthodontic retainers:

As far as the patients' understanding goes, a large proportion of the respondents appreciate why retainers are needed. However, as their understanding was investigated further, our results showed there is a great lack of understanding regarding orthodontic retainers. More than a half recognize what will happen if they abandon wearing their retainers, however only 39% of the respondents understand what "orthodontic relapse" means. Again, gender and treatment timing were insignificant factors when it comes to the level of understanding. Nevertheless, the influence of education level on the understanding of orthodontic retainer was statistically significant. University graduates and professionals showed a much deeper

understanding of the importance of retention. These findings are in agreement with previous studies where highly educated patients are more willing to maintain and invest in dental care. This potentially reflects lack of understanding among the younger groups and less educated respondents and it can be postulated that informing patients on retention should be delivered and customised according to the level of each patients' education. It also suggests that adult patients and working professionals pay more attention during treatment discussions and signing the consent as they are paying for the treatment themselves. In contrast, younger patients and secondary school students are unlikely to be paying for the treatment so they show less appreciation towards understanding what their treatment involves.

When asked about the importance of retention and retainers, the majority believed that retainers are very important or important, (45%) and (43%) respectively. Only 12% of the patients reported that wearing orthodontic retainers is not important. This agrees with previous studies investigating adherence and compliance with retainer wear. Around one third of the patients responded they are aware they will require both types of retainers (removable and fixed), however, only half of them understand why. This signifies that patients do acknowledge the importance of wearing retainers yet fail to express the reason why retainers are important. This could be attributed to the method of explaining retention and means of information provision.

Communication and information provision:

In order to reliably assess the level of knowledge and understanding of patients, it is important to assess how and what information has been provided to the patients. The majority of the respondents were informed about retainers at the start of treatment (72.2%) and nearly one third were informed during treatment (27.8%). When asked about the means of receiving information about retainers; only half of the patients reported they were informed verbally and shown pictures or videos of retainers. The majority were shown pictures of Essex (73%) or bonded retainers (40%). Previous studies on retainer compliance have found that using pictures in addition to verbal instructions increased the amount of wear and compliance with removable retainers.²¹ Moreover, in terms of patient preference, studies have shown that orthodontic patients prefer visual aids rather than verbal instruction alone to improve their understanding of orthodontic retainers.¹³ On this basis, it should be recognized that using visual aids to explain the importance of retention could have improved the understanding of patients on the importance of retention.

Limitations of the study:

This study had some limitations: 1. The respondents were all recruited from private practices in the city of Benghazi. Due to certain COVID restrictions at the time of the study, it was not possible to include orthodontic patients from public centres. As a result, the findings of this study cannot be generalised to the entire orthodontic population and can only be interpreted within the context of private practice. 2. The knowledge of patients regarding orthodontic retainers before starting treatment was not assessed. This would have allowed the authors to evaluate whether previous background information from friends, family, internet and social media had an influence on the patient's current knowledge and understanding of retention. 3. The questionnaire did not ask the respondents about their preferred method of receiving instructions and information on retention. This information would have been useful to help reform practice policies and guidelines on retention.

CONCLUSIONS AND RECOMMENDATION:

This study has provided valuable insight on the knowledge and understanding of orthodontic retainers among Libyan patients undergoing orthodontic treatment. There is a clear lack of understanding regarding the importance of retention, suggesting improving the means we deliver information to our patients. Furthermore, taking the educational and professional level of patients into consideration and customising the way information is disseminated to patients would help improve their understanding of treatment and hence their compliance with wearing their retainers.

Conflict of interest:

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

Financial support:

None.

REFERENCES:

- Melrose C, Millett DT. Toward a perspective on orthodontic retention? *Am J Orthod Dentofacial Orthop.* 1998;113(5).
- Little RM, Riedel RA, Artun J. An evaluation of changes in mandibular anterior alignment from 10 to 20 years postretention. *Am J Orthod Dentofac Orthop.* 1988;93(5).
- Littlewood SJ, Millett DT, Doubleday B, Bearn DR, Worthington H V. Retention procedures for stabilising tooth position after treatment with orthodontic braces. Vol. 2016, *Cochrane Database of Systematic Reviews.* 2016.
- Hua, F. (2019). Increasing the value of orthodontic research through the use of dental patient-reported outcomes. *J Evid Based Dent Pract* 2019.19(2), 99-105.
- Ellis, P. E., & Benson, P. E. (2002). Potential hazards of orthodontic treatment-what your patient should know. *Dental update*, 29(10), 492-496
- Friedlander, A. H., Rosenbluth, S. C., Freymiller, E. G., & Braddock, C. H. (2015). When clinical evidence is conflicted, who decides how to proceed?: An opportunity for shared decision making. *J Am Dent Assoc* 2015, 146(10), 713-714..
- Taft RM, David PR, Jugan MJ. Use of a thermoplastic retainer as an interim prosthesis for implant therapy: a case report. *Hawaii Dent J.* 2002;33(6).
- Perry J, Popat H, Johnson I, Farnell D, Morgan MZ. Professional consensus on orthodontic risks: What orthodontists should tell their patients. *Am J Orthod Dentofac Orthop.* 2021;159(1).
- Tsichlaki A, Chin SY, Pandis N, Fleming PS. How long does treatment with fixed orthodontic appliances last? A systematic review. *Am J Orthod Dentofac Orthop.* 2016 Mar 1;149(3):308-18.
- Lefer L, Pleasure MA, Rosenthal L. A psychiatric approach to the denture patient. *J Psychosom Res.* 1962;6(3).
- Nanda RS, Kierl MJ. Prediction of cooperation in orthodontic treatment. *Am J Orthod Dentofac Orthop.* 1992;102(1).
- Thomson AM, Cunningham SJ, Hunt NP. A comparison of information retention at an initial orthodontic consultation. *Eur J Orthod.* 2001;23(2).
- Al-Moghrabi D, Colonio Salazar FB, Johal A, Fleming PS. Factors influencing adherence to vacuum-formed retainer wear: A qualitative study. *J Orthod.* 2019;46(3).
- Mollov ND, Lindauer SJ, Best AM, Shroff B, Tufekci E. Patient attitudes toward retention and perceptions of treatment success. *Angle Orthod.* 2010;80(4).
- Survey Sampling. By Leslie Kish. (New York: John Wiley & Sons, Inc., 1965. Pp. xvi, 643. \$10.95.). *Am Polit Sci Rev.* 1965;59(4).
- Rattray J, Jones MC. Essential elements of questionnaire design and development. *J Clin Nurs.* 2007 Feb;16(2):234-43.
- Tsang S, Royse CF, Terkawi AS. Guidelines for developing, translating, and validating a questionnaire in perioperative and pain medicine. *Saudi J Anaesth.* 2017 May;11(Suppl 1):S80.

18. Lasance SJ, Papageorgiou SN, Eliades T, Patcas R. Post-orthodontic retention: How much do people deciding on a future orthodontic treatment know and what do they expect? A questionnaire-based survey. *Eur J Orthod.* 2020;42(1).
19. Mamai-Homata E, Koletsi-Kounari H, Margaritis V. Gender differences in oral health status and behavior of Greek dental students: A meta-analysis of 1981, 2000, and 2010 data. *J Int Soc Prev Community Dent.* 2016;6(1).
20. Ellakany P, Fouda SM, Alghamdi M, Bakhurji E. Factors affecting dental self-confidence and satisfaction with dental appearance among adolescents in Saudi Arabia: a cross sectional study. *BMC Oral Health.* 2021;21(1).
21. Lin F, Sun H, Ni Z, Zheng M, Yao L. A feasible method to improve adherence of Hawley retainer in adolescent orthodontic patients: A randomized controlled trial. *Patient Prefer Adherence.* 2015;9:1525.





Original article

Prevalence of Developmental Dental Anomalies in A Sample of Adult Libyan Patients: Orthopantomographic Study

Magdi Hamad¹, Khaled Salem², Maraai Said³.

¹Oral Medicine Specialist, Department of Oral Medicine, Benghazi Medical center, Benghazi, Libya.

²Associate professor, Department of oral and Maxillofacial Surgery, Faculty of Dentistry, University of Benghazi, Benghazi, Libya.

³Assistant professor, Department of Orthodontics, Faculty of Dentistry, University of Sebha, Sebha, Libya.

ABSTRACT

Objectives: This research was aimed to investigate the prevalence of dental anomalies among a selected adult Libyan sample using panoramic radiographs.

Materials and Methods: Retrospective study of digital panoramic radiographs of (412) Libyan adult patients of both sexes (males and females). The data was collected from different Clinics in Benghazi district over six months period of time. The radiographs were studied on a computer screen to find out the developmental dental anomalies. Descriptive statistics and bivariate analysis by age and gender were conducted using SPSS software.

Results: A total of 412 panorama radiographs were used in the data analysis. The majority were females (273, 66%), aged between 18 and 70 years old. The most common type of dental anomalies was dilaceration (130, 31.6%), followed by impaction of wisdom teeth (66, 16%) and impaction of other teeth (23, 5.6%). A few cases of other anomalies were reported; these included one case of odontome, ectopic eruption of left upper 8 and one mesiodens.

Conclusions: Dilaceration and impaction were the most common types of developmental dental anomalies among study population, with rare cases of supernumerary teeth and odontome. Multiple anomalies are common in the present study, suggestion genetic origin. The study showed that the prevalence of dental anomalies increases with the age of participants.

Keywords: Dental anomalies, orthopantomograph, adults, Libya.

Corresponding author:

Magdi Hamad: Oral Medicine Specialist,
Department of Oral Medicine, Benghazi Medical
center, Libya.
E-mail: magdydent2015@gmail.com

INTRODUCTION

Developmental dental anomalies are marked deviations from the normal presentation of the primary or permanent dentition. Local, as well as systemic factors, may be responsible for these disturbances. Dental anomalies consist of a wide range of conditions, including changes in the number, morphology, eruption, and size of teeth.¹ The developmental anomalies of teeth are caused during tooth development, whereas the acquired anomalies are caused after tooth development.² Anomalies of tooth structure (enamel and dentin defects) can be symptoms of syndromes.³ Some dental disorders and developmental defects of enamel may lead to a number of problems such as increased sensitivity and

esthetic problems, while severe tooth decay can be prevented by the timely detection of problems and appropriate intervention.⁴ Some other dental anomalies, such as impaction, play an effective role in the etiology of different types of malocclusions.⁵ Anomalies affect the occlusion and length of the jaw arch and their identification, particularly in the anterior region in young adults, and hence, are extremely important in the esthetic and orthodontic treatment plan.⁶

Several studies have addressed the prevalence of dental anomalies; however, the results of these studies were inconsistent between and within populations. These differences are a reflection of variations in race, sampling methods, and different diagnostic criteria.⁷ Therefore, researching the

prevalence of these countries at local and country level is important to provide data for policy makers and dental educators and to help in planning interventions and health care strategies to tackle these problems. Dental anomalies' incidence and distribution in different populations can provide important information for genetic studies, which help to understand variations within and between the different populations, and has an important contribution to the multidisciplinary clinical team approach to treatment.⁸ Early diagnosis allows optimal patient management and treatment planning and can reduce complications and the amount and complexity of the planned treatment. So, the aim of this study was to investigate prevalence of dental anomalies among a selected adult Libyan sample using panoramic radiographs.

MATERIALS AND METHODS

A cross-sectional study design was used to analyze radiographic data that was collected retrospectively as part of routine dental care. This design was adopted to avoid unnecessary exposure to radiations. Although random sample from the population is usually recommended to study the distribution of oral health conditions, this was not possible in our study due to ethical reasons. A convenience sample of panoramic radiographs, taken in the last six months for Libyan adult patients of both sexes (males and females), was collected from different Clinics in the city of Benghazi. Two major clinics were identified and provided consent to use their data. A total of 412 panoramic radiographs were retrieved for analysis which have at least information on patients; age and gender and meet following inclusion and exclusion criteria:

Inclusion criteria:

- Libyan dental patients
- Aged 18 years of age or older
- Good quality radiograph

Exclusion criteria

- Unclear panoramic view
- patients known for hereditary syndromes associated with dental anomalies
- Trauma or fracture of the jaw which may affect the normal growth
- History of orthodontic treatment

The radiographs were panoramic views taken as PlaneMeca EC Pro one (Helsinki, Finland) with the maximum KVP of 70, mA=12 and exposure time Sec=18. The radiographs were used in the digital form after being uploaded on computer device DELL 15inch windows10 Pantum5&500 Gp, as JPEG&PNJ pictures with maximum resolution, opened with Windows photo viewer.

Each image was scored subjectively with a 4-point ordinal grading scale covering three major aspects which consisted of anatomical coverage, density and

image contrast and also anatomical structures. The anatomical structures on panoramic image were divided into 6 anatomical zones namely: dentition (zone 1), nasal and sinus (zone 2), mandibular body (zone 3), temporal-mandibular joint (zone 4), ramus-spine (zone 5) and hyoid bone (zone 6). The average score was then calculated from those 6 anatomical zones, anatomical coverage, image density and contrast so as to represent the diagnostic quality of each panoramic image. The lower score (score of 1 or 2) indicating poorer image quality and excluded from the study.⁹

The radiographs were assessed for the presence of developmental dental anomalies which include disorders of shape, number, structure and position. The developmental anomalies are summaries in Table 1. The interpretation of the radiographs was performed by one observer and reviewed by the other observer in a separate setting. The two observers conducted agreement training before starting the interpretation of the radiographs. This included interpreting 10 radiographs with different anomalies and conflicts in the agreement were solved by discussion. Over 90% agreement was reached before commencing radiographs interpretation.

Table 1: Categories of dental anomalies assess in the present study

Numbering	• Supernumerary: mesiodens, paramolar and distomolar. • Hypodontia lateral incisors, canines, premolars. excluding third molars
Shape and size	• Microdontia • Macrodontia • Fusion • Gemenation • Dilacerations • dens in dent • Taurodontism
Impaction	• Third molars • Others

The interpretation data and available demographic data for dental patients were uploaded on excel sheet and coded as numbers. The dental anomalies for each type were coded as present or absent. If more than one anomaly of same type were present in one patient, they coded more than one. Each anomaly was coded separately. The data was then imported into SPSS statistical package (version 25). Descriptive statistical analysis was conducted to describe the demographic characteristics of study participants and the proportions of dental anomalies. The mean age of dental patients was compared among

anomalies and anomaly free subgroups using independent samples t test. The distribution of anomalies by gender was conducted using Chi-square test. The level of significance will be set at $p=0.05$.

RESULTS

A total of 412 panoramic radiographs were used in the data analysis. The majority were females (273, 66%), aged between 18 and 70 years with an average age of 37.45 ± 11.73 years.

Figure 1 shows the distribution of dental anomalies. The most common type of dental anomalies was dilaceration (130, 31.6%), followed by impaction of wisdom teeth (66, 16%) and impaction of other teeth (23, 5.6%). A few cases of other anomalies were reported; These included one case of odontome, ectopic eruption, and mesiodens.

The proportion of impacted teeth is presented in figure 1. Overall impaction was observed in 21.6% of

radiographs. Impaction of one tooth was the most common form of impaction, followed by 2 teeth, 3 teeth and four teeth.

Figure 3 shows the distribution of impacted third molars by side. The impaction was more in lower than upper teeth (11.6% and 7.7%, respectively). Single impaction was higher than 2-sided impaction in both maxilla and mandible.

Figure 4 describes the distribution of impacted wisdom teeth according to location. The most commonly seen impaction in wisdom teeth was observed in lower right side (8.5%), followed by lower left side (7.3%). The least impacted tooth was upper right eight (4.6%).

Figure 5 shows the distribution of dilacerated teeth. Dilaceration was seen in nearly one third of radiographs assessed (31.6%). The single tooth dilaceration was less common than multiple teeth dilaceration.

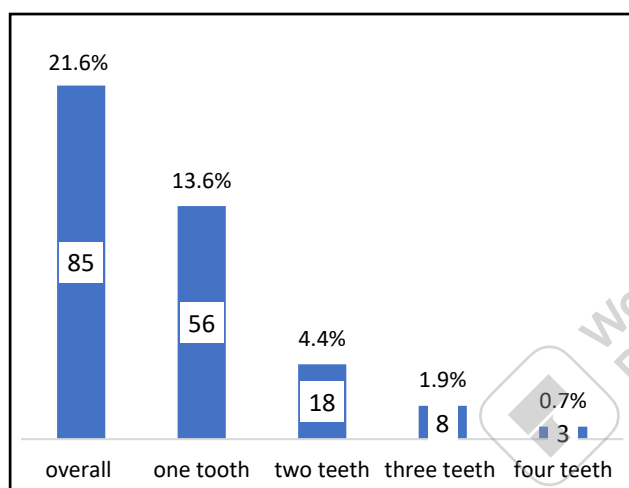


Figure 1: Distribution of dental anomalies according to type.

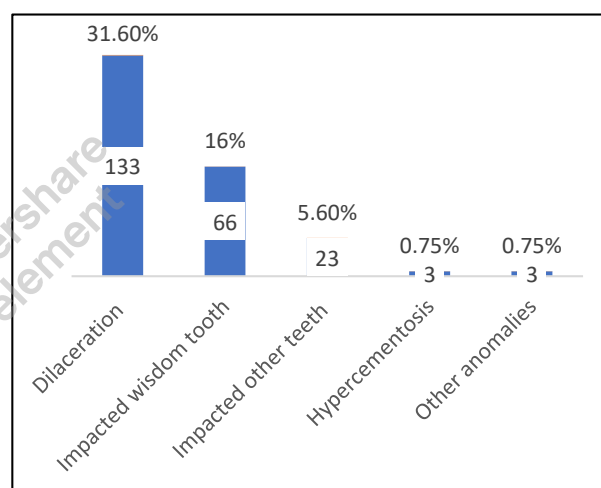


Figure 2: Frequency of impacted teeth according to their number

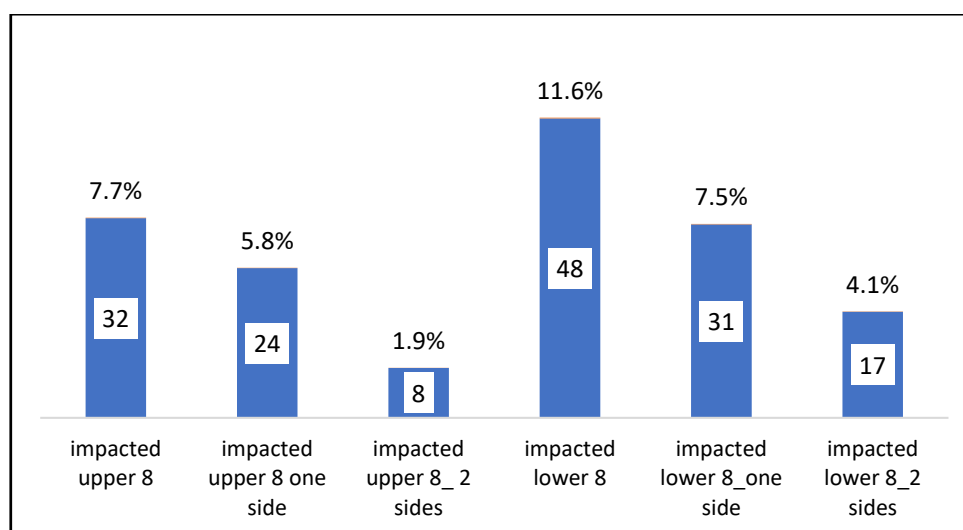


Figure 3: Distribution of impacted third molars by side

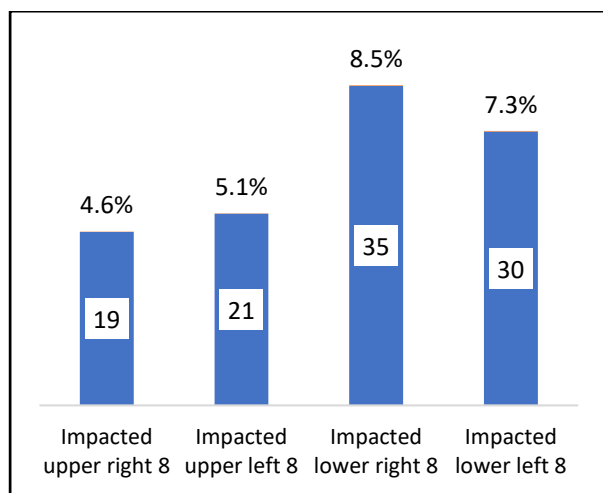


Figure 4: Distribution of impacted third molars according to location

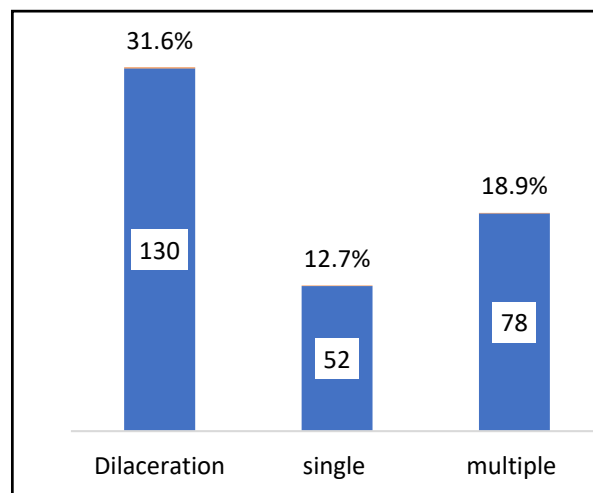


Figure 5: Distribution of dilacerated teeth

Comparisons of anomalies by characteristics of the study sample are summarized in Table 1 and 2. No statistically significant differences were found when the proportion of anomalies were compared by gender. However, statistically significant differences were found when the age was compared among those who have anomalies and those who did not.

Table 1: comparison of impaction and dilaceration by age

Variable		Mean $\pm$ SD	P value
Dilaceration	Present	33.94 $\pm$ 10.84	0.000***
	Absent	39.67 $\pm$ 11.63	
Impaction of wisdoms	Present	32.76 $\pm$ 11.22	0.003**
	Absent	38.24 $\pm$ 11.65	

Independent sample t test was used to compare subgroups

Table 2: comparison of impaction and dilaceration by gender

Variable		N (%)	P value
Dilaceration	Male	24 (17.3)	0.124
	Female	42 (15.4)	
Impaction of wisdoms	Male	37 (26.6)	0.624
	Female	93 (34.1)	

Chi square test was used to compare subgroup

DISCUSSION

The present study analyzed panoramic radiographs of adults Libyan dental patients who were outpatients of several dental clinics in the city of Benghazi, in order to describe the prevalence and the pattern of associations of different dental anomalies. Detailed study of these anomalies seems essential as they can lead to malocclusion, cosmetic deformities, and problems during tooth extraction or root canal treatment. In order to diagnose these anomalies, in addition to clinical observations and examinations, paraclinical investigations such as radiography are essential and play an important role in the differential diagnoses of these anomalies (White and Pharoah, 2004).

The analysis 412 panoramic radiographs of dental patients aged between 18 and 70 years, showed that 45 % had dental anomalies and the majority of them had multiple anomalies. This figure is relatively higher than that previously in Turkish population (39%),¹⁰ New Zealand (21%), and Iranian young population (29%)¹¹ and 40 %, ¹² but lower than that previously reported in India (73%).¹³ The present study confirms the notion that the prevalence of dental anomalies was inconsistent between and within populations, which is attributed in race, genetic and methodological factors.^{12,14} For example, some studies the types of dental anomalies assessed. However, no restrictions were applied on the type of dental anomalies included in the current study.

Dilaceration was the most common type of dental anomalies in the study sample, followed by impaction of wisdom teeth and hypodontia. Similar findings were reported in previous studies in Iran.¹² On contrary, other studies found different results, for example, impaction was the most common type of dental anomalies in an Iranian study.¹¹ However, comparison of such type of studies should be approached with caution because of variations in age groups and methodology. For instance, in a study that screened 500 digital panoramic radiographs in Rome, displaced canine and hypodontia were the most common type of developmental anomalies.¹⁵ However, the subjects were from young age group (8-12 years of age).

Interestingly, the prevalence of dilaceration in the current study is relatively high (31.65). which is way higher than that reported in other countries such as in Turkey (9.5%)¹⁶ in Nigeria (3%),^{17,18} in Jordan (3.8%) in Yazd (15%)¹². The difference in diagnostic criteria might be the cause of this dissimilarity. In the present study the tooth is considered to have dilaceration if it has angulation above 20 degree. Alternately, a study that included dilaceration at the angle of 90 degree or more, the dilaceration was reported in 7% of patients.¹⁹ Although it is difficult to explain the relatively high rate of dilaceration in the current study, it is possible that recurrent infections in the primary dentition has resulted in injuries of

permanent tooth bud.²⁰ This explanation is supported by the findings of several studies conducted in Libyan children and adults that indicated high caries rates with no treatment or extraction as common encounters.^{21,22}

The second most common developmental anomaly in the present study was the impacted teeth. Third molars which was reported in 16% of patients. This finding is low compared to studies conducted in other countries such as Yemen ,Turkey and Iran were above 40% of adults had at least one impacted third molar tooth.^{10,11,23} However, lower prevalence of impaction has been reported in several countries.¹² In fact, extraction of impacted teeth is one of the prominent causes of tooth extraction in Libyan adult population.²¹ Therefore, the findings reported in the present study can be an underestimation of the actual impaction prevalence since many patients might remove the impacted teeth surgically, especially older individuals. In addition, the assessment does not include examination to identify impacted teeth and hence many partially impacted teeth may be unrecorded.

Impaction in teeth other than wisdoms was observed in 5.6% of patients. This is comparable to what is reported in studies which suggested that the prevalence of canine impaction ranges between 0.8 and 8.8% among different populations.^{7,24,25} This dissimilarity in results in different countries is not surprising given that the prevalence of dental anomalies varied widely globally. However, this finding should be approached with caution given that the analysis is based solely on radiographic assessment with no medical records were available. Nevertheless, the present study enrolled older dental patients which minimizes the bias of miss-diagnosis usually occur in younger patients.²⁶ Above all, missing teeth to congenital or other reasons can effect quality of life and social well-being of individuals by compromising the aesthetic, function, and places additional financial burden.²⁷

In the present study the majority of patients with dental anomalies had two or more co-existing anomalies. This finding is highly suggestive of genetic origin and hereditary aspects of these anomalies. In addition, while no gender differences were observed, the prevalence of impaction and dilaceration increased with age. It is unclear why, however, it could be the case that these the panoramic radiograph is usually taken to older patients to diagnose periodontitis and hence these asymptomatic anomalies are common among older patients who comprised the majority of participants. The data used in this study is for adult patients who received dental care at some point and whose treatment necessitates the radiographic investigation. Therefore, the findings of the present study cannot be extrapolated to general population.

In the present study a few cases of supernumerary teeth and odontome were observed. This is suggesting that supernumerary teeth are relatively rare among Libyan adult. A review of literature indicates that incidence rate of supernumerary teeth ranged between 1.5% and 3.5%.²⁸

The study findings were tempered by some limitations which should be discussed here. First, the study used retrospectively collected radiographs with limited additional information such as medical history, dental history, and chief complain. Second, no clinical examination was undertaken at the time of the study which affected the diagnosis of anomalies. Therefore, future prospective studies that included both radiographic and clinical examination should be considered. Another area to investigate the role of dental education in preparing dental work force to meet the diagnostic and treatments needs of patients bearing dental anomalies. Previous studies suggested that dental curricula in Libyan dental schools do not adequately prepare dentists to provide preventive dental services.^{29,30}

The present study used a retrospective analysis of panoramic radiographs of adults Libyan dental patients. It demonstrated that developmental anomalies among Libya adults participated in the study are relatively common affecting 45% of cases and the majority of them had multiple anomalies. The most common types of anomalies were dilaceration and impaction, mainly third molars. Rare cases of supernumerary teeth were reported. The study showed that the prevalence of dental anomalies increases with the age of participants.

REFERENCES

1. Neville, B.W., et al., Oral and maxillofacial pathology. 2015: Elsevier Health Sciences.
2. White, S.C. and M.J. Pharoah, Oral radiology-E-Book: Principles and interpretation. 2014: Elsevier Health Sciences.
3. Jukić J, Škrinjarčić I, Glavina D, Ulovec Z. The prevalence of oral and dental anomalies in children with developmental disturbances. *Acta Stomatol Croat.* 2002; 36:79–83
4. Harris EF, Clark LL. Hypodontia: an epidemiologic study of American black and white people. *Am J Orthod Dentofacial Orthop.* 2008; 134:761–7.
5. Afify AR, Zawawi KH. The prevalence of dental anomalies in the Western region of Saudi Arabia. *ISRN dentistry.* 2012;2012:837270.
6. Kositbowornchai S. Prevalence and distribution of dental anomalies in pretreatment orthodontic Thai patients. *Khon Kaen Univ Dent J.* 2010; 13:92–100.
7. Fardi, A., et al., Incidence of impacted and supernumerary teeth-a radiographic study in a North Greek population. *Med Oral Patol Oral Cir Bucal.* 2011. 16(1): p. e56-61.
8. Brook, A.H., et al., The dentition: the outcomes of morphogenesis leading to variations of tooth number, size and shape. *Aust Dent J.* 2014 Jun;59 Suppl 1:131-42.
9. Sabarudin, A. and Y.J. Tiau, Image quality assessment in panoramic dental radiography: a comparative study between conventional and digital systems. *Quant Imaging Med Surg.* 2013 Feb;3(1):43-8.
10. Bilge, N.H., et al., Investigation of prevalence of dental anomalies by using digital panoramic radiographs. *Folia Morphol (Warsz).* 2018;77(2): 323-328.
11. Shokri, A., et al., Prevalence of dental anomalies among 7- to 35-year-old people in Hamadan, Iran in 2012-2013 as observed using panoramic radiographs. *Imaging Sci Dent.* 2014; 44(1): 7-13.
12. Ezoddini, A.F., M.H. Sheikhha, and H. Ahmadi, Prevalence of dental developmental anomalies: a radiographic study. *Community Dent Health.* 2007; 24(3): 140-4.
13. Guttal KS, N.V., Bhargava P, Bathi RJ. , Frequency of developmental dental anomalies in the Indian population. *Eur J Dent.* 2010; 4(3): 263–9.
14. Al-Abdallah, M., et al., Prevalence and distribution of dental anomalies: a comparison between maxillary and mandibular tooth agenesis. *Am J Orthod Dentofacial Orthop.* 2015;148(5):793-8.
15. Bruce, C., et al., A radiographic survey of dental anomalies in Black pediatric patients. *Nda j.* 1994. 45(1): 6-13
16. Miloglu, O., et al., The prevalence of root dilacerations in a Turkish population. 2010. *Med Oral Patol Oral Cir Bucal.* 2010 May 1;15(3):e441-4.
17. Udoeye, C.I. and H. Jafarzadeh, Dilaceration among Nigerians: prevalence, distribution, and its relationship with trauma. *Dent Traumatol.* 2009; 25(4): 439-41.
18. Hamasha, A., T. Al-Khateeb, and A.J.I.e.j. Darwazeh, Prevalence of dilaceration in Jordanian adults. *Int Endod J.* 2002. 35(11): 910-2.
19. Nabavizadeh, M., et al., Prevalence of root dilaceration in adult patients referred to Shiraz dental school (2005-2010). *J Dent (Shiraz).* 2013. 14(4):160-4.
20. Walia, P.S., et al., Review of Dilaceration of Maxillary Central Incisor: A Multidisciplinary Challenge. *Int J Clin Pediatr Dent.* Jan-Mar 2016;9(1):90-8.
21. Byahatti, S.M. and M.S. Ingafou, Reasons for extraction in a group of Libyan patients. *Int Dent J.* 2011; 61(4): 199-203.
22. Arheiam, A.A., R.V. Harris, and S.R. Baker, Changes in dental caries and sugar intake before and during the conflict in Libya: A natural experiment. *Comm dent oral epidemiol.* 2020; 48(3): 201-7.

23. Alhadi, Y., et al., Prevalence and pattern of third molar impaction in sample of Yemeni adults. On J Dent Oral Health. 2019;1(5):1-4.
24. Aydin, U., H. Yilmaz, and D.J.D.R. Yildirim, Incidence of canine impaction and transmigration in a patient population. Dentomaxillofac Radiol. 2004 May;33(3):164-9.
25. Aktan, A.M., et al., The incidence of canine transmigration and tooth impaction in a Turkish subpopulation. Eur J Orthod, 2010; 32(5): 575-81.
26. Rakhshan, V., Meta-Analysis of Observational Studies on the Most Commonly Missing Permanent Dentition (Excluding the Third Molars) in Non-Syndromic Dental Patients or Randomly-Selected Subjects, and the Factors Affecting the Observed Rates. J Clin Pediatr Dent, 2015; 39(3):199-207.
27. A. H. Al-Ani, Genetic and environmental factors associated with hypodontia [Thesis, Doctor of Clinical Dentistry], University of Otago, Dunedin, New Zealand, 2016, <http://hdl.handle.net/10523/6866>
28. Ata-Ali, F., et al., Prevalence, etiology, diagnosis, treatment and complications of supernumerary teeth. J Clin Exp Dent. 2014 Oct 1;6(4):e414-8..
29. Arheiam, A. and E. Bernabé, Attitudes and practices regarding preventive dentistry among Libyan dentists. Community dent health, 2015; 32(3): 174-9.
30. Arheiam, A., I. Bankia, and M. Ingafou, Perceived competency towards preventive dentistry among dental graduates: the need for curriculum change. Libyan J Med, 2015; 10(1): p. 26666.





Original article

Ameloblastoma: A Clinical and Histopathological Study of 28 Cases Diagnosed in Benghazi

Marwa Elfergani ¹, Mansora Abd Alhamid Hamad², Rehab El Maddani ³, Huda AL Jilali ⁴ and Ali Elmurtadi ⁵

¹Demonstrator, Department of Oral Medicine, Oral Pathology, Oral Diagnosis and Radiology, Faculty of Dentistry, University of Benghazi, Benghazi, Libya.

²Lecturer, Department of Oral Medicine, Oral Pathology, Oral Diagnosis and Radiology, Faculty of Dentistry, University of Omar Al-Mukhtar, Albayda, Libya.

³Assistant Lecturer, Department of Basic Sciences, Faculty of Dentistry, University of Benghazi, Benghazi, Libya.

⁴Lecturer, Department of Oral Biology, Faculty of Dentistry, University of Benghazi, Benghazi, Libya.

⁵Professor, Department of Oral Medicine, Oral Pathology, Oral Diagnosis and Radiology, Faculty of Dentistry, University of Benghazi, Benghazi, Libya

ABSTRACT

Aims:

The study aims to describe the characteristics of ameloblastoma in a retrospective sample of cases reported at the faculty of dentistry, University of Benghazi, Libya

Methods

A retrospective analysis of cases diagnosed with a ameloblastoma between 2001 and 2016 at faculty of dentistry - Benghazi-libya were reviewed histologically. The cases were then subclassified according to the basic criteria of the World Health Organization. In addition, cases were analysed in terms of clinicopathologic and histopathologic features.

Results:

A total of 28 ameloblastomas types were identified: 8 conventional, 2 peripheral, and 17 unicystic (4 cases ameloblastoma arising in dentigerous cysts) and 1 case is malignant ameloblastoma. Tumours were distributed throughout the jaws with 26 cases in mandibular, 2 cases in maxilla, (2 cases and cross midline, and 2 cases in an anterior location).

Conclusion:

The clinical epidemiological profile of the patients from the present study is very similar to other populations with regards to gender, age and tumor location, with unicystic ameloblastoma being the most common subtype in our population, in contrast to other reports.

Keywords: *Ameloblastoma, retrospective, histopathology, subtypes, Libya.*

Corresponding author:

Rehab El Maddani

Department of Basic Sciences, Faculty of Dentistry,
University of Benghazi, Benghazi, Libya.

E-mail: Rehabmadani25@gmail.com

INTRODUCTION

Ameloblastoma is an odontogenic tumor derived from odontogenic epithelium within a mature fibrous stroma ⁽¹⁾. Although classified as a benign tumor, ameloblastoma is a locally aggressive odontogenic tumor with severe clinical implications and has the potential for malignant transformation

^(2,3). It represents approximately 14% of all jaw cysts and tumors and about 9 to 11 % of all odontogenic tumors ^(4,5). Based on a report of World Health Organization (WHO) on the odontogenic tumor, ameloblastoma classified (i) unicystic, (ii) solid/multicystic, (iii) peripheral or (extraosseous), and (iv) desmoplastic ameloblastoma ⁽⁶⁾. However, the new classification of WHO in 2017,

ameloblastomas were narrowed to ameloblastoma (conventional), unicystic, extraosseous/peripheral, and metastasizing variants due to the introduction of perspective views based on updates from genetic studies⁽⁷⁾. The most common type of ameloblastoma is the conventional type, accounting for 90% of all ameloblastomas. Within this group, the most frequent pattern is plexiform and follicular histological patterns. The follicular type can show different kinds of cytological differentiation, such as basal cell, granular, and spindle cell types⁽⁸⁾.

Clinically, Ameloblastomas usually present as a painless, slow-growing swelling that develops most often in the jaw near the molars, perforation of mandible or maxilla cortical plates, and involves surrounding soft tissue sinonasal structure⁽⁹⁾. Radiographically, ameloblastomas present as unilocular and multilocular radiolucent lesions surrounded by a radiopaque border, primarily located in the posterior mandibular segment⁽¹⁰⁾.

Ameloblastoma has a reportedly varied geographical prevalence ranging from 11-24% of all odontogenic tumors in North America to an estimated worldwide incidence of 0.5 cases per million person-years^(11,12). Ameloblastoma constituted up to 99% of odontogenic tumors in sub-Saharan Africa, with the mandible being more frequently affected^(11,13). Unfortunately, little is known about ameloblastoma in the Libyan population. Therefore, the present study aimed to assess the prevalence of ameloblastoma in a retrospective sample of cases reported at the faculty of dentistry, University of Benghazi.

MATERIALS AND METHODS

This study is a retrospective analysis of 28 cases diagnosed with a ameloblastoma. The data files were retrieved from the data bank of Department of Oral Medicine, Oral Pathology, Oral Diagnosis and Radiology, Benghazi University Faculty of Dentistry. All cases diagnosed with ameloblastoma during the period between 2001 and 2016 were reviewed histologically of haematoxylin and eosin stained section. The revision was performed by two oral

pathologists, one of them is a professor of oral pathology. Any disagreement in the diagnosis was resolved by discussions and seeking a third opinion. The cases were then subclassified according to the basic criteria of the world health organization. In addition, cases were analysed in term of clinicopathologic and histopathologic features. Data was summarised using appropriate statistical methods (counts and percentages) to provide a descriptive picture according to subtypes, site within the mouth and gender and age of cases. The statistical analysis was conducted using excel sheets.

RESULTS

Clinical and histopathologic characteristics of all cases are summarized in Tables 1 and 2. Seventeen patients were males and 12 females. The mean age at time of diagnosis was 30.7 years (range from 13 to 75 years). Table 3 shows the distribution of ameloblastoma cases on the basis of age. We observed that highest number of cases belonged to age group 10-19,20-29,30-39 years (n=7) for each group. Lowest number of cases were observed in the age group 50-59 years (n=0). Tumors were distributed throughout the jaws with 26 cases in mandibular, 2 cases in maxilla, (2 cases and cross midline, and 2 cases in an anterior location).

Twenty-five cases presented as variably sized swellings of the jaws, 2 cases with ulceration, 3cases with pain, 3 cases with tooth mobility and 1 case with paraesthesia. Data on clinical follow-up and radiological assessment were retrieved from the medical record files wherever possible. five cases are associated with impacted tooth, root resorption and bone resorption occurred in 5 and 3 cases respectively, and 1 patient suffered from recurrence. There was insufficient documentation on follow-up in most of cases.

All 28 ameloblastomas were classified according to WHO classification⁽⁷⁾ into the following types: 8 conventional, 2 peripheral, and 17 unicystic (4 cases ameloblastoma arising in dentigerous cysts) and 1 case is malignant ameloblastoma.

Table 1. Clinical and histopathological Features of Ameloblastoma

No	Age	Sex	Site	Diagnosis
1	42Y	F	Mandible (premolar area)	Peripheral ameloblastoma
2	49Y	F	Mandible (premolar area)	Conventional ameloblastoma
3	17Y	M	Mandible (Premolar to ramus area)	Unicystic ameloblastoma(mural)
4	20Y	M	Mandible (molar area)	Unicystic ameloblastoma
5	31Y	M	Mandible (molar area)	Unicystic ameloblastoma
6	35Y	F	Mandible (molar area)	Unicystic ameloblastoma
7	28Y	M	Mandible (molar to ramus area)	Ameloblastoma in odontogenic cyst
8	75Y	M	Mandible (premolar to ramus area)	Conventional ameloblastoma
9	31Y	M	Mandible (ramus area)	Ameloblastoma in odontogenic cyst
10	22Y	F	Mandible (molar to ramus area)	Unicystic ameloblastoma
11	36Y	F	Mandible (premolar to ramus area)	Malignant ameloblastoma
12	19Y	M	Mandible (Premolar to ramus area)	Unicystic ameloblastoma
13	60Y	M	Maxilla (Anterior area)	Conventional ameloblastoma
14	41Y	M	Mandible (third molar area)	Ameloblastoma in odontogenic cyst
15	17Y	M	Mandible (premolar to ramus area)	Unicystic ameloblastoma
16	17Y	M	Mandible (premolar to ramus area)	Conventional ameloblastoma
17	21Y	F	Mandible (premolar to ramus area)	Conventional ameloblastoma
18	15Y	F	mandible(molar area)	Unicystic ameloblastoma
19	41Y	M	Mandible(Anterior area)	Unicystic ameloblastoma
20	41Y	M	Mandible (ramus area)	Conventional ameloblastoma
21	27Y	F	Mandible (molar area)	Unicystic ameloblastoma
22	13Y	M	Mandible premolar to molar and cross midline)	Unicystic ameloblastoma
23	14Y	M	Mandible (molar area)	Unicystic ameloblastoma
24	20Y	F	Mandible (molar area)	Conventional ameloblastoma
25	23Y	F	Mandible (Premolar and cross midline)	Conventional ameloblastoma
26	36Y	M	Maxilla (palate right area)	Peripheral ameloblastoma
27	32Y	M	Mandible (premolar area)	Unicystic ameloblastoma(mural)
28	37Y	F	Mandible (molar to ramus)	Ameloblastoma in odontogenic cyst

Table 2: Histopathological Variants of Ameloblastoma

Histopathological subtype	No
Follicular type	2
plexiform type	2
unicystic type	4
Cystic/ Follicular type	5
Cystic/ plexiform type	2
Follicular/ plexiform type	2
Follicular/desmoplastic type	2
plexiform /desmoplastic type	2
Granular /cystic type	2
Cystic/desmoplastic type	1

Table 3: Distribution of ameloblastoma cases on the basis of age

Age (years)	Number of patients
10-19	7
20-29	7
30-39	7
40-49	5
50-59	0
60-69	1
70-79	1

DISCUSSION

Despite the increasing literature about odontogenic tumors, specifically ameloblastoma, little is known about the clinicopathological aspects and frequency of these tumors in Libya.

In this study, there was a slight male predominance in the distribution of ameloblastoma Male: Female (1.3:1). Similar distribution was observed in a study conducted by Verma et al.⁽¹³⁾ (1.3:1), Montes et al.⁽¹⁴⁾ (1.2:1), Adebisi et al.⁽¹⁵⁾ (1.5:1), Poon et al.⁽¹⁶⁾ (1.4:1). In addition, the largest study on ameloblastoma published by Reichart et al.⁽¹⁷⁾ reported a male: female ratio of 1.1:1 showing a slight male predominance. However, Similar distribution was observed in other studies^(15,18,19).

Ameloblastomas were observed in a wide age range (13–75 years) in our study. This finding is in agreement with most reports in the literature^(15-18, 20-27). In the present study, ameloblastoma occurred more often in the first, second, third decades of life. None of the tumour was found below 10 years of age. According to Kim and Jang⁽²⁸⁾, the frequency of ameloblastoma in young patients (< 19 years) is relatively low, occurring in only 10 to 15% of all reported cases. Our results show a greater frequency, around 25%, for this group of individuals. In addition, our findings were close to those observed by Chidzonga et al.⁽²⁹⁾, who showed that two thirds of the patients affected by ameloblastomas were less than 40 years of age.

Almost 92,8% of ameloblastomas were located in the mandible, with a very high mandible to maxilla ratio (13:1). This is very high compared with the ratios reported by Okada et al.⁽¹⁸⁾, Reichart et al.⁽¹⁷⁾ in an extensive review of all of the cases reported in the literature, found the ratio to be around 5:1. The high occurrence in the mandible in the present institutional study may be due to loss of maxillary ameloblastomas to eye-nose throat surgeons.

According to the distribution of ameloblastoma in various anatomical regions of the jaws, the tumours tend to occur commonly in posterior area of the mandible^(19, 30-33). This finding is also compatible with our results.

In relation to the frequency of the different ameloblastoma histological subtypes, the results of the present study differ from previous reports^(19,21,34), which demonstrated a greater occurrence of the solid tumor variant. Our findings are similar to those from Montes et al.⁽¹⁴⁾, Pereira et al.⁽³¹⁾, who observed a greater prevalence of the unicystic subtype.

In accordance with the reports of several authors^(30,31), the most clinical manifestation of ameloblastoma is swelling in the area affected by the tumor. Our results are in accordance with previous reports.

An interesting finding in the current study was observed 4 cases of ameloblastoma arising from dentigerous cyst. Various studies report that between 15 and 30% of all ameloblastomas form in the wall of a dentigerous cyst⁽³⁵⁾. However, it is not known whether they arise from a neoplastic transformation of cells from an otherwise non neoplastic dentigerous epithelium or arise de novo⁽³⁶⁾. one case of ameloblastomas have recurred. it is difficult to arrive at a conclusion regarding the relationship between recurrences observed in different subtypes and treatment modalities, as these data were not available for all the ameloblastomas analysed in this study.

In our study we found 1 of 28 cases ameloblastic carcinoma deposit of ameloblastic carcinomas were considered as extremely rare malignant odontogenic epithelial neoplasm's that may arouse de novo or from a pre-existing odontogenic lesion⁽³⁷⁾.

CONCLUSIONS

The clinical epidemiological profile of the patients from the present study is very similar to other populations with regards to gender, age and tumor location, with unicystic ameloblastoma being the most common subtype in our population, in contrast to other reports.

REFERENCES

1. Sciubba JJ, Eversole LR, Slootweg PJ (2005). Odontogenic tumours. In: L Barnes, JW Eveson, P Reichart, D Sidransky, eds. *World Health Organization classification head and neck tumours*. IARC Press: Lyon, pp. 283– 328.
2. Bassey GO, Osunde OD, Anyanechi CE (2014). Maxillofacial tumors and tumor-like lesions in a Nigerian teaching hospital: an eleven year retrospective analysis. *Afr Health Sci* **14**: 56– 63.
3. Odukoya O, Effiom OA (2008). Clinicopathological study of 100 Nigerian cases of ameloblastoma. *Niger Postgrad Med J* **15**: 1– 5.
4. Lasisi TJ, Adisa AO, Olusanya AA (2013). Appraisal of jaw swellings in a Nigerian tertiary healthcare facility. *J Clin Exp Dent* **5**: e42– e47.
5. Abayomi OA SA, Oladepo AE. Ameloblastoma: Clinical features and management of 315 cases from Kaduna, Nigeria. *J Cranio-Maxillofac Surg*. 1993; 21:351–55.

6. Philipsen H. Odontogenic tumours. WHO classification of head and neck tumours. 2005;283-327.
7. Wright JM, Vered M. Update from the 4th edition of the World Health Organization classification of head and neck tumours: odontogenic and maxillofacial bone tumors. *Head Neck Pathol* 2017 Mar 1;11(1):68-77.
8. Chi AC, Damm DD, Neville BW, Allen CM, Bouquot J. *Oral and Maxillofacial Pathology-E-Book*. Elsevier Health Sciences; 2008 Jun 11.
9. Ghandhi D AA, Pogrel MA, MacDonald G, Brocklebank LM, Moos KF. Ameloblastoma: A surgeon's dilemma. *J Oral Maxillofac Surg*. 2006; 64:1010-14.
10. Gupta S, Sexana S, Bhagwat S, Aggarwal P, Gupta PK. Clinicopathological characteristics of ameloblastomas in Western Uttar Pradesh population: An institutional study. *Indian J Cancer*. 2015 Jan-Mar;52(1):57-60. doi: 10.4103/0019-509X.175557. 6
11. McClary AC, West RB, McClary AC, Pollack JR, Fischbein NJ, Holsinger CF, Sunwoo J, Colevas AD, Sirjani D. Ameloblastoma: a clinical review and trends in management. *Eur Arch Otorhinolaryngol*. 2016; 273(7): 1649-1661.
12. JingW,XuanM,LinY,WuL,LiuL,ZhengX,TangW, QiaoJ, Tian W. Odontogenic tumours: a retrospective study of 1642 cases in a Chinese population. *Int J Oral Maxillofac Surg*. 2007; 36(1): 20-25
13. Verma S, Khemka A. Clinical features of ameloblastoma cases in local population-A retrospective study. *J of Advan Med & Dent Sci Res*. 2019 Dec;7(12).
14. Ledesma-Montes C, Mosqueda-Taylor A, Carlos-Bregni R, De León ER, Palma-Guzmán JM, Páez-Valencia C, Meneses-García A. Ameloblastomas: a regional Latin-American multicentric study. *Oral diseases*. 2007 May;13(3):303-7.
15. Adebisi KE, Ugboko VI, Omoniyi-Esan GO, Ndukwe KC, Oginni FO. Clinicopathological analysis of histological variants of ameloblastoma in a suburban Nigerian population. *Head & Face Med*. 2006 Dec 1;2(1):42.
16. Poon CS, Wu PC, So MK. Ameloblastoma in Hong Kong Chinese. *HONG KONG MED J*. 1996; 2:172-6.
17. Reichart PA, Philipsen HP, Sonner S. Ameloblastoma: biological profile of 3677 cases. *Eur J Cancer B Oral Oncol*. 1995 Mar 1;31(2):86-99.
18. Okada H, Yamamoto H, Tilakaratne WM. Odontogenic tumors in Sri Lanka: analysis of 226 cases. *J Oral Maxillofac Surg*. 2007 May 1;65(5):875-82.
19. Iyogun CA, Ukegheson GE, Omitola OG. Evaluation of Histopathological Subtypes of Ameloblastoma in a Tertiary Institution in Southern Part of Nigeria. *Int J Oral Maxillofac Pathol*. 2014 Oct 1;5(4):07-11.
20. Siar CH, Lau SH, Ng KH. Ameloblastoma of the jaws: a retrospective analysis of 340 cases in a Malaysian population. *J Oral Maxillofac Surg*. 2012 Mar 1;70(3):608-15.
21. Nasrollah Saghravanian, Jahanshah Salehinejad, Narges Ghazi, Mohammad Shirdel, Mahsa Razi. 40-year Retrospective Clinicopathological Study of Ameloblastoma in Iran. *Asian Pac J Pre*,17,619-623.
22. Lu Y, Xuan M, Takata T, Wang C, He Z, Zhou Z, Mock D, Nikai H. Odontogenic tumors: a demographic study of 759 cases in a Chinese population. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 1998 Dec 1;86(6):707-14.
23. Hong J, Yun PY, Chung IH, Myoung H, Suh JD, Seo BM, Lee JH, Choung PH. Long-term follow up on recurrence of 305 ameloblastoma cases. *Int J Oral Maxillofac Surg*. 2007 Apr 1;36(4):283-8.
24. Ladeinde AL, Ajayi OF, Ogunlewe MO, Adeyemo WL, Arotiba GT, Bamgbose BO, Akinwande JA. Odontogenic tumors: a review of 319 cases in a Nigerian teaching hospital. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2005 Feb 1;99(2):191-5.
25. Tilakaratne WM, Jayasingha RD. Pattern of recurrences of ameloblastoma in Sri Lanka. *Sri Lanka Dent J* 2004; 34: 20-8.
26. Olgac V, Koseoglu BG, Aksakalli N. Odontogenic tumours in Istanbul: 527 cases. *Br J Oral Maxillofac Surg*. 2006 Oct 1;44(5):386-8.
27. Avelar RL, Antunes AA, de Santana Santos T, de Souza Andrade ES, Dourado E. Odontogenic tumors: clinical and pathology study of 238 cases. *Braz J Otorhinolaryngol*. 2008 Sep 1;74(5):668-73.
28. Kim SG, Jang HS. Ameloblastoma: a clinical, radiographic, and histopathologic analysis of 71 cases. *Oral Surgery, Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2001 Jun 1;91(6):649-53.

29. Chidzonga MM, Perez VL, Alvarez AP. Ameloblastoma: the Zimbabwean experience over 10 years. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 1996 Jul 1;82(1):38-41.
30. Karadiguddi P, Mengi R, Melkundi M, BV H, Premnath K. Clinicopathological characteristics of Ameloblastomas in a given population-A retrospective study. *J Advan Med & Dent Sci Res.* 2019 Jul;7(7):40-43.
31. Pereira F, De Araujo Melo E, Silva Gurgel CA, Cangussu MC, De Azevedo RA, Dos Santos JN. Clinicopathological and demographic characteristics of ameloblastomas in population of Bahia, Brazil. *Rev OdontoCienc* 2010; 25:2505.
32. Shekhar S, Priya P, Jain S, Verma SK. Histopathological analysis of types of Ameloblastoma: A retrospective study. *Pharma Innov J* 2019; 8(1): 499-501
33. Naz I, Mahmood MK, Akhtar F, Nagi AH. Clinicopathological evaluation of odontogenic tumours in pakistan-A seven years retrospective study. *Asian Pac J Cancer Prev.* 2014 Jan 1;15(7):3327-0.
34. El AN, Latif SM. Clinico pathological and immunohistochemical study in odontogenic cysts and ameloblastoma (using laminin-1). *Am J Life Sci.* 2013;1(3):130-5.
35. Wood NK, Kuc IM. Pericoronal radiolucencies. In: *Differential diagnosis of oral and maxillofacial lesion.* 5th ed. St.
36. Ackermann GL, Altini M, Shear M. The unicystic ameloblastoma: a clinicopathological study of 57 cases. *J Oral Pathol Med.* 1988 Nov;17(9-10):541-6.
37. Avon SL, McComb J, Clokie C. Ameloblastic carcinoma: case report and literature review. *J Can Dent Assoc.* 2003 Oct;69(9):573-6.





Original article

Awareness of and Practices Related to Forensic Dentistry Among Libyan Dentists

Oswa Mouadeb¹, Yasmin Naser¹, Tasnem kewidir¹, Ahmed El ramli², Hend Elkawash³, Arheiam Arheiam⁴

¹Postgraduate student, Department of Dental Public Health and Preventive Dentistry, Faculty of Dentistry, University of Benghazi, Libya.

²Lecturer, Department of Basic Sciences, Faculty of Dentistry, University of Benghazi, Libya.

³Assistant Professor, Department of Fixed Prosthodontics, Faculty of Dentistry, University of Benghazi, Libya.

⁴Associate Professor, Department of Dental Public Health, Faculty of Dentistry, University of Benghazi, Libya.

ABSTRACT

Objectives: Given that Libya has recently become a hot spot of armed conflicts, this study aims to investigate Libyan dentists' awareness of practices related to forensic dentistry, to inform public health policy and dental education curriculum.

Methods: A paper-based, self-administered questionnaire survey was conducted among Libyan dentists working in Benghazi between January and April 2017. The sample frame comprised all government and private dental practices in the city. The questionnaire required information on respondents' demographic and professional characteristics, sources of information, attitude, practices, and barriers related to forensic dentistry. Collected data were analyzed using SPSS software.

Results: Out of 250 questionnaires distributed, 200 were returned and used for analysis. More than half of the respondents were males (51%), and few of them worked in both private and public sectors (4.5% and 6%), and almost all of them were Libyans. Although most heard about it, only a small proportion (13%) received forensic dentistry education. A few numbers of the respondents (8) reported handling forensic cases. Around a third of participants indicated keeping some form of patient records. However, only (13.5%) of participants agreed that keeping patients' records is essential, and about (9.5%) of them disagreed. In addition, more than half of the participants (65.5%) claimed that they believe that keeping such records is essential, but they are not able to.

Conclusion: Despite a positive attitude towards and awareness of the importance of forensic dentistry, more educational and practice enabling efforts are needed to support the humanitarian role of dentists in conflict-affected environments such as Libya.

Keywords: Awareness, forensic dentistry, survey, Libya.

Corresponding author:

Yasmin Naser

Postgraduate student, Department of Dental Public Health, Faculty of Dentistry, University of Benghazi

Email: Yasminnaser1992@gmail.com

INTRODUCTION

Forensic odontology is a branch of dentistry that deals with the proper handling and examination of dental evidence and the proper evaluation and presentation of dental findings in the interest of justice¹. Forensic odontology's primary value is identifying human remains based on the

individualistic characteristics present in the teeth of different individuals. Forensic dentists should be included in the National Emergency Management Agency; an entirely created Identification Commission with two exceptionally qualified forensic dentists in each unit of identification following international standards is desirable^{2, 3}. Disaster Victim Identification is the name given to

identifying disaster victims (DVI). Teeth are the most substantial portion of the human body, capable of withstanding tremendous explosion levels while remaining unharmed^{4, 5}. In mass fatality instances where other means of identification, such as fingerprints and facial features, have been obliterated, teeth are more likely to be recovered.

Several previous studies showed that Forensic dentistry plays a significant role in identifying those individuals who cannot be identified visually or by other means. The unique nature of our dental anatomy and the placement of custom restorations ensure accuracy when the techniques are correctly employed⁵. According to studies, the dental examination has also been a helpful technique in identifying the deceased. Preparedness is the cornerstone to a successful mass disaster identification. Therefore, forensic dentists should be included in the National Emergency Management Agency; an entirely created Identification Commission with two exceptionally qualified forensic dentists in each unit of identification following international standards is desirable⁶. Victims' identification is of paramount importance and a fundamental right for their families at war times. Although forensic dentistry may offer a way for this, the issue remains that its success relies on the accuracy and availability of antemortem dental records. Given that Libya has recently become a hot spot of armed conflicts⁷, this study investigates Libyan dentists' awareness of and practices related to forensic dentistry to inform public health policy and dental education curriculum.

METHODS

A cross-sectional study design was conducted using a paper-based questionnaire in Benghazi between January and April 2017. The study population were dentists working in the city of Benghazi in the private and public health sectors. No precise list of dentists was available, and hence, a convenience sampling technique was employed to recruit study participants. However, sampling was conducted to allow the recruitment of a sample representative of different generations and types of practices in the Libyan dental practice. The dentists were approached in clinics by the principal investigator, who explained the aim of the study and obtained verbal consent to participate in the study.

A self-administered questionnaire was designed explicitly for this study. In addition, it was informed

by available literature on forensic dentistry awareness and knowledge among dentists⁸⁻¹⁰. The question format and questionnaire layout were refined over an extensive discussion with the supervisor. A close-ended structure as yes/no, questions was used. A free-text response section was included at the beginning of the questionnaire to collect sociodemographic information. The questionnaire was pre-tested for clarity and content validity among a purposeful sample of 20 experienced dentists and demonstrators at the faculty of dentistry, University of Benghazi. The participants in the questionnaire piloting process were not included in the final sample.

The questionnaire was handed in person to the dentists and collected after two days from the clinics' reception. First, the collected questionnaires were checked for completeness, where participants' answers were examined for inconsistencies across questions and contingency questions¹¹. For example, a questionnaire with all answers as 'yes' or all answers as 'no' was excluded. In addition, questionnaires with completely missing information were excluded. The questionnaires were then uploaded on an excel sheet, and numbered codes were given to each answer. For example, code one was given to the answer 'yes' and code two was given to the answer 'no'.

Data were analyzed using statistical software SPSS Version 22.0. (Armonk, NY: IBM Corp.). Descriptive statistics were used to describe the demographics and professional characteristics of the participants, the characteristics of their dental practices and their current carrier position according to years of experience (Counts and percentages were used to summarise responses to closed-ended questions and categorized answers of choices and experiences questions).

RESULTS

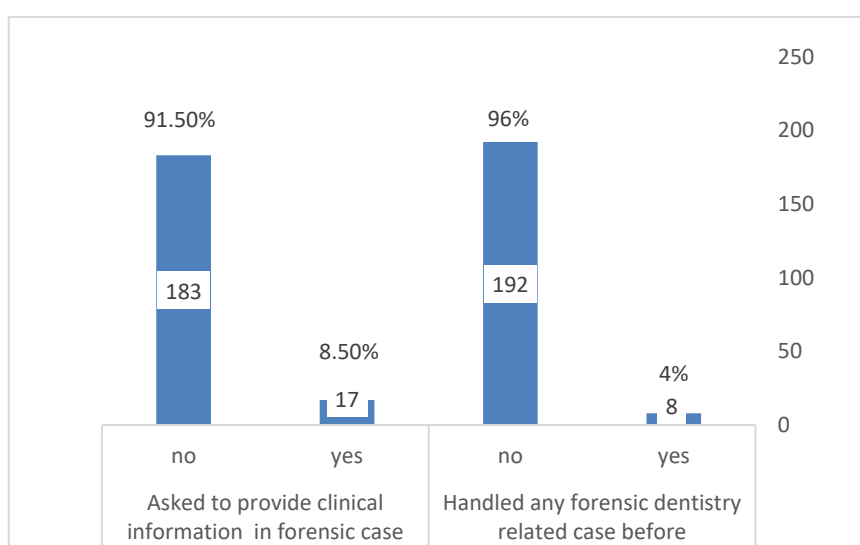
Out of 250 questionnaires distributed, 200 dentists returned complete questionnaires suitable for data analysis. The sociodemographic characteristics of the study sample are summarised in table 1. More than half of the respondents were males (102, 51%), and few of them worked in both private and public sectors (12, 6%), and almost all of them were Libyans.

Table 1: Sociodemographic characteristics of the study sample (n=200)

<i>Variable</i>		N	%
Gender	Male	102	51.0
	Female	98	49.0
Country of Graduation	India	1	0.5
	Libya	199	99.5
Attended postgraduate study program	no	191	95.5
	yes	9	4.5
Type of practice	government	93	46.5
	both	12	6.0
	private	95	47.5

Figure 1 describes the participants in terms of providing clinical information and handling any forensic dentistry related case. It shows that most of the participants (183, 91.5%) reported that they had never been asked to provide clinical information in a forensic case, and most of them (192, 96%) reported that they had never handled any forensic dentistry related case. Figure 2 describes beliefs and attitudes towards forensic dental evidence. The majority of the participants (162, 81%) believed that gender could be determined by teeth help, and dentistry plays a role in victim identification (186, 93%). Figure 3 describes the participants according to their knowledge and practices. More than half of the

participants (106, 53%) knew about bite mark patterns of teeth, and (74, 37%) of them maintain dental records in their clinic. Radiographs were the most maintained record (62, 31%). Figure 4 describes the attitude towards keeping patient records is essential or not. It shows that most participants do not know or disagree that keeping records is essential, and (49, 24.5%) of participants agreed that keeping patient records is not their responsibility. In addition, more than half of the participants (131, 65.5%) claimed that they believe that keeping such records is essential, but they are not able to.

**Figure 1: Previous experience with forensic dentistry**

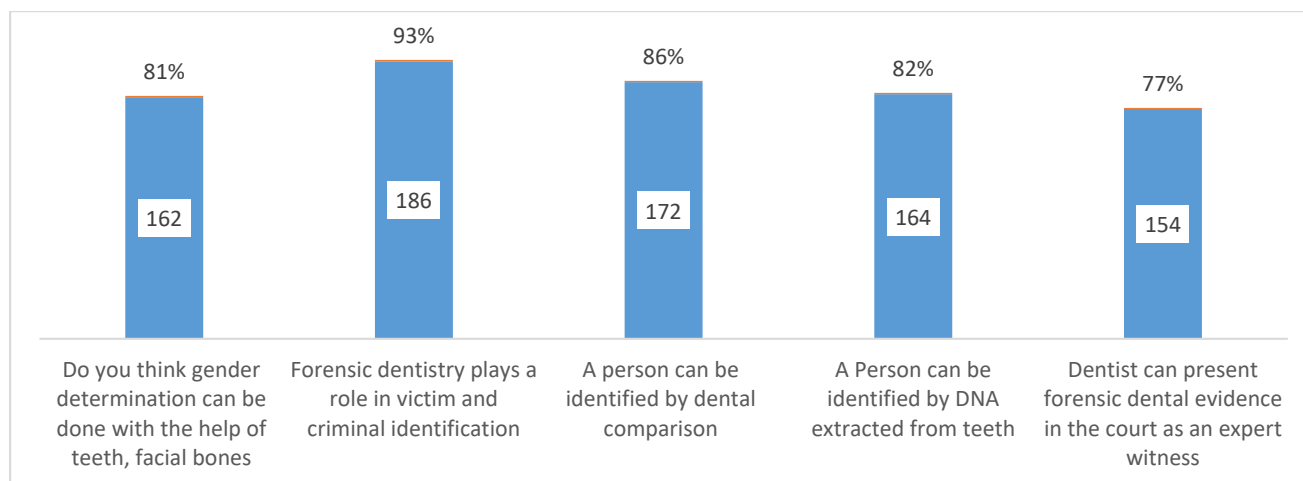


Figure 2: Beliefs and attitudes towards forensic dentistry

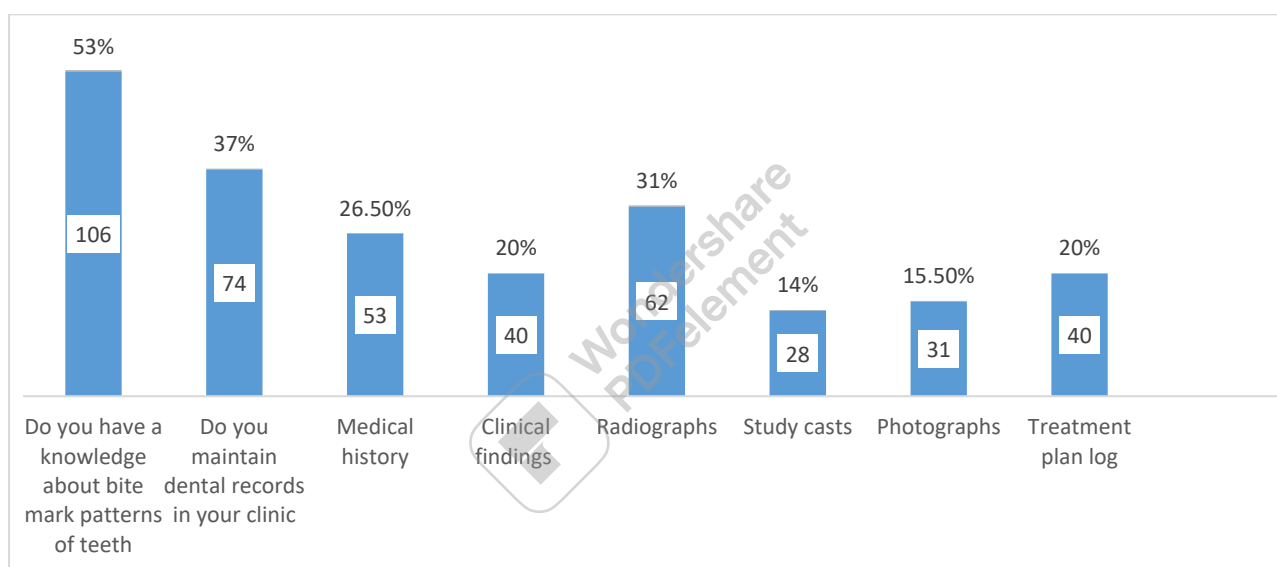


Figure 3: practices related to forensic dentistry

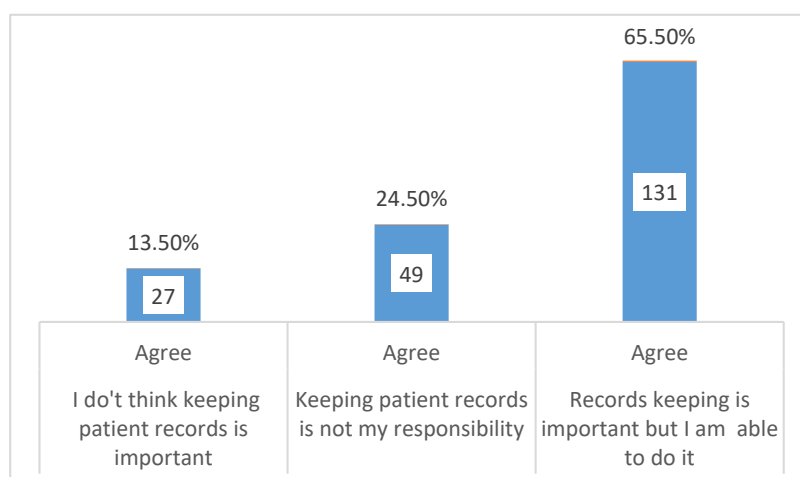


Figure 4: attitude toward record keeping

Figure 5 describes the participants' reasoning why they are not keeping patient records. It shows that almost half of participants (84, 42%) claimed that they do not keep patient records due to a lack of computer facilities in their clinic, and (75, 37.5%) of participants claimed that the reason is lack of storage space, while (67, 33.5%) stated that they have never been trained on keeping records, and (62, 31%) of them stated that they have no authority in their workplace. Additionally, lack of time was the excuse of (48, 24%) of the participants for not keeping patient records.

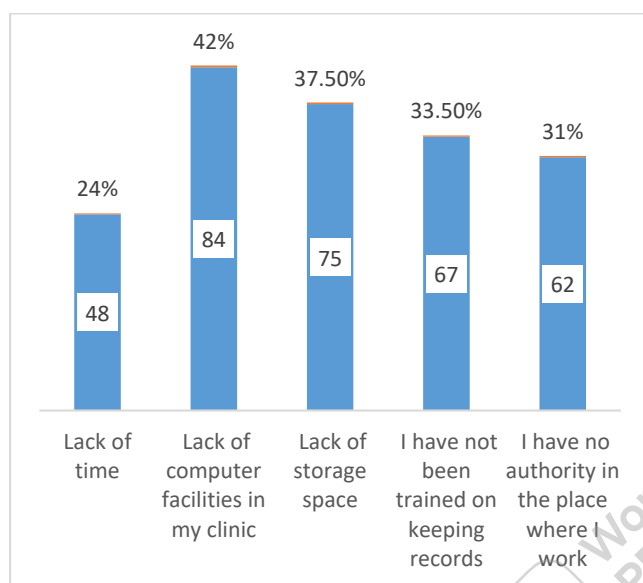


Figure 5: Barrier to appropriate record-keeping

DISCUSSION:

To the authors' best knowledge, this is the first study to assess the awareness of forensic dentistry among Libyan dentists. The topic has become increasingly important in the light of recent political changes in the country, which went through several civil wars and turmoil. The present study showed that most participants have never been asked to provide or handed forensic dentistry-related information, though the majority considered dental sciences necessary in forensic practices. These findings raise important questions about why dentists were not involved in forensic activities. While we see this as a future research area, it could be the case that forensic dentistry as a new branch of dentistry is not well known to the legal authorities in Libya. In addition, there is no such speciality in the dental education and health care systems in Libya, unlike forensic medicine. A previous study in Brazil demonstrated that the reduced number of teaching hours and lack of teachers in forensic odontology represent the primary factor in maintaining dental

records for forensic purposes¹². Therefore, efforts to raise awareness about the importance of forensic dentistry and its role should be disseminated at different educational and political levels.

The participants in the present study demonstrated varying levels of knowledge and practices related to forensic dentistry. While (106, 53%) knew about biting marks, around (31, 15.5%) kept photographs and study casts. These findings highlight that big dental data used for forensic dentistry are missing from daily dental practice, and further efforts are required to improve these practices in the Libyan setting. Most participants agree that keeping such records is essential, but they reported being unable to do so. They attributed this to several reasons: lack of time, training, storage place, or authority in their dental clinics. Similar findings have been reported in Australia, where dentists indicated no interest in keeping accurate and complete forensic odontology records due to lack of time and high load level with busy dental practices¹². In 2007, Delattre and his team conducted a study to test the attitude and practices of forensic dentists in Belgium, and they found that young male dentists used the most appropriate records to keep forensic data, but the interest in continuing to keep complete and accurate records decreased with increasing practitioner age¹². Waleed et al. (2015), have compared the recorded data by the dentists in dental hospitals during their undergraduate study to their records later where they worked in private clinics and showed that the records were more appropriate and based on the medico-legal purposes with a high awareness level during the time of learning in general hospitals than the dentists in private clinics¹³.

These findings have important implications for health care planners and educators. The dental curriculum should include training on records keeping as an essential part of the dental practice, supported by rules and guidelines developed by health authorities since dental records can confirm personal identity in forensic studies¹⁴. Finally, in line with previous studies, although the respondents demonstrated appreciation of the vital role of keeping dental records in dental practices to support forensic work, there was adequate exposure to forensic odontology during their undergraduate study¹⁵.

In Croatia, forensic odontology was introduced as a mandatory course in undergraduate programs in 1997, establishing the Chair of Forensic Dentistry at the School of Dental Medicine, University of Zagreb. It was later introduced in postgraduate programs and continuing professional education. Throughout

the course, participants are introduced to the legal obligations of record-keeping (informed consent, diagnosis, treatment plan, recording treatment) and the importance and application of documentation in dental identification and use in forensic expertise and litigation related to negligence, malpractice, and the qualification of orofacial injury¹⁶.

The International Organization for Forensic Odonto-Stomatology (IOFOS) investigated undergraduate education in forensic odontology and found that a specific teaching course in forensic odontology is neither mandatory nor elective in most undergraduate programs¹⁷. At the same time, the profile and competencies of the graduating European dentist include the Professionalism domain, composed of ethics, regulation, and professional behavior¹⁸, which are covered in an introductory forensic odontology course. However, the issue remains that forensic dentistry is not one of the usual tasks of general dental practitioners, who are usually confronted by practice and patient-related barriers that hinder their practice of appropriate dental care¹⁹.

The present study has some limitations which should be addressed here. First, the study used a cross-sectional design, which can provide descriptive data with limited application in cause and effect relationships. However, the study aimed to describe the current situation of forensic dentistry in Libya as baseline data. Second, the study used self-reported questionnaires, which can risk recall bias and social desirability bias. However, questionnaires are suitable for such types of studies, and the researchers have made efforts to minimize such biases. Finally, there was no complete list of dentists in Benghazi, and hence, the sample was convenient.

CONCLUSION

Despite a positive attitude towards and awareness of the importance of forensic dentistry, the practice of forensic dentistry is hindered by limited abilities, education, and facilities. More educational and practice enabling efforts are needed to support the humanitarian role of dentists in conflict-affected environments such as Libya.

REFERENCES

- Goldman A. Outline of Forensic Dentistry. 1982.
- Hinchliffe J. Forensic odontology, part 2. Major disasters. *Br Dent J*. 2011;210(6):269-74.
- Iskan MY, Steyn M. The human skeleton in forensic medicine: Charles C Thomas Publisher; 2013.
- Hinchliffe J. Forensic odontology, part 1. Dental identification. *Br Dent J*. 2011;210(5):219-24.
- Pretty I, Sweet D. A look at forensic dentistry-Part 1: The role of teeth in the determination of human identity. *Br Dent J*. 2001;190(7):359-66.
- Kolude B, Adeyemi B, Taiwo J, Sigbeku O, Eze U. The role of forensic dentist following mass disaster. *Ann Ib Postgrad Med*. 2010;8(2):111-7.
- Mokdad AH, Forouzanfar MH, Daoud F, El Bcheraoui C, Moradi-Lake M, Khalil I, et al. Health in times of uncertainty in the eastern Mediterranean region, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet Glob Health*. 2016;4(10):e704-13.
- Wilkins EM, Wyche CJ. Clinical practice of the dental hygienist: Philadelphia, Pa. ; Lippincott Williams & Wilkins, c2013.11th ed., International ed.; 2013.
- Rugg-Gunn AJ, Nunn JH. Nutrition, diet and oral health: Oxford University Press; 1999.
- Watt RG, McGlone P, Kay EJ. Prevention. Part 2: Dietary advice in the dental surgery. *Br Dent J*. 2003;195(1):27-31.
- Roberts BL, Anthony MK, Madigan EA, Chen Y. Data management: cleaning and checking. *Nurs Res*. 1997;46(6):350-2.
- Delattre VF. Antemortem dental records: attitudes and practices of forensic dentists. *J Forensic Sci*. 2007;52(2):420-2.
- Waleed P, Baba F, Alsulami S, Tarakji B. Importance of dental records in forensic dental identification. *Acta Inform Med*. 2015;23(1):49.
- Acharya AB. A decade of forensic odontology in India. *J Forensic Dent Sci*. 2010;2(1):1.
- Rahman J, Routray S, Mishra SS, Mohanty I, Mohanty N, Sukla N. Knowledge, awareness, and practise of forensic odontology among dental surgeons in Bhubaneswar, India. *J Unexplored Med. Data*. 2017;2:26-33.
- Savić Pavičin I, Jonjić A, Maretić I, Dumančić J, Zymber Česhko A. Maintenance of dental records and forensic odontology awareness: A survey of Croatian dentists with implications for dental education. *Dent J*. 2021;9(4):37.
- Brkić H, da Silva RHA, Pinchi V, Thevissen P, Lessig R. Textbook of Forensic Odonto-stomatology by IOFOS: Naklada Slap; 2021.
- Field J, Cowpe J, Walmsley A. The graduating European dentist: a new undergraduate curriculum framework. Wiley Online Library; 2017. p. 2-10.
- Arheiam A, Masoud I, Bernabé E. Perceived barriers to preventive dental care among Libyan dentists. *Libyan J Med*. 2014;9:24340.