

Original Article

Diagnostic Methods for Dental Caries Used by Private Dental Practitioners in Ankara

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ABSTRACT

Objectives: This study aimed to investigate the preference profiles of various types of diagnostic tools and methods used by private dental practitioners in Ankara for detecting dental caries. **Methods:** Private dental practitioners, in five districts of Ankara, were provided with questionnaires comprising demographic characteristics, possession of dental imaging systems, and methods used for caries diagnosis. The questionnaires were retrieved after 1-3 visits. Of 722 questionnaires, 371 were returned. Data were analyzed using frequency analysis and Chi-square tests. **Results:** The completed questionnaires were obtained from 160 women and 168 men, the response rate was 51.4%; aged 25-69 years; 28.4% of them were specialists. Most participants possessed a dental radiography (RG) device. Air drying and sharp explorers were the most commonly preferred methods used for caries diagnosis. There was no significant association between using a sharp explorer and sex or being a specialist ($P = 0.110, 0.226$, respectively). Almost one-third of the dentists with an experience of <11 years, never used an RG device to detect occlusal caries ($P = 0.003$). Only three participants reported the use of DIAGNOdent, while two participants used fiber-optic transillumination (FOTI). **Conclusions:** It was observed that visual-tactile examination using sharp explorer accompanied with radiographs were among the main instruments used for detecting carious lesions. Usage of magnification tools, FOTI, and DIAGNOdent were low.

KEYWORDS: Caries, dental health, diagnostic research, epidemiology, oral health

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INTRODUCTION

Dental health care service is one of the most important factors for the maintenance of oral health. The diagnostic tools and treatment approaches used by dentists aiming to serve all individuals in a community play a crucial role in the prevention of oral diseases. Therefore, dentists should be trained according to the requirements of the community they intend to practice. However, the needs and demands of a specific community can markedly vary between countries, owing to different sociocultural conditions. Although all dentists receive similar training in accordance with dental education programs, their attitudes toward the clinical decision-making process and methods used for diagnosis and treatment of dental caries can exhibit considerable differences.

Oral health markedly contributes to the maintenance of general health and improves the optimal quality of life.

The high prevalence of caries-related diseases highlights the importance of public health services for the prevention of dental caries.^[1] Furthermore, dental caries should be accurately diagnosed for the implementation and execution of appropriate preventive measures and treatment plans, respectively. To date, there have been conflicting reports and limited information associated with the evaluation techniques used by dentists for the diagnosis of dental caries in daily clinical practice.^[2-7] All visual, visual-tactile, radiographic, and alternative methods and their validity have different characteristics, indications, and limitations for use. In order to detect

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caries, some combination of methods would be the best practice managed by clinical knowledge and experience.

Many studies investigating the current oral health status in a specific population have been conducted in Turkey.^[8-9] However, to the best of our knowledge, no study has analyzed the diagnostic methods commonly used by private dental practitioners in the country. The aim of this study was to evaluate the preference profiles of private dental practitioners in using various types of diagnostic tools and methods for diagnosing dental caries in Ankara, Turkey.

METHODS

This study used the data of a Ph.D. thesis, based on a questionnaire to evaluate the preference profiles of private dental practitioners in Ankara, the capital of Turkey. This descriptive study was reviewed and approved by the Committee of the Ethics of Noninterventional Human Experimentation, University of Hacettepe, Turkey. Verbal consent procedure was approved by the Ethics Committee and informed verbal consents for the interviews were obtained from all participants after providing a clear explanation of the study protocol.

Pilot study; prior to the application of the questionnaire, first, the questionnaire was provided to 10 dental lecturers working at the Department of Restorative Dentistry, Faculty of Dentistry, Hacettepe University. Then, a pilot study was performed with 20 dentists to test its suitability in Kirikkale, a neighbor city of Ankara. After evaluating the dentist's responses, the questionnaire was considered appropriate to be used in this survey and modified with minor adjustments. The original questionnaire comprised 56 questions or items grouped under four categories: Demographic information, working conditions, diagnosis and treatment approaches, and patient records.

The first part of the study included questions on sex, age, educational qualifications (general or specialist dentist [receive Ph.D. in their degree's field and practicing privately]), and experience of the participants. The second part comprised questions associated with the preference of diagnostic devices (dental radiography [RG] and intraoral camera). Questions regarding the diagnostic methods for caries included the use of dental explorers, air drying (and its duration), radiographs, laser fluorescence (DIAGNOdent), and fiber-optic transillumination (FOTI) technique.

The names and telephone numbers of the dentists were obtained by approval from a website belonging to the Ankara Chamber of Dentists (Ankara Diş Hekimleri Odasi/ADO). The questionnaires were delivered to the dental practitioners by a single investigator and were retrieved at a later appointment after an interval of 1–3 visits. Information from respondents regarding name and

addresses were not questioned and was kept confidential and anonymous during data processing. All retrieved data were coded by the investigator and controlled by the epidemiologist. The dentists were excluded from the study if they failed to provide information after three on-site visits.

A total of 14,581 private dental practitioners in Turkey, 3229 also worked for government agencies in Ankara. This study was conducted in five central districts (Keçiören, Çankaya, Altındağ, Yenimahalle, and Mamak) in Ankara, where 1077 private practitioners resided.^[10]

Statistical analysis was performed using the IBM SPSS Statistics 21.0 software (IBM Co., Armonk, NY, USA). $P < 0.05$ was considered as a significant. Chi-square tests were used to study the association among the parameters. Because of incomplete answers, the n value varied from 283 to 328, depending on the question. During data analysis, it was noticed that some answers were not appropriate to use in the raw form; therefore, they were rearranged accordingly (i.e., experience of ≤ 10 [Group 1], 11–20 [Group 2], 21–30 [Group 3] and ≥ 31 [Group 4]).

RESULTS

Of 1077 registered dentists in Ankara, 722 were invited to participate in this study. A total of 371 dentists took part

Table 1: Demographic characteristics of the study subjects (Ankara, Turkey; 2013)

Demographic information	<i>n</i>	Percentage
Age* (<i>n</i> =328)		
25-34	123	37.5
35-44	94	28.7
45-54	66	20.1
55-64	38	11.6
≥ 65	7	2.1
Sex (<i>n</i> =328)		
Female	160	48.8
Male	168	51.2
Marital status (<i>n</i> =324)		
Married	218	67.3
Single	89	27.5
Widowed	1	0.3
Divorced	16	4.9
General dentist (<i>n</i> =235)	235	71.6
Specialist** (<i>n</i> =93)		
Not completed (<i>n</i> =32)	32	9.8
Completed (<i>n</i> =61)	61	18.6
Experience (year) (<i>n</i> =328)		
≤ 10	135	41.2
11-20	92	28.0
21-30	70	21.3
≥ 31	31	9.5

* $X \pm SS = 40.42 \pm 11.1$; median=39; 1-3. Quarters=30-48.8; minimum-maximum=25-69; **Dental specialists receive Ph.D. in their degree's field and practicing privately

in the study, representing a response rate of 51.38%, but 43 dentists excluded from the analyses due to uncompleted questionnaires. Overall, 328 questionnaires were evaluated. The demographic characteristics of the participants are shown in [Table 1].

There was no significant association between possession of a dental RG device and sex or experience ($P = 0.492$; $P = 0.733$, respectively). However, a significant association was detected between possession of an RG device and being a dental specialist ($P = 0.026$). Furthermore, possession of a radiovisiography (RVG) unit was not significantly associated with the sex of the dentists ($P = 0.682$) but was significantly associated with being a specialist ($P < 0.001$) or being experienced ($P = 0.001$). RVG devices were more commonly used by specialists and dentists with an experience of < 11 years. Moreover, possession of a panoramic RG device was significantly associated with both sex and experience ($P = 0.014$; $P < 0.001$, respectively). Possession of an intraoral camera was not

significantly associated with sex or with being a specialist ($P = 0.346$; $P = 0.226$, respectively) but had a significant association with experience [$P < 0.001$; Table 2].

A significant association was observed between the duration of air drying and experience [$P = 0.032$; Table 3]. Almost 70% of the participants never used magnification tools for detecting caries. However, it was found to be positively correlated with experience ($P = 0.005$).

Table 4 shows the percentage of dentists using a dental RG device for detecting occlusal and proximal caries. Sex and being a specialist were not significant predictors of using radiographs for examining occlusal caries. For proximal caries detection, significant differences were observed between specialist and general dentists. The percentage of specialist dentists admitting to always using a dental RG for detecting proximal caries was higher than that reported by general dentists. Significant differences were observed between active working time

Table 2: Percentage distribution of possession of diagnostic imaging systems among the private dental practitioners (Ankara, Turkey; 2013)

	Dental RG		RVG		Panaromic RG		Intra oral camera	
	n	Percentage	n	Percentage	n	Percentage	n	Percentage
Sex	$\chi^2=0.472$; df=1; $P=0.492$		$\chi^2=0.168$; df=1; $P=0.682$		$\chi^2=6.01$; df=1; $P=0.014$		$\chi^2=0.886$; df=1; $P=0.346$	
Male	116	72.5	65	40.6	34	21.2	87	54.4
Female	116	69.0	72	42.9	56	33.3	100	59.5
Being specialist	$\chi^2=4.968$; df=1; $P=0.026$		$\chi^2=28.403$; df=1; $P<0.001$		$\chi^2=1.838$; df=1; $P=0.175$		$\chi^2=1.465$; df=1; $P=0.226$	
General dentist	196	73.4	93	34.8	69	25.8	148	55.4
Specialist*	36	59.0	44	72.1	21	34.4	39	63.9
Experience (year)	$\chi^2=1.282$; df=3; $P=0.733$		$\chi^2=17.094$; df=3; $P=0.001$		$\chi^2=46.357$; df=3; $P<0.001$		$\chi^2=20.909$; df=3; $P\leq 0.001$	
≤10	99	73.3	72	53.3	64	47.4	65	48.1
11-20	63	68.5	25	27.2	12	13.0	70	76.1
21-30	47	67.1	25	35.7	11	15.7	39	55.7
≥31	23	74.2	15	48.4	3	9.7	13	41.9

*Dental specialists receive Ph.D. in their degree's field and practicing privately. RG=Radiography; RVG=Radiovisiography

Table 3: Percentage distribution of using air drying and drying time associated with some demographic characteristics (Ankara, Turkey; 2013)

Characteristics	Air drying (%)				Duration of air drying (s) (%)		
	Never	Sometimes	Frequently	Always	≤5	6-10	>10
Sex	$\chi^2=1.841$ df=3 $P=0.606$				$\chi^2=1.243$ df=2 $P=0.537$		
Male (n=157)	5.7	29.9	29.3	35.0	80.5	14.8	4.7
Female (n=162)	3.7	25.3	32.1	38.9	76.9	15.4	7.7
Being a specialist	$\chi^2=7.605$ df=3 $P=0.055$				$\chi^2=5.641$ df=2 $P=0.060$		
General dentist (n=56)	5.7	27.0	32.7	34.6	76.5	15.9	7.6
Specialist* (n=263)	-	30.4	21.4	48.2	88.9	11.1	-
Experience (year)	$\chi^2=15.706$ df=9 $P=0.073$				$\chi^2=13.821$ df=6 $P=0.032$		
≤10 (n=131)	1.5	32.1	27.5	38.9	79.8	17.1	3.1
11-20 (n=90)	7.8	26.7	40.0	25.6	74.4	14.0	11.6
21-30 (n=69)	5.8	21.7	26.1	46.4	83.1	15.4	1.5
≥31 (n=129)	6.9	24.1	27.6	41.4	76.0	8.0	16.0

*Dental specialists receive Ph.D. in their degree's field and practicing privately

Table 4: Percentage distribution of use of dental RG by some demographic characteristics (Ankara, Turkey; 2013)

	Occlusal surface (n=320) (%)				Proximal surface (n=320) (%)			
	Never	Sometimes	Frequently	Always	Never	Sometimes	Frequently	Always
Sex	$\chi^2=7.352$ df=3 $P=0.061$				$\chi^2=5.420$ df=3 $P=0.143$			
Male (n=155)	46.8	38.0	8.9	6.3	1.9	34.8	35.5	27.7
Female (n=162)	35.2	38.9	16.7	9.3	2.5	23.5	38.3	35.8
Being specialist	$\chi^2=2.576$ df=3 $P=0.462$				$\chi^2=18.375$ df=3 $P<0.01$			
General dentist (n=260)	43.0	37.3	12.2	7.6	1.9	33.1	37.7	27.3
Specialist* (n=57)	31.6	43.9	15.8	8.8	3.5	10.5	33.3	52.6
Experience (year)	$\chi^2=24.579$ df=9 $P=0.003$				$\chi^2=19.706$ df=9 $P=0.020$			
≤10 (n=131)	29.0	48.1	9.9	13.0	1.5	21.4	40.5	36.6
11-20 (n=90)	45.6	35.6	15.6	3.3	0.0	40.0	36.7	23.3
21-30 (n=67)	52.9	25.7	15.7	5.7	6.0	29.9	35.8	28.4
≥31 (n=29)	51.7	34.5	10.3	3.4	3.4	27.6	24.1	44.8

*Dental specialists receive Ph.D. in their degree's field and practicing privately. RG=Radiography

Table 5: Percentage distribution of using sharp and CPI explorer associated with some demographic characteristic (Ankara, Turkey; 2013)

	Sharp explorer on occlusal surface (n=320) (%)				Sharp explorer on proximal surface (n=318) (%)				CPI explorer on occlusal surface (n=318) (%)			
	Never	Sometimes	Frequently	Always	Never	Sometimes	Frequently	Always	Never	Sometimes	Frequently	Always
Sex	$\chi^2=6.044$; df=3; $P=0.110$				$\chi^2=4.018$; df=3; $P=0.260$				$\chi^2=10.555$; df=3; $P=0.014$			
Male	9.5	8.9	27.8	53.8	15.2	21.5	31.0	32.3	72.4	17.3	4.5	5.8
Female	12.3	16.7	27.2	43.8	8.1	25.0	31.9	35.0	64.2	21.6	12.3	1.9
Being a specialist	$\chi^2=4.348$; df=3; $P=0.226$				$\chi^2=1.227$; df=3; $P=0.747$				$\chi^2=0.614$; df=3; $P=0.893$			
General dentist	11.4	11.0	15	49.8	12.3	23.4	30.3	34.1	67.8	20.6	8.6	3.0
Specialist*	8.8	21.1	26.3	43.9	8.8	22.8	36.8	31.6	69.4	16.5	8.2	5.9
Experience (year)	$\chi^2=31.182$; df=9; $P<0.001$				$\chi^2=18.137$; df=9; $P=0.034$				$\chi^2=20.601$; df=9; $P=0.015$			
≤10	13.7	17.6	35.1	33.6	13.7	21.4	30.5	34.4	69.0	21.7	5.4	3.9
11-20	8.9	4.4	21.1	65.6	5.7	23.9	44.3	26.1	66.7	25.6	4.4	3.3
21-30	12.9	11.4	25.7	50.0	17.1	21.4	22.9	38.6	64.3	11.4	20.0	4.3
≥31	-	20.7	17.2	62.1	6.9	34.5	17.2	41.4	79.3	4.8	7.4	8.3

*Dental specialists receive Ph.D. in their degree's field and practicing privately. CPI=Community periodontal index

and the use of radiographs for examining occlusal and proximal caries ($P = 0.003$, $P = 0.020$, respectively). There was a negative correlation between experience and using RG for detection of occlusal caries.

Table 5 presents the results of the use of sharp/community periodontal index (CPI) explorers for the diagnosis of occlusal and proximal caries. There was no significant association between using sharp explorer and sex or being a specialist ($P = 0.110$, $P = 0.226$, respectively). The use of a sharp explorer significantly correlated with increased active working time for the detecting occlusal ($P < 0.001$) and proximal caries ($P = 0.034$). Significant differences were also observed between the use of CPI explorers and sex or active working time ($P = 0.014$; $P = 0.025$, respectively).

Only three participants reported the use of DIAGNodent, while two participants used FOTI.

DISCUSSION

Dental practitioners were not selected by random sampling with rather invited participations and represent a substantial diversity with regard to practice settings and patient populations. However, potential limitations of this study were the low overall response rate and the lowest rate was in the location (Çankaya) residing dental practitioners with high socioeconomic status. With these limitations, it is reasonable to assume that the present sample, with a response rate of 51.38%, appears typical for this type of survey.

In this study, the percentage of dentists with an experience of >30 years was considerably low (9.5%) compared with that of dentists with an experience of <11 years (41.2%). The sex ratio of the participants was not markedly different in this study; this observation partly correlates with the results of previous studies by Russell and Leggate^[11] reported that two-thirds of the Scottish

and English general practitioners, respectively, were males. Specialists constituted only one-fourth of the total dental practitioners in our study, and most of them were observed to be young dentists. In the near future, the sex ratio of dentists with specialization is also expected to be markedly different.

Accurate caries detection is of a paramount importance for appropriate oral health care, practically none of the currently used caries detection methods fulfill the requisite criteria.^[12-15] The dental radiograph was the most commonly used tool for caries diagnosis, as reported by almost all dentists in this study. RG is associated with the risk of ionized radiation. Instead of X-ray beams, an RVG unit is equipped with a special device that captures digital images of dental hard tissues. The advantages of an RVG system include time efficacy by bypassing chemical processing stages and the ability to produce images with less radiation. However, the use of RVG in the private dental practice is probably more influenced by individual preferences rather than its clinical performance, considering the economic obligations of using this device.^[16-18] Therefore, the possession rate of an RVG unit in dental clinics was extremely low in this study, considering its ease of use and overall benefits for the patient. However, it was more commonly used by specialist dentists compared with general dentists in this study. Further, Soğur and Akdeniz^[18] investigated differences in understanding the principles of RVG among dental students, private practitioners and academicians in Izmir/Turkey. They reported that most academicians and dental students preferred to use an RVG unit compared with private practitioners who preferred working with conventional RG, owing to its low cost. Moreover, patients can be referred to one of the several RG centers located in the city as a cheaper and more practical alternative.

Boye *et al.*^[19] have recently investigated the difference between the usage of a blunt explorer and dental mirror for visual examination and the inspection of visual photographic scores for the detection of carious lesions. No clinically significant differences were noted between the photographic scores and visual assessments, highlighting the importance of taking patient records using an intraoral camera. In this study, the number of dentists possessing an intraoral camera was not high, with most of them belonging to the younger age group. However, a statistically significant association was observed between using an intraoral camera and experience.

As a popular diagnostic approach, air drying enhances visibility during the clinical evaluation. In this study, the frequency of using an air drying was found to be consistent with that reported by Gordan *et al.*^[6] However,

the duration of air drying was markedly different between the two studies. In this study, most participants air dried the tooth for more than 10 s, whereas the participants in the study by Gordan *et al.* used <6 s. Furthermore, 12 of 240 participants reported a total air drying time of 20 s or higher, which resulted in an increase in the average air drying duration in our study.

Gordan *et al.*^[6] have indicated that magnification tools were less frequently used compared with explorers and dental radiographs. In this study, the frequency of using a magnification tool consistently increased with age, which may be attributed to the deterioration of eye function with the advanced age.

Proximal lesions can generally be detected earlier by radiographs compared with visual diagnosis alone. RG is a widely used lesion detection tool, particularly for the detection of the hidden caries or imperceptible proximal areas.^[20] Galcerá Civera *et al.*^[21] and Hopcraft and Morgan^[22] have reported an association between visual-tactile examination methods and dental RG. The findings in this study are in accordance with those reported by Gordan *et al.*^[6] wherein radiographs were used to support the diagnosis of 75–100% of proximal carious lesions by 96% of dental practice-based research network dentists. Nearly, all participants in our study used dental radiographs for determining the presence of a carious lesion on the proximal surface of a posterior tooth. However, the reliability of an RG device for the detection of enamel lesions located on occlusal surfaces is questionable because of the superimposition of the buccal and lingual enamel walls. Thus, it may be impossible to detect occlusal enamel caries on radiographs.^[23] In this study, the use of an RG device was lower for the detection of occlusal caries than for proximal lesions, in accordance with the current literature.

Students are trained to use dental explorers during their study period in dental schools in Turkey. Many studies have stated that the use of a dental explorer is of limited value for the detection of caries.^[12,24,25] The use of a sharp explorer has been recently discouraged in many countries because of the limited benefits provided by the over meticulous visual examination of a dry tooth and the lack of diagnostic sensitivity or specificity.^[12] It may irreversibly damage the tooth by turning sound and remineralizable subsurface lesion into a cavitated lesion that is more prone to lesion progression.^[26-28] This study has revealed that the sharp explorer was one of the main instruments used by dentists for detecting occlusal and proximal dental caries. The use of an explorer has been reported as a commonly used diagnostic tool in other studies.^[6,20] The use of DIAGNO dent and FOTI is found very low, consistent with the findings of Gordan *et al.*^[6]

CONCLUSIONS

This study attempted to document the current status of dental caries diagnostic methods in Ankara, Turkey, in order to improve oral health. It was observed that sharp explorers and conventional radiographs were among the main instruments used for detecting carious lesions. However, very low percentage usage of magnification tools, FOTI, and DIAGNO dent devices was observed in dental practices.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

- World Health Organisation. Available from: <http://www.who.int/mediacentre/factsheets/fs318/en/>. [Last accessed on 2015 May 15].
- Gilbert GH, Bader JD, Litaker MS, Shelton BJ, Duncan RP. Patient-level and practice-level characteristics associated with receipt of preventive dental services: 48-month incidence. *J Public Health Dent* 2008;68:209-17.
- Mettes TG, van der Sanden WJ, Mokkink HG, Wensing M, Grol RP, Plasschaert AJ. Routine oral examination: Clinical performance and management by general dental practitioners in primary care. *Eur J Oral Sci* 2007;115:384-9.
- Rindal DB, Gordan VV, Litaker MS, Bader JD, Fellows JL, Qvist V, *et al.* Methods dentists use to diagnose primary caries lesions prior to restorative treatment: Findings from The Dental PBRN. *J Dent* 2010;38:1027-32.
- Gilbert GH, Weems RA, Litaker MS, Shelton BJ. Practice characteristics associated with patient-specific receipt of dental diagnostic radiographs. *Health Serv Res* 2006;41:1915-37.
- Gordan VV, Riley JL, Carvalho RM, Snyder J, Sanderson JL, Anderson M, *et al.* Methods used by Dental Practice-based Research Network (DPBRN) dentists to diagnose dental caries. *Oper Dent* 2011;36:2-11.
- Downer MC. Validation of methods used in dental caries diagnosis. *Int Dent J* 1989;39:241-6.
- Gökalp SG, Dogan BG, Tekçiçek MT, Berberoğlu A, Unlüer S. National survey of oral health status of children and adults in Turkey. *Community Dent Health* 2010;27:12-7.
- Yaramış N, Karataş N, Ekti F, Aslantaş D. Determining oral health conditions and habits of primary school students in central Nevşehir. *J of Cont Med Educ* 2005;14:256-9.
- Turkish Dental Association (TDB). Available from: http://www.tdb.org.tr/tdb/v2/yayinlar/Dishekimi_Dagilim_Kitapciklari/2012Yili_DishDagKitapcigi.pdf. [Last accessed on 2012 Mar 19].
- Russell E, Leggate M. Dentists in general and community practice: A Scottish survey. *Br Dent J* 2002;193:333-7.
- Lussi A. Validity of diagnostic and treatment decisions of fissure caries. *Caries Res* 1991;25:296-303.
- Bamzahim M, Aljehani A, Shi XQ. Clinical performance of DIAGNodent in the detection of secondary carious lesions. *Acta Odontol Scand* 2005;63:26-30.
- Reis A, Zach VL Jr, de Lima AC, de Lima Navarro MF, Grande RH. Occlusal caries detection: A comparison of DIAGNOdent and two conventional diagnostic methods. *J Clin Dent* 2004;15:76-82.
- Souza JF, Boldieri T, Diniz MB, Rodrigues JA, Lussi A, Cordeiro RC. Traditional and novel methods for occlusal caries detection: Performance on primary teeth. *Lasers Med Sci* 2013;28:287-95.
- Wenzel A, Møystad A. Experience of Norwegian general dental practitioners with solid state and storage phosphor detectors. *Dentomaxillofac Radiol* 2001;30:203-8.
- Miles DA, Razzano MR. The future of digital imaging in dentistry. *Dent Clin North Am* 2000;44:427-38.viii
- Soğur E, Akdeniz BG. Evaluation of the Knowledge, Attitudes and Behaviours of Dental Students and General Dental Practitioners About Digital Radiography. *J Dent Fac Ankara Univ* 2005;32:207-13.
- Boye U, Willasey A, Walsh T, Tickle M, Pretty IA. Comparison of an intra-oral photographic caries assessment with an established visual caries assessment method for use in dental epidemiological studies of children. *Community Dent Oral Epidemiol* 2013;41:526-33.
- Neuhaus KW, Ellwood R, Lussi A, Pitts NB. Traditional lesion detection aids. *Monogr Oral Sci* 2009;21:42-51.
- Galcerá Civera V, Almerich Silla JM, Montiel Company JM, Forner Navarro L. Clinical and radiographic diagnosis of approximal and occlusal dental caries in a low risk population. *Med Oral Patol Oral Cir Bucal* 2007;12:E252-7.
- Hopcraft MS, Morgan MV. Comparison of radiographic and clinical diagnosis of approximal and occlusal dental caries in a young adult population. *Community Dent Oral Epidemiol* 2005;33:212-8.
- Kidd EA, Ricketts DN, Pitts NB. Occlusal caries diagnosis: A changing challenge for clinicians and epidemiologists. *J Dent* 1993;21:323-31.
- Hamilton JC. Should a dental explorer be used to probe suspected carious lesions? Yes – An explorer is a time-tested tool for caries detection. *J Am Dent Assoc* 2005;136:1526-1528.1530.
- McComb D, Tam LE. Diagnosis of occlusal caries: Part I Conventional methods. *J Can Dent Assoc* 2001;67:454-7.
- Ekstrand K, Qvist V, Thylstrup A. Light microscope study of the effect of probing in occlusal surfaces. *Caries Res* 1987;21:368-74.
- Kuhnisch J, Dietz W, Stosser L, Hickel R, Heinrich-Weltzien R. Effects of dental probing on occlusal surfaces-A scanning electron microscopy evaluation. *Caries Res* 2007;41:43-8.
- Yassin OM. *In vitro* studies of the effect of a dental explorer on the formation of an artificial carious lesion. *ASDC J Dent Child* 1995;62:111-7.