

Assessment of Knowledge, Attitude and Practice of C-shaped Root Canals among Dental Students and Dentists in the Makkah Region of Saudi Arabia- A Cross-sectional Study

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ABSTRACT

Introduction: Thorough management of root canal anatomy and its variants is important for good prognosis of endodontic treatment. C-shaped root canal is one such important variation in root canal anatomy. Due to the complex nature of C-shaped root canals the clinicians should be familiar with this variation to achieve better success rate in endodontic treatment.

Aim: To assess Knowledge, Attitude and Practice (KAP) among dental students and dentists of the Makkah region of the Kingdom of Saudi Arabia towards C-shaped root canals.

Materials and Methods: A cross-sectional questionnaire survey was conducted for a period of five months from 25th September 2020 to 25th February 2021 in Dentistry program of Ibn Sina National College for Medical Studies, Jeddah using a self-structured, close-ended, multiple-choice questionnaire consisting of 21 questions. The questionnaire was sent using online to 503 Dental students and Dentists of Makkah region of Saudi Arabia. The study population was selected using convenient random sampling. The questionnaire was constructed and validated with the help of five endodontists with adequate teaching and clinical experience. The data were analysed using IBM Statistical Package for the

Social Sciences (SPSS) version 22.0 and descriptive statistics followed by Chi-square test was applied to test of variables in the questionnaire.

Results: In the study population, 68.4% (n=344) were males and 31.6% (n=159) were females, 25.2% (n=127) were undergraduate students and 74.7% (n=376) were graduate dentists, 63.2% (n=318) believe most commonly C-shaped root canals are found in mandibular second molars, 49.3% (n=248) have strongly agreed that they are proficient in diagnosing C-shaped root canals, 75.7% (n=381) have agreed that knowledge of canal anatomy will be helpful during access preparation of C-shaped root canals, 48.5% (n=244) felt use of crown down technique will be effective in managing C-shaped root canals, 72.8% (n=366) felt multiple visit endodontics is needed for successful management of C-shaped root canals and 25.8% (n=130) felt use of thermoplasticised gutta-percha compaction will be helpful in obturation.

Conclusion: Knowledge of anatomical variations of root canal system and the use of advanced endodontic instruments and techniques will enable the dentists to handle difficult root canal cases thoroughly for good prognosis of dentition.

Keywords: Endodontic management, Mandibular second molar, Root canal anatomy

INTRODUCTION

Complete knowledge and understanding of root canal system, as well as identification of atypical canal configuration are paramount for efficient root canal therapy [1]. An important variation is the “C” configuration which was originally mentioned in the publication by Cooke and Cox in 1979 [2]. It is termed based on the cross-sectional morphology of the root canal in the molar teeth. In variation to normal anatomy, the orifice of a C-shaped canal is ribbon-shaped and transcribes an arc of 180 degrees. The feature usually begins at mesiolingual line angle of the pulp chamber, curves buccally which terminates at the distal aspect [2]. Failure of Hertwig’s epithelial root sheath to fuse on the lingual or buccal root surface is the most accepted as a cause of C-shaped root canals [3]. Attaching a name to the atypical C-shaped canals led to various classification systems which was notably developed by Melton DC et al., and Fan B et al., [4,5].

C-shaped canals often give a dentist an immense difficulty at the diagnostic level, during chemomechanical preparation and obturation. The incidence of C-shaped canal varies greatly among different ethnicities, common in Asians, but somewhat limited among European and Americans [6]. C-shaped canals are usually

observed in the mandibular second molar. However, it may also occur in maxillary molars, the mandibular first molar and mandibular first premolar [7-9]. Although conventional radiography imaging remain the method of choice for endodontic management prior to endodontic treatment [10]. CBCT is a valuable tool to evaluate the C-shaped root canal configuration in-vivo studies [11].

Knowledge and understanding of pulp chamber anatomy applied during access preparation like principle of colour change and principle of orifice location is very important to prevent endodontic mishaps. Due to the atypical form and complex nature of a C-shaped root canal, many methods are recommended to assist in the management of root canal treatment. Clinical case reports have suggested the use of ultrasonic instruments along with a nickel-titanium rotary system for successful cleaning and shaping [12] and application of thermoplasticised gutta-percha to achieve hermetic seal obturation [13]. To reduce failure of endodontic treatment in C-shaped root canals, practitioners should have a thorough knowledge of root canal morphology, should provide complete debridement of root canals and hermetic seal in obturation [14].

Although, there is scientific literature about incidence, the morphology of C-shaped root canals and their significance in the success of

endodontics [15]. However, due to the complex nature of C-shaped root canals the clinicians will have difficulty in debridement and obturation of these types of root canals effectively. Till to date, to this knowledge no study has been conducted in the Makkah region of Saudi Arabia. Hence, the rationale behind the study was to ascertain KAP among dental students and dentists of the Makkah region of the Kingdom of Saudi Arabia towards C-shaped canals through a questionnaire-based survey.

MATERIALS AND METHODS

This research was a cross-sectional questionnaire-based study conducted in the Dentistry program of Ibn Sina National College for Medical Studies, Jeddah. The study was planned from 25th September 2020 to 25th February 2021 and completed in five months. Ethical clearance was obtained from the Institutional Ethical Committee with approval number (H-14-19102020).

Inclusion criteria: The undergraduate dental students of sixth year, interns, general dentists, specialist dentists were included in the study.

Exclusion criteria: The undergraduate dental students of fourth year, fifth year and Dentists who were not willing to participate were excluded from the study.

Sample size calculation: The study population was selected using convenient random sampling. Sample size was assessed using G* power software [16].

Questionnaire

A self-structured, close-ended, Questionnaire [Annexure 1] was originally developed by chief investigator and the research team. The difficulties in understanding each question, its inference was critically analysed and minor modifications were made based on the feedback of subject experts in the final questionnaire. Cronbach's alpha of 0.72 was regarded as satisfactory for ensuring internal reliability. A total of 21 questions divided into 4 sections, 4 questions on demographic data, 4 questions on Knowledge, 5 questions on Attitude and 8 questions on Practices related to C-shaped canals among dental students and dentists of Makkah region of Saudi Arabia.

The questionnaire was sent online to 503 dental students and dentists across Kingdom of Saudi Arabia. They were asked to make the best choice from the options available. The participant's consent was obtained after assuring that their identity would be kept strictly confidential.

STATISTICAL ANALYSIS

The data were tabulated on Microsoft Excel (Microsoft, Redmond, WA, USA) and analysed using IBM Statistical Package for the Social Sciences (SPSS) version 22.0. Descriptive statistics followed by χ^2 -test was applied to test of variables in the questionnaire to determine their association. The significance value p-value ≤ 0.05 is considered as statistically significant.

RESULTS

In the study population of 503 participants from Makkah region of Saudi Arabia, 68.4% (n=344) were males and 31.6% (n=159) were females, 25.2% (n=127) were undergraduate students and 74.7% (n= 376) were Graduate dentists, 76.1% (n=383) currently practice endodontics in their clinic or field, [Table/Fig-1]. In this study, 63.2% (n=318) felt the most common tooth having C-shaped root canals in mandibular second molars, 59.4% (n=299) felt the type of population in which C-shaped root canals are found in Asians and 53.7% (n=270) have strongly agreed that knowledge of canal anatomy is helpful during access preparation of C-shaped root canals [Table/ Fig-2]. In the study population, 49.3% (n=248) have strongly agreed that they are proficient in diagnosing C-shaped root canals, 66% (n=332) felt Cone Beam Computed Tomography (CBCT) will be

Parameters	Frequency	Percentage
Gender		
Male	344	68.4
Female	159	31.6
Total	503	100
Academic position		
Undergraduate student	127	25.2
Postgraduate student	84	16.7
General dentist	94	18.7
Specialist dentist	68	13.5
Consultant dentist	38	7.6
Lecturer	22	4.4
Assistant professor	41	8.2
Associate professor	16	3.2
Professor	13	2.6
Total	503	100
Years of experience		
Not yet graduated	121	24.06
Less than 5 years	152	30.2
5 to 10 years	101	20.08
More than 10 years	129	25.6
Total	503	100
Do you currently practice endodontics		
Yes	383	76.1
No	120	23.9
Total	503	100
C-shaped canals observed in your practice		
10% or less	180	35.8
10-20%	217	43.1
20-30%	99	19.7
More than 30%	7	1.4
Total	503	100

[Table/Fig-1]: Demographic data of the study population.

Parameters	Frequency	Percentage
Most common tooth involved		
Mandibular second molar	318	63.2
Maxillary first molar	65	12.9
Maxillary second molar	40	8.0
Mandibular second premolar	64	12.7
Mandibular third molar	16	3.2
Total	503	100
Most common type of population involved		
Asian	299	59.4
European	51	10.1
Americans	35	7.0
Africans	115	22.9
Any others	3	0.6
Total	503	100
Age group of patients have C-shaped canals		
Less than 20 years	90	17.9
20-30 years	257	51.1
31-40 years	80	15.9
More than 40 years	76	15.1
Total	503	100
Knowledge of root canal anatomy in diagnosis		
Strongly agree	270	53.7

Agree	149	29.6
Neutral	60	11.9
Disagree	24	4.8
Total	503	100

[Table/Fig-2]: Knowledge of dentists regarding C-shaped root canal.

useful in diagnosing C-shaped root canals, 68% (n=342) have strongly agreed that use of magnification like operating microscope and loupes will be useful in managing C-shaped root canals, 33.4% (n=168) felt use of electronic apex locator will be useful in during working length measurement of C-shaped canals [Table/Fig-3]. In the study population, 48.5% (n=244) felt use of crown down technique will be effective in cleaning and shaping of C-shaped root canals, 39.8% (n=200) felt use of ultrasonic irrigation will be effective irrigation and 72.8% (n=366) felt multiple visit endodontics is needed for successful management of C-shaped root canals, 25.8% (n=130) felt use of thermoplasticised gutta-percha compaction as a type of obturation to create a hermetic seal in C-shaped root canals, 36.4% (n=183) felt use of custom cast post to augment the strength of endodontically treated teeth in C-shaped root canals [Table/Fig-4].

Parameters	Frequency	Percentage
Proficient in diagnosis		
Strongly agree	248	49.3
Agree	133	26.4
Neutral	72	14.3
Disagree	42	8.3
Strongly disagree	8	1.6
Total	503	100
Radiographic method used in diagnosis		
Conventional radiography	71	14.1
Xeroradiography	24	4.8
Direct digital radiography	70	13.9
Cone beam computed tomography	332	66.0
Any other	6	1.2
Total	503	100
Use of magnification during access preparation		
Strongly agree	342	68
Agree	86	17
Neutral	52	10.3
Disagree	23	4.6
Total	503	100
Working length measurement		
Conventional radiography	140	27.8
Xeroradiography	84	16.7
Direct digital radiography	111	22.1
Electronic apex locator	168	33.4
Total	503	100
C shaped canals observed in your practice		
10% or less	180	35.8
10-20%	217	43.1
20-30%	99	19.7
More than 30%	7	1.4
Total	503	100

[Table/Fig-3]: Attitude of dentists towards C-shaped canals.

Parameters	Frequency	Percentage
Technique of cleaning and shaping		
Step back technique	68	13.5
Modified step back technique	47	9.3

Passive step back technique	29	5.8
Balanced forced technique	47	9.3
Crown down technique	244	48.5
Hybrid technique	35	7.0
Anticurvature filling	11	2.2
Circumferential filling	22	4.4
Total	503	100

Irrigation technique		
Manual syringe irrigation with needle	93	18.5
Quantec-E irrigation system	101	20.1
Ultrasonic irrigation	200	39.8
Sonic irrigation	24	4.8
Endovac system	74	14.7
Rinse endo system	11	2.2
Total	503	100

Type of irrigation used		
Sodium hypochlorite	177	35.2
Ethylenediamine tetraacetic acid	157	31.21
Chlorhexidine	60	11.9
MTAD	66	13.1
Ozonated water	43	8.5
Total	503	100

Number of visits		
Single visit	137	27.2
Multiple visit	366	72.8
Total	503	100

Intracanal medicament used		
Calcium hydroxide	392	77.9
Phenolic compounds	22	4.4
Aldehyde compounds	37	7.4
Antibiotics	49	9.7
Combination of antibiotics and steroids	3	0.6
Total	503	100

Technique of obturation		
Single cone technique	114	22.7
Cold and warm lateral condensation	9	1.8
Warm vertical condensation	48	9.5
Continuous wave of condensation	93	18.5
Chemoplasticised gutta-percha	53	10.5
Thermoplasticised gutta-percha obturation	130	25.8
Thermomechanical compaction	40	8.0
Combination	16	3.2
Total	503	100

Type of sealer used		
Zinc oxide based	141	28
Salicylate based	53	10.5
Resin based	112	22.3
Tricalcium phosphate based	186	37
Calcium hydroxide based	11	2.2
Total	503	100

Postsystem		
Prefabricated post	182	36.2
Custom cast post	183	36.4
Glass fibre post	55	10.9
Threaded post	19	3.8
No post needed	57	11.3
Total	496	100

[Table/Fig-4]: Dentists practices towards C-shaped root canals. Mixture of tetracycline isomer, citric acid and detergent (MTAD)

DISCUSSION

The unusual anatomic structure of the C-shaped root canal system can lead to difficulties during endodontic treatment ultimately affects prognosis [15]; therefore, dentists should be familiar with this complex anatomy of the root canal. The prevalence of C-shaped canals differs among different ethnicities. In the present study, 59.4% of them felt that C-shaped root canals are frequently found in Asians, 22.9% in Africans and 10.1% in Europeans and 7% in Americans. This is in accordance with the study by Wang Y et al., where authors concluded prevalence of C-shaped canals is 41.27% in a native Chinese population using radiography and clinical examination under magnification [17] 8.5% in a European population [18] and 9.1% in Saudi Arabian population [19] which indicates its racial distribution.

Tratman EK observed that the C-shaped root morphology is frequently found in mandibular second molars. He named this morphology as the horse-shoe reduction form [20]. In the present study, 63.2% of them felt that C-shaped root canals are commonly occur in mandibular second molars, 12.9% in maxillary first molars, 12.7% in mandibular second premolar and 3.2% in Mandibular third molar. This is in accordance with the study by Martins JNR et al., where authors concluded C-shaped canal have higher prevalence in mandibular second molars ranging between 36-43.1% using CBCT [21]. The C-shaped canal anatomy has also been identified in maxillary first molars (0.12%), maxillary third molars (4.7%), mandibular third molars (3.5%-4%) and mandibular second premolars (1%) [22-25].

A fundamental understanding of pulp chamber anatomy is very important to prevent endodontic mishaps. In the present study, 75.7% have strongly agreed the use of knowledge of canal anatomy such as the principle of colour change and the principle of orifice location are helpful during access preparation of C-shaped root canals. Cemento-Enamel Junction (CEJ) is an established landmark and the principle of colour change and the principle of orifice location can be effectively applied in C-shaped roots [6]. In the present study, 66% have strongly agreed that CBCT is an effective tool in diagnosing C-shaped root canals; while 14.1 % felt conventional radiography is sufficient for diagnosing C-shaped root canals. Preoperative intraoral periapical radiographs provide less significance in recognising C-shaped root canals [26]. CBCT is more effective than conventional radiography in treatment planning in dentistry. This is in accordance with the study by replace with Lee TY et al., where authors concluded 36.8% of C-shaped canals were found in Korean population using CBCT [27].

Magnification devices are indeed an evolution from the conventional method of macrodentistry to high precision microdentistry. The use of magnification devices can lead to improved outcomes, thereby resulting in a higher quality of care. In the present study, the participants strongly agreed (68%) use of magnification like operating microscope and loupes is helpful during access preparation of C-shaped root canals. This is in accordance with the study by Wang Y et al., where authors concluded higher incidence of C-shaped canals was observed by using magnification devices like an operating microscope (41.27%), than using the conventional radiography (34.64%) or clinical examination (39.18%) alone [17].

Correct determination of working length is the critical step for successful endodontics. In the present study, 33.4 % felt the use of an electronic apex locator will be useful in working length determination of C-shaped root canals, while 27.8% felt the use of conventional radiography is sufficient. This is in accordance with the study by Jafarzadeh H et al., where authors concluded there was no significant differences between working length obtained by apex locator and radiography in-vitro study, although apex locator was more precise in confirmation of the working length [28].

In the present study, 48.5% felt the use of crown down technique will be useful for instrumentation of root canals, 13.5% felt the use of step back is sufficient, while surprisingly only 2.2% felt anti-curvature filling will be useful in biomechanical preparation. It has been reported that higher chance of root perforation at the thin lingual wall of C-shaped

root canals in mandibular molars and the mesial walls of C-shaped root canals in mandibular first premolars during instrumentation of root canals [29]. The main goal of root canal therapy is complete elimination of microorganisms from the root canal system and prevents recontamination. To achieve this biomechanical preparation must be combined with adequate irrigation of root canals [30]. In the present study, 39.8% felt the use of ultrasonic irrigation will be effective in the debridement of root canals; followed by 20.1 % feel Quantec-E irrigation method will be useful in irrigation. This is in accordance with the study by Zhao Y et al., where authors concluded passive ultrasonic irrigation remove more debris than syringe and needle irrigation within the C-shaped canals of mandibular molars [31].

A three-dimensional obturation is crucial for the ultimate success of endodontic treatment. In the present study, 25.8% felt the use of thermoplasticised obturation method, whereas 22.7% felt the use of single cone technique is sufficient for obturation of C-shaped root canals. This is in accordance with the study by Kim HH et al., where authors compared warm gutta-percha obturation techniques with cold lateral condensation technique using simulated C-shaped root canals embedded in resin blocks, warm gutta-percha obturation techniques gives appropriate canal filling in C-shaped root canals [32].

In the present study, 36.4% felt the need of custom cast post, other 36% felt need of prefabricated post is sufficient if post is desired. If post placement is required, distal canal is preferred [33]. The mesiobuccal and mesiolingual walls are very narrow, placement of posts in the mesiolingual and mesiobuccal areas of C-shaped root canal leads to perforation [29].

Limitation(s)

There are few limitations of the study namely level of education and quality of practice is different from dental students and practicing dentists as well as specialist dentists and the study population is not equally distributed among the participants.

CONCLUSION(S)

Although, there was a good understanding and knowledge of the anatomical variations of the C-shaped root canal among dental students and dentists. However, there was a different treatment protocol practiced among different participants, especially during biomechanical preparation and obturation. The standard of care in managing C-shaped root canals effectively can be improved by continuing dental education programs and incorporation of advanced endodontics training among dentists. With the advancement of endodontic instruments and techniques, further research is necessary to manage the C-shaped root canal cases successfully throughout the endodontic procedures for a favourable long-term prognosis.

REFERENCES

- [1] de Pablo OV, Estevez R, Péix Sánchez M, Heilborn C, Cohenca N. Root anatomy and canal configuration of the permanent mandibular first molar: A systematic review. *J Endod.* 2010;36(12):1919-31.
- [2] Cooke HG, Cox FL. C-Shaped canal configurations in mandibular molars. *J Am Dent Assoc.* 1979;99(5):836-39.
- [3] Manning SA. Root canal anatomy of mandibular second molars. Part II. C-Shaped canals. *Int Endod J.* 1990;23(1):40-45.
- [4] Melton DC, Krell KV, Fuller MW. Anatomical and histological features of C-Shaped canals in mandibular second molars. *J Endod.* 1991;17(8):384-88.
- [5] Fan B, Cheung GS, Fan M, Gutmann JL, Fan W. C-Shaped canal system in mandibular second molars: Part II-Radiographic features. *J Endod.* 2004;30(12):904-08.
- [6] Cohen S, Burns RC. *Pathways of the pulp* 8th ed. St Louis Mosby. 2002.
- [7] Newton CW, McDonald S. A C-Shaped canal configuration in a maxillary first molar. *J Endod.* 1984;10(8):397-99.
- [8] Bolger WL, Schindler WG. A mandibular first molar with a C-Shaped root configuration. *J Endod.* 1988;14(10):515-19.
- [9] De Moor RJ. C-Shaped root canal configuration in maxillary first molars. *Int Endod J.* 2002;35(2):200-08.
- [10] Yılmaz F, Kamburoglu K, Yeta NY, Öztan MD. Cone beam computed tomography aided diagnosis and treatment of endodontic cases: Critical analysis. *World J Radiol.* 2016;8(7):716-25.
- [11] von Zuben M, Martins JNR, Berti L, Cassim I, Flynn D, Gonzalez JA, et al. Worldwide prevalence of mandibular second molar c-shaped morphologies evaluated by cone-beam computed tomography. *J Endod.* 2017;43(9):1442-47.

- [12] Yin X, Cheung GS, Zhang C, Masuda YM, Kimura Y, Matsumoto K. Micro-computed tomographic comparison of nickel-titanium rotary versus traditional instruments in C-Shaped root canal system. *J Endod.* 2010;36(4):708-12.
- [13] Elumalai D, Kumar A, Tewari RK, Mishra SK, Andrabi SM, Iftikhar H, et al. Management of C-Shaped root canal configuration with three different obturation systems. *Eur J Gen Dent.* 2015;4:25-28.
- [14] Kim Y, Lee D, Kim DV, Kim SY. Analysis of Cause of Endodontic Failure of C-Shaped Root Canals. *Scanning.* 2018;2018:2516832.
- [15] Kato A, Ziegler A, Higuchi N, Nakata K, Nakamura H, Ohno N. Aetiology, incidence and morphology of the C-Shaped root canal system and its impact on clinical endodontics. *Int Endod J.* 2014;47(11):1012-33.
- [16] Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: A flexible statistical power analysis program for the social, behavioural, and biomedical sciences. *Behav Res Methods.* 2007;39(2):175-91.
- [17] Wang Y, Guo J, Yang HB, Han X, Yu Y. Incidence of C-Shaped root canal systems in mandibular second molars in the native Chinese population by analysis of clinical methods. *Int J Oral Sci.* 2012;4(3):161-65.
- [18] Martins JNR, Mata A, Marques D, Caramês J. Prevalence of C-Shaped mandibular molars in the Portuguese population evaluated by cone-beam computed tomography. *Eur J Dent.* 2016;10(4):529-35.
- [19] Alfawaz H, Alqedairi A, Alkhayyal AK, Almobarak AA, Alhusain MF, Martins JNR. Prevalence of C-Shaped canal system in mandibular first and second molars in a Saudi population assessed via cone beam computed tomography: A retrospective study. *Clin Oral Investig.* 2019;23(1):107-12.
- [20] Tratman EK. A comparison of the teeth of people; Indo-European racial stock with the Mongoloid racial stock. *Dent Rec (London).* 1950;70(3):63-88.
- [21] Martins JNR, Marques D, Silva EJNL, Caramês J, Mata A, Versiani MA. Prevalence of C-Shaped canal morphology using cone beam computed tomography- a systematic review with meta-analysis. *Int Endod J.* 2019;52(11):1556-72.
- [22] Seo DG, Gu Y, Yi YA, Lee SJ, Jeong JS, Lee Y, et al. A biometric study of C-shaped root canal systems in mandibular second molars using cone-beam computed tomography. *Int Endod J.* 2012;45(9):807-14.
- [23] Sidow SJ, West LA, Liewehr FR, Loushine RJ. Root canal morphology of human maxillary and mandibular third molars. *J Endod.* 2000;26(11):675-78.
- [24] Cleghorn BM, Christie WH, Dong CC. Root and root canal morphology of the human permanent maxillary first molar: A literature review. *J Endod.* 2006;32(9):813-21.
- [25] Yu X, Guo B, Li KZ, Zhang R, Tian YY, Wang H, et al. Cone-beam computed tomography study of root and canal morphology of mandibular premolars in a western Chinese population. *BMC Med Imaging.* 2012;12:18.
- [26] Lambrianidis T, Lyroudia K, Pandelidou O, Nicolau A. Evaluation of periapical radiographs in the recognition of C-Shaped mandibular second molars. *Int Endod J.* 2001;34(6):458-62.
- [27] Lee TY, Yang SE, Kim KJ. Prevalence and Morphology of C-Shaped Canals: A CBCT Analysis in a Korean Population". *Scanning.* 2022;2022. Doi: 10.1155/2022/9841276.
- [28] Jafarzadeh H, Beyrami M, Forghani M. Evaluation of conventional radiography and an electronic apex locator in determining the working length in C-Shaped canals. *Iran Endod J.* 2017;12(1):60-63.
- [29] Chai WL, Thong YL. Cross-sectional morphology and minimum canal wall widths in C-Shaped roots of mandibular molars. *J Endod.* 2004;30(7):509-12.
- [30] Ismail PM, Siddiq Ahamed PB, Sekhar MC, Moosani G, Reddy SN, Reddy NU, et al. Comparison of sealer penetration by using different irrigation techniques-An in-vitro study. *J Clin Diagn Res.* 2016;10(12):ZC50.
- [31] Zhao Y, Fan W, Xu T, Tay FR, Gutmann JL, Fan B. Evaluation of several instrumentation techniques and irrigation methods on the percentage of untouched canal wall and accumulated dentine debris in C-Shaped canals. *Int Endod J.* 2019;52(9):1354-65.
- [32] Kim HH, Cho KM, Kim JW. Comparison of warm gutta-percha condensation techniques in ribbon shaped canal: Weight of filled gutta-percha. *J Korean Acad Conserv Dent.* 2002;27:277-83.
- [33] Jafarzadeh H, Wu YN. The C-Shaped root canal configuration: A review. *J Endod.* 2007;33(5):517-23.

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ANNEXURE 1

Assessing Knowledge, Attitude and Practice of C-shaped Canals among Dental Students and Dentists in the Makkah Region of Saudi Arabia.

We are conducting a questionnaire on based study assessing the knowledge, attitude and practices of dentists regarding C- Shaped canals among Dental Students and Dentists in the Makkah region of Saudi Arabia. We request you to submit your responses to all questions included in questionnaire. We assure that your identity will be kept confidential. Research proposal no (H - 14-19102020). Thanking you in anticipation.

1. Gender
 - a. Male
 - b. Female
2. Academic title/Position (You can choose more than one)
 - a. Undergraduate student
 - b. Postgraduate student
 - c. General Dentist
 - d. Specialist Dentist
 - e. Consultant Dentist
 - f. Lecturer
 - g. Assistant Professor
 - h. Associate Professor
 - i. Professor
3. Years of experience since completed your undergraduate training
 - a. Not yet graduated
 - b. Less than 5 years
 - c. 5 -10 years
 - d. More than 15 years
4. In which tooth you commonly observed C-shaped canals in your practice
 - a. Mandibular second molars
 - b. Maxillary first molars
 - c. Maxillary second molars
 - d. Mandibular second premolar
 - e. Mandibular third molar
 - f. Any other please specify:

5. Which type of population do you think C-shaped canals are common?
 - a. Asian
 - b. Europeans
 - c. Americans
 - d. Africans
 - e. Any other please specify:
6. Do you currently practice endodontics in your clinic or field?
 - a. Yes
 - b. No
7. Do you believe you are proficient in diagnosing C-shaped canals?
 - a. Strongly agree
 - b. Agree
 - c. Neutral
 - d. Disagree
 - e. Strongly disagree
8. Which radiographic method do you feel helpful for diagnosis of C-shaped canals?
 - a. Conventional Radiographic method
 - b. Xeroradiography
 - c. Direct Digital radiography
 - d. CBCT
 - e. Any other please specify:
9. In your practice do you encounter any specific age group of patients who have more C-shaped canals?
 - a. Less than 20 years
 - b. 20 to 30 years
 - c. More than 30 to 40 years
 - d. More than 40 years
10. In what percentage of patients you have been observed C-shaped canals?
 - a. 10% or less
 - b. 10-20%
 - c. More than 20-30%
 - d. More than 30%
11. Do you think Principles of color change and principle of orifice location (knowledge of canal anatomy) will be useful criteria during access opening of C-shaped canals?
 - a. Strongly agree
 - b. Agree
 - c. Neutral
 - d. Disagree
 - e. Strongly disagree
12. Do you think magnification like operating microscope and loupes are helpful during access opening, cleaning and shaping of C-shaped canals
 - a. Strongly agree
 - b. Agree
 - c. Neutral
 - d. Disagree
 - e. Strongly disagree
13. Which type of working length measurement do you feel give accurate measurement in C-shaped canals?
 - a. Conventional Radiographic method
 - b. Xeroradiography
 - c. Direct Digital radiography
 - d. Electronic Apex locator
 - e. Any other please specify:
14. Which type of cleaning and shaping technique do you feel effective in managing C-shaped canals?
 - a. Step Back technique
 - b. Modified step back technique
 - c. Passive step back technique
 - d. Balanced force technique
 - e. Crown down technique
 - f. Hybrid technique
 - g. Anticurvature filing
 - h. Circumferential filing
 - i. Any other please specify:
15. Which type of irrigation method do you feel effective in managing C-shaped canals?
 - a. Manual syringe irrigation with needles
 - b. Quantec-E irrigation system
 - c. Ultrasonic irrigation
 - d. Sonic irrigation
 - e. Endo Vac system
 - f. Rinse endo system
 - g. Any other please specify:
16. Which type of irrigation solution do you feel effective in managing C-shaped canals?
 - a. Sodium hypochlorite
 - b. EDTA
 - c. RcPrep
 - d. Chlorhexidine
 - e. MTAD
 - f. Ozonated Water
 - g. Any other please specify:
17. How many visits of patient, do you feel effective in managing C-shaped canals?
 - a. Single visit
 - b. Multiple visits
18. Which type of intracanal medicament, do you feel effective in managing C-shaped canals in between the appointments?
 - a. Calcium hydroxide
 - b. Phenolic compounds
 - c. Aldehyde compounds
 - d. Antibiotics
 - e. Combination of steroid and antibiotics
 - f. Any other please specify:
19. Which type of obturation technique do you feel effective in management of C-shaped canals?
 - a. Single cone technique
 - b. Cold and warm lateral condensation
 - c. Warm vertical condensation
 - d. Continuous wave of condensation
 - e. Chemo-plasticized gutta-percha
 - f. Thermo-plasticized injectable gutta-percha obturation
 - g. Thermo-mechanical compaction
 - h. Combination
 - i. Any other please specify:

20. Which type of sealer do you feel effective in management of C-shaped canals?
- Zinc oxide based sealer
 - Salicylate based sealer
 - Resin based sealer
 - Tricalcium silicate (MTA/Bio ceramic)
 - Calcium hydroxide sealer
 - Any other please specify:
21. Which type of post system do you feel effective in management of C-shaped canals?
- Prefabricated post
 - Custom cast post
 - Glass fiber post
 - Threaded post
 - No need of post
 - Any other please specify: