Case Study

# ROOT CANALS ORIFICES LAWS AND DETECTION METHODS: KNOWLEDGE AND AWARENESS ASSESSMENT IN SAUDI ARABIA

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**ABSTRACT**

The Cementoenamel Junction is considered an important landmark for locating the pulp chambers and canals orifices as Krasaner and Rankow found. The main objective of this study is to assess the knowledge and awareness level of root canal orifice laws and detection methods among dentists, interns, and dental students in Saudi Arabia. An observational Cross-sectional study by online questionnaire survey, the questions are formulated by the authors in Saudi Arabia. The sample size was estimated using the Qualtrics calculator with an a-1 confidence level of 95%; a sample size of 384. The data were tabulated on Microsoft Excel and analyzed using IBM Statistical Package for the Social Sciences (SPSS) version 22.0. As regard to current professional status highest percent of participants who had a high knowledge score (29.1%) were dentists. More than half of those with high knowledge scores were studying dentistry in Saudi Arabia. Participants in the 4th year had the highest percent of low knowledge scores. These differences are statistically significant with P-value < .05. The study shows that the knowledge of dentists regarding root canal orifices laws and detection methods was not satisfactory only 62.1% out of 419 had high knowledge, 33.4% had medium knowledge, and 4.5% had low knowledge. Therefore, participants require an understanding of the concepts behind CBCT and related technologies and other methods of detection, making appropriate training essential for every member of the dental team.

**Key words:** Endodontic, Canal orifices, Root canal treatment, Krasner and rankow law.

## Introduction

Endodontic treatment aims to preserve the tooth by complete removal of bacterial infection in the root canal system [1]. There are Different Canals' cross-sectional forms, including ribbon-shaped canals, long-oval canals, round canals, and oval-shaped canals [2]. For endodontic success, locating all root canals as having received appropriate debridement of the canals [1], and understanding common root canal morphology and its possible variations is a fundamental step [2].

Endodontic Therapy can be done by using magnification like a loupe, a Dental operating microscope, a modular endoscope system, and an Ora-scope to guarantee the accuracy and quality of the treatment [3]. Independent root canals that go from the pulp chamber to the apex are referred to as the independent canal system. The term "confluent canal system" refers to a group of canals that converge at a single foramen [4]. Since the majority of endodontic treatment mistakes are caused by failing to respect the anatomy of the canals, studying anatomy is crucial in this field [5]. The root canal's anatomy being poorly understood is one of the main reasons why treatments fail [6].

The comprehensive removal of contaminated pulp tissue, and bacteria, and full three-dimensional closure of the root canal area are essential for the effectiveness of endodontic therapy [7]. Anatomical variations can be found in all types of teeth and can be exceedingly complicated, according to studies of the internal and external anatomy of teeth [8]. The literature now contains several prevalence studies on root and root canal anatomy that have their roots in many nations because of the widespread usage of CBCT technology [9].

Clinical studies have suggested using cone beam computed tomography (CBCT), dental operating microscopes (DOM), direct vision, and selective dentin removal along with ultrasonics to aid in the detection of second mesiobuccal canals in maxillary 1st and 2nd molars [10]. Because molar teeth, in particular, have varying canal configurations, conservatively prepared cavities would limit the detection of canal orifices [11].

Due to insignificant numbers related to our topic, especially in Saudi Arabia. there are a few numbers of sample sizes and a variation in results in previous research. With the use of digital image processing and the dental-operating microscope (DOM), assess the displacement brought about

by the movement of root-canal orifices during the first stage of rotational root canal therapy in molars. Among teeth receiving endodontic treatment, the total frequency of missing canals was 18 percent. Maxillary-first molars had a greater frequency of missing canals 40.6 percent. Among teeth with missing canals, apical periodontitis was present in 90 percent of cases. In the maxilla, it was 84.2 percent, and in the mandible, it was one hundred percent. The main objective of this study was to assess the knowledge and awareness level of root canal orifice laws and detection methods among dentists, interns, and dental students in Saudi Arabia.

## Materials and Methods

*Study design*

An observational Cross-sectional study by online questionnaire survey, the questions are formulated by the authors. Participants were recruited from dentists, Interns, and dental students in Saudi Arabia.

The sample size has been selected according to inclusion and exclusion criteria. Included subjects are those who are general Dentists, dental students, and dental interns, while excluded subjects were pre-clinical dental students, specialists, and consultants.

*Sample size*

In this cross-sectional survey, A sample size calculation was done by (the Raosoft sample size calculator program)— with a minimum of 384 population size to be expected to participate.

*Method for data collection and instrument (Data collection Technique and tools)*

To assess knowledge and awareness level of root canal orifices laws and detection methods. We have gathered information from a total of 385 participants using an online survey questionnaire. Through volunteer sampling, participants were chosen at random from among dentists, interns, and dental students in Saudi Arabia. The questionnaire was divided into two sections: the first is to gather demographic data and, the second is to gauge knowledge and awareness of root canal orifices laws and detection methods.

The knowledge questionnaire form contains several multiple questions each question has the correct answer, there was one score for each correct answer. Knowledge was categorized as (High Knowledge), (Medium Knowledge) and (Low Knowledge) Corresponding to the knowledge score acquired. High knowledge 17-24, Medium Knowledge 9-16, Low Knowledge 0-8, (Total scores 24).

*Analyzes and entry method*

Microsoft Excel (Microsoft, Redmond, WA, USA) was used to tabulate the data, and IBM Statistical Package for the Social Sciences (SPSS) version 22.0 was used to analyze it. A simple frequency was done for all univariate variables. Across tabulation was done for bivariate variables. The association between variables was measured using Chi-square. A p-value of $< 0.05$ was considered significant.

## Results and Discussion

**Table 1** shows the socio-demographic characteristics of the Participants. About 419 individuals participated in this study. More than half of them (51.8%) were males. About (56.6%) of the studied participants were in the age category of (15-25) years old. As regards Current professional status (40.1%) of them were Dentists. Majority of them (88.3%) Study dentistry in Saudi Arabia. About (23.6%) of them were dental interns.

**Table 1.** Socio-demographic characteristics of the Participants (No= 419)

| variables | No | | % |
|---|---|---|---|
| **Age** | **Mean ± SD**<br>**median (Range)** | | 26.16 ± 4.24<br>25 (18-54) |
| | 18 - 25 | 237 | 56.6 |
| | 26 - 35 | 167 | 39.9 |
| | 36- 55 | 15 | 3.6 |
| **Gender** | Male | 217 | 51.8 |
| | Female | 202 | 48.2 |
| **Current professional status** | Dental student | 152 | 36.3 |
| | Dental intern | 99 | 23.6 |
| | Dentist | 168 | 40.1 |
| **Study dentistry in Saudi Arabia** | Yes | 370 | 88.3 |
| | No | 49 | 11.7 |
| **Year of Study** | 4th year | 43 | 10.3 |

| | | | |
|---|---|---|---|
| | 5th year | 39 | 9.3 |
| | 6th year | 79 | 18.9 |
| | Dental intern | 99 | 23.6 |
| | Dentist | 159 | 37.9 |

As shown in **Table 2** Participant's knowledge and awareness level about root canal orifices laws and detection methods. The majority of participants (84%) reported the right answer when they were asked that Krasner and Rankow found that the cemento-enamel junction (CEJ) was the most important anatomic landmark for determining the location of pulp chambers and root canals. (75.2%) and (74.7%) knew that there are two laws of symmetry and there are three laws of orifice location respectively. About two-thirds of them recognized that the floor of the pulp chamber is located in the center of the tooth at the level of the CEJ. More over majority of them (85.4%) identified that the most helpful devices in the detection of extra canals are Dental operating Microscopes and ultra-sonic tips. The majority of participants (87.4%) reported the right answer when they were asked that the accuracy of detection of MB2 by Micro-Ct and CBCT is better than Digital Radiographs About (61.1%) knew the right information when questioned that Small Access cavity can't affect chance of locating the Root Canals Orifices. More than half of them (54.9%) answered the right answer regarding the question that anatomical variations can't be found in all types of teeth.

**Table 2.** Distribution of Participants according to their answers about knowledge and awareness of root canals orifices laws and detection methods

| **Variables** | **Answer** | **No (%) (No=419) (100%)** |
|---|---|---|
| **1-** Krasner and Rankow found that the cemento-enamel junction (CEJ) was the most important anatomic landmark for determining the location of pulp chambers and root canal orifices. | ***Yes*** | 352 (84) |
| | No | 34 (8.1) |
| | I don't know | 33 (7.9) |
| **2-** There are two laws of symmetry. | ***Yes*** | 315 (75.2) |
| | No | 57 (13.6) |
| | I don't know | 47 (11.2) |
| **3-** There are three laws of orifice location. | ***Yes*** | 313 (74.7) |
| | No | 55 (13.1) |
| | I don't know | 51 (12.2) |
| **4-** The floor of the pulp chamber is located in the center of the tooth at the level of the CEJ | ***Yes*** | 343 (81.9) |
| | No | 55 (13.1) |
| | I don't know | 21 (5) |
| **5-**The walls of the pulp chamber are always concentric to the internal surface of the tooth at the level of CEJ. | Yes | 182 (43.4) |
| | ***No*** | 197 (47) |
| | I don't know | 40 (9.5) |
| **6-** The pulp chamber floor is always whiter in color than the walls. | Yes | 110 (26.3) |
| | ***No*** | 287 (68.5) |
| | I don't know | 22 (5.3) |
| **7-** The location of the canal orifices may not change if the teeth have deviation and rotation | Yes | 134 (32) |
| | ***No*** | 247 (58.9) |
| | I don't know | 38 (9.1) |
| **8-** The complex root and canal anatomy of maxillary molars lie behind the high rates of endodontic treatment failure observed for these teeth | ***Yes*** | 328 (78.3) |
| | No | 41 (9.8) |
| | I don't know | 50 (11.9) |
| **9-** The pulp chamber is always situated in the center of the tooth at the level of the cemento-enamel junction (CEJ) and its walls are always concentric to the external surface of the crown at the CEJ level | ***Yes*** | 328 (78.3) |
| | No | 49 (11.7) |
| | I don't know | 42 (10) |

| | | |
|---|---|---|
| **10**-Nearly all root canals are curved, particularly in a facial-lingual direction | ***Yes*** | 276 (65.9) |
| | No | 89 (21.2) |
| | I don't know | 54 (12.9) |
| **11**-The possibility of the presence of MB2 canal in maxillary 1st molar can get up to 90% of cases: | ***Yes*** | 330 (78.8) |
| | No | 54 (12.9) |
| | I don't know | 35 (8.4) |
| **12-** The most helpful devices in the detection of extra canals are Dental operating Microscope and Ultra Sonic tips | ***Yes*** | 358 (85.4) |
| | No | 35 (8.4) |
| | I don't know | 26 (6.2) |
| **13**-The accuracy of detection of MB2 by Micro-Ct and CBCT is better than Digital Radiographs | ***Yes*** | 366 (87.4) |
| | No | 31 (7.4) |
| | I don't know | 22 (5.3) |
| **14**-Small Access cavity can't affect the chance of locating the Root Canals Orifices | Yes | 132 (31.5) |
| | ***No*** | 256 (61.1) |
| | I don't know | 31 (7.4) |
| **15**-The Rostrum Canalis which is lines in the pulp chamber can help in locating Root canal orifices: | ***Yes*** | 308 (73.5) |
| | No | 23 (5.5) |
| | I don't know | 88 (21) |
| **16**-The use of magnification loupes combined with illumination can be helpful in the detection of all canals orifices: | ***Yes*** | 368 (87.8) |
| | No | 29 (6.9) |
| | I don't know | 22 (5.3) |
| **17**-For detecting and locating canals orifices using Ultra Sonic tips is Better than using Bur: | ***Yes*** | 354 (84.5) |
| | No | 33 (7.9) |
| | I don't know | 32 (7.6) |
| **18**-Number of root canal orifices in the upper 1$^{st}$ molar could be more than three canals in some cases: | ***Yes*** | 367 (87.6) |
| | No | 28 (6.7) |
| | I don't know | 24 (5.7) |
| **19**-Knowledge of diversification of tooth's anatomy before the treatment helps in locating and debride all canals: | ***Yes*** | 359 (85.7) |
| | No | 25 (6) |
| | I don't know | 35 (8.4) |
| **20**-Independent root canals from pulp chamber to apex more complicated than canals at a single foramen? | ***Yes*** | 311 (74.2) |
| | No | 54 (12.9) |
| | I don't know | 54 (12.9) |
| **21**-The most common mistake in endodontic treatment is not knowing how number of canals. | ***Yes*** | 322 (76.8) |
| | No | 68 (16.2) |
| | I don't know | 29 (6.9) |
| **22-**Anatomical variations can't be found in all types of teeth? | Yes | 161 (38.4) |
| | ***No*** | 230 (54.9) |
| | I don't know | 28 (6.7) |
| **23-**Is the use of the CBCT technique important in all cases of endodontic treatment? | Yes | 130 (31) |
| | ***No*** | 258 (61.6) |
| | I don't know | 31 (7.4) |
| **24-** Underextending the access cavity preparation may lead to missed canal | ***Yes*** | 367 (87.6) |
| | No | 30 (7.2) |
| | I don't know | 22 (5.3) |

As illustrated in **Table 3** the relation between the Socio- demographic characteristics of Participants and knowledge

score about root canal orifices laws and detection methods. (30.1%), (29.6%), and (2.4%) of Participants who had high knowledge scores were in the age group (15-25), (26-35) and (36-55) years old respectively. As regards current professional status highest percent of participants who had a high knowledge score (29.1%) were dentists. More than half of those with high knowledge scores were studying dentistry in Saudi Arabia. Participants in the 4th year had the highest percent of low knowledge scores. These differences are statistically significant with P-value < .05.

**Table 3.** Relation between Socio-demographic characteristics of Participants and knowledge and awareness score about root canals orifices laws and detection methods

| Variables | Low Knowledge (No=19) (4.5%) | Medium Knowledge (No=140) (33.4%) | High knowledge (No=260) (62.1%) | Total (No=419) (100%) | P_ Value* |
|---|---|---|---|---|---|
| | No (%) | No (%) | No (%) | No (%) | |
| **Gender** | | | | | |
| Female | 11(2.6) | 69 (16.5) | 122 (29.1) | 202 (48.2) | .622 |
| Male | 8 (1.9) | 71(16.9) | 138 (32.9) | 217 (51.8) | |
| **Age** | | | | | |
| 18 - 25 | 16 (3.8) | 95 (22.7) | 126 (30.1) | 237 (56.6) | ***.001*** |
| 26 - 35 | 2 (0.5) | 41 (9.8) | 124 (29.6) | 167 (39.9) | |
| 36- 55 | 1 (0.2) | 4 (1.0) | 10 (2.4) | 15 (3.6) | |
| **Current professional status** | | | | | |
| Dental student | 11(2.6) | 60(14.3) | 81(19.3) | 152(36.3) | ***.002*** |
| Dental intern | 2(0.5) | 40(9.5) | 57(13.6) | 99(23.6) | |
| Dentist | 6(1.4) | 40(9.5) | 122(29.1) | 168(40.1) | |
| **Study dentistry in Saudi Arabia** | | | | | |
| Yes | 13 (3.1) | 127 (30.3) | 230 (54.9) | 370 (88.3) | ***.018*** |
| No | 6 (1.4) | 13 (3.1) | 30 (7.2) | 49 (11.7) | |
| **Year of Study** | | | | | |
| 4th year | 7 (1.7) | 18 (4.3) | 18 (4.3) | 43 (10.3) | **<.001** |
| 5th year | 3 (0.7) | 17 (4.1) | 19 (4.5) | 39 (9.3) | |
| 6th year | 3 (0.7) | 31 (7.4) | 45 (10.7) | 79 (18.9) | |
| Intern | 2 (0.5) | 37 (8.8) | 60 (14.3) | 99 (23.6) | |
| Dentist | 4 (1.0) | 37 (8.8) | 118 (28.2) | 159 (37.9) | |

**Chi-Square Test

**Table 4** shows, according to the logistic regression model it revealed that a participant in 4th-year grade is .129 less likely to have a high knowledge score. Also, it is detected that to be a participant in the 5th year is .177 less likely to have a high knowledge score. This is statistically significant.

**Table 4.** Ordinal logistic regression of factors that affect the level of knowledge and awareness about root canals orifices laws and detection methods among participants

| Variable | OR | 95% confidence interval | | P-value |
|---|---|---|---|---|
| | | Lower | Upper | |
| ***Gender*** | | | | |
| Male (ref) | | | | .581 |
| Female | .890 | .589 | 1.345 | |
| ***Age*** | | | | |
| 36- 55 (ref) | | | | |
| 18 - 25 | .692 | .191 | 2.501 | .574 |
| 26 - 35 | 1.312 | .395 | 4.366 | .657 |
| ***Current professional status*** | | | | |
| Dentist (ref) | | | | |

| | | | | |
|---|---|---|---|---|
| Dental student | 4.256 | .918 | 19.722 | .064 |
| Dental intern | 1.038 | .228 | 4.728 | .962 |
| ***Study dentistry in Saudi Arabia*** | | | | |
| Yes (ref) | | | | |
| No | .829 | .423 | 1.627 | .586 |
| ***Year of Study*** | | | | |
| Intern (ref) | | | | |
| 4th year | .129 | .031 | .525 | ***.004*** |
| 5th year | .177 | .043 | .725 | ***.016*** |
| 6th year | .258 | .067 | .998 | .050 |
| Dentist | 1.325 | .272 | 6.458 | .728 |

The lack of ability of the physician to determine the location of each root orifice is one of the primary reasons why endodontic therapy fails [12]. Missed canals are a typical occurrence in the root canal system because of its intricate structure. The first step in reducing the likelihood of missing root canals is to take excellent pre-operative radiography. One option to address the shortcomings of traditional radiography is Cone-Beam Computed Tomography (CBCT). To locate the root canal orifices, proper access-cavity preparation is essential. Ultrasonics are also crucial tools for locating missing canals. When receiving root canal therapy, the likelihood of discovering every root canal is increased with increased magnification and light [13].

The portion of the cavity that runs from the occlusal surface to the canal orifice is referred to as the "access cavity." On the other hand, the location, form, and dimensions of its design are determined by the canal's full length, its curvature, and the placement of its orifices. When preparing a root canal, enough tooth structure should be removed to make it possible for tools to be readily inserted into each canal's opening without obstructing overhanging walls. To place an instrument, each canal's orifice has to be visible and reachable. During the diagnostic stage, the access-cavity-outline form should be adjusted if additional roots and/or canals are detected [14].

The practitioner needs to be well-versed in the anatomy of the pulp chamber to properly prepare an access cavity. To ascertain the anatomy of each tooth that is going to be treated, the pre-operative radiographs need to be examined carefully [15]. When the pulp chamber is exposed, using specially designed equipment like a DG16 ultrasonic-tip-endodontic probe greatly simplifies the process of inspecting the pulp chamber floor and finding canal orifices. The pulp-chamber anatomy can be changed in clinical settings by prosthetic crowns, massive restorations, occlusal trauma, and dystrophic-calcification [16].

The main objective of this study is to assess the knowledge and awareness level of root canal orifice laws and detection methods among dentists, interns, and dental students in Saudi Arabia.

In our study, we have found that 62.1% out of 419, had high knowledge, 33.4% had medium knowledge, and 4.5% had low knowledge.

We have also found that the majority of participants (84%) reported the right answer when they were asked that Krasner and Rankow found that the cemento-enamel junction (CEJ) was the most important anatomic landmark for determining the location of pulp chambers and root canal. (75.2%) and (74.7%) knew that there are two laws of symmetry and there are three laws of orifice location respectively. About two-thirds of them recognized that the floor of the pulp chamber is located in the center of the tooth at the level of the CEJ. More over majority of them (85.4%) identified that the most helpful devices in the detection of extra canals are Dental operating Microscopes and ultra-sonic tips. The majority of participants (87.4%) reported the right answer when they were asked that the accuracy of detection of MB2 by Micro-Ct and CBCT is better than Digital Radiographs. About (61.1%) knew the right information when questioned that a Small Access cavity cannot affect the chance of locating the Root canal orifices. More than half of them (54.9%) answered the right answer regarding the question that anatomical variations can't be found in all types of teeth. Regarding the relation between the Socio-demographic characteristics of participants and knowledge score about root canal orifices laws and detection methods. We have found that, about (30.1%), (29.6%) and (2.4%) of participants who had high knowledge scores were in the age group (15-25), (26-35) and (36-55) years old respectively. As regards current professional status highest percent of participants who had a high knowledge score (29.1%) were dentists. More than half of those with high knowledge scores were studying dentistry in Saudi Arabia. Participants in the 4th year had the highest percent of low knowledge scores. These differences are statistically significant with P-value < .05.

On the other hand, another study conducted to assess knowledge and awareness level of root canal orifice detection methods among dentists revealed that [17]. At the start of the study, 78 percent of the respondents said they were aware of the differences in root canal structure, and at the conclusion, 57 percent said they were certain they needed to learn more about this topic.

Of those surveyed, 42.5 percent were aware that the optimum technique for it was CBCT. 56.5 percent of respondents knew about the laws of Krasner and Rankow, and 59.5 percent knew about Vertucci's-classification. Mandibular-2end molars with C-shaped canals were known to 24.2% of the dentists. Using the chi-square test, it was possible to ascertain a relationship between the different answers to each question depending on the practitioner's expertise. There was a statistically significant difference ($p < 0.05$).

Another investigation carried out in Ankara, Turkey [18] found that theoretical lectures on CBCT have only recently been included in the dentistry school curriculum and that CBCT awareness, in general, is still relatively new in Turkey. Dentists in North Karnataka, India, have an average level of knowledge about the CBCT technique, according to another study [19], which found that about 91.0% of the dentists know about CBCT, which is greater than the findings of various research studies conducted by Torabi *et al*. in Kerman 89.0 present [20], Keerththana and Arathy in Chennai 82.0 present [21], Kamburoglu *et al*. in Turkey 63.3 present [22], Reddy *et al*. in South India 42.5 present [23], and others. Despite the high prescription rate for cone-beam computed tomography (CBCT), a second investigation [24], which assessed Iranian dentists' knowledge and attitudes regarding the procedure, found that they were uninformed and unfriendly. Furthermore, compared to individuals who did not use this strategy, those who did had greater levels of knowledge and attitude.

## Conclusion

The study shows that the knowledge of dentists regarding root canal orifices laws and detection methods was not satisfactory only 62.1% out of 419 had high knowledge, 33.4% had medium knowledge, and 4.5% had low knowledge. As a result, participants must comprehend the principles underlying CBCT, associated technologies, and additional detection techniques. This means that proper training is crucial for each member of the dental team. There are multiple approaches to reduce the likelihood of root canals being missed. The effectiveness of endodontic therapy may be enhanced by being aware of these methods and benefiting from these unique tests. One of the most crucial elements in the medical and dental fields is CBCT. Its scope for diagnosis and therapy has greatly expanded. While traditional 2D imaging techniques provide access to technical processes in the event of surgery, they should be used cautiously and with restrictions to enhance patient management.

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