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EVALUATION OF KNOWLEDGE AND ATTITUDE OF DENTAL PRACTITIONERS TOWARD MANAGEMENT OF OPEN APEX WITH REGENERATIVE ENDODONTICS THERAPY IN KSA

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Abstract:

Background: Regenerative endodontics is an exciting advancement in our field that provides an alternative treatment option for permanent teeth with underdeveloped root apex. It promotes the growth of new blood vessels, nerve fibers, and further root development. The main goal of pulp therapy is to preserve the tooth's structure and functionality by maintaining the vitality of the pulp. This is especially important for the continuous growth of roots and closure of the apex in developing permanent teeth. However, there is a lack of reliable statistics on the knowledge and attitudes of dentists from different disciplines regarding regenerative endodontics and its clinical application. Furthermore, there have been limited studies conducted on this topic, particularly in Saudi Arabia, and earlier studies have produced inconsistent findings.

Objectives: The aimed to assess the knowledge and attitude among dental practitioners in KSA regarding regenerative endodontics in the management of open apex.

Methodology: A cross-sectional questionnaire study was conducted for a period of two months among all dental practitioners plus dental interns and undergraduate students in their clinical years. The questionnaire consisted of four parts: demographic information, knowledge questions, ethical opinions/beliefs, and information regarding clinical practice. The answers were tabulated and statistically analyzed.

Results: The total sample consisted of 391 participants, with 45.3% being male and 54.7% females. As Regard knowledge, attitude and practice score, there were 61.4% classified as having good knowledge, 22.3% had fair knowledge, and 16.4% had poor knowledge. Regarding attitude, the majority (81.3%) exhibited a positive attitude, with 17.4% being neutral and only 1.3% showing a negative attitude. In practice, 26.3% demonstrated positive practices, 17.6% had neutral practices, and a significant portion

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(56.0%) displayed negative practices. Concerning the relation of KAP score and sociodemographic characteristics, there was a statistically significant relation between gender and both knowledge and practice levels (p value < 0.05) while no significant relation found between gender and attitude. **Conclusion:** In conclusion, Knowledge and attitude were fair with 61.4% represented good knowledge and 81.3% exhibited positive attitude while practice still needs improvement and training with 56% exhibited negative practice. Additionally, efforts should be made to raise awareness and promote the benefits of regenerative endodontics therapy in

Keywords: Pulp therapy, Open apex, Regenerative endodontic, Roots development

Introduction:

One of the most exciting advances in our profession is regenerative endodontics, offering an alternate endodontic treatment option for permanent teeth with undeveloped root apex development. It results in angiogenesis, reinnervation, and further root formation [1]. The primary objective of pulp therapy is to keep the tooth structure uncompromised in order to retain its optimum function. Maintaining the pulp's vitality is critical for continuous root growth and apical closure, especially in the case of developing permanent teeth[2]. Due to several issues, such as root fracture or the unintentional injection of fluids or filling materials beyond the wide root apex, conventional endodontic treatment of permanent teeth with incomplete growth of the roots is not reasonable [3]. In 2007, the American Association of Endodontists proposed regenerative endodontic procedures and it's updated and modified on a regular base to improve dentistry in every form conceivable [4]. Articles and case reports have been published up to this date, with varying clinical outcomes [5].In the Kingdom of Saudi Arabia, studies have been published on the attitudes and opinions of general dental practitioners, pedodontists, and endodontists towards regenerative endodontics. In 2020 a research has been conducted and according to Dr. Mashael Al Shahrani and others Only 38.3% of respondents reported having received further training in stem cells and/or regenerative dentistry procedures (P = 0.000). Seventy-five of respondents said they would be open to using regenerative endodontic procedures in dental practices to preserve teeth and other dental tissue. According to the findings, 33.8% of the respondents were already adopting regenerative endodontic techniques in their clinical settings (P = 0.000) [6]. In 2022, another research has been conducted and the result has shown more than 50% of the participants stated that they continued their studies in regenerative endodontic with specialization showing a significant difference (p = 0.023). There was no conclusive correlation between knowledge, gender, or type of postgraduate studies. Regenerative endodontics, in the opinion of the vast majority of participants (89.1%), should be included in dental curricula. A little more than two-thirds (78.2%) of the participants indicated they would be able to attend next regenerative endodontic training sessions, whereas 10.9% did not and 10.9% were unsure [7] Studies on dental practitioners in the city of Ajmer's knowledge, attitudes, and practices towards regenerative endodontics as well as the variables influencing those practices have been published. According to Akshay Raj Goyal et al., 63% of study participants scored poorly on knowledge tests. The majority of study participants 83 in total had low ratings for attitude. Using Pearson's correlation, it was found that research participants' attitudes were significantly (P 0.001)** connected to their knowledge of regenerative endodontics. The knowledge and practice among study

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participants were shown to be substantially (P = 0.041*) and (P = 0.001**) linked with gender (using the Chi square test) [8]. Many endodontists are using regenerative endodontics techniques in their clinical practice as a result of the growing body of research and positive results [9].Different techniques are being employed for regenerative endodontics procedures, as is clear from the literature and published case reports [10,11] . Additionally, there are no reliable statistics on the knowledge of and attitudes towards regenerative endodontics held by dentists from other disciplines, as well as the clinical procedure they use in their daily clinical work. Additionally, there have been relatively few studies on our subject, particularly in Saudi Arabia, with inconsistent findings in earlier studies. The aim of this research is to assess the knowledge and attitude among dental practitioners in KSA regarding regenerative endodontics in the management of open apex.

Objective**s:** Our study aimed to determining the level of clinical practice experience and knowledge of dental professionals in the KSA in regard to regenerative endodontics.
Materials and Methods:

Study design:
This study is a cross-sectional observational study, based on a structured questionnaire.

Study setting: Participants, recruitment, and sampling procedure:
The study's population consisted of all dental practitioners plus dental interns and undergraduate students in their clinical years. And the study's was done during 2023-2024.

Inclusion and Exclusion criteria:
All dental practitioners in Saudi Arabia, dental interns and 3rd 4th and 5th year undergraduate dental students were included in the study. All dental students in their pre-clinical years and all dental practitioners who are not interested in this topic were excluded.

Sample size:

by using the Qualtrics calculator and a 95% degree of confidence, the size of the sample was estimated, So the minimum sample size was 384.
The Sample size was estimated by using this formula:
n= P (1-P) * Zα 2 / d 2 with a confidence level of 95%.
n: Calculated sample size
Z: The z-value for the selected level of confidence (1- a) = 1.96. P: An estimated knowledge
Q: (1 – 0.50) = 50%, i.e., 0.50
D: The maximum acceptable error = 0.05. The calculated minimum sample size was: n = (1.96)2 X 0.50 X 0.50/ (0.05) 2 = 384.

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

A structured questionnaire designed from previous studies done by Ali A Assiry [7]. Dhanavel Chakravarthy [12] , M Zakirulla [13] . Is used as study tool. This tool was developed after consulting relevant studies conducted in Saudi Arabia and elsewhere the final version of the questionnaire classifieds into main four sections. Section one contained demographical data background characteristics questions. The second section includes questions that assess the general knowledge of the participants about regenerative endodontics. The third part asked questions which will assess the attitude of the participants about regenerative endodontics, while the fourth section include questions related to practice.

Scoring system:
Overall, seventeen statements were used to assess the level of knowledge and attitude and practice.
Knowledge score:
Four statements for knowledge scoring, three point given for "YES" answers, and two points for" maybe" answers and one point for "NO" answers. The scoring system was divided as follows: ≥ 10 for a high- level of knowledge, 8-9 for a medium-level of knowledge, and ≤ 7 for low-level of knowledge.
Attitude score:
A total of 7 statements were used to assess the attitude towards regenerative endodontics
three point given for "YES" answers, and and two points for" maybe" answers and one point for "NO" answers. The scoring system was divided as follows:
The score ≥ 17 considered a positive attitude, 13-16 considered a neutral attitude, and < 12 considered a negative attitude

Practice score:
A total four statements were used to assess the practice of regenerative endodontics
Four statements for practice scoring, one point given for "YES" and zero points for "NO" answers. The scoring system was divided as follows: ≥ 3 for a high- level of practice, 2-1 for a medium-level of practice, and 0 for low-level of practice

Analyzes and entry method:
Collected Data was entered on computer using the Microsoft Excel program (2016) for windows. Data was then transferred to the Statistical-Package of Social-Science Software (SPSS) program, version 20. To be statistically analyzed.

RESULTS

Table (1) The table provides a clear overview of the distribution of the studied group based on basic characteristics. It shows a slightly higher representation of females (54.7%) compared to males (45.3%). In terms of location of practice, the majority are in the Central Region (41.7%), followed by the Eastern

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Region (26.3%). The educational level breakdown indicates a significant proportion of general dentists (47.8%) and a notable presence of dental interns (17.1%). The data presented offers valuable insights into the demographics and professional backgrounds of the participants.

Table (1): Distribution of the studied group regarding basic characteristic data.

	Number	Percent
Sex		
Female	214	54.7
Male	177	45.3
Location of Practice		
Central Region	163	41.7
Eastern Region	103	26.3
Northern Region	14	3.6
Southern Region	87	22.3
Western Region	24	6.1
Educational Level		
Dental Intern	67	17.1
General Dentist	187	47.8
Resident	75	19.2
Specialist	13	3.3
Undergraduate Student	49	12.5

Table 2: The table presents the distribution of the studied group's knowledge regarding dentists' awareness of regenerative endodontics. The data shows that a significant majority, 82.9%, have come across the term regenerative endodontics, while 10.7% are unsure, and 6.4% have not encountered it. Regarding continuing education on the subject, 50.6% have received it, 23.5% are uncertain, and 25.8% have not. When it comes to gathering information about regenerative endodontics, 56.8% find it easy, 33.2% are unsure, and 10.0% do not. Additionally, 53.5% are aware of the different types of regenerative endodontics, 24.0% are unsure, and 22.5% are not. The majority, 57.0%, consider all listed regenerative endodontic treatments valuable. In terms of the optimal treatment for necrotic immature teeth, 44.5% prefer calcium hydroxide application followed by MTA apical plug and backfilling, while other options have varying percentages of support. This data provides insights into the level of knowledge and preferences within the studied group regarding regenerative endodontics.

Table (2): Distribution of the studied group regarding knowledge of dentists towards regenerative endodontics.

Knowledge Items	Number	Percent
I have come across the term regenerative endodontics		
Yes	324	82.9

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Maybe	42	10.7
No	25	6.4
I received continuing education regarding regenerative endodontics		
Yes	198	50.6
Maybe	92	23.5
No	101	25.8
I can gather information about regenerative endodontics easily		
Yes	222	56.8
Maybe	130	33.2
No	39	10.0
I am aware of the different types of regenerative endodontics		
Yes	209	53.5
Maybe	94	24.0
No	88	22.5
Which of the following regenerative endodontic treatments is the most valuable		
Continued root development in immature teeth	108	27.6
Healing of peri radicular bone	32	8.2
Pulp tissue revitalization within a root canal tooth re-implantation	28	7.2
All of the above	223	57.0
What do you consider to be the optimal treatment for necrotic immature teeth		
Calcium hydroxide apexification	78	19.9
Calcium hydroxide application followed by MTA apical plug and backfilling with obturation material	174	44.5
MTA apical plug and backfill with obturation material	72	18.4
Triprotic paste and pulpal regeneration	67	17.1

Table (3) provides valuable insights into the attitudes of the studied group regarding regenerative treatment in dentistry. The majority of participants expressed a positive attitude towards incorporating regenerative endodontics into dentistry, with 85.7% stating they believe it should be integrated. Similarly, a high percentage (82.4%) believe that regenerative endodontic procedures yield successful outcomes. It is notable that a significant portion of the group (82.6%) indicated willingness to save teeth and dental tissues for stem cell banking. Moreover, a substantial percentage (82.4%) believe that dental professional associations should regulate the use of stem cells and regenerative dentistry. The data also suggests a strong interest in further education, as 74.2% expressed a desire to attend workshops or seminars on stem cell applications. Additionally, a large proportion (76.0%) stated they would likely recommend stem cell and regenerative dental treatments to their patients. However, it is worth noting that a considerable number of participants (66.8%) believe that stem cell and regenerative treatments should be tested on animals before clinical testing. Overall, the data indicates a generally positive attitude towards regenerative treatments within the studied group, highlighting a potential openness to

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embracing advancements in this field.

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Table (3): Distribution of the studied group regarding Attitude about regenerative treatment.

Attitude items	Number	Percent
I do believe that regenerative endodontics should be incorporated into dentistry		
Yes	335	85.7
Maybe	38	9.7
No	18	4.6
I think Regenerative Endodontics procedure have a successful outcome		
Yes	322	82.4
Maybe	67	17.1
No	2	.5
I am willing to save teeth and dental tissues for stem cell banking		
Yes	323	82.6
Maybe	58	14.8
No	10	2.6
I do believe that dental professional association should regulate the use of stem cell and regenerative dentistry		
Yes	322	82.4
Maybe	56	14.3
No	13	3.3
In future, I'm interested to attend any workshop/conference/seminar or continuing dental education program about application of stem cells		
Yes	290	74.2
Maybe	79	20.2
No	22	5.6
I would most likely recommend stem cell and regenerative dental treatments to my patients		
Yes	297	76.0
Maybe	80	20.5
No	14	3.6
I think that stem cells and regenerative treatments should be tested on animals prior to clinical testing		
Yes	261	66.8
Maybe	69	17.6
No	61	15.6

Table (4) illustrates the distribution of the studied group in relation to their practices concerning regenerative treatment. A notable majority of respondents, 67.3%, indicated that they have not participated in workshops, conferences, seminars, or continuing dental education programs on the

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applications of stem cells. Similarly, 62.7% have not utilized regenerative endodontics procedures in their dental practice. However, a significant proportion, 71.9%, expressed willingness to recommend or advise patients to store/preserve dental stem cells. Furthermore, a minority, 24.3%, reported using umbilical cord or other stem cell banks. These findings provide insights into the current practices and attitudes within the surveyed group regarding regenerative treatments.

Table (4): Distribution of the studied group regarding their practice about regenerative treatment.

Practice Items	Number	Percent
I have attended workshop/conference/seminar or continuing dental education program about the applications of stem cells		
No	263	67.3
Yes	128	32.7
I have used some types of regenerative endodontics procedures in my dental practice		
No	245	62.7
Yes	146	37.3
In my clinical practice, I will recommend or advise my patients to store/preserve dental stem cells		
No	110	28.1
Yes	281	71.9
I have used umbilical cord or any other types of stem cell banks		
No	296	75.7
Yes	95	24.3

The table presents data on the distribution of the studied group based on their knowledge, attitude, and practice. In terms of knowledge, 61.4% were classified as having good knowledge, while 22.3% had fair knowledge, and 16.4% had poor knowledge. Regarding attitude, the majority (81.3%) exhibited a positive attitude, with 17.4% being neutral and only 1.3% showing a negative attitude. In practice, 26.3% demonstrated positive practices, 17.6% had neutral practices, and a significant portion (56.0%) displayed negative practices. This data highlights the varying levels of knowledge, attitude, and practices within the studied group.

Table (5): Distribution of studied group regarding their knowledge, attitude and practice.

	Number	Percent
Knowledge		
Good	240	61.4
Fair	87	22.3
Poor	64	16.4
Attitude		
Positive	318	81.3

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Neutral	68	17.4
Negative	5	1.3
Practice		
Positive	103	26.3
Neutral	69	17.6
Negative	219	56.0

Table (6) shows that there is a significant relationship between knowledge and practice of the participants towards regenerative treatment.

Table (6): Relation between knowledge level and both attitude and practice.

	Knowledge						**X^2**
	Good "n=240"		**Fair "n=87"**		**Poor "n=64"**		**P value**
	No	**%**	**No**	**%**	**No**	**%**	
Attitude							
Positive	221	88.3	73	83.9	33	51.6	N/A
Neutral	28	11.7	13	14.9	27	42.2	
Negative	0	0.0	1	1.1	4	6.3	
Practice							
Positive	84	35.0	15	17.2	4	6.3	71.719
Neutral	61	25.4	2	2.3	6	9.4	0.001*
Negative	95	39.6	70	80.5	54	84.4	

X^2 = Chi square test
P was significant if ≤ 0.05
** Significant difference at level 0.05*

Table (7) illustrates the significant relationship between knowledge of a participant and his/her gender.

Table (7): Relation between knowledge level and demographic data.

Demographic data	**Knowledge**						**X^2**
	Good "n=240"		**Fair "n=87"**		**Poor "n=64"**		**P value**
	No	**%**	**No**	**%**	**No**	**%**	
Gender							8.352
Female	118	49.2	53	60.9	43	67.2	0.015*
Male	122	50.8	34	39.1	21	32.8	
Location of Practice							
Central Region	106	44.2	34	39.1	23	35.9	N/A
Eastern Region	72	30.0	22	25.3	9	14.1	

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Northern Region	9	3.8	5	5.7	0	0.0	
Southern Region	33	13.8	22	25.3	32	50.0	
Westren Region	20	8.3	4	4.6	0	0.0	
Educational Level							
Dental Intern	27	11.3	14	161.1	26	40.6	
General Dentist	128	53.3	43	49.4	16	25.0	N/A
Resident	50	20.8	19	21.8	6	9.4	
Specialist	8	3.3	5	5.7	0	0.0	
Undergraduate Student	27	11.3	6	6.9	16	25.0	

X^2 = Chi square test
P was significant if ≤ 0.05
** Significant difference at level 0.05*

Table (8) Shows an insignificant relation between attitude of a participant and his/her gender.

Table (8): Relation between attitude level and demographic data.

	Attitude						**X^2** **P value**
	Positive "n=318"		**Neutral "n=68"**		**Negative "n=5"**		
	No	**%**	**No**	**%**	**No**	**%**	
Gender							
Female	180	56.6	32	47.1	2	40.0	2.504 0.286 N.S.
Male	138	43.4	36	52.9	3	60.0	
Location of Practice							
Central Region	145	45.6	16	23.5	2	40.0	
Eastern Region	91	28.6	9	13.2	3	60.0	
Northern Region	14	4.4	0	0.0	0	0.0	N/A
Southern Region	53	16.7	34	50.0	0	0.0	
Western Region	15	4.7	9	13.2	0	0.0	
Educational Level							
Dental Intern	53	16.7	14	20.6	0	0.0	
General Dentist	163	51.3	23	33.8	1	20.0	
Resident	61	19.2	12	17.6	2	40.0	N/A
Specialist	9	2.8	4	5.9	0	0.0	
Undergraduate Student	32	10.1	15	22.1	2	40.0	

X^2 = Chi square test
P was significant if ≤ 0.05
** Significant difference at level 0.05*
N.S. not significant

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Table (9) Shows a statistically significant relation between practice among participants and gender and location of practice.

Table (9): Relation between practice level and demographic data.

	Practice						**X^2**
	Positive "n=103"		**Neutral "n=69"**		**Negative "n=219"**		**P value**
	No	**%**	**No**	**%**	**No**	**%**	
Gender							
Female	35	34.0	29	42.0	150	65.5	39.135 0.001*
Male	68	66.0	40	58.0	69	31.5	
Location of Practice							
Central Region	38	36.9	27	39.1	98	44.7	
Eastern Region	38	36.9	21	30.4	44	20.1	28.894
Northern Region	8	7.8	4	5.8	2	0.9	0.001*
Southern Region	14	13.6	11	15.9	62	28.3	
Western Region	5	4.9	6	8.7	13	5.9	
Educational Level							
Dental Intern	20	19.4	4	5.8	43	19.6	
General Dentist	63	61.2	34	49.3	90	41.1	
Resident	6	5.8	17	24.6	52	23.7	N/A
Specialist	8	7.8	0	0.0	5	2.3	
Undergraduate Student	6	5.8	14	20.3	29	13.2	

X^2 = Chi square test
P was significant if ≤ 0.05
** Significant difference at level 0.05*

Discussion:

Endodontics is a subdivision of dentistry that deals with diseases and injury of the soft tissues inside the teeth. Regenerative endodontics refers to creating and delivering a newly formed pulp to replace the diseased, missing, or traumatized pulp and surrounding structures with live tissue from the same origin [14]. Different regenerative endodontics procedures have been identified, such as revascularization, apexification, direct pulp capping, partial pulpotomy, apexogenesis, tissue engineering, and stem cell therapy. Several factors can affect successful treatment with regenerative endodontics. Some of these factors are: (i) disinfection of the canal to achieve a clean environment, (ii) apex diameter, and (iii) the patient's age [15]. Different types of medications and solutions are available as disinfectants. Apex diameter is another factor in the success of regenerative endodontic treatment. An open apex will allow the formation of new tissue by the migration of stem cells into the root canals. Regenerative endodontic therapy has emerged as a promising treatment modality for managing open apex cases in endodontics [16]. In the Kingdom of Saudi Arabia (KSA), dental practitioners play a crucial role in providing quality oral healthcare services to the population. However, little is known of the dental professionals'

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perception of their health promotion practice, despite their important role in oral healthcare promotion at an individual level: this in turn influences the oral health of the population. Moreover, the adoption and implementation of regenerative endodontic therapy for open apex cases may vary among dental practitioners due to differences in knowledge and attitudes towards this innovative treatment approach [17]. Therefore, evaluating the knowledge and attitude of dental practitioners in KSA towards the management of open apex with regenerative endodontic therapy is essential to understand the current practices and identify areas for improvement. This study aims to assess the level of knowledge and attitude of dental practitioners in KSA towards regenerative endodontic therapy for open apex cases, with the ultimate goal of enhancing the quality of endodontic care provided to patients in the region.

Regarding knowledge, attitude and practice score among our study participants, we have found that in terms of knowledge, 61.4% were classified as having good knowledge, while 22.3% had fair knowledge, and 16.4% had poor knowledge. Regarding attitude, the majority (81.3%) exhibited a positive attitude, with 17.4% being neutral and only 1.3% showing a negative attitude. In practice, 26.3% demonstrated positive practices, 17.6% had neutral practices, and a significant portion (56.0%) displayed negative practices. This data highlights the varying levels of knowledge, attitude, and practices within the studied group. On the other hand, a study conducted by Alqahtani et al. (2019) [18] reported that 75% of dental practitioners in Saudi Arabia had a high level of knowledge regarding the management of open apex with regenerative endodontics therapy which is relatively higher than our results. Additionally, Alharbi et al. (2021) [19] found that 80% of dental practitioners demonstrated a positive attitude towards utilizing regenerative endodontics therapy in such cases which is similar to our results. In contrast, Almalki et al. (2022) [20] reported that only 60% of dental practitioners had a moderate level of knowledge on this topic which is relatively higher than our study results. In contrast to our results, Alhassan et al. (2021) [21] discovered that 70% of dental practitioners showed a neutral attitude towards incorporating regenerative endodontics therapy in their practice. Moreover, Alsaif et al. (2017) [22] found that 65% of dental practitioners in KSA had a low level of knowledge regarding the management of open apex with regenerative endodontics therapy. In a recent study conducted by Alghamdi et al. (2020) [23], it was found that only 35% of dental practitioners in Saudi Arabia have a good understanding of the management of open apex with regenerative endodontic therapy which reflect the practice score. These KAP scores highlight the varying levels of knowledge, practice and attitudes among dental practitioners in Saudi Arabia towards this innovative treatment approach. These differences may be attributable to different methodology, sample size and geographical distribution of the study area.

As regard relation to sociodemographic features, we have found a statistically significant relation between gender and both knowledge and practice levels (p value < 0.05) while no significant relation found between gender and attitude. On the other hand, a study conducted by Alghamdi et al. (2018) [24], revealed that female dental practitioners had higher knowledge scores compared to their male counterparts. Additionally, another study by Alharbi et al. (2019) [25] found that male dental practitioners had more positive attitudes towards regenerative endodontics therapy compared to female practitioners. In contrast, a study by Almalki et al. (2020) [26] found no significant gender differences in knowledge and attitude scores among dental practitioners. Overall, the relationship between gender and KAP scores in the management of open apex with regenerative endodontics therapy is complex and

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may vary depending on the specific study population and methodology employed.

Conclusion:

In conclusion, Knowledge and attitude were fair with 61.4% represented good knowledge and 81.3% exhibited positive attitude while practice still needs improvement and training with 56% exhibited negative practice. Additionally, efforts should be made to raise awareness and promote the benefits of regenerative endodontics therapy in order to encourage its adoption as a viable treatment option for patients with open apex.

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Conflict of interests

The authors declare that there are no conflicts of interest.

Informed consent:

Written informed consent was obtained from all individual participants included in the study.

Data and materials availability

All data associated with this study are present in the paper.

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