ORIGINAL ARTICLE

Visual Interpretation of Pediatric Panoramic Radiographs: An Eye-Tracking Mixed-Method Observational Study

Ghalia Y. Bhadila[1], BDS, MS, PhD, Safiya Alsharif[2], Seba Almarei[2]
Jamila A. Almashaikhi[1], and Dania Bahdila[1]

[1]Department of Pediatric Dentistry, Faculty of Dentistry, King Abdulaziz University, Jeddah, Saudi Arabia
[2]General Dentist, King Abdulaziz University Hospital, Jeddah, Saudi Arabia

Correspondence
Dr. Ghalia Y. Bhadila
Department of Pediatric Dentistry, Faculty of Dentistry, King Abdulaziz University
P.O. Box 80205, Jeddah 21589
Kingdom of Saudi Arabia
e-M: gbhadila@kau.edu.sa

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Abstract

Background: Recently, the use of eye-tracking technology (ETT) has gained popularity in the medical field for interpreting visual gaze patterns. However, its application in dental research remains in its early stages. We investigated the performance of postgraduate students (PGs) and dental interns in detecting abnormalities in pediatric panoramic radiographs using ETT. We explored the association between different eye-tracking (ET) measurements and students' detection accuracy. Finally, we assessed participants' experiences with ETT as a learning aid.

Methods: This mixed-method observational study involved 30 pediatric PGs and 32 dental interns at King Abdulaziz University Dental Hospital. Nine pediatric panoramic radiographs containing abnormalities were used for the text. A RED-m® SMI ET system tracked participant gaze patterns and BeGaze software identified abnormalities. Parameters extracted included entry time, dwell time, fixation time, fixation count, and revisit count. Univariate, bivariate, and multivariable analyses were conducted. Semi-structured interviews were analyzed and categorized into themes using NVivo 11.

Results: PGs were more successful at identifying abnormal radiographs compared to dental interns ($p = 0.003$) with PGs revisiting areas of interest (AOIs) significantly more often ($p = 0.003$). Interestingly, for each additional revisit, the odds of correct detection increased by 1.17 ($p = 0.009$). The interview data analysis uncovered five themes: ETT experience, challenges encountered, ETT as an educational tool, anticipated improvements, and final recommendations.

Conclusion: This study employed ETT and demonstrated that pediatric PGs have a higher likelihood of correctly identifying abnormalities in radiographs. Additionally, PGs exhibited a significantly higher frequency of revisiting AOIs compared to dental interns.

Clinical significance: This study objectively assessed how dentists at different training levels detect lesions in pediatric dental radiographs. It also explored the potential of ETT as an innovative pedagogical aid in dental education.

Keywords

Eye-tracking technology, Eye gaze, Education, Panoramic radiography, Pediatric dentistry

INTRODUCTION

In pediatric dentistry, panoramic radiography is a preliminary tool for detecting developmental defects, odontogenic cysts, various inflammatory diseases, and systemic metabolic disorders[1]. Pediatric tumors and cysts in the jaws are often asymptomatic, posing challenges for interpretation, especially for undergraduate students[2]. Fortunately, most pediatric oral tumors are benign, with only 3% classified as malignant[3]. However, radiographic misinterpretations can result in inaccurate diagnoses[4], potentially delaying treatment[5].

Eye-tracking technology (ETT) can aid in understanding how clinicians visually identify pathologies in dental radiographs[6]. It provides an objective and reliable way to analyze factors influencing an observer's decision-making and the causes of misdiagnosis[7–9]. By tracking specific visual search parameters, ETT can shed light on the reasons behind false positive and false negative diagnoses[6].

ETT is gaining popularity in both medicine and dentistry, with a surge in its use for dental research[10–11]. This study investigated the performance of postgraduate dental students (PGs) and dental interns in detecting abnormalities in pediatric panoramic radiographs using ETT. We explored the association between different eye-tracking (ET) measurements and students' odds of correct detection. Finally, we assessed participants' experiences with ETT as a learning aid through semi-structured interviews. ETT allows for objective recording of participants' visual attention, enabling researchers to identify factors influencing decision-making and sources of misdiagnosis[7–10].

Beyond enhancing learning and clinical skills for dentists, ETT holds exciting possibilities for improving the dentist's work environment. By tracking eye movements during procedures, researchers can identify areas of visual focus and potential ergonomic challenges[12]. This information can guide the design of dental equipment and operatory layouts that optimize efficiency, reduce fatigue, and minimize musculoskeletal disorders among practitioners. Similarly, ETT can benefit patient care. A study analyzing where pediatric patients look upon entering a dental clinic highlights the potential of ETT to inform strategies for reducing patient anxiety and fostering trust, ultimately leading to better patient engagement during dental treatment[13–14].

ETT offers innovative opportunities for dental education. By tracking how students look at various instructional materials and educators, ETT can provide insights into their attention patterns, comprehension levels, and areas of difficulty[2–6]. This technology can also be used to assess learning outcomes by comparing the viewing patterns of students at different stages of their dental education. Vogel *et al.* observed a positive correlation between viewing time and completeness in reading radiographs, with participants being more likely to detect important findings with increased viewing duration. Additionally, those with more education and experience exhibited a more thorough scan pattern[2]. By understanding how students engage with different clinical materials over time using ETT, educators can develop more effective teaching methods, ultimately leading to improved patient care[15]. Thus, the aim of this study was to explore the association between different eye-tracking measurements and students' detection accuracy and to assess participants' experiences with ETT as a learning aid.

METHODS

This mixed-method observational study received ethical approval from the Ethics Committee at King Abdulaziz University Dental Hospital (KAUDH) (#112-10-22) and adhered to the Strengthening the Reporting of Observational Studies in Epidemiology guidelines[16]. Due to the limited number of actively enrolled PG pediatric dental students, our target population encompassed all of them. Consequently, we employed a census approach (enrolling all members) instead of a sample. All PGs were invited via email to participate voluntarily; 30 agreed, while 2 declined. To ensure a comparable control group, we concurrently recruited and enrolled 32 dental interns. Written informed consent was obtained from the participants before they began the computer-based test. To maximize participation, we offered a gift card as an incentive.

STIMULI

To create a test set of panoramic dental radiographs, we extracted images from the KAUDH electronic health system, specifically the database of the oral pathology department. This database included patients diagnosed with jaw lesions between 2015 and 2018. To minimize student recognition of any patient, radiographs treated within the past three years were excluded. All cases required the presence of at least one abnormality. A panel of three pediatric dentists and an oral radiologist (all with at least five years of clinical experience) from KAUDH reviewed the selected cases to ensure good radiographic quality.

The nine (n = 9) panoramic radiographs used in this study presented various abnormalities designated as areas of interest (AOIs). These included dentigerous cysts, odontogenic keratocysts, fibrous dysplasia, periapical radiolucencies, rudimentary teeth, retained primary teeth, and dilacerated roots. No image manipulation was performed. The type of lesion for each patient was documented and confirmed using their dental records. All identifying information was removed, and each case was assigned a de-identified serial number.

RELIABILITY

To assess the test's reliability, we adopted exam question items from two ET studies in the field of dental education[8-9]. The test was divided into three scoring sections: lesion detection, lesion location, and total score. For lesion detection, a score of 0 was assigned for reporting "No abnormality" and 1 for "Yes, there is an abnormality." Lesion location scores ranged from 0 to 6, with 0 indicating "no abnormality reported," 1 indicating an abnormality in one sextant, and so on. Test-retest reliability was measured with a two-week interval between assessments. Cronbach's alpha was used to analyze reliability for lesion detection, lesion location, and total score.

Nineteen (19) out of the 22 students recruited for testing internal consistency and reliability completed the test-retest process. All participants were dental interns rotating at KAUDH and were excluded from the main experiment. Cronbach's alpha for internal consistency was 0.77 for lesion detection, 0.89 for lesion location, and 0.84 for the total score. These results indicate good internal consistency and reliability of the test for this population.

PROCEDURE

The experiment took place in a quiet, dimly lit room with no distractions in the participant's field of view. Participants viewed the radiographs independently on a 15.6-inch laptop screen (Latitude E6530, Dell Corporation, Round Rock, TX, USA) positioned at their eye level using a magnetic strip. The RED-m® SMI software (Sensomotoric Instruments, Teltow, Germany) tracked their gaze movements as they looked at the x-rays on the screen. AOIs were pre-identified on each radiograph using BeGaze software (Sensomotoric Instruments, Teltow, Germany) (Figures 1D and F). This software recorded various ET parameters including entry time, fixation time, fixation counts, revisit counts, and dwell time.

Before starting the experiment, all participants completed a five-point eye tracker calibration to ensure accurate data collection. Individuals with gaze deviation ≥ 1° were excluded. Inclusivity was maintained by allowing students wearing contact lenses or glasses to participate.

Participants received a verbal explanation of the experiment procedures and instructions before being seated comfortably. The laptop screen was positioned perpendicular to the floor, with a viewing distance of 50–75 cm between the participant's eyes and the screen. The experiment began with a section collecting demographic information: age category, sex, years of clinical experience, and academic level (dental intern or PG). Finally, the radiographic images were presented in the same random order to each participant.

Participants viewed the radiographs at their own pace. Upon finishing the slides, they were presented with an optional survey asking if they were interested in receiving their test reports and participating in an interview about their experience using ETT as a learning aid. A blank screen then appeared, signifying the completion of the test. The entire procedure took approximately 20 minutes. Data collected for each participant was automatically transferred from the experimental software (Experiment Center 3.3, Sensomotoric Instruments, Teltow, Germany) to the analysis software (BeGaze).

MEASURES

Participants viewed and analyzed one panoramic radiograph at a time, followed by a series of three questions assessing their ability to identify and localize abnormalities. The first question was a binary choice: "Are there any abnormalities in the radiograph?" The second question asked participants to either locate any abnormalities by selecting the affected sextants on the image or indicate if the radiograph appeared normal. Finally, if an abnormality was identified, participants

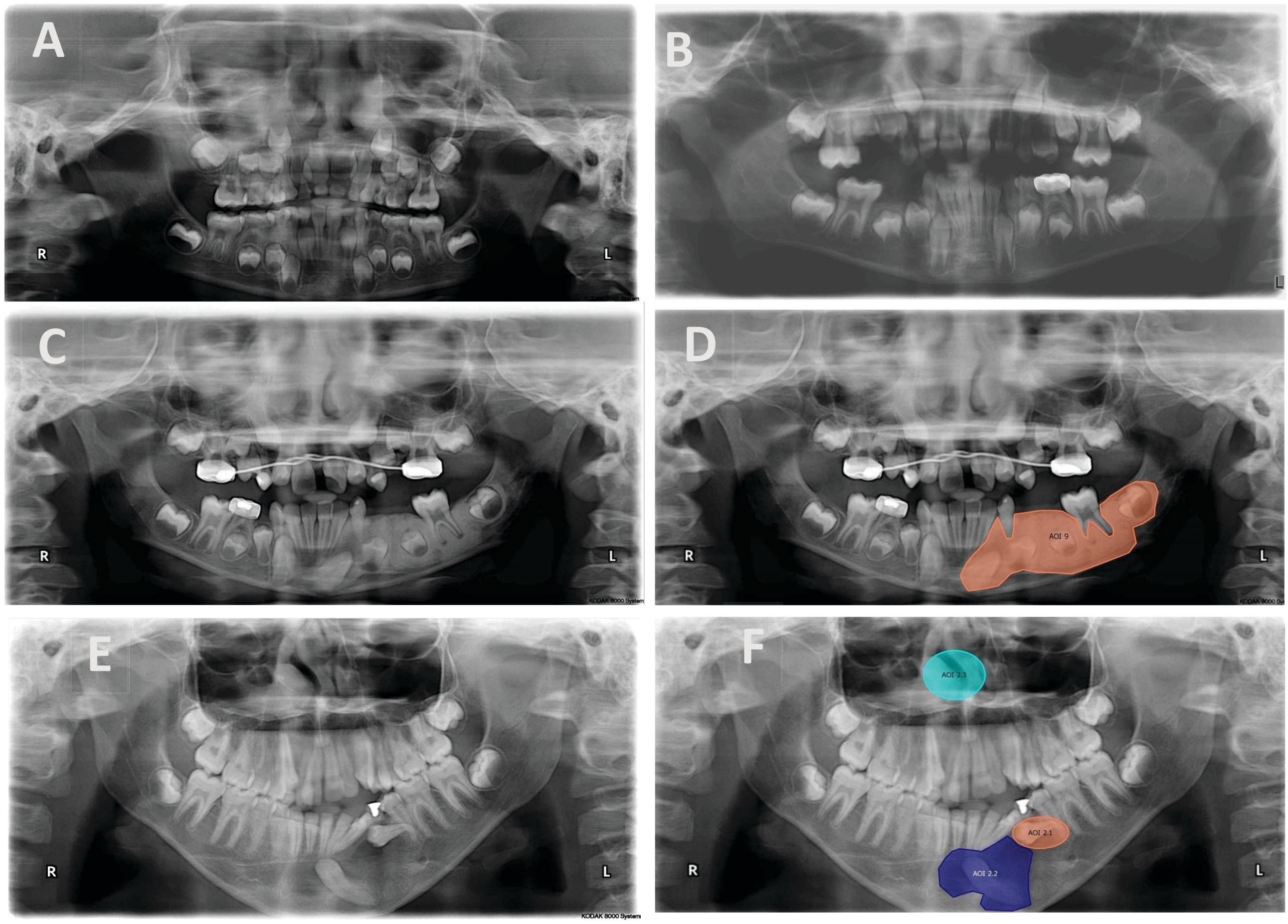

Figure 1. **(A, B) Normal panoramic radiograph; (C) Abnormal panoramic radiographs; (D) Illustrate the areas of interest (AOIs) in (C) in which a radiopacity is extending from the left ramus to the midline (Fibrous dysplasia) that causes impaction to tooth #33, 34, 35; (E) Abnormal panoramic radiographs; and 4(F) Illustrate the areas of interest (AOIs) in (E) in which AOI 2.1: Dilacerated and impacted tooth # 34, AOI 2.2: Impacted canine surrounded by a radiolucency (Dentigerous cyst), AOI 2.3: Deviated nasal septum and enlarged nasal conchae.**

were asked to describe it or provide a differential diagnosis to confirm their understanding. The last question was to ensure the participant described the targeted abnormality.

Several eye-tracking metrics were obtained using BeGaze software to assess participant interaction with radiographs. These metrics included: **entry time**—the time in milliseconds it took for a participant's gaze to first land on a specific AOI on a radiograph[17]; **dwell time**—the total time in milliseconds a participant spent looking at a specific AOI (encompassing fixation time and saccades within that area); **fixation time**—the total time in milliseconds a participant's gaze remained fixated on a specific AOI; **revisit counts**—the number of times a participant's gaze returned to a specific AOI after initially looking away; and **fixation counts**—the total number of times a participant's gaze fixated on a specific AOI[18].

INTERVIEWS

One week after the test, follow-up qualitative interviews were conducted with participants who expressed interest in receiving their test results and discussing their experiences using ETT. After obtaining informed consent for recording the interview, the interviewer confirmed the participants' understanding of the correct lesion locations used in the assessment. A semi-structured, one-on-one interview then explored the participants' experiences with ETT, including their perspectives on the potential benefits and challenges of incorporating ETT into dental education. Each interview lasted approximately 10–15 minutes.

ANALYSIS

Univariate analysis was conducted to characterize participant demographics and performance on the ET assessment. Descriptive statistics included frequencies, medians, and the associated 25th and 75th percentiles (interquartile range).

Bivariate analyses employed the Mann-Whitney U test to compare ET measures between pediatric PG dental students and dental interns. To account for multiple comparisons, the significance level (alpha) was adjusted using Bonferroni correction from .05 to .005. Additionally, a two-sample test of proportions compared the correct identification rate of radiographs between the two groups.

Multivariable analysis employed adjusted multilevel binary logistic regression to assess factors associated with correctly identified radiographs and AOIs. The dependent variable was the correct identification of normal radiographs or abnormal AOI (identified vs. unidentified). Independent variables included participant academic rank, sex, and other ET measures (revisits, fixation count, and dwell time). Based on the bivariate analysis and to avoid multicollinearity with fixation count or dwell time, fixation time was excluded from the regression model. A multilevel analysis addressed the lack of independence between observations, with students at level 2 and AOIs at level 1. The adjusted odds ratio (AOR) and its corresponding 95% confidence interval (95% CI) were used as the measure of association. Both the two-sample test of proportions and the multivariable analysis used a significant level (*p* - value) of less than .05. Data analysis was performed using STATA/IC version 15.1.

The qualitative analysis addressed all potential participant concerns before the interviews, including the interview format, recording process, and data confidentiality. Recorded interviews were transcribed, and thematic analysis with coding was used to generate qualitative data. Interview transcripts were anonymized, and then themes were independently highlighted by two investigators (S.ALS. and S.ALM.). Highlighted themes were grouped, with any discrepancies resolved through negotiation. NVivo 11 (QSR International Pty Ltd., Doncaster, Vic, Australia) was used for word cloud generation and subtheme development.

RESULTS

PARTICIPANTS' CHARACTERISTICS AND ET PERFORMANCE

The study recruited 30 pediatric PG students and a matching number of dental interns (*n* = 32). A total of nine radiographs were used, with two being normal. The abnormal radiographs contained several AOIs ranging from one to eight. For normal radiographs, the entire image was designated as a single AOI by the ET software. The ET system recorded key performance indices (KPIs) for each AOI separately, resulting in a total of 1,240 observations from the 62 participants. Table 1 summarizes the characteristics of the stimuli used.

Table 1. Panoramic radiograph characteristics.

Radiographs Characteristics	Number of Radiographs	Type of Radiographs	Number of AOI[a]	Number of Participants	Total Recorded Observation[b]
By Case					
Case 1	1	Normal	1	62	62
Case 2	1	Abnormal	3	62	186
Case 3	1	Abnormal	8	62	496
Case 4	1	Normal	1	62	62
Case 5	1	Abnormal	2	62	124
Case 6	1	Abnormal	2	62	124
Case 7	1	Abnormal	1	62	62
Case 8	1	Abnormal	1	62	62
Case 9	1	Abnormal	1	62	62
Overall					**1,240**

Note. [a]AOI: Area of Interest. [b]Total recorded observation: Number of participants multiplied by the AOI.

Table 2 presents the participant demographics, including sex, age, academic level, and clinical experience. Among the 62 participants, 42 (67.7%) were female, and most were under 30 years old. PG pediatric dental students constituted 48.4% of the participants, with 73.3% being female. Most of the PGs (66.7%) were aged 26-30 and had 2-4 years of clinical experience (56.7%).

Figure 2 illustrates the percentage of correctly identified radiographs by academic level. Overall, participants correctly identified 90.1% of the radiographs. Breaking this down further, PG students achieved a higher identification rate (91.9%) compared to dental interns (88.5%). Interestingly, for normal radiographs, the detection rate was significantly higher for interns (67.2%) compared to PG students (65%). However, a statistically significant difference (p = 0.003) was found in the identification of abnormal radiographs, with PG students achieving a higher rate (99.5%) compared to interns (94.6%).

Table 2. **Participants Characteristics.**

Participants Characteristics	*n* (%)		Total
	Pediatric Postgraduate Dental Students	Dental Interns	
Overall	30 (48.4)	32 (51.6)	62 (100.0)
Sex			
Female	22 (73.3)	20 (62.5)	42 (67.7)
Male	8 (26.7)	12 (37.5)	20 (32.3)
Age Category (Years)			
20–25	0 (0.0)	27 (84.4)	27 (43.6)
26–30	20 (66.7)	5 (15.6)	25 (40.3)
31–35	7 (23.3)	0 (0.0)	7 (11.3)
36–40	3 (10.0)	0 (0.0)	3 (4.8)
Clinical Experience (Including Internship Year)			
1 or less years	0 (0.0)	29 (90.6)	29 (46.8)
2–4 years	17 (56.7)	1 (3.1)	18 (29.0)
5 or more years	13 (43.3)	2 (6.3)	15 (24.2)

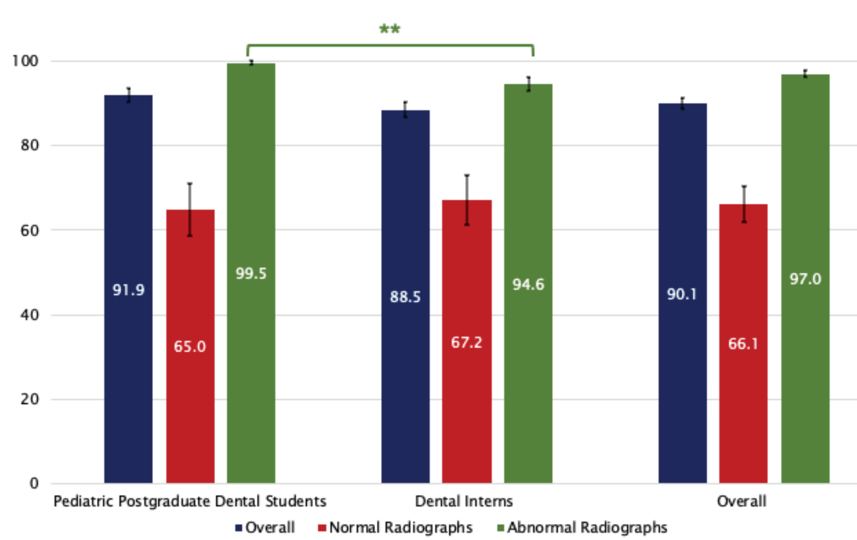

Figure 2. **Percentage of correctly identified radiographs stratified by participant's' academic level. *Note.* (**): The Two-sample test of proportions indicates a statistically significant difference between the proportion of correctly identified abnormal radiographs by pediatric postgraduate dental students compared to dental interns (*p* - value = 0.003).**

Table 3. Eye tracking key measures for each recorded AOIs, stratified by participant's academic level

Eye-tracking Measures	OPG	Median Score (25th - 75th IQR)			Mann-Whitney U Test *p*-value*
		Overall	Pediatric Postgraduate Dental Students	Dental Interns	
Revisits (Count)	Normal	0.0 (0.0–1.0)	0.0 (0.0–0.5)	0.0 (0.0–1.0)	0.607
	Abnormal	3.0 (1.0–7.0)	4.0 (1.0–8.0)	3.0 (1.0–6.0)	0.003
Fixation Count (Count)	Normal	98 (65.5–136.5)	114 (75–148.5)	89.5 (50.5–121)	0.011
	Abnormal	3 (0–10)	4 (0–11)	3 (0–9)	0.029
Entry Time (Milliseconds)	Normal	4.2 (1.9–6.8)	4.55 (1.75–6.9)	4.1 (1.9–6.8)	0.729
	Abnormal	3,120.8 (1,026.6–11,449.9)	3,551.9 (1,073.3–11,721.4)	2,914.4 (1,018.5–10,671.8)	0.269
Fixation Time (Milliseconds)	Normal	30,824.25 (18,947.65–45,188.8)	34,806.05 (23,554–46,715.35)	27,528.95 (15,147.85–45,034.55)	0.069
	Abnormal	1,213.95 (0–3,479.05)	1389.15 (0–3591.9)	997.1 (0–3308.15)	0.083
Dwell Time (Milliseconds)	Normal	33,478.5 (20,487.7–47,971.05)	37,191.9 (26,261.5–50,525.55)	29,665.7 (16,469.95–46,185.65)	0.031
	Abnormal	1,230.75 (0–3,521.05)	1414.15 (0–3696.35)	997.1 (0–33,66.55)	0.076

Note: *OPG: Panoramic Radiograph. IQR: Interquartile Range. AOI: Area of Interest. Bold font indicates statistical significance. (*): Alpha level is 0.005 after Bonferroni Correction.*

Table 4. Adjusted multilevel binary logistic regression analysis of the correctly identified radiographs and areas of interest

Predictors	AOR of correct detection [95% CI]	*p*-value
Participants Characteristics		
Academic Level		
Dental interns	Reference	
Pediatric postgraduate dental students	1.58 [0.64–3.90]	0.324
Sex		
Female	Reference	
Male	0.44 [0.18–1.10]	0.079
Eye Tracking Measures		
Revisits (counts)	1.17 [1.04–1.31]	0.009
Fixation count	1.00 [0.98–1.03]	0.776
Dwell Time (Milliseconds)	1.00 [0.99–1.00]	0.077

Note: *AOR: Adjusted Odds Ratio. CI: Confidence Interval. Bold font indicates statistical significance.*

Table 3 summarizes the key ET measures for the recorded AOIs by participant level. While PG students exhibited a higher number of fixations on normal radiographs compared to interns, this difference was not statistically significant (p = 0.011). Interestingly, PG students also tended to be slower in identifying normal radiographs, reflected by slightly longer entry times (p = 0.729). However, for abnormal radiographs with predefined AOIs, PG students revisited each AOI significantly more often than interns (p = 0.003).

Table 4 presents the results of the adjusted multilevel binary logistic regression analysis examining factors associated with correctly identified radiographs and AOIs. While PG students had a higher likelihood of correctly identifying radiographs compared to dental interns (AOR 1.58, 95% CI [0.64-3.90]), this difference was not statistically significant (p = 0.324). However, the analysis revealed a statistically significant association (p = 0.009) between revisit count and correct identification. For each additional revisit, the odds of correctly identifying a radiograph increased by 1.17. Fixation count and dwell time were not statistically significant predictors of correct radiograph identification.

QUALITATIVE RESULTS

Twenty students (10 PGs and 10 dental interns) participated in the follow-up interviews. A word cloud (Figure 3) visually presents the most frequently used terms and language from the interviews.

Seventy percent of the interviewees reported a positive experience with ETT, and for 45%, this study was their first encounter with the technology. Half of the participants (n = 10) indicated no significant

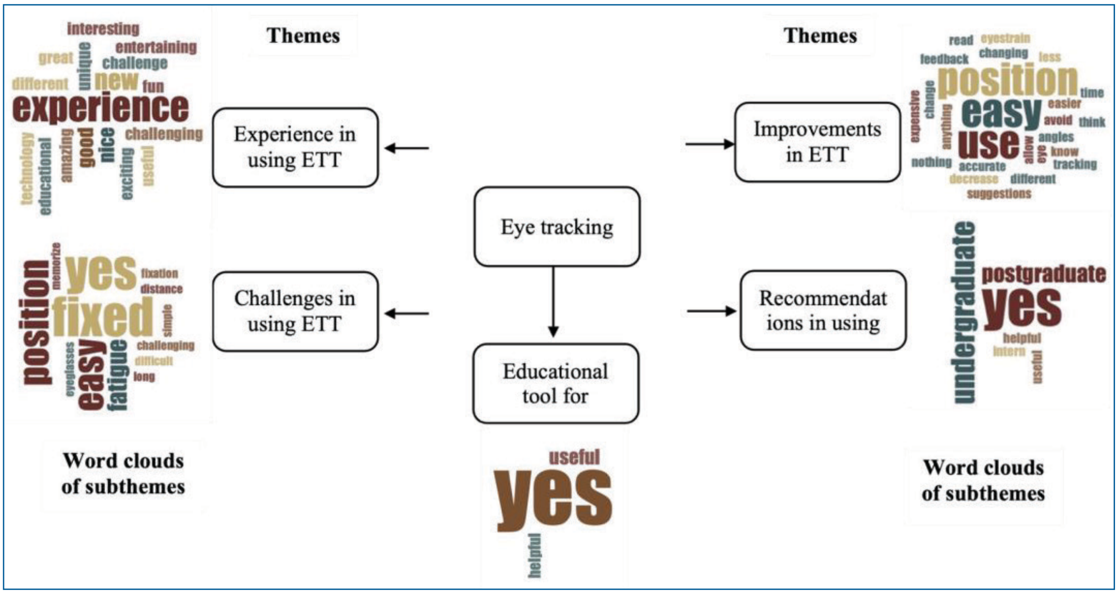

Figure 3. **Word cloud of the sub-themes of the participants' responses regarding the use of eye-tracking technology.**

difficulties using ETT. The most common challenge reported by 40% of respondents was maintaining a fixed position throughout the text.

While most respondents (*n* = 14) believed ETT could be a valuable educational tool, one participant expressed concern about its cost as a limiting factor. Out of the 20 interviewees, 11 suggested no improvements, while 7 proposed advancements such as more user-friendly software. Two participants recommended including fewer cases per test.

All respondents endorse the use of ETT in dental programs to improve patient care. Six specifically recommended its integration into undergraduate education to promote the early development of image interpretation skills. The remaining respondents suggested its use for assessing PGs when reviewing cone-beam computed tomography scans.

DISCUSSION

This mixed-method study investigated the visual parameters of dental students at two educational levels (PG students and interns) using ETT while viewing pediatric panoramic radiographs. This study aimed to compare the ET performance of PG students and dental interns in detecting abnormalities in panoramic radiographs, explore the relationships between different ET measures, determine the odds of abnormality detection in radiographs, and assess participant experience using ETT as a learning aid.

Building upon a previous study by our team that evaluated PG students' ability to identify abnormalities in panoramic radiographs[19], this research incorporates a control group (dental interns) for a comparative analysis of ET performance between the two distinct groups. We aimed to explore the impact of various ET metrics on detection accuracy and delve into the participants' experiences using ETT as a learning tool. Our findings revealed that PG students had a higher probability of correctly identifying abnormalities and revisiting AOIs significantly more often than dental interns. Additionally, the results suggest a link between revisit count and the likelihood of detecting a radiographic lesion.

Our findings suggest that PGs were more cautious than dental interns, potentially leading to a slight overreporting of abnormalities in normal radiographs. This is reflected by a longer trend of fixation and dwell times on normal radiographs for PGs. It is worth noting that this difference may be due to the AOI encompassing the entire radiograph for normal cases, whereas the ET system recorded separate KPIs for each AOI in abnormal radiographs.

While not statistically significant, PG students, who generally have more experience than interns, exhibited longer entry times for both normal and abnormal radiographs. This aligns with the findings of Bahaziq *et al.*[9] who reported that expert orthodontists spend more time examining panoramic radiographs for incidental findings compared to novice orthodontists[9]. However, this contradicts another study where experienced observers demonstrated faster scanning times with potentially less thoroughness than inexperienced observers[7].

Our observations showed that PGs were slower to confirm their identification of normal radiographs compared to dental interns, resulting in slightly longer entry times. Additionally, PGs demonstrated greater consistency in correctly detecting abnormalities. This aligns with a previous study where senior dental students, despite slower scanning times, achieved higher diagnostic accuracy compared to juniors[2]. Additionally, juniors in that study more frequently missed abnormalities in peripheral areas and bones[2].

Furthermore, PG students revisited each AOI significantly more often than interns when analyzing abnormal radiographs. Our multivariable analysis revealed a positive association between revisit and the odds of accurate detection, with a 1.17 increase in odds for each additional visit. Interestingly, PG students exhibited lower specificity (more false positives in normal radiographs) but higher sensitivity (more true positives in abnormal radiographs) compared to dental interns. This data can inform training programs to emphasize the differentiation between normal and abnormal radiographs, particularly for specialists, to minimize overdiagnosis. It is important to consider that desirability bias might have contributed to the overdiagnosis observed in this study.

Innovative teaching modalities like ETT hold great promise, especially when combined with other modalities. For instance, a previous study examined how massed practice, an instructional modality that involves focused learning of a specific material type, influences the panoramic radiograph interpretation and student diagnostic performance[20]. The study evaluated dental students' performance before and after massed practice using ETT. Their findings suggest that massed practice is a valuable tool for enhancing students' ability to detect anomalies and focus on commonly overlooked areas[20]. Additionally, ETT can be beneficial for undergraduate students needing remediation in radiology courses or for specialized groups like PG dental radiology programs[6–21]. Therefore, ETT's effectiveness as a teaching tool can be gradually introduced and continuously evaluated to ensure its added value for dental students.

The second phase of this study employed semi-structured interviews with volunteer participants to gather qualitative data on their experiences using ETT. While the quantitative portion effectively measured student performance, information on ETT's impact on the learning process may not be well-suited for quantitative research. Although most dental research on ETT has utilized quantitative methods, the participants in this study provided valuable insights into their experiences, challenges, and recommendations for integrating this technology into dental education. These topics, including user perception, challenges, and future directions, are not only underexplored in relation to ETT but are also difficult to capture quantitatively due to their anecdotal nature. This exploratory section followed established protocols for in-depth interviews, the most prevalent and reliable qualitative data collection method in healthcare settings[22].

This study breaks new ground by evaluating the performance of PGs and dental interns in detecting abnormalities in pediatric panoramic radiographs. ETT provided a contemporary approach to understanding participants' visual scanning patterns and interpretation skills. Additionally, the mixed methods design offered a comprehensive assessment of participants' performance and experiences from multiple perspectives. This multifaceted approach yielded valuable insights into both the strengths and limitations of using ETT for dental education. Another key strength lies in the study's real-world setting, utilizing actual patient records without time constraints for viewing radiographs. Furthermore, the research was conducted at one of the country's largest dental schools, accredited by both the National Dental Association and the American Dental Association.

Several limitations are important to consider. First, while participation from PGs was high, the overall study population was relatively small. Second, the ET machine's range limited participant movement, potentially impacting natural viewing patterns. Additionally, some PGs may have approached the assessment with a sense of being tested, possibly contributing to the observed overdiagnosis of normal radiographs. Furthermore, participants reported the text length and fatigue associated with viewing multiple radiographs. Presenting the radiographs in the same order for all participants partially addressed this concern. Finally, although the study was conducted at a prominent public dental school, it remains a single institution. Future studies should consider incorporating random samples from various dental schools across the country.

CONCLUSION

Pediatric PG dental students demonstrated greater accuracy in detecting abnormalities within pediatric panoramic radiographs compared to dental interns. However, a slight trend of overdiagnosis was observed in normal radiographs among PGs. Based on these findings, this study recommends the incorporation of ETT as a supplementary teaching tool in dental education. Future research should investigate PGs' performance in interpreting other types of dental radiographs.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare. All co-authors have seen and agreed with the contents of the manuscript, and there is no financial interest to report. We certify that the submission is an original work and is not under review at any other publication.

DISCLOSURE

The authors did not receive any form of commercial support, either in the form of compensation or financial assistance, for this case report. The authors have no financial interest in any of the products, devices, or drugs mentioned in this article.

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DATA AVAILABILITY STATEMENT

Data will be made available on a reasonable request.

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