Original Article

CBCT VS OPG in Detecting Root Resorption

Cone-Beam Computed Tomography VS Panoramic Radiography: Evaluation of Root Resorption Associated with Impacted Maxillary Canines

Ebrahim S Alshawy

ABSTRACT

Objective: This investigation aims to quantify the degree of root resorption in individuals with impacted maxillary canines through a comparative analysis of OPG and CBCT radiographic techniques.
Study Design: A retrospective radiographic study.
Place and Duration of Study: This study was conducted at the College of Dentistry, Qassim University, Qassim, Saudi Arabia between September 2021 and June 2023.
Methods: Data from 40 patients with unilateral impacted maxillary canines were obtained from the Dental clinics of Qassim University Hospital Qassim, Saudi Arabia. The grading system of Ericson and Kurol was slightly modified and employed to quantify the degree of root resorption OPG and CBCT radiographs. One investigator evaluated the OPG and CBCT radiographs and graded the amount of root resorption. Cohen's kappa coefficient test was used to assess the intra-rater reliability. The differences between OPG and CBCT images regarding the severity of root resorption were evaluated using the Pearson Chi-square test. A P-value of <0.05 was considered to be statistically significant.
Results: A total number of 40 patients with unilateral impacted maxillary canines were evaluated. There were 17 males and 23 females, with a mean age of 26.6 years. Grades 0 and 1 showed statistically significant differences between OPG and CBCT readings. The OPG showed a lower occurrence of root resorption.
Conclusion: Proper investigation of impacted canines and root resorption is essential to obtain a comprehensive treatment plan. In the current study, OPG was found to be less precise than CBCT for identifying root resorption, particularly in the early stages of root resorption.
Key Words: Panoramic Radiographs, Three-dimensional Imaging, root resorption, CBCT

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INTRODUCTION

External root resorption (ERR) is a frequent and detrimental complication associated with impacted teeth. These unerupted teeth can erupt in an abnormal direction, applying pressure and triggering the breakdown of the external root surface on adjacent teeth. Histologically, ERR manifests as the gradual loss of the root's outer layer, potentially progressing deeper to affect the dentin and ultimately the pulp, the innermost sensitive region of the tooth[1].

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The resorption reflects a permanent destruction of the tooth structure, resulting in a permanent loss of width and length of the root. Numerous and complicated factors are related to the occurrence of ERR[2]. Risk factors of ERR can be categorized into internal and external.[3] Internal causes include genetic predisposition, systemic diseases, age, gender, root morphology, impacted teeth, and parafunctional habits[4,5]. Impacted teeth, such as maxillary canines, are generally associated with the ERR of the adjacent teeth. The roots of the lateral maxillary incisors are frequently affected by the impacted maxillary canines[6]. Orthodontic treatment can influence root resorption through several factors, including treatment duration, appliance type, force magnitude and directionality, tooth extraction decisions, and the application of root torque[3,7].

Diagnosis of the ERR starts with obtaining a comprehensive history of the patient, including the medical and dental history and incidence of previous trauma on the teeth[8]. Radiographically, some different types and techniques are used to diagnose the ERR. Periapical radiographs, orthopantomography (OPG),

and cone-beam computed tomography (CBCT) are frequently used to assess the presence and severity of the ERR[9,10].

The severity of the ERR is categorized into 5 grades[12]. The first grade emphasizes no resorption of the root surface (Grade 0). The second grade shows an intact root surface with only resorption of the cementum (Grade 1). The third grade indicates up to half the resorption of the dentin (Grade 2). The fourth grade presents with moderate dentin resorption (<50%), but the pulp remains unexposed (Grade 3). The fifth grade characterized by severe root resorption with the involvement of the pulp (Grade 4). Teeth with more severe root resorption will have a poorer prognosis compared to teeth with mild resorption. In cases with impacted maxillary canines, orthodontic treatment planning can be altered and guided according to the extent of root resorption[6,12]. In some severe cases, extraction of the affected tooth might be the better treatment option[14,15].

Current radiographic methods have limitations in accurately assessing external root resorption, often resulting in overestimation or underestimation of its severity. Consequently, a definitive diagnostic technique for ERR remains elusive. Until recently, the 2-dimensional radiograph techniques were the most commonly used methods in orthodontic planning and impacted canine localization[16]. The panoramic imaging is considered as the standard technique for pre-operative diagnosis in orthodontics[16]. The two-dimensional techniques, such as periapical radiographs and OPGs, are associated with magnification errors, image distortion, reliability issues, and superimposition. Furthermore, when using these techniques alone, it would be challenging to identify between buccal and palatal root resorption. On the other side, three-dimensional techniques, such as CBCTs, overcome these weaknesses and limitations and provide superior qualitative assessment[17]. However, CBCTs are associated with higher machine costs and radiation dosage.

This study investigates the effectiveness of OPG and CBCT in assessing the extent of root structure loss induced by impacted maxillary canines. The reliability and accuracy of the OPG and CBCT radiographs will be assessed.

METHODS

The current retrospective study was approved by the Committee of Research Ethics, Deanship of Scientific Research, Qassim University, Saudi Arabia (IRB Reference No: 11-04-21).

Data from 40 patients (>13 years old) with unilateral impacted maxillary canines were retrospectively obtained from the Dental clinics of Qassim University Hospital Qassim, Saudi Arabia. All included patients should have OPG and CBCT radiographs. Patients with history of orthodontic treatment and trauma of teeth were excluded. Also, we excluded patients with bony disorders and systemic diseases that can influence the ERR, such as cleft palate. Soredex machine (CRANEX Novus, Helsinki, Finland) was used to take the Panoramic radiographs. Sirona GALILEOS Comfort PLUS machine was utilized to obtain the CBCT images.

The grading system of Ericson and Kurol was slightly modified and utilized for the evaluation of root resorption severity on OPG and CBCT radiographs[12]. Grade 0 indicates no sign of root resorption. Grade 1 suggests loss of the cementum. Grade 2 emphasizes mild resorption of the dentin (<half of the root is resorbed). Grade 3 shows moderate root resorption of the dentin (>half of the dentin without pulp exposure). Grade 4 exhibits severe root resorption with pulp exposure.

To assess intra-rater reliability, a single examiner evaluated the OPG and CBCT radiographs for root resorption severity using a standardized grading system. The examiner then re-evaluated all radiographs after a 3-week interval. SPSS for Windows, version 20.0 (IBM Corp., Armonk, NY) was used to analyze the data. Cohen's kappa coefficient was calculated to quantify the intra-rater reliability between the two observations. The Pearson Chi-square test was employed to investigate potential discrepancies between OPG and CBCT radiographs in depicting the severity of root resorption. A *P*-value of <0.05 was considered to be statistically significant.

RESULTS

A total of 40 patients with unilateral impacted maxillary canines were evaluated. The sample involved 17 male and 23 female patients with a mean age of 26.6 (SD=±2.2) years. The readings and extent of root resorption from OPG and CBCT radiographs are shown in Table. Grades 0 and 1 showed statistically significant differences between OPG and CBCT readings. Figure shows an OPG image of one of the studied patients with severe root resorption.

The Cohen's kappa coefficient test suggested a high correlation (92.5%) between the two observations for OPG and CBCT radiographs.

Table No.1: Amount of root resorption from OPG and CBCT radiographs.

Grade	OPG - n (%)	CBCT - n (%)	P value
Grade 0	20 (50)	15 (37.5)	0.0178*
Grade 1	7 (17.5)	12 (30)	0.0213*
Grade 2	6 (15)	5 (12.5)	0.0735
Grade 3	5 (12.5)	6 (15)	0.0735
Grade 4	2 (5)	2 (5)	1
Total-n (%)	40 (100)	40 (100)	

Figure No.1: shows an impacted maxillary canine causing a severe root resorption on the distal side of the upper right lateral incisor.

DISCUSSION

This study investigated the effectiveness of OPGs and CBCTs in investigating the relationship between impacted maxillary canines and adjacent tooth root resorption. External root resorption, a potential consequence of impacted canines on adjacent teeth, can be assessed through various methods in clinical practice. However, there is no gold standard diagnostic technique to evaluate the ERR. Despite the ongoing search for a definitive diagnostic method, OPG and CBCT diagnostic modalities remain the most prevalent tools for assessing ERR due to their accessibility and established reliability. In the current sample, there were more females than males, which is consistent with other studies[12,16]. Walker et al., suggested that the gender and genetic differences could be explanations for the condition occurrence being higher in females[18]. Another potential cause may be that males pursue orthodontic management less frequently than males[18].

The present study revealed a significant discrepancy between OPGs and CBCTs in detecting root resorption in impacted canine cases. While nearly half (50%) of the cases exhibited root resorption on OPG images, CBCT scans identified this issue in a considerably higher proportion (62.5%). This marked difference was most pronounced for cases in the earliest stages of root resorption, highlighting the limitations of OPGs in pinpointing early signs of resorption. The OPGs were less effective in identifying root resorption in the early stages. Alqerban et al., reported a significant difference between CBCT and OPG scans. OPG images significantly underestimate the root resorption, particularly in the early stages of the resorption[12].

Different published studies evaluating the reliability of the OPG and CBCT images showed agreement with the results of the current study. A clinical research carried out by Dudic et al., showed that 69% of the cases on CBCT images had root resorption and 44% with OPG images[1]. According to another study, the CBCT technique can significantly detect a higher number of cases with root resorption than the OPG technique[1]. The occurrence of root resorption was identified in 29.9% of the samples using CBCT and 15.2% using the OPG. A recent prospective clinical study reported that CBCT images showed a significantly higher occurrence of root resorption (53.6%) than the OPG images (7.5%)[13]. On the other hand, a systematic review and meta-analysis carried out by Deng et al., reported that OPG images might overestimate the degree of root resorption[3]. The conflict of the results in the previous study can be referred to the type of radiograph machine used and the examiner's experience.

CBCT scans are not routinely indicated for all patients diagnosed with impacted maxillary canines. In accordance with the American Dental Association's (ADA) guidelines, the CBCT should be used only when it is expected to significantly improve diagnostic accuracy and, consequently, significantly improving clinical judgment[8]. The utilization of CBCT has been proposed as the primary diagnostic modality for accurately quantifying the extent of root resorption in cases classified as moderate or severe[10]. The benefits of the OPG radiographs are being readily available for an initial assessment of the teeth[14]. They are relatively cheaper and produce less radiation dose than CBCT images. However, they create lower-quality scans[7]. The use of CBCT scans requires a personalized approach, tailored to the specific needs of each patient, the potential benefits against the associated costs. CBCT offers a valuable advantage in diagnosing root resorption related to impacted maxillary canines. This precise information is crucial for formulating optimal treatment plans considering the health of adjacent teeth[17].

The CBCT was recommended as the superior imaging modality for diagnosing root resorption in impacted canine cases compared to the OPG[14]. The overlap between the crown of the impacted canine and the root of the adjacent teeth might obscure the amount of the resorption[15]. The findings of the CBCTs can alter the treatment plan as they may provide a better view of the amount of the resorption[12]. It has been reported that utilizing the CBCT increases the confidence level of the orthodontist[12]. However, two clinical studies showed no significant differences in treatment decisions when utilizing CBCT and OPG as diagnostic modalities[12,13]. The two techniques provide similar information the treatment planning.

CONCLUSION

Early detection of impacted canines and root resorption is crucial for developing an optimal treatment plan. While panoramic radiographs (OPGs) are readily available and can identify impacted canines, they may not provide sufficient detail for precise diagnosis, particularly regarding root resorption. In such cases, cone-beam computed tomography (CBCT) offers a more comprehensive view, potentially improving both diagnosis and treatment planning. This study confirms the limitations of OPGs in detecting root resorption

compared to CBCT. However, OPGs remain a valuable tool for initial assessment, especially when CBCT is unavailable.

Author's Contribution:

Concept & Design of Study:	Ebrahim S Alshawy
Drafting:	Ebrahim S Alshawy
Data Analysis:	Ebrahim S Alshawy
Revisiting Critically:	Ebrahim S Alshawy
Final Approval of version:	Ebrahim S Alshawy

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