COMPARISON OF PROGNOSTIC INDICATORS OF MAXILLARY IMPACTED CANINE USING OPG (ORTHOPANTOMOGRAM) WITH CBCT (CONE BEAM COMPUTED TOMOGRAPHY)

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ABSTRACT:

OBJECTIVES:

The aim of the present study was to compare OPG (orthopantomogram) in locating impacted canines with CBCT (cone beam computed tomography) scans of the same patients.

METHODOLOGY:

The cross-sectional study was carried out on the OPG (orthopantomogram) and CBCT (Cone-Beam Computed Tomography) of 27 patients (17 females and 10 males) presenting with impacted permanent maxillary canines. Thirty-five impacted canines were subsequently assessed on the four guidelines devised by McSherry and Pitt and applied to the panoramic films and CBCT scans.

RESULTS:

The results show weak agreement for the canine's angle to the midline and the canine's horizontal root apex position (k value=0.55, 0.46, respectively). Moreover, significant differences were found between the OPG (orthopantomogram) and the CBCT (Cone-Beam Computed Tomography) for all the variables using Chi-square and Fisher's exact test (p=.000)

CONCLUSION:

The results showed a significant difference in the 2D and 3D images of impacted maxillary canines, which can produce different diagnoses, and therefore treatment plans. OPG (Orthopantomogram) cannot be completely relied upon for the routine diagnosis of impacted canines.

KEYWORDS: *Diagnosis, Maxillary Impacted Canine, Radiograph, Orthopantomogram (OPG), Cone-Beam Computed Tomography (CBCT)*

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INTRODUCTION:

With a prevalence 1-3%, the permanent maxillary canine is the second most frequently impacted tooth after the third molar[1,2]. Impacted canines pose an orthodontic challenge whose success is governed by many factors[3,4]. Early and accurate diagnosis is the basis for treatment. Inaccurate diagnosis leads to complications during the development and eruption phase of canine including the reported resorption of the maxillary lateral incisor, central incisors, and the third one premolars[5,6]. The accurate location of an impacted canine and determining their relationship to the adjacent incisors and anatomical structures involves the diagnostic process and is essential for successful treatment. This necessary information may be partially obtained from conventional two-dimensional radiographs which are used in daily practice as an initial step in examination process[7-9] The conventional methods of radiographic investigations include periapical X-rays (involving a parallax technique), OPG (orthopantomogram), and occlusal radiographs[10]. All of the modalities are 2 dimensional and require the use of at least one additional radiograph for an accurate spatial localisation of an impacted maxillary canines. Manystudies have questioned the accuracy of 2-dimensional radiographs in assessing the exact location of unerupted canines[11,12]. The introduction of cone-beam computed tomography scans in dentistry has brought a revolution in the orthodontic diagnosis and treatment planning. Cone-beam computed tomography provides low radiation, rapid image scanning which provides radiographic and 3D volumetric data for a patient[13]. The rapid development of cone-beam computed tomography scanning combined with 3D rendering techniques produces high-resolution images that have been proven to be useful for the diagnosis of impacted teeth, treatment planning, and the identification of associated complications. Cone-beam computed tomography overcomes the limitations of conventional two-dimensional (2D) imaging[14,15]. Although cone-beam computed tomography has been used in the localisation, there is little evidence regarding its potential in assessing the prognostic factors in the management of impacted maxillary canines. Indices such as those proposed by other researchers are primarily designed for OPG (orthopantomogram) but can be potentially utilised in the images and volumes obtained from CBCT (cone-beam computed tomography). Therefore, the aim of the present study was to compare prognostic indicators of maxillary impacted canines using OPG (orthopantomogram) and CBCT (cone-beam computed tomography). The results of this study may help in formulating guidelines for determining the prognostic factors on cone-beam computed tomography volumes for the management of maxillary impacted canines.

METHODOLOGY:

This was a cross sectional study carried out on the OPG (orthopantomogram) and CBCT (cone beam computed tomograms) of 27 patients (17 females and 10 males) who had at least one maxillary impacted canine diagnosed between January 2020 to February 2021[1]. Sampling was done using a purposive sampling technique. Approval was obtained from the ethical committee. The consent for the use of records for research was obtained at the beginning of the record taking as dictated by departmental protocol. For all patients before the treatment started, the CBCT (cone-beam computed tomography) images were obtained at the same time as conventional radiographs or within a maximum interval of 2 weeks. All patients were referred for a CBCT (cone-beam computed tomography) examination because 3D visualisation of the canine relative to the adjacent teeth was clinically indicated to generate a treatment plan. Exclusion criteria included the presence of deciduous teeth, craniofacial anomalies, incomplete root formation and existing orthodontic appliances. For each subject, traditional 2D radiographs and CBCT (cone-beam computed tomography) scans in DICOM format were obtained from a cone-beam computed tomography machine (CBCT) machine (Carestream CS 9000, Carestream Dental, Atlanta, Ga). Sampling was done using a purposive sampling technique, in which only the cases with at least one unilateral palatially impacted canine were collected from the records of patients in the department. Using coded numbering to determine the reliability of the McSherry and Pitt index[16,17], the index was first used on OPG (orthopantomogram) with the identification of each case blinded to an assessor. All patient information was removed, including name, gender, age, and race. Using similar coding, the same index was used on the 3D rendering of CBCT (cone-beam computed tomography) of the respective patients. For angular measurements, the integration was set at 50.0mm using an orthogonal view. The agreement between the two modalities was determined. The four parameters assessed are shown in Figure 1. The same assessment of OPG (orthopantomogram) and CBCT (Cone-Beam Computed Tomography) was individually conducted by four different examiners each with at least 3 years of orthodontic experience. Before assessment, the parameters were shown again to the assessors to calibrate themselves. The sequence of OPG (orthopantomogram) and CBCT (Cone-Beam Computed Tomography) were randomised for each assessment. At least two weeks following the first assessment, five pairs of OPG (orthopantomography) and CBCT (cone-beam computed tomography) were randomly selected from the sample and were reassessed by the same examiner to test for intra-operator reliability. The time to complete each case ranged from 10 to 15 minutes. Statistical analyses were performed using SPSS version 25.0 (IBM Inc, Armonk, NY). Agreement between CBCT (cone-beam computed tomography) and OPG (orthopantomography) for each variable was evaluated using Cohen"s Kappa statistic. Inter-rater and intra-rater reliability was also assessed using Fleiss Kappa statistic. A Kappa value (k value) of 0.81-1.00 was considered as strong level of agreement[18]. Differences between the OPG (orthopantomography) and CBCT (cone-beam computed tomography) were assessed using the Chi-square for and Fischer Exact tests. A P-value ≤0.05 was considered significant.

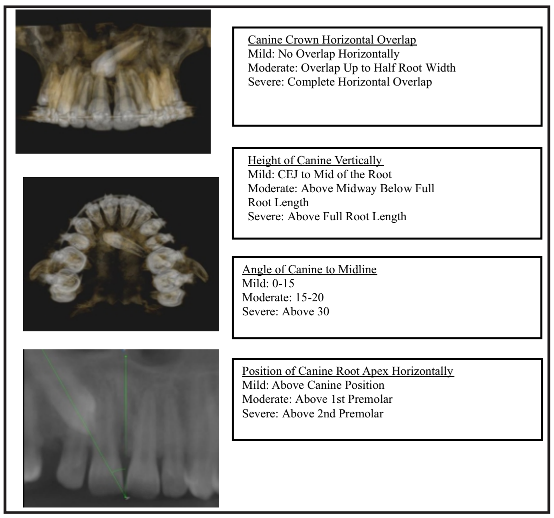

Figure 1: Diagrammatic Representation of the Difficulty Index Described by McSherry[16] and Pitt[17]

RESULTS:

Thirty-five impacted canines were identified which included 8 bilateral impactions. Nine unilateral canines were identified on the right, while 10 were on the left. The subjects ranged in age between 15 to 23±2.5 years. Table 1 and 2 gives a frequency and percentage grading of OPG (orthopantomogram) and CBCT (Cone-Beam Computed Tomography) outcomes, respectively. The majority of the canines were in poor category related to horizontal overlap and angulation to midline in both groups. There was strong agreement regarding the vertical height of the canine (k value=0.81), There was good agreement for horizontal canine crown overlap (k value=0.70). However, there was weak agreement for the angle of the canine to the midline and canine root apex position horizontally (k value=0.55,0.46 respectively). Moreover, significant differences were found between the OPG (orthopantomogram) and CBCT (cone-beam computed tomography) for all variables using Chi square and Fisher"s exact test (p=.000) (Table 3). Kappa values for inter-rater reliability showed significant differences for all variables with the weakest agreement for vertical canine height (k value=0.074). However, the results indicated low me asurement error on the intra-rater reliability assessment for CBCT (Cone-Beam Computed Tomography) and OPG (orthopantomogram) (k value=0.82).

Table 1: Frequency and Percentage Grading of Orthopantomogram Using Mcsherry[16] and Pitt[17] Criteria

Orthopantomogram		Frequency	Percentage (%)
Horizontal Overlap	Good	13	34.8
	Average	6	17.4
	Poor	16	47.8
Vertical Height	Good	20	57.1
	Average	13	34.3
	Poor	3	8.6
Angulation to Midline	Good	3	8.8
	Average	14	41.2
	Poor	17	50.0
Root apex	Good	10	28.6
	Average	12	34.3
	Poor	12	34.3

In this study the most common blood group transfused wasB+ that is about 32% out of 100 transfusions, O+ that is 29% of total transfusion and A+, which is 28% of total transfusion. The least common blood group transfused was O- and B- that were 2% each. Thus B+ and O+ are the most common blood group transfused in study patients as clear from Figure 1.

Table 2: Frequency and Percentage Grading of Cone Beam Computed Tomography Using Mcsherry[16] and Pitt[17] Criteria

Cone-Beam Computed Tomography		Frequency	Percentage (%)
Horizontal Overlap	Good	11	31.4
	Average	8	22.9
	Poor	16	45.7
Vertical Height	Good	21	60.0
	Average	9	25.7
	Poor	5	14.3
Angulation to Midline	Good	5	14.3
	Average	11	31.4
	Poor	19	54.3
Root Apex	Good	6	17.1
	Average	13	51.4
	Poor	4	31.4

Table 3: Differences and Correlations Between the Orthopantomogram and Cone-Beam Computed Tomography

	Chi- Square Value	Exact Value	k-Value
Horizontal Overlap	.000	.000	0.7*
Vertical Height	.000	.000	0.8*
Angulation to Midline	.000	.000	0.551*
Root Apex	.000	.000	0.46*

*p-value ≤0.05

DISCUSSION:

The aim of the present study was to determine the reliability of the McSherry and Pitt index to assess the prognosis of impacted maxillary canines using OPG (orthopantomogram) and CBCT (cone-beam computed tomography). Good positional reliability was found for the horizontal overlap and vertical height and fair to poor reliability for canine angulation to the midline and canine apex localisation when assessed by the McSherry and Pitt criteria. The McSherry and Pitt index is a commonly used index to assess the difficulty of orthodonticallyrecovering impacted maxillary cani nes. The index is easy to use and understand; however, it has been used on OPG (orthopantomogram) only, but the present study extended the index to compare OPG (orthopantomogram) with CBCT (cone-beam computed tomography)[10]. The percentage agreement found for the vertical tip cusp position (80%) was higher than the 50% of agreement described in a previous studies[13]. Similarly, a study by Pico et al,[19] found high intra-rater agreement (85.9%) for vertical height of canine cusp tip position, suggesting that both OPG (orthopantomogram) and CBCT (Cone-Beam Computed Tomography) allow satisfactory determination of the canine cusp in the vertical plane. A satisfactory agreement of 70% was found for canine horizontal overlap which matched that reported by Hanley et al,[13] (79%) when 7 judges‟ assessed 25 teeth using the 2 methods. In 21% of the responses, there was a difference reported between the 2 methods. This suggests that the horizontal overlap of the canine on the neighbouring incisor tooth roots is a reliable measure on both OPG (orthopantomogram) and CBCT (Cone-Beam Computed Tomography). A systematic review by Eslami and Barkhordar et al,[20] concluded that there was only fair to moderate agreement between the CBCT (cone-beam computed tomography) and conventional radiography methods for the localisation of impacted canines. This difference can potentially affect the treatment planning. The present study suggested satisfactory agreement for horizontal overlap and vertical height, while there was fair agreement for the tooth‟s angulation to the midline and weak agreement for root apex position as recorded by CBCT (Cone-Beam Computed Tomography) and OPG (orthopantomogram). Wriedt et al,[12] determined that in more than 25% of cases, the canine apex was not identifiable in the OPG (orthopantomogram). Similarly, Pico and Vale et al,[21] showed that the exact location of mesiodistal cusp tip position and labio palatal root apex position were difficult to identify on an OPG (orthopantomogram). Therefore poor agreement was found between the two methods when determining the mesio-distal position of the canine‟s apex. This may well be a reason for the poor agreement in the canine root apex between two methods used during the present study. Sarikir et al,[22] found no correlation between OPG (Orthopantomogram) and CBCT (Cone-Beam Computed Tomography) regarding the bucco palatal position of the impacted maxillary canines. Also reported were significant differences in the estimation of the angulation of the canines to the midline between the OPG (Orthopantomogram) and CBCT (Cone-Beam Computed Tomography). The present findings regarding the angulation to midline were in accordance with previous findings, although good correlations were identified regarding the morphology of the permanent lateral incisor, the contact relationship, and possible root resorption. The present results suggest that there are significant differences between the two methods regarding the angulation of the impacted canine to the midline and the horizontal position of canine root apex. This difference is most likely due to the lack of 3D information provided by a panoramic radiograph, suggesting the use of CBCT (Cone-Beam Computed Tomography) in such cases. However, regional guidelines for the use of CBCT (Cone-Beam Computed Tomography) must be followed to justify its use.

LIMITATIONS:

There were several limitations of this study. Sample size was not calculated because of limited data and hence the number of canines studied was small. Also, most of the sample consisted of female patients. Future studies from larger settings can rectify these limitations.

CONCLUSION:

There is a good agreement of the results between OPG (orthopantomogram) and CBCT (Cone-Beam Computed Tomography) for the horizontal overlap and vertical height positional localization of impacted permanent maxillary canines when assessed by the McSherry and Pitt criteria. The agreement for canine apex and angulation is weak showing differences between the two methods. OPG (orthopantomogram) cannot be completely relied upon for the routine diagnosis of impacted canines. Diagnostic doubts related to OPG (orthopantomogram) findings, suggests that a patient would benefit from a CBCT (Cone-Beam Computed Tomography).

CONFLICT OF INTEREST: None

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