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Surveying CBCT usage among North Indian children and adolescents at a dental hospital. Investigating requests and indications.

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**Conflicts of Interest:** Nil

# Abstract

**Objectives:** CBCT is an essential diagnostic modality for dental diagnosis. This retrospective study aims to evaluate the requests and indications for CBCT evaluation in a dental institute over a 3-year period. Specific aims were to determine what technical settings were used, which dental professional write the referrals, and how often and for what reasons re-exposure was necessary, along with characteristics of the referring dentists.

**Materials and methods:** Patients of 18yrs of age and less who had been referred to the oral and maxillofacial radiology department for a CBCT scan during 2019–2022 were included in the study.

**Results:** In the present study, 80 children and adolescents under the age of 19 years were referred from various departments with varied indications. Mean

participant age was 16.2 years (range: 6–18; 29 females [36.3 %] and 51 males [63.7%]). The most frequent request for CBCT scan was to assess an ectopic impacted canine. Re-exposure was required in 11 cases (13.7% of the included 80 scans). In this study, the patients had been referred from general dental practitioner and dental specialists: GPDs (7.5%), orthodontists (48.7%), oral and maxillofacial surgeons (26.2%), paediatric dentists (7.5%), and Endodontics (10%). The vast majority of CBCT referrals in the present study selected the narrow field of view.

**Conclusions:** CBCT is an efficient 3D imaging modality which has gained popularity in dentistry. It should be used judiciously in children and adolescent patients in order to avoid unnecessary radiation exposure. High scanning speed to reduce motion artefacts and a half rotation to reduce the radiation dose to the patient should be preferred.

Keywords: CBCT, Children, Referrals, Field of View.

# Introduction

The radiographic examination represents an important tool for dental diagnostics [1]. The need for more accurate images has led to the application of new 3D technology for the improvement of image quality [1]. However, the more advanced techniques provided better imaging qualities at the expense of increased cost and often radiation exposure [2-4]. Cone-beam computed tomography (CBCT) is a newer radiological technique used in dental and maxillofacial radiology giving high diagnostic quality [5,6]. It is based on volumetric tomography and yields images in three dimensions: in the axial, sagittal and coronal planes. This technique delivers a relatively high radiation dose to the patients compared to conventional dental radiographic techniques but less than medical tomography, CT. [7] Studies have evaluated various CBCT examinations to verify the need for this technique [8,9]. Studies have also investigated CBCT units from various manufacturers to measure radiation doses to patients. It was found that, due to the numerous technical settings, such as field of view (FOV), tube voltage (kV), and tube current (mA), the delivered radiation dose can vary greatly between units [10,11]. Additional advantages include the availability of digital formats with image enhancement tools, with the possibility of making different measurements along with possible printing of different images required [12].

In order to reduce unnecessary radiation exposure to the patient, radiographic examination should not be done before a thorough assessment of the patient history and a clinical examination. Availability and use of CBCT in child and adolescent care has grown in recent years. The risk of permanently modifying human genetic material (DNA) and causing mutations increases with each exposure to ionizing radiation, which could induce cancer [13]. The latency period between exposure to ionizing radiation and the clinical development of a cancer is estimated to be between 20 and 45 years. Children are 2–10 times more radiosensitive than adults and, thus, suffer a higher risk of stochastic effects [14]. Patient benefit should exceed the potential risk of inducing cancer. The As Low As Reasonably Achievable (ALARA) principle includes quality assurance, assessment of techniques and equipment, and the lowest radiation doses that will reasonably deliver the necessary diagnostic information should be followed [14].

The guidelines must be developed for when and why examinations should be performed to minimize the radiographic dose to young patients. In order to do this, it is important to determine how CBCT is presently being used. Thus, the aim of the present study was to investigate the indications being used for recommending a CBCT examination of children and adolescents, during a 3-year period. Specific aims were to discover the types professional sending of dental referrals, the characteristics of the patients, and the technical parameters used and necessity of a re-exposure in CBCT exams.

# **Materials and Methods**

The present study was performed in Sri Guru Ram Das Institute of Dental Sciences and Research, Amritsar. All patients who were less than 19 years old had been imaged with a CBCT unit during 2019–2022 were included in the study. The CBCT unit at the Department of Oral and Maxillofacial Radiology at SGRD, Amritsar hospital was a CARESTREAM CS 9300. Referral and reports were retrieved from the department records and were manually searched for inclusion in the research.

The data from each selected patient were collected from the manual form like who sent the referral, age at the time of examination (years), gender, requests and indications, technical settings (FOV dimensions, mA [tube current] and kV [tube voltage], exposure time, and rotation angle), and whether a scan was repeated the same day.

One investigator analysed all data received from the records. These data were organized in a Microsoft Office Excel 2016 spreadsheet for further processing. After data collection, we divided the patients into four age groups: 0-5, 6-10, 11-15 and 16-18 years.

# Results

In the present study, 80 children and adolescents under the age of 19 years were referred from various departments with varied indications. Mean participant age was 16.2 years (range: 6–18; 29 females [36.3 %] and 51 males [63.7%]). The largest age group was the 16 to 18year olds (n<sup>1</sup>/448; Figure 1). Seven types of requests were made in the referrals (Figure 3). The most frequent indication for CBCT scan was to assess an ectopic impacted canine.

The two most common questions asked were – (i) localization of an ectopic impacted canine and (ii) resorption of adjacent roots – were most frequent in the 16 to 18 year age group (Figure 5). Re-exposure was required in 11 cases (13.7% of the included 80 scans). Primary reasons were all motion artefacts caused by anxiety, lack of patient cooperation or just accidental movement. Artefacts occurred most frequently in the 6-to 10-year age group, but correlations between age and re-take frequency was non-significant.

The 80 patients included in this study had been referred from general practice and specialized caregivers (Figure 2): GPDs (7.5%), orthodontists (48.7%), oral and maxillofacial surgeons (26.2%), paediatric dentists (7.5%), and Endodontics (10%). Two scout images, one frontal and one lateral image, were made for all patients. These images were produced with a radiation dose equal to one intra-oral radiographic image, such as a bitewing. The scout images were used to determine the best FOV and rotation angle for each examination. Figure 4 illustrate the distribution among the examinations of the three most frequently used FOVs. The clinical standard at the department was a voltage of 90 kV and a current of 5 mA.

## Discussion

Cone Beam computed tomography is an advanced diagnostic 3D imaging modality and is favoured over conventional radiography due to its 3-dimensional representation, superior image quality, acquisition speed, and relatively low radiation exposure dose compared to conventional CT [15]. However, the high cost and higher radiation exposure compared to conventional 2-D radiographic modalities necessitate careful evaluation for the actual need for their use [16].

The current study aimed at evaluating the CBCT referral patterns in children and adolescent in an academic institution. The uniqueness of this is the presence of the machine within the same building. Previous studies [17, 18] have found this technique to be useful and provide detailed images in comparison to intraoral and panoramic radiographic imaging.

The present study found many indications for recommending a CBCT examination in children and adolescent patients. The most investigations (60%) were made in the 16 to 18 year age group. Assessment of an impacted ectopic canine was most common in this group, as it was in all age groups. An endodontic evaluation and extent of a periapical lesion was the second most common indication in the 16- to 18-year group while evaluation of jaw lesions followed by

various cleft palate indications and mesiodens evaluation took second place in the youngest, 6- to 10-year group. The second most common referral among the oldest children, the 16- to 18-year group, concerned bone changes in periapical pathology and endodontic evaluation. A previous study [9] found that CBCT does not always improve diagnostic accuracy compared with other imaging methods, such as panoramic imaging. Wriedt et al. evaluated CBCT accuracy for indications concerning impacted ectopic canines and resorption on adjacent teeth. They concluded that small volume CBCT may be justified as a supplement to intraoral radiography when root resorption of adjacent teeth is suspected or when the canine apex is not clearly discernible in the panoramic X-ray, implying dilacerations of the canine root [6]. Christell et al. [19] concluded that not all patients benefit from a CBCT examination if the primary outcome is a change in treatment plans. Christell et al.[19] also found no support for routine control of maxillary canine eruption disturbance.

As children are more radiosensitive than adults, radiation exposure should be kept as low as reasonably achievable. However, the availability of CBCT machine in academic institutes has encouraged a too frequent use of this modality. This is a concern in child and adolescent dental care. Even though the ICRP has published guidelines [20] for a restricted use of CBCT, the number of referrals and performed examinations have unfortunately been on the rise since their introduction. A licensed specialist in oral and maxillofacial radiology must decide when CBCT is justified and then supervise the examination [21].

The most common reason for re-exposure in the present study was the motion artefacts which resulted in an inferior image quality followed by inappropriate FOV. In a systematic review [17], they found that prevalence of movement during CBCT investigations could be approximately 20%. Spin- Neto et al. [18], have in a previous study, concluded that all kinds of movement give artefacts in CBCT images. They also concluded that movement of young patients during CBCT examination not always resulted in inferior image quality and it was the number and duration of the movement which affected the image quality [19].

The specialty/ department that issued the referral was formulated as follows: the most significant number of referrals came from the orthodontists (48.7%) followed by oral surgery department (26.2%), Endodontics(10%), paediatric dentists (7.5%) and GPDs (7.5%). Norwegian survey reported that the highest referral rate was for impacted teeth localization [15], dental implant planning and site evaluation was reported to be the main reason for CBCT referrals in several other studies [16, 17]. In the literature, the main reason for orthodontist referrals was the evaluation of impaction and cleft cases [19], while Endodontics tended to use the images mainly when surgical endodontic therapy was planned [18].

The present study found many indications for recommending a CBCT examination which are as follows impacted canine localization, localization of impacted mesiodens, periapical lesions with endodontic evaluation, jaw extensive lesions, implant survey, delayed eruption of permanent tooth, cleft palate assessment. This reflects the diversity of child and adolescent care and the need for detailed investigations with 3D imaging.

As discussed, the most frequent query in the 16- to 18year group was how the canines were situated and whether adjacent teeth had any sign of resorption. This is an area needing more research to determine whether and what proportion of the examinations supported a change in patient treatment plans. The cost of any investigation

and the actual benefit should always be included in guidelines for any clinical investigation. Previous studies [11, 21, 22] have been made in an effort to make clinicians and researchers aware of the costs involved in health care. Another study [21] concluded the involving costs for a CBCT examination was approximately four times the costs for panoramic imaging also regarding removal of the third molar in the mandible. However, one study [23] has concluded that it is not possible to generalize the cost involved in radiographic examinations due to different types of health care system in different countries.

The field of view (FOV) describes the imaged volume and can be generally divided into limited FOV (less than 8 cm), medium FOV (8 to 15 cm), and large FOV (greater than 15 cm) [3]. Most referrals selected the limited field of view (FOV). Limited FOV is known to use smaller radiation doses and produce higher image quality [3]. The correct decision of FOV is highly dependent on the clarity of written referrals [42]. The vast majority of CBCT referrals in the present study selected the narrow field of view (Figure 4).

In any radiographic investigation, the query should determine the modality and number of images. Due to high cost and high radiation dose to the patient, CBCT must be done using optimal settings and follow the ALARA principle. Thus, scan settings, that is, all technical settings including FOV, must be customized for each patient. New CBCT units are commonly equipped with automatic exposure control, which is favourable for reducing patient exposure.

A limitation of this retrospective survey was that patients from only one academic institute were included. The sample, however, was rather small but extended over 3 years; thus, it should be representative for dental radiology in north Indian dental hospitals. The main concern, possibly, is that only one specialist in oral and maxillofacial radiology evaluated the requests and determined whether a CBCT examination was warranted. The referring dentists ask a question they want an answer to and usually, they do not specify the kind of examination they would prefer.

#### Conclusion

CBCT is an efficient 3D imaging modality which has gained popularity in dentistry. The most common request and indication for CBCT examination of children and young adults were to assess an impacted canine and determine the presence of resorption of adjacent teeth. It should be used judiciously in children and adolescent patients in order to avoid unnecessary radiation exposure. The reason for re-exposures was motion artefacts. High scanning speed to reduce motion artefacts and a half rotation to reduce the radiation dose to the patient should be preferred. The need for continuous work with quality and systematic monitoring of radiographic procedures at any radiology department should be given high priority.

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Figure 1: Age distribution in the study group (n<sup>1</sup>/4 80) according to gender.





Figure 2: Referrals according to referring dental specialists



Figure 3: Distribution of requests for a CBCT scan by age group.



Figure 4: Distribution of the various fields of view (FOVs) in the cone-beam computed tomography (CBCT) (n<sup>1</sup>/480 examinations).





Figure 5: Distribution of referral questions in the conebeam computed tomography (CBCT) scan.