ORIGINAL RESEARCH PAPER

Volume-8 | Issue-6 | June-2019 | PRINT ISSN No. 2277 - 8179

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

# USE OF CONE BEAM COMPUTED TOMOGRAPHY IN THE PREOPERATIVE EVALUATION OF IMPACTED TEETH: A PROSPECTIVE STUDY

Dental Science

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## ABSTRACT

Accurate preoperative three dimensional imaging of impacted teeth aids in proper diagnosis and treatment planning of impacted teeth. It helps to shorten the duration of surgery, increases patient comfort and minimizes the incidence of intraoperative and postoperative complications. The use of Cone Beam Computed Tomography (CBCT) in the preoperative evaluation of impacted teeth therefore appears rational. Thirty patients with impacted teeth seeking surgical treatment were included in the study. Preoperative CBCT imaging was performed and data pertaining to type of impaction, root morphology, position of impacted tooth and relations to adjacent anatomical structures were noted from the images. Suitable treatment plan was formulated and indicated procedure was performed. The data obtained from the images were correlated with the intraoperative findings. There was a 100% correlation between the data obtained from the CBCT images and that obtained clinically at operation.

## KEYWORDS

Cone Beam Computed Tomography, Impacted teeth

### INTRODUCTION:

Most permanent teeth erupt into occlusion unassisted. Some permanent teeth fail to erupt because either the tooth is congenitally missing or it may be impacted. Impaction is defined as a failure of tooth eruption at its appropriate site in the dental arch; within its normal period of growth.[1] This situation often requires intervention by both an Oral and Maxillofacial Surgeon and an Orthodontist. The decision for such interceptive treatment takes into account several factors, including whether the tooth needs to be surgically exposed for the purpose of orthodontic retraction or for extraction. Other factors include location of the impaction, prognosis of intervention on the impacted tooth and its adjacent teeth, surgical accessibility, impact of treatment on final functional occlusion and post surgical morbidity.[2] Preoperative examinations when done carefully can help avoid surgical complications and post surgical functional impairment and reduce surgical stress.[3] The radiographic techniques most frequently requested in the treatment planning of this type of surgery are the periapical, occlusal views and panoramic radiographs. However, the images obtained may not allow visualization of all the structures in three dimensions, especially due to overlapping of the anatomical structures. [4]Besides, plain radiographs have several confounding factors such as image enlargement and distortion, limited identifiable landmarks and positioning problems that can adversely affect image quality, thus increasing the risk of misinterpretation.[5] In the past decade, detailed information about impacted teeth has been obtained by Computed Tomography (CT). Conventional CT can provide highly detailed three dimensional information either directly, or with the aid of dental software, avoiding superposition of bony and dental structures. However, the disadvantages of its relatively high cost and high radiation dose outweigh the advantages in the context of impacted teeth.[6] Cone Beam Computed Tomography (CBCT) has been introduced to improve conventional CT. CBCT uses a low energy fixed anode tube and the machine rotates around the patient only once, capturing the data using a cone shaped X ray beam. Thus it allows a less expensive, smaller machine that exposes the patient to approximately 20% of the radiation of a helical CT, equivalent to the exposure from a full mouth periapical series.[7] CBCT also provides better image quality of teeth and their surrounding structures compared with conventional CT.[8] This technique is already showing good results for visualization of the anatomic relationships for implant planning.[9]

The present study was performed with an aim to detect the reliability and accuracy of CBCT in localization of impacted teeth and providing all necessary anatomic details and relations of impacted teeth in order to facilitate its surgical removal with great reduction of the associated surgical complications through the correlation between the preoperative cone beam findings and the intraoperative clinical findings during surgery.

### MATERIALS AND METHOD:

This prospective study was approved by the institutional review board after which 30 healthy patients aged 11 to 50 years gave their informed written consent to participate in the study. They were patients who sought surgical treatment for impacted teeth in maxilla or mandible. After recording a detailed case history and performing clinical examination, Cone Beam Computed Tomography (CBCT) imaging was performed for each impacted tooth using the Kodak CS 9000 3D machine. Data pertaining to the type of impaction, presence of any dilacerations, position of the impacted tooth and proximity of the impacted tooth to adjacent tooth or anatomic structures were reported by the oral radiologist who performed the imaging. A suitable treatment plan was then formulated in consultation with an Orthodontist, when indicated. The indicated procedure was then performed by a suitable approach chosen based on the imaging data with precautions to prevent any anticipated complications, under local anaesthesia. During the procedure, the data obtained from imaging was evaluated for accuracy and reliability by comparing with the corresponding findings noticed intraoperatively.

### RESULTS:

A total number of 30 individuals (30 impacted teeth) aged from 11 to 50 years were included in the study. The study population consisted of 13% patients with impacted maxillary right canine, 33% patients with impacted maxillary left canine, 3% patients with impacted maxillary right second premolar, 13% patients with impacted mandibular left canine, 13% patients with impacted mandibular left third molar, 10% pateints with impacted mandibular right third molar, 10% patients with impacted supernumerary teeth and 3% patients with impacted maxillary right lateral incisor (Figure 1). Comparison of the data obtained from CBCT imaging and data obtained regarding type of impaction, presence of any dilacerations, spatial position of the impacted tooth showed 100% correlation between the two (Table 1 and 2). 63% of the impacted teeth were reported to be in proximity to an adjacent tooth or anatomic structure (Figure 2) based on CBCT data and adequate precautions taken during the procedure resulted in a zero incidence of intraoperative or postoperative complications related to damage to these structures.

| | Demographic data | | Table 1- Cone Beam Computed Tomography findings | | | | |
|---|---|---|---|---|---|---|---|
| Patient no. | Age | Sex | Tooth number | Type of Impaction | Root shape and crown form | Position of tooth | Proximity of tooth to adjacent tooth or anatomical structure |
| 1 | 16 years | F | 33 | vertical , rotated | curved lingually at the apex | labial | None |
| 2 | 16 years | F | 23 | oblique | curved palatally at the apex | palatal | in contact with nasal floor at the apex |
| 3 | 20 years | M | supernumerary 24,25 | vertical | incompletely formed, straight | palatal | apical third approximating with the sinus floor |
| 4 | 30 years | F | 23 | oblique | straight root | labial | apex approximating nasal floor |
| 5 | 18 years | F | 23 | Horizontal | straight root | labial | None |
| 6 | 46 years | M | 23 | oblique | straight root | labial | apex approximating with the nasal floor and sinus wall |
| 7 | 27 years | M | 13 | Horizontal | straight root | labial | apex approximating with the sinus floor |
| 8 | 11 years | F | 23 | Horizontal | straight root | labial | None |
| 9 | 17 years | F | 15 | vertical | root dilacerated mesially at the middle 1/3rd | buccal | apical third within the sinus, close to the lateral wall |
| 10 | 20 years | F | 23 | oblique | curved mesially at the apex | labial | apex in contact with lateral nasal wall |
| 11 | 21 years | M | supernumerary 24,25 | vertical | incompletely formed, curved distally | palatal | None |
| 12 | 21 years | M | supernumerary 34,35 | vertical | incompletely formed, straight | lingual | None |
| 13 | 25 years | F | 23 | oblique | straight root | labial | mesial surface of crown close to lateral wall of nose |
| 14 | 33 years | M | 33 | oblique | straight root | labial | apex of root close to inferior border of mandible |
| 15 | 21 years | M | 38 | vertical | mesial root curved distally | Pederson's Position A | None |
| 16 | 23 years | M | 23 | vertical | apex curved labially | labial | apex approximating with the nasal floor and sinus wall |
| 17 | 21 years | M | 38 | vertical | apical third of distal root is curved buccally and mesially | Pederson's Position B | mesial root approximating the IAN canal |
| 18 | 14 years | M | 13 | oblique | straight root | labial | None |
| 19 | 14 years | M | 12 | horizontal | incompletely formed, straight | palatal | None |
| 20 | 32 years | M | 48 | Horizontal | distal root curved inferiorly, mesial root curved labially | Pederson's Position B | None |
| 21 | 14 years | F | 13 | vertical | straight root | labial | None |
| 22 | 14 years | F | 23 | vertical | straight root | labial | apex close to nasal floor |
| 23 | 23 years | M | 48 | Horizontal | fused roots curved towards each other at the apex | Pederson's Position B | middle third of the root approximating the IAN canal |
| 24 | 25 years | F | 48 | Horizontal | straight root, fused | Pederson's Position C | entire root surface approximating the IAN canal |
| 25 | 23 years | M | 38 | Mesioangular | straight roots | Pederson's Position B | None |
| 26 | 22 years | M | 23 | oblique | straight root | palatal | apex approximating the sinus floor |
| 27 | 14 years | F | 13 | oblique | curved mesially at the apex | palatal | apex approximating with the nasal floor and sinus wall |
| 28 | 22 years | M | 33 | oblique | Straight | labial | apex of root close to inferior border of mandible |
| 29 | 15 years | F | 33 | Horizontal | Straight | labial | apex of root close to inferior border of mandible and lingual cortex |
| 30 | 41 years | F | 38 | vertical | 3 rooted, mesial root curved distally and lingually, distal roots curved buccally at the apex | Pederson's Position B | IAN canal passing between the apex of distal root apices |

| | Table 2- Surgical Outcomes of all patients | | | | | | |
|---|---|---|---|---|---|---|---|
| Patient no. | Treatment Plan | Approach | Type of Impaction | Position of Impacted tooth | Root shape and crown form of impacted tooth | Intraoperative complications | Postoperative complications |
| 1 | Transalveolar extraction | Labial | vertical , rotated | labial | curved lingually at the apex | none | None |
| 2 | Transalveolar extraction | Palatal | oblique | palatal | curved palatally at the apex | none | None |
| 3 | Transalveolar extraction | Palatal | vertical | palatal | incompletely formed | none | None |
| 4 | Transalveolar extraction | Labial | oblique | labial | straight root | none | None |
| 5 | exposure and retraction | Labial | Horizontal | labial | could not be assessed | none | None |
| 6 | Transalveolar extraction | Labial | oblique | labial | straight root | none | None |
| 7 | Transalveolar extraction | Labial | Horizontal | labial | straight root | none | None |
| 8 | exposure and retraction | Labial | Horizontal | labial | could not be assessed | none | None |
| 9 | exposure and retraction | Buccal | vertical | buccal | could not be assessed | none | None |
| 10 | exposure and retraction | Labial | oblique | labial | could not be assessed | none | None |
| 11 | Transalveolar extraction | Palatal | vertical | palatal | incompletely formed, curved distally | none | None |
| 12 | Transalveolar extraction | Lingual | vertical | palatal | incompletely formed, straight | none | None |
| 13 | exposure and retraction | Labial | oblique | labial | could not be assessed | none | None |
| 14 | Transalveolar extraction | Labial | oblique | labial | straight root | none | None |
| 15 | Transalveolar extraction | Conventional | vertical | Pederson's Position A | mesial root curved distally | none | None |
| 16 | exposure and retraction | Labial | vertical | labial | could not be assessed | none | None |
| 17 | Transalveolar extraction | Conventional | vertical | Pederson's Position B | apical third of distal root is curved buccally and mesially | none | None |
| 18 | exposure and retraction | Labial | oblique | labial | could not be assessed | none | None |
| 19 | exposure and retraction | Palatal | horizontal | palatal | could not be assessed | none | None |
| 20 | Transalveolar extraction | Conventional | Horizontal | Pederson's Position B | distal root curved inferiorly, mesial root curved labially | none | None |
| 21 | exposure and retraction | Labial | vertical | labial | could not be assessed | none | None |
| 22 | exposure and retraction | Labial | vertical | labial | could not be assessed | none | None |
| 23 | Transalveolar extraction | Conventional | Horizontal | Pederson's Position B | fused roots curved towards each other at the apex | none | None |
| 24 | Transalveolar extraction | Conventional | Horizontal | Pederson's Position C | straight root, fused | none | None |
| 25 | Transalveolar extraction | Conventional | Mesioangular | Pederson's Position B | straight roots | none | None |
| 26 | exposure and retraction | Palatal | oblique | palatal | could not be assessed | none | None |
| 27 | exposure and retraction | Palatal | oblique | palatal | could not be assessed | none | None |
| 28 | Transalveolar extraction | Labial | oblique | labial | Straight | none | none |
| 29 | Transalveolar extraction | Labial | Horizontal | labial | Straight | none | None |
| 30 | Transalveolar extraction | Conventional | vertical | Pederson's Position B | 3 rooted, mesial root curved distally and lingually, distal roots curved buccally at the apex | none | None |

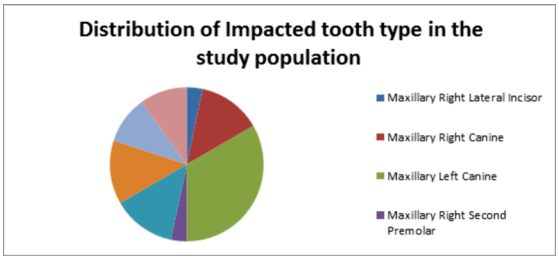


**FIGURE 1**

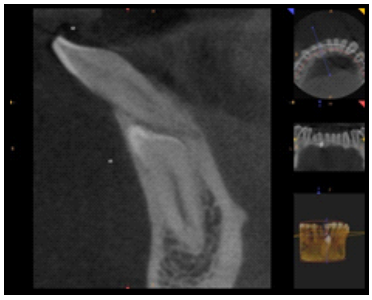

**FIGURE 2- CBCT section demonstrating proximity of the crown of impacted tooth 43 to the root of tooth 42**

## DISCUSSION:

Impacted tooth is defined as a tooth which is completely or partially unerupted and is positioned against another tooth, bone or soft tissue so that its further eruption is unlikely, described according to its anatomic position.[10] Successful management of impacted teeth often requires an accurate diagnosis and localization of the impacted tooth. Historically, various radiographic techniques have been used to aid in diagnosis and localization of impacted teeth. These include intra oral periapical radiographs, occlusal radiographs, orthopantomographs, frontal (PA) cephalogram, lateral cephalogram, PA 15° open mouth projection, conventional cross sectional tomography, computed tomography, low dose multislice tomography, multiprojection narrow beam radiography (scanograms). Cone beam computed tomography is a recent technology which has been introduced into maxillofacial radiology. The aim of the present study was to evaluate the usefulness of the data obtained from cone beam computed tomographic evaluation of impacted teeth, in the treatment planning and execution of impacted teeth.

### Radiographic Assessment of Impacted teeth:

The purpose of radiographic assessment of impacted teeth cannot be over emphasized. Radiographs aid in defining exact position, inclination and relations with the neighbouring structures. Knowing the precise location of the tooth also decreases the invasiveness of the surgery, increasing the overall patient comfort and the quality of treatment. Plain radiographs are usually the first choice of radiographic modality. Ericson and Kurol[11] through their study found out that plain radiography may not always be sufficient in the preoperative radiographic assessment of impacted teeth. Obtaining a three dimensional image was known to show the surgeon an exact picture of what will be seen in the operating room when the flap is opened and the impacted tooth is laid bare. These developments led to the introduction of the use of cross sectional conventional computed tomography in the assessment of difficult impacted teeth. The results of a study by Tontanapornkul et al[12] showed that medical CT is not very accurate. This was followed by the invention of cone beam volumetric imaging system (CBVI) by Willi Kalender in the 1980s. The images obtained from this technique are reconstructed in a three dimensional data set using a modification of the original cone beam algorithm developed by Feldkemp et al[13] in 1984. Dedicated scanners for the oral and maxillofacial region were pioneered in the late 1990s independently by Arai et al,[14] in Japan and Mozzo et al, [15] in Italy.

Studies describing a review of literature on the applications of CBCT in Oral and Maxillofacial Surgery[7, 16, 17] included use of CBCT in assessment of pathological lesions, trauma, TMJ disorders, Craniofacial syndromes, Orthognathic surgery including airway assessment, ectopically erupted teeth.

This prompted the assessment of use of CBCT in the treatment planning of impacted teeth. The three main parameters with reference to impacted teeth that were correlated clinically in the present study include root morphology, proximity to adjacent anatomical structures and spatial position. Root morphology is one of the indices of difficulty of extraction since teeth with curved root often fracture, increasing the operating time. Tsuyoshi Sawamura et al[18]conducted a study to evaluate the usefulness of 3D Dental CT for preoperative evaluation and concluded that 3D dental CT were superior to plain radiographs for examining dilacerations of roots of impacted teeth. The results of the present study showed a 100% correlation between the information provided pertaining to root morphology and number from the CBCT and that seen clinically following extraction. Proximity to adjacent anatomic structures is yet another factor that needs to be carefully evaluated prior to planning an intervention for impacted teeth. The findings of Takahisa[19] et al and Niek[20] et al supported the finding that CBCT can detect most tubular structures representing the branches of nerve. Also, it has been shown that an evaluation of risk factors has been simplified by the use of CBCT. Risk factors like fully developed roots, lingual course of the canal, mesial angulations etc., which can alter the surgical approaches (e.g., coronectomy instead of a transalveolar extraction), have been known to be easily identified on CBCT. The results of studies performed by Deng-gao Liu et al[3]and Nematolahi et al[21]demonstrated that CBCT is also useful in predicting the root morphology and relations of supernumerary teeth. The results of CBCT for supernumerary teeth and third molars in the present study have also been favourable. Becker et al[22]recommended the use of CBCT as a routine diagnostic aid in the proposed treatment of all but the most superficial of impacted canines and inferred that CBCT is a mandatory prerequisite in the revaluation of failed cases. Use of CBCT has also known to have altered the treatment plan for many impacted canines.[10]The results of CBCT used in localization of impacted canines in the present study have also shown a 100% correlation between the imaging data and clinical occurrence.

Although the use of CBCT in oral and maxillofacial surgery has been increasing, concerns regarding the safety have always been a matter of conflict. Recently, the American Academy of Oral and Maxillofacial Radiology issued a position statement concerning the use of Cone Beam Computed tomography. The academy in its statement, mentioned that selection of the appropriate radiographic imaging technique is based on the principle that practitioners who use imaging with ionizing radiation have a professional responsibility of beneficence- that imaging is performed to serve the patient's best interests. This requires that each radiation is justified clinically and that procedures are applied that minimize patient exposure while optimizing maximal diagnostic benefit. The extension of this principle, referred to as the "as low as reasonably achievable" to CBCT is supported by the ADA. Justification of every radiographic exposure must be based primarily on the individual patient's presentation including considerations of the chief complaint, medical and dental history and assessment of the physical status and treatment goals. Thus, it must be kept in mind that a judicious use of the technology has to be carried out keeping in mind patient safety as the sole main criteria before drawing conclusions on interventions.[10]

## CONCLUSION:

Cone beam Computed tomography (CBCT) is a very accurate tool for the preoperative evaluation of impacted teeth and it provides all the necessary anatomical data that helps the surgeon in its treatment planning with avoidance or reduction of treatment related complications

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