

Awareness on usage of cone-beam computed tomography as a tool in endodontic diagnosis among dental practitioners

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ABSTRACT

Imaging of the dentoalveolar structures by radiography is essential in diagnosis, treatment planning, and follow-up in endodontics. There are many factors that are responsible for confounding interpretation of an image that includes the regional anatomy as well as superimposition of the dentoalveolar structures. As periapical radiographs are two-dimensional, they allow only limited view of the true three-dimensional aspect of the structural anatomy. When anatomical structures are imaged using conventional radiographic methods, there is often geometric distortion of the structures if any component of the imaging chain process is compromised. Cone-beam computed tomography (CBCT) is advantageous as it improves diagnosis, treatment planning, and the assessment of the outcome of endodontic treatment. Most of the applications of CBCT are focused on pre-operative assessment and treatment planning. The purpose of this cross-sectional survey is to assess the awareness about the potential uses of CBCT in the assessment and management of endodontic problems as this three-dimensional imaging technique is a beneficial adjunct to the endodontists' armamentarium as it overcomes the limitations of conventional radiography.

Keywords: Cross-sectional survey, cone-beam computed tomography, radiographs, endodontic treatment, endodontic imaging

Introduction

An adequate depiction of the root canal morphology by diagnostic imaging is an important prerequisite for an adequate diagnosis and treatment in endodontics.^[1] Diagnostic imaging techniques are needed for successful management of endodontic problems and are reliant to provide critical information about the teeth and their surrounding anatomy. The mainstay of imaging in endodontics has been conventional radiography since its inception. Various imaging techniques have been researched as potential diagnostic and treatment planning tools in endodontics are magnetic resonance imaging, digital subtraction radiology, ultrasound, tuned-aperture computed tomography (CT), and CT.^[2]

The inadequacies of conventional radiography when assessing the unique anatomy of the maxillofacial skeleton have been highlighted after the development of cone-beam CT (CBCT).^[2] This three-dimensional imaging system is the subject of independent research of unparalleled levels in dental imaging.^[3]

The purpose of this cross-sectional survey is to assess the awareness about the potential uses of CBCT in the assessment and management of endodontic problems as this three-dimensional imaging technique is a beneficial adjunct to the endodontists' armamentarium as it overcomes the limitations of conventional radiography.

Materials and Methods

The questionnaire [Table 1] was designed for dental practitioners, and a cross-sectional survey was carried out among 500 randomly selected dentists in Chennai District, Tamil Nadu. Data collection was done [Graph 1], and the results were analyzed.

Interpretation of Results Expansion of CBCT

7% of the respondents were not aware that the expansion of CBCT as cone-beam computed tomography [Table 2].

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Table 1: Questionnaire

S. No.	Questions	Options-answers
1	What does CBCT stand for root canal system	Cone-beam computed tomography Computed-beam cone tomography Uncertain
2	Do you use it as an aid for endodontic diagnosis	Yes No
3	If so, how often do you use it in your practice	Every case Not often Only when other tests are inconclusive
4	Do you think it is a useful aid in endodontic diagnosis	Yes No
5	Why do you not use it as an aid in diagnosis of all endodontic cases	Cost factor Radiation factor Other factor
6	When would you prefer to use CBCT as an aid in endodontic diagnosis	Missing canals Apical periodontitis Detection of lesion Uncertain Prognosis
7	Are you aware of the various field of view available in CBCT	Yes No
8	If so, which field of view CBCT is preferred in endodontics	Limited or focused Wide Uncertain
9	Are you aware of the optimal resolution of CBCT used in endodontics	100 µm 200 µm 400 µm Uncertain
10	If so, to which landmark does it correspond to	Periodontal ligament space Lamina dura Uncertain
11	Are you aware that size of lesions in cancellous bone cannot be detected radiographically	Yes No
12	Detection of apical periodontitis is considerably higher in CBCT than conventional radiographs	Yes No Uncertain
13	Which slice of data is ideal to locate unidentified and untreated root canals	Axial slice Sagittal slice Uncertain
14	Would you prefer to use CBCT in future for endodontic diagnosis	Yes No
15	Do you think CBCT has the potential to replace conventional radiographic techniques in future	Yes No

Usage as aid in endodontic diagnosis

77% of the respondents have not used CBCT as an aid in endodontic diagnosis.

Use of CBCT in daily practice

93% of the respondents used CBCT only when results were inconclusive after using other diagnostic aids while 7% of the respondents did not use CBCT often.

Is it a useful aid in endodontic diagnosis

23% of the respondents felt that CBCT is a useful aid in endodontic diagnosis.

Perceived disadvantages of CBCT

33% of the respondents felt that cost is a disadvantage while 63% of the respondents felt that the radiation factor is a disadvantage while 1% of the respondents cited other reasons.

Table 2: Results of the survey

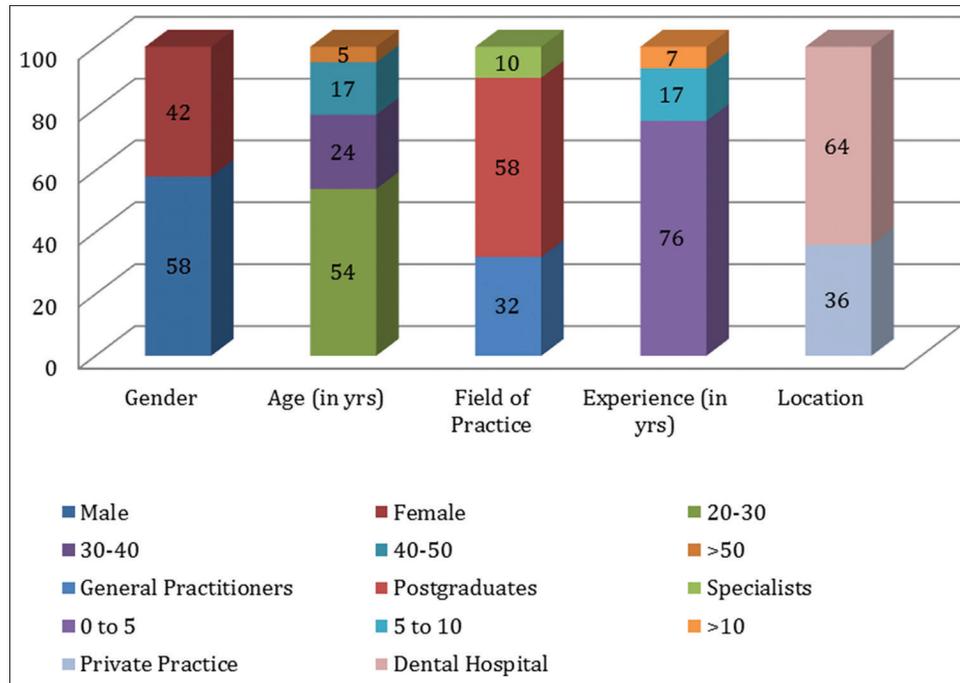
S. No.	Questions	Response (n=100) (%)
1	What does CBCT stand for root canal system	Cone-beam computed tomography 93 Computed beam cone tomography 5 Uncertain 2
2	Do you use it as an aid for endodontic diagnosis	Yes 23 No 77
3	If so, how often do you use it in your practice	Every case 0 Not often 7 Only when other tests are inconclusive 93
4	Do you think it is a useful aid in endodontic diagnosis	Yes 23 No 77
5	Why do you not use it as an aid in diagnosis of all endodontic cases	Cost Factor 33 Radiation Factor 63 Other Factor 1
6	When would you prefer to use CBCT as an aid in endodontic diagnosis	Missing canals 29 Apical Periodontitis 21 Detection of Lesion 33 Uncertain Prognosis 17
7	Are you aware of the various field of view available in CBCT	Yes 21 No 79
8	If so, which field of view CBCT is preferred in endodontics	Limited or focused 36 Wide 21 Uncertain 43
9	Are you aware of the optimal resolution of CBCT used in endodontics	100 µm 19 200 µm 41 400 µm 25 Uncertain 15
10	If so, to which landmark does it correspond to	Periodontal Ligament space 46 Lamina dura 44 Uncertain 10
11	Are you aware that size of lesions in cancellous bone cannot be detected radiographically	Yes 69 No 31
12	Detection of apical periodontitis is considerably higher in CBCT than conventional radiographs	Yes 73 No 18 Uncertain 9
13	Which slice of data is ideal to locate unidentified and untreated root canals	Axial slice 43 Sagittal slice 34 Uncertain 23
14	Would you prefer to use CBCT in future for endodontic diagnosis	Yes 23 No 77
15	Do you think CBCT has the potential to replace conventional radiographic techniques in the future	Yes 23 No 77

Preference for usage in endodontic diagnosis

29% of the respondents used CBCT for detecting missing canals while 21% of the respondents used CBCT for detecting apical periodontitis. 33% of the respondents used CBCT for detection of lesion while 17% of the respondents cited uncertain prognosis.

Awareness about the fields of view in CBCT

79% of the respondents were not aware of the fields of view in CBCT.



Graph 1: General information of the demographic surveyed

Field of view preferred in endodontic diagnosis

64% of the respondents were not aware that limited or focused field of view is the view preferred in endodontic diagnosis.

Optimal resolution used in endodontic diagnosis

59% of the respondents were not aware that 200 μm is the optimal resolution desirable for use in endodontic diagnosis.

Correspondence of the optimal resolution to anatomical landmark

54% of the respondents were not aware that the 200 μm optimal resolution corresponds to the periodontal ligament space.

Detection of lesions radiographically in cancellous bone

31% of the respondents were not aware that detection of the size of lesions in cancellous bone cannot be done radiographically.

Detection of apical periodontitis is higher while using CBCT

27% of the respondents were not aware that the detection of apical periodontitis is higher while using CBCT.

View used to detect missing canals

Fifty-seven percentages of the respondents were not aware that axial view is used to detect missing canals.

Preference to use CBCT in the future

23% of the respondents were willing to use CBCT for endodontic diagnosis in the future.

Potential to replace conventional radiographic methods in the future

23% of the respondents felt that CBCT could replace conventional radiographic methods in the future.

Discussion

Imaging of the dentoalveolar structures by radiography is essential in diagnosis, treatment planning, and follow-up in endodontics. There are many factors that are responsible for confounding interpretation of an image that includes the regional anatomy as well as superimposition of the dentoalveolar structures.^[4]

As periapical radiographs are two-dimensional (2D), they allow only limited view of the true three-dimensional aspect of the structural anatomy.^[5,6] When anatomical structures are imaged using conventional radiographic methods, there is often geometric distortion of the structures if any component of the imaging chain process is compromised.^[7] In endodontics, success is assessed in healing of the periapical bone adjacent to obturated canals. In a study done by Goldman *et al.*, they showed that in evaluation using 2D periapical radiographs to assess healing of periapical lesions, there was only 47% agreement between six examiners.^[8] In another study, they also reported that the same films were evaluated by the same

examiners evaluated at two different times, they only had 19–80% agreement between the two evaluations.^[9]

CBCT has the potential to improve diagnosis, treatment planning, and the assessment of the outcome of endodontic treatment. Most of the applications of CBCT are focused on pre-operative assessment and treatment planning that include diagnosis and canal morphology,^[6,10,11] assessment of internal^[6,11,12] and external root resorption,^[11,13,14] treatment planning and assessment of traumatic dental injuries,^[14,15] assessment of root fractures,^[6,16] pre-surgical anatomic assessment,^[6,11] and treatment planning for tooth anomalies such as dens invaginatus.^[17,18] Comparison studies have shown CBCT to be more accurate than conventional periapical radiographs in the measurement of the length of root fillings^[19] and diagnosing the presence of resorption lesions,^[20-22] periapical bone defects,^[23-27] root fractures,^[28-30] and perforations.^[31]

Field of view

It primarily depends on the beam projection geometry, shape and size of the detector, and the ability to collimate the beam as it limits the exposure to the region of interest. When the scan volume is smaller, higher is the resolution of the image and the effective dose of radiation is lower. The optimal resolution of CBCT for endodontics does not have to exceed 200 μm as it corresponds with the average width of periodontal ligament space.^[32] For endodontic imaging, limited or focused field of view is preferred over large volume CBCT.^[4]

Radiation dose considerations

Smaller the field of view, the lower is the radiation dose applied.^[33,34] Removing the organs from the path of the X-ray beam reduces the effective dose as it is computed from a weighted summation of doses to various organs.

Ionizing radiation dosages (approximate)		
Activity	Effective dose in μSv	Dose as days of equivalent background radiation
1 day background radiation, sea level	7-8	1
1 digital PA radiograph	6	1
4 dental bite-wing radiographs, F-speed film	38	5
FMZ; PSP or F-speed film	171	21
Kodak CBCT focused film, anterior	4.7	0.71
Kodak CBCT focused film, maxillary posterior	9.8	1.4
Kodak CBCT focused film, mandibular posterior	38.3	5.47
3D Accutomo, J. Morita	20	3
New tom 3G, Image works	68	8
Chest X-ray	170	25
Mammogram	700	106
Medical CT, head	2000	243
Medical CAT scan (Spiral CT abdomen)	10000	1515
Federal occupation safety limit per year	50000	7575

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Limitations of CBCT

Beam-hardening artifacts and scatter are caused by high-density structures such as enamel, restorations, root-end filling materials, and radiopaque materials such as metal posts will affect the image quality and diagnostic accuracy of CBCT images.^[35-37]

Questions were directed at these facts to assess the awareness among general practitioners.

Conclusion

Within the limitations of this survey, awareness regarding the use of CBCT as a diagnostic aid in endodontics is less among the general practitioners in Chennai. Henceforth, knowledge has to be imparted to dentists regarding the use of CBCT in the field of endodontic diagnosis.

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