A Questionnaire Cross-Sectional Study on Application of CBCT in Dental Postgraduate Students

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Summary

Background:
CBCT is a new emerging imaging technique which uses a cone-shaped radiation beam that is centered on a 2D detector. It is now routinely evaluated for oral and para-oral disorders. It has been widely accepted in practice in radiology in academic and hospital settings and included in the curricula of some countries. The present study aimed to evaluate the awareness of and knowledge on CBCT among postgraduates.

Material/Methods:
After obtaining permission and ethical clearance from concerned authorities, an anonymous survey on CBCT was conducted in a dental college by using a close-ended validated questionnaire to get to know the knowledge on CBCT among postgraduates in a dental college in India.

Results:
A total of 100 volunteers participated but only 88 postgraduates responded to the questionnaire. Among the respondents, 54.5% were not using CBCT for diagnostic purposes at their place of work. A total of 68.2% of respondents were partially aware of common terminologies used in CBCT. Most of the respondents were unsure about radiation exposure of CBCT when compared to other types of imaging. Almost nobody had any idea on relative importance of image characteristics. Only half of the respondents were willing to attend a hands-on course on CBCT interpretations versus pathology.

Conclusions:
In the present study it was apparent that most of the respondents were lacking adequate knowledge on CBCT. Hence, there is an urgent need for more training programs on CBCT which would result in better diagnosis and treatment planning.

MeSH Keywords:
Cone-Beam Computed Tomography • Cross-Sectional Studies • Dose-Response Relationship, Radiation

Background

Since the discovery of X-rays in 1845, the field of imaging has evolved from the two-dimensional imaging modalities to the current advanced modalities including three-dimensional imaging enabling superior treatment options and virtual surgeries [1]. The era of “cut and see” has transformed into the era of “see and cut” because of the paradigm shift seen in the field of imaging today. The quality of imaging has not only improved the diagnostic accuracy of diseases but the quality care with regard to patient exposure and time consumption [1,2].

In CBCT dental imaging the scanner rotates around the patient’s head, producing cone-beam-shaped radiation which obtains nearly 600 distinct images. A single rotation (360 degrees) over the region of interest acquires a volumetric data set. The scanning software collects the data and reconstructs it, producing a digital volume composed of three-dimensional voxels of anatomical data that can be then manipulated and visualized with specialized software [2,3].

In the present day, CBCT is an emerging imaging modality with an advantage of a rapid scan time, it is designed to produce cone-shaped beam limited to the head and neck region, reduce radiation doses when compared with CT and have interactive display modes that offer maxillofacial
imaging and multiplanar reformation, making them more useful at the work place of dental practices [4,5].

CBCT is indicated for diagnosis and treatment plan, for nerve tracing in cases of third molar extraction; it is a useful tool in implant placement, for maxillofacial surgeries, in sinus pathologies, in endodontics for locating additional roots and accessory canals and in detecting vertical root fracture, orthodontic cases and orthognathic surgeries, in evaluating cysts and tumors and in TMJ disorders and even used in forensic dentistry [5–7].

As CBCT is one of the extensively employed imaging modalities that has recently become a useful tool at a work place of dental practice [8–11]. The present study was conducted among postgraduates of dental specialty of oral medicine and radiology to assess their knowledge on CBCT.

A literature search revealed various studies that focused on the use of various digital systems in imaging and interpretation of CBCT images, but there was no study to present the awareness of and knowledge on CBCT among postgraduate students of Oral Radiology.

Material and Methods

An anonymous survey was carried among postgraduates of dental specialty of oral medicine and radiology in a dental college in India to access their knowledge on CBCT. The study protocol was reviewed by the Ethical Committee of Dental College and Hospital and was granted ethical clearance.

The investigators distributed the prepared validated questionnaire among delegates, i.e. staff and students from various colleges across India, who attended a CBCT hands-on course on a pre-decided date. A total of 100 volunteers participated in the study but only 88 postgraduates responded to the questionnaire which comprised of 14 close-ended questions. (sample of the Questionnaire is mentioned below). Respondents of either gender with age between 24–28 years, being students of the dental specialty of oral medicine and radiology in different colleges from both states (i.e. Telangana Andhra Pradesh), India were included in the study. Prior consent was obtained from the participants and their confidentiality was maintained. The completed questionnaires were collected, results obtained and tabulated. The results thus obtained were subjected to statistical analysis using SPSS software.

Results

Among 100 participants 88 volunteers responded to the questionnaire. Ninety-two percent of respondents felt that there was a need for a CBCT scanner at their work place (Table 1). A total of 54.5% of respondents said that they had not used or advised CBCT for diagnostic purposes in their cases (Table 2). Among all the respondents only 68.2% were
| Valid | Frequency | Percent | Valid percent |
|-------|-----------|---------|---------------|
| Unsure | 54        | 61.4    | 61.4          |
| 1     | 4         | 4.5     | 4.5           |
| 3–6   | 15        | 17.0    | 17.0          |
| 10    | 4         | 4.5     | 4.5           |
| 25    | 3         | 3.4     | 3.4           |
| 50 or more | 8 | 9.1 | 9.1 |
| Total | 88        | 100.0   | 100.0         |

| Valid | Frequency | Percent | Valid percent |
|-------|-----------|---------|---------------|
| Unsure | 55        | 62.5    | 62.5          |
| 1     | 7         | 8.0     | 8.0           |
| 3–6   | 11        | 12.5    | 12.5          |
| 10    | 6         | 6.8     | 6.8           |
| 25    | 2         | 2.3     | 2.3           |
| 35    | 4         | 4.5     | 4.5           |
| 50 or more | 3 | 3.4 | 3.4 |
| Total | 88        | 100.0   | 100.0         |

| Valid | Frequency | Percent | Valid percent |
|-------|-----------|---------|---------------|
| 1     | 6         | 6.8     | 6.8           |
| 3–6   | 5         | 5.7     | 5.7           |
| 10    | 7         | 8.0     | 8.0           |
| 25    | 2         | 2.3     | 2.3           |
| 35    | 1         | 1.1     | 1.1           |
| 50 or more | 3 | 3.4 | 3.4 |
| Total | 88        | 100.0   | 100.0         |

| Valid | Frequency | Percent | Valid percent |
|-------|-----------|---------|---------------|
| Unsure | 60        | 68.2    | 68.2          |
| 1     | 4         | 4.5     | 4.5           |
| 3–6   | 8         | 9.1     | 9.1           |
| 10    | 9         | 10.2    | 10.2          |
| 25    | 3         | 3.4     | 3.4           |
| 35    | 1         | 1.1     | 1.1           |
| 50 or more | 3 | 3.4 | 3.4 |
| Total | 88        | 100.0   | 100.0         |
Table 5. Response of individual about CBCT image characteristics.

| Question | Frequency | Percent | Valid percent |
|----------|-----------|---------|---------------|
| q13a high spatial resolution | Not important | 7 | 8.0 | 8.0 |
| | Moderately important | 21 | 23.9 | 23.9 |
| | Very important | 29 | 33.0 | 33.0 |
| | I don't know what that means | 31 | 35.2 | 35.2 |
| Total | 88 | 100.0 | 100.0 |
| q13b high contrast resolution | Not important | 3 | 3.4 | 3.4 |
| | Moderately important | 21 | 23.9 | 23.9 |
| | Very important | 31 | 35.2 | 35.2 |
| | I don't know what that means | 33 | 37.5 | 37.5 |
| Total | 88 | 100.0 | 100.0 |
| q13c capability to adjust FOV | Not important | 3 | 3.4 | 3.4 |
| | Moderately important | 18 | 20.5 | 20.5 |
| | Very important | 33 | 37.5 | 37.5 |
| | I don't know what that means | 34 | 38.6 | 38.6 |
| Total | 88 | 100.0 | 100.0 |
| q13d capability to take/have short scan times | Not important | 4 | 4.5 | 4.5 |
| | Moderately important | 13 | 14.8 | 14.8 |
| | Very important | 35 | 39.8 | 39.8 |
| | I don't know what that means | 36 | 40.9 | 40.9 |
| Total | 88 | 100.0 | 100.0 |
| q13e Image capture with image intensifier | Not important | 5 | 5.7 | 5.7 |
| | Moderately important | 9 | 10.2 | 10.2 |
| | Very important | 37 | 42.0 | 42.0 |
| | I don't know what that means | 37 | 42.0 | 42.0 |
| Total | 88 | 100.0 | 100.0 |
| q13f Image capture with flat panel screen | Not important | 2 | 2.3 | 2.3 |
| | Moderately important | 17 | 19.3 | 19.3 |
| | Very important | 28 | 31.8 | 31.8 |
| | I don't know what that means | 41 | 46.6 | 46.6 |
| Total | 88 | 100.0 | 100.0 |
partially aware of common terminologies used in CBCT, like FOV, SSV, MIP, MPR, and DICOM images (Table 3). Only 29.5% of the respondents were able to interpret CBCT images while 46.6% said that they would self-interpret the images and also relied on the reports given by medical radiologists. Among the questions related to the software used in the interpretation of CBCT images, a majority of the respondents (34.1%) were familiar with iCAT classic. Some of the respondents (i.e. 34.1%) said that they had no knowledge on the software used while some respondents (i.e. 34.1%) found that iCAT vision software is more user-friendly for interpreting CBCT images.

When questioned how many images they come across a month, 83.0% said that around 0-5 images. The majority of participants i.e. 53.4% said they never used CBCT scanners for 2D panoramic radiography while a few said ‘rarely’ (23.9%) and ‘once in a month’ (11.4%). Majority of respondents i.e. 45.5% never used CBCT in case of the third molar while a few reported rare use (31.8%) and once a week (11.4%). A total of 36.4% of respondents said they never used CBCT in diagnosing fracture cases while 27.3% said ‘rarely’, and 17.0% ‘once a month’. Most of the participants, i.e. 42.0%, said that they never used CBCT for sinus pathologies while a few said ‘rarely’ (25.0%) and ‘once a month’ (22.7%). As much as 34.1% of respondents said that they never used CBCT for diagnosing cysts and tumors, followed by 25.0% ‘once a month’, and 21.6% ‘rarely’. A total of 39.8% of respondents said that they never used CBCT for TMJ pathologies while a few said ‘rarely’ (25.0%) and ‘once a month’ (22.7%). As much as 54.5% of respondents said that other medical professionals seek their opinion for CBCT of the maxillofacial region while 42.0% reported that those professionals seek their opinion ‘sometimes’.

When enquired about the radiation exposure for CBCT, a majority of them were unsure about it as compared to other types of imaging (Table 4). Most of the respondents did not have any idea on image characteristics (Table 5). A majority of respondents were willing to attend a CDE program on CBCT in future (Table 6).

### Discussion

Imaging has experienced a paradigm shift from conventional to advanced in the recent years with the advent of numerous advanced imaging modalities which technically converted two-dimensional images into three-dimensional life-like images making interpretation and diagnosis more accurate.

CBCT scanners used in oro-facial imaging were first employed by Aria et al. and Moshiri et al., and since then CBCT has become a preferred imaging modality for various maxillofacial pathologies and treatment needs in dentistry [12–14].

As mentioned earlier, CBCT finds its applications in almost all areas of dentistry and is one of the most widely accepted imaging modality in the current practice. Owing to its recent recognition as an imaging modality, it is often found that little is known about its application, and especially about interpretation of the images using various software. This could be due to the advanced level of software knowledge as regards understanding and interpreting CBCT images. Hence, the current study was conducted to assess the knowledge on CBCT and its use among dental postgraduates in the specialty of Oral Medicine and Radiology.

In our study we found that most of the respondents felt a need of a CBCT scanner at their work place to help them in diagnosis and treatment plan. Moreover, a CBCT scanner can be very helpful in educational institutions for practical training purposes. A similar study conducted by Shishir Ram Shetty et al., among dentists in M’lore found a 100% necessity of having a CBCT scanner in dental institutions [8].

In our study we found that most of the respondents did not use/advised CBCT for diagnostic purposes and only half of the participants were partially aware of common terminologies used in CBCT like FOV, SSV, MIP, MPR, and

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**Table 6. Response of individuals about willing to attend CBCT programme in future.**

| Hand on course on CBCT equipment operations | Frequency | Percent | Valid percent | Cumulative percent |
|---------------------------------------------|-----------|---------|---------------|--------------------|
| Hand on course on CBCT software applications | 12        | 13.6    | 13.6          | 25.0               |
| Hand on course on CBCT interpretations versus pathologic images | 44        | 50.0    | 50.0          | 75.0               |
| Hand on course on normal anatomy            | 6         | 6.8     | 6.8           | 18.2               |
| All                                         | 16        | 18.2    | 18.2          | 100.0              |
| Total                                       | 88        | 100.0   | 100.0         | 100.0              |
DICOM images. This can be attributed to the unavailability of CBCT at their workplace. Most of the respondents in our study felt that there is a need for a CBCT scanner at their workplace because it is important to get familiar with the handling of the scanner and to interpret more images rather than to have theoretical knowledge only. This is in accordance with the study by Kamburoğlu et al., on Turkish dental students which highlighted the difficulties with acquiring knowledge on a given system without practical experience and thus the lack of CBCT units at institutions may constitute a significant factor contributing to students’ unfamiliarity with this technology [15].

It was observed in our study that almost all the respondents felt a need for CBCT in dentistry. The limited use of CBCT as shown in our study for the purpose of nerve tracing, fracture cases, implant placement, sinus pathologies, cyst and tumors, TMJ pathologies and orthognathic surgeries could be attributed to the lack of CBCT units at institutions or workplace.

Dölekoğlu et al. conducted a study among Turkish dentists and found that they were referring for CBCT examinations in implant planning and diagnosing of cyst-tumors. That study was supported by the findings of Arnheiter et al. study [16,17].

Yalcinkaya et al. conducted a study on Turkish endodontists and he mentioned the following reasons for referring patients for CBCT: cyst/tumor 82.4%, implant planning 71.6%, trauma 50%, to indicate the resorption area 32.4%, to examine the morphology of a root canal 25.7%, to detect the exact place of broken files 16.2%, which was in contrast to the present study where most of the respondents were well aware of the applications of CBCT even though its use was limited due to the lack of the scanner at their workplace [9].

In the present study we found that most of the respondents were unsure about their radiation exposure when compared with other imaging modalities. Moreover, a majority of the respondents did not have any idea on image characteristics of CBCT which could be attributed to the lack of CBCT units at their workplace and even the lack of practical experience and unfamiliarity with image characteristics in image acquisition. A review of literature suggested that not all CBCT units produce the same dose of radiation. The effective radiation dose is dependent on the field of view (focused or large), power settings, rotation around the head (180° or 360°), etc. An effective dose for a radiographic examination and the background exposure is mentioned in the Table 7 [18,19].

Conclusions

We conclude from this present study that unfamiliarity with the use of CBCT among the post-graduates, due to an insufficient curriculum coupled with limited resources, led to decreased practical application thereof. What is more, we recommend that by increasing the number of continued education programs, the knowledge on CBCT and its application can be increased and thereby improve dental health care practices in future.

| S. no. | Radiographs                  | Effective dose (μSv) | Equivalent background exposure (days) |
|--------|------------------------------|---------------------|--------------------------------------|
| 1      | Intraoral (full mouth)       |                     |                                      |
|        | D speed film                 | 388                 | 46                                   |
|        | F speed film/PSP             | 171                 | 20                                   |
|        | CCD sensor                   | 85                  | 10                                   |
| 2      | Extraoral                    |                     |                                      |
|        | Panoramic                    | 9–24                | 1–3                                  |
| 3      | CBCT                         |                     |                                      |
|        | Large field of view          | 68–1073             | 8–126                                |
|        | Medium field of view         | 45–860              | 5–101                                |
|        | Small field of view          | 19–652              | 2–77                                 |
| 4      | Multislice CT                |                     |                                      |
|        | Head (conventional protocol) | 860–1500            | 101–177                              |
|        | Head (low dose protocol)     | 180–534             | 21–63                                |

Table 7. Typical effective doses for radiographs [18].
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1. Have you used CBCT for diagnostic purposes in your practice? ( )
   A) Yes B) No

2. Do you feel that there is a need for a CBCT scanner at your workplace? ( )
   A) Yes B) No

3. How aware are you of common terminologies used in CBCT, like FOV, SSV, MIP, multiplanar reconstructions, DICOM images? ( )
   A) Never heard B) Partially C) Fully aware

4. How do you interpret the CBCT images? ( )
   A) Self-interpretation always B) I rely on an OMR specialist C) A and B D) I relay on radiologist reports

5. What brands of CBCT scanners you are familiar with? ( )
   A) iCAT classic B) iCAT next generation C) Kodak 9500 D) Newtom 3G
   E) Planmeca F) Scanora 3D G) Others H) No idea

6. Which CBCT software is more user-friendly for interpreting CBCT images? ( )
   A) Carestream B) NNT viewer C) On demand D) Romaxis
   E) Xoran F) iCAT vision G) Others H) No idea

7. On an average, how many CBCT images do you come across a month? ( )
   A) 0–5 B) 5–10 C) 10–20 D) Above 20

8. The following is the list of preferential uses of CBCT in dentistry. Please indicate the frequency you refer for CBCT for each use in the space provided? (Please tick only one item in the column)

| Use                                                                 | Once a day | Once a week | Once a month | Rarely | Never |
|----------------------------------------------------------------------|------------|-------------|--------------|--------|-------|
| Do you prefer CBCT scanners for 2D Panoramic Radiography             |            |             |              |        |       |
| Third molar extractions (for nerve tracing)                           |            |             |              |        |       |
| Fracture cases                                                       |            |             |              |        |       |
| Implant placement                                                    |            |             |              |        |       |
| Sinus pathologies                                                    |            |             |              |        |       |
| Endodontic purposes (like locating additional roots and accessory canals) |            |             |              |        |       |
| Orthognathic surgeries                                               |            |             |              |        |       |
| Cysts and tumors                                                     |            |             |              |        |       |
| TMJ pathologies                                                      |            |             |              |        |       |
| Orthodontic analysis                                                 |            |             |              |        |       |

9. Do other medical professionals seek your opinion on CBCT in maxillofacial region interpretation? ( )
   A) Rarely B) Sometimes C) Always

10. Do you have any idea about radiation exposure of CBCT for a small field of view when compared to other types of imaging mentioned below? (Please tick only one item in the column)

| Type of Imaging                                                       | Unsure | 1 | 3–6 | 10 | 25 | 35 | 50 or more |
|-----------------------------------------------------------------------|--------|---|-----|----|----|----|------------|
| How many full-mouth series of IOPA does this scan equal               |        |   |     |    |    |    |            |
| How many panoramic exposures does this scan equal                      |        |   |     |    |    |    |            |
| How many days of background exposure does one scan equal              |        |   |     |    |    |    |            |
| How many of these scans equal one head and neck CT scan               |        |   |     |    |    |    |            |
11. Do you have any idea about radiation exposure of CBCT for a medium field of view when compared to other types of imaging mentioned below? (Please tick only one item in the column)

|                      | Unsure | 2  | 3-6 | 10 | 25 | 35 | 50 or more |
|----------------------|--------|----|-----|----|----|----|------------|
| How many full-mouth series of IOPA does this scan equal |        |    |     |    |    |    |           |
| How many panoramic exposures does this scan equal       |        |    |     |    |    |    |           |
| How many days of background exposure does one scan equal|        |    |     |    |    |    |           |
| How many of these scans equal one head and neck CT scan |        |    |     |    |    |    |           |

12. Do you have any idea about radiation exposure of CBCT for a large field of view when compared to other types of imaging mentioned below? (Please tick only one item in the column)

|                      | Unsure | 3-6 | 8  | 10 | 25 | 35 | 50 or more |
|----------------------|--------|-----|----|----|----|----|------------|
| How many full-mouth series of IOPA does this scan equal |        |     |    |    |    |    |           |
| How many panoramic exposures does this scan equal       |        |     |    |    |    |    |           |
| How many days of background exposure does one scan equal|        |     |    |    |    |    |           |
| How many of these scans equal one head and neck CT scan |        |     |    |    |    |    |           |

13. Please rate the relative importance of the following CBCT image/scanner characteristics? (please tick only one in the column)

|                              | Not important | Moderately important | Very important | I don’t know what that means |
|------------------------------|---------------|----------------------|----------------|-----------------------------|
| High Spatial Resolution      |               |                      |                |                             |
| High contrast resolution     |               |                      |                |                             |
| Capability to adjust FOV     |               |                      |                |                             |
| Capability to have short scan times |           |                      |                |                             |
| Image capture with image intensifier |           |                      |                |                             |
| Image capture with flat panel screen |             |                      |                |                             |

14. What type of CDE program would you like to attend on CBCT in future? ( )
   A) Hand-on course on CBCT equipment operations
   B) Hand-on course on CBCT application
   C) Hand-on course on CBCT interpretations
   D) Hand-on course on normal anatomy versus pathologic images

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