A Survey on Skills for Cone Beam Computed Tomography Interpretation among Endodontists for Endodontic Treatment Procedure

Abstract
Introduction: Cone beam computed tomography (CBCT) is used as a diagnostic tool, which aids in deciding the treatment plan in various fields of dentistry. In endodontics, CBCT is a useful tool in diagnosing apical periodontitis, resorptions, perforation, root canal morphology, traumatic injuries, and voids. The objective of this study was to evaluate the knowledge attitude and practice in diagnosing and interpreting the endodontic treatment using CBCT among the endodontists. Materials and Methods: A cross-sectional questionnaire survey was conducted among endodontists. Overall, 97 participants were included in the survey and the questionnaire containing 15 closed-ended questions was administered to the participants. Descriptive statistics were used to analyze the data. Results: On analyzing the response to the questionnaire, it was found that out of 97 participants, 24 had professional experience of more than 10 years. About 57% of participants preferred using digital radiographic technique for diagnosis. Majority of them were aware that CBCT is used for identifying location, size, and extent of periapical lesions. About 46% of participants stated that in detecting voids, CBCT was thrice significant compared with periapical radiography. According to 31% of the endodontists, CBCT was not reliable to detect vertical root fracture. It was found that 63% of the endodontists said they have not undergone any training or workshop in CBCT. Conclusion: This research study revealed that adequate training and skills are required in interpreting CBCT in endodontic treatment procedure among endodontists.

Keywords: Cone beam computed tomography, diagnosis, endodontists, questionnaire survey, root canal treatment

Introduction
With the advent of cone beam computed tomography (CBCT), the imaging modalities have progressed from two-dimensional to three-dimensional visualization. The quality of imaging has not only improved the diagnostic accuracy of diseases but also the quality care with regard to patient exposure and time consumption.[1,2] Limitation of conventional radiography, such as compression of three dimensional structures, geometric distortion, and anatomic noise, has led to the development of CBCT.[2] CBCT produces cone-shaped beam limited to head and neck region.

CBCT is used as a diagnostic tool and in deciding the treatment plan in various fields of dentistry, such as nerve tracing during third molar extraction, location of the tooth, during implant placement, maxillofacial surgeries, orthognathic surgeries, evaluating cyst and tumors, and Temporomandibular Joint (TMJ) evaluation.[3]

In endodontics, CBCT is a useful tool in diagnosing apical periodontitis, resorptions, perforation, root canal morphology, traumatic injuries, and voids. Although CBCT is effective in diagnosis, it has a few limitations in assessing with vertical root fracture (VRF), crown bridge, implant, restoration, and intracanal post, which can mimic complication or hide the existing one.[4-6] A few studies have shown that patient’s age, number of existing restoration, and implant have a negative impact on CBCT image quality.[6]

Literature search revealed no previous report on knowledge, attitude, or skills on interpretation of CBCT in endodontic treatment procedure; therefore, this study was conducted to evaluate the knowledge attitude and practice in diagnosing and interpreting the endodontic treatment using CBCT among the endodontists.

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Materials and Methods

This is a questionnaire-based cross-sectional study carried out among endodontists. The questionnaire was administered to 97 participants who gave consent.

Fifteen closed-ended questions were formulated and validated. The questionnaire consists of basic demographic details of the participants and questions related to knowledge and awareness of interpretation of CBCT in endodontic treatment procedures among endodontists.

The sample size was calculated based on a study done by Lavanya et al.,[7] assuming 95% confidence interval and 5% marginal error. The estimated sample size found to be 97.

Statistical analysis

The collected data were analyzed with IBM, SPSS statistics software 23.0 Version. To describe the data, descriptive statistics like frequency analysis and percentage analysis were used.

Results

Among 97 endodontists who participated in the survey, 41 participants had professional experience <5 years; 32 of them had 5–10 years of experience and 24 participants had professional experience >10 years. On analyzing the response to the questionnaire, it was found that 57% of the population preferred using digital radiographic technique for diagnosis [Figure 1a]. It was found that around 40% of the population reported that CBCT is sensitive compared with digital radiography [Figure 1b].

About 81% of the participants were aware that with CBCT usage location, size and extent of periapical lesions can be identified, whereas only 8% of the participants reported that they do not have knowledge and 6% of the participants reported that they have a vague knowledge [Figure 1c].

About 81% of the population was aware that using CBCT, radiolucent endodontic lesions can be detected before buccal and lingual plate demineralized, which showed that majority of the participants had knowledge on CBCT [Figure 1d].

In detecting the presence of middle mesial canal, second mesiobuccal canal, and distolingual canal with the use of CBCT, 51 participants stated that presence of second mesiobuccal canal can be detected. About, 31 of them stated that CBCT can detect the presence of middle mesial canal, whereas 23 participants were able to detect the presence of distolingual root.

In detecting the maxillary sinus before periapical surgery with the aid of CBCT, 63% of the population reported that they were able to detect, whereas 23% of the population stated that panoramic imaging was used to detect maxillary sinus. Seven percent of the population stated that they did not have knowledge.

When compared with CBCT, 48% of the population reported that conventional radiography underestimated external/internal resorption, whereas 27% of the population reported cervical resorption and 14% of the population did not have knowledge. Majority of the population (74%) stated that CBCT can detect external resorption.

About 46% of population stated that in detecting voids, CBCT is thrice significant compared with periapical radiography, whereas 19% of the population stated that CBCT is twice significant compared with periapical radiography. About, 17% of the population said that they were not aware which radiograph to be used.

It was found that 51% of the population reported panoramic imaging is not reliable in detecting VRF, whereas 31% of the population reported that CBCT is not reliable to detect VRF. About 21% of the population stated that they did not know which radiographic method is reliable in detecting VRF.

About 43% of the population stated that they were not aware of the reason why CBCT is not reliable in detecting VRF and 26% of the population correctly reported that image artifact and presence of radio dense material are the reason why CBCT is not reliable.

In identifying root canal system, 58% of population reported that CBCT to be considered as accurate as gold
standard histopathological method, whereas 17% of the population concluded that periapical radiographic method is as accurate as gold standard histopathological method. Around 11% of the population reported lack of awareness.

About 47% of the population concluded that CBCT can lead to misdiagnosis of fracture due to artifact and 34% of the population reported that CBCT can lead to misdiagnosis of root perforation due to artifact. Around 63% of the population said they have not undergone any training or attended workshop in CBCT.

Discussion

The objective of this study was to analyze the skill in CBCT interpretation among the endodontists for endodontic treatment procedures. Correct interpretation of diagnosis is of utmost importance in dental practice.

Based on the professional experience, it was found that 41 endodontists had >10 years of professional experience. This study discusses the sensitivity of CBCT and the ability to detect the presence of resorption, voids, vertical root fracture, perforation, and identification of root canal systems. This study revealed that majority of the participants did not undergo professional training on CBCT.

According to literature review, more periapical lesions were detected before and after primary root canal treatment using CBCT compared with periapical radiography.

On comparing periapical radiographs and limited CBCT for detection of apical pathology in maxillary molars, premolars, and mandibular molars, the study demonstrated that 38% of the lesions were undetected by periapical radiography, despite the fact that an additional periapical radiograph was taken from a different angle.

Previous report showed that size of the periapical lesion is often underestimated using periapical radiograph. CBCT enables the detection of radiolucent endodontic lesion before the lingual and buccal plate is demineralized. Periapical area of 83 treated or untreated roots in dog’s teeth was examined. It was found that periapical lesion was present on CBCT image but absent on periapical radiograph. This indicates that CBCT is sensitive in case of apical periodontitis.

Comparing CBCT and periapical radiography, it was reported that on mandibular molar, periapical lesions were detected with sagittal CBCT sections, which were not detected with periapical radiographs. True size location and extent of periapical lesions were appreciated. Further study compared CBCT with panoramic radiography (PAN) and reported that the use of CBCT led to the detection of more periapical lesions than PAN.

However, this study revealed that 40% of the participants reported that CBCT is equally sensitive to that of digital radiography in detecting apical periodontitis. This showed that the participants did not have awareness on interpretation of CBCT in detecting apical periodontitis. Periapical lesions of varying sizes were created in pig mandibles to compare CBCT and digital and conventional periapical radiography. CBCT was found to be twice as sensitive as digital and conventional radiography. A study revealed no difference between CBCT and periapical radiography. In a systematic review, it was concluded that there were no results showing CBCT better than periapical radiography.

On assessment of tooth morphology and its complication, it was stated that CBCT accurately detects the presence/absence of mesiobuccal 2 canals in 78.95% sample, compared with gold standard of clinical section in presence of untreated/missed canal intraoperatively root canal filled teeth as well as perforation.

Comparing the ability of charge coupled device (CCD) and Photostimulable phosphor (PSP) plate, digital radiography and CBCT were used to detect number of root canal in 72 extracted teeth. The study found that with digital radiography, endodontists failed to identify one canal in 40% teeth when compared with CBCT. However, in this study, 51 participants reported that they were able to identify second mesiobuccal canal and 31 participants reported that they were able to detect middle mesial canal.

Ten participants reported that they were able to detect both.

Tu et al. who investigated apparent prevalence of distolinguinal roots identified with periapical radiograph and CBCT, observed prevalence of 21% and 33%, respectively. They concluded that multiple periapical radiograph (especially 25 degree mesial tube shift) or CBCT was required to assess the presence of distolinguinal roots. For complex situations, CBCT was indicated as it had visualization of lesions that are difficult to visualize in periapical radiograph. Use of dental operating microscope and CBCT has led to increase in likelihood of locating canals.

Bornstein et al. confirmed that the limited CBCT imaging is a valuable diagnostic method to evaluate anatomically demanding areas such as maxillary sinus before periapical surgery. CBCT has been recommended for the planning of endodontic surgery and also concluded that CBCT may play an important role in planning for periapical microsurgery on the palatal roots of maxillary first molars.

Upon the detection of external internal and invasive cervical root resorption, ex vivo studies have reported on the superior diagnostic accuracy of CBCT over periapical radiography in the detection of simulated external resorption and internal root resorption. Estrela et al. reported that when compared with CBCT, conventional radiography grossly underestimates the extent of inflammatory root resorption. Ex vivo experiments
by D’Addazio et al.[26,27] have also shown CBCT to be significantly more effective than periapical radiography at determining the position of simulated resorption defects on root surfaces and differentiating between artificially created internal and external root resorption cavities. It was confirmed that in the detection of external resorptions, CBCT was significantly superior to radiographs. In this study, 74% of the participants reported that CBCT was able to detect external resorption, whereas 18% of the participants reported digital radiograph to detect external resorption.

Patel et al.[28] found that CBCT was 100% accurate in its ability to diagnose the presence of root resorption, whereas sensitivity of periapical radiograph was significantly low. The ability of CBCT in detecting the voids in root canal filled teeth was found in 46.2% of cases. It is three times more significant as the periapical radiograph.

Özer[29] created fracture of known width ranging from 0 to 0.4 mm and reported that CBCT is more successful than periapical radiograph in correctly diagnosing the fracture (82% and 42%, respectively). Earlier Hassan et al.[30] found that the overall accuracy of CBCT for detecting simulated VRF in root filled and non-root filled teeth was significantly higher than periapical radiographs, 0.86 and 0.66, respectively. Later, a review stated that CBCT cannot be recommended for the diagnosis of vertical root fracture. To use CBCT in diagnosis of root fracture, more clinical studies are required with proper control group. Artifacts caused by gutta-percha contributed to the inaccuracy of CBCT.[31]

Literature search on root perforation revealed that the overall sensitivity of periapical radiographs and CBCT scans to diagnose strip perforations in root-filled teeth was low, although CBCT scans showed higher accuracy than periapical radiographs.[32] However, there was no difference between the methods for the detection of root perforations. According to Hassan et al.[30] streak artifacts associated with root canal filling could mimic fracture and reduce the specificity of CBCT scans in diagnosis. The same artifact could increase the risk of perforation misdiagnosis. A survey study was done to assess knowledge on CBCT technology for better diagnosis and treatment planning and it was concluded that more detailed knowledge, information and professional training should be imparted into dental curriculum.[33]

Conclusion

This research showed that endodontists had an average level of knowledge regarding CBCT. It is recommended that qualification programs must be held for dentists to increase their awareness to gain more knowledge about indications and contra indications of CBCT.

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Conflicts of interest
There are no conflicts of interest.

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