How to Cite:
Roshan, G. M. S., Sindhu, R., Dhamodhar, D., Prabu, D., Rajmohan, M., & Bharathwaj, V. V. (2022). Cognizance about potential cancer risks due to cone-beam computed tomography systems among dental professionals. *International Journal of Health Sciences*, *6*(S4), 6574–6583. https://doi.org/10.53730/ijhs.v6nS4.10152

Cognizance about potential cancer risks due to cone-beam computed tomography systems among dental professionals

G M Sivsri Roshan
Undergraduate student, SRM Dental College, Ramapuram, Chennai, India

Sindhu R
Master of Dental Surgery, Senior lecturer, Department of Public Health Dentistry, SRM Dental College, Ramapuram, Chennai, India

Dinesh Dhamodhar
Master of Dental Surgery, Reader, Department of Public Health Dentistry, SRM Dental College, Ramapuram, Chennai, India

Prabu D
Master of Dental Surgery, Professor and Head, Department of Public Health Dentistry, SRM Dental College, Ramapuram, Chennai, India
Corresponding author email: researchphdsrm@gmail.com

Rajmohan M
Master of Dental Surgery, Reader, Department of Public Health Dentistry, SRM Dental College, Ramapuram, Chennai, India

Bharathwaj V V
Master of Dental Surgery, Senior lecturer, Department of Public Health Dentistry, SRM Dental College, Ramapuram, Chennai, India

***Abstract*---**Background: There is an increase in the number of Cone Beam Computed Tomography users, and it comes to the risk of developing cancer and mutations of genes in children below 18 years of age and the foetus of pregnant women. Knowing such conditions is necessary among dentists to prevent these conditions in the future. Aim: To determine the knowledge and familiarity about Cone Beam Computed Tomography (CBCT) and its side effects among dental professionals. Methodology: A cross-sectional questionnaire-based study is done among 202 dentists. The results were validated using Chi-square values. In addition, the criterion-based purpose sampling technique was used to select the participants. Results: Out of 202 individuals, less than 30% were only familiar with CBCT and its side

effects. The majority of the dental professionals were aware of the risk of suggesting a CBCT scan to children below 18 years (p value=0.003). Conclusion: The study result shows the lack of knowledge of CBCT and its side effects among dentists.

***Keywords*---**CBCT, radiosensitivity, effective dose, carcinogenesis, seivert.

Introduction

The Cone Beam Computed tomography (CBCT) systems used by dental professionals rotate around the patient, capturing data using a cone-shaped X-ray beam. The data are used to reconstruct a three-dimensional (3D) image of the following regions of the patient's anatomy: teeth, oral and maxillofacial region, and ENT, used by radiologists and dental professionals for various clinical applications, including dental implant planning, visualization of abnormal teeth, evaluation of the jaws and face, cleft palate assessment, diagnosis of dental patients.

CBCT is much different from a conventional Computed Tomography (CT) scan. The dental cone beam CT can be used to produce images similar to those produced by conventional CT scans. With cone beam CT, an x-ray beam in the shape of a cone is moved around the patient to produce more images and views. CBCT produce high-quality images [1]. Dentists gain an accurate 3-D image of the patient's facial anatomy from a CBCT scan. These 3-D images allow them to diagnose better and understand the progress and severity of the dental disease to provide the exact treatment for patients [2].

When radiographs are one of the best diagnostic tools available to medical and dental practitioners, radiation safety has become an important issue worldwide. Repeated radiation exposure to patients over long periods can lead to irreversible eye damage, gene defects, the development of malignancies in the lens of the eye, salivary glands, thyroid, bone marrow, and skin. A study says that a CBCT scan is equivalent to 400 chest x rays [3]. While CBCT scanning the child's phantom head with the adult settings resulted in significantly higher equivalent radiation doses to children than adults, ranging from a 117% average ratio of equivalent dose to 341%. Readings at the cervical spine level were decreased significantly, down to 30% of the adult equivalent dose [4].

Taking such powerful dose radiation in young patients has higher risks of developing cancer than adults, as the paediatric population of patients below 18 show increased radiosensitivity compared to adults due to the higher rates of cell growth and organ development. In addition, their susceptibility to mutagenic factors increases due to differences in assimilation, metabolism and excretion. Also, they have a longer lifespan to express the radiation-induced effects [5]. A paediatric patient is more radio-sensitive than an adult. Therefore, the juvenile patient has a whole lifetime to develop tumours induced at an early age. The methodologically-flawed paper which linked dental radiation exposure with brain tumours 5, 6 may turn out 20 to 40 years later, considering the current level of

CBCT use on children today. Although the paper contains a kernel of truth, the paper is flawed that we ought to heed. Therefore the paediatric should be imaged slowly with less radiation exposure [6].

Even though CBCT is considered a low dose radiological method, the effective dose of CBCT is several to hundreds of times higher than conventional dental radiography [5]. Even though the radiation doses from dental CBCT scans are generally lower when compared to other CT scans, dental CBCT scans generally deliver more radiation than conventional dental X-rays. Therefore the radiation exposure is greater for younger patients because they are more sensitive to radiation (that is, the estimates of younger patients lifetime risk for cancer incidence and mortality per unit dose of ionizing radiation are higher than adult patients), and they have a longer lifetime for ill-effects to develop[7]. The advantages of a CBCT scan are decreased examination time, decreased patient movement, and increased x-ray tube efficiency. The disadvantage is increased scattered radiation potential for cone-beam artefact if an inappropriate reconstruction algorithm is used [8].

A paediatric patient is more radio-sensitive than an adult[9], so when they are subjected to a CBCT scan which has a high amount of radiation, it can lead to serious problems in future as the paediatric patient has a whole lifetime ahead to develop alterations of a gene that are induced in childhood. The effective dose caused by a CBCT scan is several hundred times higher than conventional dental radiography [5]. Even the low levels of ionizing radiation of CBCT can cause stochastic effects and is a potential risk factor of carcinogenesis [10]. CBCT generates a high amount of exposure compared to a conventional dental radiograph. The radiation risk from paediatric CBCT results in health problems [11].

Effective dose (E) is the dosimetry quantity used for radiation purposes to evaluate the radiation risk of a patient from exposure to ionizing radiation caused by radio imaging devices. The standard international unit is Sievert (Sv) which is equivalent to 1 joule per Kg. Micro sievert (μSv) to express the dose in dentistry. According to the International Commission for Radiation Protection (ICRP), the effective dose is equivalent to each tissue multiplied by the individual tissue weighting factor [12].

The deterministic effect of ionizing radiation is calculated by the threshold dose below the effect that doesn't occur, and the harshness of the effect increases as the exposure increases. It develops because of cell killing by high dose radiation [13]. There is a continuous relationship between radiation dose and cancer risk, but they're no threshold dosage below, where the risk becomes zero [14]. The estimated risk of cancer from dentoalveolar CBCT in children ranges from 3 in 20,00,000 to 3 in 30,000 and 3 and in and craniofacial CBCT is 6,70,000 to 3 in 18,200 respectively[15].

Taking such powerful dose radiation in paediatric patients has higher risks of developing cancer than adults, as the paediatric population of patients below 18 show increased radiosensitivity compared to adults due to the higher rates of cell growth and organ development. They are more susceptible to mutagenic factors,

have a longer lifespan, and be even more exposed to radiation in the future for medical reasons. This study aims to assess the knowledge of Cone Beam Computed Tomography among dental professionals and its side effects caused in children below 18 years of age and pregnant women.

Methodology

A qualitative approach was considered to create awareness and extensive understanding of experiences in dentists' lives. The methodology involves interpretive phenomenological analysis to delve into the dentists' perception and provide a close picture of dentists' unique experiences. A sample of 202 participants was selected for this study. The criterion-based purpose sampling technique was used to select the participants. The inclusion criteria include participants who practice dentistry and pursue a master in dentistry. The study's purpose, importance, and relevance were explained to the participants, and informed consent was obtained from them. In addition, all the participants were assured of their identity and responses. The questionnaire was pre-tested for validity and reliability (Cronbach's value = 0.82).

The samples were collected through Google forms. It includes the dentist's demographic details of type, place and duration of the profession; values of various radio imaging devices like Intraoral Periapical (IOPA), Radiovisiography (RVG), Orthopantomogram (OPG); type of protective gears suggested for the doctor and the patient; when it's safe to radio image in special cases(pregnancy, lactation, paediatric period). The responses are segregated according to their branch of the dental profession and their place in the profession.

Results

A total of 202 individuals responded to the questionnaire. There were no missing responses, and the response rate was 100%. The study participants include dental professionals. Of the whole study, population majority belong to a group of dentists who practise between 5 to 10 years (36.6%).

Table 1. Chi-square test related to CBCT variants

Question	P-value	Chi-square value
Recommendation of CBCT to children below 18 years.	0.002696653	0.351846318
The risks of suggesting CBCT scans for children below 18 years.	0.15871166	0.710723021
A radio imaging device that has low radiation risk.	3.45333	0.710723021

Table 1 depicts the chi-square and P values related to CBCT variants.

Figure 1: Recommendation of CBCT scan to children below 18 years

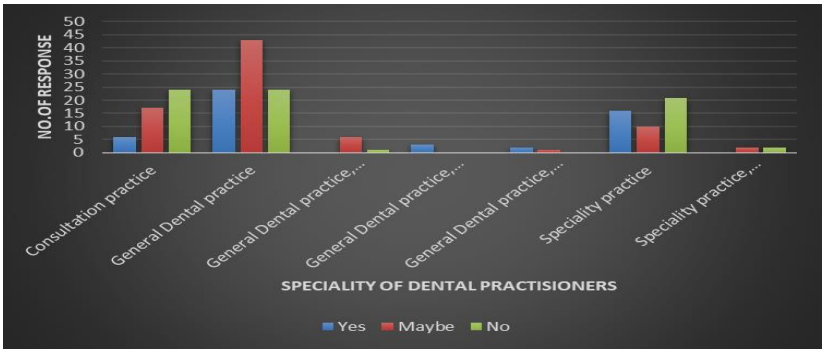

Figure 1 depicts the recommendation of a CBCT scan for children below 18 years of age.

Figure: Risks of suggesting CBCT scans for children below the age of 18 years.

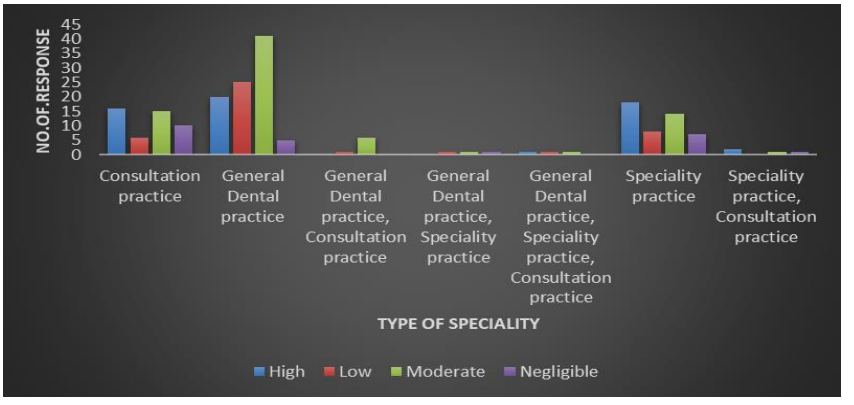

Figure 2 depicts the risks of suggesting CBCT scans for children below 18 years.

Figure 3: A radio imaging device that has low radiation risk

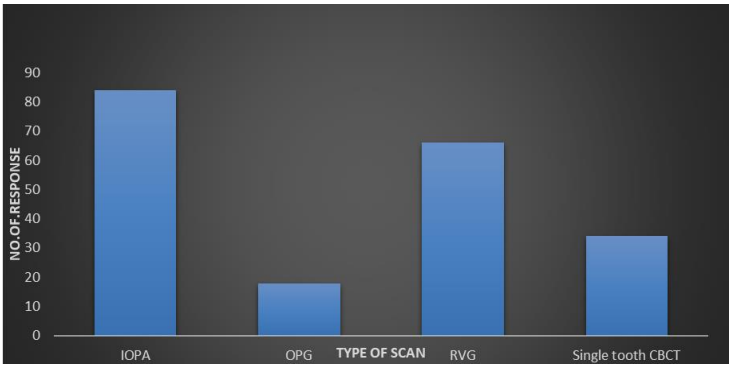

Figure 3 depicts the Radio imaging device that has low radiation risk

Table 2: Radiation emitted by radio imaging devices

Question	Answer	Responses
Radiation exposure of an Intra Oral Periapical radiographs	5 µSv	55(27.2%)
Radiation exposure in intraoral RVG	2 µSv	62(30.7%)
Radiation exposure of OPG radiographs	10 µSv	54(26.7%)
Maximum radiation exposure from a CBCT scan	18-200 µSv	56(27.7%)
Radiation exposure from maxillofacial CT scan	1800 to 2600 µSv	21(10.4%)
Maximum recommended lifetime radiation exposure limit	400 mSv	29(14.4%)
Annual maximum radiation dosage for a paediatric age group	2 mSv	24(11.9%)

Table 2 depicts the radiation emitted by radio imaging devices, and it shows only a few of the participants have known the radiation values and the risks of radio imaging devices.

Table 3: Distribution of perception among dental professionals about CBCT scan

Responses	Frequency (%)
Type of practice	
General Dental practice	104(51.5%)
Consultation practice	61(38.2%)
Speciality practice	57(28.2%)
Experience	
Less than 5 years	57(28.2%)
5 to 10 years	74(36.6%)
More than 10 years	71(35.1%)
Suggestion of CBCT	
Extraction	9(4.5%)
Implant placement	128(63.4%)
Impaction	40(19.8%)
Other	25(12.3%)
Protection gears used by doctors	
Lead apron	132(65.3%)
Radioprotective gloves	44(21.8%)
Maintaining proper distance	74(36.6%)
None of the above	30(14.9%)
Protection gears used by the patient	
Lead apron	79(39.1%)

Thyroid collar	75(37.1%)
Avoid scan during pregnancy	115(56.9%)
Avoid multiple exposures	96(47.5%)
Radiation risk of CBCT when compared to OPG	
Low risk	51(25.2%)
Moderate risk	83(41.1%)
High risk	55(27.2%)
Negligible	13(6.4%)
Reason of suggestion of CBCT for age below 18	
Pulpal pain	10(5.6%)
Missing tooth	39(21.8%)
Impacted tooth	46(25.7%)
All of the above	44(24.6%)
None of the above	68(38%)
Use of CBCT for initial investigation of orthodontic treatment	
Yes	79(39.1%)
No	123(60.9%)
Recommendation of CBCT for soft tissue abnormalities for below 18 years	
Yes	50(24.8%)
No	91(45%)
I'm not aware	61(30.2%)
More susceptible for radiation risk for CBCT	
Children	33(16.3%)
Adult	13(6.4%)
Pregnant women	119(58.9%)
Lactating women	37(18.3%)

Table 3 depicts the distribution of perception among each dental professional about the CBCT scan.

Discussion

The cognizance of radio imaging devices is a significant part of dentistry that dentists shouldn't neglect. Lack of awareness about radio imaging devices can lead to serious problems in human health. For example, it can cause mutation of cells in children below 18 years of age and pregnant women. However, in various studies related to radio imaging devices, their awareness among dentists was not assessed. This study aims to judge the knowledge about CBCT scans among dentists. In this present study, only some dental professionals were aware of radiation caused by CBCT scans.

In this study conducted in the 21st century, very few of the individuals were aware of the amount of radiation emitted by various radio imaging devices. A CBCT scan is equivalent to 400 chest x-rays [3], as it emits a high amount of radiation compared to other radio imaging devices. Therefore, it has to be avoided for children and pregnant women. RVG has the lowest radiation risk[16][17], but a majority of the dental professionals had opted for IOPA. Most dental professionals suggest CBCT for implant placement, but some had chosen others that contain ortho treatment that is dangerous if taken for paediatric patients. Most doctors

use a lead apron as protective gear while taking radiographs, while some doctors don't have any of the gears. For patients, doctors mostly avoid radiographs during pregnancy, and for other patients, they use a lead apron.

The radiation risk of CBCT compared to an OPG is high, by an assessment done by Issrani R *et al.,* [18], but most of the participants had chosen moderate. Most dental professionals don't suggest CBCT for minor problems for children below 18 years. For an initial investigation of orthodontic treatment, some doctors suggest a CBCT scan, which can be avoided because there is still a lack of evidence considering optimization and justification for the use of CBCT in the paediatric population[19]. Although for soft tissue abnormalities, generally, we shouldn't suggest CBCT, most dental professionals don't suggest CBCT for soft tissue abnormalities for children below 18 years. Still, some of the dental professionals suggest, and some are not aware of it.

Pregnant women are more susceptible to radiation risk caused by CBCT. Most dental professionals avoid CBCT for pregnant women as they are more susceptible. Dentists who do Speciality practice were more familiar with radio imaging devices and their radiation values. Therefore, they take necessary precautions while taking radio images. The reason for neglect and lack of awareness could be due to lack of knowledge and conditions caused due to overexposure. However, this study has some limitations in that it was done only in a confined population belonging to a certain location, the information could have been biased, and these responses were collected through Google forms due to the covid-19 pandemic.

Conclusion

Dental professionals must know the importance, advantages, and disadvantages of CBCT scans and all other radio imaging devices, when a CBCT should be used and when to be avoided. Most importantly, CBCT scans should be avoided in children below 18 years and pregnant women. So that in future, we avoid radiation-induced cancer and other serious illness.

Reference

1. (ACR), R., 2021. *Dental Cone Beam CT*. [online] Radiologyinfo.org. Available at: <https://www.google.com/amp/s/www.radiologyinfo.org/en/info/dentalconect%3fgoogle=amp> [Accessed 16 November 2021].
2. Cone Beam Computed Tomography: How safe is CBCT for your patients? [Internet]. Dentaleconomics.com. 2022 [cited 9 February 2022]. Available from: https://www.dentaleconomics.com/science-tech/article/16394714/cone-beam-computed-tomography-how-safe-is-cbct-for-your-patients
3. Ngan DC, Kharbanda OP, Geenty JP, Darendeliler MA. Comparison of radiation levels from computed tomography and conventional dental radiographs. Aust Orthod J. 2003;19(2):67-75. PMID: 14703331.
4. AI Najjar A, Colosi D, Dauer 11 Prins R, Patchell G,Branets 1, Goren AD, Faber RD. Comparison of adul And child radiation equivalent doses from 2

dental Cone-beam computed tomography units. American Journal of Orthodontics and Dentofacial Orthopedics. 2013;143(6):784-92.
5. Colceriu-Şimon IM, Băciuț M, Ştiufiuc RI, Aghiorghiesei A, Țărmure V, Lenghel M, Hedeşiu M, Băciuț G. Clinical indications and radiation doses of cone beam computed tomography in orthodontics. Medicine and pharmacy reports. 2019;92(4):346.
6. MacDonald D. Cone-beam computed tomography and the dentist. Journal of investigative and clinical dentistry. 2017;8(1):e12178.
7. U.S. Food and Drug Administration. 2021. *Dental Cone-beam Computed Tomography | FDA*. [online] Available at: <https://www.fda.gov/radiation-emitting-products/medical-x-ray-imaging/dental-cone-beam-computed-tomography> [Accessed 15 November 2021].
8. Knipe, H., 2021. *Cone beam CT | Radiology Reference Article | Radiopaedia.org*. [online] Radiopaedia.org. Available at: <https://radiopaedia.org/articles/cone-beam-ct> [Accessed 16 November 2021].
9. Pauwels R, Beinsberger J, Collaert B, Theodorakou C, Rogers J, Walker A, et al.; SEDENTEXCT Project Consortium. Effective dose range for dental cone beam computed tomography scanners. Eur J Radiol. 2012;81(2):267–71.
10. Lee CY, Koval TM, Suzuki JB. Low-Dose Radiation Risks of Computerized Tomography and Cone Beam Computerized Tomography: Reducing the Fear and Controversy. J Oral Implantol. 2015;41(5):e223–30.
11. De Felice F, Di Carlo G, Saccucci M, Tombolini V, Polimeni A. Dental cone beam computed tomography in children: clinical effectiveness and cancer risk due to radiation exposure. Oncology. 2019;96(4):173-8.
12. Board on Radiation Effects Research Division on Earth and Life Studies. Health risks from exposure to low levels of ionizing radiation: BEIR VII Phase 2. Washington: National Academies Press; 2006.
13. De Felice F, Musio D, Tombolini V. Osteoradionecrosis and intensity modulated radiation therapy: an overview. Crit Rev Oncol Hematol. 2016;107:39–43.
14. Theodorakou C, Walker A, Horner K, Pauwels R, Bogaerts R, Jacobs R; SEDENTEXCT Project Consortium. Estimation of paediatric organ and effective doses from dental cone beam CT using anthropomorphic phantoms. Br J Radiol. 2012;85(1010):153–60.
15. Isaacson KG, Thom AR, Atack NE, Horner K, Whaites E. Guidelines for the use of radiographs in clinical orthodontics, 4th ed. London: British Orthodontic Society; 2015.
16. Soh G, Loh FC, Chong YH. Radiation dosage of a dental imaging system. Quintessence International. 1993;24(3):189-191.
17. Ellingsen MA, Harrington GW, Hollender LG, Odont D. Radiovisiography versus conventional radiography for detection of small instruments in endodontic length determination. Part 1. In vitro evaluation. Journal of Endodontics. 1995;21(6):326-31.
18. Issrani R, Prabhu N, Sghaireen M, Alshubrmi HR, Alanazi AM, Alkhalaf ZA, Alnusayri MO, Aljohani FM, Khan ZA. Comparison of Digital OPG and CBCT in Assessment of Risk Factors Associated with Inferior Nerve Injury during Mandibular Third Molar Surgery. Diagnostics. 2021;11(12):2282.
19. De Grauwe A, Ayaz I, Shujaat S, Dimitrov S, Gbadegbegnon L, Vande Vannet B, Jacobs R. CBCT in orthodontics: a systematic review on justification of

CBCT in a paediatric population prior to orthodontic treatment. European journal of orthodontics. 2019;41(4):381-9.
20. Rahma, D. Y., & Atmaja, M. H. S. (2022). Peritoneal carcinomatosis and mimicking on CT scan findings. *International Journal of Health & Medical Sciences*, *5*(1), 154-162. https://doi.org/10.21744/ijhms.v5n1.1864
21. Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2021). Health and treatment of diabetes mellitus. *International Journal of Health Sciences*, *5*(1), i-v. https://doi.org/10.53730/ijhs.v5n1.2864