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Original Research Article

Intraoral digital radiography- A way forward or risk of overexposure: A questionnaire-based study

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ABSTRACT

Introduction: Digitization of intraoral radiography has revolutionized dentistry. It comes with plethora of advantages, such as quick image production elimination of processing chemicals, reduced patient exposure. With easy and instant image acquisition, the number and frequency of radiographs as well retakes have also increased. Therefore, making us think is there an actual reduction in the radiation exposure or not.
Aim: To assess clinical utilisation of intraoral digital radiography among practicing dental surgeons.
Materials and Methods: It is a questionnaire-based study. Questionnaire was curated using google forms and divided into two sections. First section included personal data and second section was focused on the clinical practice. Questionnaire link was circulated through various social media platform. 112 responses were collected.
Result: Out of all responses, 78.6% are using intraoral digital radiography, among them 53.4% are using CCD sensors. Maximum number of practitioners (54.5%) take on an average 0-5 intraoral digital radiographs and 98.9% of them take 1-6 retakes per day. Errors in positioning the receptor and PID were the most common reasons for taking repeats.
Conclusion: It appears that there is an increase in number and frequency of radiographs and number of retakes which might be nullifying the dose reduction from intraoral digital radiography. Practitioners should not neglect the radiation exposure from intraoral digital radiography as it may have a cumulative effect in long run and should abide by the radiation protection protocol and ALADA principle.

1. Introduction

Since the discovery of x-rays in 1895 by W. C. Roentgen,[1] x-ray technology has been undergoing constant development and modification. Digital radiography is considered as the greatest technological advance in the field of medical imaging.

Conventional radiography has been the backbone of diagnostic imaging since the beginning in both medical field and dentistry. With time, many advancements and modifications have been introduced to film-based radiography to improve the image quality and to reduce the radiation exposure. Darkroom processing in conventional form poses certain disadvantages such as, increase time for image acquisition and exposure to harmful chemicals. It also comes with the challenge of disposing the used films, lead foil and the chemical solutions, presenting a threat for environment. Additionally, lack of storage facility, degradation of image overtime, loss of image, and inability share the image poses the threat of repeat exposure.[2]

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Digital radiography provides us with plethora of benefits. Reduced exposure and instant image acquisition being the focus of interest.[3] Along with these, it also eliminates the disadvantages possessed by conventional radiography and also gives us access to telecommunication without degrading the image quality. But as every boon comes with a curse, digital radiography also has certain drawbacks including initial high cost of installation and risk of increase in number of radiographs requested due to ease of taking radiograph.[3] Few studies have shown that the number and frequency of radiographs as well as retakes have increased alarmingly.

As International Commission on Radiological Protection (ICRP) publication titled "Managing patient dose in digital radiology" has cautioned, "If careful attention is not paid to the radiation protection issues of digital radiography, medical exposure of patients will increase significantly and without concurrent benefit".[4] So, a questionnaire study was planned aimed at answering the question- "whether there is an actual reduction in radiation exposure from intraoral digital radiography compared to conventional radiography?"

2. Materials and Methods

The target population of this study was practicing dental surgeons.

A questionnaire was curated using google forms and validated by experts of different fields of dentistry. The questionnaire link was circulated through various social media domains such as email and WhatsApp, to practicing dental surgeons, and data were for the month of December 2021 and January 2022.

The questionnaire consisted of 24 questions divided into two sections. Questions in section one were designed to get the demographic data, type of practice, the field of specialty (if applicable), and whether using the digital system for intraoral radiographs.

Only those who opted for "yes" to the question of using intra-oral digital radiography were directed to the next section.

Section two consisted of questions regarding the clinical use of x-ray machines with exposure parameters, type and size of sensors used, with duration. Questions regarding the number of radiographs and retakes along with reasons and most common area requiring retake were also included. To assess the radiation exposure to both the patients and doctors, questions on radiation protection methods used in their practice, handling of receptor during exposure, duration of image storage and mode of transfer to patient were also included. The experience of dental practitioners with the digital system was also recorded.

112 responses were collected in two months duration.

3. Result

The total number of responses received in our study were 112.

Most of the respondents were either private practitioners (40.2%) or working in a private set-up (30.4%). Out of all the responses (112), 88 practitioners use intraoral digital radiography, which accounts for 78.6%, and the rest, 21.4%, are using conventional radiography. (Figure 1)

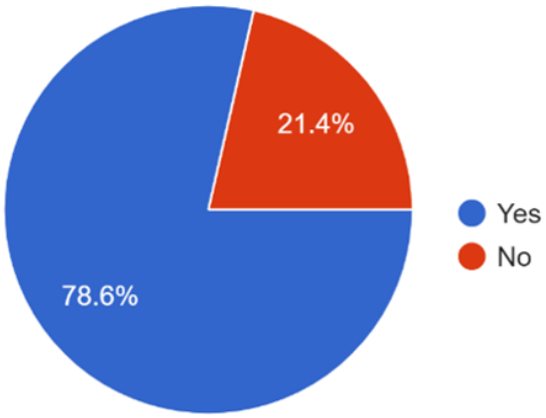

Fig. 1: Depicts the percentage of respondents using intraoral digital radiography and conventional radiography

The maximum number of respondents (70.5%) have been using the intra-oral digital radiographic system for 1-5 years, suggesting the newer trend of digitization.

Answers also revealed that solid state detectors (SSD) was the most common intraoral digital sensor used, followed by charged coupled device (CCD) (53.4%) which was more popular than complementary metal-oxide Sulphur (CMOS) (35.2%). (Figure 2)

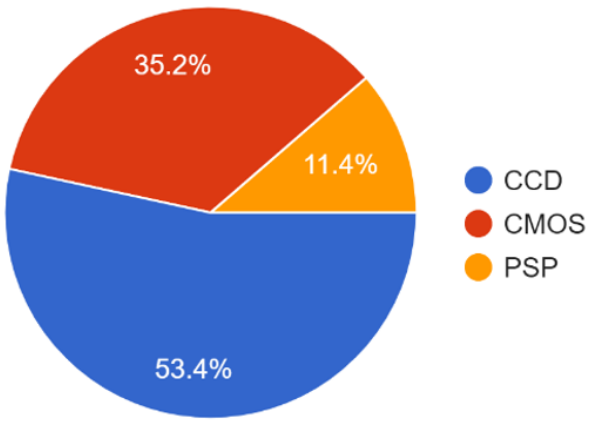

Fig. 2: Shows the usage of different types of intraoral digital sensors

Table 1 shows exposure times for various regions of the oral cavity.

Table 2 shows the total number of radiographs and retakes taken along with the most common region requiring the retake and the most common mistake resulting in retakes,

It was found that 54.5% of the practitioners take approximately 0-5 radiographs and 31.8% take 6-10 radiographs daily. The study also revealed that 98.9%of the respondents take 1-5 retakes every day.

On further detailing it was found that the maxillary posterior (58%) region was the most common site requiring retakes, and errors in positioning of the receptor (38.6%) and PID (36.4%) were the main reasons for repeat exposures. Patient motion at 29% was also considered as contributing factor for more retakes.

42% of the practitioners responded that they ask patients to hold the receptor while exposure and 35.22% of dental practitioners responded that they hold the receptor in the patient's mouth. Only 13.64% of practitioners use receptor-holding devices while taking an intraoral digital radiograph. (Figure 3)

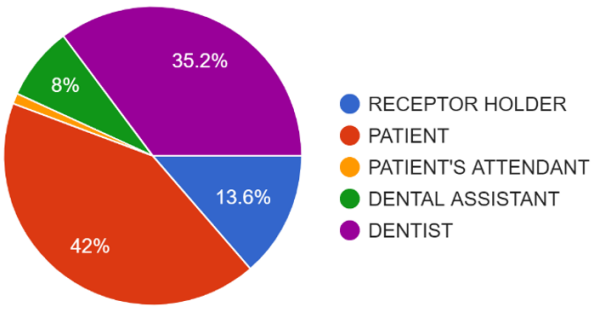

Fig. 3: Chart represents the percentage of various ways used for holding intra oral digital receptor during exposure

Replying to the radiation safety measures taken, 22.7% use only the position distance rule, and 21.6% use only the lead apron. Only 7.95% of the respondents use the position distance rule, lead apron, and lead barrier together for radiation protection.

Instant image production (40.9%) and reduction in radiation exposure (35.2%) were the most common advantages considered by practitioners using digital radiography, followed by the elimination of darkroom processes (14.8%).

Most of the practitioners using intraoral digital radiography systems are highly satisfied (30.7%) while 29.5% of them are either not satisfied (19.3%) or disappointed (10.2%) with the digital system. (Figure 4).

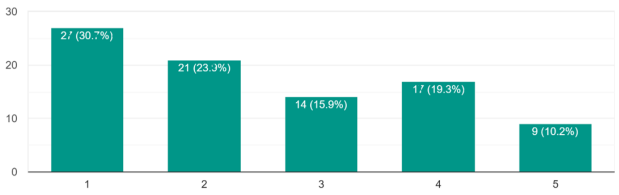

Fig. 4: Depicts the satisfaction of respondents on ascale of 1-5 with 1 depicting highly satisfied and 5 representing disappointed with the intraoral digital system

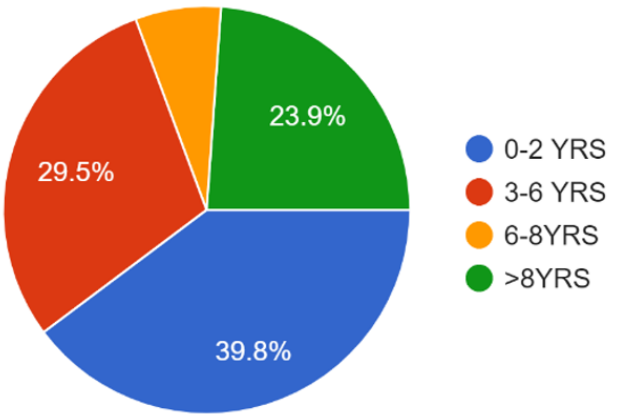

Fig. 5: Depicts the average number of years for which respondents store patient data in their practice.

4. Discussion

Intraoral radiography has been under constant change and rapid development since introduction of digital system in dentistry and has been seeing a steady increase in its acceptance which has revolutionized intraoral radiography.[5] The current study was aimed at assessing the clinical utilisation of intraoral digital radiography among practicing dentists. This study is one of its kind to be conducted in Indian scenario.

The present study indicates the increased popularity of intraoral digital radiography (78.6%), unlike the study by H. D. Anissi et al (2014) which showed 36%.[6] It can be inferred that the digitization has gradually gained popularity in the past decade in dentistry.

Current study also reported that 70.5% respondents are using the intra-oral digital radiographic system for 1-5 years, suggesting the acceptance of the newer trend of digitization. A similar trend was seen in one study where there was an increased number of digital systems in the group with 0-10 years of work experience implying that new generation dentists are preferring digital systems over conventional systems.[6] This shift from conventional to digital system can be attributed to the better feasibility and quick image production with the digital system. The same study revealed the use of PSP systems more than CCD,

Table 1: Shows the frequency and percentage of different exposure times used for anterior and posterior regions

Exposure time (s)			
Anterior region		**Posterior region**	
0.08s-0.12s	62 (70.5%)	0.20s-0.25s	39 (44.3%)
0.13s-0.17s	12(13.6%)	0.26s-0.30s	29(33%)
0.18s-0.22s	8(9.1%)	0.31s-0.35s	13 (14.8%)
0.23s-0.27s	5 (5.7%)	0.36s-0.40s	4 (4.5%)

Table 2: Gives the average number of radiographs and retakes taken per day along with the most common area requiring retakes and the most common reasons for taking retakes

Number of radiographs taken per day		**Number of retakes taken per day**		**Most common area requiring retakes**		**Most common reason for retakes**	
0-5	48 (54.4%)	1-5	87 (98.9%)	Maxillary Anterior	8(9.1%)	Patient motion	29(33%)
5-10	28 (31.8%)	6-10	-	Maxillary Posterior	51(58%)	Improper positioning of receptor	34(38.6%)
>10	12 (13.6%)	>10	1 (1.1%)	Mandibular anterior	6(6.8%)	Improper positioning of PID	33(37.5%)
				Mandibular posterior	23(26.1%)	Small size of the recptor	17 (19.3%)

whereas the current study showed the popularity of CCD system over PSP.[6]

Digital imaging system in intraoral radiography was introduced for instant image acquisition after exposure, with the additional knowledge that it also reduces the patient as well as operators' radiation exposure if proper radiation protection measures are followed. Also, untroublesome image production with image enhancement software, have worked in favor of this system but concurrently it has also resulted in increase in number and frequency of the radiographs taken.

There are many studies unfolding the fact that the number and frequency of intraoral radiographs have increased with the introduction of digital systems in dental practices. One such study done by WER Berkhout et al (2002) found that general dental practitioners using intraoral digital radiographic systems were more inclined to take radiographs than their other counterparts using conventional radiography.[7]

In another study by WER Berkhout et al (2003) reported that general dental practitioners using digital sensors were taking a significantly higher number of x-rays than those using film.[8] To have a better diagnosis as well as for the accuracy of the treatment plan and ongoing treatment were most important reasons for taking more number of radiographs.[8]

During the era of conventional radiography, because taking radiograph and processing it was cumbersome, repeats and retakes were advised only when it was absolute necessary.

Recent literature suggests that not just the number and frequency but also the repeats and retake of the radiographs have increased with digital radiography as can be seen in the result of current study which is also in accordance with the study done by B. Svenson et al.(2011), in which it was found that intraoral digital system accounted for 12% more retakes in total. They further added that SSD had more retake frequency than PSP and attributed this finding to the small size of the SSD receptor.[9] According to WER Berkhaut et al (2002) dentists consider the user friendliness of digital radiographs to be better than film post exposure and hence there has been an increase in number of retakes taken. Also, positioning of digital intraoral sensor is difficult due to bulkiness of the sensor than film resulting in improper radiographic images further adding to the number of retakes.[7]

The current study revealed that the maxillary posteriors were the most common regions for retakes followed by mandibular posterior. The increased number of retakes for maxillary posteriors can be attributed to the overlapping of structures with molar roots as well as requiring different angulations for viewing all the roots of the multirooted teeth. It also revealed that errors in receptor positioning and position indicating device are the major cause of repeat radiographs, which was similar to the study done by B. Svenson et al. They reported projection errors and poor image quality as the major reason for retakes of x-rays.[9] Another study reports difficulty in the positioning of the detector and poor quality images as reasons for an increased number of radiographs.[6] Other reasons reported are lack of operator skills, particularly with regard to patient positioning and proper equipment operation,[10] and the knowledge that it requires less radiation was reason enough for repeat radiographs,[8] small size of the sensor not covering the area of interest,[11] patient factors such as shallow floor of the mouth, low palatal vault, severe gag

reflex.[10]

Reduction in radiation exposure is the main advantage of digital radiography, but with an increase in the number and frequency of radiographs taken as well as an increase in the number of retakes per person, it can be argued that whether there is an actual reduction in radiation exposure from intraoral digital radiography as claimed, or rather there is an increase in radiation exposure.[8,9]

Various authors have studied the dose required for taking digital radiography compared to conventional film. John Ludlow et al (2001) concluded in their study that exposure reduction from the digital system can be expected to be half of E-speed films.[12] Wenzel A et al in 2001 reported a dose reduction of 55% with digital system.[13] H. D. Anissi et al reported the exposure time for the film to be twice required for SSP and 2.8 times that required for SSD system.[6]

WER Berkhaut (2004) in one of their studies reported that though the dose required per exposure is lower with digital radiography, the increase in radiographs taken suggests that the total radiation exposure is relatively higher with digital radiography.[14] The current study also reveals that most of the practitioners ask patients to hold the receptors, due to the cumbersome nature of using receptor holder which again further adds to the additional exposure to the patients. A good percentage of respondents said they hold the receptor while exposure. This may be because of the high cost of the digital receptors. This negligence can be attributed to having perquisite knowledge that there is less radiation exposure from digital system, not considering the cumulative effect in long run.

Regarding the radiation safety measures taken, half of the respondents use either only the position distance rule or only the lead apron as a protective measure which is in accordance with the study of H. D. Anissi et al which reported that around 88.4% of the General Dental Practitioners use lead aprons for radiation protection while only one third used other effective devices such as thyroid shields and rectangular collimator.[6] The present study also reported that only 7.95% of practitioners use the position distance rule, lead apron, and lead barrier together for radiation protection. Since most of the respondents in the study are practitioners in clinic, use of lead barriers and position distance rule becomes difficult due to limited space which further impacts the radiation safety of practitioners.

Recently handheld intraoral x-ray machines have gained popularity due to its portability which again raises the question of radiation exposure to the operator as well.

Though literature suggests that the exposure from handheld is minimum. Continuous and frequent exposure over a long period of time may have adverse effect and hence should be considered! Consciously!

Acknowledging the necessity, Atomic energy regulatory board (AERB) has recently released an advisory (December 2022) regarding the supply and use of hand held medical diagnostic x-ray equipment and has recommended that the use of hand held x-ray machine should be limited to situations where use of fixed or mobile x-ray machine is impractical or medically unacceptable.

From the current study it can be observed that the negligence of dentists towards the inadvertent prescription of digital radiographs and retakes and the lacunae in abiding by the radiation protection protocols may have impact over the actual reduction in total radiation exposure from intraoral digital radiography. It can be very well argued whether there is an increase in radiation exposure from intraoral digital radiography rather than reduction!

5. Conclusion

With great advancements come great responsibilities, as with the digitization of intraoral radiography. Amidst the benefits of instant image production, ease of use, and reduced radiation exposure, intra-oral digital radiography also comes with the risk of an increase in number and frequency as well as higher retakes eventually nullifying the advantage of lesser exposure. In some scenarios, it may even lead to increased radiation exposure. Therefore, there is a need for a more vigilant approach to reduce the risk of over-exposure to patients as well as the operator. General dental practitioners as well the dental radiologists need to understand and acknowledge the risks that accompany the plethora of advantages of digital radiography and must abide by the principle of ALADA (As low as diagnostically acceptable). With the limited number of responses for the current study, we cannot generalize the findings and hence, there is a need for further research in the same direction covering a larger population of practicing dental surgeons.

6. Source of Funding

None.

7. Conflict of Interest

None.

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