From the time of its discovery, X-rays have played a pivotal role in the field of medical and dental science. Ranging from diagnostic to therapeutic applications, the use of X-rays is manifold. Probably, the most widespread application is in the field of dentistry from the simple diagnosis of incipient caries, miniscule fractures to aiding in more complex procedures such as precision implant planning. The modalities at the disposal of dentists range from intraoral radiography to cone beam computed tomography.

During the course of their training, all health-care personnel are trained regarding radiation hazards and requisite safety measures. However, the sincerity with which the matter is considered needs to be assessed from time to time. In the present study, we attempt to evaluate the awareness and validate the radiation protection and safety measures by conducting a study among general dental practitioners in Southern India. Although the quantum of ionizing radiation is low in diagnostic examinations, special attention to radiation protection is called for. Radiographic investigations in medicine cause radiation exposure to both the patient and the radiographer, and care is to be taken to protect both. In the field of dentistry, radiation

**ABSTRACT**

**Aim and Objective:** The aim and objective is to evaluate the level of awareness and attitude about radiation hazards and safety practices among general dental practitioners in Trivandrum District, Kerala, India.

**Materials and Methods:** A questionnaire-based cross-sectional study was conducted among 300 general dental practitioners in Trivandrum District, Kerala, India. Postanswering the questions, a handout regarding radiation safety and related preventive measures was distributed to encourage radiation understanding and protection.

**Statistical Analysis:** Statistical analysis were done by assessing the results using Chi-square statistical test, t-test, and other software (Microsoft excel + SPSS 20.0 trail version).

**Results:** Among 300 general practitioners (247 females and 53 males), 80.3% of the practitioners were found to have a separate section for radiographic examination in their clinics. Intraoral radiographic machines were found to be the most commonly (63.3%) used radiographic equipment while osteoprotegerin was the least (2%). Regarding the practitioner’s safety measures, only 11.7% of them were following all the necessary steps while 6.7% clinicians were not using any safety measure in their clinic, and with respect to patient safety, only 9.7% of practitioners were following the protocol.

**Conclusion:** The level of awareness of practitioners regarding radiation hazards and safety was found to be acceptable. However, implementation of their knowledge with respect to patient and personnel safety was found wanting. Insisting that they follow the protocols and take necessary safety measures by means of continuing medical education programs, pamphlets, articles, and workshops is strongly recommended.

**KEY WORDS:** Awareness, dentist, radiation

In the present study, we attempt to evaluate the awareness and validate the radiation protection and safety measures by conducting a study among general dental practitioners in Southern India.
exposure for diagnostic purpose is minimal and an attempt to analyze its detrimental effect is an arduous task.[6‑13] The present scenario is to minimize the exposure to ionizing radiation to as low as possible. All dental practitioners should follow the guidelines to reduce the harmful effects of radiation. On the basis of surveys conducted among practicing dentist, they show no effective practices toward dose-reducing techniques.[6‑13]

Materials and Methods

A cross-sectional study was conducted to assess the level of radiation safety practices and awareness among 300 general dental practitioners in Trivandrum District, Kerala, India. A questionnaire comprising 18 questions in clinical, radiographic practice was formulated. Information regarding demographic data such as age, sex, qualification, and years of experience was also obtained. After obtaining clearance from the institutional research and ethical committee, the questionnaire was distributed among general practicing dentists and collected back with their response. An awareness brochure pertaining to radiation safety was given to the participating dental practitioners on return of their completed responses.

Statistical analysis

Independent samples t-test, at \( P = 0.05 \) significance level, to compare mean scores between qualifications, and years of experience, was used for analysis. The results were assessed by Chi-square statistical test and other software (Microsoft excel + SPSS 20.0 trail version, IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp).

Results

On analysis of the answered questionnaire, the following results were obtained. Total sample size of the study was 300 general practitioners (247 female and 53 male), of which 83% of the dentists had been practicing for more than 5 years and 259 out of 300 dentists were general dental practitioners with no specialized qualification. Intraoral radiographic machines with conventional X-ray films were widely used by them in their practice (63.3%), followed by radiovisiography (RVG) (17.7%) and osteoprotegerin (2%) and 17% were using a combination of radiographic machines and techniques in their practice. Nearly 80.3% had a separate section for radiographic equipment in their practice. Most of the dentists (71%) instruct their patients to hold the intraoral periapical (IOPA) film with their fingers while carrying out the radiographic exposure and only 16.7% were using holders in their practice while 12.3% of the clinicians used other methods for placing IOPA films. On statistical analysis, \( P = 0.579 \) for practical score was obtained based on qualification [Table 1], and based on years of experience, \( P = 0.834 \) for practice score was obtained [Table 2].

Many of the practitioners (28.3%) followed exclusively the “position distance rule” while 22% were found to be using lead barrier. Sixteen percent used lead apron in their practice, and 33.3% have used a combination of safety techniques such as lead apron and lead barrier. However, 90.3% are not providing any radiation safety measure for their patients. Based on the qualification, an attitude score with \( P = 0.081 \) is obtained [Table 1], and by year of experience, \( P = 0.307 \) is obtained [Table 2].

Only 22% of the practitioners were aware of special situation such as pregnant women and children who are more susceptible to the hazardous effect of radiation. Most of the dentists (84.3%) reported that they were aware of as low as reasonably achievable (ALARA) principle, but 66.7% were not aware of the Atomic Energy Regulatory Board (AERB) recommendations. Ninety-eight percent of the practitioners were aware of the function of thermoluminescent dosimeter (TLD) badges, but only 2% of them were using TLD badges in their practice. A mere 14.7% of the dentists were aware of annual whole body radiation limit for radiation worker and only 21% of the practitioners knew about radiation dose limit for the patient. Majority of the dentists were interested in updating their knowledge about radiation hazard and safety using various modes, 52.3% by continuing medical education programs, 7.3% by articles and journals, and 13% by internet update and the remaining 27% through a combination of continuing medical education programs, journals, workshops, and internet updates. Based on their qualification, a knowledge score of \( P = 0.924 \) [Table 1] was obtained, and based on the years of experience, a knowledge score of \( P = 0.216 \) [Table 2] was obtained.

Discussion

A study done on radiation protection by Svenson and Petersson among Swedish dental practitioners revealed their knowledge, attitude, and practices in the field as dentist having higher level of knowledge with 5–25 years of experience than those with lesser or greater years of experience. The study also revealed that specialists have a better knowledge than other

| Table 1: Independent samples t-test to compare mean scores between qualifications |
|---|---|---|---|---|
| Score | Qualification | n | Mean | SD | t | P |
| Knowledge score | BDS | 259 | 3.0618 | 0.78998 | 0.096 | 0.924 |
| | MDS | 41 | 3.0488 | 0.89306 | 0.216 | 0.834 |
| Practice score | BDS | 259 | 2.7761 | 0.74452 | 0.556 | 0.579 |
| | MDS | 41 | 2.7073 | 0.67985 | 0.307 | 0.78998 |
| Attitude score | BDS | 259 | 1.5367 | 0.66005 | 1.754 | 0.081 |
| | MDS | 41 | 1.7317 | 0.67173 | 0.307 | 0.78998 |

If \( P<0.05 \), then statistically significant. SD: Standard deviation

| Table 2: Independent samples t-test to compare mean scores between years of experience |
|---|---|---|---|---|
| Score | Years of experience (years) | n | Mean | SD | t | P |
| Knowledge score | \( \leq 5 \) | 140 | 3.1214 | 0.77244 | 1.240 | 0.216 |
| | >5 | 160 | 3.0063 | 0.82795 | 0.081 | 0.924 |
| Practice score | \( \leq 5 \) | 140 | 2.7571 | 0.70834 | 0.210 | 0.834 |
| | >5 | 160 | 2.7750 | 0.76025 | 1.240 | 0.216 |
| Attitude score | \( \leq 5 \) | 140 | 1.5214 | 0.66211 | 1.023 | 0.307 |
| | >5 | 160 | 1.6000 | 0.66541 | 1.240 | 0.216 |

If \( P<0.05 \), then statistically significant. SD: Standard deviation
general practitioners. In our study too, we found that practitioners with more than 5 years of clinical experience had better awareness regarding radiation hazards and safety but scored poorly when it came to practices pertaining to the same [Table 2].

All the practitioners included in the study were found to have facilities for radiographic investigation in their clinic. Among them, in that 63.3% were using intraoral radiographic machine with conventional X-ray films. The distribution of dentist using different radiographic equipment is demonstrated in Graph 1. Hayakawa et al. have done a study on radiation dosage reduction in general dental practice using digital intraoral radiographic systems, which concluded that radiation exposure is reduced to 40–60% in RVG than using E-speed intraoral films. International recommendation for radiological protection also recommends using RVG by which radiation exposure can be reduced by 60% as compared to E-speed intraoral films.

According to the AERB, safety code for the installations of medical diagnostic X-ray equipment mentions that all X-ray using institutions should have a separate X-ray room and specific instructions for the particulars in the room. Among 300 general practitioners, 80.3% had a separate section for radiographic examination in their clinic.

Since 1977, the International Commission on Radiological Protection started to implement risk/benefit concept. All radiation exposure done in medicine must be based on the ALARA principle (as low as reasonably achievable). In the present study, 84.3% of the practitioners were aware of the ALARA principle [Graph 2]. Ilgü et al. in their study to check dentist’s knowledge about radiographic equipment, dose reduction techniques, and quality of dental radiographic service in general dental practice in Turkey indicate that for reducing any unnecessary radiation, attempts should be made to improve dentist’s knowledge about radiation dose reduction techniques.

A study by Sheikh et al. reported poor radiation protection practices among Indian dental practitioners. Our study revealed that majority of the practitioners (28.3%) still followed the position and distance rule, 22% were found to be using lead barriers while 16% mere used lead aprons and 33.3% were using a combination of various safety techniques [Graph 3]. Distance in radiation protection refers to distance from the source and the individual. As the distance increases, radiation exposure reduces. Moreover, shielding includes both protective barriers such as lead shield and personnel protective measures such as lead apron. Ninety-eight percent reduction in scattered radiation and attenuate dose to 0.04 µR can be achieved using lead aprons. Patient should wear thyroid collar during radiation exposure as it reduces attenuation of scattered radiation to 92%. Proper shielding from radiation and by increasing the distance from source protect radiographer as well as patient for unnecessary exposure to radiation. According to position distance rule, radiographer position should be at least 6 feet from the source at an angle of 90 to 135° to the central ray of X-ray beam. A study by Noohi among radiographers in Kerman (Iran) concluded that percentage of
protective shields used for patient and radiographers is 0.01% and 15.7%, respectively. However, another study by Mojiri and Moghimbeigi among radiographers in Hamandan City shows significantly higher results of 78.9% and 83.1%, respectively.

The present study concludes that 90.3% of general practitioners were not providing any safety measure for their patients [Graph 4]. Shahab et al. in their study among Iranian dentists concluded that most of the dentists are not using proper method, material, and equipment for reducing unnecessary radiation exposure to patients. Film holders not only help radiographers to position the film but also help patients to avoid unnecessary exposure to their fingers. History of patient exposure must be maintained after every exposure. Our study shows that 71% of the dentists are instructing their patients to hold the IOPA films with their fingers and only 16.7% are using holders in their practice and 12.3% of clinicians use other methods for placing the IOPA films [Graph 5].

Radiation exposure to pregnant women causes several biological effects on fetus such as intrauterine death, developmental abnormalities, and mutagenic carcinogenic effects. In pregnancy, it is better to avoid radiation exposure during the first trimester, i.e., during 8–15th week of pregnancy. If radiological investigation is inevitable, it should be carried out during the second and third trimester with proper protection by means of lead apron, thyroid collar, etc. Our study reveals that only 22% of dentists were aware of their patients who are more susceptible to radiation, such as pregnant ladies and children. Amout and Jafar done a questionnaire-based study on 57 undergraduate dental students reveal that about 50–60% of future dentists do not undertake any radiographic procedure for pregnant patients, without considering patient’s trimester or level of emergency. Another study by Razi et al. on 250 general dentists in Tabriz concluded that dentists do not have sufficient awareness regarding radiation risk associated with pregnancy.

Radiation dosimeters are instruments used to detect and measure the amount of radiation. They monitor and provide data regarding exposure dose limits and proper undertaking of protective measures. In India, TLD is commonly used for this purpose. Lithium fluoride, lithium borate, calcium fluoride, and calcium sulfate are materials used in TLD badges which emit light by the stimulation of heat. The two regions where these badges to be worn are on the trunk, at the level of the radiographer’s waist on the anterior aspect or on the collar area of upper chest region on the anterior aspect. These badges are to be monitored for exposure levels every 3 months interval. Compact personnel electronic monitoring devices which connect to the base station are under process. Our study revealed that over 90% of the dentists were aware of TLD badges but a paltry 2% were using it in their practice.

Recommended occupational dose limit by the AERB is 20 mSv/year. The present study revealed that only 14.7% of the dentists were aware of annual radiation dose limit for radiation workers. Another study by Amirzadeh and Tabatabaee among radiation employees reveals that 51.2% of the workers were aware of radiation dose limit. A study done by Mojiri and Moghimbeigi among radiographers in Hamandan City revealed 58% of radiographers to be aware of radiation dose limit.

Biological effects of ionizing radiation are grouped into stochastic and deterministic effects. Above a particular determined dose of radiation biological damage begins to appear, this is called as deterministic effect. Stochastic effect is that in which there is no particular dose level above which biological change occurs in the body. Ionizing radiation causes both the effects depending on radiation doses and body’s response to these radiations. Dentists as well as patients are more prone to the risk of stochastic effects because of its lack of a dose threshold limit. The positive aspects of disease diagnosis and disease detection should be considered while evaluating the risks of the biological effects of radiation. Over 88% of the dentists in our study were unaware of the biological effects of radiation. A study by Razi et al. concluded that 70% of the general practicing dentists in their group were unaware of the biological hazards of radiation.

**Graph 4:** Analysis of the attitude of the general practitioners revealed that 90.3% of them are aware about radiation safety measures for patient

**Graph 5:** Comparison of the techniques being used for taking intraoral periapical radiograph revealed that 70.9% of the practitioners are asking the patient to hold the intraoral periapical film during the X-ray exposure.
It is very important for dentist to update their knowledge about new trends in diagnostic techniques, protective measures, etc., This can be achieved by means of continuing education, journals, workshops, and other media. The distribution of the preferred method of updating their knowledge and awareness is illustrated in Graph 6. Studies by Aps to assess general dental practitioner’s knowledge about dental radiography and radiation protection in Belgium show the results that clearly indicated the need for continued education on the subject.[11] A study by Amin Tavakli et al. in Shahid Beheshti University of Medical Science also revealed that the dentist believes they need continuing education programs in radiology to update their awareness.[17]

**Conclusion**

The study suggests that practicing dentists need to be enticed and encouraged to conform to the rules of protection from X-rays; implementing and enforcing the matter via enforcement agencies will take us a long way in this context. Protection of one’s self and patient from all kinds of health hazards is the hallmark of concerned doctors. The AERB recommendations should reach out through the dentists’ platform (e.g., IDA) to the dental practitioner. Better “safe than sorry” remains no more a virtue but a fundamental necessity.

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**Conflicts of interest**

There are no conflicts of interest.

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