Radiation protection in dental department

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■ **Abstract**

Background: In recent decades many guidelines has been conducted by radiation protection organizations about radiation protection in dentistry. This study aimed to evaluate the observance of these guidelines in educational clinics of many dental centers in Tripoli Libya.

Material and Methods: In this cross-sectional study a self-administered questionnaire was conducted, the radiology departments of the dental centers clinic were surveyed in this study. The questionnaire was collected and surveyed after the employees answered it in addition to general questions (gender, age, Qualification, name of the hospital or clinic where the questionnaire was filled by the dental department, included questions. This questionnaire contains many questions related to radiation protection according to basic on National Radiation Protection Board (NRPB) and European Commission guidelines

Results: in this study clear it to us there are a lot of problems related to this worker in dental department and shows that there is a careless by the workers in the application of radiation protection methods as well as a lack of wearing protective clothing, leaving the door of the room is open during take images examination, which causes risks to workers all staff and patients.

These problems have caused negligence in the application of safety to radiation protection.

Conclusions: This study has emphasized on the need for further consideration of radiation protection principles in dental centers especially on the all thing related to the radiation protection.

■ **Key words** ***ICRP, NRPB, Questionnaire, radiation protection***

1. Introduction

The average radiation dose, annually received by general public is 2.5msv, and 15% of them are related to medical exposures (Rahman N, et.al. 2008,

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pp 119-122). The use of radiation in the medical practice has evolved since its beginning and 30% to 50% of medical decisions are affected by radiologic examinations. However, the hazards of Ionizing radiation are irrefutable (Quinn AD, et.al. 1997, pp 102–106). According to recently studies in United Kingdom was estimated that 100-250 death per year occurred because of harmful effects of medical radiation exposures. Reducing the patients received dose as low as reasonably achievable (*ALARA*) is based on the recommendations of all radiation protection organizations such as *ICRP* and *NRPB* (Shiralkar S, et.al. 2003, pp 371-372).

Dental radiography represents one of the most frequently used radiologic examinations in the industrialized world. The hazards involved with dental radiography are certainly small (Sitra G, et.al. 2008, pp45-48). However, this type of radiography stands for 25% of the radiologic examinations performed in the European Union (George J, et.al. 2004, pp858–863). It means that the dose to the population as a whole is considerable Therefore some particular attention should be pay to radiation safety and dentists must keep up to date with changes in techniques and equipment and modify their own practice (Stavrianou K, et.al. 2005, PP622-927).

Significant decreases in radiation dose of dental radiography occur with the use of faster image receptors (Peterson CA, et.al.1997, PP61-70), intra-oral film holders, rectangular collimation for bitewing and periapical radiography [6], and also use of long, rectangular position indicating devices (Geist JR , 2002 PP697-702). Moreover, leaded rubber aprons and thyroid collars have been shown to minimize X-ray exposure to various parts of the body ,Implementation of quality-control programs including periodic checks of films, processing chemicals, darkroom lighting, and X-ray units, helps maintain a high level of radiographic quality and subsequently results in fewer re-exposures (Geist JR, et.al. 2002 PP496-505).

The aim of this study was to investigate the radiation protection principles observance in centers of dental Tripoli area it was six centers the objectives were to determine radiation protection principles observance.

- **Exposure and Dose Reduction**

Critical factor in discussing the effects of radiation is not the amount of radiation at a point in air (exposure) but rather than the amount of energy absorbed by a tissue at specific point (dose). So in a clinical practice we should give more importance to the dose reduction. Dose reduction can be achieved mainly in 3-steps decision-making, optimizing radiologic procedures and patient protection.

• **Decision-making**

Radiographic examination shall be performed only when indicated by patient's history and physical examination and when radiological investigation can affect the diagnosis and treatment. Decision to use diagnostic radiography rest on professional judgment, its necessity for the benefit of total health of the patient. If this decision has been made, it is then becomes the duty to produce a maximum yield of information per unit of X-ray exposure. (White, Pharoah, 2000, PP42-61).

• **Optimizing Radiologic Procedures**

In dental practice more importance should be given to optimizing radiologic procedures, as it is the best way to minimize patient and operator exposure.

• **Patient Protection**

Stabilization of patient head before the exposure decrease blurring and cone-cutting of the image. All radiation exposure must be based on the principle ALARA (as low as reasonably achievable). Figure 7, and the section on Radiation Protection shows more.

• **Dental Radiographic Machine Requirements**

A. X-ray Tube Housing DIAGNOSTIC TYPE TUBE HOUSING"

Leakage radiation does not exceed 100 m rems, or 1mSv, in any one hour at a distance of 1 meter (39.37 inches) figure .1

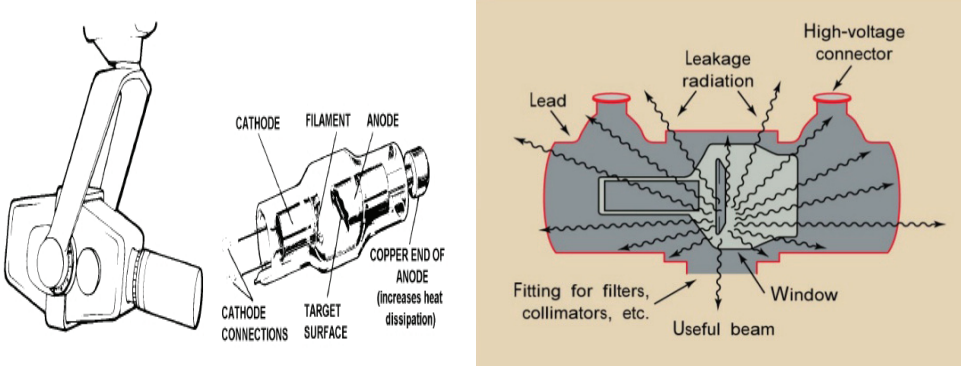

Figure .1 X-ray tube housing, after California Dental Association2014

B. Collimating Device

The X-ray beam shall be restricted to a diameter of not more than 7 cm (2.75 inches) in diameter at the surface of the skin figure .2. This size of the X-ray beam is sufficient to allow for reasonable alignment errors. It is highly desirable to add a rectangular collimator that limits the X-ray beam to a size just larger than that of the dental image receptor used. This can be

accomplished by either adding a rectangular collimator adapter to the aiming cylinder, replacing the aiming cylinder with a rectangular collimator model, or by incorporating a rectangular collimator into the film holding device.as shown figure 2

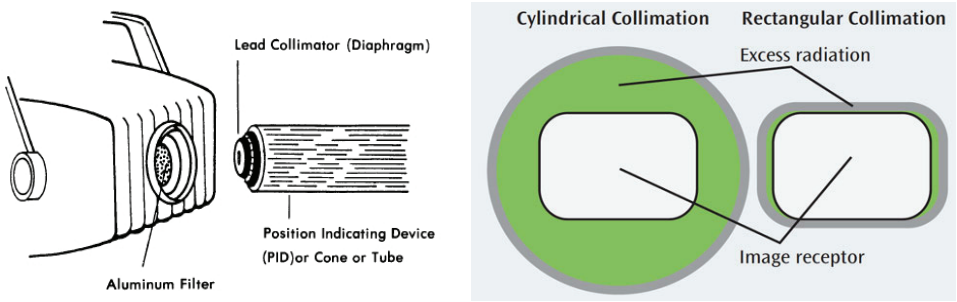

Figure 2 Collimating Device after California Dental Association2014

C. X-ray Beam Filtration

Only the X-rays with higher energies can penetrate the tissue of the patient's face and react with the image receptor area Low-energy X-rays that have no effect on image production and are absorbed by the tissues, can cause tissue damage. As shown table .1:

Tube Operating Potential (kV)	Minimum Total Filtration
Below 50	**0.5**
50 to 70	**1.5**
71 and above	**2.5**

Table .1 the regulations specify the minimum total filtration

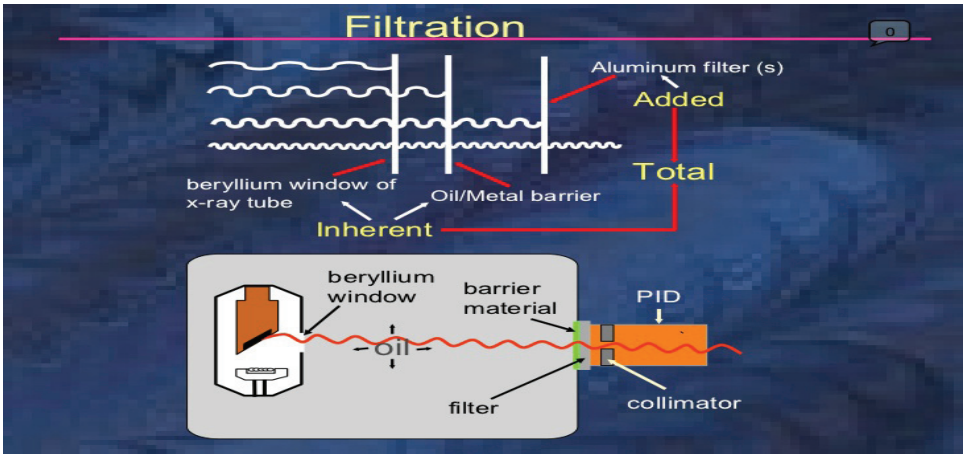

Figure .3 shown the Aluminum filter in X ray housing tube.

"Aluminum-equivalent" is defined as a substance equivalent to aluminum in its ability to absorb preferentially less penetrating radiation". (California Dental Association2014).

D. Exposure Cord

The exposure switch must be permanently fixed in a safe shielded location or the exposure cord on a remote hand switch must be long enough to permit the operator to make exposures figure .4 while positioned at least six feet from the patient. This six-foot distance must also be between 90°-135° to the direction of the primary X-ray beam.

E. Exposure Timer

The X-ray machine must have a device to terminate the exposure after a preset time or exposure figure .5. This is usually in the form of a "dead-man" type exposure switch. This type of switch requires constant pressure from the operator in order for the machine to function (www.slide sheare.com, 2017).

Figure .4 shown the Exposure Cord after www.slide sheare.com, 2017

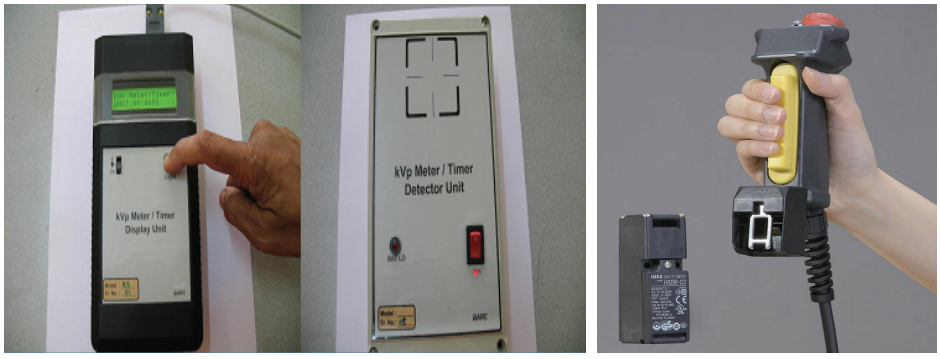

Figure .5 X-ray Tube Head and Flexible Arm Assembly after IAEA, L22

The flexible extension arm allows the X-ray tube head to be adjusted to various positions required for dental radiography. The mechanical support of the X-ray tube head and cone shall maintain the exposure position without drift or vibration as we see figure .6.

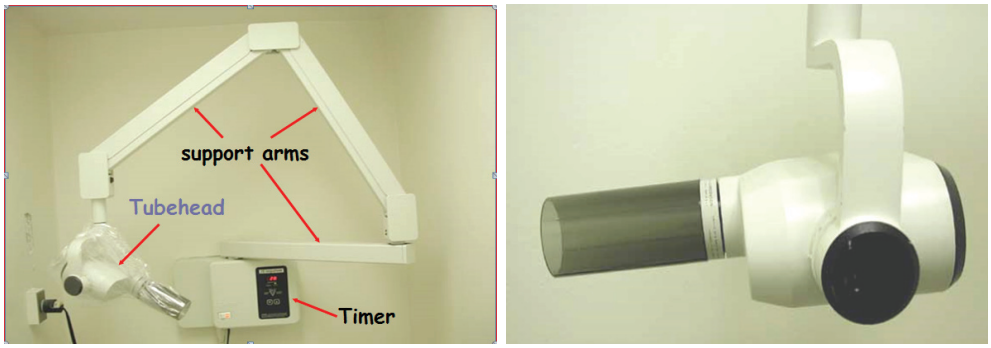

Figure .6 X-ray Tube Head and Flexible Arm Assembly after www.slide sheare. com, 2017

1.3 Radiation Protection

All individuals unnecessary to the dental radiographic examination leave the X-ray room prior to making an exposure, anyone who is in the X-ray room at the time of exposure must be behind a protective barrier or they can wear protective apron. The apron should be preferably 0.5 mm of lead or lead-equivalent but not less than 0.25 mm of lead or lead-equivalent thickness.

The reduction in exposure resulting from placing 0.25 mm lead-equivalent apron material in a primary X-ray beam of 100 kVp would only be 60% as compared to 0.50 mm lead-equivalent apron that will attenuate the beam by 85%.

Figure .7 Equipment for radiation protection to prevent exposure to radiation after www.slide sheare.com, 2017

A specially designed lead-impregnated thyroid collar can be used to protect the thyroid gland from excessive and/or unnecessary radiation during intraoral X-ray exposures as we see in Fig.7.

Shielding: Shielding implies that certain material (concrete, lead) will attenuate radiation when they are placed between source and operator. Shielding include X-ray tube shielding, room shielding, and personnel shielding. Lead-impregnated leather or vinyl aprons must be used to cover the reproductive organs of all patients who undergo dental X-ray examinations. Fig 7. (BN Praveen, et.al. 2005, PP10024-1289).

■ **Adverse Effects of Ionizing Radiation**

Adverse effects of ionising radiation can be of two types. Deterministic effects have threshold below which no damage occur and their severity increases with dose For example skin erythema, hair loss, sterility. Stochastic effects results from DNA damage, including genetic hereditary and carcinogens. (European commission radiation protection number 172, 2012).

Effective dose: Effective dose is the tissue weighted sum of the equivalent doses in all specified tissues and organs of human body and represents the stochastic health risk to the whole body which is the probability of cancer induction and genetic effects of low levels of ionising radiation.

The effective dose for common dental imaging varies widely from 1.5 micro Sieverts for intraoral radiograph to 2.4-2.7 micro Sieverts for panoramic radiograph, Effective dose for CBCT ranges from 11-1073 micro Sievert (American Dental Association Council. 2016).

• **iterature review**

- Study entitled "KNOWLEDGE, AWARENESS AND PRACTICE REGARDING RADIOGRAPHIC TECHNIQUES AND RADIATION PROTECTION AMONG GENERAL DENTAL PRACTITIONERS IN PIMPRI-CHINCHWAD" Vol. 7, Issue, 9, pp. 13310-13315, September, 2016

The aim of the study was to assess the knowledge of radiographic techniques used by different practitioners, the awareness regarding radiation hazards and radiation safety measures taken and the practice of radiation protection measures followed by the dental practitioners. Methods and methodology: A cross sectional questionnaire based study was conducted using a pre-tested and pre- validated self-administered questionnaire containing 24 items to be answered.

The questionnaire was hand-delivered to 227 dentists working as private practitioners in Pimpri- Chinchwad city, a list of which was obtained from the Indian Dental Association (IDA), Pimpri-Chinhwad branch. Out of 227 dentists registered in the IDA Pimpri- Chinchwad, 68 dentists were specialists, 9 were academicians, 17 dentists refused to participate in the study and 15 dentists did

not return the questionnaire even after 3 consecutive visits, hence were excluded from the study. 118 dentists returned the questionnaire duly answered and hence were included in the study. Results: Out of the 118 dentists who responded, 97.5% (115) dentists used intraoral radiographic machine with 72.1% (83) using a digital sensor as image receptor and only27.8% (32) dentists used films. 72.9% (86) dentists use bisecting angle technique, only 12.7% (15) use paralleling cone technique while the rest used both. 47.5% (56) dentists never use lead aprons and 81.4% (96) dentists never used thyroid shields. Conclusion: The results of the study clearly reflect that the awareness and practice of radiation protection is unsatisfactory. The knowledge regarding the radiographic equipment used is also disappointing. Hence all the dentists should attend educational programs on basic imaging and radiation protection on regular basis and practice dental radiology in an ethical manner making X-rays safer for patients and themselves. (Tugnait A. et.al. 2003, PP197-203).

- Study" Radiation protection practices and related continuing professional education in dental radiography: A survey of practitioners in the North-east of England" Volume 11, Issue 4, November 2005, Pages 255-261

The Purpose of this study is to establish the level of implementation of recommendations from the National Radiological Protection Board, relating to best radiation protection practice in dental radiography within general dental practices in the North-east of England. To survey the opinion of practitioners on the availability of related post-graduate courses in the region. This study used a A postal survey in the form of a self-reported questionnaire was mailed to all practices in the North-east of England in November 2000. The questionnaire, consisting of closed and open-ended questions, was to be completed where possible by the resident radiation protection supervisor. Two hundred and sixteen practices responded to the questionnaire, a response rate of 53%. The survey revealed variation in the standards of application of best radiation protection practice. Some 23% of practitioners had not attended any post-graduate courses on radiation protection since qualifying. Post-graduate education provision on radiation protection in the region was considered insufficient by 51% of respondents. It is concluded that a significant proportion of practices were not making full use of opportunities to reduce dose to their patients. In addition, a small number of practices had untrained staff acting as the Radiation Protection Supervisor. A significant proportion of practitioners had not been updated in radiation protection practices within a 5-year period, and this may account for the failure to implement best radiographic practice. Over half felt that there was insufficient availability of post-graduate courses in radiation protection. The regional provision of continuing professional education in this field may need development. (Davies C. et.al. 2005, PP 255-261)

■ MATERIALS AND METHODS

The cross- sectional questionnaire based study was conducted between September 2016 and February 2017 recommendations about *radiation protection* in *dental radiography*. *The radiology departments* of six dental centers of Libya- Tripoli were surveyed in this study , Questionnaires were completed by direct interview with directors of Oral and *Maxillofacial Radiology* in 6 dental, *Descriptive statistics type spss* are used in this study The questionnaire was consisted of many question's *TARGET AUDIENCE* From the onset, the target audience was defined as individuals who were identified as having the necessary training to prepare patients and take dental X rays, e.g. *dentists, orthodontists*, *dental surgery assistants*, *hygienists*, etc.

The questionnaire was collected and surveyed after the employees answered it in addition to general questions (gender, age, Qualification, name of the hospital or clinic where the questionnaire was filled by the dental department, included questions. This questionnaire contains many questions related to radiation protection were as follows:

Q-1. Are you interested in helping the researcher to get a sample for a research study?

Q-2. Sector where it is available to work within the dental field

Q-3. As a worker in the field of dental do you have information on radiation protection?

Q-4. When taking a radiation image of the patient's teeth, do you repeat the image more than once?

Q-5. As worker in dental department do you using Thermoluminescence (TLD) when you take radiation image for teeth?

Q-6. As worker in dental department do you have a background that the walls of the dental room, which includes a radiograph of the teeth are prepared with lead?

■ Result and DISCUSSION

The aim of dental radiography is to obtaining a high-quality image from oral and maxillofacial structures with the least exposure of the patient. Therefore, along with an increase in the diagnostic application of X-ray, more consideration should be given to radiation protection protocols (Kaviani F, et.al. 2007 PP49-52). Our finding, about radiation protection principles observance in intraoral radiography, has pointed out to a slightly better situation than that mentioned by other studies (Eskandarlou and Akhtari, 2003, PP47-50).

Questionnaires were completed by direct interview with all staff of Oral

and *Maxillofacial* in 6 dental centers, *Descriptive statistics type spss* are used in this study, the name of the hospital or clinic where the questionnaire was filled by the dental department table.2

Table. 2 dental department Descriptive statistics are displayed

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	first center	6	20.0	20.0	20.0
	second center	6	20.0	20.0	40.0
	third center	6	20.0	20.0	60.0
	fourth	6	20.0	20.0	80.0
	fifth	6	20.0	20.0	100.0
	Total	30	100.0	100.0	

- **Gender**

It is clear to us that the Individuals involved in the study sample were 30 individuals 12 of them (40% females) and 18 (60% male) due to the increase in the number of males more than females and the reason related to the males worker more than female in the dental clinic although the presence of women in the clinic and their consent to fill out of the questionnaire and answer For the study questions, as in table .3

Table .3 Distribution of study by gender.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	18	60.0	60.0	60.0
	female	12	40.0	40.0	100.0
	Total	30	100.0	100.0	

- **Age.**

Table .4 shown the questionnaire results for the sample of the study sample that the largest number was in the 20-30 age group and number of frequency was 20 (66.7%) while the number of the group At least age (40-30%) and number of frequency was 10 (33.3%) The age groups (50-40) are non-existent categories of clinic.

.Table .4 Division of the sample study by age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	30_20	20	66.7	66.7	66.7
	40_30	10	33.3	33.3	100.0
	Total	30	100.0	100.0	

- **Qualification.**

Table .5 shows the rise of specialists in this field ,the number of frequency was 24 (80%) while those who have training courses in this field less than 6 (20%).

Table .5 Division of study according to Qualification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	specialization	24	80.0	80.0	80.0
	Training courses	6	20.0	20.0	100.0
	Total	30	100.0	100.0	

- **Helping the researcher.**

Table .6 shows the number of dental workers in the study sample They were interested in helping the researcher to get a sample for a research study the number was 21 (70%) and the rest were Not interested in these posts and their number was 9 (30%).

Table .6 Division of study sample by scientific participation.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	21	70.0	70.0	70.0
	no	9	30.0	30.0	100.0
	Total	30	100.0	100.0	

- **Sectors of works:**

Table .7 shows that the largest number of workers in the private sector was 17 (56.7%), while in the public sector it was 7 (23.3%) and the number of workers in both sectors was 6 (20%).

.Table .7 A sample study of the distribution according to the workplace

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	public sector	7	23.3	23.3	23.3
	privet	17	56.7	56.7	80.0
	both	6	20.0	20.0	100.0
	Total	30	100.0	100.0	

• Information about radiation protection.

Table .8 shows that most dental workers had information on radiation protection with 23 (76.7%), while others had no information on radiological protection 7 (23.3%).

Table. 8 The study sample is divided according to information on radiation protection

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	23	76.7	76.7	76.7
	no	7	23.3	23.3	100.0
	Total	30	100.0	100.0	

•Patients repeat the image: _

Table .9 shows that the number of patients returning the image more than once was 19(63.3 %) while those who did not repeat the image more than once image were 7 (23.3%). Their number is 4 (10%)

Table. 9 Study sample by repeat the image

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	19	63.3	63.3	63.3
	no	7	23.3	23.3	86.7
	Sometimes	4	13.3	13.3	100.0
	Total	30	100.0	100.0	

•Using *Thermoluminescence* (TLD):_

Table .10 illustrates that the dental worker in dental department they used *Thermoluminescence* (TLD), when they were take radiation image for teeth were 8 (26.7%) while those who did not have a dosimeter of the body were 22 (73.3%).

Table .10 The study sample was divided according to the use of the dosim-(eter Thermoluminescence (TLD

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	8	26.7	26.7	26.7
	no	22	73.3	73.3	100.0
	Total	30	100.0	100.0	

•Walls of the dental room

Table 11.shows that workers in dental department have a background, that the walls of the dental room, which includes a radiograph of the teeth are prepared with lead were 24 (80%) while those who did not have a background was 6 (20%)

Table 11.distribution of dental department room are prepared with lead

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	24	80.0	80.0	80.0
	no	6	20.0	20.0	100.0
	Total	30	100.0	100.0	

• Conclusion

In conclusion the emphasize of present study is on the need for further consideration of radiation protection principles, especially on the field of quality of education a programs related to radiation protection in dental centers in Tripoli –Libya

Dentist should implement radiation protection programs in their offices and should remain informed on safety updates and the availability of new equipment, supplies and techniques that will further improve the diagnostic ability of radiographs and reduced exposure. A dentist should try to keep theirs as well as the patient's radiation exposure to the minimum as possible in order to protect from the harmful effects of radiation exposure.

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