All Sciences Proceedings

1st International Conference on Pioneer and Innovative Studies

June 5-7, 2023 : Konya, Turkey

ICPIS

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Occupational radiation exposure for dental radiation workers and diagnostic radiology workers in Albania

Irma Berdufi*, Florinda Cfarku[2] and Manjola Shyti[3]

[1]*Department of Radiation Protection and Monitoring Network/Institute of Applied Nuclear Physics, University of Tirana, Albania*
[2]*Department of Radiometry and Radiochemistry/Institute of Applied Nuclear Physics, University of Tirana, Albania*
[3]*Department of Radiometry and Radiochemistry/Institute of Applied Nuclear Physics, University of Tirana, Albania*

*(irmaberdufi@gmail.com) Email of the corresponding author

Abstract **–** The development of dental radiology in Albania has been over a century. Medical imaging is essential to dental practice. X-rays examinations help dentists to diagnose, plan treatments and monitor both treatments and lesion development. This study explored mainly the profile of dental radiation workers comparing it with the diagnostic radiology workers and their occupational radiation exposure in Albania for the period 2016 to 2020. The assessment and analysis procedures of this study were carried out at the personal dosimetry laboratory, Institute of Applied Nuclear Physics. The total number of monitored dental radiation workers increased from 39 in 2016 to 82 in 2020. The annual collective effective exposure dose fluctuated from 26.84man-Sv to 70.14man-Sv, and it showed an increasing trend. In addition, the average annual effective exposure dose of total monitored dental radiation workers varied from 0.73mSv to 0.87mSv. The total number of monitored diagnostic radiology workers increased from 196 in 2016 to 332 in 2020. The annual collective effective exposure dose fluctuated from 240.99man-Sv to 358.03man-Sv, and it has showed an increasing trend. The average annual effective exposure dose of total monitored diagnostic radiology workers varied from 1.08 mSv to 1.40 mSv. The results of the measured annual dose were well below the international recommended dose limit of 20 mSv.

Keywords – Occupational Radiation Exposure, Dental Radiation Workers, Diagnostic Radiology Workers, Annual Collective Exposure Dose, Average Annual Effective Dose

I. INTRODUCTION

Medical radiation contributes more than natural background radiation to the population dose. Medical imaging is essential to dental practice. X-rays examinations help dentists to diagnose, plan treatments and monitor both treatments and lesion development. There are more registered x-ray users in dentistry than any other profession. Dental examinations account for 21% of the total on a global scale and are the most frequent type of radiological procedure. Dentistry uses two main ionizing radiation modalities, x-rays and cone beam computed tomography (CBCT). In dentistry the doses are very low, both for the patient and occupational risks are very low, however good practice should be followed [1, 2]. There are four types of dental radiological procedure - intraoral (bitewing, periapical and occlusal) radiography, panoramic radiography, cephalometric radiography, and cone-beam CT (CBCT). Even though the individual doses are small, the collective doses cannot be ignored due to the high volume of procedures [2]. The Cone Beam Computed Tomography an advanced imaging modality proved to be a successful technique for dental and maxillofacial imaging. Radiation exposure dose from CBCT is 10 times less than from conventional CT scans during maxillofacial exposure [3]. The occupational doses are very low and negligible with good practice but unnecessary scans are not justified. Cone beam computed tomography should not be used as a routine scanning tool for general dentistry but only for complex issues [1, 2]. The development of dental radiology in Albania is

almost synchronized with the world. All related dental radiation workers are under the management of the Radiation Protection Commission and the Albanian law and regulations for radiation protection on ionizing radiation [4, 5] which are according to the IAEA recommendations [6, 7]. Therefore, only dentists and medical radiation technologists are qualified to operate dental equipment capable of producing ionizing radiation. The occupational exposure of all the registered medical radiation workers was measured for the purpose of maintaining their dose record to ensure regulatory compliance [5]. The personal dosimetry laboratory in the Institute of Applied Nuclear Physics is using the HARSHOW4500 Reader and TLD-100 cards (2 elements cards) for the occupational dose of all occupational expose workers (dentistry, medicine, industry, researcher institutions, etc.) in Albania. This study evaluates the annual collective exposure dose and the average annual effective dose of the total monitored workers in dental radiology and diagnostic radiology workers in Albania during the period 2016 – 2020, using the occupational dose recorded by the personal dosimetry laboratory.

II. Materials and Method

The personal dosimetry laboratory in the Institute of Applied Nuclear Physics is involved in providing personal dosimetry services at national level concerning the assessment of occupational exposure of medical staff and all occupational exposure workers who works with ionizing radiation sources. The medical radiation workers are divided into 5 categories, including the diagnostic radiology, dental radiation, nuclear medicine, radiotherapy, and all other applications. This study involves dental radiation and diagnostic radiology workers that are monitored for occupational exposure in Albania and analyzed the records of occupational radiation exposure for the period 2016 to 2020. The paper compared the profile of dental radiation workers, dentists, and diagnostic radiology workers from 2016 to 2020. The radiation quantities recommended by UNSCEAR [8] were used to analyze individual doses for the period 2016 - 2020.

III. Results

In this study have been monitored the medical radiation workers of two categories, dental radiation and diagnostic radiology, their gender, and two parameters of occupational radiation exposure in Albania from 2016 to 2020 are obtained and shown in the Table 1 and Table 2. Therefore, the annual collective exposure dose (man-Sv) and the average annual effective exposure dose workers is decreased year by year, and had the largest proportion of reduction, while the diagnostic radiology workers had the largest proportion of increase in the annual collective exposure dose. For the average annual effective exposure dose of the total monitored workers for the two categories of medical workers studied here, the dental radiation workers usually received a smaller average annual effective exposure dose than the diagnostic radiology workers who received a larger average annual effective exposure dose of the total monitored workers (mSv) between dental radiation workers and diagnostic radiology workers has been compared.

Annual collective effective dose (S)

The annual collective effective dose (S) was obtained according to the following equation given by UNSCEAR [8]:

$$S = \sum_{i=1}^{N} E_i \qquad (1)$$

Where E_i is the annual effective dose received by the i_{th} worker and N is the total number of the monitored workers. The parameter S, gives an estimate of the impact of particular practice on the population in given time frame.

Average annual effective dose (E)

The average annual effective dose E_{average} was obtained from the ratio $E_{average} = \frac{S}{N}$ where the meaning of symbols is the same as in Equation (1).

Table 1. Occupational radiation exposure of monitored dental radiation workers in Albania from 2016 to 2020

	Number of total monitored dental radiation workers			Parameters of radiation occupational exposure	
	Male	Female	Total	S	E
2016	29	10	39	29.02	0.74
2017	20	14	34	26.84	0.79
2018	27	19	46	33.37	0.73
2019	38	40	78	67.86	0.87
2020	40	42	82	70.14	0.86
Total increased number	11	32	43		

S - the annual collective effective exposure dose (man-Sv)

E - the average annual effective exposure dose of the total monitored workers (mSv)

The total number of monitored dental radiation workers increased from 39 in 2016 to 82 in 2020 (Table 1). The number of male dental radiation workers was higher than female dental radiation workers in 2016 and has seen a trend in increased of the number of female dental radiation workers from the period 2016 to 2020 more than the number of male diagnostic radiology workers with a ratio 4.2 for female dental radiation workers regarding the ratio almost 1.4 of male dental radiation workers. The annual collective effective exposure dose fluctuated from 26.84man-Sv to 70.14man-Sv, and it showed an increasing trend. In addition, the average annual effective exposure dose of total monitored dental radiation workers varied from 0.73mSv to 0.87mSv but well below the annual average dose limit by national regulation [5] and international organizations [9, 10].

Table 2. Occupational radiation exposure of monitored diagnostic radiology workers in Albania from 2016 to 2020

	Number of total monitored diagnostic radiology workers			Parameters of radiation occupational exposure	
	Male	Female	Total	S	E
2016	159	37	196	240.99	1.23
2017	171	38	209	291.80	1.40
2018	188	67	255	306.25	1.20
2019	218	58	276	332.40	1.20
2020	250	82	332	358.03	1.08
Total increased number	91	45	136		

S - the annual collective effective exposure dose (man-Sv)
E - the average annual effective exposure dose of the total monitored workers (mSv)

The total of monitored diagnostic radiology workers increased from 196 in 2016 to 332 in 2020 (Table 2). The number of male diagnostic radiology workers is higher than female diagnostic radiology workers and has seen a trend in increased of the number of female diagnostic radiology workers from the period 2016 to 2020 more than the number of male diagnostic radiology workers with a ratio 2.2 for female diagnostic radiology workers regarding the ratio almost 1.6 of male diagnostic radiology workers. The annual collective effective exposure dose fluctuated from 240.99man-Sv to 358.03man-Sv, and it has showed an increasing trend. In addition, the average annual effective exposure dose of total monitored diagnostic radiology workers varied from 1.08 mSv to 1.40 mSv but well below the annual average dose limit by national regulation [5] and international organizations [9, 10].

IV. DISCUSSION

The dental radiation group had the smallest number of workers than the diagnostic radiology group. For the dental radiation group, there are more female workers than male workers, and the female workers had a larger mean annual increased number than the male workers. The annual collective exposure dose of dental radiation workers is smaller than the diagnostic radiology workers. For the average annual effective exposure dose of the total monitored workers for the two categories of medical workers studied here, the dental radiation workers usually received a smaller average annual effective exposure dose than the diagnostic radiology workers who received a larger average annual effective exposure dose. Following the radiation protection concepts, exposure to all occupational exposure workers should be kept at the level as low as reasonably achievable (ALARA). Therefore, radiographic procedures must be optimized to provide dentists with acceptable diagnostic information, while minimizing radiation exposure for all dental patients and dental staff.

V. CONCLUSION

The annual collective effective exposure dose fluctuated from 26.84man-Sv to 70.14man-Sv, and the average annual effective exposure dose of total monitored dental radiation workers varied from 0.73mSv to 0.87mSv.

The annual collective effective exposure dose fluctuated from 240.99man-Sv to 358.03man-Sv, and the average annual effective exposure dose of total monitored diagnostic radiology workers varied from 1.08 mSv to 1.40 mSv.

The radiation exposure risk of dental radiation workers is much lower than that of diagnostic radiology workers.

Dental radiation work is a very safe type of medical radiation work. However, radiographic procedures must be optimized to provide dentists with acceptable diagnostic information, while

minimizing radiation exposure for all dental patients and dental staff.

Acknowledgment

I am grateful to all of those with whom I have had the pleasure to work during this paper.

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