Reference dose levels for dental periapical radiography in Chonnam Province

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ABSTRACT

Purpose : To establish reference doses of periapical radiography in Chonnam Province, Korea.
Materials and Methods : The target-skin distances were measured for dental patient's 1235 exposures including 345 mandibular molar areas. Each periapical radiation exposure was simulated with exactly the same patients exposure parameters and the simulated radiation doses were measured utilizing Mult-O-Meter (Unfors Instruments, Billadal, Sweden). The measurements were done in 44 dental clinics with 49 dental x-ray sets in Chonnam Province for one or two weeks at each dental clinic during year 2006.
Results : The third quartile patient surface doses were 2.8 mGy for overall periapical exposures and 3.2 mGy for periapical mandibular molar exposures.
Conclusion : The third quartile patient surface doses in Chonnam Province can be used as a guide to accepted clinical practice to reduce patient radiation exposure for the surveyed reference doses were below the recommended dental periapical radiography dose of 7 mGy by IAEA. (***Korean J Oral Maxillofac Radiol 2009; 39 : 195-8***)

KEY WORDS : Radiation, Gray, Dental radiography

Introduction

Potential health benefits to patients from dental x-ray exposure preclude establishment of specific and meaningful dose limits for patients.[1] However, it is recognized that exposure to such low doses of radiation in diagnostic radiology is associated with an increased risk in the long term of malignant disease in those irradiated, and there is also real, though low risk, of serious hereditary disease in their descendants.[2] Thus the specific goal of protection of the patient should be to obtain the required clinical information while avoiding unnecessary patient exposure and all x-ray machines need to meet the design specification and inspected regular bases.[1]

The patient exposure per intraoral film, measured at skin entry, has been reduced significantly since the early days of dental radiology. These reductions have been accomplished by improvements in x-ray equipment, operating procedures, and films. Continuing efforts are needed to provide further reduction of exposure per image and a method to achieve this goal is the use of a diagnostic reference level.[1] A diagnostic reference level is a patient dose-related quantity per x-ray procedure or image. And the reference dose was based on the third quartile values for the distributions of doses found in the survey, ie 75% of clinics are giving patients doses below the reference doses.

In 1996 International Atomic Energy Agency (IAEA) proposed a guidance dose level 7 mGy for dental periapical radiography.[3] The guidance dose level for the mandibular molar is are as on able indication of doses for average sized patients and can be applied with flexibility to allow higher exposures if there are a indicated by sound clinical judgment. A nationwide investigation in UK suggested reference dose of 3.9 mGy in 1999.[4] In Spain lowered reference dose of 3.5 mGy was suggested in 2001.[5] References mean doses on molar bitewing and cephalometric projects were reported as 1.6 mGy and 0.20 mGy respectively in 2003.[6] A number of states in USA have established diagnostic reference levels that are applicable for a given state.[6]

These reference doses are based on the third quartile values for the distributions of doses found in the surveys, ie 75% of hospitals are giving patients doses below the reference value.[4]

Received September 30, 2009; Revised October 23, 2009; Accepted October 30, 2009
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Table 1. Entrance surface dose distribution for intraoral radiography (mGy)

Regions (No. of exposure)	Mean dose	Lowest dose	Highest dose	75 percentile dose
Upper anterior (202)	1.5	0.17	5.8	2.1
Upper premolar (112)	2.3	0.08	9.5	3.1
Upper molar (343)	2.4	0.22	9.5	3.2
Lower anterior (125)	1.4	0.15	7.2	1.9
Lower premolar (108)	1.9	0.27	4.4	2.9
Lower molar (345)	2.2	0.23	8.5	3.2
Overall (1235)	2.0	0.08	9.5	2.8

This reference dose was not intended to be a limit. It is purely pragmatic approach to help identify the 25% of dentists most urgently in need of improved dose control below the reference dose. Equally, the reference values cannot be used as a guide to optimum performance. Further dose reduction may still be reasonably practicable.

Exceeding the reference doses requires investigation of the causes and/or suitable repair or reconditioning of the equipment, followed by a subsequent check on the efficacy of the change made.[5]

While the reference dose levels have been established in UK and Spain, but not in Korean. The purpose of this study is therefore to investigate the current level of dental periapical radiation dose in Chonnam Province and to establish dental reference dose level in Korea.

Materials and Methods

In this study, data of periapical intraoral radiographic exposure doses were collected from 44 dental clinics with 49 dental x-ray sets in Chonnam Province during 2006. A trained examiner visited each dental clinic and measured the distance between the tube end and patient's skin surface on each periapical intraoral exposure for dental examination. The exposure parameter of each periapical exposure was simulated and exposed on Mult-O-Meter (Unfors Instruments, Billdal, Sweden) for measuring skin entrance dose. The measurements were lasted for one or two weeks at each dental clinic. The dose detector was calibrated by the Swedish Radiation Protection Institute and The John Perry Radiation Metrology Laboratory and measurements were done during the warranty period. The measured doses and the permanent tooth bearing areas to be examined were recorded.

The number of total exposures were 1235 including 345 molar areas. The statistical analysis were mean, lowest, highest, 75 percentile doses for overall and for mandibular molar areas.

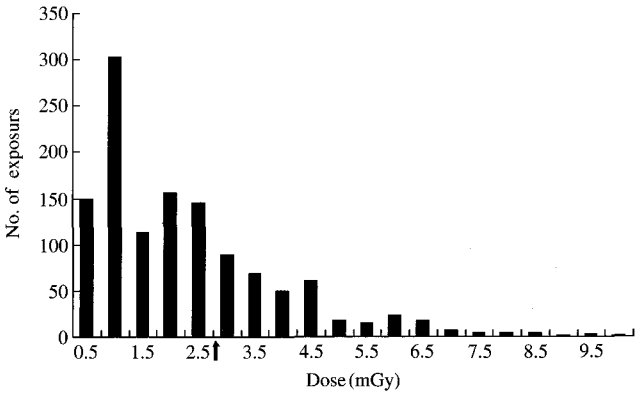

Fig. 1. Distribution of patient surface doses for overall areas: 1235 intraoral periapical radiographic exposures. Arrow indicating the third quartile dose of 2.8 mGy.

Results

The mean patient surface doses were 1.5 mGy for upper anterior, 2.3 mGy for upper premolar, 2.4 mGy for upper molar, 1.4 mGy for lower anterior, 1.9 mGy for lower premolar, and 2.2 mGy for lower molar regions. The overall mean patient surface dose was 2.0 mGy.

The lowest patient surface doses were 0.17 mGy for upper anterior, 0.08 mGy for upper premolar, 0.21 mGy for upper molar, 0.15 mGy for lower anterior, 0.26 mGy for lower premolar, and 0.23 mGy for lower molar regions. The overall lowest patient surface dose was 0.08 mGy.

The highest patient surface doses were 5.8 mGy for upper anterior, 9.5 mGy for upper premolar, 9.5 mGy for upper molar, 7.2 mGy for lower anterior, 4.5 mGy for lower premolar, and 8.6 mGy for lower molar regions. The overall highest patient surface dose was 9.5 mGy.

The third quartile patient surface doses were 2.1 mGy for upper anterior, 3.1 mGy for upper premolar, 3.3 mGy for upper molar, 2.0 mGy for lower anterior, 2.9 mGy for lower premolar, and 3.2 mGy for lower molar regions. Overall third quartile patient surface dose was 2.8 mGy (Table 1).

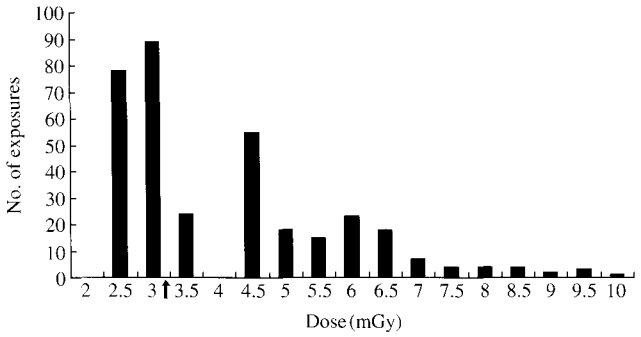

Fig. 2. Distribution of patient surface doses for mandibular molar areas: 331 intraoral periapical radiographic exposures. Arrow indicating the third quartile dose of 3.2 mGy.

The mean patient surface exposure doses of dental periapical intraoral radiography was 2.04 mGy with lowest dose of 0.08 mGy and highest dose of 9.54 mGy and The third quartile dose was 2.82 mGy (Fig. 1).

The mean patient surface exposure doses of the mandibular molar was 2.2 mGy and with lowest dose of 0.23 mGy and highest dose of 8.56 mGy and The third quartile dose was 3.17 mGy (Fig. 2).

Discussion

The purpose of reference doses is to encourage departments to investigate their patient radiation dose levels. If these doses exceed the recommended reference dose level, the departments or clinics should investigate the causative factors of the high doses[7] and improve the current techniques or justify their continued use.[8] It has also proposed that reference doses should be the result of optimization in radiation protection and should be used as an aid to keeping doses as low as reasonably achievable.[7,9,10]

The third quartile patient surface dose for an adult mandibular molar in UK surveyed during 1995-1998 and in Spain reported in 2001 were 3.9 mGy and 3.5 mGy respectively.[4,5] The third quartile dose for overall adult posterior bitewing was 2.2 mGy which was reported in USA by CRCPD.[6] The third quartile doses in this study were 2.8 mGy for overall periapical intraoral radiography and 3.2 mGy for mandibular molar area surveyed in Chonnam Province. This study results were not based on the nationwide surface exposure dose survey but on a province in Korea, the third quartile value can be used as temporary reference dose value. The third quartile patient surface doses in Chonnam are lower than the reference doses in UK and Spain. There as on of the slightly reduced doses surveyed in Chonnam compared to those reports may be resulted from more wide usage of higher speed film of Insight recently.

The reference dose does not consider the area of radiation exposure. Changing 7 cm diameter round beam into rectangular collimated beam could reduce patient radiation risk by more than 75%. Thus it is desirable to recommend the usage of rectangular tube over the round tube combined with reference dose for reducing patient's total radiation exposure.

This study measurements were done in μGy, but simplify these values with mGy by reducing significant figures for other surveys and dose level of IAEA were expressed in mGy.[3]

By the safety standards of IAEA, the guidance levels should be revised as technology and techniques improve.[3] Patient exposure per intraoral radiography, measured at skin entrance, has been reduced significantly since the early days of dental radiology. These reductions have been accomplished by improvements in x-ray equipments, operating procedures, and film speed. Nowadays many dentists are using digital detectors such as CCD, CMOS and imaging plate and it is time of transition from film-based practice to digital. Digital intraoral receptors require less radiation then speed E film and F, thus lowering the patient absorbed dose. The easy of image acquisition of digital periapical radiography without any cumbersome darkroom procedures may lead to more exposures than clinically necessary.[6] This study results and our previous surveyed results of periapial intraoral reference doses may be used for reference to reduce dental patient exposure on everyday dental practice.

Conclusion

The third quartile patient surface doses of 3.2 mGy for mandibular molar and 2.8 mGy for overall jaw areas in this study showed lower reference dose applied in Chonnam Province considering the reference doses established by IAEA of 7 mGy, UK of 3.9 mGy, and Spain f 3.5 mGy.

Those dentists who are carrying out periapical radiography using doses above these reference levels, they should undertaken a thorough review of their radiographic practice and do every effort to reduce radiation exposure and upgrade the conventional AC machine with high frequency current machine.

Further nationwide surface exposure dose survey is needed for establishing Korean dental periapical reference dose.

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