PEAK

The Image Gently in Dentistry campaign:

Promotion of responsible use of maxillofacial radiology in dentistry for children

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Promotion of responsible use of maxillofacial radiology in dentistry for children

The Image Gently in Dentistry campaign is an education and awareness initiative focusing on radiation safety in pediatric maxillofacial radiology. This effort is directed to both the dental professional community and the general public and is supported by numerous dental organizations including the American Dental Association (ADA) and the American Academy of Oral and Maxillofacial Radiology (AAOMR). The goal of this campaign is to raise awareness of the special considerations needed for pediatric dental radiology and to promote radiation safety by providing a "Six-Step Plan" of considerations to standardize clinical workflow and encourage team responsibility. Implementation of the recommendations in this plan can be an effective tool in the ongoing effort to maximize radiation safety during maxillofacial radiographic procedures on pediatric patients.

BACKGROUND

In 1999 the Institute of Medicine (IOM) released a pivotal report concluding that some patient morbidity and mortality was a result of medical errors caused by faulty systems, processes, and conditions that lead people to make mistakes or fail to prevent them.[1] IOM recommends "raising performance standards and expectations for improvements in safety through the actions of oversight organizations, professional groups, and group purchasers of health care." Standards and expectations can be achieved through regulation; however, professional societies have a responsibility to establish their own performance standards and to communicate with practitioners and their patients about safety issues.

Radiation protection is a safety issue of increasing public concern, because ionizing radiation at high doses is a recognized risk factor for leukemia and many solid tumors.

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Total radiation exposure to a member of the public includes sources of background radiation as well as artificial sources such as medical and occupational exposures. Since the 1980s, exposure of the population to ionizing radiation from medical imaging has increased tremendously such that in 2006, medical exposure constituted nearly half of the total radiation exposure of the US population from all sources.[2] Computed tomography (CT) is the major single contributor of diagnostic radiation exposure. Recent publications have raised concerns regarding the appropriate use and safety of diagnostic x-ray imaging procedures in children, including the increased use of (and wide variations in exposure from) CT in children.[3-5] In addition, emerging epidemiologic data suggest a more direct link between exposure to radiation from CT and overall or organ-specific cancer risk in children.[6-8] Radiation-associated risk to children has been a particular concern, as they are substantially more susceptible to the effects of radiation exposure for most cancers than adults, owing to their longer life expectancy and the increased radiosensitivity of some developing organs and tissues.[3,9]

RADIATION EXPOSURE FROM ORAL AND MAXILLOFACIAL RADIOLOGY

Although individual doses from radiographic procedures in dentistry are relatively low, these examinations are quite common. There were an estimated 500 million intraoral bitewing and full-mouth radiographic procedures performed in 2006 in the United States,[2] almost twice the number of conventional medical radiographic and fluoroscopic examinations combined. Furthermore, studies of various dental populations have found that there is a broad range of exposures used in dental offices.[10] The typical effective doses associated with intraoral examinations such as the bitewing (5 μSv) and full-mouth series (range, 34-388 μSv) or extraoral imaging such as panoramic radiography (range, 14-24 μSv)[5,11] are substantially lower than those typically provided by conventional head CT (median, 2000 μSv; range, 300-6000 μSv).[12] Nonetheless, recent concerns over radiation risks associated with these procedures have also been raised in dentistry,[13] particularly in association with intracranial meningioma[14,15] and thyroid cancer.[16,17] Although the validity of these epidemiologic studies has been called into serious question,[18,19] the contribution of x-ray exposure from dentistry to per capita annual dose may well be increasing, as is the case in diagnostic imaging in general, which now accounts for almost 50% (3000 μSv) of annual per capita radiation dose in the United States (6200 μSv).[2]

Perhaps the major contributing factor in the general rise of dose in dentistry has been the rapid rise in the availability and use of cone beam computed tomography (CBCT) in clinical practice.[20] The number of CBCT units[21] will likely soon surpass the number of standard CT systems in the United States, estimated to be 10 335 in 2007.[22] Although the reported range of effective doses for examinations conducted on CBCT units (20 μSv to approximately 500 μSv)[23-25] is lower than that of examinations performed using standard CT systems by a factor of 4 to 100, there should still be concern in dentistry, because some CBCT unit doses to specific organs are high and CBCT examinations are being proposed, by some, as substitutes for conventional imaging.

Despite our understanding of tissue (deterministic) and carcinogenic (stochastic) effects from radiation biology, risk models and the concept of radiation exposure risk for diagnostic imaging procedures remain, to some extent, controversial. However, greater availability of diagnostic imaging in dentistry and increasing options for acquisition settings between brands and models as well as within a particular unit imply that there are multiple opportunities to reduce patient exposure. Taking advantage of these opportunities to reduce radiation exposure is especially important for children, as the cancer risk per unit dose of ionizing radiation is generally higher for younger patients than for adults, and younger patients have a longer lifetime for the effects of radiation exposure to manifest. Also, the use of x-ray equipment settings designed for adults can result in a larger radiation dose than necessary to produce a useful image for a smaller pediatric patient.

PROMOTION OF DOSE REDUCTION IN PEDIATRIC IMAGING: IMAGE GENTLY

In 2007, the Society for Pediatric Radiology reached out to organizations representing members of the entire health care team in pediatric radiology including radiologists (American College of Radiology), radiologic technologists (American Society of Radiologic Technologists), and medical imaging physicists (American Association of Physicists in Medicine) to found the Alliance for Radiation Safety in Pediatric Imaging (www.imagegently.org). The mission of the Alliance is to improve the safety and effectiveness of the imaging care of children worldwide. This can be achieved through increased awareness, education, and advocacy for parents, patients, and medical professionals on

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the need for the appropriate examination methods and radiation dose when imaging children. Since 2007, more than 80 organizations, medical societies, agencies, and regulatory groups have joined the Alliance forces to improve patient care and change practice through an educational and awareness campaign called Image Gently. Almost all of the dental specialty organizations in the United States are members of the Alliance, including the AAOMR, the American Academy of Oral and Maxillofacial Pathology, the American Academy of Pediatric Dentistry, the American Academy of Periodontology, the American Association of Endodontists, and the American Association of Oral and Maxillofacial Surgeons. The ADA (representing organized dentistry), the American Dental Education Association, the Canadian Association of Oral and Maxillofacial Radiology, and the European Academy of DentoMaxilloFacial Radiology are also members of the Image Gently alliance. Other interested organizations are encouraged to join this campaign.

THE IMAGE GENTLY IN DENTISTRY CAMPAIGN

Image Gently provides guidance to professionals, parents, and patients in specific areas of diagnostic imaging including CT, fluoroscopy, digital radiography, interventional radiology, nuclear medicine, and ultrasonography. The newest initiative, set for public launch in September 2014 (to coincide with the annual session of the AAOMR in Orlando, FL, USA, and immediately before the annual meeting of the ADA in October in San Antonio, TX, USA), is the Image Gently in Dentistry campaign. The campaign will comprise advertising and outreach programs through professional media promoting the responsible use of dental and maxillofacial radiographic imaging for children. Six simple steps will be advocated by the campaign to improve radiation safety in pediatric imaging in dental practice. These steps, based on the concepts of justification for use and reduction of radiographic exposures as low as diagnostically acceptable (ALADA)[26] are intended to assist the dental care provider in providing diagnostically acceptable images while minimizing patient and operator exposure. We use the term *x-ray* as a synonym for *radiograph* throughout these steps because of its accepted usage in conversations with patients on dental practice.

Six-step plan to minimize radiation exposure to children in the dental office

1. Select x-rays for a patient's individual needs, not as a routine.
The need for and types of x-rays to be performed should be customized for each patient and based on individual need, such that for each exposure the benefits to diagnosis or the treatment plan (or both) outweigh the small potential risks of radiation dose. This requires professional clinical judgment based on patient presentation, including considerations of the chief complaint, medical and dental history, availability of previous x-ray examinations, and a thorough clinical intraoral examination. Appropriate image selection criteria are available to assist the practitioner in this decision-making process for common dental office imaging procedures[27] and, more recently, for CBCT.[28,29] Specific guidelines are also available for prescribing CBCT imaging in orthodontic treatment.[30]

2. Use the fastest image receptor possible.
The fastest film (E- or F-speed) or digital system available should be used for intraoral radiography to reduce exposure dose without compromising image quality. D-speed film, which requires approximately twice the exposure of F-speed film and comparable solid state and storage phosphor digital systems, should not be used. For panoramic radiography, newer digital equipment is recommended. For film-based panoramic systems, rare-earth intensifying screens, combined with a high-speed film of 400 or greater, are recommended because they reduce a patient's radiation exposure by 50% compared with calcium tungstate intensifying screens.

3. Collimate the x-ray beam to expose only the area of interest.
Restriction of the x-ray beam by the use of physical collimation limits the amount of radiation, both primary and secondary, to which the patient is exposed. Intraoral radiographic equipment should provide rectangular collimation for exposure of periapical and bitewing radiographs. Intraoral rectangular collimation is the most efficient dose-reduction technique, because it can decrease exposure by up to 5-fold as compared with circular collimation.[12] Marked dose reductions can be achieved in CBCT examinations by reducing the field of view to the region of interest.[31,32]

4. Use thyroid collars.
During dental radiographic procedures, the amount of scattered radiation striking a patient's abdomen is negligible. However, the thyroid gland, located in the anterior neck and in the vicinity of primary exposure in all dental radiographic procedures, is sensitive to radiation, particularly in children.[33] Protective thyroid collars are

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recommended for both dental intraoral and CBCT radiographic procedures, because their use reduces radiation exposure to the thyroid gland by about 50%.[34-36] Leaded aprons should include thyroid collars.

5. Child-size the exposure.
There are differences in the size and morphology of the teeth and jaws of children compared with those of adults, and less radiation is required to provide optimal image quality than would be required in an adult. Particular attention must be paid to reducing exposure times in offices using storage phosphor plates, because the wide latitude of these systems will allow visually acceptable images to be made in children even when using exposure settings more appropriate for adults. In addition, the inadvertent use of adult settings for pediatric CBCT imaging may result in an overall increase of up to 29% in effective dose[37] and an increase of 17% to over 278% in specific organ doses.[37,38]

6. Use CBCT only when necessary.
Because CBCT systems generally expose the child to greater doses than conventional imaging, CBCT exposures should be considered only when lower-dose techniques are unable to answer the clinical question that prompts imaging. If possible and appropriate in the sense of ALADA, reduced scan angles (e.g., a 180° scan) should be applied. Specific recommendations for appropriate CBCT imaging in orthodontic treatment have been published.[30]

SUMMARY

The Image Gently in Dentistry campaign to be launched in September 2014 is a specific initiative of the Alliance for Radiation Safety in Pediatric Imaging, supported by organized dentistry and dental education as well as many dental specialty organizations. The objective of the campaign is to change practice by increasing awareness of the opportunities to improve radiation protection when imaging children in dental practices. Six practical steps are provided that underline the principle that one size does not fit all, especially when it comes to using radiography during pediatric dental procedures. When we image children, let us image gently: More is often not better.

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