EDITORIAL

This far but no farther: elimination of protective radiation shielding for dental patients

Earlier this year, an article written by Mary Chris Jaklevic of *Kaiser Health News* brought to public attention the fact that hospital radiology departments are beginning to abandon the use of external shielding of the reproductive organs and fetal areas in patients during radiographic procedures.[1] This change in the longstanding practice of protecting these tissues and organs is being advocated by the American Association of Physicists in Medicine (AAPM) and has been officially endorsed by the American College of Radiology (ACR). Similar moves are being considered in Australia and Canada, according to the article, and efforts are underway in the United Kingdom to eliminate the use of patient shielding.

Interviews with medical physicists and radiologists in the United States revealed support for the change in policy, but some physicians harbor doubts. Among their concerns is the psychological effect that such a change might have not only among patients, who have come to expect the use of protective aprons, but also among health care professionals in radiology. A medical physicist was quoted as saying, "How do you approach something that is so deeply ingrained in the minds of the health care community and the minds of patients?"[1]

In its position statement of April 2019, the AAPM cited scientific reasons for eliminating the gonadal and fetal lead shield, the main reason being the current understanding that risks to the reproductive organs and to the fetus from exposure to diagnostic x-radiation are "minimal to nonexistent."[2] The International Commission on Radiologic Protection (ICRP) Publication No. 103 stated that no research involving human patients has provided direct evidence that diagnostic exposure is associated with an excess of heritable diseases in offspring.[3] With regard to birth defects in fetuses, the Guidelines of the American College of Obstetricians and Gynecologists state that radiation exposure for diagnostic purposes, even in the form of nuclear imaging techniques, almost always involves a "dose much lower than the exposure associated with fetal harm,"[4] a position endorsed by the ACR. The AAPM position statement also mentions that lead shields placed over body parts do nothing to prevent scatter radiation that occurs inside the body during radiographic exposures.

What about dental radiology? The article by Mary Chris Jaklevic states, "The movement also has yet to gain much traction among dentists, whose offices perform more than half of all X-rays... Public confusion might develop if dentists continue to shield while hospitals don't ... It's high time we bring them into the discussion." Well, let us begin the discussion now.

For decades, dentists were educated about the use of leaded rubber aprons that covered the thorax and reproductive organs during radiographic procedures. This made sense in the days when the primary x-ray beam lacked added filtration and was not collimated and the use of slow-speed film required very long exposure times. It was also based on the assumption that the major risk from radiation exposure was mutations in the gametes, leading to heritable diseases, as summarized by the National Council on Radiation Protection and Measurements (NCRP) in its most recent report on radiation protection in oral and maxillofacial imaging.[5] In contrast, dentists today use x-ray generators with added filtration and have the options of delivering a tightly collimated beam during intraoral radiography, with approximately 90% reduction in exposure time as a result of more sensitive image receptors. The NCRP report states that the dose to a fetus from a full-mouth intraoral radiographic series is between 4 and 6 orders of magnitude smaller than natural background radiation exposure over the 9 months of gestation.[6] Similarly, the absorbed dose in the gonads from full-mouth intraoral or panoramic radiography has been estimated at 5 μGy or lower, and most of this dose results from scatter radiation within the patient's body, which cannot be eliminated with external shielding.[5] The ICRP report of 2007 downgraded the nominal risk for heritable effects by 6- to 8-fold compared with their previous publication in 1990.[3]

Even the larger radiation doses and greater area of exposure with cone beam computed tomography (CBCT) deliver virtually no radiation to the gonads (approximately 1 μGy), with or without shielding.[7] The European Union guidelines for radiation protection in dentistry state, "There is no evidence for the routine use of abdominal shielding ("lead aprons") during dental CBCT examinations, in line with recommendations for conventional dental radiography."[8] The issue of stochastic effects (cancer) in the gonadal region cannot be completely discounted if the linear nonthreshold model of risk assessment is accepted.[3] However, if medical radiation exposures over large portions of the body, often near the gonads and the fetal area, are now believed by medical physicists, radiologists, and obstetricians not to increase the risk of biologic harm, there is no reason to expect dental radiographic exposure to do it.

In its latest report, the NCRP confirmed the position it took in 2003[9] by qualifying the discontinuation of the use of leaded aprons during intraoral and panoramic radiographic examinations provided, that other dose-reduction steps outlined in the report are taken.[5] These include the use of rectangular beam-limiting devices of not less than 40 cm source-image receptor distance and E- or F-speed intraoral film or digital imaging sensors for intraoral radiography, the fastest film-screen combinations or digital systems for extraoral projections, and the application of selection criteria when ordering all radiographs. The American Dental Association (ADA), in its most recent official publication on radiology, takes the same position and, in fact, cites this reference as evidence.[10] It could be argued that use of an apron is justified if any of these conditions are not met, and this is undoubtedly the situation in almost all dental practices outside of dental schools. However, the European Commission goes further, stating that there is no evidence to justify the routine use of chest aprons for dental radiography, with no qualification.[11]

The dental community should be in full agreement with the move among medical radiologists to abandon shielding of these regions. But what body parts should be protected? The NCRP states that shielding of the thyroid gland with a protective collar is necessary to meet acceptable standards of protection for all patients in procedures where the collar will not interfere with the primary beam or obscure anatomic structures critical to the examination[5]; the ADA makes the same recommendation.[10] This is a change from the previous 2003 NCRP report, which indicated that thyroid collars were necessary only for children but were to be prudently used for adults, subject to exceptions.[9] The new position is supported by the European Commission[11] and the American Thyroid Association, which believes that although there is no unequivocal evidence connecting dental radiography to increased risk of thyroid cancer, the inherent sensitivity of the gland to radiation effects warrants caution.[12] This is especially true for children, whose glands are 2 to 10 times more susceptible to radiation-induced cancer because of the rapid proliferation of the less differentiated cells, the closer proximity of the thyroid gland to the x-ray beam than in adults, and the longer life expectancy of the patients; as the NCRP puts it, "Children are not small adults."[5] It is, however, important to note that the advantages of rectangular beam limitation in reducing radiation exposure to the thyroid gland can equal those that come with the placement of leaded rubber collars.[5,10,11,13,14] Ideally, both will be used.

Thyroid collars are clearly indicated for intraoral projections,[13,14] for which radiation exposure to the thyroid gland is significantly reduced, especially for exposures in the anterior parts of the jaws.[13] It might seem difficult to place a thyroid collar in a position where it would not interfere with the beam in panoramic radiography, and the European Commission calls thyroid collars "inappropriate" for this technique.[11] But it can be done, most successfully in patients with long necks and small shoulders. In addition, collars of different sizes and compositions are available on the market. A smaller collar might be useful in panoramic exposures by covering the gland without blocking the x-ray beam.[15] Although internal scatter is as always a problem that cannot be eliminated by shielding,[15] research indicates that thyroid collars can significantly reduce the absorbed dose to the thyroid gland and total effective doses in some panoramic devices.[15,16] Similarly, cephalometric radiographs can be acquired in the presence of a thyroid collar. Although the lower cervical vertebrae will be obscured, the information for orthodontic diagnosis and treatment can be sufficient, except for measurement of skeletal maturity index.[17]

Of all radiographic modalities widely available to dentists, CBCT involves the greatest radiation doses. Exposure of the thyroid gland contributes substantially to calculations of the effective dose involved in CBCT, but it is not known how much of this results from internal scatter.[8] Use of the thyroid shield can reduce the effective dose to the gland by 40% to 50% if the collar is snugly fitted to the neck.[18] The thyroid shield may interfere with the cone beam path, especially in large field-of-view (FOV) scans; therefore, the European Commission recommends that the decision to use a collar be made on a case-by-case basis.[8] Research indicates a substantial reduction in effective dose to the gland occurs with a decreased FOV.[19] The thyroid gland, therefore, should still be shielded with collars and/or small FOV for patients of all ages.

The use of leaded eyeglasses during radiographic exposure has received some attention in recent years as a result of controversy regarding the radiation dose effect in the formation of cataracts. These opacifications of the eye lens have long been classified as a deterministic radiation effect requiring a threshold dose much larger than typically encountered in oral and maxillofacial imaging. However, in 2012, the ICRP lowered the threshold dose from 500 mSv to 20 mSv per year, averaged over a 5-year period.[20] Evidence indicates that leaded eyeglasses have the ability to reduce absorbed doses to the eye,[21,22] but doses to the unshielded eye from panoramic exposures range from 4 to 10 μGy.[23] Even with CBCT, doses to the lens in one investigation were found to be much lower than the new smaller threshold of 20 mSv (see article published in this issue).[24] Radiation-protective eyewear may warrant further investigation, but, for now, it appears to be a solution without a problem.

Nothing in this writing should suggest that protective aprons cannot be used for the psychological well-being of the patient.[5,14] Some states mandate the use of patient shielding of various anatomic regions, so dentists should consult the regulations in their respective jurisdictions to ensure compliance with policy. Barring these situations, dentists can join their medical colleagues and part company with the apron. Protection of the thyroid gland, however, is necessary. A biblical quotation from the Book of Job might summarize our approach to the elimination of patient shielding: "This far but no farther."

*James R. Geist, DDS, MS**
University of Detroit Mercy School of Dentistry,
Detroit, Michigan UNITED STATES

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Corresponding author.
geistjr@udmercy.edu, jrgeist2@att.net