Dental Updates™

200 Seminars and 30 Journals Reviewed Yearly for the Latest, Cutting Edge Information

Excerpted Article *e-mail: re777@comcast.net*

The Lead Apron Dinosaur

Why is this outdated and useless piece of equipment in dental radiology still being used?

Richard Erickson, MS, DDS

Subscriptions:

$120/yr hard copy (US & Canada only)
$99 email version (worldwide)-identical to hard copy

www.dentalupdates.com
770-973-9824
re777@comcast.net

© 2007, ~~DCI~~ *Dental Careers* ™, All Rights Reserved.
Incorporated

The Lead Apron Dinosaur:

There are a few rebels out there who say the lead apron should go the way of the cuspidor, belt-driven handpiece and foot pumped barber chair. I am one of them. I am aware of the ADA's position on recommending its use for every patient but is that really in the patient's best interest? More importantly, is there any scientific basis in the literature for this polemic "standard of care"? Perhaps in cases of pregnant women requiring a dental xray, it would be prudent from a legal standpoint only, as our litigious friends would like nothing better than to confront a dentist us in court on this issue should a birth defect occur. However, is it necessary for all other patients? Let's look at dental xrays and the lead apron from a historical perspective. It is my belief that the reason lead aprons are still used in dentistry is simply because, "That's the way we've always done it." But haven't things changed since Röntgen first xrayed his wife's hand using a crude, unshielded xray tube in the laboratory (right).

Just because "we've always done it that way", does it make scientific sense to continue to do it? Our medical colleagues routinely take chest xrays and mammograms without additional patient shielding using dosages much higher than those used in dental xrays. If there is no logical reason for using a lead apron on most patients, are we not helping to perpetuate the historical paranoia many patients have toward dental xrays? The laying of a heavy lead apron serves only to emphasize in the patient's mind the power and danger of dental xrays, a mental picture which is very real for many patients..

Before the advent of modern dental xray equipment, dental xray machines were poorly shielded and xray film was many magnitudes slower than that used today. The resultant xray exposure to the patient was significant by today's standards. The word "cone-cut" which we still use today to describe a blank part of the film from poor beam alignment, comes from the old cone shaped exit port of the xray head shown in this old Ritter unit (right). It scattered xrays in all directions, unlike the long tube collimators used in today's xray machines.

Modern collimators focus the beam so precisely that when an xray today is "cone-cut", the blank unexposed portion where no xrays have struck the film form a perfect tracing of the collimator. To repeat, the blank area of a cone-cut film, just outside the beam, has had no xrays strike it and is the same light transparent gray color of an unexposed xray. Perhaps 80 years ago a lead apron was justified by the unshielded xray machines of the day shown at right, looking like something out of the movie "Aliens".

The Health Physics Society[1] is a scientific and professional organization whose members specialize in occupational and environmental radiation safety. The Society is a nonprofit organization whose mission is to promote the practice of radiation safety. Since its formation in 1956, the Society has grown to approximately 6,000 scientists, physicians, engineers, lawyers, and other professionals representing academia, industry, government, national laboratories, the Department of Defense, and other organizations. Here's what the Health Physics Society had to say about dental xrays and lead aprons:

> ***"Use of the lead apron to protect the patient undergoing dental radiographic examination was recommended some 50 years ago, when equipment was crude. This was because x-ray beams were not restricted to the area of clinical interest, beams were not filtered, and x-ray film was slower, causing radiation exposures 10 to 100 times higher than received today. With the current technology reducing radiation exposure significantly and the beam limited only to the area of interest, there is little or no measurable difference in whole-body dose WHETHER A LEAD APRON IS USED OR NOT (emphasis mine, Ed.). The lead apron is no longer regarded as essential although some consider it a prudent practice, especially for pregnant and potentially pregnant females."***

The society also says this concerning xrays and exposure of the unborn fetus:

> ***"There is no information suggesting any risk to an unborn child from dental x rays received by the mother. When a pregnant patient undergoes a complete dental x-ray examination, the RADIATION DOSE TO THE FETUS IS INSIGNIFICANT. And, by the way, it DOES NOT MATTER WHETHER A LEAD APRON WAS USED OR NOT" (emphasis mine, Ed.),***

Please Note:

The techniques and procedures in this newsletter are intended to be suggestions only. Any licensed practitioner reviewing this material must make his or her own professional decisions concerning specific treatment or techniques. Dental Updates and Richard H. Erickson, DDS are not responsible for any damages or other liabilities (including attorney's fees) resulting, or claimed to result in whole or in part from actual or alleged problems arising out of the use of this material.

Dental Updates and Richard H. Erickson, DDS receive no compensation whatsoever from any manufacturer, or seminar group mentioned or recommended in this newsletter. No person or manufacturer may use any endorsements of products or services mentioned in this newsletter without expressed written permission from Dental Updates.

Richard H. Erickson, MS, DDS (Editor)
Dental Careers, Inc. (Publisher)
4338 Highborne Drive
Marietta, GA 30066
770-973-9824; FAX: 770-973-4638

www.dentalupdates.com

Subscribers: Your subscription ends with the vol. # listed after your name on the mailing label**.** DU is published 4 times per year,

[1] www.hps.org Health Physics Society, McLean, Virginia (703-790-1745)

Does anyone see lead aprons in the typical hospital radiographic examinations shown below?

So why are the dental profession and the ADA, so paranoid about dental xrays and as such, transferring that paranoia to our patients who constantly fret about "getting xrays". As I say to my dental assisting students, *"When was the last time you had a lead apron for a hospital chest xray, mammogram or orthopedic xray?"* Of course the answer is always *"Nada, ZIPPO, ZERO, Never!"* Do patients complain about it to the hospital technician? Again, the answer is NO even though these kinds of xrays are 20-85 TIMES the radiation dosage of a dental xray as seen by the chart below:

Event	**Dose** (mrem)
Maximum permissible occupational exposure[2]	5000/yr
	1
FMX 18 intraorals[2]	1.2
Bitewings (4)[2]	0.2
Panoramic[2]	0.8
Background radiation[2]	360/yr
Shuttle Astronauts[3]	27/day
Chest Xray[2]	17
US average natural yearly radiation[2]	120/yr
Avg yearly dose for hospital radiologists[2]	500/yr
Avg chest xray[4]	10-16
Avg. CT (CAT) scan[5]	4 to 74
Average mammogram[6]	400
Mean glandular dose for mammogram exam at 3 different hospitals[7]	150 To 4060
CT pulmonary angiography exam radiation dose to female breasts[8]	2,000
Radiation dosage to bone marrow associated with leukemia[12]	>5000
Radiation dosage associated with thyroid cancer[12]	⩾ 5000
Background radiation, 1 day[2] Or, one 4 hour airline flight Or, 1 year of TV	1

[2] http://hyperphysics.phy-astr.gsu.edu/hbase/nucene/radexp.html
[3] Badhway GD: *Radiat Meas*, 1996; 26(6):901-16
[4] www.radiologyresource.org/en/info.cfm?pg=chestrad&bhcp=1
[5] O'Daniel JC: *Am J Roentgenol*, 2005; 185(2):509-15
[6] http://www.screeningservices.org.uk/btw/screen/leeflets/radiation.asp & Chevalier M: *Med Phys*, 2004; 31(9):2471-9
[7] Khoury H: *Radiat Prot Dosimetry*, 2005; 115(1-4):337-9
[8] Parker M: *Am J Roentgenol*, 2005; 185(5):1228-33

With regard to the mammogram values in the preceding table, do you see any LEAD APRON on this patient shown here undergoing a mammogram examination? With mammogram radiation dosages of 200 to over 4000 times HIGHER than a dental exam, the medical community does not seem to be overly concerned about this amount of radiation. So why is there no uproar from not using a lead apron here? Yet dentists continue to be anal about radiation dosages of **less than one millirem**. "Hello, is anyone listening on the ADA standard of care committee??"

There are many units of measure for xray exposure, the rad (R), rem, millirem, roentgen, Gray (Gy) and sievert (Sv). While the reams of scientific research reviewed for this article contained every variety of unit measure, I have converted all into millirem units (mrem) for clarity and the sake of comparison.

Gordon Christensen[9] has noted recently that lead aprons have been done away with for dental xrays in Great Britain. Other studies from fifteen years ago[10] showed that ovarian and testicular radiation exposure did NOT differ significantly between the lead shielded and the unshielded human models. Again the question must be asked, *"So why do we continue to use it?"* The simple answer is, *"We've always done it that way."*

In response to a question from their public online forum regarding not being offered a lead apron when the patient visited both the orthopedist's office and the podiatrist's office, the Health Physics Society had this to say[11]:

> ***"All x-ray machines used for medical purposes must meet stringent Food and Drug Administration (FDA) performance standards before they can be marketed. Part of the standard requires that the x-ray beam must be collimated so that stray radiation, outside of the useful beam, is shielded by a tube housing and collimation system. The useful beam also must be limited to only irradiate the image receptor, either the film or the digital cassette"***
>
> ***"Radiation levels outside of the direct beam are very small and do not constitute a radiation hazard. Consequently, wearing a lead apron in the cases you described would provide little extra benefit. The inherent shielding of the x-ray tube housing protects much more than the lead apron would. In dental and podiatry practices, lead aprons are often used to reassure patients that they are protected but, in reality, they provide little additional shielding. Unfortunately, when they are not used, patients often incorrectly assume that they received significant radiation exposures to the rest of their body. In reality, the additional extra radiation your body received is so small that it is dwarfed by the natural radiation levels you receive each day from the sun and naturally occurring radioactive materials."***

Comprehensive Literature Review

For the purpose of this article, an extensive literature search was conducted of both medical and dental articles related to radiation dosage during routine dental and medical xray examinations encompassing CT (CAT) scans, chest xrays, full mouth surveys (FMX) and panoramic xrays. Many articles compared the shielded benefits of lead aprons worn to protect the thyroid and gonadol areas to doses to those areas when no shielding was used. When reading the following bulletized facts, keep in mind that the naturally occurring radiation exposure to the body for simply being on Planet Earth is 120-200 mrems per year and a mammogram is 400 mrems per exam.

- Uterine exposure to the fetus for a single dental (PA) xray was fount to be 0.004 mrem per xray[12]. Doses of less than 1000 mrems have been shown to produce little risk to the fetus[13].

- Dosimetry films[14] were positioned 30 inches from a panoramic machine and left for 7 months, during which time 1414 panoramic films were made. The TOTAL 7 month radiation dosage to the dosimetry films was found to be only 100 mrems.

- Five different digital panoramic machines were measured for scatter radiation at a distance of 1 meter from the machine. Following evaluation of the dosimetry devices, it was determined that a practitioner could take 500 panoramic films standing only 1 meter away and only receive 0.5 to 1.5 mrems in the thyroid area and 0.5 to 4 mrems in the gonadol area[15]. Contrast this with data showing thyroid cancer associated with radiation exposure at doses of 5000 mrems and higher [13].

- In a study[16] to determine whether a gonad shield was effective in reducing exposure during a normal CHEST XRAY, it was found that the radiation dose [from a chest

[9] Christensen G: Hinman Meeting 2006, Atlanta, Georgia
[10] Wood R: Oral Surg Oral Med Oral Pathol. 1991 May;71(5):642-6
[11] Http://www.hps.org/publicinformation/ate/q4821.html posted in October, 2005
[12] Weber J: *Dtsch Zahnarzti* 1989; 44(5):340-3
[13] Miles D: *Radiographic Imaging for Dental Auxiliaries* (3rd. Ed.); Saunders: 289
[14] Reid JA: *Oral Surg Oral Med Oral Pathol*, 1993; 75(6):780-2
[15] Gijbels F: *Dentomaxillofac Radiol*, 2005; 34(3):150-3
[16] Hashimoto M: *Nippon Hoshasen Gijutsu Gakkai Zasshi*, 2004; 60(12):1704-12

xray] to the gonads is only about 0.2 to 0.3 mrems without shielding protection. It was concluded that a radiation protective apron was NOT necessary for diagnostic chest radiography.

{ Swiss researchers[17] found that it was not possible to measure radiation doses at the unshielded gonad level for a single dental or temporomandibular radiograph, even by the most sensitive measuring device. After 50 exposures without a lead apron, the gonad radiation doses ranged from 0.003 to 0.199 mrems. (LESS THAN ONE MILLIREM)

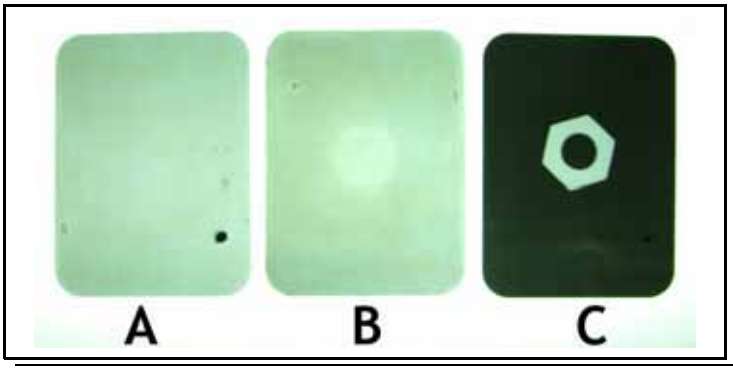
{ Radiation dose measurements[18] were performed in the gonad and ovarian areas for dental xrays (occlusal and periapical) made both with and without lead shielding. The absorbed dose in those areas did NOT DIFFER significantly from with or without lead shielding and did not differ significantly from the controls.

{ Researchers in Basel, Switzerland[19] found that lead neck protection shields and lead half aprons are of "no use to the patient to protect against unnecessary radiation" as has been shown by present measurements. Scatter radiation produced within the body of the patient creates most of the scatter radiation to the surrounding organs and this cannot be shielded by neck (thyroid) lead shields.

{ Studies on the dose of radiation[20] received in the gonadol areas during intraoral or panoramic radiography showed a negligible risk.

{ For bitewing radiography, there is no significant difference in doses to the thyroid gland with or without a lead thyroid collar shield. There was little difference for periapical radiographs. The researchers[21] concluded, "Use of thyroid collars does not seem to be a reasonable measure to [afford] radiological protection during intraoral radiography.

As most of you know, in 1987 I developed the system for dentists to teach Dental Assisting as a second income for dentists. In the early years of teaching our students dental radiography, we used to begin their training by taking periapicals on dental manikins. During one such session, as a test for scatter radiation, I performed the following experiment. Using occlusal films, I placed a metal nut on one film, took a normally exposed xray of it and developed it. It is labeled "**C**" in the previous photograph. As a control, I took second occlusal film and ran it through the developer, unexposed. It is labeled "**A**". I then took a third occlusal film, taped the metal nut to it and fastened it to the dental chair holding the xray manikin. The xray was positioned approximately at the level of a patient's diaphragm, with the metal nut and xray film facing the head of the manikin. Following this, approximately 100 periapical xrays were taken by dental assisting students on that manikin using a 70Kv Gendex machine during the course of the day. The exposed film was then developed at the end of the day and is shown in the photograph labeled "**B**". It is immediately apparent that the xray positioned about 12 inches from where 100 periapical xrays were taken looks almost like the unexposed film, **A**. While this experiment may not show the subtleties of hard vs. soft xrays using sensitive xray dosimeters, it does serve to illustrate the questionable value of the lead apron.



So one might logically ask, what's this crusade against the lead apron all about? Am I just too lazy to use one? My answer is twofold:

FEAR: When patients receive medical, hospital or mammography examinations, lead aprons are rarely, if ever used. In the dental office however, the xray exam is preceded by the placement of a heavy, ominous lead shield with the subliminal message, *"These xrays are so powerful, we have to protect the rest of your exposed body from them."* Of course, nothing could be further from the truth. Yet our patients' reluctance and fear of having dental xrays are perhaps largely based on apprehension caused by the placement of a lead apron.

CROSS CONTAMINATION: The antiquated lead apron poses a much greater threat to patients from cross contamination than any value it may render from imagined protection from stray radiation. If the lead apron is not handled using a strict, non-contaminatory protocol, it quickly becomes contaminated and continues to become more so, week after week in the dental office. Our hygienists or assistants are often rushed to complete treatment or assist with something else and the lead apron gets inadvertently picked up with saliva contaminated rubber gloves. It then becomes cross contaminated and/or re-contaminated by the next patient. I believe the practice of using a lead apron should be stopped, especially with the recent development of low dose digital xrays. Low dose digital radiography produces no measurable scatter radiation below the area of radiographic examination.

If you are continuing to use a lead apron however, a protocol to follow to avoid contamination is this:

1. BEFORE GLOVING, position the lead apron on the patient.
2. Wash and glove for intraoral xray placement. Take the necessary intraoral xrays, placing exposed film in a cup. If

[17] Affolter A: *SSO Schweiz Monatsschr Zahnheilkd*, 1979; 89(12):1221-38
[18] Wood RE: *Oral Surg Oral Med Oral Pathol*, 1991; 71(5):642-6
[19] Roth J: *Schweiz Monatsschr Zahnmed*, 2006; 116(11):1151-7
[20] Saini T: *Odontostomatol Trop*, 1990; 13(2):67-71
[21] Schmidt K: *Ned Tijdschr Tandheelkd*, 1998; 105(6):209-12

desired, the exposed film in the cup can be sprayed with Lysol for decontamination, agitating the film with your gloved fingers.

3. Set the xray cup aside and REMOVE YOUR GLOVES. Take off the lead apron and hang up in the designated location.

Lead aprons cannot be sterilized and are difficult to disinfect. Can any practitioner say with certainty if their staff rigorously adheres to the prevention of lead apron contamination at all times? In our next issue of *Dental Updates*, we will address the cross contamination possibilities by culturing samples taken from several dental office's lead apron to see just what kinds of bugs are lurking there. Stay tuned.

Dr. Dale Miles, internationally recognized expert in dental radiology, has reported[22] that the National Council on Radiation Protection and Measurements has released its latest report (No. 145) on radiation safety. One of the more interesting recommendations is that the use of lead aprons shall NOT be required if ALL other recommendations in the report are followed, among them:

- Thyroid collars should not be used on extraoral radiography (panoramic and cephalometric)
- All intraoral xray head collimators shall be rectangular, NOT circular, to minimize stray radiation.
- For film xrays, the film speed shall be "E" or faster. D film shall no longer be used. Since Kodak no longer makes E speed film, this will mean going to F-speed or using another manufacturer.
- High speed (400 or greater) rare-earth intensifying screens shall be used in extraoral films and digital systems shall employ a similar equivalent.
- For all new construction, shielding design will need to be provided by a qualified expert. Lead need not be used if proper thickness of gypsum board is used for the walls.
- Dentists MUST examine their patients BEFORE ordering or prescribing xrays.
- Rigid dark room requirements, documentation and daily developer chemistry evaluation and a quality assurance protocol manual will be required.

The last bullet in particular may be the final nudge to those who have not yet gone digital to do so. Some of the recommendations have a low impact and make sense, however some do not. It is interesting to note their recommendation to abandon the use of the lead apron. It is mentioned several places within the report that doses from dental radiography are very low, with effective doses numerically equal to the unavoidable natural background radiation received in a few hours to a few days by the average American.

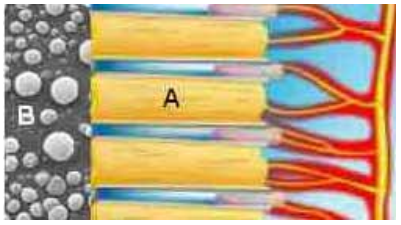
My last comment is, why is the ADA continuing to require this outdated practice of lead apron "protection" for our patients? Why has this been around for as long as it has? Our medical colleagues must chuckle over our profession's continued paranoia over dental xrays. Our patients are picking up on this paranoia as well and expressing it with their resistance to needed radiographic examinations. Isn't it about time for a change in this practice?

Bonding:

Breakthrough?

The problem with bonding agents is that they must aspire to have two very different chemical properties: hydrophilic and hydrophobic. This is why the two bottle systems have an advantage over the one-bottle systems, the primer can be hydrophilic and penetrate into the hybrid layer (etched dentin), to be followed by the hydrophobic adhesive which is then water repellent.

All one-bottle systems whether they are phosphoric acid-etch or self-etch systems suffer from the fact that they MUST be HYDROPHILIC in nature, sacrificing any hydrophobic properties, in order to penetrate the wet hybrid layer. This hydrophilic quality DOES NOT CHANGE after light curing which is why many experts say these one bottle systems will eventually breakdown from hydrolysis (water penetration) of the hybrid layer,. In fact, as we have shown in past issues of Dental Updates from Tay's research, the dentinal tubular pressure forces water droplets (B) to the surface fairly quickly through this CURED BONDED BUT HYDROPHILIC LAYER (photo right).



The wet-fingered significance of this all-in-one-bottle "leakage" through bonded dentin was made apparent in some current research which tested these products (One-Up Bond F™; Tri-S™; and FluoroBond Shake-One™) in teeth with simulated pulpal fluid pressure. If you recall, in a past issue we noted that MOST research (95%) on bond strength is done on EXTRACTED TEETH with NO real-world pulpal pressure. So how do these hydrophilic, one-bottle bonding systems perform on "real" teeth? A new study showed that the above three materials' bond strength dropped 18-36% from extracted teeth to simulated pulpal pressure teeth, i.e., real teeth. The experimental control bonding agents (Protect Bond; SE Bond) did NOT undergo a significant drop in bond strength under the same circumstances. Recall that Protect Bond and SE Bond are TWO bottle systems consisting of a hydrophilic, self-etching primer and a second hydrophobic resin bonding material.

Because these two bottle systems, whether they be total-etch or self-etch, have a final layer of hydrophobic impenetrable resin, it is the reason they are preferred by most

[22] Personal Communication; Miles D: *Dentistry Today*, 2004; search dentistrytoday.com for "NCRP Report No. 145"