

Dental X-Rays and Meningioma, "Risky Business "or Not? A response to the recent claim by Claus et al.

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Recently (2011), Claus et al, epidemiologists, reported, in the journal Cancer, a “possible” link between dental x-rays and the **benign** tumor, meningioma. Their study – based on interviewing patients about their recall of dental x-ray history – concluded that some types of dental x-rays are linked to this tumor. Calling dental x-rays an “environmental risk factor”, they found that:

“Exposure to some dental x-rays performed in the past, when radiation exposure was greater than in the current era, appears to be associated with an increased risk of intracranial meningioma”.

Before addressing some of the many problems of the study, let's examine other citations and published works looking at radiation risk.

Hall et al., in the journal Canadian Family physician (2006) looked at 250 individuals from seven clinical practice sites who had a medical history of 20 years or more. These researchers looked at whether or not there was a history of cancer in these individuals reported in the medical history. According to their study design, these researchers stated:

"All x-ray procedures, the dates they were performed, the amount of radiation exposure from each procedure based on standard charts, and whether diagnosis of any form of cancer was noted on the chart."

The mean, lifetime radiation exposure for this group was 14.94 milliesieverts (mSv). No patient had exceeded their lifetime limit of 400 mSv, although 4.4% of the group exceeded their annual limit of 20 mSv.

At least in this study, the lifetime level of radiation to which these patients were exposed by diagnostic imaging appears far below the maximum recommended level. They concluded that:

1). Some patients exceed the maximum recommended annual level, but this overexposure is generally warranted due to serious medical illness or injury, where the benefit outweighed the risk and

2). *There was no evidence of an association between these low levels of radiation and development of cancer.*

Both of these studies were based on epidemiologic evaluations. One was looking for a specific benign tumor. The other was trying to determine from verified dose data from medical examinations and history if there was any additional risk from any medical radiographic procedure-the doses of which are always significantly higher than those from dental x-rays.

How could one study looking at overall cancer risk from significantly higher medical x-ray studies find no relationship while the other which ignored any history of medical X radiation found a correlation from dental bitewing x-rays?

The study by Claus et al., used simple reporting from the patient about their recollection of dental x-rays over their lifetime. These types of studies are notorious for patient recall problems. Although the researchers took great pains to minimize this problem, it is still a problem. In addition there was no documentation - unlike the Canadian study from a medical record. The data from the second study is obviously stronger.

What are some of the problems with the "meningioma" study?

The most obvious problems are listed below:

1. small sample size
2. no verifiable medical record used
3. lack of any data about other x-ray exposures such as medical x-rays of the head, including conventional CT
4. lack of understanding of the x-ray beam direction in dental radiography
5. reliance on patient memory about their frequency, type and number of dental x-rays
6. a finding that bitewings had a higher correlation than FMXs

The Claus study was published in the journal Cancer. The epidemiologic design was obviously sound. The article made it through a peer review. The article stirred public attention and that of the media and has been cited in the lay literature in magazines such as "The Economist". **The question is "Why?"**.

The public has always had a fear of x-rays whether they are medical or dental. The news media likes to report on controversial issues that will stir public debate. However, neither the media nor the medical profession has any idea of the true x-ray dose delivered by dental x-rays. These two groups tend to lump all x-ray exposure together, when dental x-ray doses are extremely small.

Medical CT has also made news recently because of the high dose of these examinations when applied to children's medical cases. The Radiologic Society of North

America (RSNA) as well as the American College of Radiology (ACR) have launched a campaign called "Image Gently" in response to published research about the high x-ray exposure dose from conventional CT in children. The American Academy of Oral and Maxillofacial Radiology has also joined this campaign because of the adoption of cone beam CT in the dental profession.

The American Dental Association (ADA) and FDA (Food and Drug Administration) have published for many years "Selection Criteria " to minimize the patient's dose from dental x-rays. As early as 1988 these guidelines establish the need for the examination of the patient prior to ordering any dental x-ray images. With the advent of digital x-ray imaging and faster films the doses to patients are extremely low, in many cases negligible. Dentists and dental specialists practice the use of selection criteria are minimizing the x-ray dose from almost all the procedures.

How do medical and dental x-ray doses compare?

Below are tables reconstructed from published x-ray dose tables in the dental and medical literature. These show quite graphically the extremely low dose procedures practiced by dentists and dental specialists.

Table 1. Sources and effects of ionizing radiation-United Nations

Plain Film X Rays	
Single Radiographs	Effective Dose, mrem (mSv)
Skull (PA or AP) ¹	3 (0.03)
Skull (lateral) ¹	1 (0.01)
Chest (PA) ¹	2 (0.02)
Chest (lateral) ¹	4 (0.04)
Chest (PA and lateral) ⁵	6 (0.06)
Thoracic spine (AP) ¹	40 (0.4)
Thoracic spine (lateral) ¹	30 (0.3)
Lumbar spine (AP) ¹	70 (0.7)
Lumbar spine (lateral) ¹	30 (0.3)
Abdomen (AP) ¹	70 (0.7)
Abdomen ⁶	53 (0.53)
Pelvis (AP) ¹	70 (0.7)
Pelvis or hips ⁶	83 (0.83)
Bitewing dental film ⁶	0.4 (0.004)
Limbs and joints ⁶	6 (0.06)

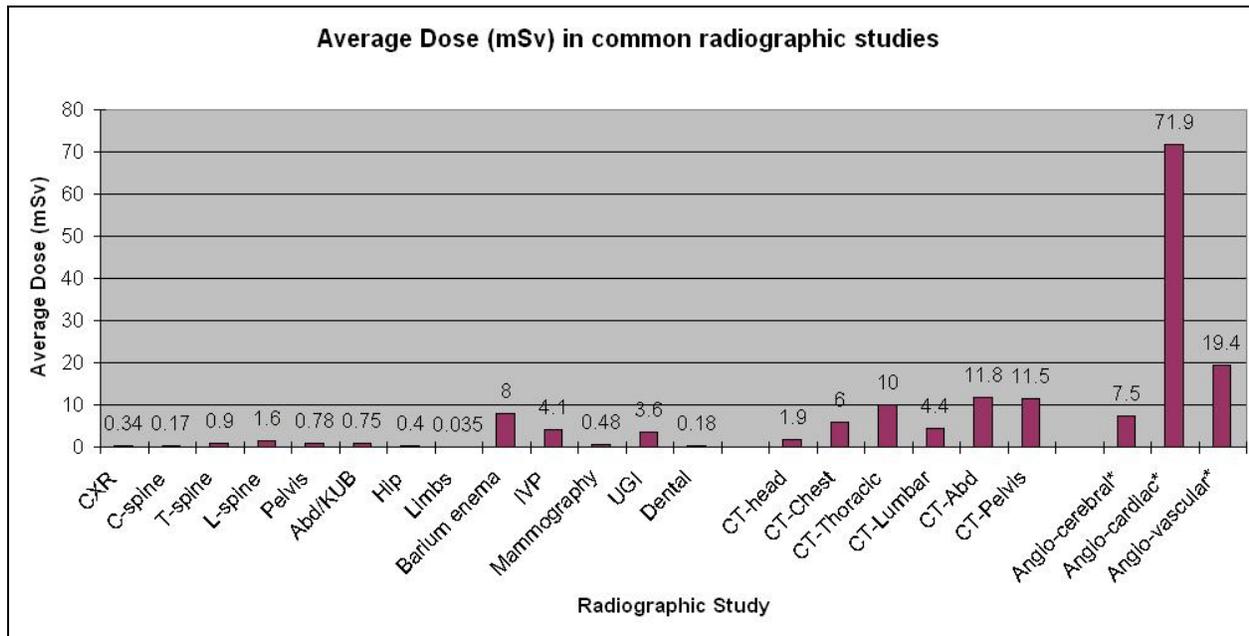
United Nations Scientific Committee on the Effects of Atomic Radiation. Sources and Effects of Ionizing Radiation, Volume 1: sources. New York, NY: United Nations publishing; 2000.

Table 2. X-ray Dose Comparisons of Procedures to Background Dose

For this procedure:	* Your approximate effective radiation dose is:	Comparable to natural background radiation for:	** Additional lifetime risk of fatal cancer from examination:
BONE:			
Radiography (X-ray)-Spine	1.5 mSv	6 months	Very Low
Radiography (X-ray)-Extremity	0.001 mSv	3 hours	Negligible
CENTRAL NERVOUS SYSTEM:			
Computed Tomography (CT)-Head	2 mSv	8 months	Very Low
Computed Tomography (CT)-Spine	6 mSv	2 years	Low
CHEST:			
Computed Tomography (CT)-Chest	7 mSv	2 years	Low
Computed Tomography (CT)-Chest Low Dose	1.5 mSv	6 months	Very Low
Radiography-Chest	0.1 mSv	10 days	Minimal
DENTAL:			
Intraoral X-ray	0.005 mSv	1 day	Negligible
HEART:			
Cardiac CT for Calcium Scoring	3 mSv	1 year	Low
WOMEN'S IMAGING:			
Bone Densitometry (DEXA)	0.001 mSv	3 hours	Negligible
Mammography	0.4 mSv	7 weeks	Very Low

Source: American College of Radiology

Table 3. - ACR Graph of "Average Dose" for Common X-ray Procedures



Source: American College of Radiology

<http://emedicine.medscape.com/article/1464228-overview>

You may wonder why, in Table 2, there is a comparison for x-ray dose and background radiation. Radiation is around us every day. We cannot escape it. We can, however, reduce our patient's exposure to x-radiation by using judiciously. In order to explain the risks of our procedures to our dental patients it might be better to equate the risks of dental x-rays to things that they do commonly every day. The table below does just that.

This table equates the risk of dying from everyday risks that are equivalent to "**One in 1 Million**". The data is derived from insurance morbidity and mortality tables where the risk is known. We take risks every day; driving a car, drinking wine, and for some smoking cigarettes. You may be surprised to know that your risk of dying from a full mouth series of dental x-rays (14-20) is about "one in 1 million". Your patient, however, will be even more surprised to see how little this risk is knowing that they will rarely have more than three or four full mouth series of dental x-rays in their lifetime. Even adding in one or two cone beam CT ready graphic examinations does little to significantly increase the risk relative to the things that we do on a daily basis.

Table 4 below can be used to explain the "safety" of dental x-rays to your patients.

Table 4. Situations in which a person has a one-in-a-million risk of dying* equivalent to an FMX

<u>Risk situation</u>	<u>Cause of fatality</u>
Being a man, age 60, for 20 minutes	Cardiovascular disease, cancer
Living in New York for 2 days	Air pollution
Living in Denver for 2 months	Cosmic radiation
Living in a stone building for 2 months	Natural radioactivity, (radon)
Drinking water in Miami for 1 year	Carcinogens
Riding in a canoe for 6 minutes	Accident
Riding a bicycle for 10 miles	Accident
Riding in a car for 300 miles	Accident
Traveling by airplane for 1,000 miles	Accident
Traveling by airplane for 6,000 miles	Cosmic radiation
Working in a typical factory for 10 days	Accident
Smoking cigarettes, 1/2 pack	Cardiovascular disease, cancer
Drinking wine, 500 cc	Cirrhosis
Drinking diet soda, 30 cans	Carcinogens

***Adapted from:**

1. Pochin, E.E., *Why be quantitative about radiation risk estimates? L.S. Taylor Lecture Series, no. 2. Washington, D.C., NCRP Publications, 1978.*
2. Wilson R., *Risks caused by low levels of pollution. Yale J Biol Med 51:37-51, 1978.*

Of course the data in the table above is from 1978. Using newer data the following table demonstrates the current estimates of "relative risk" of 1 million chances of dying from common activities.

Table 5. Updated risk estimates from common activities

Activity	Cause of Dying
smoking 1.4 cigarettes	lung cancer
spending two days in New York	air pollution
driving 40 miles in the car	accident
canoeing 6 minutes	accidental drowning
receiving 10 mrem of radiation	cancer

Adapted from: DOE (Department of Energy) radiation worker training manual, based on work by B.L.Cohen, Sc.D

Probably the simplest and most precise explanation of why the Claus study is flawed comes from conclusions of the **International Council on Radiation Protection** from their publication: ***Annals of the International Commission of Radiological Protection Vol. 37 N. 6 ICRP 105 (2007) Radiological Protection in Medicine.***

The following are three statements in the conclusions of this publication (with thanks to Dr. Roberto Molteni, a radiation physicist and friend, for sharing this with our oral and maxillofacial radiology community):

Sect. 3.2 “It is not feasible to determine on epidemiological grounds alone that there is, or is not, an increased risk of cancer for members of the public associated with absorbed doses of the order of 100 mGy or below.”

Sect. 4 “[effective Dose] should not be used to assess risks of stochastic effects in retrospective situations for exposures in identified individuals, nor should it be used in epidemiologic evaluations of human exposure, because ...”

Sect. 5.2 “provided that the medical exposure of patients have been properly justified, and the associated dose are commensurate with the medical purpose, it is not appropriate to apply dose limits or dose constraints to medical exposure of patients, because such limit constraints would often do more harm than good.”

Thus we can conclude that, with our current knowledge and data, it is impossible to separate the risk from dental x-ray procedures with their very low doses from normal, everyday background radiation with any certainty. In addition dental x-radiation of any modality is certainly at the lower end of the spectrum of x-ray dose that a patient might incur from diagnostic or investigative procedures. As long as we are prudent about the selection of the x-ray modality for the diagnostic task and determined that the positive findings expected from the study away the risk there is little need to fear any dental diagnostic x-ray procedure. In fact the harm from the diseases, disorders and problems that would be missed if the x-rays were not taken will away the risk of the diagnostic x-ray procedure itself. Dentists and dental specialty should not be restricted from ordering x-ray procedures, they simply have to understand the need for keeping the number type and frequency of these procedures to a minimum. In other words really practicing the concept of ALARA - as low as reasonably achievable. To do otherwise might be considered negligent.

Finally, I would like to share data from the Consumer and Clinical Radiation Protection Bureau of the Canadian government by their department called Health Canada.

Table 6 - Average Radiation Dose to an Unborn Child from X-ray Procedures

Radiation source	Average dose (mGy)	Radiation source	Average dose (mGy)
Dental	<0.01*	Barium meal (upper GI) (Fluoroscopy)	1.1
Chest	<0.01	Barium enema (Fluoroscopy)	6.8
Mammography	<0.05*	Head (Computed tomography)	<0.005
Pelvis	1.1	Chest (Computed Tomography)	0.06
Abdomen	1.4	Lumbar Spine (Computed Tomography)	2.4
Natural background radiation (entire pregnancy)	0.5*	Pelvis (Computed Tomography)	25

To put this in perspective and tie it in with our discussion of background radiation, the unborn fetus during term receives 0.5 mGy (units almost identical to mSv) from background radiation alone. The dose from dental x-ray is 0.01 mGy or about 50 times less than what the fetus would receive naturally. Stated another way the mother would have to receive 50 intraoral dental x-ray exposures at one time to receive the equivalent of nine months of background exposure to the fetus. Despite this incredibly low risk, dentists still restrict exposure of the mother to a dental x-ray, even for an emergency procedure, to the first third trimesters - the safest times to expose the mother. In addition, a lead apron is always used for any emergency dental x-ray procedure, usually restricted to the middle trimesters possible. So from this example you can see that dentists and fashion understand the potential risk, however low, and you take stringent precautions to keep the patient's x-ray dose to an absolute minimum.

The authors of the study linking benign meningioma to dental x-rays made no attempt to determine what additional medical, diagnostic x-ray procedures the patient experienced even while they were asking about dental bitewings. This is a significant in the study. Furthermore dental bitewings and dental periapical images, except on very rare occasions, very rarely, except for scatter radiation, irradiate the cranial cavity. The angulations during the image acquisition and use of a round, lead lined cone restricted sufficiently to eliminate virtually all of those to the brain. This represents another flaw in the study and a basic misunderstanding dental x-ray procedures.

In conclusion although the researchers have every right to conduct studies into the relative risk of all x-ray procedures, their attempt to think dental x-ray procedures with benign meningiomas is rather ill-conceived when they don't understand the actual procedures themselves and the measures taken to focus the x-ray beam to the region of interest; namely, the teeth and related bony structures. So not only is the design of the study flawed but their knowledge of the procedures insufficient to actually proceed with the study, let alone publish it in such a prestigious journal as Cancer. I am rather surprised that it actually made it through the peer review process. I would be interested to know whether or not dentists or oral and maxillofacial radiologists were even part of the review process or considered by the University's Institutional Review Board. If they had been the research would probably not have even been performed let alone published.

If Selection Criteria are used and the ALARA principle followed, dental x-rays are absolutely the safest type of x-ray procedure performed in either medicine or dentistry.

References

1. Claus, E. B., Calvocoressi, L., Bondy, M. L., Schildkraut, J. M., Wiemels, J. L. and Wrensch, M. (2012), Dental x-rays and risk of meningioma. Cancer. doi: 10.1002/cncr.26625
2. Hall JD, Godwin M, and Clarke T: Lifetime exposure to radiation from imaging investigations. Can Fam Physician. 2006 August 10; 52(8): 977.

[\(http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1781500/\)](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1781500/)