There is a need to exercise caution while going in for dental X-rays and mammograms to avoid the risk of triggering thyroid cancer. It is worth minimizing the radiation in every way possible. 

**Thyroid Cancer**

**Risk from Dental X-ray Diagnostics**

Concerns have recently been raised regarding triggering of thyroid cancer due to X-ray-based diagnostic procedures. It is being recommended that patients should insist on a leaded collar, also called a Thyroid Guard, wearing it over the thyroid to protect it from radiation.

Most people in the developing world, including India, may not even be aware that a thyroid guard exists. A Thyroid Guard is a collar that is placed around the neck, covering the thyroid gland, to assure maximum protection for the patient. It may be a separate unit or a little flap on the top of the Lead Apron that can be lifted up and wrapped around the neck. The American Dental Association recommends that a Thyroid Guard be placed for all dental X-rays to reduce exposure to radiation.

These concerns do not appear to be entirely unfounded. X-ray based diagnostics might actually be causing greater damage, than hitherto considered, to the thyroid gland and other tissues in the vicinity, including parathyroid glands and brain.

People do not bother to ask for the Thyroid Guard during X-rays, especially during dental X-rays. The Thyroid Guard should be used to protect the technologist as well as anyone that has to be in the room with the patient being X-rayed.
According to certain investigators, however, depending on the study being done and on individual anatomy, use of Thyroid Guard might interfere with the diagnosis. For example, if it blocks the upper edges of the lung tissue, a small abnormality such as a tumor in the hidden area may be missed. Similarly, if the Thyroid Guard blocks the tail end of the breast tissue near the arm pit or deep breast tissue abutting the chest wall, the mammogram may not show a small cancer.

However, the patient should be proactive in minimizing exposure to radiation by discussing these concerns with the doctor.

**UnFortunately, most doctors advise X-rays carelessly**

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**Radiation effects are cumulative, that is, we can be damaged by the combined effects of all the X-ray doses that we have ever received. The risk of radiation is greater to unborn babies, so in pregnant patients, the benefits of the investigation X-ray needs to be balanced with potential hazards to the unborn fetus. Fathers exposed to diagnostic X-rays are more likely to have infants who contract leukemia, especially if exposure is closer to conception or includes two or more X-rays of lower gastrointestinal tract or lower abdomen.**

The thyroid gland is very sensitive to radiation, especially if exposure has occurred during childhood. Exposure to radiation, nuclear fall-out and large doses of radiation therapy are significant risk factors in the development of thyroid cancer.

Unfortunately, most doctors order X-rays carelessly, and would rather convey to the patient that radiation is at such a low level that it cannot do any harm. But what we need to know is that there is no minimum level of radiation below which any individual is safe from harm. Dr. Greg Hodges, a professional health physicist, suggests use of the ALARA (As Low As Reasonably Achievable) principle for radiation safety. Dr Nigel Carter, Chief Executive of the British Dental Health Foundation, takes pride that the number of X-rays being taken in dental practice in the UK has greatly reduced in recent years and the dosages from modern equipment are extremely low.

Dental X-rays are valuable in providing information about a patient’s oral health that can not be ascertained on the basis of visual and physical examination of the mouth. X-ray therapy of the neck is associated with a high incidence of thyroid cancer.
The thyroid gland is a small butterfly-shaped endocrine gland lying in the front part of the neck across the wind pipe, about two fingers below the Adam’s apple and just above the sternum. It is made up of two halves or lobes joined together by a narrow band of thyroid tissue called isthmus and weighs less than an ounce. Four or more parathyroid glands, about the size of rice grains, are located on the surface of the thyroid gland.

**THYROID GLAND**

The thyroid gland secretes three crucial hormones. Of these, thyroxine (levothyroxine, L-thyroxine, tetraiodothyronine or T4) and triiodothyronine (liothyronine or T3) are secreted by follicular cells of the thyroid gland and regulate general body metabolism, heart beat, body temperature and many other basic functions. About 100 μg of T4 is produced daily by the thyroid gland.

Daily production of T3, the active form of the hormone, is about 30 μg, of which about 20% is produced by the thyroid gland, and the remaining by deiodination of thyroxine in extrathyroidal tissues. Iodine from food and water is essential for proper thyroid function as it is a component of both T4 and T3.

The third hormone calcitonin is secreted by parafollicular or C-cells of the thyroid gland, which along with parathormone secreted by parathyroid glands and vitamin D (cholecalciferol), produced in our skin by the action of ultraviolet rays on its precursor 7-dehydrocholesterol or received through diet or supplements. Calcitonin maintains calcium homeostasis in the extracellular fluid in our body.

The thyroid gland, like most endocrine glands, functions on a very delicate feedback mechanism to continuously provide optimal concentration of its hormones. The gland is under the control of the pituitary gland, a peanut sized gland at the base of the brain, which in turn is regulated by a neuroendocrine center in the brain called the hypothalamus. The hypothalamus produces a Releasing Hormone (TSH-RH) which tells the pituitary gland to release thyroid stimulating hormone or TSH to stimulate the thyroid gland to produce T4 and T3 hormones. With increasing levels of T4 and T3, the hypothalamus and pituitary respond by decreasing TSH-RH and TSH production by negative-feedback mechanism.

In a healthy individual, the thyroid gland produces just the right amounts of T4 and T3. Symptoms of hypothyroidism include fatigue, sluggishness, depression, difficulty in concentrating, memory problems, unexplained or excessive weight gain, dry, coarse and/or itchy skin, dry hair, hair loss, feeling cold especially in the extremities, constipation, muscle cramps, joint pain, carpal tunnel syndrome and low sex drive.

In comparison, symptoms of hyperthyroidism include palpitations, heat intolerance, nervousness, insomnia, breathlessness, increased bowel movements, light or absent menstrual periods, fatigue, trembling hands, weight loss, muscle weakness, warm moist skin, hair loss, staring gaze etc. The weight gain issue is not easy to diagnose as irregular thyroid function since some patients actually gain weight because of increase in their appetite.

Usually the symptoms of hyperthyroidism are so gradual in their onset that patients don’t realize until the symptoms have become more severe. In women, hypo- or hyper-thyroidism can cause irregular, heavy or loss of menstrual periods and may reduce chances of becoming pregnant.

There are four main types of thyroid cancer – papillary, follicular, anaplastic and medullary thyroid carcinoma. Each tumor type has its own predilection for metastatic spread.
Radiation and Thyroid Cancer Risk

With increasing use of X-rays in diagnostics, most people get exposed to radiation many times during their life. Owing to its location, the thyroid gland is highly vulnerable to scattered X-rays during X-ray based diagnostics. Apart from iodine deficiency, exposure to high-dose ionising radiation is the main established environmental cause of thyroid cancer. However, with no definite consensus on the minimum level of radiation for safety from harm or the inability to parse out the cumulative effect of radiation, the epidemiological evidence is mixed.

Dr. Daniel Kopans, Director of Breast Imaging at Massachusetts General Hospital, feels that the amount of scatter radiation that the thyroid is exposed to is equal to thirty minutes of background radiation, which is the radiation that we absorb every day from gases, minerals and sunlight around us. According to a 1995 Swedish study (Inskip et al., J Natl Cancer Inst, 87:1613-21), too, the risk of thyroid cancer due to medical diagnostic X-rays, if any, is very small.

However, there is plenty of evidence that points to the link between radiation and thyroid cancer. A first ever interview-based study led by Dr. Elizabeth B. Claus from the Department of Epidemiology and Public Health, Yale University School of Medicine, USA and Department of Neurosurgery, Brigham and Women’s Hospital, USA (published online in the journal Cancer on 10 April 2012) has shown a correlation between dental X-rays taken at a young age or on a yearly basis with increased risk of intracranial meningioma. While the vast majority of meningiomas are non-malignant, they often grow to very large size and may cause vision and hearing loss, frequent headaches, memory loss and seizures.

Meningiomas represent the most frequently diagnosed primary brain tumor in adults, accounting for 33.8% of all primary brain and central nervous system tumors reported in the United States between 2004 and 2006. According to Dr. Claus and co-investigators, the risk is similar to that of Orthopantomogram (OPG) or Dental Panoramic Radiograph (DPR), a panoramic scanning dental X-ray of upper and lower jaws that provides two-dimensional view of a half-circle from ear to ear. Individuals who had received such films at ages below 10 years had 4.9-times increased risk of developing intracranial meningioma. The investigators concluded that exposure to some dental X-rays performed in the past, when radiation exposure used to be greater than in the current era, appears to be associated with increased risk of intracranial meningioma.

The thyroid may be inadvertently exposed during high-dose radiation therapy targeted to treat other cancers, especially if the radioactive beam enters an area close to the gland such as the chest, neck and head, or from total body radiation used prior to bone marrow transplantation.

Patients should insist on a leaded collar, also called a Thyroid Guard, to be worn over the thyroid to protect it from radiation while going through X-Rays.

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Daily production of T3, the active form of the hormone, is about 30 μg, of which about 20% is produced by the thyroid gland, and remaining by deiodination of thyroxine in extrathyroidal tissues.
ALTHOUGH the most common endocrine malignancy, thyroid cancers are generally uncommon, accounting for less than a percent of all cancers and less than 0.5% of all cancer deaths. Thyroid cancer has an annual incidence of approximately 2.3 per 100,000 women and 0.9 per 100,000 men.

There are four main types of thyroid cancer – papillary, follicular, anaplastic, and medullary thyroid carcinoma. Each tumor type has its own predilection for metastatic spread. Papillary carcinoma, which occurs between second and third decades of life, is most common (70-80%), with a 3:1 female preponderance and is derived from thyroid follicular cells. It tends to spread via the lymph nodes to the lymph nodes, and is most responsive to treatment and cure.

Follicular carcinoma, which tends to occur in older patients, also comes from thyroid follicular cells and makes up 10-15% of thyroid cancers, with a 2:1 female preponderance. It is more aggressive than papillary carcinoma and may spread to lungs, liver and bones via the blood stream. Anaplastic carcinoma tends to present in patients in the sixth and seventh decades. It is uncommon, comprising of less than 10% of thyroid cancers, with a slight (1:5:1) male preponderance. Anaplastic carcinoma is extremely aggressive and spreads rapidly via local invasion, through lymph nodes and blood stream. Medullary carcinoma makes up 5-10% of all thyroid cancers, and arises from parafollicular or C-cells that produce calcitonin.

Thyroid cancer is usually seen as a palpable lump – solitary or multi-nodular – in the neck. Features that increase likelihood of malignancy include family history of cancer, particularly if parents or sibling have had thyroid cancer, previous neck irradiation, a rapidly growing nodule and swollen lymph nodes. Common symptoms of thyroid cancer include:

- Difficulty in swallowing or breathing
- Change or hoarseness of voice
- Lingering cough, unrelated to a cold
- Sore throat or pain or lump in the neck
- Swelling or fullness in the neck

An easy way to detect thyroid cancer is by performing periodic thyroid self-examina#on test that requires only a glass of water and a mirror as described below:

- Stand in front of a mirror keeping your eye on the area just below the Adam’s apple and right above the collar bone.
- Take a sip of water and #lt# your head back slightly, just enough to keep your eye focused on the thyroid area while you swallow.
- Slowly swallow the water in your mouth while keeping your fingers pressed lightly. Feel your trachea for any unusual enlargements or swelling around the area of the thyroid while you swallow.
- Size of a pea (1 cm) :Stage 1 Thyroid Cancer
- Size of a peanut (2 cm) :Stage 2 Thyroid Cancer
- Size of a walnut :Stage 3 Thyroid Cancer
- Size of a lime :Stage 4 Thyroid Cancer

• If already the size of a lime, then cancer usually has gone outside of the thyroid gland.
• Repeat the test a few #mes and report any findings to the doctor immediately.

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An increased risk of thyroid cancer has been reported in dentists, dental assistants and X-ray workers also. According to a 2010 population-based case-control study conducted by Memon and coworkers (Acta Oncologica, 49:447-453), among 313 patients with thyroid cancer and a similar number of individually matched (year of birth±3 years, gender, nationality, district of residence) control subjects in Kuwait, exposure to dental X-rays – particularly multiple exposures – was significantly associated with increased risk of thyroid cancer with a dose-response pattern.

However, in view of the comparatively higher incidence of thyroid cancer in Kuwait and the fact that these researchers relied on patients’ recollections rather than dental records, further studies in alternate settings where historical dental X-ray records may be available are warranted to support this hypothesis. To quote Dr. Memon: “Our study highlights the concern that like chest (or other upper-body) X-rays, dental X-rays should be prescribed when the patient has a specific clinical need and not as part of routine check-up or when registering with a dentist. This approach should also apply to mammograms.”
Mammograms and Thyroid Cancer
Breast cancer ranks second as the cause of cancer death in women. The prime goal of screening examinations for early breast cancer detection is to find cancers before they cause symptoms. The importance of mammography in the diagnosis of breast cancer cannot be over emphasised. Ever since mammography appeared in the mid-1980s, the rate of breast cancer has gone down by 30%.

If a Thyroid Guard interferes with mammogram image, then it is better to do a mammogram without the Thyroid Guard than to skip the mammogram altogether. An experienced mammographer should be able to figure out if the image is being compromised.

Mammograms have been the gold standard for detecting breast cancer for more than twenty years. Screening mammogram is a low dose X-ray of a woman’s breast performed on women with no breast symptoms for detecting breast cancer at an early stage. Women should have a clinical breast exam about every three years for women in their 20s and 30s, and every year for women 40 years and over and continuing for as long as a woman is in good health.

Usually two X-rays are taken of each breast, one from the side and the other from the top. The whole procedure takes about 20 minutes. To obtain a clear picture and to minimise radiation dose, the breast is positioned and compressed between two flat plates, which though uncomfortable lasts only a few seconds. Low dose radiation used in screening mammogram has not been proven to cause harmful effects. Standard mammogram is recommended for women who don’t have very dense breast tissue or are over the age fifty. On average, mammography detects 80-90% of breast cancers in women without symptoms.

Tests that could revolutionize the future of breast cancer detection and help guide therapy while avoiding getting X-radiation particularly in women under the age of fifty, include the following:

- **Magnetic Resonance Imaging (MRI):** Recent studies have shown that MRI is more sensitive than mammography in detecting tumors in women with an inherited susceptibility to breast cancer. The American Cancer Society recommends that some women – because of their family history, a genetic tendency, or certain other factors – be screened with MRI in addition to mammograms.

- **Automated Whole Breast Ultrasounds (AWBU):** According to Dr. Rachel Brem, MD, Director, Breast Imaging and Interventional Center, George Washington University Medical Center and Vice Chair, Department of Radiology, AWBUs are good for women with dense breasts. In women with dense breasts, 35% of cancers don’t show up on mammograms. In women with dense breasts, 35% of cancers don’t show up on mammograms. In a study involving 4419 women, Dr. Brem and her colleagues observed significant cancer detection improvement resulting in increase in diagnostic yield from 3.6 per 1,000 with mammography alone to 7.2 per 1,000 by adding AWBU.

- **Breast Specific Gamma Imaging (BSGI):** In a follow-up study with 160 women newly diagnosed with breast cancer, BSGI detected additional lesions missed by physical examination and mammography. Half of these cancers were very small (less than one centimeter), so it is not surprising that these cancers were not seen on the mammograms. Interestingly, 73% of these women had dense breast tissue, which made detection by mammogram difficult. According to Dr. Brem and colleagues, as additional malignancies were identified before therapy was initiated, BSGI provided information that determined important differences in therapy. Unlike mammography, which relies on breast structure to identify cancers, BSGI tracks uptake of intravenously administered radiotracer (Technetium Tc99m Sestamibi) by breast cancer cells which tend to take up tagged Sestamibi molecule much more than normal cells. A Nuclear Medicine Scanner tracks the areas where radioactive substance is concentrated, suggesting breast cancer.

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Insist on a thyroid guard when going in for dental X-rays.

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- **Digital mammography:** Digital mammography is starting to replace traditional plain film X-rays due to better resolution, ease of use and reduced amount of radiation needed and used. Digital X-rays are taken with a specialized sensor that sends the image directly to the computer, where it can be immediately viewed, stored online and compared to subsequent images. The dentist can also zoom in on specific areas of the X-ray and even create a larger image. In comparison, if the image with plain film X-ray comes out too light or too dark, it would need to be retaken.

- **Tomesynthesis:** Tomosynthesis provides three-dimensional images of breast tissue from all sides and all angles. These images are sharper and easily delineate the area of concern from the normal breast tissue.

**Better Safe Than Sorry**

While dental X-rays and mammograms may not be the only cause of thyroid cancer, it is worth minimizing the radiation in every way possible. This requires the ability to have an open conversation with your doctor and being proactive in making choices about your health.

1. Keep a record of all CT scans, PET scans, X-rays, any radiation treatment for cancer and any occupational radiation exposure.
2. The next time when your physician recommends an X-ray based diagnostic scan, ask:
   - How will having this examination improve my care? If the test’s outcome will not change the diagnosis, you should not have it done.

- Are there equally good alternatives? Some diagnostic scans such as MRI or ultrasound don’t emit radiation. If you need a CT scan and you weigh less than 180 pounds (or about 81 kg), your doctor may be able to decrease the radiation dose.
- Ask whether you can receive a digital X-ray, which uses less radiation than film X-ray.
- Can you use an older test result? Let your doctor know if you have received any imaging at another office or hospital within the past five years. He may be able to reexamine the results and spare another round of radiation.

3. Wear a Thyroid Guard and lead apron.

It is not helpful to worry about the unwanted and unprotected radiation exposure that one has already had. Focus on what you can do from here on to get good care.

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