

# Long term effects of Radiation



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## LONG TERM EFFECTS OF RADIATION TO THE EYES:

**Effects:** Depending on the treatment volume and dose required, radiation therapy may result in injury to the lens, lachrymal apparatus, retina, or optic nerve, cataracts.

**Physical findings:** Abnormal intraocular pressure, cataract, presence of tears, fundoscopic examination

**Recommendations:** Ophthalmologic examination; assess for cataracts, xerophthalmia; Slit lamp examination, fluorescein retinal angiography, electroretinogram, visual field evaluation, fitting for corrective lenses as needed.

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## LONG TERM EFFECTS OF RADIATION TO THE EARS/HEARING:

**Effects:** Tinnitus, hearing loss; failure to follow instructions, poor school performance; Decreased hearing acuity ("People don't talk loud enough") Middle and high-frequency range hearing thresholds are worse among children treated with combined therapy than among those receiving radiation therapy alone or cisplatin with no radiation

**Physical findings:** Presence of fluid or pus behind tympanic membrane; Rinne and Weber tests

**Recommendations-** Pure tone audiometry, brainstem auditory evoked

response.

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### **LONG TERM EFFECTS RADIATION TO THE TEETH:**

**Effects:** Disturbances in dentine and enamel; Root stunting, microdontia, hypodontia, taurodontia (enlarged pulp chamber), over-retention of primary teeth, osteoradionecrosis; these may not be expressed for months or years. Increased risk for infection and caries; Xerostomia (dry mouth).

**Physical findings:** Caries present, gum recession, pitting of enamel, hypoplastic teeth

**Recommendations:** Routine dental examination, panorex evaluation, fluoride applications, oral hygiene education; evaluate viability of teeth and degree of gum recession.

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### **LONG TERM EFFECTS OF RADIATION TO THE SALIVARY GLANDS:**

**Effects:** Dry mouth, bad breath, susceptibility to carries

**Physical findings:** Dry mouth, possibly caries, gum recession

**Recommendations:** Assess saliva production and, if decreased, institute early and regular dental surveillance and therapy

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### **LONG TERM EFFECTS OF RADIATION TO THE HEAD AND NECK:**

**Effects:** Maxillofacial abnormalities and maldevelopment, hormonal deficiencies (see below), cognitive disabilities, thyroid neoplasia

**Physical findings:** Changes consistent with above radiation effects

**Recommendations:** Institute early and regular surveillance and therapy as needed

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### **LONG TERM EFFECTS OF RADIATION TO BONE:**

**Effects:**

**1. Spine** ♦ decrease in vertebral height; narrowing and asymmetry of vertebral body resulting in the reduction in spinal growth; Scoliosis is a late effect, (example ♦ patient with Wilm ♦s tumor); short stature; back

pain

2. **Long bones** - hypoplasia, widening and fraying of the metaphyseal plate, sclerosis, and abnormal trabeculation. There may also be functional limitation, shortening of the extremity, osteonecrosis, increased susceptibility to fracture, and poor healing. Avascular necrosis of the femoral neck and slipped capital femoral epiphysis after pelvic radiation.

**Recommendations:** focused physical examination, appropriate orthopedic or reconstructive intervention and physical therapy as needed.

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### **LONG TERM EFFECTS OF RADIATION TO THE HEART:**

**Effects:** may vary depending on radiation dose, age and combination with cardiotoxic chemotherapy and may include: Pericarditis, pericardial effusion, myocardial fibrosis, ischemic heart disease, decreased size of left ventricular cavity secondary to restrictive left ventricular cardiomyopathy, valvular damage.

**Physical findings: may include** jugular venous distention; blood pressure; pulses paradoxus; heart rhythm and rate; murmur; pericardial friction rub; peripheral edema

**Recommendations:** focused history and physical examination and evaluation (may include echo/stress testing), therapeutic intervention as needed.

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### **LONG TERM EFFECTS OF RADIATION TO THE PERIPHERAL ARTERIES:**

**Effects:** Claudication, Premature plaque formation

**Physical findings:** Decreased or absent peripheral pulse, decreased local skin temperature, skin ulcers, hypertension, flow bruits.

**Recommendations:** Doppler ultrasound flow evaluation; additional tests, such as angiogram, depending on the clinical situation

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### **LONG TERM EFFECTS OF RADIATION TO THE LUNGS/PULMONARY SYSTEM:**

**Effects:** may damage the elastic properties of the lung volume, decreasing compliance and diffusing capacity of lung volume. May increase risk of lung malignancies.

**Physical findings:** restrictive lung disease

**Recommendations:** Pulmonary function testing at regular intervals if suspicious symptoms are elicited. Chest radiograph and counseling about increased risk of lung cancer, tobacco avoidance or cessation

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### **LONG TERM EFFECTS OF RADIATION TO THE BREAST:**

**Effects:** increased risk of subsequent breast cancer

**Recommendations:** Breast exam, mammography beginning age 25-30

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### **LONG TERM EFFECTS OF RADIATION TO THE LIVER:**

**Effects:** may cause acute or chronic damage, including chronic hepatic fibrosis. The potential to develop long term sequelae is enhanced if radiation is administered in combination with dactinomycin or doxorubicin and if juxtaposed to hepatic resection.

**Physical findings:** Spider nevi, jaundice, distention of superficial thoracic veins, hepatomegaly, splenomegaly.

**Recommendations:** liver function evaluation and focused history and physical examination.

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### **LONG TERM EFFECTS OF RADIATION TO THE GI TRACT:**

**Effects:** May result in fibrosis, stricture., obstruction, ulceration, malabsorption syndromes. Radiomimetic chemotherapy or surgery may compound toxicity

**Physical findings:** Hyperactive bowel sounds, rectal atrophy or stricture, evidence of malabsorption or weight loss.

**Recommendations:** Elicit history for late sequelae such as malabsorption , adhesive/obstructive complications; Liver function test; stool examination for occult blood, upper GI series, barium enema, compliance with American Cancer Society recommendations

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### **LONG TERM EFFECTS OF RADIATION TO THE GENITOURINARY/RENAL SYSTEM:**

**Effects:** may include renal dysfunction including renal failure; combinations with radiomimetic chemotherapeutic agents such as Actinomycin D and Adriamycin may exacerbate toxicity.s

**Recommendations:** monitor renal function and urine sediment;

additional biochemical or radiologic evaluation as needed.

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### **LONG TERM EFFECTS OF RADIATION TO THE BLADDER:**

**Effects:** may include hematuria, pyuria, dysuria, increased frequency of voiding, urinary incontinence, chronic cystitis; bladder fibrosis, contractures

**Physical findings:** Bladder distention.

**Recommendations:** Urinalysis with microscopic examination, urine for cytology (every 3-5 years, cystometric evaluation and voiding cystourethrography in patients with hematuria or urinary frequency; additional evaluation as needed

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### **LONG TERM EFFECTS OF RADIATION TO THE GONADS:**

**Effects:** both genders have increased risk for sterility and decreased sex steroid production; radiation after puberty increases risk of gonadal dysfunction

**Physical findings:** abnormal development of secondary sexual characteristics

**Recommendations:** focused history of sexual and reproductive function, physical examination for age appropriate sexual maturation, reproductive hormone measurements.

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### **LONG TERM EFFECTS OF CHEMOTHERAPY AND RADIATION TO THE MUSCULOSKELETAL SYSTEM:**

**Effects:** Decrease in bone growth associated with a decrease in muscle mass and soft tissue mass; avascular necrosis; scoliosis; cosmetic deformities; Pain in back, shoulder, or hip; impaired function of an extremity; difficulty walking or running. Increase risk of radiation-induced sarcomas.

**Physical findings:** Decreased range of motion, spine curvature, leg length discrepancy, atrophy of soft tissues, musculoskeletal asymmetry.

**Recommendations:** careful physical exam and appropriate radiologic evaluation. Referral to orthopedic specialist, physical therapist or rehabilitation as needed

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### **LONG TERM EFFECTS OF RADIATION TO THE NERVOUS**

### **SYSTEM:**

**Effects:** Progressive impairment of cognitive, motor or sensory function may occur. Radiation that includes the hypothalamic or pituitary areas frequently results in impaired pituitary function including abnormal growth and development.

**Recommendations:** surveillance of neurologic and cognitive function; evaluation of pituitary function and appropriate hormone replacement as needed.

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### **LONG TERM EFFECTS OF RADIATION TO THE ENDOCRINE SYSTEM:**

**Cancer Therapy:** Radiation involving the **Hypothalamic-Pituitary gland**

**Effects:** isolated growth hormone deficiency is the most frequent sequela; additional hypothalamic and pituitary deficiencies may occur.

**Physical findings:** Growth and pubertal delay or failure, thyroid or adrenal insufficiency, hypothalamic obesity.

**Recommendations:** careful assessment of growth and development, nutritional counseling and therapy as needed

**Cancer Therapy:** Radiation to neck, mediastinum that includes the **thyroid gland**

**Effects:** increased risk for hypothyroidism (progressively over many years); increased risk of thyroid nodules and thyroid cancer. .

**Physical findings:** signs of hypothyroidism or thyroid and neck masses.

**Recommendations:** regular surveillance of thyroid function and physical examination of the neck; additional evaluation if abnormalities are detected. The use of routine radiologic evaluation is controversial.

**Cancer Therapy:** Radiation to **Ovaries:** see above genitourinary system.

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### **LONG TERM EFFECTS OF RADIATION TO THE SKIN:**

**Effects:** Hyperpigmentation, atrophy and dermatologic malignancies

**Recommendations:** regular physical examination

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