CODEN [USA]: IAJPBB ISSN: 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES

http://doi.org/10.5281/zenodo.3549700

Available online at: http://www.iajps.com *Review Article*

# RADIATION-INDUCED DENTAL CARIES, PREVENTION AND TREATMENT - A SYSTEMATIC REVIEW

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**Abstract:**
*The treatment of head and neck cancer (HNC) involves radiotherapy. Patients undergoing radiotherapy for HNC are prone to dental complications. Radiotherapy in the head and neck area leads to xerostomia and salivary gland disorders, which greatly increase the risk of dental caries and its consequences. Radiotherapy (RT) also affects hard tooth tissue by increasing its susceptibility to demineralization after RT. Radiation caries is a rapidly developing and highly destructive type of dental caries. Radiation-related caries and other hard tissue changes can occur within the first 3 months after RT. Therefore, all efforts should be directed towards prevention to treat patients with severe caries. This can be achieved by a good preoperative dental treatment, frequent dental examination and follow-up treatment (excluding extractions) and consistent home-based care with self-applied fluoride. A reparative management of caries by radiation can be difficult. When restorative materials are selected, the dentist to be restored must take into account the altered tooth substrate and a hostile oral environment. Radiation-induced changes of the enamel and dentin may affect the adhesion of adhesive materials. As a result, it has been shown that glass ionomer cements are a better alternative to composite resins in irradiated patients. Patient consultation before and after radiotherapy can be performed to alert them to complications.Radiotherapy and therefore can help prevent it.*

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*Please cite t h i s article in press Muntaha Tariq et al.,* ***Radiation-Induced Dental Caries, Prevention And Treatment - A Systematic Review.,*** *Indo Am. J. P. Sci, 2019; 06(11).*

## INTRODUCTION:

Squamous cell carcinoma of the head and neck is the sixth most common form of cancer in the world, accounting for about 5% of cancers diagnosed each year in the United States. According to the WHO, in 2012, 8.2 million people worldwide died from cancer. 60% of annual new cases occur in Africa, Asia and Central and South America. Head and neck cancer (HNC) is often treated with radiotherapy (RT), a technique that uses ionizing radiation and semi-selectively damages the genetic material of endangered malignant cells, either directly or through the production of free radicals, which leads to death. Beech et al. In one study it was mentioned that RT also damages normal cells, especially those that divide rapidly, with the same mechanism, causing RT-induced adverse effects [2]. The oral cavity is a common site for radiation-induced side effects. Adverse effects may be due to high turnover rates of oral mucosal cells, a diverse and complex microflora, and oral tissue trauma during normal functioning.[3] Irritation-related side effects can affect oral structures both directly and indirectly, and can be acute or chronic. These side effects include mucositis, xerostomia, loss of taste, dental caries, infection, trismus and osteoradione necrosis. [4] Fattore et al. said that one of the first problems after RT is the development of abnormal tooth decay. [5] Irradiated patients are at increased risk of developing a rapid and rampant carious process called radiation caries. [6] Caries often becomes severe at the cervical and incisal edges of the teeth and, if left untreated, can rapidly lead to pulpal involvement. [5] Dentists play an important role in preventing the condition through full oral care before, during and after active cancer therapy. The purpose of this article is to examine the mechanisms underlying the development of radiation-induced caries, including their prevention and clinical management.

## MATERIALS AND METHODS:

The literature was selected by searching in electronic PubMed and MEDLINE databases for the following keywords: cancer, radiotherapy, oral complications and dental caries. The research was limited from 1939 to May 2015. Fifty-seven articles met the inclusion criteria and were included in the study. Etiological aspects of the radiation caries RT in the head and neck leads to dysfunction of the salivary glands and xerostomia, which increases the risk of dental caries and its consequences. RT also affects hard tooth tissue by increasing its susceptibility to demineralization. [7] Therefore, the problem of caries in irradiated HNC patients is caused by irradiation of the salivary glands and the teeth, which weaken the dentin-enamel bonds and cause incision fractures. Radiation-induced xerostomia Irradiation can irreversibly affect the production and quality of saliva in the large and small salivary glands. Even a low dose of 20 Gy can lead to changes in the amount of saliva and its consistency. Saliva can become thin, thick and stiff after 4-5 fractions. [4] According to Epstein et al. Total saliva production stimulated and at rest decreased by 36.67% and 47.9%, respectively, by the end of a week RT. [8th] The incidence is also related to the location of the tumor and the technique used for radiotherapy. The latest radiation therapy techniques such as Intensity Modulated Radiation Therapy (IMRT) avoid higher radiation doses for the glands and get greater functionality. [2] The recovery of saliva production and post-IMRT xerostomia levels are much better in patients with a conserved contralateral gland. Studies have shown that the volume of the gland remains unchanged (as nothing changes in a number of cells), only the excretory function is reduced or lost. [9] The patient may feel uncomfortable as the saliva lubrication is lost resulting in a sticky mucous membrane, difficulty in swallowing (dysphagia) and food sticking to the teeth. Individuals also complain of the burning sensation when eating spicy foods. This leads to a reduction in food intake and weight loss. The dry mucous membrane is also more susceptible to bleeding, resulting in bleeding gums. [10]

Radiation therapy also causes a change in the salivary composition, an increase in viscosity, a reduction in buffering capacity, changes in salivary electrolyte concentrations, and a change in the immune system responsible for the immunity. According to Kielbassa et al. On average, the pH after irradiation drops from 7 • 0 to 5 • 0, which is cariogenic. As the pH and buffering capacity of the saliva are low, melting and dentin minerals dissolve easily. Therefore, the process of remineralization of hard tooth substance in the oral environment of patients with HNC does not occur after the radiation therapy has undergone demineralization. As a result, the ability to remineralise saliva is compromised. [11] Accompanied by decreased oral clearance, these effects cause enormous changes in the oral flora in patients treated with radiotherapy, with an increase in acidogenic and cariogenic microorganisms (Streptococcus mutans, Lactobacillus and Candida). [8,12] These changes occur from the beginning of radiotherapy until 3 months after completion, and then remain more or less constant. Undoubtedly, the shift of oral microflora towards cariogenic bacteria, reduced salivary flow (oral clearance), and altered salivary composition (buffer capacity, pH, immunoproteins, and oral clearance) clearly result in a tremendous increase in caries risk with an increased risk of periodontal disease , [11]

**Direct effect on hard tissue**

Springer et al. a study concluded that radiation has a direct destructive effect on dental hard tissue, especially on the dentin-enamel compound (dej). [13] In addition to the destruction at the DEJ, there are significant differences in the demineralized nature of the irradiated tooth enamel, suggesting that enamel is less resistant to acid attack after irradiation. [13] If the teeth are in the area of radiation, hypovascularization will reduce blood flow to the pulp tissue. [13] The influence of radiation on the vascular flow in the direction of the entire dentition also plays a role in this multi-faceted cycle of caries production [14].In the study by Springer et al. A significant increase in crosslinking of hydroxy-dialidiridinoline collagen and lysyl pyridinoline in irradiated dialysate and ultrafiltered irradiated pulp tissue probes compared to unirradiated teeth showed a significant increase in the amount of collagen fragments from direct destruction X-ray. [13] It has been suggested that the radiogenic destruction of collagen in the dental pulp may contribute to secondary fibrosis and diminished vascularization, thereby affecting odontoblastic metabolism. The degeneration of the odontoblast processes, which led to the destruction of the dentinal tubules, was found to be due to direct damage to the radiogenic cells with impaired vascularization and metabolism, especially in the area of the termination of odontoblastic processes. [15] A metabolic deficit in combination with a latent parenchymal damage finally led to functional symptoms such as caries in the subsurface. [15] Caries in the subsoil is the major factor in the atypical and relatively rapid progression of radiation caries, which can not be explained by hyposalivation alone. [16]

Near DEJ an increase in enamel and dentin stiffness was observed. It is believed that the increased rigidity is due to a radiation-induced decrease in protein content, with the melting points much more reduced than that of dentin. These changes in mechanical properties and chemical composition may contribute to the biomechanical failure of the DEJ and delamination of the enamel that occurs after radiation therapy. [17] It has been observed that minimal tooth damage occurs below 30 Gy. There was a 2-3 times higher risk of tooth fractures between 30 Gy and 60 Gy, probably due to the effect of the salivary glands. and a 10-fold higher risk of tooth damage if the dose at the level of the tooth is greater than 60 Gy, indicating radiation-induced damage to the tooth as well as damage to the salivary glands. These results suggest a direct effect of radiation on the tooth structure with increasing radiation dose to the tooth. [18] Geariogenic damage is therefore the result of a reduction.Salivation and possible direct radiogenic damage.

**Clinical Picture**

Clinically, radiation caries begins at the labial surface of the cervical areas of the teeth, and caries affects the smooth surfaces, including lower anteriors, which are unexpected because these areas are most resistant to decay in unirradiated populations. [19,20] This effect is presumably due to the mechanical cleaning of these surfaces from the continuous flow of saliva, which is strongly prevented by radiation-induced hyposalivation. The lesions spread and surround the cervical areas of the tooth, suggesting that this area is particularly prone to tooth decay. Subsequently, changes in translucency and color (brown-black discoloration of all dental crowns) may occur, which lead to greater brittleness and rupture (accompanied by wear of the cutting and occlusal surfaces) of the tooth and can be complete seen amputation of the crown.

Clinically, three different patterns were identified.

• Type 1 - Most common model. It affects the cervical aspect of the teeth [Figure 1] and extends to the cement junction. The decay on the circumference develops and it often comes to a crown amputation

• Type 2: Appears as demineralization area on all tooth surfaces. Generalized erosions and worn occlusal and incisal surfaces are observed [Figure 2].

• Type 3: less common model. See how the color in the dentin changes. The crown turns dark brown-black and there are occlusal and incisive signs of wear [Figure 3]. [22-25]

So far no microscopic differences between carious initial radiation lesions and healthy incipient lesions have been found. This similarity is true for both histological features and enamel [26,27] and for dentin [28] and for initial clinical demineralization [29,30] and remineralization reactions. [31]

**Management of radIatIon carries**

Radiation caries management includes the management of xerostomia and radiation-induced caries. Preventive measures before radiotherapy Before the start of radiotherapy, a complete dental examination (clinical examination and radiographs of the entire mouth), diagnosis and treatment is to be performed. A complete examination of the mucosa, dentition and periodontium should be performed. The vitality of the teeth should be evaluated. Restoration of the carious lesion, endodontic therapy and repositioning of the restorations must be performed prior to radiotherapy to prevent future complications. Teeth with severe lung or periodontitis should be extracted in the pre-irradiation phase to reduce the risk of osteoradiation necrosis. Thorough dental prophylaxis should be performed. [32] The patient

must be given preventive home care instructions, strict oral hygiene (including interdental techniques such as flossing), daily self-administration of topical fluoride, limited intake of cariogenic foods and remineralization solutions of mouthwashes or .

artificial saliva preparations. We recommend daily topical application of 1.0% sodium fluoride gel with customized fluoride carriers to reduce tooth decay. [33,34]

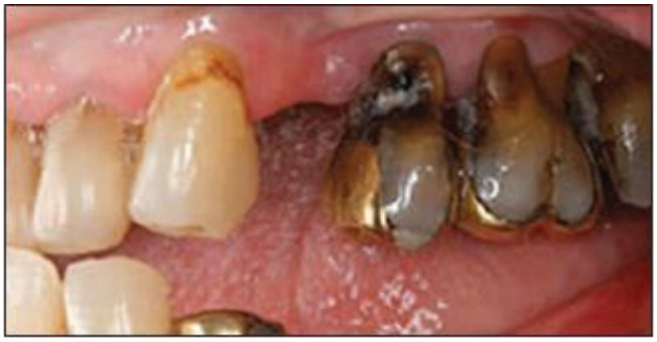

**Figure 1:** Type 1 are lesions affecting the cervical aspect of the teeth and extending along the cementoenamel junction

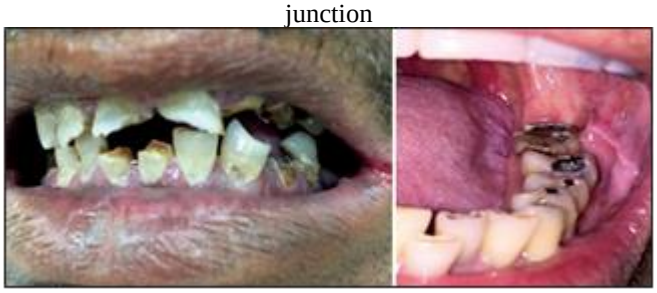

**Figure 2:** (a) Type 2 presents with demineralized and worn occlusal surfaces. (b) Type 2 presents with demineralized and worn occlusal surfaces

**Figure 3:** Type 3 lesions present as color changes in the dentin. The crown is dark brown-black, along with occlusal wear

In addition to fluorides, other alternatives have been explored. In a clinical study, the preventive efficacy of caries was compared to a mouth rinse solution containing casein derivatives in combination with calcium phosphate (CD-CP) with a 0.05% sodium fluoride mouthwash. It has been found that CD-CP preparations are promising as a means of preventing tooth decay for persons with dry mouth. Similarly, the efficacy of remineralization of toothpastes (which also provide calcium sulfate and phosphate ions) has recently been investigated and it is concluded that they could prevent root caries in irradiated patients. [36,37]

**Prevention of xerostomia** The salivary gland RT, cytoprotective agents, cholinergic muscarinic agonist (pilocarpine, cevimeline), and submandibular gland surgical transfer as per the American Society of Clinical Oncology's quality of life management guidelines and recommendations were presented by Brennan et al. (Oral Care Study Group 2010). [38]

**Saliva-sparing radiation technology** Salivary production has been shown to increase overtime in patients receiving parotid-sparing IMRT rather than conventional radiotherapy, as IMRT limits

radiation exposure to healthy structures in the vicinity of radiation targets. [39]

**Cytoprotective drugs** Radiation protection can be achieved through the use of some medications (amifostine [WR-2721, EthyolR]), which accumulate in the tissue of the salivary glands and make it less sensitive to radiation damage. The drug enters the bloodstream where it is rapidly hydrolyzed by endothelial alkaline phosphatase and converted to its active form WR - 1065. The drug then enters the cells and nuclei and acts as a radical scavenger against free radicals and prevents radiation damage to the DNA. [40] In a clinical study, it was found that the incidence of acute grade 2 xerostomia dropped significantly from 78% to 51% after oral administration of 200 mg / m2 and from 34% to 34% in chronic xerostomia one day before each fraction , [41] Administration of amifostine causes mild to severe side effects such as nausea, (generally mild) vomiting and transient hypotension. Some other related issues are the cost of therapy and logistical issues, as the drug must be administered just prior to each RT session.

**Transmission of the submandibular** gland The usual treatment portals of HNC provide the main salivary glands with 60-65 Gy. However, the submental region receives only radiation corresponding to 5% of the total dose. In the early 1980s, surgical techniques were introduced to protect the salivary glands from head and neck radiation therapy. [42] The procedure involves transferring a single submandibular salivary gland into the submental space while being treated at the facial artery, facial vein, and submandibular ganglion. [43] It can only be done in patients with clinically negative cervical lymph nodes using the gland on the contralateral side of the primary tumor and is therefore not suitable for all patients.

**Management during and after radiotherapy** Good oral hygiene must be guaranteed throughout the duration of treatment. Includes the daily 2-4-time brushing with a toothbrush with soft bristles and floss. In order to control plaque formation, chlorhexidine mouth rinses should be continued simultaneously with and after the normal daily toothbrush. Fluoride prophylaxis must be maintained with tailor-made carriers and highly concentrated fluorides (5000 ppm). [11] Salivary substitutes can be used to relieve symptoms and syphic agents to stimulate saliva. [44] Dialogues: In patients who received pilocarpine (greater than 2.5 mg 3 times daily) for 8-12 weeks, total salivary flow rates increased significantly without stimulation at 3 and 6 months, [45] although this was not the case were significant differences in xerostomia. [46] One study found that the efficacy of oral pilocarpine depends on the dose distributed to the gland. [47] Contraindications are asthma, iritis and glaucoma. Caution is advised in patients with chronic obstructive pulmonary disease and cardiovascular disease. A new muscarinic agonist, cevimeline, when given 30-45 mg three times a day for 52 weeks, increased the non-stimulated but not stimulated saliva levels to a very low degree. [48] Lemon drops can be aspirated to increase the amount of total salivary secretion, thus improving the dry mouth. Sugar-free gums containing xylitol can stimulate salivation, buffering and sugar clearance and prevent dental caries. [49] Oral mucosal / saliva replacement products are the treatment of choice for patients who do not respond to gustatory or pharmacological stimulation with chewing. Saliva substitutes are based on various substances, including animal mucin, carboxymethyl cellulose, xanthan gum and aloe vera. Anyone can alleviate xerostomia, but a common drawback is generally the short duration of relief. The most well-described method for relieving xerostomia is manual acupuncture using ear points, which in some cases are integrated into electrostimulation

It is administered twice a week for 6 weeks, greatly improving xerostomia problems and increasing overall non-stimulated salivary flow rates. [50] Stem cell replacement therapy may be a good option for the treatment of radiotherapy-induced hyposalivation, but a better understanding of the mechanism is needed [51]. After completion of radiotherapy, frequent follow-up appointments for patients must be scheduled. The reduction and planning of the roots takes place with sufficient antibiotic coverage, if the patient does not comply with the correct oral hygiene. The carious lesions are restored immediately. Tooth extraction after irradiation should be avoided if possible. As a result, endodontic therapy should in many cases be the treatment of choice [52] and has been shown to be a valid alternative to exodontia, minimizing traumatic injury and thereby reducing the risk of osteoradione necrosis. [53,54] Unfortunately, it is not always possible to prevent the development of radiation decay. Radiation restoration of caries can be extremely difficult due to difficult access to the cervical lesions, which results in incomplete excavation of caries.

In addition, the cavity preparation can be difficult to define and provide poor mechanical retention. [55] In addition to technical problems, choosing the most suitable restoration material is difficult because of the difficult oral environment experienced by patients who have been irradiated. Ideally, the material chosen should have sufficient adhesion, prevent secondary caries, and resist dehydration and acid erosion. McComb et al. [56] confirmed the efficacy of fluoridated release

materials in preventing caries recurrence in irradiated patients. It has been shown that composite resins prevent recurrent disintegration in vitro and the retention of these materials has also been demonstrated for long periods of time. [57] However, when time is limited, glass ionomer cements appear to be effective transient treatments. [55.56] Hu et al. [55] showed that glass ionomers can prevent the development of secondary caries, even if the restorations have been lost. In addition, glass ionomers appear to provide satisfactory properties, adhesion and physical properties. The lack of saliva buffering in xerostomic patients, however, can lead to a decrease in the plaque's normal pH and hence to the formation of hydrofluoric acid and erosion of the glass ionomer. [56] Patients should be informed about the importance of good oral hygiene. Patients should be advised to use customized carrier trays for the lifetime use of fluoride gel or chlorhexidine. It is important that the patient remains under control to reduce the incidence of caries due to radiation.

## CONCLUSION:

Radiotherapy leads to changes in the teeth, saliva and oral microflora of patients with HNC. Radiation caries has a multifactorial etiology, but hyposalivation remains the main cause. Therefore, radiation caries could be prevented by sparing the salivary glands, or prevention is achieved with full dental care before, during and after the RT. Patients' motivation, adequate plaque control, stimulation of salivation and the use of fluoride are essential to reduce the incidence of radiation caries and improve the quality of life of HNC patients.

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