Management of the Patient with Dental Caries and Salivary Gland Hypofunction following Head and Neck Radiotherapy

Preventive Treatment Plan

This includes all levels of prevention – primary, secondary and tertiary (restoration of teeth and replacement of missing tissue). Prior to radiotherapy you have already extracted nonrestorable/questionable teeth. You have also implemented a preventive plan to help reduce caries risk during and after radiotherapy. (See Murdoch-Kinch and Zwetchkenbaum, MDA Journal 2011)

After radiotherapy, and for the rest of the patient’s life, the dentist must work with the patient to prevent dental caries, preserve teeth, manage the symptoms of dry mouth, and avoid infection and extractions in irradiated bone to prevent osteoradionecrosis.

We need to be very specific about recommendations we make to the patient, preferably in writing. **Be specific about foods to avoid, products to avoid, as well as products to use and how often.** Consider the patient’s literacy level and oral health literacy.

These recommendations are based on evidence from studies of high risk patients with dental caries and salivary gland hypofunction, whenever available. There are currently clinical trials underway to identify strategies to develop risk-stratified approaches to dental treatment planning before, during and after head and neck radiotherapy, that take into consideration new salivary gland sparing techniques that may be associated with lower caries risk.

**Top 10 Strategies to Manage Salivary Gland Hypofunction and Dental Caries:**

1. Daily prescription strength fluoride, preferably neutral sodium fluoride (NaF) 1.1% delivered in custom trays worn once per day for 10 minutes, NOT during sleep. Patients with significant salivary hypofunction cannot spit out the fluoride gel adequately – they do not have enough saliva to clear the material, so if they use it through the night or more than once per day in this fashion they may develop fluoride toxicity – see article from JADA 2005 (Eichmiller FC et al) Stannous fluoride (0.4%) is another good choice but it stains the teeth and tastes bad so compliance may be an issue for some patients. If the patient cannot afford trays or will not wear them he can brush the gel on the teeth before bed, spit and do not eat or drink anything for 30 minutes afterwards.

1.1% NaF toothpaste such as Prevident 5000 is another good choice for the patient who will not use trays. Use instead of regular toothpaste once per day (before bed is the best). In addition to daily prescription fluoride, **MI paste™** is a cream that contains calcium and phosphate (CPP-ACP) and can be used to promote remineralization. (needs a prescription or to be dispensed by a dentist) It also contains fluoride but in suboptimal concentration for the xerostomic patient, so consider supplementing with prescription fluoride. (Weyant RJ et al, 2013)
2. **Alcohol-free 0.12% chlorhexidine rinse** to be used **twice daily**. This will help control plaque and can help prevent oral candidiasis which is a common problem in xerostomic patients. Alcohol-free formulations are preferred for the patient with dry mouth and sensitive mucosa. If you cannot get it then regular chlorhexidine mouth rinse could be used, diluted with water so the patient can tolerate it. Please note, research on efficacy of topical chlorhexidine coating in caries prevention for adults has provided conflicting results. (Papas AS et al; Symington JM et al)

3. **Oral Hygiene Instruction** - Brush after every meal and before bed, using bland toothpaste such dry mouth toothpaste, or children’s toothpaste. With sensitive mucosa the patient should **avoid any extra ingredients in dental products** such as whiteners, antimicrobials, pyrophosphates (tartar-control) and strong flavoring agents. Some patients will develop reactions to sodium lauryl sulfate (SLS), so choosing toothpaste without this is advised. Floss once per day. Waterpik also can help with plaque control, since many patients are not compliant with flossing or do a very poor job, because of the dexterity required.

4. **Caries control** – restore active caries with **glass ionomers** (release fluoride) or amalgam. **Document** her caries and restorations at the first visit and at subsequent recall exams— a dental chart (odontogram), electronic patient record with dental charting, intraoral photos are good ways to accomplish this. Why? You need to know for sure what she presented with and what develops during the time you are treating her as a patient in order to assess response to preventive treatment and control of the disease process. This may also have medico-legal implications.

   **Defer phase 2 treatment** with crowns and other extensive restorative treatment until you know you have gained control of the caries process, or at least slowed it down. **Fluoride varnish** can be applied **three times per year** to add benefit to his daily fluoride regimen.

5. **Frequent recall** – Decide when you want to see her again – start with **2-3 month recall**, and take it from there. Remember, you can always increase the interval between recall visits if she has a caries-free check-up. Frequent recall helps reinforce preventive home care.

6. **Diet counseling** – discuss the role of frequency of fermentable carbohydrates in the diet and caries risk. Decrease frequency of sugars, starches and acidic food in the diet. It is not surprising that most patients with dry mouth sip beverages frequently to try to keep the mouth moist and often choose sweet tea, pop, coffee (creamer contains sugar) and sports drinks (very low ph and high sugar). Water is all that should be sipped through the day. Chewing sugar-free gum can stimulate saliva and keep the mouth moist. Have the patient complete a 3 day food diary- everything that goes in the mouth counts. And review it at your next appointment. It is amazing to see when written down – people often don’t realize how often they eat something that is cariogenic. Then you can make suggestions /substitutions based on this. **If this part of the caries etiology is not controlled your chances of controlling her disease is questionable.**

7. **Prescribe a sialogogue to stimulate saliva.** It is a good idea to measure stimulated saliva flow before you prescribe so you can compare flow before and after the medication to know if
you have gained anything. You can easily do this using a medicine cup – the patient can be asked to chew on sugarless gum and spit into the cup for 5 minutes. Flow should be at least 1 ml/minute to be within normal limits. Another choice is the Saliva-Check kit and other chairside caries risk assessment kits that test saliva pH, buffering capacity and flow. These can help you track her progress with diet and plaque control (contributes to salivary pH) and salivary flow. Also remember, these drugs only work if the salivary glands are functional. Pilocarpine and Cevimeline are the two most commonly prescribed cholinergic agonists. There are contraindications – look up in drug reference before prescribing. Side effects include frequent urination and sweating.

8. Prescribe salivary substitutes to help relieve feelings of dry mouth. These do not affect caries risk, however. Most of these do not really provide any therapeutic benefit but can help the patient’s symptoms for a short period of time. Give choices and recommend that the patient use them whenever the mouth feels dry. May be preferable to sipping on water – this often makes the mouth feel drier since it evaporates so quickly. Caphasol is an artificial saliva with FDA approval for use in patients with radiation mucositis. It contains calcium and phosphate in supersaturated solution and can aid in remineralization when given with fluoride on a daily basis. (Singh ML and Pappas AS, J Clin Dent 2009) This can be used 3-5 times throughout the day to relieve dryness and provide this additional remineralization effect. It must be prescribed for the patient, and is covered by durable medical equipment insurance (the type of insurance that covers crutches, wheelchairs etc.) as it is classified as a device. See www.caphasol.com for more information about this. Patients with dry mouth should avoid alcohol in mouthwashes – it burns and dries out the tissues. Also avoid cinnamon, tobacco and spicy food.

9. Patients with dry mouth have a very high risk for candidiasis- patient’s sore mouth may be due to this or to the dryness. Avoid medications containing sugar – fluconazole may be a good choice to treat an infection since it will not contribute to caries. If you only have to treat for 2 weeks, clotrimazole troches are a good choice – if the patient is not too dry to dissolve a lozenge. As time goes on, the chlorhexidine rinse you prescribed above can help prevent recurrent yeast infections. Fluconazole is contraindicated if patient is taking certain meds and if he has liver disease.

10. Patients with a history of head and neck cancer have a greatly increased risk for a recurrence OR a new primary tumor. Therefore, you should be suspicious of any lumps or swellings that arise and are detected by good head and neck examination, done at every recall visit. Refer the patient to a physician accordingly.

Treating such a patient will take a lot more time than treating a healthy patient with low caries risk and more easily modifiable risk factors. You may want to schedule this patient at the end of the day, in case you run over time, to avoid messing up your schedule. After the disease control and preventive plan is implemented, schedule a recall/re-evaluation 3-6 months later. The recall visit should include a re-assessment of the patient’s caries risk and response the therapy.
References and Resources


Dental Management of the Head and Neck Cancer Patient Treated with Radiation Therapy


Approximately 36,540 new cases of oral cavity and pharyngeal cancer will be diagnosed in the USA this year; more than 7,880 people will die of this disease. The vast majority of these cancers are squamous cell carcinomas. Most cases are diagnosed at an advanced stage: 62 percent have regional or distant spread at the time of diagnosis. The five-year survival for all stages combined is 61 percent. Localized tumors (Stage I and II) can usually be treated surgically, but advanced cancers (Stage III and IV) require radiation with or without chemotherapy as adjunctive or definitive treatment. See Table 1. Therefore, most patients with oral cavity and pharyngeal cancer receive head and neck radiation therapy (RT) as part of their treatment.

The oral complications of head and neck RT result from radiation injury to the salivary glands, oral mucosa and taste buds, oral musculature, alveolar bone, and skin. They are clinically manifested by xerostomia, oral mucositis, dental caries, accelerated periodontal disease, taste loss, oral infection, trismus, and radiation dermatitis. Some of these effects are acute and reversible (mucositis, taste loss, oral infections and xerostomia) while others are chronic (xerostomia, dental caries, accelerated

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T_n: in situ  
T_1: < 2 cm  
T_2: > 2 cm and < 4 cm  
T_3: > 4 cm  
T_4: Invades adjacent structures  
N_0: No nodal involvement  
N_1: Ipsilateral, < 3 cm  
N_2: Ipsilateral > 3 cm and < 6 cm  
N_2a: Ipsilateral, multiple, < 6 cm  
N_2b: Bilateral/contralateral, < 6 cm  
N_3: > 6 cm  
M_0: No metastases  
M_1: Distant metastases

Adapted from Brandwein-Gensler and Smith.
periodontal disease, trismus, and osteoradionecrosis.) Chemo
therapeutic agents may be administered as an ad-
junct to RT. Patients treated with multimodality chemo-
therapy and RT may be at greater risk for oral mucositis and
secondary oral infections such as candidiasis. The oral
complications of therapy for head and neck cancer can signi-
ficantly impair quality of life.  

The oral health care team serves a vital role in the pre-
tevention and management of short- and long-term oral com-
plications of cancer treatment. Hospital-based dentists spe-
cially trained in oral oncology treat some of these patients,
but currently in North America most long-term dental care
is provided by general dentists in private practice.  

Depending on available health care resources, the patient may rely
on his local dentist for pre-treatment oral care and support-
ive care during cancer treatment, as well as continued oral
health care to manage the long-term oral complications of
cancer therapy. It is essential that all health professionals
caring for the cancer patient be knowledgeable about the di-
agnosis, prevention and management of oral complications
of therapy and their sequelae, in order to work together as a
team to minimize the impact of these toxicities on the pa-
tient’s life.

This article provides an overview of oral complications of
RT for head and neck cancers, with a particular em-
phasis on caries, periodontal disease, and osteoradione-
crosis of the jaws, and guidelines for the dental manage-
ment of the head and neck cancer patient treated with
RT.

Oral Complications of Head and Neck RT

a. Xerostomia and salivary gland hypofunction:
Xerostomia is the most common oral complication of head
and neck RT. In fact, up to 64 percent of patients treated
with conventional head and neck RT still experience a
moderate to severe degree of permanent xerostomia when
assessed up to 22 years after radiation therapy. The
most severe complaints occur in patients treated for can-
cer of the nasopharynx and oropharynx, most likely due
to the close proximity of the field to the parotid glands.

Paradoxically, for such highly differentiated tissues,
salivary glands are very sensitive to radiation. There is a
sharp decrease in the salivary flow rate during the first
week of RT with conventional fractionation (2 Gy/day).
The decrease in flow rate continues throughout the treat-
ment period, especially when both parotids are irradi-
ated. This correlates to the dose and duration of RT.
There is immediate serous cell death accompanied by in-
flammatory cell infiltration, and then continuous reduc-
tion of salivary flow rates. Patients often complain of
thick, ropy saliva and a sensation that there is too much
saliva because it is difficult to swallow. The exact mecha-
nism of radiation-induced damage to the salivary glands
is not currently well understood.

With conventional RT, xerostomia is permanent. Salivary
gland-sparing techniques using intensity modulated
radiation therapy (IMRT) have been pioneered at the
University of Michigan. IMRT is rapidly emerging as
the standard of care for head and neck cancer. Salivary
gland-sparing IMRT is associated with gradual recovery
of salivary flow over time, and improved quality of life as
compared to conventional RT. Residual salivary flow can be stimulated by sialogogues such as pilocar-
pine or cevimeline, and/or use of sugarless gum and
buffered citric acid tablets (Numoisyn™, Align Phar-
maceutical, Berkeley Heights, N.J.) Salivary substitutes
provide transient symptomatic relief.

b. Radiation mucositis: Mucositis is an important
common acute short-term complication of head and neck
RT. It is a dose-limiting toxicity and may be more severe in
patients receiving multimodality therapy for head and neck
cancer. It is characterized by ulceration in the oro-esopha-
geal and gastrointestinal mucosa, resulting in significant
pain and dysphagia.

Mucositis initially presents clinically as erythema after
4-5 days of therapy, corresponding to cumulative doses of

![Figure 1 — Xerostomia and radiation mucositis in patient one
month after the end of radiotherapy. Saliva is thick and sticky.
Mucositis is painful and interferes with eating.](image1)

![Figure 2 — Silicone mucosal guards. These custom-made guards
cover metallic restorations with 5 mm of silicone impression mate-
rial, to prevent heating of the metal and backscatter of radiation
in contact with the mucosa.](image2)
10 Gy to the head and neck. The patient often complains of oral burning or intolerance to spicy food. As the mucositis progresses after cumulative radiation doses of 30 Gy (approximately two weeks), ulcers develop. (Figure 1). Radiation-induced mucositis can involve any radiation-exposed area, including the hard palate. It may be worse in tissue in direct contact with metallic restorations. Radiation-induced mucositis peaks at two weeks post RT of 60-70 Gy. This ulcerative phase may last for up to 5-7 weeks following RT, with gradual healing. Chronic mucositis is a rare occurrence following RT.29,32-33

Mucositis has a significant health and economic impact on cancer patients. It is one of the most common reasons for a break in the administration of RT.32 Measures specifically designed to prevent and treat oral mucositis can be provided by the patient’s oncology team. The dentist can assist by providing basic oral care consisting of patient education, disease control, and oral hygiene instruction. These measures can decrease the microbial load in the oral cavity and prevent other complications associated with therapy. In addition, patients who have heavily restored teeth may benefit from the use of silicone mucosal guards worn during RT (Figure 2) to reduce the severity of mucositis associated with scatter of radiation off metal restorations.34-36

c. Oropharyngeal candidiasis (OPC): This is a very frequent complication of cancer therapy; up to 27 percent of patients undergoing RT present with evidence of OPC.37 It may present as a pseudomembranous candidiasis (thrush), with thick white plaques that wipe off (Figure 3), or as generalized erythema and burning discomfort. Clotrimazole has been shown to be more effective than nystatin for treatment of OPC; clotrimazole 10 mg troches administered five times per day are effective in treating mild to moderate OPC.38 Some topical preparations have a high sucrose content that may contribute to caries risk in the xerostomic patient. Fluconazole 50-100 mg daily has been associated with clinical recovery in 80 percent of patients within 10 days, or within five days with 200 mg daily. Complete mycologic cure is difficult to achieve. Resistance to fluconazole is associated with non-albicans yeast such as Candida glabrata and C. krusei.39 A recent systematic review of this topic failed to find strong enough evidence to support one drug over another in the treatment of OPC in this population.40-41 Although initially encountered during RT, it also can present a long-term problem in patients with xerostomia. Antifungal prophylaxis may be beneficial in high-risk patients; the oncology team should make this decision.
d. Dental caries: After standard RT there is a profound shift in the oral microflora to a predominance of acidogenic microbes, primarily Streptococcus mutans and lactobacilli, coincident with a decrease in salivary flow, and an increase in caries risk.42-44 Dental caries in irradiated patients may develop rapidly, as early as three months after RT. Lesions typically involve the cervical portions of the teeth (Figure 4); however, caries may affect any tooth surface, including those typically resistant to dental caries such as the incisal edges of the mandibular incisors.45-46 Prevention and treatment of dental caries. A strict daily oral hygiene regimen that includes fluoride and meticulous plaque removal has been shown to prevent the development of caries.43,45 Chlorhexidine gel has also been shown to clinically reduce caries risk by lowering mutans streptococci and lactobacilli counts in patients undergoing RT.47-48 Chlorhexidine gel is not currently available in the U.S.; however, chlorhexidine mouthrinse could provide similar benefits.48 Alcohol-free formulations should be selected to reduce discomfort in patients with dry mouth. Caries lesions should be restored before RT to prevent progression of disease and reduce microbial load. Also, the patient will be more comfortable during treatment if the oral mucosa is intact. Patients should also receive diet counseling about cariogenic foods and their deleterious effects on the dentition.

Vissink and colleagues concluded that a lifelong commitment to improved oral hygiene and home care should include meticulous oral hygiene and frequent self-appli-
cations of fluoride, either neutral NaF 1 percent gel applied at least every other day\textsuperscript{46,50} in custom-made fluoride carriers or NaF 3 percent toothpaste twice per day.\textsuperscript{45} The daily use of 4 percent stannous fluoride also is effective.\textsuperscript{51-52} Presently, there is inadequate evidence to support one type of fluoride product over another for patients undergoing RT; the frequency of application appears to be more important. Because hyposalivation is irreversible in most head and neck irradiation patients, especially those treated with standard therapy, the application of fluoride must be continued indefinitely; otherwise, caries will develop within months.\textsuperscript{50,53-56}

In patients receiving parotid-sparing IMRT, where salivary output has been shown to increase over time,\textsuperscript{12,14-15,17,20} and in patients receiving amifostine during RT, evidence suggests that caries risk may be reduced.\textsuperscript{57} Amifostine is a radioprotective drug that has been shown to have a significant protective effect on the salivary glands\textsuperscript{58} and oral health.\textsuperscript{57} In the past, controversy has surrounded this drug because of two potential problems: tumor protection and toxic side effects. Nevertheless, amifostine is increasingly being added to many chemoradiation (CRT) protocols to protect the salivary glands.\textsuperscript{59} If so, these new types of RT may allow modification of current caries prevention recommendations. Further research is needed to investigate modification to current guidelines for these new treatment modalities.

e. Periodontal disease: RT effects on periodontal health include direct effects on the periodontium, and indirect effects associated with changes in the oral microflora caused by radiation-induced xerostomia. Two potential problems result: accelerated periodontal attachment loss and increased risk for osteoradionecrosis (ORN) associated with periodontal disease. RT causes changes in both bone and soft tissue that can produce hypovascular, hypocellular and hypoxic bone.\textsuperscript{60-62} This reduces the capacity of the affected bone to remodel and, depending on the dose, may increase the risk of infection, which can lead to osteoradionecrosis, discussed in the next section.

A recent study showed increased tooth loss and greater periodontal attachment loss in teeth that were within high-dose irradiated sites (Figure 5).\textsuperscript{62} Because attachment loss in teeth was greater in the irradiated fields, the authors recommend that dentists consider the impact of increased attachment loss on remaining teeth, when planning dental treatment before RT.

It is well-established that periodontal involvement of teeth in high-dose irradiated sites can produce osteoradionecrosis.\textsuperscript{63-64} Extractions in irradiated bone may increase risk for ORN but pre-irradiation extraction of teeth carries a lower risk of ORN than extractions following RT.\textsuperscript{64-66} Periodontal treatment, including periodontal surgery, is possible within irradiated sites. In a study conducted in 1994,\textsuperscript{67} various periodontal surgeries were performed in compliant patients with good oral hygiene and a mean follow-up of 38 months. Although all patients showed isolated sites of increased pocket depth, only four patients showed sites where the pocket depth increased by more than 2 mm. The authors concluded that if few stigmata of RT are seen, such as induration of soft tissue, mucosal and skin telangiectasia, loss of facial hair, mucosal cutaneous atrophy, and xerostomia, the risk of osteoradionecrosis (ORN) might be reduced. Meticulous surgical technique should be employed with nonsurgical periodontal management. The authors further concluded that periodontal surgery could be performed in selected patients following RT, if all these conditions are met.\textsuperscript{67}

**Prevention of periodontal disease and attachment loss.** Optimal oral hygiene must be maintained because of the lowered biological potential for healing of the periodontium after radiation therapy. The risk for developing ORN is reduced in patients who receive topical fluoride applications and maintain good oral hygiene because they are less likely to develop caries, periodontal disease and their sequelae.\textsuperscript{53,68-69} These measures help to reduce the likelihood of rampant periodontal destruction that occurs in the absence of good oral hygiene, especially within high-dose irradiated sites.\textsuperscript{63}

f. Osteoradionecrosis (ORN): ORN is caused by the hypoxic, hypocellular, hypovascular deterioration of bone that has been irradiated. Marx\textsuperscript{60} has proposed that this results from the radiation-induced deficient cellular turnover and collagen synthesis in a hypoxic, hypovascular and hypocellular environment in which tissue breakdown exceeds the repair capabilities of the wounded tissue. Clinically, ORN may initially present as bone lysis under intact gingiva and mucosa (type I). This process is self-limiting because the damaged bone sequestrates, then is shed with subsequent healing. If the soft tissue breaks down, the bone becomes exposed to saliva and secondary contamination occurs. Sepsis may also be introduced by dental extraction or surgery, producing a more aggressive form (type II) (Figure 6). This progressive form may produce severe pain or fracture, and require extensive resection. The reported incidence of ORN varies widely depending on

![Figure 5 — Gingival recession on mandibular teeth in the field, more than two years post radiotherapy. Patient wears a complete upper denture.](image-url)
the institution, type of RT, and follow-up time. The reported incidence of ORN ranges from 0.92 percent of all head and neck cancer patients receiving RT to 2.59 percent of patients receiving post-irradiation extractions.59-70

Sulaiman and colleagues69 reviewed the records of 1,194 patients followed in the Memorial Sloan Kettering Cancer Center (MSKCC) Dental Service during 1998-2001. Mean time for follow-up was 22.09 months. Decisions to perform pre-irradiation dental extractions were based on several factors: radiation dose, modality of treatment, field of radiation, and tumor prognosis, as well as pre-existing periodontal condition of the tooth or teeth, severity of caries, pulpal involvement and status, presence of advanced or symptomatic periodontal disease, mobility with root furcation involvement, residual root tips not fully covered by alveolar bone or showing radiolucencies and symptomatic impacted or incompletely erupted teeth that were not fully covered by alveolar bone. Following formal empiric guidelines at MSKCC regarding dental extractions in patients receiving radiation therapy for head and neck cancer, almost 85 percent of patients did not require dental extractions to prevent ORN. Of the 77 patients who had extractions before radiotherapy for head and neck cancer patients, 24 (31.2 percent) developed ORN. Of the 77 patients who had extractions before radiation therapy, 21 (27.3 percent) developed ORN. All of the extractions were located in the posterior region of the mandible in a radiation dose greater than 70 Gy. All of the extractions were located in the posterior region of the mandible in a radiation dose greater than 70 Gy.

In the Sulaiman study,69 extractions were done at least two weeks before RT whenever possible. Their protocol for dentate patients undergoing RT or with a history of RT included a neutral fluoride regimen — usually neutral NaF 1.1 percent in a 5,000-ppm dentifrice toothpaste. For patients with extensive dental restorations, fluoride trays were also fabricated. Because 84.34 percent of their patients did not require extractions after RT, the investigators concluded that the fluoride regimen was efficacious. In addition, follow-up in the immediate post-radiotherapy period was mandatory, with average follow-up time of 22 months post-extraction, with a range of 0-149 months. Most of the patients who had extractions did not experience post-operative complications.69

A recent retrospective study showed a further reduced incidence of ORN following IMRT for head and neck cancer. This reduced incidence was attributed to parotid sparing and better dental treatment, which reduced the number of dental extractions and surgical procedures required post-radiotherapy.36

Prevention of ORN. ORN may be prevented by extracting these teeth at least two weeks before RT: periodontally involved teeth; unerupted teeth with communication with the oral cavity; third molars with evidence of pathology such as cysts or pericoronitis; and pulpally involved or nonrestorable teeth. Prevention of dental caries and periodontal disease and their sequelae can prevent ORN in most cases. If teeth must be extracted after RT, care should be given to use atraumatic technique, smooth sharp edges of bone, and avoid reflection of the periodontium, if possible. The risk of dental extraction-related ORN does not appear to decrease over time after RT.

g. Trismus. Trismus can be a significant side effect of RT, especially if the lateral pterygoid muscles are involved. In patients in whom the pterygoid muscles were irradiated, and not the temporomandibular joint (TMJ), 31 percent experienced trismus. In addition, radiation to the TMJ also was associated with a decrease in maximum vertical opening.72-73 Limited mouth opening can interfere with proper oral hygiene and dental treatment. Therefore, before RT starts, patients who are at risk for developing trismus should receive instruction in jaw exercises that will help them maintain maximum mouth opening and jaw mobility. Tongue blades can be used to gradually increase the mandibular opening. Dynamic bite opening appliances have been used.74-75

The dentist should measure the patient’s maximum mouth opening and lateral movements before RT, and re-evaluate mandibular opening and function at follow-up.
dental visits. For patients who experience reduced mouth opening, the intensity and frequency of the exercises should increase, and a physical therapy regimen prescribed.

**Pre-RT Dental Assessment and Treatment**

Patients scheduled to undergo RT should receive a comprehensive dental assessment before therapy begins. The assessment should be conducted soon after diagnosis to allow adequate time for wound healing if teeth need to be extracted. The dentist must understand the basis for RT, the radiation treatment planned (dose, schedule and fields), and the oral/dental/periodontal status of the patient in order to make appropriate treatment decisions. Therefore, a consultation with the radiation oncologist and the medical oncologist, if the patient is undergoing chemotherapy, is recommended.

**Goals of Dental Management**

The dentist caring for a head and neck cancer patient should have clearly defined goals of dental management during the three phases of treatment:

1. **Pretreatment goals**
   - a. eliminate potential sources of infection;
   - b. counsel patient about short- and long-term complications of cancer therapy;
   - c. provide preventive care.

2. **Goals during cancer therapy**
   - a. provide supportive care for oral mucositis;
   - b. provide treatment of oral candidiasis;
   - c. manage xerostomia;
   - d. prevent trismus.

3. **Long-term, post-treatment goals**
   - a. manage xerostomia;
   - b. prevent and minimize trismus;
   - c. prevent and treat dental caries;
   - d. prevent postradiation osteonecrosis (ORN);
   - e. detect tumor recurrence.

Pre-RT dental treatment planning is imperative to address:

1. the limited time to provide dental treatment to the patient, especially if the prognosis for survival is poor;
2. the risk of ORN in irradiated bone with dental extractions or untreated infection;
3. the increased risk of dental caries in the patient whose radiation field includes major salivary glands.

Ideally, treatment planning for all patients should include disease control and prevention phases of care. Prosthetic rehabilitation usually is provided several months after RT. Disease control includes caries removal and restorations, scaling and prophylaxis, establishing good oral hygiene, removing overhanging restorations, and replacing defective restorations, especially if irritating the soft tissues. If deep scaling is needed (pocket depths less than 6 mm) the dentist should allow 14 days healing time before therapy if possible. Ill-fitting dentures should be repaired or replaced. The placement of soft liners should be avoided because they can be a nidus for candidiasis and the surfaces tend to be irregular and irritating.

If teeth are to be retained, the dentist should provide the patient with daily fluoride therapy, either as 1.1 percent NaF gel in custom dental trays or as 1.1 percent NaF toothpaste to be used once daily before, during and after RT, for the rest of the patient’s life. Regular dental recalls are essential to maintain compliance with preventive strategies and detect disease at an early stage.

The dentist should encourage the patient to adopt a non-cariogenic diet. Tooth extraction should be performed 14 days before radiation or chemotherapy starts. After RT, allow at least three months of healing time to elapse before providing prostheses in edentulous patients. There appears to be little evidence to support a longer delay to definitive prosthetic care. During pre-RT extractions, the dentist should aggressively remove sharp pieces of bone to avoid alveoloplasty later. If the lateral pterygoid muscles are within the field of radiation and trismus poses a risk, the patient should receive instruction on mandibular range of motion exercises. After RT, the exercises should be reassessed and, if necessary, modified. Caries prevention plans may also include the prescription of pilocarpine or cevemeline to stimulate saliva flow, chewing sugarless gum containing xylitol, and rinsing with artificial saliva containing calcium and phosphate to encourage remineralization.

**Decisions to extract teeth.** Formalized dental treatment planning models have been proposed in which decisions are based on both dental and cancer therapy conditions. The primary decision is when teeth should be extracted before therapy. In Schiodt’s model, dental conditions associated with high risk dental risk factors (DRF) include:

- teeth with primary and secondary deep caries;
- root caries > ½ the root circumference;
- pulpal disease and periapical disease (nonvital pulps and no previous RCT), periapical osteitis > 3 mm;
- internal/external root resorption;
- probing depth or gingival recession > 6 mm.

Other high risk factors include furcation involvement, mobility > 2 mm, partially impacted teeth and residual root tips, fully impacted teeth with “pericoronal pathoses,” poor oral hygiene and low dental awareness or lack of cooperation.

This model also considers malignancy risk factors (MRF). High malignancy risk factors include radiation dose > 55 Gy, a radiation field that includes molars, teeth that are near the tumor, and if radiotherapy begins in fewer than 14 days. This decision-making model suggests that teeth considered as high MRF and high DRF should be removed. However, extraction decisions also should consider the strategic importance of the teeth, the overall impression of the patient, and the risk associated with extraction (clinical judgment).
Zlotolow\textsuperscript{76} also proposed that the dentist consider the following factors when determining whether or not to extract teeth:

- an optimal recovery time after teeth extraction is 14 to 21 days;
- bone remodeling may occur after RT;
- the risk of ORN is greater in the mandible;
- primary wound closure and alveolectomy may be needed to decrease healing time;
- nonvital asymptomatic teeth in the field can be endodontically treated.

In summary, the decision to extract teeth before RT should consider:

- teeth that are in a high-dose radiation field. Such teeth are non-restorable or may require significant restorative, periodontal, endodontic, or orthodontic intervention.
- patients with moderate to severe periodontal disease (pocket depths > 5-6 mm) or with advanced recession.

The dentist may develop a more aggressive dental treatment plan for the patient with low dental awareness, lack of motivation or cooperation, a poor history of regular dental care treatment, poor oral hygiene, and evidence of past dental/periodontal disease. The dentist also should consider factors such as position of teeth, relative importance of such teeth for function, oral hygiene, potential impact of trismus and limited mouth opening on oral hygiene and dental treatment, taurodontism, and root anatomy.

See Table 2 for the Pre-Radiation Therapy Protocol from the University of Michigan Department of Oral and Maxillofacial Surgery and Hospital Dentistry. This and other information can also be accessed at http://sites-maker.umich.edu/dent.onc. At our institution all patients planned to receive head and neck RT are referred for dental evaluation and treatment, and cleared from a dental standpoint before RT begins. Although the majority of patients are seen in the Hospital Dentistry Department prior to RT, in order to expedite treatment, most patients return to their private dentist in the community for long-term dental maintenance. In cancer treatment centers and hospitals without a dentistry department, which is most common, this pre-RT dental care is provided by private practice dentists in the community.

Although not widely published in the literature, and thus not cited in the aforementioned guidelines, at the University of Michigan and other medical centers in the U.S. standard supportive care for dentate patients undergoing head and neck RT with metal restorations included the fabrication of mucosal guards. These guards are made of putty silicone impression material with the patient in occlusion, and cover the teeth to prevent radiation backscatter off metallic restorations to oral mucosa which would normally be in direct contact with these fillings and crowns (Figure 2). The patient wears these guards during simulation and subsequent radiation treatments. In our experience this strategy appears to reduce the severity of mucositis in regions of mucosa which are normally in contact with these restorations. More formal investigation of the efficacy of these mucosal guards to reduce mucositis associated with RT is clearly indicated.\textsuperscript{35-36}

**Conclusions**

Dental treatment decisions require an understanding of the staging of the patient’s cancer and prognosis for survival, the types of therapy planned, timing of therapy, patient’s motivation and ability to cooperate, and anticipated oral complications of treatment.

In general, the dental care provider can help prepare the patient prior to therapy by treating any active or potential dental infection, providing patient education, and supportive care during treatment. The dental treatment and oral management of patients with head and neck cancer should include an oral evaluation including periodontal examination before the patient begins cancer treatment. This evaluation will help to prevent or mitigate oral complications associated with radiation and chemotherapy, and systemic sequelae of oral infection.

Many of the oral complications of cancer therapy, such as mucositis, oral candidiasis, and osteoradionecrosis, are managed by the oncology team. Radiation-induced xerostomia and dental disease is the responsibility of the dental team. The general dentist or specialist in private practice who is asked to provide dental care for the head and neck cancer patient must be familiar with the most current recommendations for care and understand the scientific rationale. Dentists should be prepared to consult with the oncology team in order to provide the most appropriate care for the cancer patient before treatment, and for the rest of the patient’s life.\textsuperscript{6}

**References**

1. Patient education, both oral and written
   a. Effect on salivary glands
      i. Dry mouth strategies
         1. Increased hydration
         2. Salivary substitutes
         3. Salivary stimulation – sugarless chewing gum, pilocarpine, cevimeline
      ii. Caries prevention
         1. Diet counseling
         2. Daily fluoride use
         3. Regular frequent dental check-ups
   b. Effect on bone in irradiated field
      i. Need for pre-RT dental evaluation
         1. Consult usually requested by radiation oncology
      ii. Need for UMHS contact prior to future extraction or surgery in the irradiated field.
   c. Potential for trismus
      i. Maintain range of motion
         1. Tongue blades
         2. Therabite™
         3. Dynabite™

2. Patient evaluation and treatment plan
   a. Consult should provide adequate information about planned field. If not, contact radiation oncologist.
      i. All head and neck cancer patients at University of Michigan now undergo parotid-sparing IMRT
   b. Determine the need for extraction based on periodontal and dental condition, oral hygiene, history of regular dental visits, etc.
   c. If time permits and patient wishes, perform extractions at the time; or schedule for future day.
   d. Inform radiation oncologist of time required for healing before starting RT.
   e. Oral hygiene instructions, other treatment to be scheduled.

3. If indicated in consult, fabricate silicone tooth guards to minimize radiation backscatter. Consult should indicate if guards should be fabricated in a position with teeth open or closed. If time is available to trim and smooth the guards, deliver at this time. If not enough time is available, reschedule the patient.

4. If xerostomia is anticipated, consider fluoride use using toothbrush application or carriers. If there are multiple missing teeth, the toothbrush technique is preferred. Alginate impressions are made if carriers are to be made. Schedule patient to return for delivery of these. At this time prescription can be provided for fluoride.
   a. Sodium fluoride dentifrice or gel, OR
   b. Stannous fluoride gel

5. Schedule the patient to return in approximately seven weeks, during the last week of radiation therapy. If the date is not known, advise the patient to schedule this appointment. During this appointment, reinforce the information provided earlier about caries prevention. Determine where the patient will be getting his routine dental care, either with the local dentist or in our clinic.

6. If care is to be provided in private practice, we continue to be a resource regarding dental treatment and information for the patient and his dentist.


50. Jansma J, Vissink A, Grovenmade EJ, Visch LL, Fidler V, Retief DH. In vivo...


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