Oral cancer is associated with documented risk factors, yet no comprehensive screening program is in place in the United States for early detection of the disease. Oral cancer often is diagnosed in more advanced stages, resulting in a poor prognosis. Dental practitioners and radiographers play an important role in the management of the disease and in helping to improve the quality of life for people who have oral cancer. This article discusses types of oral and oropharyngeal cancer, their diagnosis, treatment options, and the role of dental imaging in patients with these cancers.

Radiographers provide medical imaging services for patients who have many types of cancer, but they might be less familiar with oral cancer. Oral cancers are part of a diverse group of head and neck cancers that often are not diagnosed until the cancer has metastasized.1

Oral cancer refers to cancer of the oral cavity, and oropharyngeal cancer refers to cancer of the oropharynx, which includes the middle throat, back of the tongue, soft palate, tonsils, and the side and back walls of the throat. In the literature, oral and oropharyngeal cancer often are included under the umbrella term oral cancers, and the National Cancer Institute defines oral cancers as any cancer that “forms in the oral cavity (the mouth) or the oropharynx (the part of the throat at the back of the mouth).”2

Both oral and oropharyngeal cancers are types of head and neck cancer.3,4 Head and neck cancers typically originate in the squamous cells that line the mucosal surfaces of the mouth, nose, sinuses, and throat.3,4 Oral and oropharyngeal cancers make up 85% of all head and neck cancer incidence.1 Typical sites for oral and oropharyngeal cancers are shown in Box 1.

Epidemiology

According to World Health Organization statistics, oropharyngeal cancer was the 11th most common cancer in 2005.5 More than 450,000 new cases are diagnosed worldwide each year, and the average U.S. 5-year survival rate is currently near 57% according to the Oral Cancer Foundation.6 This represents an increase in survival of only about 3% in the past 10 years.1 A particularly noteworthy trend is the increased incidence of the disease in developing countries.5 The 5-year survival rates vary from country to country, but for most it stands at 50%.1

Oral and oropharyngeal cancers are more common in men than in women, and they tend to be diagnosed in older

Medical Imaging of Oral and Oropharyngeal Cancer

Susan M Anderson, MAED, R.T.(R)
Medical Imaging of Oral and Oropharyngeal Cancer

incidence rates of oral and oropharyngeal cancers include South and Southeast Asia such as Sri Lanka, India, Pakistan, Bangladesh, and Taiwan. In these areas, oral cancer is the most common cancer among men.

Hungary, Slovakia, Romania, and France have the highest rates of oral, lip, and oropharyngeal cancer in the world. Oral and oropharyngeal cancers were listed as the fifth-most common cancer among men in the European Union in 2012. In Hungary, incidence and mortality rates for oral and oropharyngeal cancers have doubled in recent decades. Oral cancers are the most common cancer among men in Hungary, with the third highest cancer-related mortality rate. In France, Romania, and Slovakia, oral and oropharyngeal cancers are the fourth most common cancer among men. They also are fourth highest in cancer-caused mortality rates for men in Romania and Slovakia and the seventh highest for cancer-related mortality in France.

In South America and the Caribbean, the countries of Brazil, Uruguay, and Puerto Rico have the highest incidence rates. In this geographic region, oral and oropharyngeal cancers rank fifth in cancers among men and sixth among women in occurrence.

**United States Prevalence**

According to American Cancer Society 2013 statistics, oral and oropharyngeal cancers are the eighth leading cancer site for new cases in men. Estimates for 2015 predicted approximately 39,500 new cases of oral and oropharyngeal cancer in the United States, and 7,500 deaths; the disease is estimated to contribute to the death of one person every hour. In the United States, the median age at diagnosis is 62 years and the median age at death is 67 years. Fifty-seven percent to 62% of individuals who receive an oral or oropharyngeal cancer diagnosis survive more than 5 years. In the United States, the mortality rate for oral cancer is higher than the mortality rate for Hodgkin lymphoma, malignant melanoma, or cervical, thyroid, testicular, or laryngeal cancers.

**Global Prevalence**

Incidence for oral and oropharyngeal cancers differs by geographic location. Globally, areas with high

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**Box 1

Typical Sites of Presentation for Oral and Oropharyngeal Cancers**

<table>
<thead>
<tr>
<th>Oral Cancer</th>
<th>Oropharyngeal Cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical sites include:</td>
<td>Typical sites include:</td>
</tr>
<tr>
<td>Anterior two-thirds of the tongue.</td>
<td>Base of the tongue (posterior third).</td>
</tr>
<tr>
<td>Buccal mucosa and lips.</td>
<td>Sides and back of the throat.</td>
</tr>
<tr>
<td>Floor of the mouth beneath the tongue.</td>
<td>Soft palate.</td>
</tr>
<tr>
<td>Gingivae.</td>
<td>Tonsils.</td>
</tr>
<tr>
<td>Hard palate.</td>
<td></td>
</tr>
<tr>
<td>Lips.</td>
<td></td>
</tr>
<tr>
<td>Retromolar trigone (area located behind the molars).</td>
<td></td>
</tr>
<tr>
<td>Salivary glands.</td>
<td></td>
</tr>
</tbody>
</table>

Anatomic sites of oral cancer at diagnosis vary by patients’ geographic region. In Spain and in white populations of Australia and Canada, the lip is the most common reported site for oral cancer. In the United States and European Union other than Spain, the tongue is the most common site. In Asia, the buccal mucosa is the most common site for oral cancers. Other common sites include the palate, the floor of the mouth, and the gingivae.

**Risk Factors**

Several risk factors are associated with the development of oral and oropharyngeal cancers. It is estimated that between 75% and 90% of these cancers are directly related to lifestyle choices and could be prevented. The most important risk factors associated with oral cancer are the use of tobacco (including smokeless tobacco, chewing tobacco, and snuff) and alcohol. Smoking marijuana is not associated with increased risk for developing oral and oropharyngeal cancers.
**Tobacco Use**

Use of any form of tobacco causes most oral and oropharyngeal cancers.\(^7\) The risk increases with the amount smoked per day and the length of smoking history.\(^15\) After quitting, the risk of oral cancer from smoking decreases each smoke-free year. Generally, the risk from smoking a pipe or cigar is similar to the risk associated with smoking cigarettes.\(^14,15\) Pipe smoking increases the risk for lip cancer more so than cigarette or cigar smoking.\(^14,15\) Exposure to secondhand smoke in the home increases the risk of oral and oropharyngeal cancers in nonsmokers.\(^14,15\) The risk of oral and oropharyngeal cancer is twice as high for nonsmokers if they are exposed to secondhand smoke for 15 years or more.\(^14,15\)

The use of chewing tobacco increases the risk of cancer to the cheeks, gingivae, and inner lip mucosa.\(^14,15\) The risk of cancer increases as years of use increase. For long-term users, the risk can be 50 times that of a person who has never used chewing tobacco.\(^15\)

**Alcohol**

Drinking alcohol is linked to increased risk of developing oral and oropharyngeal cancer.\(^14,15\) It is estimated that 7 out of 10 people who have oral cancer have a history of heavy drinking.\(^15\) However, many patients with oral cancer use both tobacco and alcohol, which makes it difficult to determine how alcohol use contributes to increased risk for oral cancers.\(^14,15\) According to some studies, individuals who both smoke and drink alcohol could be 100 times more likely to develop oral and oropharyngeal cancers than individuals who abstain from both.\(^15\)

**Paan and Gutka**

Paan is a popular chewable stimulant, made of areca nut and slaked lime wrapped in a betel leaf.\(^3,17\) Gutka is a similar preparation, but with tobacco included. Paan and gutka are commercially available products in India and Asia; paan is most popular in Southeast Asia.\(^3,13,16\) Chewing paan increases risk of oral cavity cancer by 3.5 times the rate of the general population. Chewing gutka increases risk of oral and oropharyngeal cancer 7 times more than for people who do not use these products. A person who chews gutka, smokes cigarettes, and drinks alcohol has a risk of oral and oropharyngeal cancer that is 30 times that of the general population.\(^15\) Studies show that paan and gutka could be responsible for 50% of all oral cancer cases in India.\(^17\)

**Radiation**

Ultraviolet radiation is a probable cause of lip cancer in people with outdoor jobs that expose them to sunlight for long periods. Lip cancer is more common in people who have fair skin; the risk increases further in those who smoke tobacco.\(^4,15\)

According to Cancer Research UK, ionizing forms of radiation such as x-rays and gamma rays are known causes of salivary gland cancer. Salivary gland cancer is relatively rare, but incidence is higher in survivors of childhood cancers, thyroid cancer, and Hodgkin lymphoma. This is primarily because of treatment using radioactive iodine or radiation therapy.\(^15\)

**Human Papillomavirus**

*Human papillomavirus* (HPV) is a group of more than 150 specific viruses. Infection with certain types of these viruses can cause plantar and genital warts, while infection with other types of HPV can cause cancer.\(^16\) The HPV viruses are assigned numbers to identify each type. HPV-16 has been linked to oropharyngeal and cervical cancer.\(^16,18\) There is no current U.S. Food and Drug Administration–approved test for HPV infections of the mouth and throat.\(^18\)

According to the Oral Cancer Foundation, the incidence of oral and oropharyngeal cancers is rising among people aged 25 to 50 years. Typically, these individuals are otherwise healthy and do not smoke, implicating the HPV virus in the development of oral cancers. Signs of HPV infection are present in 2 of every 3 oropharyngeal cancers and some oral cancers. In the United States, nonsmoking white men aged 35 to 55 years are most at risk for HPV-related oral cancers.\(^18\) In the United States, the prevalence of HPV-related oropharyngeal cancers has increased 225% between 1988 and 2004.\(^16\)

**Precancerous Conditions**

Several diseases or conditions that occur in the mouth are considered precancerous; these are leukopla-kia and erythroplakia. Both conditions can be precancerous, but each also can be attributed to specific causes other than cancer.
Leukoplakia is an abnormal patch of white tissue or plaque that forms in the mouth (see Figure 1). In many cases, leukoplakia is simply the response of an individual’s body to an irritant and can be attributed to problems such as ill-fitting dentures, chronic cheek biting, or malocclusion. Heavy alcohol use, smoking, and the use of smokeless tobacco also can cause leukoplakia. In approximately 20% of cases, leukoplakia shows evidence of dysplasia or carcinoma; sites such as the floor of the mouth and the ventral surface of the tongue have demonstrated a 45% rate of dysplasia or carcinoma.

Erythroplakia is described as an abnormal red patch of tissue that forms on the mucosal surfaces in the mouth (see Figure 2). Causes of erythroplakia include exposure to harsh chemicals or UV radiation, and tobacco and alcohol use. Erythroplakia is cause for concern, as it has been reported to have up to 91% dysplasia, or precancerous findings, at diagnosis.

**Other Risk Factors**

Several other factors are associated with an increased risk of having oral or oropharyngeal cancers, including:

- Age – people older than 55 are at greater risk.
- Sex – men are twice as likely to have oral and oropharyngeal cancer, despite a substantial increase in women with oral and oropharyngeal cancers in recent decades. Before the increase, the cancer ratio was 6 to 1 for men vs women.

**Screening and Diagnosis**

The initial signs and symptoms of oral or oropharyngeal cancer can be confused with other conditions (see Box 2 and Figures 3-4). In addition, many patients are asymptomatic or take little notice of initial symptoms. Diagnosis of oral and oropharyngeal cancer begins with detection. This is important because the low global rate of 5-year survival (50%) for people who receive a diagnosis can be largely attributed to late detection of the disease, after metastasis. Metastatic spread typically occurs through the lymph nodes. Diagnosis at later stages is not a result of oral and oropharyngeal cancers being hard to detect, but rather because of a lack of public information and screening programs in many countries, including the United States.

Screening is ideal for oral cancers because they often are preceded by premalignant lesions and the progression to malignancy is slow; it can take from 2.5 to 8 years for the average premalignant oral lesion to become cancerous. Individuals can be screened for the disease by a physician or by request during regular dental check-ups. According to the Oral Cancer Foundation,
for those who have risk factors for oral cancers. Self-screening should never replace a dental examination or screening by a medical professional (see Box 3).

There are no recommendations with respect to frequency or effectiveness of self-screening. The general public should be aware of the signs and symptoms of oral cancers and how to look for changes in the mouth. In addition, everyone should regularly visit his or her dentist, especially young adults. The fastest growing group of people diagnosed with oral cancer has become young nonsmokers who have developed the disease as a result of contracting HPV-16.

Dental professionals perform a screening examination similar to the self-screening that patients can perform at home. Patients who are uncertain whether they have received an oral cancer screening when visiting their dentist should ask the dentist to perform one. Dentists also can teach patients the steps for home screening and provide guidance on healthy appearance of oral tissues and structures so that patients can better identify early changes in the mouth if they occur.

Changes observed in the mouth that persist for 2 weeks typically indicate the need for medical attention. After a suspicious area is identified during a medical screening appointment, tests are required to determine whether malignant cells are present. Both dentists and doctors can order or perform these tests. A biopsy confirms the oral or oropharyngeal cancer diagnosis.

Box 2

**Signs and Symptoms of Oral and Oropharyngeal Cancer**

- Constant bad breath.
- Difficulty chewing or swallowing (dysphagia).
- Loosening of the teeth or pain around the teeth.
- Mass or thickening in the cheek or neck.
- A mouth sore that does not heal or is present longer than 2 weeks.
- Numbness of the tongue or other area in the mouth.
- Persistent mouth pain.
- Persistent sore throat or feeling that something is caught in the throat.
- Swelling of the jaw, resulting in poorly fitting dentures.
- Trouble moving the jaw or tongue.
- Voice changes.
- Weight loss.
- White or red patches on the tongue, gingivae, cheeks, or tonsils present more than 2 weeks.

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*Figure 3. Ulceration on the lower lip. Biopsy was positive for squamous cell carcinoma. Image courtesy of Dublin Dental University Hospital, Dublin, Ireland.*

*Figure 4. Swelling on alveolar area of the maxilla. Biopsy was negative for cancer. Image courtesy of Dublin Dental University Hospital, Dublin, Ireland.*

60% of Americans see a dentist yearly and professional studies show that fewer than 25% of them report having oral cancer screenings during these visits. The foundation has set a goal of increasing awareness in the dental profession.33

Screening for oral and oropharyngeal cancer is a relatively simple process that takes less than 10 minutes to complete and is minimally invasive. Individuals can perform self-screening at home; this might be recommended...
The least invasive type of biopsy for diagnosing oral cancers is exfoliative cytology.\textsuperscript{3,22} Using this technique, the doctor or dentist scrapes the suspected area vigorously with a small brush to collect cells for microscopic examination. This procedure is easy to perform, is non-invasive, and can extract samples from small areas that are only slightly abnormal in appearance. Exfoliative biopsy cannot be used alone, however. This method might not detect all cancers and sometimes fails to distinguish between malignant and abnormal, but benign, cells. A traditional biopsy should follow this approach if abnormalities are found.\textsuperscript{3,22}

The more traditional approach is the incisional biopsy. The biopsy can be performed in the office or in an operating room. A doctor or dentist removes part or all of the lesion, mass, or abnormal tissue.\textsuperscript{3,25} A punch biopsy, in which a small circular blade is pressed into an area of abnormal tissue and a small core of tissue is removed is a common type of incisional biopsy used for oral cancer diagnosis.\textsuperscript{3,25} This technique can be effective for small areas of abnormal coloration in the mouth. There is little bleeding with this type of biopsy and the area often heals with no need for stitches.

A third type of biopsy used for masses, especially those located on the neck, is a fine-needle aspiration biopsy. The doctor or dentist uses a small-gauge needle and a syringe to extract cells from a mass. This type of biopsy also is used in patients with known oral or oropharyngeal cancer to determine whether the cancer has metastasized to the lymph nodes.\textsuperscript{3,25}

Patients with suspected oropharyngeal cancers might undergo an endoscopic procedure called a panendoscopy to look at the oral cavity, nose, pharynx, larynx, trachea, and esophagus.\textsuperscript{26,27} This examination also can be used to obtain tissue samples for biopsy.\textsuperscript{26,27} The scope’s light and lens provide the physician with an improved view for visual evaluation and tissue sample removal.

If biopsy results are positive, a patient might undergo additional tests to determine the extent of the cancer and to establish a formal treatment plan best suited to the patient’s needs. In addition to blood tests to assess the overall health of the patient before surgery, diagnostic imaging might be used. Imaging examinations for preoperative assessment and staging can include:

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**Box 3**

**Self-screening for Oral Cancer**\textsuperscript{24}

Find a comfortable area with good lighting and a large mirror. Have a small dental mirror handy along with gauze or a small washcloth for drying the mouth and tongue. Signs to note include color differences, texture changes, lesions, and lumps. Most oral cancers are found in the floor of the mouth and on the tongue, but individuals should examine 6 areas of the mouth during self-screening:

- Tongue.
- Buccal mucosa and gingivae.
- Lips.
- Floor of the mouth.
- Roof of the mouth.
- Back of the throat.

**To perform the examination, follow these steps:**

1. Dry the inside of the mouth with gauze or a washcloth.
2. Gently grasp the tip of the tongue with the cloth or gauze and extend the tongue out as far as possible. With the mirror, look closely at the sides, top, and underside of the tongue for any white, red, or dark areas. Feel for lumps or erosions.
3. Using an index finger, feel the lip, gum, and cheek areas for lumps and erosions. Visually inspect the same areas using the dental mirror. Look for areas of discoloration such as patches of white, red, or dark coloration.
4. Assess the floor of the mouth and the area under the tongue. With the mouth open and the tongue curled back in the mouth, examine the floor of the mouth in the dental mirror and look for areas of discoloration.
5. Place one index finger in the mouth behind the lower front teeth and the other index finger under the jaw at the chin to assist in feeling for lumps and swelling by moving both fingers toward the back of the mouth. Repeat this action on both sides of the mouth and then directly under the tongue.
6. Assess the palate by looking at it using the dental mirror for areas of white, red, or dark discolorations. With an index finger, feel the roof of the mouth for lumps or areas of softness.
7. Use 2 or 3 fingers to palpate the outside of both sides of the mouth and the front of the neck to check for swelling or lumps.
8. Open the mouth as fully as possible and depress the tongue or extend it out of the mouth as far as possible and look at the back of the throat. With the dental mirror, look for areas of discoloration and assess the tonsils for asymmetry, swelling, or visible lumps.
Chest radiography – assists in evaluating metastases to the lungs or lung conditions that might affect a surgical procedure’s safety or outcome.

Computed tomography (CT) – helps determine the size and location of any tumors and possible metastases, particularly to bone. CT scans also can help the physician determine whether a tumor can be surgically excised.

Magnetic resonance (MR) imaging – used to evaluate soft tissues such as the tongue or tonsils and to display the soft tissues of the neck, primarily to look for metastasis.

Positron emission tomography (PET) scans – helpful in the cancer staging process and in identifying distant metastases.

Staging

After initial diagnosis and staging, patients receive treatment from physicians, dentists, and health care professionals who provide support for pain and symptom management, wound management following surgery, adverse effects of radiation therapy, nutritional support, speech therapy, and social work or case management.  

Staging helps determine the extent of the cancer, whether and how far the cancer has metastasized, patient prognosis, and optimal treatment options. Oral and oropharyngeal cancers are staged using the TNM (tumor-node-metastases) staging system, which provides information on the:

- Size (in centimeters) of the primary tumor.
- Presence of metastasis, including number of sites, size, and local lymph node involvement.
- Presence or absence of distant metastases.

Combining the TNM classifications provides the information needed to assign a stage grouping for the cancer. Stage 0 is associated with the best prognosis for the patient, and stage IV with the worst. General staging information for oral and oropharyngeal cancers is listed in Box 4.

Survival rate is part of the prognosis and is based on 5 years of surveillance following treatment for people with the same cancer type and stage. According to the Surveillance, Epidemiology, and End Results program, 5-year survival rates in the United States from 2005 through 2011 were 63.2% for people diagnosed with oral and oropharyngeal cancers. The Table shows survival data for lip, tongue, and mouth floor cancer.

Treatment

Once the cancer has been staged, a team of physicians determines optimal treatment based on the type, location, staging, and molecular information gathered. The team assists the patient in making the best possible treatment choice to meet individual patient needs and goals.

Treatment Team

The treatment team for oral and oropharyngeal cancers might include several physicians and other health care professionals. A medical oncologist or radiation oncologist typically oversees treatment. In the United States, some community hospitals use a tumor board, a multidisciplinary group of health care professionals who meet regularly to review cancer cases and discuss the best treatment options for patients. In addition to the radiation oncology team, the treatment team for patients with oral and oropharyngeal cancer might include these health professionals:

- Otolaryngologist.
- Oral and maxillofacial surgeon.
- Dental oncologist.
- Psychologist.
- Prosthodontist (a dentist who restores the mouth following surgery).
- Plastic surgeon.
- Dietician.
- Speech therapist.

Treatment plans and teams are specific to each patient’s needs. Treatment plans typically consider the patient’s age, overall health, patient input, and treatment preference, along with the type of cancer, stage, and the expert opinions of the treatment team.

Treatment Options

Treatment options for patients with oral and oropharyngeal cancers generally include surgery, radiation therapy, chemotherapy, targeted therapy, and palliative therapy. One or more of these options can be used depending on the cancer’s stage and site. Surgery is the most common treatment for patients with oral cancer.
Palliative therapy often is used for patients with advanced cancer. Patients with less advanced stages of oral cancer also might receive therapy for pain management.

Surgery is performed to remove the tumor or cancerous tissue. Surgical approach is determined by tumor size and site. If a tumor is located near the front of the mouth, the tumor can be removed through the mouth. Often, the surgeon has to reach the tumor through an incision in the neck that requires mandibulotomy, or surgically splitting the mandible to facilitate tumor removal.

Radiation therapy has been used to destroy cancer cells or slow tumor growth for oral and oropharyngeal cancers as a primary treatment. Typically, radiation therapy is the primary treatment for small, early-stage cancers. Radiation therapy also is used in conjunction with surgery for larger or more advanced cancers. The most common types of surgical procedures for oral and oropharyngeal cancers are listed in Box 5.

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Chemotherapy for oropharyngeal or oral cancers typically uses intravenous injection of oral medications; chemotherapy usually is used in conjunction with radiation therapy. The combination of chemotherapy and radiation therapy can be used instead of surgery to treat some oral cancers or to treat cancers that are too
Adverse Effects

Patients with oral and oropharyngeal cancer face many possible adverse effects from their cancer treatments; many of the effects are long lasting and can be life altering. For example, various treatments can affect a survivor’s appearance, as well as the ability to eat, chew, swallow, speak, and hear.3,26,27

Surgical resection can cause the most disfigurement for patients because healthy skin, muscle, and bone might be removed along with the cancer. In some instances, all or part of the patient’s tongue, cheek, lip, mandible, maxilla, gingivae, teeth, hard palate, or zygoma (the bony arch below the eye orbit) might be removed.3,26,27 These patients require further reconstructive surgery after the cancer is removed. They also can experience problems with the ability to eat, chew, and speak if the zygoma is removed.

Patients who undergo a partial glossectomy will still be able to speak, although not as clearly as before surgery and the surgery might affect their ability to swallow normally.34 A total glossectomy results in the patient losing both the ability to speak and swallow. Reconstructive surgery and speech therapy might help the patient regain some speaking and swallowing function.34 A laryngectomy also affects speaking and swallowing.26,34

Chemotherapy combined with radiation therapy might produce better results than radiation therapy alone, but the adverse effects can be severe and difficult to tolerate for some patients, especially those in poor health.27

Chemotherapy can be used alone or with radiation to decrease the size of large tumors before surgery.3,26,32 Chemotherapy alone or with radiation therapy also can be used following surgery to destroy any remaining cancerous cells.3

Targeted therapy medications target the genes or proteins in cells that affect the cancer’s ability to grow and survive.3 The use of targeted therapy is designed to limit damage to healthy surrounding tissues while destroying the cancer cells. Targeted therapy drugs often have different or less severe adverse effects than standard chemotherapy drugs. Targeted therapy also can be used in conjunction with radiation therapy or standard chemotherapy.3

Box 5

Common Surgeries for Oral Cancers30,31

- Resection of the primary tumor. The entire tumor and surrounding area of normal appearing tissue are removed. Resection is used often for cancer of the lip, floor of mouth, tongue, alveolar ridge, retromolar trigone, hard palate, and buccal mucosa.
- Glossectomy, which is removal of all or part of the tongue.
- Mandibulectomy, or removal of part or all of the mandible.
- Maxillectomy, removal of part or all of the maxilla.
- Laryngectomy, which is complete or partial removal of the larynx.
- Neck dissection, which is performed to remove affected lymph nodes. The amount of tissue removed from the neck depends on the primary lesion size and local-regional spread of the cancer.
  - Partial neck dissection involves removal of only selective lymph nodes.
  - Modified radical neck dissection involves removal of most lymph nodes on the ipsilateral side of the neck between the mandible and clavicle, along with some surrounding muscle and nerve tissue.
  - Radical neck dissection involves removal of all ipsilateral lymph nodes in the neck and extensive muscle tissue, nerves, and veins.

Advanced or widespread for successful surgical resection.27 Chemotherapy combined with radiation therapy might produce better results than radiation therapy alone, but the adverse effects can be severe and difficult to tolerate for some patients, especially those in poor health.27

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Xerostomia (dry mouth).
- Trismus (jaw spasm).
- Dysgeusia (lost or distorted sense of taste).
- Loss of appetite.
- Change in voice or hoarseness.
- Infections of the mouth, such as Candida infection (see **Figure 5**).

Adverse effects of radiation therapy can be damage to the salivary glands, mandible, pituitary gland, or thyroid gland. As a result of this damage, patients might experience permanent xerostomia, which can lead to extensive tooth decay and difficulty swallowing foods. 

Extensive caries (cavities) can occur following radiation therapy because of poor saliva production (see **Figure 6**). 

Osteonecrosis of the mandible can be a serious adverse effect of radiation treatment. Osteonecrosis occurs when the bone begins to weaken and die because of decreased blood flow. 

Osteoradionecrosis describes osteonecrosis from compromised blood flow to the bone following radiation treatments. The risk of osteoradionecrosis lasts for the duration of the patient’s life and is higher following tooth infections, dental irritation, periodontal disease, tooth extractions, or trauma to the mouth. Complications of osteoradionecrosis include pain, drug dependency, fistulas, pathologic fractures, and loss of bone and soft tissues (see **Figures 7-8**).

Adverse effects from chemotherapy often are specific to the medication used. Some general adverse effects of chemotherapy include:

- Neutropenia, or reduction in circulating white blood cells, which increases the patient’s risk of infection.
- Bruising and bleeding because of reduced platelet count.
- Anemia and fatigue.

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**Figure 5.** White areas represent Candida fungal infection. Image courtesy of Dublin Dental University Hospital, Dublin, Ireland.

**Figure 6.** A. Orthopantomogram (OPG) acquired as part of preradiation therapy dental evaluation. B. OPG of the same patient 7 months after completion of radiation therapy. Radiolucent areas (arrows) show extensive radiation-induced caries and broken teeth. Images courtesy of Dublin Dental University Hospital, Dublin, Ireland.

**Figure 7.** Extensive bone loss in the anterior mandible from necrosis. Image acquired 1 year following completion of radiation therapy for oral cancer. Image courtesy of Dublin Dental University Hospital, Dublin, Ireland.
emotional changes; physical appearance; and activities such as eating, speech, and hearing. Because of this, the patient’s treatment team includes support professionals. Dietitians help patients receive proper nutrition and manage difficulty or pain with chewing or swallowing.\textsuperscript{3,26} Speech therapists can assist patients with speech problems caused by the cancer or treatment. An otolaryngologist might be needed to assist with changes to hearing, and a psychologist or cancer counselor can help patients with their emotional and psychological needs relating to cancer and the changes they face.\textsuperscript{3,26,27}

Patients who have surgical resections might require additional surgery to replace bone and teeth, or to reconstruct facial features. Reconstruction can help repair damage following cancer treatments and restore the function and appearance of the affected area. Specialists in reconstruction or maxillofacial surgeons typically perform these procedures. If a portion of the maxilla or the mandible is removed, the patient also is cared for by a maxillofacial prosthodontist.\textsuperscript{26}

Most adverse effects of chemotherapy cease after treatment. The use of chemotherapy in conjunction with radiation therapy can worsen adverse effects, making it difficult for some patients to tolerate treatments.\textsuperscript{26,27,35} Osteochemonecrosis causes bone complications.\textsuperscript{5} It typically presents as pain, soft tissue swelling, loose teeth, infection, and exposed areas of bone (see Figure 9).\textsuperscript{36}

Many aspects of oral cancer and its treatment affect a patient’s quality of life, in particular psychological and emotional changes; physical appearance; and activities such as eating, speech, and hearing. Because of this, the patient’s treatment team includes support professionals. Dietitians help patients receive proper nutrition and manage difficulty or pain with chewing or swallowing.\textsuperscript{3,26} Speech therapists can assist patients with speech problems caused by the cancer or treatment. An otolaryngologist might be needed to assist with changes to hearing, and a psychologist or cancer counselor can help patients with their emotional and psychological needs relating to cancer and the changes they face.\textsuperscript{3,26,27}

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Reconstruction

Because oral and oropharyngeal cancer can cause both functional and cosmetic impairments that can affect a patient’s quality of life, reconstruction or restoration procedures might be recommended. Cancer site and extent of tissue removal contribute to decisions regarding the procedure used.
A radical or partial maxillectomy might be performed in patients with cancers affecting the maxilla, particularly the hard or soft palate. A total, or radical, maxillectomy involves resection of the entire maxilla to the midline. The bone is removed through incisions in the patient’s upper lip and cheek. In a partial maxillectomy, the physician removes the diseased area through the mouth.

Eating can be difficult for patients who have had a partial or radical maxillectomy, which can affect both chewing and swallowing. Food and liquids can be forced up through the surgical opening, into the nasal cavity and out the nose when swallowing. The patient also might have facial disfigurement, problems with nasal cavity secretions collecting in the surgical area, and drying of nasal cavity mucous membranes.

Restoration for maxillary defects can begin during the maxillectomy. During surgery, a preconstructed surgical obturator, which is a temporary prosthesis, is placed into the surgical opening, closing the defect. The surgeon can place a permanent prosthesis after the tissues have healed.

Glossectomy and mandibular resection often present the greatest challenges of all surgeries for oral cancer. Patients can experience difficulty with speech, swallowing, mandibular movement, and salivary control; facial disfigurements are common and often result in diminished function compared with presurgical abilities.

Advanced tumors involving the floor of the mouth and the anterior portion of the tongue often result in a large amount of tissue being resected. The tongue can be reconstructed using tissue from the patient’s thigh or forearm. Figure 10 shows a postmandibular resection for cancer involving the left mandible before beginning the restoration processes.

Restoration processes for the mandible can be initiated during the cancer resection. Bone sections from the patient’s fibula are commonly used to replace bone lost from surgical removal and initiate the restorative process, which might involve dental implants to improve chewing and preserve cosmetic appearance (see Figures 11-12). The entire restoration process can take several years to complete.

**Role of the Dental Team**

Dental professionals including hygienists, nurses, radiographers, and dentists all have a role in the care of patients with oral and oropharyngeal cancers. Often, the dentist is the health care professional who first discovers a suspicious abnormality in the mouth and initiates investigation, or in some cases, performs the biopsy.

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**Figure 10.** An OPG demonstrating removal of the left body of the mandible and ramus. No initial restorative steps had been taken at the time the image was acquired. Image courtesy of Dublin Dental University Hospital, Dublin, Ireland.

**Figure 11.** Patient with fibular restoration. Dentition on the right has not yet been replaced. Image courtesy of Dublin Dental University Hospital, Dublin, Ireland.

**Figure 12.** Patient with healed fibular restoration with dental implants to restore dentition on the right. The image is slightly distorted with the patient rotated to the right. Image courtesy of Dublin Dental University Hospital, Dublin, Ireland.
Pretreatment Evaluation

Once a patient has received an oral or oropharyngeal cancer diagnosis, and if the treatment plan includes radiation therapy or chemotherapy, the patient requires a thorough pretreatment dental evaluation by a dental oncologist. Assessment should take place at least one month before treatment initiation and can involve several visits. Pretreatment assessments are used to:

- Reduce risk or severity of oral complications from treatment.
- Identify and treat current oral problems (such as infections or caries) and minimize the risk of developing complications during treatment.
- Provide a baseline for future examinations.
- Prevent, eliminate, or reduce oral pain.
- Prevent or minimize complications that could affect nutrition.
- Prevent or reduce chances of osteonecrosis.
- Preserve and improve oral health.
- Provide patient education about oral hygiene during and after treatment.
- Help improve the patient’s quality of life.
- Decrease the cost of care.

During the first visit, a thorough dental evaluation, including dental radiography, is conducted. The evaluation assesses teeth, gums, and surrounding soft tissues. The dental evaluation for a patient with oral cancer usually begins the process of:

- Identifying and initializing treatment for mouth infections, caries, broken teeth, and any tissue injuries or disease.
- Identifying and extracting any teeth in the radiation field that cannot be restored to minimize the chances of osteonecrosis from post-treatment extractions. Required oral surgery should take place at least 2 weeks before treatment begins.
- Evaluate current prostheses such as dentures in the patient’s mouth to ensure cleanliness and proper fit.
- Measure saliva flow.

From the pretreatment evaluation, a dental plan is created and discussed with the patient. Patient education is essential for reducing complications and ensuring treatment success. Patients are advised about oral care, nutrition, and smoking and alcohol cessation as necessary.

Patients also are advised regarding an oral care routine to follow during treatment. Oral care education includes the type and use of toothbrushes and dental floss, instructions for using fluoride gel if applicable, jaw exercises to maintain flexibility and prevent stiffness and trismus, the use and care of dental appliances, and strategies for relieving xerostomia and mucositis.

During pretreatment dental visits, patients also might have impressions taken for fitting medication trays and radiation stents. Medication trays are used for application of a medicated or fluoride gel to help prevent tooth decay. Radiation stents serve as positioning aids during radiation treatment and help minimize effects from radiation to the surrounding healthy tissues.

Patients also will have a thorough cleaning of their teeth by a dental hygienist before treatment. Scaling to remove tartar and teeth polishing also will be performed. Patients are instructed how to perform daily mouth checks and record changes in their oral and dental condition during and after treatment.

During Treatment

During cancer treatment, a dental nurse plays a primary role in helping patients maintain oral care. The dental nurse can assist the patient by:

- Answering questions about daily mouth checks.
- Monitoring adherence to daily oral care by giving guidance and support to caregivers and patients.
- Providing topical or systemic analgesia as directed and allowed by scope of practice for pain management.
- Administering medications for mouth infections such as thrush as directed by dentist or other physician.
- Helping the patient manage xerostomia.

A patient with oral cancer might see the dental oncologist for up to 2 years following radiation therapy or chemotherapy. During these visits, the dentist checks teeth and soft tissues for disease, treats the mouth as needed, and monitors saliva flow. The patient continues to receive education and advice regarding diet and oral hygiene during this time. Patients also...
should continue to keep regular appointments with their own dentist.

Some hospitals employ dental radiographers who are specifically trained to acquire images for dental patients. Dental radiographers are fully qualified radiologic technologists who undertake extra training to become competent in dental imaging for special needs, pediatric, and oncology patients. Although dental hygienists and nurses who complete a specified training course are allowed to perform dental radiography, a dental radiographer has a more in-depth understanding of radiography and might be preferred to image patients with oral cancer.

**Role of Radiography**

Radiography is not used in the initial diagnosis of oral or oropharyngeal cancer, although radiographs can assist in displaying alveolar bone and tissues in the region of suspected cancer to assess for localized involvement. Cancers of the mouth and oropharyngeal region are routinely diagnosed through tissue biopsy with histological examination of the tissue samples. CT scans, PET scans, or a chest radiograph might be used to assist with evaluation of metastases and staging in some cases. Oral radiographs are an integral part of the patient’s evaluation and follow-up.

Obtaining dental images of the patient with oral or oropharyngeal cancer following treatment can be difficult for the dental radiographer. Positioning can complicate imaging because of the patient’s limited motion and anatomic changes associated with the cancer or treatment. To obtain the best images possible, the dental radiographer should have knowledge of the type of cancer, the treatment options used, adverse effects or complications from treatment, and the specific indication for the examination.

Radiographs that are part of the patient’s evaluation before and after treatment include intraoral and extraoral imaging. Intraoral images are taken with the film, image plate, or digital detector placed inside the patient’s mouth. Extraoral imaging places the film, image plate, or detector outside the patient’s mouth. Most commonly, orthopantomograms (OPGs), periapical images, or bitewing images are taken. Each type of image plays a specific role in demonstrating anatomy and pathophysiology in the mouth.

**Orthopantomogram**

OPG images are based on tomography principles and are considered an extraoral examination. The OPG equipment uses tube and receptor motion to create a 2-D slice image of the patient’s entire lower face from the temporomandibular joints to the mandibular symphysis. OPG imaging uses long exposure times of 16 to 20 seconds while the machine moves in a circular motion around the patient’s head to form a single-slice image that demonstrates dentition and bones of the entire mandible and maxilla. A long object-to-image receptor distance results in a magnified image that is diagnostically useful.

OPG images routinely are acquired as part of the pretreatment and post-treatment assessment of patients with oral and oropharyngeal cancer. Indications for OPG imaging before radiation or chemotherapy treatment include assessment for bone loss; lesions; general status of tooth health, such as evidence of broken teeth or caries; and retained roots from prior extractions. Following treatment, an OPG might be used to assess restorations and dental implants. A periapical radiograph or bitewing images might be ordered to provide better detail of an area the dentist observes on the OPG.

![Figure 13. Periapical image of lower right premolars and first 2 molars. Tooth 7, the second molar, has a large cavity in the crown; tooth 6, the first molar, is broken and has an associated infection below the apex, or root tip. Image courtesy of Dublin Dental University Hospital, Dublin, Ireland.](image-url)
Periapical Radiographs

Periapical images are intraoral images that show individual or small sections of teeth and their surrounding tissues (see Figure 13). Their usefulness in imaging the patient with oral cancer is to further explore an area of concern noted by an OPG, physical examination, or patient complaint. Periapical images are used for detection of periapical disease or infection that occurs at the root of the tooth and its surrounding tissues, evaluation of lesions in the alveolar bone, assessment of areas around loose or sensitive teeth, evaluation of roots before tooth extraction, to evaluate caries, and to evaluate single implants in patients who can tolerate the image receptor placement in their mouth.

Bitewing Images

A common type of intraoral image taken for caries assessment between the crowns of the teeth is the bitewing image. Bitewing images also can be used to monitor caries’ progression and assess restorations to crowns (see Figure 14).4 Bitewing images display the crowns of the molar and premolar teeth used most for chewing. Assessment of the alveolar ridge also is possible from these images.

Bitewing images might be used to assess patients before and after radiation and chemotherapy treatments begin. If multiple areas of caries are noted on the OPG image or by dental examination, bitewing images might be taken to provide a closer assessment of the caries. Bitewing images also are used to detect smaller, less obvious caries between the teeth.

Positioning

Positioning of patients for dental radiography following surgery or radiation therapy can pose special challenges for the dental radiographer because of complications from treatment such as trismus and mucositis. In addition, positioning can be made more difficult because of anatomic changes in the patient’s mouth and facial area from surgical removal of tissue, teeth, and bone. The extraoral OPG often is the simplest radiography examination to perform for patients with oral cancer immediately following surgical resection or radiation therapy; the OPG provides information for a good general assessment of the entire mouth. Because the OPG detector is located outside the patient’s mouth, limitations from mucositis, trismus, or internal anatomic changes are of less concern for imaging.

When positioning for an OPG, 3 positioning planes are used. The patient rests the chin on the unit’s chin rest and the unit is moved vertically to ensure the Frankfort plane (infraorbital meatal line) is parallel to the floor.42 The midsagittal plane is aligned to the central positioning light. The positioning light, called the canine light, is placed between the patient’s upper cuspid and lateral incisor on either side (the upper second and third teeth according to the Federation Dentaire International system).42 Use of the patient’s left or right upper teeth during positioning is based solely on location of the positioning light on the panoramic unit and is of no clinical significance. Patients who are edentulous might have the canine positioning light placed at the outer junction of the lips. The patient then bites gently on the bite stick with the front teeth or gums. The patient must be able to stand or sit erect for the 15-second exposure without moving while the C-arm detector and x-ray tube rotate around the patient’s head (see Figure 15).

Positioning must be precise for an OPG. Because orthopantomography is based on tomographic principles, the image is a slice or section of the area of interest. The section, which is referred to as the focal trough, is the part of the image that is in focus and well
Any changes to patient positioning alter the area that is in focus.

The main positioning challenge when acquiring OPGs on patients with oral cancer is with patients who have had a recent mandibulectomy. These patients can have swelling and pain in the lower anterior jaw region or in the neck. The dental radiographer might need to adjust positioning for patients following mandibulectomy to minimize discomfort from the surgical site resting on the chin rest.

Intraoral images such as periapicals and bitewings can pose problems for dental radiographers when imaging patients following radiation therapy, chemotherapy, and surgical resection. Intraoral images require that an image plate and holder be placed inside the patient’s mouth parallel to the area of interest (see Figure 16). The beam alignment ring remains outside the patient’s mouth. The typical size of an image plate used for intraoral imaging is 1.2 inches × 1.6 inches (31 mm × 41 mm), which is a particular problem for patients with trismus.

Restricted mouth opening can affect a patient’s ability to eat, speak, and perform oral hygiene. Trismus can develop secondary to surgical scarring and edema or be induced by radiation treatments. The ability of the patient to open his or her mouth can be measured using 3 fingers. If a health care practitioner can insert 3 fingers stacked between the upper and lower front teeth (incisors), then the opening is considered functional. Anything less is considered an indication for treatment and possibly for alteration of the examination or positioning.36

The dental radiographer must adjust positioning for patients who have trismus and need intraoral images. Most often, this means that the image plate holder and beam alignment cannot be used. The dental radiographer might have to place the image plate in position using one finger or hand...
and slide it into position in the patient’s mouth without bending the image plate or causing the patient discomfort. The radiographer should then instruct the patient how to use a finger to hold the plate in position during the radiographic exposure. Because dental intraoral units have no collimator or central ray lights, the radiographer must line up the tube and image plate visually to ensure the image is captured.

Mucositis is another adverse effect of radiation therapy or chemotherapy that can hinder the acquisition of intraoral radiographs following treatment. Although mucositis usually resolves by the time a patient arrives for a 6-month or 1-year follow-up examination, some patients need radiographs before 6 months, or have more serious or long-lasting mucositis. Mucositis can cause sores or ulcers in the mouth, tongue, or gums and pain, swelling, and bleeding. Patients who have ulcers or pain in the area of interest might not be able to tolerate intraoral images. The radiographer who attempts to acquire intraoral images in these cases should take extra care to avoid causing further pain or tissue damage in the area. This includes positioning the imaging plate slowly and gently. As with patients with trismus, the radiographer might need to have the patient hold the plate.

Scarring or surgical removal of bone or tissue also can complicate intraoral radiography. Scars, edema, or changes to the patient’s anatomy can prevent the radiographer from placing the image plate in the mouth properly. Swelling or changes to patient anatomy can prevent the image plate from being positioned well enough to include the roots of the teeth and the apex region in the field of view; these areas often are required on periapical images.

It is the radiographer’s responsibility to recognize when it is not possible to take diagnostic quality dental images of patients with oral cancer. It also is the radiographer’s responsibility to suggest other options for imaging the area of interest (eg, extraoral imaging or oblique images). No exposure should be made unnecessarily.

**Communication and Radiation Safety**

The dental radiographer should demonstrate compassion, empathy, and patience when working with patients. Often, a patient has an altered appearance from scarring or removal of bone, teeth, or tissue following treatment and might feel embarrassed and concerned about the changes. Pain from treatment and anger at the diagnosis also can affect patients. Radiographers should understand that some patients with oral and oropharyngeal cancer might have speech difficulties or be unable to speak while recovering from glossectomy or laryngectomy. The radiographer can alter assessments to include simple “yes” or “no” questions, or ask the patient to nod if speaking is too difficult.

The radiographer should thoroughly explain the examination to the patient. This includes explaining steps the radiographer is taking and what the patient needs to do to assist with the examination. The more time spent with the patient and the more the patient understands what is required, the better cooperation radiographers are likely to receive, even if the procedure causes some discomfort for the patient.

Because of the low dose of radiation used in dental imaging, there is no need to shield a patient’s gonadal regions, breast, or thyroid in most circumstances. Doses from dental images do not affect tissues or organs below the diaphragm, and if the proper rectangular collimators are used, the dose will not affect the thyroid unless the beam is directed toward the thyroid or the thyroid is located in the primary beam. Dental departments using circular collimators should shield the patient’s thyroid area.

Patients who have received radiation therapy usually are concerned about the amount of radiation they receive from follow-up radiographs and might ask that shielding be used. The shields should be used to reduce these fears if possible. Radiographers also can explain radiation protection trends in radiography and dentistry so that patients are aware of standards; radiographers should never refuse to provide shielding if it is requested and available. Shielding cannot be used for the external OPG unit because the shield will affect the image quality. The radiographer might need to explain this thoroughly to ensure the patient understands the limitation and consents to the examination.

Survivors of oral cancer might need several radiographs during the 2 to 3 years following treatment. Some patients return because of cancer recurrence, but others
might need additional radiographs to evaluate complications from osteonecrosis, xerostomia, and increased caries formation. Radiographs also might be needed to evaluate for extractions because of tooth disease or infection or to assess the mouth for restoration and placement of dental implants. The dental radiographer is integral to the patient’s care and health care experience.

**Conclusion**

Oral cancers affect many aspects of life for patients and their families. Patients can suffer severe physical and emotional changes from the cancer, its treatment, and potential lifelong changes to appearance, speech, and function.26,32

Simple screenings for oral and oropharyngeal cancers can aid early diagnosis, which leads to a higher survival rate.13 No comprehensive screening programs are in place in the United States, and public awareness is still lacking. As a result, most cancers are found in the later stages and are associated with a poor 5-year survival rate.1,4 Because these cancers are on the rise in young nonsmokers, often as a result of HPV infection, dental and radiography professionals should be advocates for implementing screening protocols and increasing public awareness.1,3

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**References**


Medical Imaging of Oral and Oropharyngeal Cancer

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Read the preceding Directed Reading and choose the answer that is most correct based on the article.

1. Head and neck cancers typically originate in the _______ cells that line mucosal surfaces.
   a. epithelial
   b. squamous
   c. epidermal
   d. sarcoma

2. Which of the following are sites for oropharyngeal cancer?
   1. soft palate
   2. tonsils
   3. gingivae
   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3

3. The most commonly reported oral cancer site in the United States is the:
   a. tongue.
   b. gums.
   c. lips.
   d. inner surface of the cheeks.

4. Which of the following is not a known risk factor for the development of oral cancer?
   a. cigarette smoking
   b. chewing paan
   c. drinking alcohol
   d. smoking marijuana

5. _______ is a risk factor that is implicated in increased oral cancer among adults aged 25 to 50 years.
   a. Cigarette smoking
   b. Alcohol use
   c. Human papillomavirus
   d. AIDS
6. ______ is an abnormal red patch that forms in the mucosal lining of the mouth that is a concern for dysplasia and cancer.
   a. Erythroplakia
   b. Leukoplakia
   c. Erythema nodosum
   d. Xerostomia

7. Which of the following statements regarding oral cancer screening is false?
   a. Oral cancers are easy to identify early through screening.
   b. Screening can be done by patients at home and takes less than 10 minutes.
   c. The United States has a comprehensive oral cancer screening program.
   d. Screening looks for color differences, texture changes, lesions, and lumps.

8. On average, changes that persist in the mouth for ______ indicate a need for medical attention.
   a. 4 days
   b. 2 weeks
   c. 2 months
   d. 4 months

9. A(n) ______ biopsy uses a small circular blade pressed into an abnormal area to remove a small core of tissue.
   a. exfoliative cytology
   b. punch
   c. fine-needle
   d. conventional

10. According to the article, computed tomography is used in oral cancer for:
    1. screening.
    2. determining the size and location of a tumor.
    3. detecting possible metastases.

   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3

11. Cancer at which location is associated with a 5-year relative survival rate of 38%?
    a. distant tongue
    b. regional tongue
    c. regional floor of the mouth
    d. localized floor of the mouth

12. Radiation therapy is the most common treatment for patients with oral cancer and early stages of oropharyngeal cancer.
    a. true
    b. false

13. Glossectomy is surgical removal of:
    a. a tumor of the gums.
    b. all or part of the tongue.
    c. all or part of the buccal mucosa.
    d. lip tissues.

14. Radiation therapy for oral cancer can cause which of the following adverse effects?
    1. skin erythema
    2. trismus
    3. dysgeusia

    a. 1 and 2
    b. 1 and 3
    c. 2 and 3
    d. 1, 2, and 3
15. Which of the following statements is false regarding osteoradionecrosis?
   a. It is an adverse effect of radiation therapy for oral cancer.
   b. The risk of osteoradionecrosis is present only during treatment.
   c. The complication causes bone to weaken and die from loss of blood.
   d. Tooth extractions or trauma to the mouth increase risk for osteoradionecrosis.

16. Chemotherapy for oral cancer can cause:
   1. alopecia.
   2. mucositis.
   3. skin erythema.
   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3

17. Restoration processes for the mandible can be initiated during cancer resection.
   a. true
   b. false

18. A dental evaluation for a patient with oral cancer usually begins the process of:
   1. initializing treatment for possible infections, caries, or broken teeth.
   2. evaluating current oral prostheses to ensure cleanliness and fit.
   3. measuring saliva flow.
   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3

19. Radiation ______ serve as positioning aids during treatment and can minimize effects from radiation to the surrounding healthy tissues.
   a. stents
   b. prostheses
   c. obturators
   d. trays

20. Which of the following is an extraoral dental radiographic examination?
   a. bitewing
   b. orthopantomogram (OPG)
   c. periapical
   d. occlusal

21. Assessing which of the following would not be an indication for taking a periapical image?
   a. caries
   b. the apex of the tooth
   c. lesions in the alveolar bone
   d. the entire mandibular dentition

22. Which of the following examinations would be best for patients with trismus?
   a. OPG
   b. periapical
   c. left bitewing
   d. magnetic resonance imaging

23. Which of the following statements is true regarding imaging of a patient who has mucositis as an adverse effect of treatment?
   a. Mucositis has no effect on intraoral or extraoral radiography.
   b. Patients will not be required to hold the plate during imaging.
   c. The primary problem with mucositis is sores and ulcers that cause pain in the mouth during intraoral positioning.
   d. The radiographer must adjust positioning to avoid artifacts that interfere with image quality.

continued on next page
24. According to the article, which of the following is false regarding radiation protection in dental imaging?
   a. Thyroid shielding always must be used.
   b. Patients do not need shielding for the gonadal region.
   c. Circular collimators require thyroid shielding.
   d. When using rectangular collimators, patients do not need any shielding.

25. If a patient is concerned about radiation from a dental imaging examination, the radiographer should:
   1. explain current radiation protection trends.
   2. provide shielding if available and requested.
   3. refuse shielding when it is not clinically necessary.

   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3