Radiation prosthesis: A review

Renu Gupta, R. P. Luthra, Deepak Gautam

Department of Prosthodontics & Crown and Bridge, H. P. Government Dental College, Shimla, Himachal Pradesh, India

Abstract

Radiation has been used for the treatment of various head and neck tumors. Sadly, this treatment causes complications by increasing the mortality of the neighboring tissues. In radiation of the oral cavity and the paranasal sinuses tumors, the level of which the tissues are included in the radiation treatment portals will determine the gravity of the oral unease during treatment. Affecting the nutritional status of the patients and may finally affect the total dose of radiation which the patients can receive for the treatment. The adverse tissue reactions are discomforting and also lowers the life’s quality, mostly dispiriting the patient from undergoing therapy. Radiation prostheses can prevent the unnecessary irradiation of the surrounding normal tissues, therefore reducing the severity of reactions. Since the use of these stents is personalized, close association between the radiotherapist and prosthodontist is essential. This article aims at presenting the various prostheses that can be used by the oral cancer patients to receive better treatment and reduce post radiation difficulties.

Keywords: Irradiation, radiation prosthesis, stent, tumor

Introduction

The use of radiation has increased slowly since the discovery of X-rays in 1895 and of radium in 1898 by Curie. Lack of knowledge in this type of radiation frequently resulted in damage to the patient and to all involved in the treatment procedure. Therapeutic response to an intraoral carcinoma includes surgery, radiotherapy or chemotherapy. Radiation is divided into extraoral and intraoral therapy. Oral complications caused by head and neck radiotherapy are disheartening for the patients as well as the caregivers. It has been established that the incidence and extent of mucositis are related to the total cumulative radiation dose and volume of oral tissue affected by such radiations. Recent studies investigated the use of customized intraoral prostheses with the intention of both decreasing radiation dose in healthy structure and minimizing the adverse effects of radiation. As a precautionary measure or to reduce the level of the harmful effects, radiotherapy protective prosthesis can be fashioned and used during treatment. These prostheses are used for the protection or displacement of vital structures, to locate the diseased area in repeated positioning of beam during the treatment, carrying a radioactive material, as a dosimetric device, reshape tissues to simplify dosimetry and shield the healthy tissues. Before the beginning of radio therapy, flexible mouth trays can be constructed covering the teeth and used for applying topical fluoride for the prevention of radiation-induced tooth problems.

Radiation Prosthesis

Radiation prosthesis is a man-made device that helps in the methodical administration of dose to the desired areas and thus limiting post radiotherapy complications.

Methods of radiation delivery

Patients are usually treated at 1.8-2 Gy per fraction. The treatments are usually from Monday to Friday with no treatments on weekends. The treatment lasts from 4 to 7 weeks. This type of schedule is called conventional fractionation schedule

1. External beam radiation
2. Internal beam radiation
3. Modern radiotherapy.

Materials used for the fabrication are:
- Heat cure acrylic resin, tin foil and wood’s metal (cerrobend alloy)
- Wood’s metal is a eutectic fusible alloy of 50% bismuth, 26.7% lead, 13.3% tin and 10% cadmium by weight and has a melting point of 158°F.

Adverse Effects

Complications of radiation include change or loss of taste, inflamed mucosa, pain, infection, change in salivary function, and effects nutrition. Longstanding complications include poor tissue tolerance, mucosal atrophy, soft tissue and bone necrosis,
fibrosis of connective tissue and muscle, trismus, pain, infection, xerostomia, and rampant caries. There’s a range of effects that the patient may experience based on the type of radio therapy, the treatment sites (body area that is treated), location of disease, total dose, location to vital organs, individual resistance, overall health and mental attitude. The adverse effects include radiation mucositis, ulcers, fungal infections, xerostomia, caries from decreased salivary flow and pH changes, possibilities of infection in the jaws or the potential for osteoradionecrosis from infection or trauma to irradiated bone. Harm to healthy tissues can be prevented using methods such as a befitting method of therapy and by use of fractionation regime. Physical methods such as shielding and correct positioning are also used for reducing the damage.\(^\text{[4]}\)

Radiation prosthesis can be classified into three groups: They are:\(^\text{[7]}\)

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### Positioning stent

Prostheses that displace the movable tissues away from or towards the source of radiation. Example: The lips, tongue, cheeks, and soft palate may need to be directed away from the source of radiation to prevent their damage or maybe direct toward the source when indicate.\(^\text{[1]}\)

Radiotherapy of maxilla and the hard palate carcinomas usually involves the temporomandibular joint and masticatory muscles, which causes inelasticity of the joint, and fibrosis of the muscles leading to trismus, which can be reduced by oral exercises and use of the appliances.\(^\text{[3]}\)

They are of two types:
- a. Peri-oral cone positioning stent
- b. Tongue depressing stent.

#### Peri-oral cone positioning stent

These stents are indicated where treatment of superficial lesions involving is required. They position the cone in an exact position when boosting the dose to the trauma site is required. The actual cone or cylinder of the same diameter as the cones is used to form an acrylic resin ring of 5-6 cm long. Tinfoil is wrapped around the cone as a separator from acrylic resin. In the presence of a radiotherapist, the cylinder is attached to the maxillary record base (edentulous patient) or occlusal indices (dentulous patients), and the cone is centered over the lesion. The treatment cone is inserted into the positioning stent for verification of the position. It lowers the tongue and places it in repeatable and the exact position during therapy. It separates the mandible and maxilla [Figure 1].\(^\text{[6]}\)

#### Problem with standard cones

Intraoral cones mostly used range from 3 to 4 cm in diameter having bevelled tips. It is advisable in treating lesions from the end of the cone being in contact with mucosa within the entire duration of the treatment procedure. This is very difficultly achieved owing to the varied topography of the mouth. If there will be space between the tip of cone and the tissue, there can be two situations, either the healthy tissue outside the field will be unnecessarily irradiated or the dose will be reduced by an amount proportional to the square’ of the distance between the end of the cone and the tissue. In 1975, Parel and Drane described the method for constructing a modified intra oral prosthesis for directing a radiation beam.\(^\text{[6]}\) A customized metal extension can be fabricated either directly or indirectly using this technique. The final stent allows homogeneous and steady direction of the beams for treating lesions intraorally.\(^\text{[9]}\)

#### Tongue depressing stent

Healthy tissues are protected from beam by placing them outside the radiation zone or shielding the beam. Patients undergoing radiation of unilateral regions of parotid or retromolar-trigone lesions must have their tongue protected or it will be inflamed, making speech and swallowing hard.\(^\text{[10]}\) Tongue depressing stents are a custom made device which positions the mandible, depresses the tongue and protects the parotid gland during radiotherapy. Controlled depression of tongue allows the radiation to better focus on the clinical tumor volume. The clinician takes upper and lower alginate impressions and then a bite registration is done with the focus to place the inter-incisal distance between 10 and 15 mm [Figure 2].

#### Advantages

Previously cork and tongue blades were used to depress the tongue, but these stents provide more accuracy and great patient comfort. Minor salivary glands and taste buds can be saved from radiation injury. This reduces xerostomia and hence improves the patient’s quality of life. According to a study done by Bart Johnson in the year 2013, a significant decrease in oral mucositis, xerostomia, and taste dysfunction was seen.\(^\text{[10]}\)
Shielding stent
A shielding stent of particular thickness of acrylic and containing lead or cerrobend can be used to protect structures which are close to the radiation therapy sites. This prevents radiation to the surrounding normal tissues and prevents any side effects. E.g., tongue shielding devices and lip shielding devices (Goswami et al., 2013; Santiago, 1965). When the radiation is directed at the buccal mucosa, the skin, mucosa and alveolar bone adjacent to it undergo irradiation too. A cheek shielding device containing cerrobend can be placed intraorally in the buccal vestibule, thus protecting the intraoral tissues. They are of two types:

Tissue recontouring stent
These stents are useful when the beam is adjusted for midlines for treating skin lesions associated with lips. Due to curvature of the lip, low doses of radiation are delivered at the corner of the mouth, whereas higher doses are delivered at the midline. These stents flatten the lips and the corner of the mouth thereby placing the entire lip in the same plane and providing equal and exact radiation dose (Goswami et al., 2013) [Figure 3].

Tissue bolus compensators
These prostheses help in treating superficial lesions of face with irregular borders. Due to irregularities in the lesion, some areas within the field may go untreated while others may develop isolated hotspots (Mantri and Bhasin, 2010). Bolus is a tissue equivalent material which is placed directly onto the irregularities that helps in converting irregular tissue contours into flat surfaces which are perpendicular to the central access of the ionizing beam, to thereby more accurately aid in the homogenous distribution of the radiation [Figure 4].

Radiation carriers incorporated with radioisotopes
These prostheses hold radium or cesium-137 securely in a planned site during every treatment (Santiago, 1965). These prostheses administer radiation to a confined region by means of capsules, beads or needles of radiation emitting materials.

Radiation measuring stent/dosimeter positioning stents
These prostheses contain lithium fluoride capsules that help the radiotherapist to calculate radiation encountered by tissues which are in contact with the capsule [Figure 5].

Radiotherapy mask
Radiotherapy has to be aimed very precisely to make sure that exactly the right area of the body is treated each time. It is important that a person having radiotherapy lies still while the treatment is in progress. This is because any movement could change the area that gets treated. To help with this, a radiotherapy mask (sometimes called a mold, a head shell, or a cast) is made to be worn during the treatment.
Conclusion

The Maxillofacial Prosthetic Department can help in the care of radiation therapy patients beyond the routine dental prophylaxis. Various intraoral prostheses can be fabricated easily and with expertise for each individual patient to help meet difficult problems of delivering high dose radiation therapy to the oral cavity and the paranasal sinus areas. Modification of the described prostheses based on individual patient need is necessary to maximize these benefits. At times, the head and neck surgeon and radiotherapist are not fully aware of the many primary and supportive services that the maxillofacial prostodontists can perform through the use of the prostheses. It is recommended that such a specialist be on the team for consultation before planning any head and neck cancer surgery or before starting radiotherapy. These measures make the patient’s treatment course smoother and simplify the surgeon’s treatment plan. Large prospective trial that includes prevention and treatment of radiation-induced trauma to oral tissues are required for improving management and increase prognosis.

References