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Review Article

Radiotherapy - A Focused Ray of Hope

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Abstract

Oral carcinoma has occupied the sixth position with the 5 year survival rate at 50% or even less. Over the years various other diagnostic methods have been added for the process of diagnosis, however they are just adjunctive to the screening methods. Right treatment at the right time remains as a very important aspect even today and is considered to play a vital role in achieving a good prognosis. Treatment includes surgery, chemotherapy, radiotherapy and many more. However, the role of each of the treatment is to eradicate oral carcinoma but has its own side effects. Radiotherapy can be used as a single modality as well as an adjuvant to the surgical management after surgery. However, the side effects is a matter of concern in radiotherapy.

Herein, this article focuses on radiotherapy and the pathways to deliver the same for a better life.

Keywords: Oral Carcinoma; Radiotherapy; Chemotherapy

Introduction

Oral carcinoma has occupied the sixth position with the 5 year survival rate at 50% or even less. However squamous cell carcinoma was and is still ranked the number one most common carcinoma of the oral cavity with the prognosis being poor [1].

The recurrence of oral carcinoma even after an arduous follow up is has not lost its pace or its rarity and manifests as a major problem even after treating oral carcinoma. Research over the years has helped in early diagnosis of cancer which not only helps in early detection but also in management and a favorable diagnosis which is the aim of each and every individual [1].

Although many etiologic factors for oral carcinoma have been established, still tobacco (smoking and smokeless form) and alcohol remain the primary cause for the disease process [2]. World Health Organization (WHO) has emphasized the importance of the knowledge of healthcare professionals which will help in early diagnosis as visual examination is still the primary method of screening.2 Over the years various other diagnostic methods have been added for the process of diagnosis, however they are just adjunctive to the screening methods [3].

Right treatment at the right time remains as a very important aspect even today and is considered to play a vital role in achieving a good prognosis. Treatment includes surgery, chemotherapy, radiotherapy and many more. However, the role of each of the treatment is to eradicate oral carcinoma but has its own side effects. Herein, this article focuses on radiotherapy and the pathways to deliver the same.

Radiotherapy (RT) plays a vital role in the management of head and neck carcinoma. The radiation dose required for the management of oral carcinoma is based on the location and the type of malignancy, which has been found to be around 50-70 Gy units [4].

Even though the primary effect of radiotherapy is tumoricidal, the ionizing radiation causes damage to the other normal tissues which are located in the purview of the radiation. The head and neck region is a complex structural area which is composed of the mucosal lining, skin, subcutaneous connective tissue, teeth and the bone/cartilage, which have varying type of responses to the ionizing radiation being harmful in nature.[4] Also the oral complications arising from radiotherapy is a vital part in defining the quality of life in the carcinoma patients [5].

Oral mucosal changes such as erythema, pseudomembrane covered ulcers, reduced salivation and changes in the composition of saliva, decreased taste acuity and skin (erythematous desquamation) are the immediate changes which are seen after radiotherapy, however late changes are still an evident part occurring in tissues as a curse.

Radiotherapy can be used as a single modality as well as an adjuvant to the surgical management after surgery.[6] However, the side effects is a matter of concern in radiotherapy.

Modernization has replaced the conventional radiotherapy using simpler rectangular treatment fields with linear accelerator forms which produce high-energy external radiation beams [7-9].

Intensity-modulated radiotherapy (IMRT)

It is the radiotherapy with high precision which utilizes computer controlled linear accelerators with static or multi-leaf collimators or volumetric arc modulated therapy to distribute specific radiation bouts to the malignant tumor or its specific tumor site [7,10].

It is being used mainly to treat the head and neck region, prostate cancer, central nervous system, breast, thyroid, lung, gastrointestinal and gynecologic carcinomas [6,10].

Herein, 3-D computed tomography (CT) or magnetic resonance image (MRI) is utilized to determine the site and also the dose intensity pattern to cover the tumor site and shape in one shot while eliminating the necessity for field matching, thus curtailing any dosimetric qualms [7].

The advantages of IMRT are that it spares the [7]

- Salivary gland,
- Mucosa of digestive tract,
- Optic nerves
- Pharyngeal constrictors
- Brain stem and spinal cord.
- Oral and hypopharyngeal muscles
- Cochlea.

Disadvantage

- Highly precise or precisely inaccurate.
- The greatest risk can be to miss the tumor altogether while attempting to be very precise in defining targets and sparing normal structures [6].

Image Guided Radiotherapy (IGRT)

It consists of 2 dimensional images which are usually acquired in orthogonal plane to determine the iso-center of the lesion. Images are produced by the megavoltage (MV) beam of the treatment machine or less often by a devoted ancillary kilo voltage unit. IGRT is often used with intensity-modulated radiation therapy (IMRT), proton beam therapy, or stereotactic body radiotherapy (SBRT) to treat carcinoma cases [11].

Spine and skull are typically the bony landmarks which are used as reference points for alignment during the treatment process.

IGRT is used to treat the body organs that are prone to movement which include the head and neck cancers and tumors in areas of the body, lungs, sites close to critical organs and tissues [11]. Further, image guidance helps to delineate tumor and to correct intra and inter fraction movement during radiotherapy [7].

IGRT helps to diagnose and exact the topographical error that can ensue during treatment delivery. IGRT can be combined with Positron emission tomography, which helps to delineate the gross tumor volume with the help of radio-active tracer element explicitly more common element being Fluorine 18 labelled fluoromisonidazole. This element exclusively shows the hypoxic tumor areas which is depictive of the tumor site [6].

Three-dimensional (3D) conformal radiotherapy

In three-dimensional assisted radiotherapy there is radiotherapy guided and directed towards a specific site, which would be accurate and more precise in treating the tumor site.

Three-dimensional (3D) conformal radiation therapy uses reconstructed matched computed tomograms (CT) and Magnetic Resonance images (MRI) which helps to reduce an amiss during treatment plan and its tumor site.

The beam distribution can be confined to the tumor extent and silhouette by the use of customized dense block or by multi-leaf collimators which contains 40 pairs of tungsten measuring 1 cm in width [7].

The change in the distribution of the beam helps in reducing the dose of the radiation by up to 50% to the normal tissues, which would help in a faster recovery and reduced late tissue injury [8].

Intensity modulated proton (IMPT)

It allows modulation of the influence and position of Bragg peak, permitting three dimensional dose distributions. The present role of proton therapy lies in the treatment of tumor close to the skull base or spinal cord and in pediatric patients. Proton therapy provides maximum benefit in terms of normal tissue sparing [6].

Particle radiation therapy

Charged particle beams which consists of protons and carbon ions have the Bragg peak effect and allow highly localized deposition of energy that can be used for increasing radiation doses to target while minimizing irradiation to adjacent normal tissues [12,13].

Charged particles like protons deposit little energy until they reach their end of their range at which point most of the energy is deposited in a small area until they near the end of their range at which point the rate of energy loss increases resulting in what is term as the Bragg peak [14].

Carbon ion therapy

Carbon ion radiotherapy is also the same and offers superior dose confirmatory target site volume than the other modalities.16 Also high linear energy transfer (LET) radiation such as carbon ion beams have greater biological effectiveness than low LET radiation, such as X rays and proton beams.

This higher cell killing potency and dose distribution among the tissues makes carbon ion radiotherapy an outstanding potent treatment for carcinoma patients [15-17].

Boron neutron capture therapy (BNCT)

It works on the principle of selective uptake of non-radioactive boron compounds which is injected into the patient and on achieving the required drug levels in the tumor site which can later be irradiated with a neutron beam causing boron B10 to be converted into B11, which disintegrates to release an α particle and 7Li, which have high linear energy transfer (LET), thus killing the cancer cells with almost no damage to the surrounding normal tissues [18].

The BNCT delivery agents currently used in clinical trials are sodium borocaptate (BSH) and boronophenylalanine or BPA.

Volumated Intensity modulated Arc Therapy (VMAT)

VMAT delivers IMRT-like distributions in a single rotation of the gantry with varying gantry speed and dose rate during delivery in contrast to standard IMRT, which uses fixed gantry beams. This technique has been implemented in the Eclipse treatment planning software under the name Rapid Arc (RA) Planning.

Studies using RA demonstrate shorter planning and treatment time, lesser monitor units for treatment delivery, better dose homogeneity and normal tissue sparing [6,19,20]. There is a lack of data in regard to clinical implementation of this technique [6].

Adaptive radiotherapy (ART)

It can also be termed as progressive variable radiotherapy, as the radiation dose is altered depending on the state of the tumor site during the 6-7 weeks treatment phase [11].

Along with physical deformation there could also be biological variations with redistribution of tumor cells through the phases of cell cycle and re-oxygenation of previously hypoxic cells, converting radio resistant cells to radio sensitive in some cases and vice versa [11].

Thermo radiotherapy

In this technique high temperature is applied at the tumor site during radiotherapy, which improves the treatment outcome carried out during radiotherapy [7].

Radio immunotherapy

Here, cytotoxic radionuclides such as Yttrium 90, Iodine 131 are in alliance with the antibodies, which are target specific toward the tumor site, which in turn helps to deliver toxins to the target tumor site [7].

The more dense the tumor, the more is the drug delivery and hence more absorption of radiation at the area, hence more commonly known as Targeted Radiotherapy.[6] Further, even if the target tumor site misses the conjugation with the drug process, still it will undergo radiation induced tumor cells death and are not spared [14].

If has been proved to be efficacious in treating lymphomas, with still trials in progress to treat oral carcinoma using monoclonal antibodies.

Stereotactic radiotherapy

It is a single painless high dose of radiation technique used to treatment brain tumors. The stereotactic radiation works by directing a small focused radiation beam within the cancerous tissue.

A classic example of this technique is the Gamma Knife, which is a radical surgery using radiation targeted to treat brain abnormalities which has been proven safe and effective, with good outcomes.

The imaging systems which include computed tomography scans, magnetic resonance imaging and arteriograms help to isolate the unusual areas within the brain and destroy them using multiple beam of low dose gamma rays which converge to produce a high dose of radiation at the exact side, and being a protector of the innocent side [7].

Sanctuary therapy

It is an exquisite treatment focused to treat the hidden tumor cells which have the capability to evade the oncologist, even when the patient has undergone adjuvant chemotherapy which can attributed to the lipid layer which act as guard barriers against the entry of the chemotherapeutic agents. It consists of prophylactic radiation treatment of 2000 to 3000 rads targeted towards the site of interest [21].

Intraoperative electron radiation therapy (IOERT)

It is also called as precision radiotherapy as it spares the lives of the non-tumor tissues and the critical structures surrounding the target volume. It targets only the target site and not the other surrounding tissues and the structures during any intraoperative procedures. IOERT has proven to be beneficial when used in conjunction with endovascular brachytherapy which in turn reduces integral dose and treatment time [22,23].

Conclusion

Radiotherapy has shown that it has the capability to trim itself and serve the purpose as per others needs and not limit itself only to the conventional old field of technology alone. It has the power, but just needs the right directions to unleash itself which would be our responsibility.

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