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Review Article

REVIEW ON RAPID ARC BASED STEREOTACTIC BODY RADIOSURGERY FOR LUNG, HEAD AND NECK CANCER

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ABSTRACT

Steriotactic body radiation therapy is a newly emerging radiotherapy treatment method to deliver a high dose of radiation to the target in a single dose or number of fractions. The features of SBRT patients both normal and abnormal tissue are defined with CT, MRI, or angiography or any other image studies that may be useful in localizing the target volumes. It is a non-surgical procedure that uses highly focused X rays beams to treat lung cancer. Unlike surgery SBRS is painless and patients can continue routine life style activities without any difficulty. Rapid arc radiotherapy represents a new revolution in cancer care. Cancers including head and neck malignancies, brain tumors, thoracic tumors, abdominal tumors, pelvic tumors have been treated with this technology.

Key words: Rapid arc radiotherapy, cyber knife, linear accelerator, steriotactic radio surgery .

INTRODUCTION

Lung cancer is the commonest cancer in India in males[1]. The symptoms of lung cancers are vague. Steriotactic body radiation therapy is a newly emerging radiotherapy treatment method to deliver a high dose of radiation to the target in a single dose or number of fractions. Cancers including head[2] and neck[3] malignancies, brain tumors[4], thoracic tumors, abdominal tumors, pelvic tumors also have been treated with this technology. This involves the administration of very large radiation doses to an isolated tumor within an extracranial location. SBRS is high precision radiation therapy modality which delivers high doses to extremely precise targets. It is completely noninvasive and achieves similar out comes as surgery. It is a non surgical[5] procedure that uses highly focused X rays beams to treat lung cancer. Unlike surgery SBRS is painless and patients can continue routine life style activities without any difficulty. Rapid arc radiotherapy represents a new revolution in cancer care. Cancers including head[6] and neck[7] malignancies, brain tumors, thoracic tumors, abdominal tumors, pelvic tumors have been treated with this technology. Stereotactic radio surgeryis a highly precise form of radiation therapy used primarily to treat tumors and other abnormalities of the brain. It is a non surgical[8] procedure that uses highly focused X rays beams to treat certain types of brain tumors, inoperable lesions and as a post-operative treatment to eliminate tumor tissue. The treatment involves the delivery of doses of radiation beams focused directly to the tumor. The software enables stereo tactic radio surgery to minimize the amount of radiation to healthy brain tissue. It can also be used to treat obsessive compulsive disorder and even movement disorders. This enables radiation oncologists to treat several types of cancers with great precision in significantly less time. It is a volumetric modulated arc therapy that delivers a 3D dose distribution with a single or multiple rotation of linear accelerator gantry. This treatment can be given to the most irregular tumor shapes and smallest structures can be effectively spared.

ELIGIBLITY OF THE PATIENTS

- Candidates tumor size in lung must be less than 6 cm
- Non meta static
- Mediastinal nodes not positive
- Inoperable patients
- Presence of medical co morbidities

COMPARISION OF SBRT / SBRS WITH SURGERY

- Surgery carries a risk of complications including long term pain but not in the case of SBRS.
- Surgery requires chronic oxygen supply compared with SBRS
- Sometimes surgery leads to death. It is occasional in the case of SBRS.
- Death rates of lung cancer surgery is as high as 10 -20%
- Patients who are not suitable for surgery are treated with external beam radiotherapy[9] where lung is exposed to high doses of radiation.

MERITS OF RAPID ARC BASED SBRS

- In SBRS, low volume of lung exposed to radiation
- Curing rate is high in SBRS
- Low risk of long term complications in the case of SBRS
- Less uncertain because the movements that compromise treatment are avoided
- More accurate due to quick delivery
- More comfortable for the patients
- Dose distribution is superior to the IMRT
- Treatment time reduced by 80%
- This treatment is considered noninvasive and no incision is made.
- No general anesthesia is required
- Disease control for those who are having high surgical risk
- It is performed on an outpatient basis leaving the patient free to go home after surgery
- Ability to deliver higher doses of radiation with minimal risk to the healthy surrounding tissue
- Efficient, more patient convenience and high thorough put.
- Perform conventional and electron treatments .
- Visualize soft tissue via cone beam CT which is not available with cyber knife.

EQUIPMENTS USED

Linear accelerator[10] (LINAC) machines, prevalent throughout the world, deliver high-energy x-rays, also known as photons.

Gamma Knife[11] which uses 192 or 201 beams of highly focused gamma rays all aiming at the target region.

STEREOTACTIC RADIOSURGERY USING THE GAMMA KNIFE

Radiosurgery involves imaging of the tumor location, computerized dose planning, and radiation delivery. The lightweight aluminum head frame is a guiding device that makes sure the Gamma Knife beams are focused exactly where the treatment is needed.

Next, magnetic resonance imaging (MRI) scan will be performed to show the exact location of the tumor. In some cases, a computed tomography (CT) scan may be performed instead of, or in addition to, an MRI scan. Then using special computer software,irradiate the tumor and minimize dose to surrounding normal tissues.Depending on the Gamma Knife model and the treatment plan, the whole treatment may be performed without interruption or it may be broken up into multiple smaller parts. The total treatment may last less than one hour or up to four hours.

STEREOTACTIC RADIOSURGERY USING LINEAR ACCELERATOR (LINAC)

Magnetic resonance imaging (MRI) scan and computed tomography (CT) scan will be performed to show the exact location of the tumor. The imaging, treatment planning, and first treatment may be spread out over multiple days. It may be up to five treatments over the span of one or one and a half weeks. The beams of radiation from a LINAC are shaped to a very high degree of accuracy by metal tubes known as collimators. Unlike the gamma knife unit, the LINAC moves around the patient during treatment, delivering arcs of radiation matched by computer to the shape of the tumor.

SIDE EFFECTS

Stereotactic radiosurgery[12] does not produce some of the side effects commonly associated with radiation treatment, such as reddening of the skin or hair loss. [13]Most patients can return to their usual daily activities following treatment without any special precautions. The risks of stereotactic radiosurgery include mild headache, tiredness, nausea and vomiting, and recurrence of the tumor. Radiosurgery can cause secondary tumors in some cases but it is very least possibility.

COMPARISON OF RAPID ARC STEREOTACTIC RADIO SURGERY & CYBER KNIFE[14, 15]

	CN	SRS
Treatment time	2-10 min	35-90 min
Treatment planning	I plan treatment	Multiplan treatment
Set up localization	On board imager	Room based
Treatment delivery	6 MV	6MV and 1000 MU

INDICATIONS

Stereotactic radio surgery	high grade glioma pituitary[16] adenoma trigeminal [17]neuralgia
Hyper fractionated Stereotactic Radiotherapy	Brain metastasis Large arteriovenous malformations vestibular schwannomas
Stereotactic Radiotherapy	craniopharyngiomas [18,19]pituitary adenoma vestibular schwannomas

TREATMENT PROCEDURE

Stereotactic radiosurgery (SRS) can be performed with two different types of machines to provide the radiation used to kill the tumor cells. The gamma knife is a stationary unit that contains 201 sources of gamma rays derived from cobalt-60 that can be focused by a computer on a single small area of the brain. The radiation can be directed very precisely to the tumor without destroying nearby healthy tissue. The patient lies on a couch with a large helmet attached to his or her head frame. The helmet contains holes that allow beams of radiation to enter. The couch is then slid into a gantry containing the cobalt-60. Treatment time varies from several minutes to over an hour, depending on the size, shape, and location of the tumor. Gamma knife radio surgery is usually a single-dose treatment.

Radio surgery can also be performed with a linear accelerator (also called a LINAC), which is a device that produces high-energy photons that can be used to treat larger tumors, metastatic tumors or arteriovenous malformations. Linear accelerators are preferred for multi-session treatments using smaller doses of radiation. Radiosurgery performed with divided doses is known as fractionated radiosurgery; some doctors prefer to call it fractionated stereotactic radiotherapy. The advantage of fractionated treatment is that it allows a higher total dose of radiation to be delivered to the tumor without harming nearby normal tissues. The beams of radiation from a LINAC are shaped to a very high degree of accuracy by metal tubes known as collimators. Unlike the gamma knife unit, the LINAC moves around the patient during treatment, delivering arcs of radiation matched by computer to the shape of the tumor.

An eleven field coplanar unopposed beam arrangement using 6 MV photons was prepared. The isocenter was set in the center of target L 4. The prescription dose was 18GY administered in a single fraction to the planning target volume. The maximum dose to the cordthekal sac was 9.9 Gy and maximal dose to both kidneys was 7.9 Gy. About 95% of the target volume received at least 18Gy and the maximal target dose was about 22Gy. The left iliac crest was also treated with a total dose of 6 Gy using two oblique beams at the same isocenter at L 4.

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