Treatment of Brain Metastases Using Stereotactic Radiosurgery

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Introduction

This research-based project will demonstrate the effectiveness of stereotactic radiosurgery compared to whole brain radiation therapy in managing cognitive function and improving the quality of life in patients diagnosed with brain metastases. Metastatic brain cancer is diagnosed through a physical exam, which gathers information on family history and symptoms along with a neurological exam which is comprised of vision and reflex tests. In addition, a computed tomography (CT) or magnetic resonance imaging (MRI) test will be ordered to visualize any physical properties of a possible tumor in the brain. After an individual is diagnosed, a patient is evaluated to determine treatment paths and options. If a patient is selected for radiation therapy, they will undergo the process of simulation followed by a treatment plan involving whole-brain radiation therapy (WBRT) or stereotactic radiosurgery (SRS) but may opt for both.

Brain Metastases

Metastatic brain cancer is caused when cancer spreads to the brain from other areas of the body. The cancerous cells will break away from their original location and travel through the bloodstream or lymph system. Ultimately, they end up in the brain where they begin to disperse. The most prevalent cancers that can spread to the brain are lung, breast, melanoma, colon, kidney, and thyroid gland cancers (Bettegowda, 2022).

- Around 1/3 of patients with another form of cancer as stated above will develop one or multiple metastatic brain tumors (Bettegowda, 2022).
- The risk of developing metastatic brain tumors increases after the age of 46 and continues to significantly increase in individuals over 65 (Bettegowda, 2022).
- Some common sign and symptoms include headache, personality changes, memory loss and seizures (Mayo Clinic, 2020)

Diagnosing Brain Metastases

- Positron emission tomography (PET), magnetic resonance imaging (MRI), and computed tomography (CT) scans are the exams of choice used to diagnose brain metastases
- An MRI perfusion study is most common when diagnosing individuals with brain metastases (Mayo Clinic, 2020)
- A biopsy may be performed to determine whether the cells of the tumor are malignant or benign.
- Surgical resection of the tumor may be performed
- Once a patient is diagnosed, treatment options depend on age, performance status, and tumor type (Washington & Leaver, 2016).
- Brain metastases can be treated on three different types of machines such as a linear accelerator, gamma knife, or through proton beam therapy (Mayo Clinic, 2020)

What is SRS?

Stereotactic radiosurgery is the administration of high-dose radiation that is delivered in a single or up to five sessions to a specific brain tumor under the guidance of real-time imaging (Beydoun et al., 2021). SRS treatment allows for high-dose delivery of radiation to treat these lesions in the brain without killing healthy tissue as well as cutting down the treatment sessions significantly.

Advantages and Disadvantages of SRS

- WBRT improves central nervous system control and decreases the risk of neurological death, although not without risk of deteriorating cognitive side effects.
- SRS patients allow for a similar survival rate, but a generally better cognitive function compared to WBRT patients.
- A study on SRS-treated patients demonstrated a lower risk of deterioration in their learning and memory functions (Al-Wassia & Iskanderani, 2021).
- A three-year study was done on SRS treatment for brain metastases. The results of the research showed that 83.3% of patients had expired, while only 16.7% had remained alive with a mean survival rate of 313 days (Al-Wassia & Iskanderani, 2021).
- Although, many of the patients had passed away, findings in the research demonstrated that SRS treatments had significantly decreased tumor enhancement and tumor size.
- A setback of SRS treatments is the risk of missing remnants of minuscule tumors leading to tumor regrowth.

Treatment Set-Up

Varian True Beam Linear Accelerator

- Gantry (rotates around the patient to deliver treatment)
- SRS aquaplast mask
- Cone beam CT scanner (inspects patient positioning)

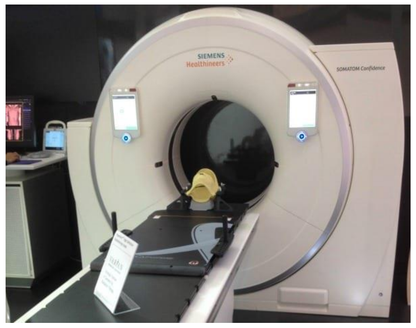
https://physicsworld.com/a/optical-surface-tracker monitors-patient-position-during-brain-radiotherapy/

Patient Demographics and Medical History

A case study involving a 56-year-old woman who was originally diagnosed with carcinoma of the left breast in 2009, which later metastasized into her lungs in 2020 was cured of both cancers. In late 2020, early 2021 the cancer metastasized into her brain where her doctor suggested stereotactic radiosurgery. The patient's doctor believed she was a great candidate for this treatment. This patient has seen an improvement in her symptoms after her treatment.

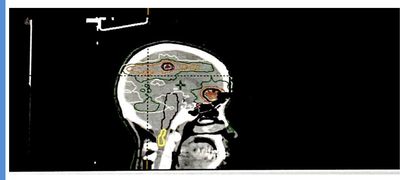
Patient Simulation

- 1/21/22- Patient treatment was simulated
- Patient positioned with an SRS aquaplast mask rested into black head mold, which minimizes movement during treatment, provides precise precision of dose to the tumor(s).
- A roll is placed underneath patient's knees for comfort & to keep midline of patient properly aligned along with handles placed at sides to depress the shoulders
- Patient is aligned with laser in the room, mask is taped and marked where lasers cross.
- CT scan is done for dosimetrist to calculate appropriate dose plan to target tumors and spare critical organs and anatomy.
- 1/24/22- A total dose is calculated 2700 cGy over a total of three fractions (900 cGy dose per fraction)

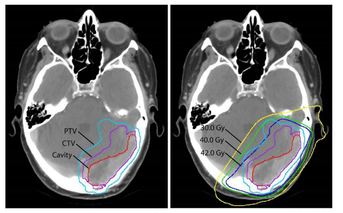


https://24x7mag.com/medical-equipment/imaging-equipment/ct/siemens-introduces-ct-scanner-radiation-therapy/

Patient Treatment Planning



- Sagittal CT scan of planned dose



- Planned Target Volume (PTV)
- Clinical Target Volume (CTV)
- Cavity (tumor

(Bryne., et al, 2020)

***PTV and CTV accounts for possible variations in beam alignment due to patient positioning, motion, or deformity (Bernstein, Taylor, Nill, & Oelfke, 2021).

SRS Treatment Team

- Radiation oncologist oversees treatment by outlining tumor(s) to be treated, evaluates any tissues or organs at risk, approves the treatment plan along with radiation dose.
- Medial radiation physicist establishes the delivery of exact dose of radiation to the patient.
- Dosimetrist uses specialized computer software to develop treatment plan, by calculating the exposure and beam configuration to treat targeted areas with prescribed dose given by the oncologist.
- Radiation therapist positions the patient on the treatment table, while operating machine from outside the room to deliver prescribed dose of radiation.
- Nurse is responsible for assessing the patient and provides any information involving possible symptoms or questions regarding to the treatment.

(stereotactic radiosurgery, 2020)

Conclusion

This project was done to demonstrate the effectiveness of stereotactic radiosurgery compared to whole brain radiation therapy in managing cognitive function and improving the quality of life in patients diagnosed with brain metastases. Stereotactic radiosurgery is becoming more favorable in treating patients with brain metastases because there is a lower risk of deterioration in learning and memory functions. However, sometimes it is recommended SRS is used in conjunction with or after WBRT to avoid possibly missing minuscule remnants of tumor(s). With further research on SRS treatment, it can only advance patient outcomes and treatment options for the future.

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