Stereotactic Radiosurgery (SRS) at John Muir Health TRUE Radiosurgery

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Abstract

There were an estimated 149,000 people living with primary brain and spinal cord cancer in the U.S. in 2012. In 2015, there will be an estimated 22,850 new cases and 15,320 deaths, indicating that brain and spinal cord cancer is one of the deadliest forms of cancer[1]. In addition to primary brain and spinal cord cancers, another 10-30% of adults with cancer will develop brain metastases, accounting for up to 170,000 new cases per year. Brain metastases are most commonly diagnosed in patients with breast and lung cancer, and melanoma. Skeletal regions are the third most common areas for cancer to metastasize, with the spine being the most frequent.

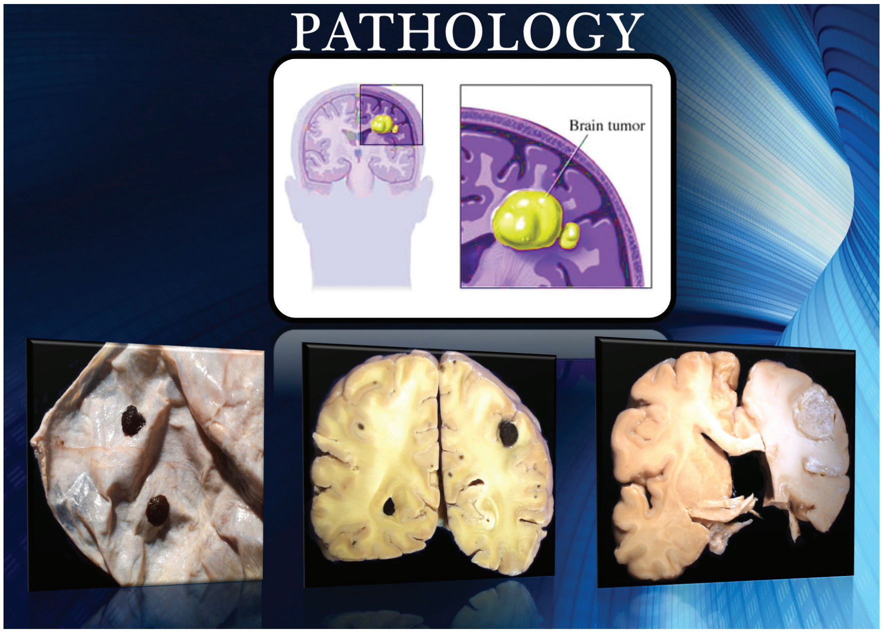
The rising incidence of brain metastases is primarily due the aging population, improved treatment for the primary disease, and improved imaging techniques. Brain metastases are an increasing source of morbidity, mortality and cognitive impairment at the time of diagnosis. Left untreated, brain metastases lead to rapid neurologic deterioration and death.

Management has become increasingly complex as patients with brain and spinal cord metastases are living longer and more treatment options develop. This white paper reviews the treatment of brain and spinal cord cancer, with a particular focus on stereotactic radiosurgery (SRS).

Introduction

Treatment of brain and spinal cord cancer depends on the tumor's size, location, and type, as well as the patient's age and general health. Recently, there has been a re-definition of the various types of brain cancer, along with recommended treatments. The main treatments include surgery, radiation therapy, and chemotherapy. A combination of treatments is often used. Treatment goals should consider patient survival, and preserving quality of life and neurologic function. Goals for treating spinal cord cancer also include managing pain and preserving mechanical stability, as a small percentage of patients present with spinal cord compression and spinal instability.

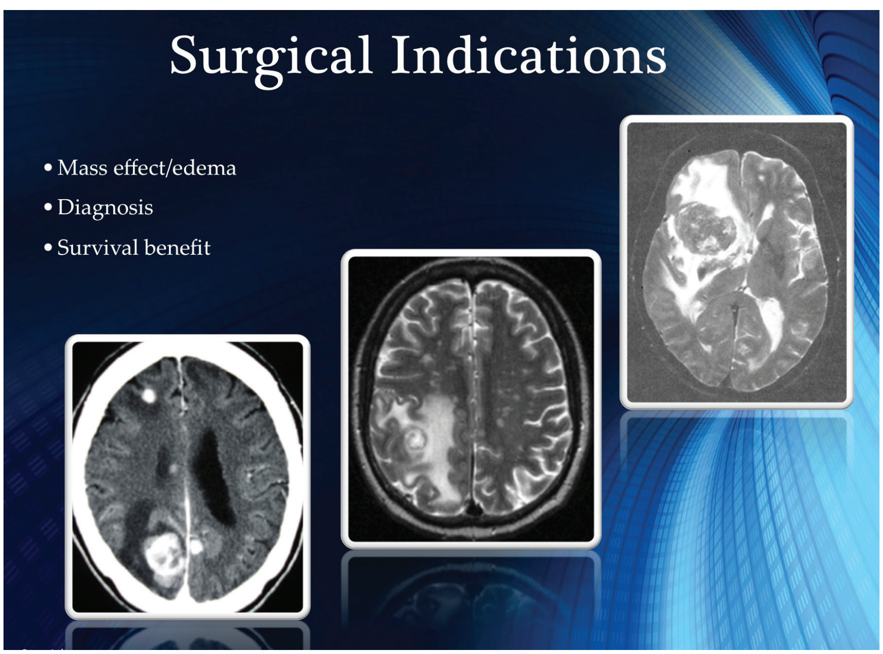
JOHN MUIR HEALTH



Before treatment, a patient may be given corticosteroid drugs to reduce swelling of brain tissue. Anticonvulsant drugs also may be prescribed to prevent or control tumor-related seizures.

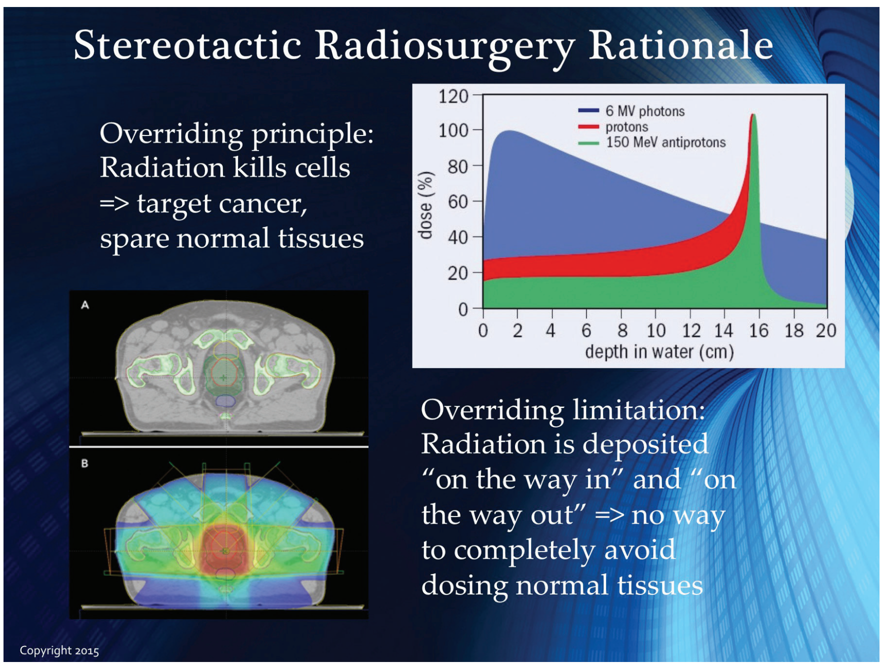
Treatment

Surgery, also called surgical resection, can successfully remove benign and malignant brain and spinal cord tumors. In some cases, a tumor cannot be removed surgically or surgery is too risky. For example, the tumor may sit adjacent to or wrap around critical healthy tissue. Damage to these tissues during surgery could cause the patient significant disability. Surgery is also not recommended for patients presenting with several metastases (usually more than 4).



Radiation therapy for brain cancer involves directing a beam of radiation through the skin to the tumor and a small amount of normal surrounding tissue. Whole brain radiation therapy (WBRT) is used to treat brain metastases that involves large areas of the brain, or a large number of sites. While WBRT has been shown to be effective in certain cases, it is associated with a high incidence of side effects as normal healthy tissue also receives a therapeutic dose of radiation.

Stereotactic radiosurgery allows precisely focused, high-dose radiation beams to be delivered to a small, localized area of the brain. With stereotactic radiosurgery, the goal is to kill the tumor cells and spare the surrounding healthy tissue. Sophisticated imaging allows contouring the radiation beam to the tumor shape. Stereotactic radiosurgery is especially helpful in reaching tumors deep in the brain, and in treating multiple tumors that are smaller (less than 3 cm) and more localized. Treatment may be designed to precisely deliver a single high dose of radiation in a one-day session, or as fractionated treatment, involving smaller doses over multiple days.



Stereotactic radiosurgery has also been shown to be effective as an adjunct following surgical resection, and as a “boost” or salvage following WBRT. It also has been shown to be an effective treatment for certain cancers that are more resistant to conventional radiation therapy, such as renal cancer.

Not all SRS technology is the same

There are several technologies available for delivering stereotactic radiosurgery.

The Gamma Knife® has a long history in the treatment of brain metastases, and uses highly focused gamma rays aimed at the target region. Doses conform to the tumor shape but are not uniform in nature. The Gamma Knife® is able to deliver high doses of radiation, but treatment times are slower than with other technologies. Imaging used in planning and guiding treatment is not included as part of the delivery system. Also, the Gamma Knife® is a frame-based delivery system, requiring the patient to wear a fixed mechanical frame around their head during treatment.

GAMMA KNIFE®

Advantages	Disadvantages
• Neurosurgeons tool • Long history	• Restricted to head and upper spine • Non-uniform dose • Framed Delivery • Moves the patient • No 4D capability • Technology has run its course

The CyberKnife® is a newer technology that delivers high doses of radiation, but that requires a very long delivery time. Unlike the Gamma Knife®, the CyberKnife® is a frameless delivery system, allowing patients a greater degree of comfort during treatments. Imaging is incorporated within the delivery system and includes the latest 4D imaging techniques. The CyberKnife® provides sub-millimeter precision in targeting tumors and is considered by some to be more precise than the Gamma Knife®.

CYBERKNIFE®

Advantages	Disadvantages
• New • High precision (sub-millimeter) • Frameless delivery • Imaging during treatment (sort of) • Automated alignment • 4D capable	• Field shaping restriced to cones • Long delivery times • Restricted to SRS only (no SRT)

The TrueBeam™ STx is one of the latest stereotactic radiosurgery technologies. Offering either framed or frameless delivery, the TrueBeam™ STx incorporates 4D imaging technology and motion management with its delivery. Radiation delivery times are shorter with the TrueBeam™ STx than with other technologies, and it similarly offers sub-millimeter targeting precision like the CyberKnife®. Based on measures of dose conformity, the TrueBeam™ STx is superior in its ability to target diseased tissue and spare healthy tissue.

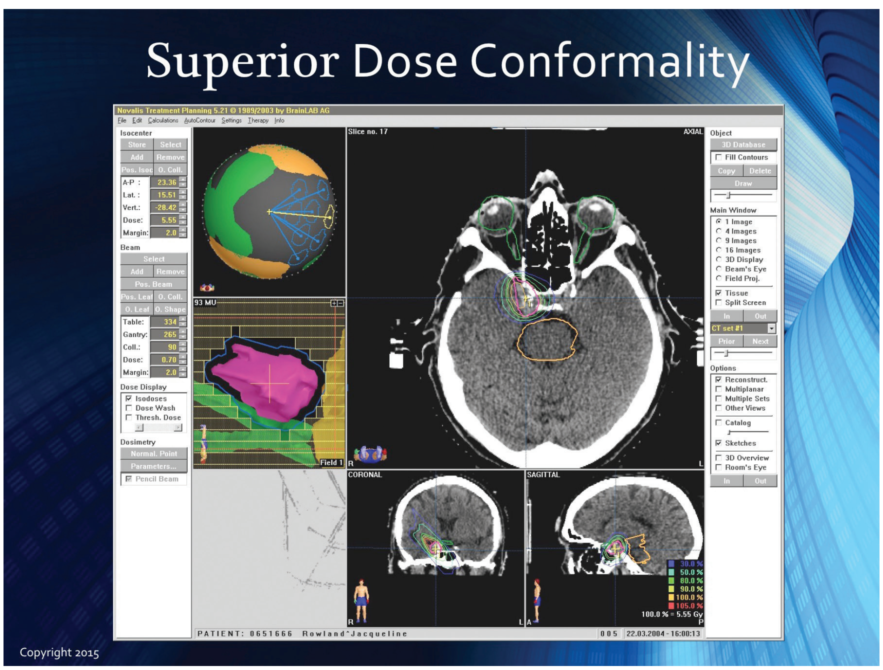
TRUEBEAM™ STx

Advantages

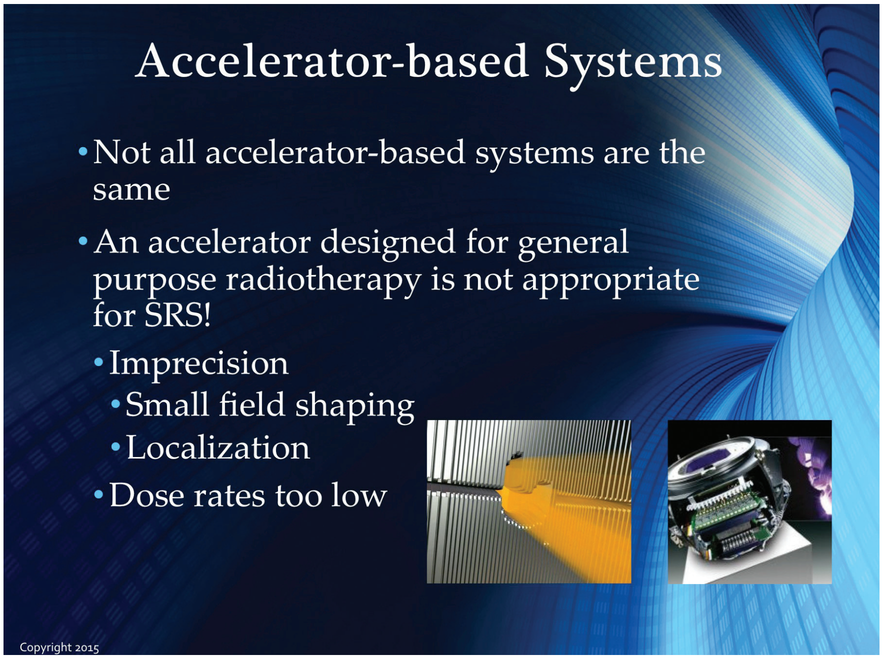
- High precision (sub-millimeter)
- Frameless or framed delivery
- Monitoring during treatment
- Automated alignment
- 4D capable
- Multiple delivery modes (cone, MLC)

Disadvantages

- Medium delivery time



Other linear accelerator technologies are also widely available but most have been developed for general purpose radiotherapy and are not dedicates SRS systems. Most have been adapted for SRS through the use of cones to target the radiation beam. Traditional linear accelerators do not offer the precision of the TrueBeam™ STx and other dedicated SRS systems. The dose rates are also too low to treat many brain and spine cancers.



SRS at John Muir Health

John Muir Health offers a comprehensive approach to the treatment of brain and spinal cord cancer. This includes providing a full portfolio of treatment options including the TrueBeam™ STx, and a highly qualified team of neurosurgeons, radiation oncologists, radiologists, medical oncologists, pathologists and other professionals who have treated over 150 patients with brain and spinal cord cancer. All treatments are individualized to help improve patient outcomes, and maximize patient comfort and convenience. A Tumor Board meets weekly to review all cases, and referring physicians are welcome to attend and participate in patient care. A dedicated nurse navigator helps facilitate referrals.

References

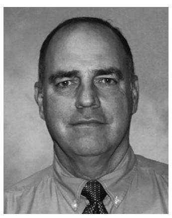
1. American Cancer Society. Brain and CNS Tumors in Adults. www.cancer.org. Jan 2015.

About the Authors

Dr. George J. Counelis, M.D., F.A.A.N.S., F.A.C.S.

Dr. Counelis is a Board Certified neurosurgeon who specializes in complex brain and spinal problems. He received his medical training at Tufts University School of Medicine in Boston. After a post-doctoral clinical fellowship in cerebral blood flow at UCLA, he completed his internship and six years of neurosurgical training at the Hospital of the University of Pennsylvania. During his training at the University of Pennsylvania, he completed fellowships in brain tumor research and complex spinal surgery. In 2004, Dr. Counelis joined the medical staff of John Muir Health and was chosen as the Medical Director of the Brain Tumor and Neuro-Oncology Program in 2008.

Dr. William S. Bice, Ph.D.



Dr. Bice was awarded his doctorate by the University of Florida in 1985 and certified by the American Board of Radiology in Therapeutic (1988) and Diagnostic (1994) Radiologic Physics. As a medical physicist he has been responsible for linac-based stereotactic radiosurgery programs for more than 20 years. Prior to accepting the chief of physics position at John Muir Health, he practiced medical physics in London, England for two years. Dr. Bice was on the faculty of the University of Texas Health Science Center in San Antonio for more than 25 years, teaching medical physics as well as conducting and publishing research.

Dr. Marjaneh Moini. M.D.

Dr. Moini is certified by the American Board of Radiology/Radiation Oncology. After completing medical school at the Universita Cattolica Del Sacro Cuore, Milan, Italy, she completed her internship at Yale University School of Medicine. Her Residency program was at Johns Hopkins University School of Medicine. She has held faculty positions at Johns Hopkins University and U.C. Davis Medical Centers