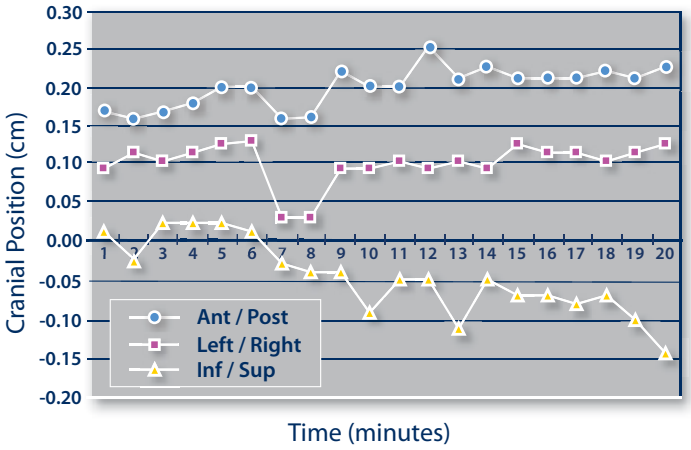
Intracranial Radiosurgery

Delivering unprecedented targeting accuracy with continual image guidance throughout the treatment

In the United States, brain metastases affect nearly 170,000 individuals per year.[1] Primary benign brain tumors and malignancies constitute an additional 39,000 cases annually.[2] While surgery, chemotherapy, and radiation therapy have historically been the standard of care, radiosurgery has emerged as a revolutionary treatment for intracranial lesions. With more than 100 systems in clinical use worldwide, the CyberKnife® Robotic Radiosurgery System has set new standards for radiosurgical accuracy, conformality, and versatility.

Patient Movement in Frameless Image-Guided Radiosurgery



Murphy MJ, Chang SD, Gibbs IC, Le QT, Hai J, Kim D, Martin DP, Adler JR Jr. Patterns of patient movement during frameless image-guided radiosurgery. Int J Radiat Oncol Biol Phys. 2003 Apr 1;55(5):1400-8.

Unprecedented Targeting Accuracy

Many modern radiosurgery systems now incorporate "frameless" capabilities, however, most fail to adequately manage sub-millimetric intra-fraction movements common with non-invasive intracranial immobilization (see graph). Where technologies such as IGRT and cone beam CT provide pre-treatment set-up image guidance, target movements during the treatment remain unrecognized, which may result in an increased risk of toxicity to sensitive structures.

The CyberKnife System has revolutionized frameless intracranial radiosurgery as the only system capable of continual image guidance to automatically track, detect, and correct for intra-fraction target movements throughout the treatment. With this unique image guidance technology, the CyberKnife System has proven to maintain an unprecedented 0.31 mm targeting accuracy treating intracranial lesions in independent, peer-reviewed studies.[3] Most remarkable, this accuracy applies to both spherical and non-spherical targets, where radiosurgical targeting accuracy has proven to erode using multiple isocenters via conventional radiosurgery systems.[4]

Unrivaled Dose Conformality

For more than 30 years, radiosurgery technical research and clinical studies have demonstrated that a large array of uniquely angled beams enhances dose conformality while reducing the risks of dose toxicity. Unconstrained by the clockwise/ counter-clockwise gantry rotations of conventional radiation therapy equipment, the robotic mobility of the CyberKnife System extends these proven benefits by delivering diverse non-coplanar treatments routinely in daily clinical practice. Unlike the 7 to 9 beam plans commonplace with gantry-based systems, a typical CyberKnife System treatment includes more than 100 uniquely angled, highly focused beams per fraction.

Where isocentric treatment delivery is common for treating large radiotherapy fields and spherical targets, this technique is often not optimal for treating targets of complex shapes – especially with radiosurgical doses and when radiosensitive structures are in close proximity. As the only system capable of delivering both isocentric and non-isocentric treatments, the CyberKnife System has an unparalleled ability to precisely sculpt delivered dose around sensitive critical structures.

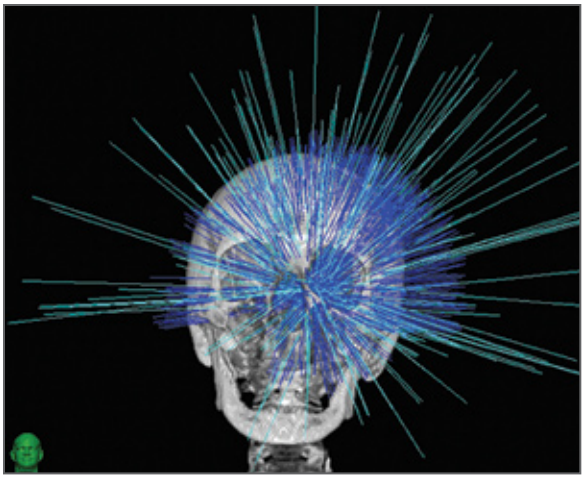


Image courtesy of Barrow Neurological Institute

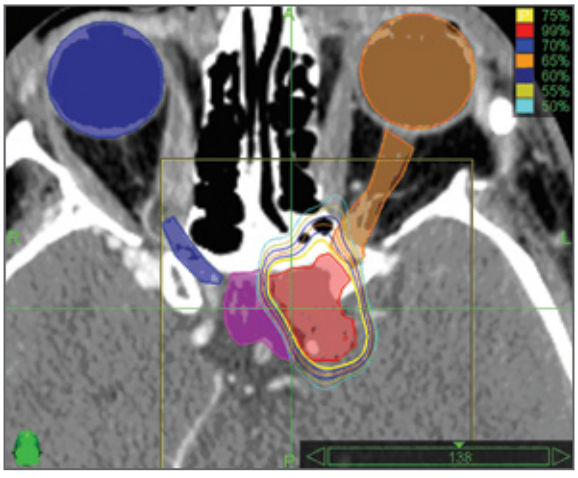


Image courtesy of Barrow Neurological Institute

Expanded Neurosurgical Applications

Similar to cobalt-based systems, the CyberKnife® System treats a wide variety of intracranial indications including benign, primary malignant, and metastatic tumors, as well as vascular and functional disorders. However, the versatility of CyberKnife System extends its capabilities to a significantly broader patient population:

- The need to deliver more than a single fraction is often imperative, particularly when intracranial targets are surrounded by other radio-sensitive structures.[5] The CyberKnife System offers the flexibility to efficiently and painlessly deliver both single and multiple fraction treatments.
- The completely non-invasive nature of the CyberKnife System enables the treatment of intracranial targets for pediatric patients – providing a safe, painless and non-claustrophobic experience.
- Unconstrained by a fixed hemisphere, the CyberKnife System delivers complete intracranial access – keeping extreme peripheral targets always within reach.
- With unhindered robotic mobility, the CyberKnife System extends its reach beyond the head to all levels of the spine – cervical through sacral.

Convenient Treatment Delivery Workflow

Typically requiring only a thermoplastic mask for immobilization, patient set-up with the CyberKnife System is simple and requires considerably less effort than that which is often necessary with conventional radiosurgery systems. Without the need for stereotactic frames, treatment planning and delivery workflow is streamlined, eliminating the need for a full-day, contiguous "scan-plan-treat" regimen. Instead, planning and delivery tasks with the CyberKnife System have the flexibility to be either contiguous or distributed across multiple days, allowing for more effective staff scheduling and significantly less patient discomfort and disruption.

Proven Capabilities – Proven Results

The CyberKnife System is now recognized as the premier solution for safe and effective radiosurgery treatment delivery. With a large body of academic support, the CyberKnife System has now treated more than 50,000 patients and has been installed as the radiosurgery system of choice by more than 140 institutions globally – including many of the most prestigious cancer centers in the world.

"The flexibility of robotic targeting has been combined with advanced inverse treatment-planning algorithms to enable the CyberKnife to deliver an unusually conformal treatment to non-spherically shaped lesions."

Steven D. Chang, M.D.
Co-Director, CyberKnife Neuroscience Program
Stanford University School of Medicine,
Stanford Cancer Center
Palo Alto, CA

Source: The CyberKnife, Potential in Patients with Cranial and Spinal Tumors, Am J Cancer 2005; 4 (6): 383-393.

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4. Ma L, Chuang C, Petti P, Smith V, Verhey L. Whole Procedure Accuracy of Gamma Knife Radiosurgery of Large Tumors Via Multiple Isocenter Delivery. Meeting of the American Association of Physics in Medicine, Minneapolis, MN, July 2007.
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