Radiosurgery Systems:
Treating Brain Tumors and Abnormalities

There are several stereotactic radiosurgery devices available today to treat brain tumors and other abnormalities. Trying to decide which system is the best treatment option can be a difficult task. The goal of this summary is to help clarify differences in radiosurgery systems and shed light on any misleading information.

It is a known fact that radiation is an effective way to treat tumors and other abnormalities within the human body. The two most important factors to consider, when selecting a radiosurgery system, are the accuracy of the treatment device and the dose of radiation being delivered to healthy tissue. Radiosurgery systems are divided into two general categories, which are the LINAC-based systems and the Cobalt-based systems.

LINAC-based systems use high energy x-rays to treat conditions. Examples of LINAC-based units are Trilogy™, X-Knife™-RT, Cyberknife®, Novalis Tx™, BrainLAB, TomoTherapy®, Varian Body Array and ONCOR™.

Cobalt-based systems use a gamma emitting element, Cobalt 60, to treat conditions. Gamma Knife® is the only cobalt-based system currently being manufactured.

Both LINAC and cobalt-based systems have the ability to deliver a high radiation dose to the area being treated. Both systems have been shown to be effective in treating many conditions. While the LINAC systems can treat anywhere in the body, the Gamma Knife® was designed specifically to treat conditions in the brain. The Gamma Knife® is the gold standard and is recognized worldwide as the preferred treatment for brain tumors. (1)

There are several LINAC-based systems with stated achievable accuracies of less than 2 millimeters; however, none can provide the consistent, guaranteed submillimeter accuracy of the Gamma Knife®. The CyberKnife® system claims to be "…the world's most accurate, real-time, image guided robotic radiosurgery system in the world,"(2) when comparing average achievable clinical accuracy, the Gamma Knife® proved to be over 4 times more accurate than the Cyberknife®.(3)

Some radiosurgery manufacturers promote the use of a "frameless" system when treating conditions in the brain. However, "placement accuracy of the shots is critical to localization of the radiation…anything that would degrade this precision is unacceptable."(4) For example, a clinical study of 146 Cyberknife® cases, which uses the frameless system, demonstrated target shifts greater than 2 mm during treatment had occurred in 58% of the patients.(5) This same study demonstrated that half of all cranial cases showed systematic drifting of the target away from the initial setup position.(6)

The dose of radiation received to structures outside the treatment area will correlate with treatment side effects. Due to the design of the Cyberknife® "excess radiation is not well contained and its treatment delivers as much as 100 times more stray radiation compared to Gamma Knife® Perfexion radiosurgery.(6)

Although the Cyberknife has been approved to treat cranial conditions since 1998, there is little published data on the effectiveness and complications that have occurred with the Cyberknife® system. Also, the Cyberknife® and other LINAC-based units have not been demonstrated to be an effective and safe treatment for trigeminal neuralgia and other functional brain disorders. (9) However, one study published in 2008, involving 95 patients treated with the Cyberknife®, did list patient complications. This study dealt with the treatment of trigeminal neuralgia. In order to effectively treat this condition a high dose of radiation needs to be delivered to a very precise target location. Patients in this study incurred a complication rate of 18%. Many of the complications were considered significant. The complication rate for patients treated for the same condition with the Gamma Knife® was 1 %.(8) "Unlike Gamma Knife® Radiosurgery, Cyberknife® and other LINAC Radiosurgery have not been demonstrated to be an effective and safe treatment for Trigeminal Neuralgia."(10)

Radiosurgery Systems:
Treating Brain Tumors and Abnormalities

LINAC based systems are frequently not able to safely deliver a single-session treatment for conditions in the brain because of the higher doses being delivered to healthy tissue.(11) Therefore, LINAC based systems will require treatment with lower doses over a longer period of time, which is known as fractionated treatment. Fractionated treatments require more time constraints for the patient and their family. In addition, when a treatment is fractionated, each treatment session results in a separate insurance billing. Each of these billings typically adds to the patient's out-of-pocket expense. However, with Gamma Knife® Radiosurgery, fractionation is not necessary due to the fact that this system is more precise. Gamma Knife® Radiosurgery uses multiple fixed sources to deliver a high dose of radiation precisely to its target while sparing healthy tissue. This is both cost effective and convenient to the patient and their family.

Having documented information available is an important step in making an informed decision about what radiosurgery system is the best treatment option. When treating conditions within the brain, it becomes even more critical to preserve the healthy tissue surrounding the area being treated. In addition, it is also critical to be as precise as possible to assure only the area of unhealthy tissue is being treated no matter how close it is to other critical structures. It is typical of any institution to use the equipment that is available. Now more than ever, it is important that the patient and their family educate themselves prior to any treatment decision. The more knowledge that you have, the easier it will be for you to discover misleading information about any treatment option. It is hopeful the published data provided on this web site will assist you in making a more informed decision.

References:

(1) www.irsa.org/gamma_knife.html

(2) www.polkv1.ascensionhealth.org/cyberknife/why_chose_cyberknife.php

(3) www.braintumortreatment.org/doctor.html

(4) www.radiologyinfo.org/en/info.cfm?pg=gamma_knife

(5) www.braintumortreatment.org/doctor.html

(6)Murphy Ph.D, M. J., Chang M.D, S. D., Gibbs M.D, I. C., Le M.D, Q., Hai Ph.D, J., Kim M.D, D. ., et al. (2003). Patterns of Patient Movement During Frameless Image-guided Radiosurgery. *International Journal of Radiation Oncology*, *55*(5), 1400-1408.

(7) Koppenheffer, MBA, M. (Ed.). (2007). *Technology Assessment Compendium* (pp. 78-79). Washington, D. C: The Advisory Board Company.

(8) Villavicencio, M.D, A. T., Lim, M.D, M., Burneikiene, M.D, S., Romanelli, M.D, P., Alder, M.D, J. R., McNeely, M.D, L., et al. (2008). Cyberknife Radiosurgery for Trigeminal Neuralgia Treatment: A Preliminary Multicenter Experience. *Neurosurgery*, *62*(3), 647-655.

(9) www.irsa.org/trigeminal_neuralgia.html

(10) www.irsa.org/trigeminal_neuralgia.html

(11) Hall, E. (2000). *Radiobiology for the Radiologist* (5th Ed.). Philadelphia: Lippincott Williams &Wilkins.