

*This article was written for the Childhood Brain Tumor Foundation, Germantown, Maryland.*

## **Radiosurgery Expands Treatment Options for Children and Infants with Tumors of the Brain and Spine**

Nothing is more frightening than to learn that your child has a brain tumor. These serious tumors are unfortunately all too common; in fact, malignant brain tumors are the most frequent type of solid cancer seen in childhood. To make matters more difficult, conventional radiation therapy - a mainstay of treatment for adults - cannot be used freely in young children because of the risk of cognitive problems in later life. However, the relatively new technique of radiosurgery allows many children with brain tumors to be treated with radiation in a safe and effective manner. Here we discuss the role of this new technology in the treatment of childhood brain tumors.

### **The Problem of Radiation for Children**

The three mainstays of treatment for adult tumors - surgery, chemotherapy and radiation therapy - are also used to fight tumors in children. Complex combinations of these options are often chosen, with success depending on the type of tumor and the individual details. These regimens require the guidance of pediatric experts - pediatric oncologists, surgeons and radiation oncologists - because childhood tumors behave differently than adult tumors.

Because radiation controls many tumors in adults, physicians were once hopeful that children could also benefit from this treatment. However, children respond differently to radiation than adults. For children under the age of three years, their brains are in critical stages of development and are simply too fragile to withstand radiation without harm. Within several years, the radiation can lead to severe developmental delay, memory and cognition deficits, and structural changes in brain tissue. By later life, many are devastated.

Older children, those greater than five years of age, are less prone to these complications, and radiation therapy remains an important part of their treatment. Pediatric oncologists, nevertheless, carefully consider the potential for harmful effects of radiation in all children. And most oncologists usually withhold radiation from younger children, relying instead on surgery and chemotherapy to control the tumor until the child is old enough to withstand radiation therapy. Many feel that therapy is compromised by the omission of radiation, but they are still reluctant to add this treatment until the child is older. Unfortunately, the cost of sparing these children the later ravages of radiation is the denial of a potentially life-saving treatment.



### **A Partial Solution: Radiosurgery and the Gamma Knife**

In the 1950's, the Swedish neurosurgeon Lars Leksell had a groundbreaking idea. Why not devise a machine that could focus the radiation onto the tumor alone, sparing the surrounding brain from the offending radiation? Such a device might hold immense benefits for children, since

the minimal exposure to the surrounding brain meant that the risk of devastating side effects would be small.

Leksell's idea brought about the Gamma Knife®, which is actually not a knife at all. Instead, it is a large spherical metal helmet containing 201 holes, which guide the radiation to a single spot at the helmet's center. Since that one spot receives more than 200 times than the dose to the surrounding brain, the result is the desired effect of focusing.

The Gamma Knife® is used differently than standard machines for radiotherapy. Instead of a fractionated plan consisting of small doses given daily for many weeks to kill tumor cells without harming normal tissue, Gamma Knife® treatments consist of a single, powerful dose given in one sitting designed to annihilate any tumor within the targeted area. Since the Gamma Knife® is so precisely focused, this strategy of radiosurgery has been spectacularly successful in treating a variety of adult brain tumors. However, the Gamma Knife® cannot be used for young children because its use requires attachment of a metal frame to the head, a frame too heavy and too tight for the fragile infant skull. For older children with thicker skulls, Gamma Knife® radiosurgery remains a good option with success rates similar to those seen for adults.

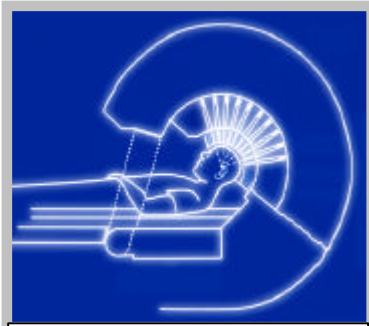
### **A New Approach: the CyberKnife®**

The CyberKnife® offers the precision of radiosurgery without the requirement of a head frame. Consisting of a robotically guided source of radiation, the CyberKnife® maintains the required precision by taking x-ray images of the patient throughout treatment to update its position: the robot senses any movement of the patient's head and automatically compensates. In fact, extensive testing has shown that the precision of the CyberKnife® approaches that of the Gamma Knife®. This means that radiosurgery can be delivered with the CyberKnife® without a head frame, so that radiosurgery can be offered to the infants and young children that have been denied this option in the past.

### **Limitations of Radiosurgery and Advantages of the CyberKnife®**

Although the Gamma Knife is a powerful tool for the treatment of many brain tumors in children, not all brain tumors are suitable for Gamma Knife radiosurgery. For reasons that are unclear, the risk of complications increase if the tumor is greater than an inch in diameter or if the tumor is located in fragile locations of the brain such as the brainstem or thalamus. In such cases, a single, large radiosurgical dose may be too dangerous even if the repeated, small doses of a fractionated plan may be ineffective. In an effort to achieve the best of each, many centers offer hypofractionated plans in which a large dose of radiation is given in 3 to 7 smaller daily doses. These new plans have not been fully studied but have theoretical appeal and preliminary reports have been encouraging. They are not easily accomplished with the Gamma Knife® since the patients are rarely able to wear the head frame for 3 to 7 days. Hypofractionation can easily be obtained with the CyberKnife® since no frame is required to maintain the needed precision. For children with larger tumors or tumors located in sensitive areas, hypofractionation with the CyberKnife® is an option and extends beyond what was previously available.

## When to Use What: Gamma Knife®, CyberKnife® or Other?



Gamma Knife

Deciding between these many options is not easy. The experts do not always agree, so you will need the advice of your doctors. Here is one approach.

Children less than three years of age. Because of the risk of serious cognitive problems in later life, the use of conventional fractionated radiation therapy to treat young children is uncommon.

Radiosurgery with the CyberKnife®, however, remains an option for these fragile patients because the focused fields of the CyberKnife® minimize radiation exposure to normal brain tissue. Furthermore, a rigid headframe is not required. Young children and even babies with delicate skulls can therefore be offered CyberKnife® radiosurgery.

Older Children. The options for older children include conventional radiotherapy, Gamma Knife® radiosurgery, and CyberKnife®. Radiotherapy may be given if the tumor is too large for radiosurgery or if the tumor infiltrates into a large volume of brain. Single dose radiosurgery can be given with either the Gamma Knife® or the CyberKnife®, although the CyberKnife® may be chosen for some children to avoid the discomfort of the head frame or the use of general anesthesia. Hypofractionation with the CyberKnife® may be chosen if the tumor is large or has been treated in the past with radiation.

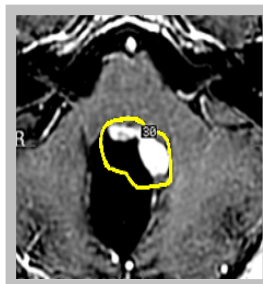


CyberKnife®

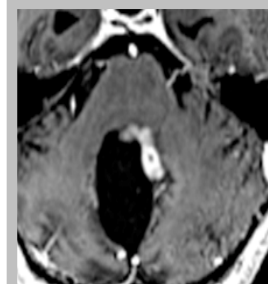
## What About Tumors of the Spine?

Since the CyberKnife® does not require a headframe, it can deliver radiation to any structure in the body, including the spine. Experience has been promising but early, and most of the patients receiving radiosurgery for tumors of the spine have been adults. However, the technique is possible in infants and children; consult with your doctors and your CyberKnife® center.

### Sixteen-year-old with pilocytic



Pretreatme



3 months post  
treatment

## **The Baylor Radiosurgery Center**

The Baylor Radiosurgery Center is a facility on the campus of Baylor University Medical Center in Dallas that is dedicated to radiosurgery and houses both a Gamma Knife® and a CyberKnife®. The physicians on the medical staff at the Baylor Radiosurgery Center pioneered the use of CyberKnife® radiosurgery in infants, and work closely with the pediatric oncology community in Dallas. If you wish to obtain more information about the services offered at the Baylor Radiosurgery Center, please call us at [214-820-HOPE](tel:214-820-HOPE).

*Physicians are employees of HealthTexas Provider Network and are neither employees nor agents of Baylor Health Care System, Baylor University Medical Center at Dallas or Baylor Health Care System's subsidiary, community or affiliated medical centers.*