The Gamma Knife

Matin Amani, Biomedical Engineer

The gamma knife is used to treat brain tumors by applying a high dose of radiation over a short period. It was invented by Lars Leksell, a Swedish neurosurgeon, in 1967 at the Karolinska Institute in Sweden. Using 201 cobalt-60 sources which have 30 curies each, oriented in a circular array inside a shielded structure the gamma knife aims gamma radiation at a target point in the patient's brain. The patient brain is stabilized by a helmet that is surgically fixed to the skull, allowing for the gamma rays to be delivered directly to the skull. This design allows for a strong dose of radiation to be sent directly to the tumor site, protecting the remainder of the brain. Each individual radiation beam does not have sufficient energy to harm the brain tissue it passes through; however, the effect of gammaknife radiosurgery occurs only at the spot in the brain where all the beams meet. This spot can be accurately plotted to within a fraction of a millimeter.

Gamma knife radiosurgery has been shown to be effective for patients suffering from malignant brain tumors, vascular malformations including arteriovenous malformation (AVM), or pain. The gamma knife procedure is less invasive than alternative surgeries such as micro-decompression. For treatment of trigeminal neuralgia the procedure may be used repeatedly on patients. The operation is most effective in the following environments,

1) Intracranial tumors such as acoustic neuromas, pituitary adenomas, pinealomas, craniopharyngiomas, meningiomas, chordomas, chondrosarcomas, metastases and glial tumors.
2) Vascular malformations including arteriovenous malformations.
3) Functional disorders such as trigeminal neuralgia and obsessive-compulsive disorder.

The risks of gamma knife treatment are very minimal and complications are related to the condition being treated. The complication rate is increased when the method is used to treat conditions which are life threatening in the short term. Furthermore, use of the gamma knife has many advantages, the lesion being treated receives a high dose of radiation while nearby tissue

is sufficient effected. Furthermore, the cost of a gamma knife procedure is often 25% to 30% less than traditional neurosurgery, and the procedure simultanesouly removes patient discomfort, reduces the risk of hemorrhage and infection, and hospitalization period is reduced. Most importantly gamma knife operation allows treatment of inoperable lesions. The procedure offers hope to patients who were formerly considered untreatable or at very high risk during open skull surgery. Gamma knife radiosurgery is used to treat patients that do not require immediate surgical relief and small tumors, usually, $4-5\ cm$ or less.

In some cases, gamma-knife radiosurgery can cause radiation injury to brain tissue surrounding the target. This can cause swelling, which may develop months after the procedure. In most cases, this swelling is temporary and resolves without treatment.

References

[1] http://gammaknife.org/index.htm
[2] http://www.irsa.org/gamma_knife.html
[3] http://www.mayoclinic.com/health/gamma-knife-radiosurgery/MY00206