Gamma Knife® Radiosurgery

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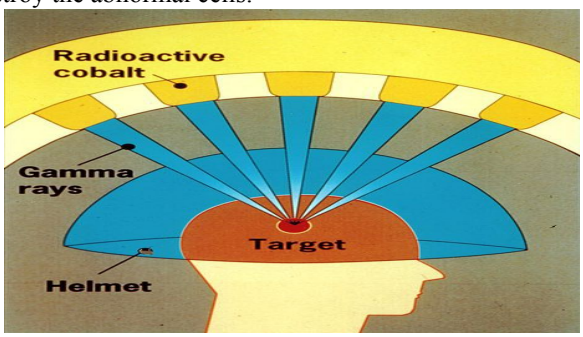
***Abstract*—Brain tumors, and blood vessel malformations are sometimes better treated without invasive brain surgery. The Leskell Gamma Knife® is a non-invasive procedure used to treat these conditions. It uses highly concentrated and precisely targeted gamma radiation, that destroys abnormal cells while leaving healthy cells undamaged.**

I. Introduction

Tumors and vascular abnormalities of the brain affect hundreds of thousands of people every year. Invasive surgery for these types of conditions involve making incisions and cutting into the skull which can leave patients with lifelong scars and long recovery times. In 1967 Lars Leskell and Börje Larsson, working for Elekta AB in Sweden, invented the Leskell Gamma Knife®. It is a device that allows non-invasive treatment of brain tumors and vascular abnormalities, using gamma radiation. Today more than 50, 000 patients undergo Gamma Knife® surgery each year and 300,000 have already been successfully treated. There are 250 Gamma Knife® systems in use today.

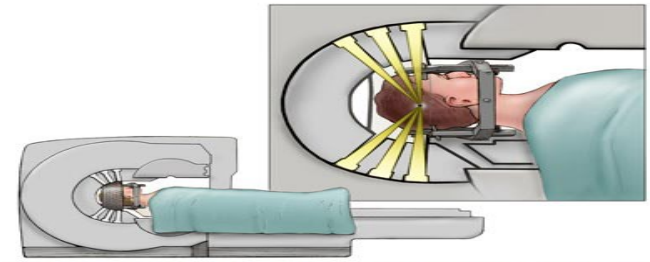
II. Methods

The Gamma Knife® consists of 190-201 sources of cobalt-60 of 30 curies (3.7×10^{10} decays per second) each, all in a circular array. The array is then heavily shielded. Each of the cobalt sources emits a beam of gamma radiation, and all of the beams converge at one point of high concentration. It is at this focal point that the gamma rays are powerful enough to destroy the abnormal cells.



Before the procedure the patient is fitted with a helmet or frame with a coordinate box. The patient then undergoes MRI and CT scans to precisely determine the dosage and location of the radiation treatment for their condition. The coordinate box is then removed from the frame, the patient is placed into the machine containing the cobalt-60 array, and the head frame is locked into place to keep the patient from moving out of position.

The coordinate and dosage results are then entered into the system. The machine then positions the patient so that the tumor rests at the focal point of the gamma radiation. With today's advanced scanning techniques and advancements to the Gamma Knife® machines, the patient can be positioned with sub millimeter accuracy.



IV. Discussion

The advantages of the Gamma Knife® are numerous. Because it is non-invasive there is no risk of infections or bleeding that would come along with invasive neurosurgery. There is also no need for general anesthesia which benefits those with heart disease or other conditions who cannot be subjected to treatments that involve it. The Gamma Knife® procedure also involves minimal pain and discomfort only that which comes from the attachment and wearing of the frame on the head. Most times a patient is able to leave the hospital the same day and resume their daily activities immediately. The precision of the device is also an advantage. Because the gamma radiation beams by themselves are weak and only meet at one point, the only cells that are damaged are the targeted cells. The healthy cells are left intact. One aspect that could be considered a disadvantage is that the abnormal cells are not removed they are only damaged and unable to replicate. This means that the patient and their physician will have to monitor the condition from weeks to months before it shrinks enough or disappears. But, despite this disadvantage most treatments are successful.

References

[1] Radiosurgery <http://en.wikipedia.org/wiki/Radiosurgery>.
[2] The Penn Gamma Knife® Center at Pennsylvania Hospital <http://www.pennmedicine.org/neuro/gammaknife/>.
[3] How Does the Gamma Knife® Work? <http://www.pennmedicine.org/neuro/gammaknife/work.html>
[4] What is Gamma Knife Radiosurgery? <http://www.pennmedicine.org/neuro/gammaknife/video.html>
[5] <http://upload.wikimedia.org/wikipedia/commons/thumb/0/00/Gamma_Knife_Graphic.jpg/464px-Gamma_Knife_Graphic.jpg>
[6] <http://www.riversideonline.com/source/images/image_popup/bn7_gamma.jpg>

[7] <http://apleasantdistraction.com/wp-content/uploads/2010/10/Gamma-Knife-Procedure-002.jpg>