Gamma Knife Radiosurgery

A Revolutionary Noninvasive Brain Surgery Procedure

By Michelle Manders RN BSN

What Is Gamma Knife?
- Gamma Knife is not really a knife. No incision is made
- Uses a high dose of radiation from Cobalt 60 sources
- A total of 201 beams of radiation intersect to focus precisely on the targeted abnormal tissue in the brain

Gamma Knife
- Beams are so weak on their own that they don’t cause any damage to the brain or skin
- It is when the 201 beams intersect together that you get the treatment effect
- Unlike traditional forms of radiation, GK is one day treatment only

Gamma Knife
- Usage is so precise that only the targeted tissue is affected thus sparing surrounding healthy tissue and structures
- Can target to within 0.1mm accuracy

What is Radiosurgery
- Single fraction - one treatment only
- High dose
- Small target(s)
- Head fixation device is used
- Highly accurate

What is the difference between Radiosurgery and Radiotherapy?
Radiosurgery
- One fraction
- High single dose
- Very high precision
- Uses head frame

Radiotherapy
- Multiple fractions
- Lower dose
- High precision
4 Steps in GK

- Frame Placement
- Imaging
- Treatment planning
- Delivery of radiation

Frame Placement

- Pt arrives at 05:45am
- Emla cream applied to forehead
- Premeds given
- Saline lock started
- Decadron 10 mg IVP given
- Valium IVP given

Frame is placed by Neurosurgeon
Frame is made out of Titanium and is compatible with the MRI
Injection of Lidocaine 1% with epi and bupivicaine 0.25% 50/50 mixture injected to numb up the skin
Anatomy of Brain

Gamma Knife

Gamma Knife 4 C unit

Gamma Knife Collimator
There are 4 sizes of collimators used in order to conform to the shape of the patient’s tumor. The diameter of the holes are 4, 8, 14 and 18 mm. Either a single or a combination can be used to achieve an optimal treatment plan.

History Of Gamma Knife

- Developed in Sweden in 1950’s by Lars Leksell and Borge Larsson
- Very labor intensive in the beginning
- Much more streamlined since the invention of CT and MRI
- 269 facilities World wide
- 123 centers in the USA- 3 centers in Michigan- Beaumont Hospital in Royal Oak, Karmanos Cancer Institute in Detroit and Midland Michigan

Why do we only work in the brain?

- The brain is easy to stabilize
- Virtually no movement
- Needs very high precision
- Confined space

Conditions Treated With Gamma Knife

- Primary brain tumors
- Metastatic brain tumors
- Resection cavaties
- Pituitary tumors
- Meningiomas
- Acoustic neuroma
- Trigeminal neuralgia
- Arteriovenous malformations
- Glomus Jugulare tumors
- Ependymomas

Criteria For Gamma Knife

- There should be 10 or less tumors present unless okayed by oversight committee (pt would otherwise have WBRT)
- Size of tumor
- Karnofsky Performance Scale (KPS) of 70 or more
- Patient’s underlying disease is well controlled

How Does Radiation Work

- Radiation works over a period of time
- It causes damage to the DNA of the tumor cell which knocks out the ability of the cell to grow
- The tumor slowly decreases in size and can eventually dissolve
- In arteriovenous malformations (AVM) radiation causes damage by scarring the lumen of the vessel
- Blood flow over time eventually slows and vessel ultimately occludes
- Can take 2-3 years to occur
How Will It Be Decided Who Gets Gamma Knife

- Patient is seen by both a neurosurgeon and a radiation oncologist.
- If case is questionable then it is presented at the neurosurgery tumor board.
- The tumor board is a multidisciplinary team. As a group they will decide what the best treatment option is for the patient.

Treatment Options

- Large tumor - surgery is an option.
- Primary brain tumor – biopsy needed to determine pathology.
- Surgery can be difficult based on location of tumor.
- Damage can occur to surrounding structures and brain function can be lost.

Treatment Options

- Chemotherapy – most don’t pass through the blood-brain barrier.
- Gamma Knife - noninvasive radiation treatment specifically given at the target site thus minimizing or avoiding side effects to normal tissue.

Step 2 Imaging

- MRI/CT of brain is performed on all patients.
- If pt has an implantable device CT only used.
- Slice thickness of MRI is 1 mm.
- The MRI box fits down over the frame. It contains copper sulfate in channels along the front, back and sides of box.
- The CT box has strips of copper which light up on these images.
- The MRI and CT are fused to look at the accuracy of the MRI.

MR Fiducial Box

MRI fiducial markers
If pt is being treated for a vascular malformation, a cerebral angiogram is done after the MRI and CT are completed. This gives more information of where the cluster or nidus of vessels is located and assists in treatment planning. Once all the imaging is completed, bubble measurements are taken of the patient’s head.

A plastic bubble sits down over the frame. Measurements are taken at set points around the circumference of the bubble. These numbers are entered into the computer and a 3D image is created of the patient’s skull. The length of the posts and pins are measured to ensure there is no collision with the equipment.
Step 3. Treatment planning

- Computerized planning is done by the neurosurgeon, radiation oncologist and the physicist
- All images taken are reviewed and used in the treatment planning
- Can have 500-600 images per pt

Multiple Metastases

Step 4. Treatment

- Treatment time is dependant upon the number, size and location of tumors
- The actual procedure is painless and quiet
- Once treatment is completed the frame is removed, pin sites cleansed and antibiotic ointment applied
- Pt is observed for 1 hour
- The patient can resume their previous activities
- Patient may go home with a Rx for steroid and GI prophylaxis
Side Effects

- Very few side effects
- Headache
- Discomfort at pin sites
- Some bruising
- Cerebral edema

Follow Up

- Follow-up in 2 weeks
- Pin sites assessed
- Steroid taper
- A follow-up MRI will be scheduled.
- For metastatic tumors MRI will be repeated in 10-12 weeks
- For benign condition most MRI’s are repeated in 3-6 months

Benefits of Gamma Knife

- No surgical complications or side effects from general anesthesia
- Risk of hemorrhage or infection is minimal as no incision made
- No prolonged recovery time
- More cost effective
- Able to access areas of the brain that conventional surgery can’t
- No delays for other treatment

Other Conditions Under Study for Gamma Knife

- Parkinsons and other movement disorders
- Epilepsy
- Chronic intractable pain
- Psychiatric Illnesses (depression, OCD)
- Cluster Headaches/Migraines