The Gamma Ray Knife in Stereotactical Radiosurgery

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Introduction to the Gamma Knife

The gamma knife, in a therapeutic sense, has only been around for 20 years. The gamma knife is a type of radiosurgery which uses a pinpointed, precise treatment to deliver beams to the brain using a linear accelerator.[1] There is no true incision associated with the gamma ray and stereotactical radiosurgery (SRS). Therefore, there are no factors such as bleeding, infection, or complications with anesthesia that occur with traditional neurosurgery.[2] There are six components that make up the gamma knife. The patient couch and electric bed system make it simple for the patient to be aligned for treatment. Located inside the gantry, are the tungsten collimators, the radiation unit, and beam focusing technology. The final component is the treatment planning system found within the computer. The treatment planning system allows the doctors to locate the targeted tissue while sparing the adjacent tissues (see Figure 1). The accuracy of newer gamma knife models are found to be within 0.3 mm. The average marginal dose is 16 Gy, which allows for the treatment to take place in one session rather than multiple.[3]

Phases of Treatment

1. **Designing an immobilization device.** The head frame is custom built to prevent the patient from moving during the exam. The frame itself helps guide the gamma rays to the target zone.[5]
2. **Imaging.** Computed tomography, magnetic imaging resonance, and nuclear medicine, with the use of the positron emission tomography scan, come together to pinpoint the exact location of the planned treatment.[5]
3. **Image-guided radiation therapy**. This step ensures the accuracy of the treatment, and can be done the day of treatment or the day before.[6]
4. **Gamma knife treatment.** The knife uses 192 to 201 beams aimed at the target region. The treatment can take anywhere from one to four hours. The patient can return home when finished, but imaging check-ups are required for optimization.[6]

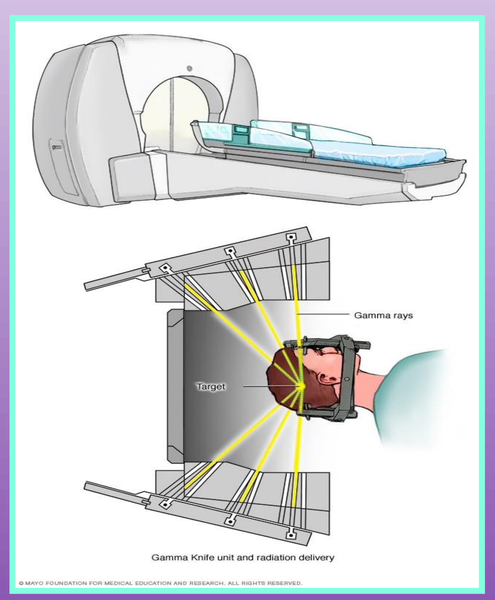

Figure 1

The image shows the layout of the gamma knife, along with a depiction of the imaging process.[4]

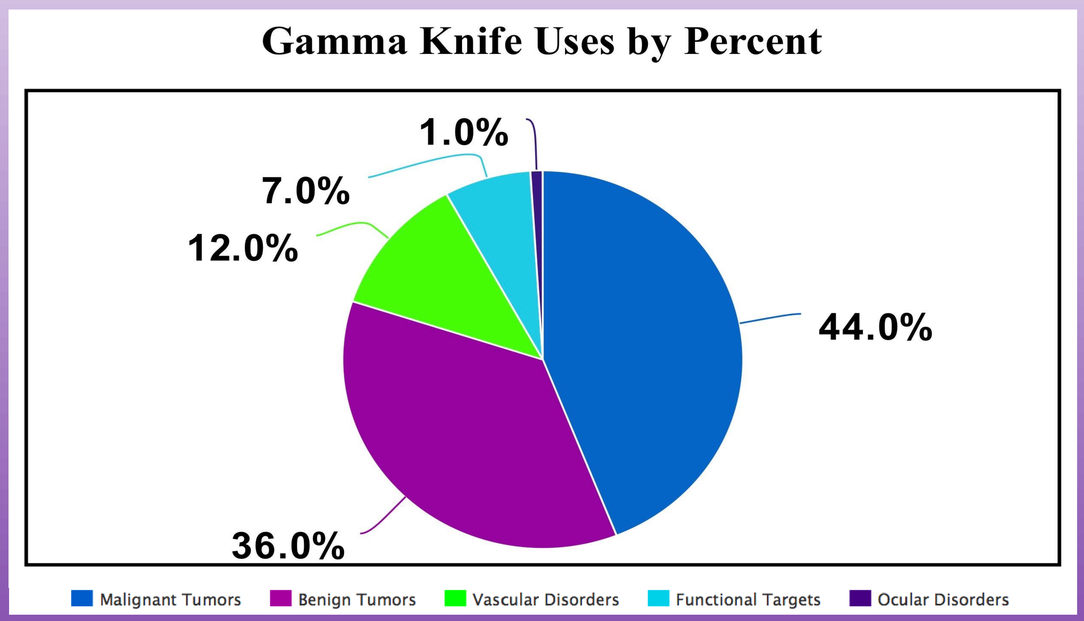

Table 1

This tables show a visual comparison of the uses of the gamma knife in radiosurgery. The vast majority of treatments are shows to be tumor related.[7]

Uses

The primary use of the gamma knife is to treat metastatic brain tumors (MBTs) that arise from the lungs. The gamma knife is also shown to treat specific tumors, cancers, and arteriovenous malformations (AVMs) (see Table 1). For the treatment of MBTs, the gamma knife is an optimal choice due to the good survival rate, good tumor growth control, and less complications associated with SRS (see Figure 2).[8] AVMs are unstable lesions in the cerebrovascular system that can cause intracranial hemorrhages. Gamma knife treatment is considered superior to surgery because of the minimally invasive and precision needed to locate an AVM.[9]

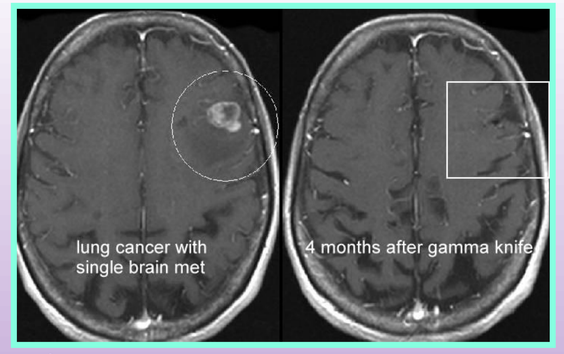

Figure 2

The image shows a before treatment and a four month follow up comparison with the use of the gamma knife on a brain metastasis.[10]

References

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