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The Effect of Radiotherapy on Cancerous Tumors (Brain Tumors) Using the Linear Accelerator Device

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Abstract:

MRI findings after stereotaxic radiosurgery using the Gamma Knife. To evaluate the temporal evolution and appearance of a radiosurgical lesion at magnetic resonance (MR) imaging and the clinical response in patients undergoing stereotactic radiosurgical pallidotomy or thalamotomy with the gamma knife. A wide variety of intracranial diseases are treated with the Gamma Knife; These include movement disorders, trigeminal neuralgia, tumors, and arteriovenous malformations. MRI is invaluable in studying treatment outcomes, because pathological data are limited on this minimally invasive technique. Examinations may be performed to check lesion status, determine the effects of the radiation dose on target tissues, and detect complications related to treatment.

CONCLUSION: Findings in this pilot study suggest that radiosurgical thalamotomy is a promising treatment for medically refractory tremor. Three- month follow-up MR studies show a ring-enhancing lesion surrounded by a variable amount of vasogenic edema. Visualization of the radiosurgical lesion and the clinical response are delayed compared to that with radio-frequency procedures. Successful treatment with the gamma knife may result in growth arrest, regression, or obliteration of the neoplastic lesion. Growth arrest has been reported in approximately 90% of

benign neoplasms at the skull base and 85% of solitary metastases .Tumor regression is uncommonly seen earlier than 3 months posttreatment and may take years to fully evolve. For example, the median time for regression of vestibular schwannomas is approximately 1 year, with a range of 3-33 months [5, 7] Tumor regression occurs more rapidly in malignant neoplasms .Fibroblasts and myofibroblasts aid in tumor retraction.

INTRODUCTION

Every technological progress has its pros and cons and risks to the environment and therefore to humans. As a result of the advancement of technology in the proper uses in the field of radiation, especially in the medical field, whether therapeutic or diagnostic, it led to a huge boom in the treatment of serious diseases and the diagnosis of many pathological conditions, so it worked to serve humanity. Despite this, its disadvantages may lead to radiation damage as a result of exposure to an excessive dose of radiation, whether from the occurrenc occurrence of radiation leakage from the devices used in radiological treatment and diagnosis, or from the radioactive materials used in this type of treatment, and it may be a result of exceeding the permissible dose limits. To find out the damages of exposure to these rays, the trend was towards studying the effect of radiation therapy on cancer tumors.

Objectives

Studying different types of radiation therapy methods. Getting acquainted with radiotherapy devices. Knowing the harms and risks resulting from radiation therapy. Learn about brain tumors, their symptoms and causes. Previous studies: Children undergoing cranial irradiation are at risk for radiation-induced brain tumors. Among a cohort of 8831 children diagnosed with ALL and enrolled on Children's Cancer Group therapeutic protocols between 1983 and 1995, 19 patients had developed a second brain tumor. The relative risk for brain tumors among children who had received 18-24 Gy of cranial irradiation was significantly increased to 2.4 (95% confidence interval, 1.1-5.2). In an analysis of one of the St. Jude Children's Research Hospital leukemia protocols, the combination of prophylactic cranial radiotherapy and antimetabolite therapy resulted in an unexpectedly high frequency of brain tumors (6 of 52, 13 percent), possibly magnified by a genetic defects in thiopurine methyltransferase in the affected individuals, Among the 198 children treated within the Pediatric Oncology Group of prolonged postoperative chemotherapy and delayed irradiation for children diagnosed with a brain tumor at less than 3 years of age, five developed second malignancies: choroid plexus carcinoma (2 children), ependymoma (1 child), desmoplastic infantile ganglioglioma (2 children), and medulloblastoma (1 child). The interval from diagnosis of initial tumor to second malignancy ranged from 33 to 92 months. CONCLUSIONS — Cranial radiation is an integral component of the management of patients with primary and metastatic brain tumors and certain types of leukemia. However, cranial radiation is associated with risks of various acute and late toxicities, and these risks should be acknowledged and discussed during the pretreatment counseling session with any patient for whom cranial radiation is recommended. Radiosurgery for re-irradiation of brain metastasis: results in 54 patients.

Brachytherapy: This type of treatment is based on the use of sealed radioactive sources. They are made in the form of tubes or small capsules that are placed inside cavities, such as the uterus, or in the form of needles or wires that are inserted directly into and around the tumor. The radiotherapy approach is distinguished by the possibility of giving an intense radiation dose to an area limited. Also, there are currently three types of radiotherapy technology available closely:

1. Intracavitary brachytherapy Cancer of the uterus, vagina and esophagus is the main area of this method.

2. Interstitial therapy or implantation, using needles or wires, is a commonly used method for treating cancer of the tongue, lip, or skin.
3. Treatment from the surface (surface application or mold method). This method is used to treat superficial tumors that appear on flat surfaces. Radioactive sources are placed according to special systems on the outer surface of the mold, which is often made of plastic, with a thickness ranging from 0.5 to 2 cm.

The source produced from the tissues or cavities of the body is placed temporarily or permanently, which is called internal radiation therapy or treatment with radioactive source implantation. The radioactive material is placed in a capsule or made in a solid form and is permanently closed, or the closed radioactive. source is strong enough to keep the amount of leakage as low as possible, i.e. the solid radioactive material or the capsule containing radioactive material is non-disseminable.

Advantages of the ideal internal healing resource

Advantages of the ideal internal treatment sources:

1. A source that emits gamma rays on its own with an energy suitable for the intended treatment site. 2. It has high radioactivity and is suitable for high dose source application.
2. Small in size.
3. It is used for temporary implantation.
4. Its life is relatively long. In the case of permanent implantation, it has an average half-life.
5. It is economical and the processing depends on the skill and experience of the operator.

Kama knife

The Leksell Gamma Knife is an alternative or adjunct to conventional brain surgery. The principles behind the development of the Gamma Knife were first conceived by a Swedish neurosurgeon, Lars Leksell, during the 1950s. He envisioned a multisource Gamma ray emitter that would be able to focus very accurately on an intracranial target and thus replace open surgery for some conditions. In 1967, the first Gamma Knife unit was put into clinical use in Karolinska and this was a 179 cobalt 60 source.

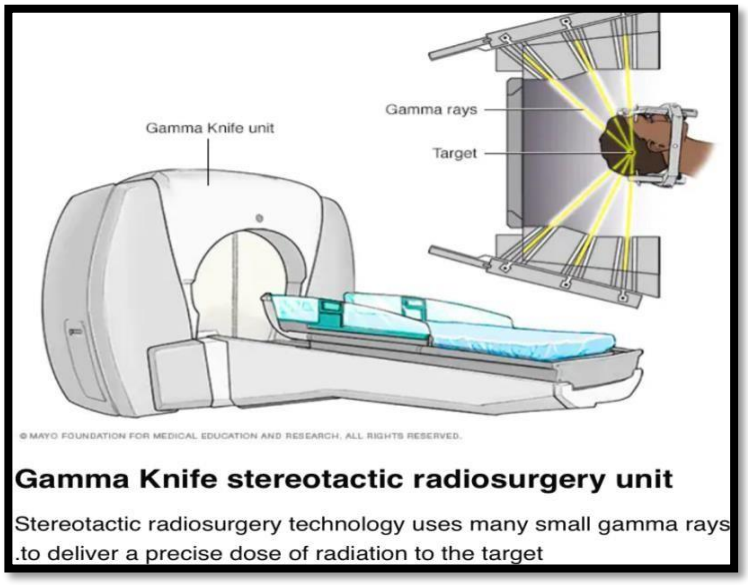


Figure (1) kama knife.

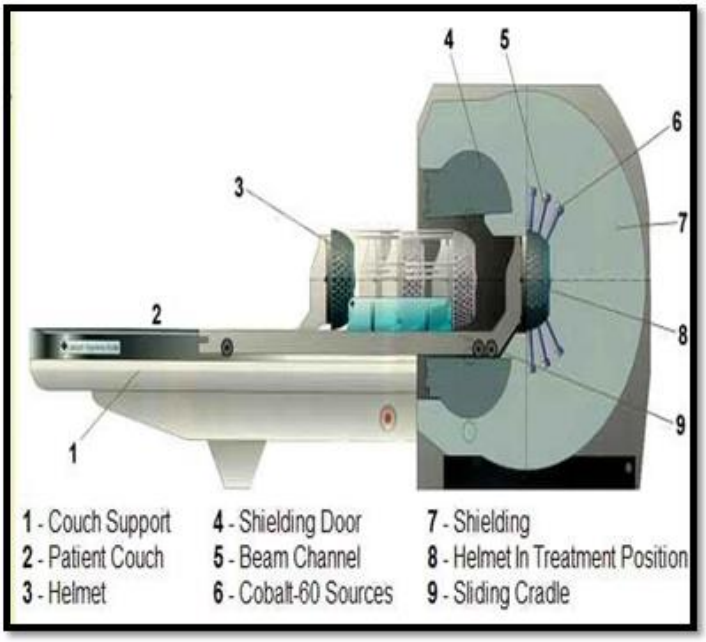


Figure (2) parts kama knife.

Gamma Knife stereotactic radiosurgery has been in use in the United States for over 10 years and there have been in excess of 300,000 procedures performed worldwide. The most common diseases treatable would be brain mets, AVM's and perhaps trigeminal neuralgia.

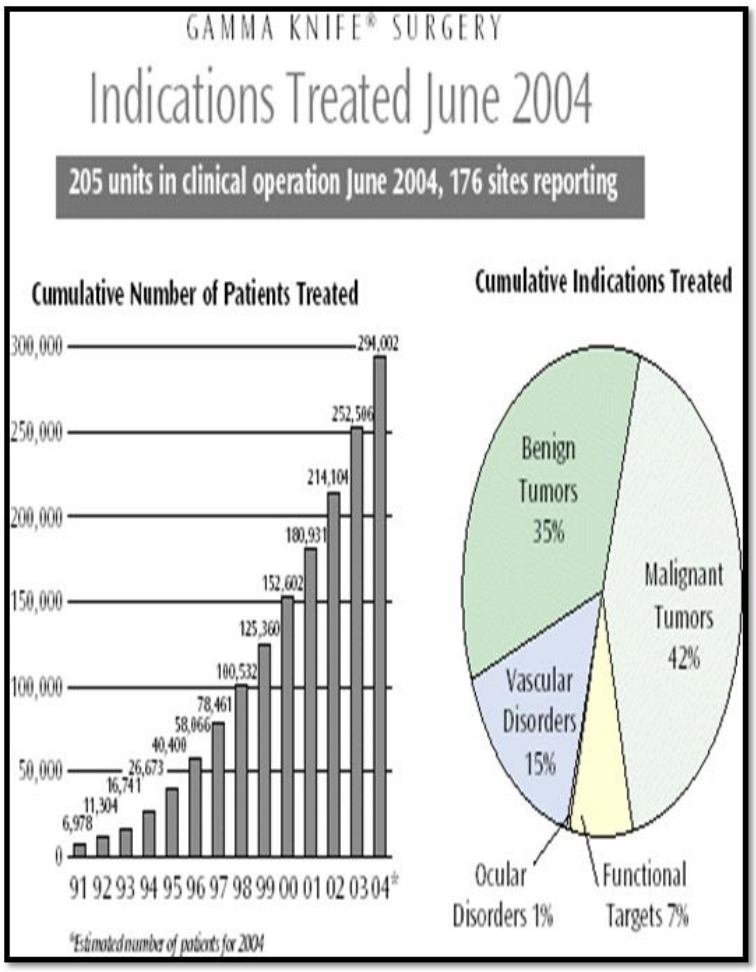


Figure (3) Global statistics.

The Gamma Knife procedure has been proven highly effective in the treatment of certain malignant and benign brain tumors, arteriovenous malformations and trigeminal neuralgia. In addition, treatments for Parkinson's disease, epilepsy, and intractable pain are showing promising research results. The Gamma Knife treats the patient with 201 individual gamma rays, targeted with great precision to converge on small, well circumscribed and critically located structures in the brain. Stereotactic radiosurgery is defined as the delivery of a single, high dose of radiation through the intact skull to a small and critically located intracranial volume. The gamma knife contains 201 cobalt-60 sources of approximately 30 Curies each at the time of loading, placed in a hemispherical array in a heavily shielded unit. A collimator helmet focuses the radiation to a specific target point within the head with sub-millimeter positioning accuracy in such a fashion that a high dose of radiation is delivered to the target while sparing the surrounding tissue. Complex-shaped lesions are treated by combining collimators of different sizes with selected beam blocking and weighting using a sophisticated computer planning system. This ensures that tight conformation of the dose to the edge of the target volume is achieved such that each patient receives a "tailored" plan. Unlike the linear accelerator, the gamma knife has few moving parts thereby eliminating many sources of inaccuracy and unreliability. Because the radiation fall off is very steep outside the target area, the surrounding brain receives little radiation thereby minimizing harmful side effects to neighboring critical structures. Conventional surgery requires opening the head with a scalpel and staying in the hospital for long periods The opening may result in serious bacterial infections . Therefore, a system was designed and manufactured that uses radiosurgery without the need to open the head and is used as a radiological scalpel instead of the traditional surgical scalpel. It is also used for a number of diseases that affect the brain. This device was called Gamma Knife. It is considered a safe and effective tool for treating brain tumors and arteriovenous aneurysms. The patient does not feel pain, and the anesthesia is local, without the need for general anesthesia. The results of treatment with Gama Knife showed a significant decrease in side effects compared to the side effects that accompany surgical operations. Some types of Gamma Knife contain 201 sources of cobalt 60 with a radioactivity of 30 qu, placed in a circular row inside a ring in a large shield system of lead or depleted uranium. It treats tumors while preserving the surrounding parts of the brain without effect. This is due to the ability of gamma knife to focus a large number of rays in a specific place with high accuracy. In the treatment of tumors, the radiation dose that can kill the tumor is sent out in one treatment session. While the rest of the surrounding brain tissue receives much less than the lethal dose. Ola Biskin Gama has proven its therapeutic efficacy for thousands of patients with benign or malignant brain tumors, vascular malformations such as venous malformations, headaches or other function problems.

Gamma Knife is also used to treat trigeminal nerve pain. Treatment may be used and repeated On times on patients.

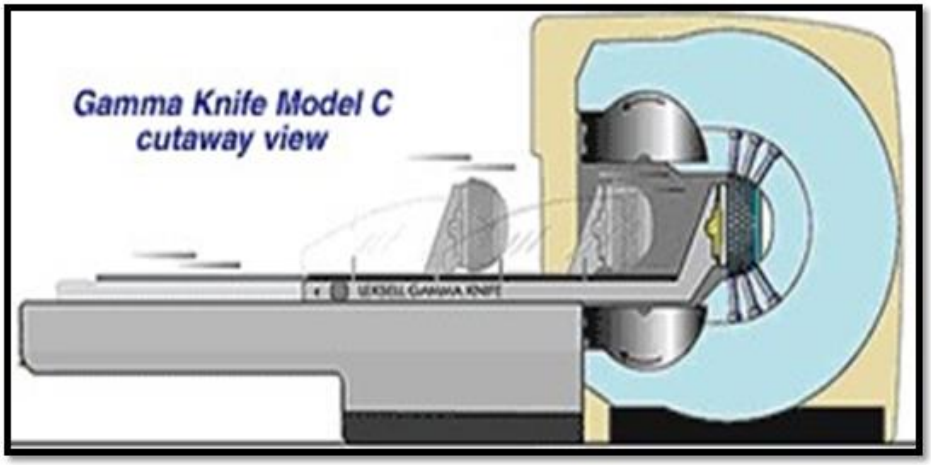


Figure (4) Kama knife device.

Stages of treatment with the Kama Knife

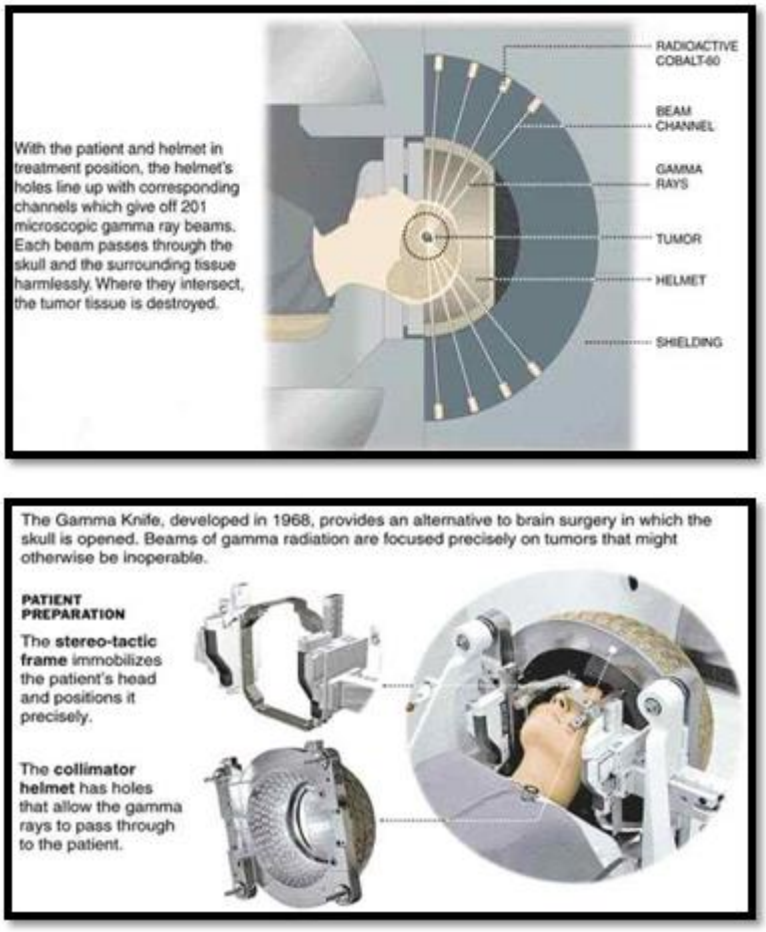


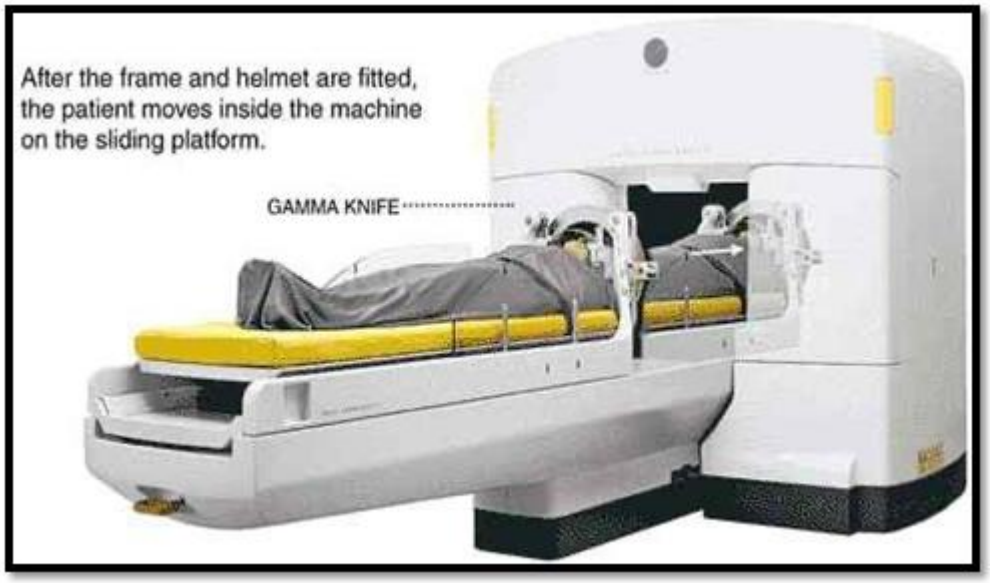
Figure (5) treatment steps.

Before the treatment: the doctor explains and clarifies the treatment steps to the patient and the assisting medical staff, and the treatment does not require shaving the hair.

Installing the metal ring: One of the important elements in gamma therapy is fixing the metal ring on the patient's head, as this ring enables the doctor to accurately locate the treatment inside the brain.

X-rays: After completing the installation of the metal ring in the patient's head, the tumor area is photographed using one of the imaging techniques, which is magnetic resonance imaging, computed tomography, and cerebral catheterization. These images enable the doctor to determine the size, shape and location of the tumor within the brain with high accuracy.

Treatment planning: After taking the picture, the doctor carefully plans the treatment plan, as the treatment plan for each patient is not similar to the treatment plan for another patient. To suit his pathological condition, size and location of the tumor. The doctor cooperates with the medical physicist in designing a treatment plan and how to implement it. The treatment takes a few hours.



Treatment: The treatment begins with the patient sleeping on the device table, and the metal ring is installed in its designated place, and the doctor and medical staff leave the treatment room to avoid radiation exposure. The doctor and nurse are in constant contact with the patient through the television camera and the audio system prepared for that. At the beginning of the treatment, the table moves inside The device is quiet and without any pain. The medical team monitors the course of treatment for a short or long period, depending on the size and shape of the tumor.

Follow-up: After completing the treatment, the attending physician will follow up the case by radiographing the tumor or a diagnostic catheter after a period of the end of the treatment. Radiation therapy is designed to stop the growth of tumors that are targeted, so the effect appears after weeks or months.

Non-sealed radioisotope therapy

This type of treatment depends on the ability of some cells to capture and concentrate some elements for use in building certain compounds as part of their natural functions. Regarding the functions of cobalt 60, most nuclear medicine centers use the medical radiotherapy unit with cobalt 60 as a source for the radiation beam directed at the patient's body, and as we find that in the centers that contain linear accelerators, the cobalt unit is still used in them along with the accelerators, the cobalt device is one of the best radiotherapy devices Because it is economical compared to others, as uh, it does not require refrigeration and its half-life is relatively long, as the source can be changed every five years, because there are factors that have an important role in determining the appropriate radiation source for treatment, such as radiation characteristics and intensity, construction and operational costs, shielding and calibration requirements, and availability of spare parts.

Complications of stereotactic radiosurgery

Stereotactic radiosurgery is a technique that utilizes multiple convergent beams to deliver a high single dose of radiation to a radiographically discrete treatment volume. Although initially developed for the treatment of benign tumors and vascular malformations, it is being increasingly used for malignant disease, particularly metastatic intracranial lesions. The complications of cerebral stereotactic radiosurgery will be reviewed here. TYPES OF REACTIONS — In general, there are fewer complications associated with stereotactic radiosurgery compared with standard fractionation cranial irradiation. This is because of the limited field of treatment, and the methodology of strict stereotactic localization and immobilization. In addition to varying with time from treatment, the incidence and type of complications from stereotactic radiosurgery are a

function of the type of underlying lesion and the location of the lesion within the brain. In general, the complications of stereotactic radiosurgery are divided into three categories based upon the time of onset following treatment:

1. bullet Acute.
2. bullet Subacute.
3. bullet Delayed.

Acute reactions

Acute reactions — The symptoms associated with acute reactions are due to transient swelling that occurs 12 to 48 hours after therapy. One study reviewed the immediate side effects (ISE) following stereotactic treatment of 78 adult patients with a variety of intracranial lesions. ISE, defined as those occurring during and up to two weeks after therapy, developed in 35 percent. Most of the ISE (87 percent) were mild, and consisted of nausea, dizziness or vertigo, seizures, and new persistent headache. Two patients had worsening neurologic deficit and two others required hospitalization for seizure or worsening neurologic deficit. The location of the treated lesion may impact on the incidence of posttreatment seizures. In one report, seizures following radiotherapy were more common in patients whose lesions were located in the motor cortex than elsewhere in the brain (66 versus 16 percent). Other suggest that acute reactions are rare. In one series that included 835 consecutive patients undergoing gamma knife radiosurgery,18 (2.2 percent) had a neurologic event (new focal deficits or seizure) or death (n = 3) within seven days of treatment. Acute reactions do not predict for the development of delayed side effects. Routine administration of short duration steroids around the time of radiosurgery may prevent or delay the clinical signs.

Subacute reactions

Subacute reactions — Subacute reactions occur 3 to 10 months following therapy (later than the subacute reactions following conventionally fractionated radiotherapy) and may be reversible, or progress to permanent sequelae. These are probably due to tumor swelling from treatment and associated edema in the surrounding normal parenchyma. This tumor swelling is indicative of radiation- induced damage and it has not been reported following conventionally- fractionated radiotherapy. Tumor shrinkage occurs later, with subsidence of the surrounding edema, and this phenomenon may therefore be regarded (paradoxically) as a good prognostic sign. Contrast enhancement in the tumor perimeter, as defined by cranial magnetic resonance imaging (MRI) or computed tomography (CT) reflects a reactive response and not tumor activity.

Delayed reactions

Delayed reactions — Persistent clinical neurologic symptoms or signs, and MRI changes (best seen on the T2-weighted sequences) can persist beyond two years, indicating delayed damage. About one to 24 months following radiosurgery, increased T2 signal is seen in 10 to 30 percent of patients treated for arteriovenous malformation (AVM) and about 5 to 10 percent of those with benign tumors.These late normal tissue reactions (particularly permanent late sequelae) are universally referred to as "necrosis." These areas usually represent scarring or focal coagulative necrosis without mass effect. Areas of low signal with mass effect and significant surrounding edema usually indicate coagulative necrosis, and surgical decompression is occasionally needed.Posttreatment cranial neuropathies also represent late or delayed reactions. In one series, all new or worsened deficits occurred within 28 months of treatment.

COMPLICATIONS OF RADIOSURGERY FOR PRIMARY INTRACRANIAL TUMORS

Radiosurgery is a reasonable treatment option for selected benign or low grade intracranial tumors such as meningioma or acoustic neuroma.

Meningioma — Posttherapy complications occur in less than 10 percent of patients undergoing radiosurgery for meningioma: bullet In a prospective series of 88 consecutive patients who underwent radiosurgery for skull base meningiomas, there was no treatment-induced visual loss, and nine patients (10 percent) developed new trigeminal neuropathy; six of these had received locoregional doses >19 Gy bullet In a second report that included 107 patients with 118 meningiomas (54 percent in the skull base), worsening symptomatic peritumoral edema without tumor growth followed treatment in 1 of 49 (2 percent) skull-base tumors and in 4 of 39 (10 percent) non-basal tumors. Although rare, secondary brain tumors have been reported following radiosurgery for meningioma.

Acoustic neuroma — Radiosurgery is a reasonable treatment option for selected patients with smaller tumors (<3 cm) or for patients with enlarging tumors who are not candidates for surgery. After radiosurgery for acoustic neuromas, hearing loss, and facial or trigeminal nerve dysfunction are significant neurologic complications. The incidence of cranial nerve complications after radiosurgery is a function of dose, with the risk being highest at tumor margin doses greater than or equal to18 Gy. This was illustrated in a prospective study in which 40 consecutive patients were treated with standard tumor margin doses of 20, 18, and 16 Gy for tumor diameters of 2 cm or less, 2.1 to 3 cm, and 3.1 to 4 cm respectively. The subsequent 40 consecutive patients were treated with a reduced dose protocol providing 16, 14, and 12 Gy for tumor volumes of 4.2 cm3 or less, 4.2 to 14.1 cm3, and more than 14.1 cm3 respectively. The incidence of facial and trigeminal neuropathy at two years was significantly lower with the reduced dose protocol compared to the standard dose protocol (facial neuropathy, 8 versus 38 percent; trigeminal neuropathy, 15 versus 29 percent).

a. Hearing loss — Variable rates of hearing loss are reported in different studies due in part to differences in delivered dose, variable rates of pretreatment hearing loss, and to the definition of hearing outcome. The following illustrates the range of findings:

Patients with pretreatment hearing deficits may improve following therapy. As an example, in one report, 38 patients were treated with stereotactic radiosurgery to a total dose of 20 Gy; 16 tumors were greater than or equal to3 cm in greatest dimension. Among the patients with diminished but clinically useful hearing pretreatment, hearing was improved in 25 percent, stable in 50 percent, and reduced in 25 percent after treatment. Radiation dose is an important predictor of posttherapy hearing impairment. This was illustrated in a series of 29 patients with intracanalicular acoustic tumors,15 of whom had preradiosurgery hearing assessment. Long term followup demonstrated serviceable hearing preservation in all 10 patients who received doses to the tumor margin of less than or equal to14 Gy, but in only one of five who received >14 Gy The only significant risk factor for hearing loss in a retrospective study involving 125 patients undergoing stereotactic radiosurgery for acoustic neuroma was underlying neurofibromatosis type 2 (NF2). b.Facial and trigeminal nerve dysfunction — In the study of 162 patients referred to the overall results relative to facial and trigeminal nerve dysfunction were: Normal facial nerve function was preserved in 85 percent of patients who had normal function preoperatively. No patient with initial normal function developed complete facial weakness, and there was no facial sensory dysfunction in patients with intracanalicular tumors. bullet Trigeminal nerve function was preserved in 84 percent of patients with normal preoperative function.

COMPLICATIONS OF RADIOSURGERY FOR BRAIN METASTASES

A growing body of evidence suggests that radiosurgical treatment of single or multiple brain metastases may result in equivalent survival and fewer complications when compared to historical results from resection or whole brain radiotherapy Acute side effects from radiosurgery occur in 10 to 20 percent of patients. They are generally mild and consist of nausea, headache, and mild seizures. Delayed side effects, occurring several months after treatment, are uncommon. Symptoms include increased seizures, headaches, or worsening neurologic deficits, and corticosteroid

treatment is usually beneficial. However, 5 to 10 percent of such patients develop severe symptomatic necrosis and may require surgical resection. In one large series of patients treated with radiosurgery for brain metastases, mass effect necessitating surgery, and treatment-related cranial neuropathies were found in 7 and 1 percent of the patients respectively. In a second report of 97 patients suffering from multiple brain metastases peritumoral edema occurred in 5 patients and necrosis in one.

Radiation-induced brain tumors

There is an increased risk of meningiomas, nerve sheath tumors, and malignant gliomas with cranial or craniospinal radiation therapy. (See "Risk factors for brain tumors"). Meningeal cells appear to be particularly susceptible to effects of ionizing radiation. The median induction period from cranial radiation to the development of the new tumor may be lengthy, even more than 10 years. Children undergoing cranial irradiation are at risk for radiation-induced brain tumors. Among a cohort of 8831 children diagnosed with ALL and enrolled on Children's Cancer Group therapeutic protocols between 1983 and 1995, 19 patients had developed a second brain tumor. The relative risk for brain tumors among children who had received 18-24 Gy of cranial irradiation was significantly increased to 2.4 (95% confidence interval, 1.1-5.2). In an analysis of one of the St. Jude Children's Research Hospital leukemia protocols, the combination of prophylactic cranial radiotherapy and antimetabolite therapy resulted in an unexpectedly high frequency of brain tumors (6 of 52, 13 percent), possibly magnified by a genetic defects in thiopurine methyltransferase in the affected individuals. Among the 198 children treated within the Pediatric Oncology Group of prolonged postoperative chemotherapy and delayed irradiation for children diagnosed with a brain tumor at less than 3 years of age, five developed second malignancies: choroid plexus carcinoma (2 children), ependymoma (1 child), desmoplastic infantile ganglioglioma (2 children), and medulloblastoma (1 child). The interval from diagnosis of initial tumor to second malignancy ranged from 33 to 92 months. Risks Associated with Radiation Therapy

a. Risks Associated with Radiation Therapy: Common (more than 10 out of 100 patients):

Temporary partial hair loss with some areas of permanent hair loss. Headache. Fatigue Sleepiness. Dry mouth. Altered sense of taste. Scalp redness or soreness. Uncommon (more than 1 but less than 10 patients out of 100): Hearing loss. Dryness of the ear canal. redness of the external ear if in radiated area. Rare (less than 1 out of 100 patients): Eye injury resulting in blindness.Mental slowness, behavioral changes. Severe damage to normal brain tissue that may require additional surgery. Brain swelling in the area receiving the radiation therapy. Seizure. Risks Associated with Whole Brain Radiation Therapy: Likely: Scalp redness or soreness. Hair loss. Dry mouth or altered taste. Fatigue, sleepiness. Muffled hearing (temporary). Less Likely: Fever, chills, heavy sweating. Upset stomach, nausea and/or vomiting. Loss of appetite, taste changes. Headaches, seizure, weakness. Rare, But Serious: Permanent hair loss. Hearing loss. Eye injury resulting in blindness. Mental slowness, behavioral changes. Risks of Radiosurgery: Likely: Pin site soreness for a day or two. Less Likely: Brain swelling, which may cause any prior or existing neurologic symptoms to get worse. Muffled hearing (temporary). Rare, But Serious: Radiation necrosis, which can cause brain swelling months later.

Brain tumors

A brain tumor is a growth of cells in or near the brain. Brain tumors can occur in brain tissue. It can occur near brain tissue. These proximal places include the nerves, the pituitary gland, the pineal gland, and the membranes that cover the surface of the brain. Brain tumors can start inside the brain. They are called primary brain tumors. Sometimes, cancer spreads from other parts of the body to the brain. These tumors are called secondary brain tumors, and metastatic brain tumors are also called. Primary brain tumors have several different types. Some brain tumors are not cancerous. These are called noncancerous brain tumors or benign brain tumors. Noncancerous brain tumors

may grow over time and put pressure on brain tissue. Other types of brain tumors are brain carcinomas, also called malignant brain tumors. Brain cancers can grow quickly. Cancer cells can invade and destroy brain tissue. Brain tumors range in size from very small to very large. Some brain tumors are discovered when they are very small because they cause symptoms you notice right away. Other types of brain tumors grow to a very large size before they are detected. Some parts of the brain are less active than others. If a brain tumor begins in a less active part of the brain, it may not cause symptoms right away. The tumor may reach a very large size before it is detected. Brain tumor treatment options vary, depending on the type, size, and location of the tumor. Common treatments include surgery and radiotherapy.

Types of brain tumors

There are many types of brain tumors. The type of brain tumor depends on the type of cells that make up the tumor. Laboratory tests of tumor cells can provide information about the cells. The health care team uses this information to find out the type of brain tumor. Some types of brain tumors are usually not cancerous. These are called noncancerous brain tumors or benign brain tumors. In some cases, some types of brain tumors are cancerous. These types are called brain cancers or malignant brain tumors. Some types of brain tumors can be benign or malignant. Benign brain tumors are usually slow growing. While malignant brain tumors are often rapidly growing.

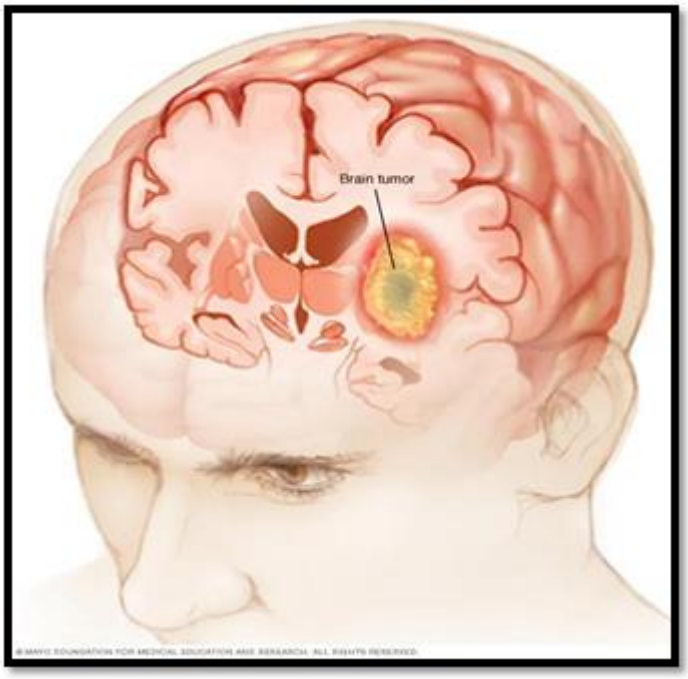


Figure (5) Brain tumors.

Types of brain tumors include

Gliomas and associated brain tumors: associated brain tumors. Gliomas are abnormal growths of glial-like cells. Glial cells are cells that surround and support neurons in brain tissue. Gliomas and associated brain tumors include astrocytoma , glioblastoma , oligodendroglioma, and ependymoma . Gliomas can be benign, but most are malignant. Glioblastoma is the most common type of malignant brain tumor. Choroid plexus tumors. Choroid plexus tumors begin in the cells that secrete the fluid that surrounds the brain and spinal cord. This fluid is called cerebrospinal fluid. Choroid plexus tumors are located in fluid-filled cavities in the brain, called ventricles. Choroid plexus tumors can be benign or malignant. Choroid plexus carcinoma is the most malignant form of this type of brain tumor. It is more common in children.

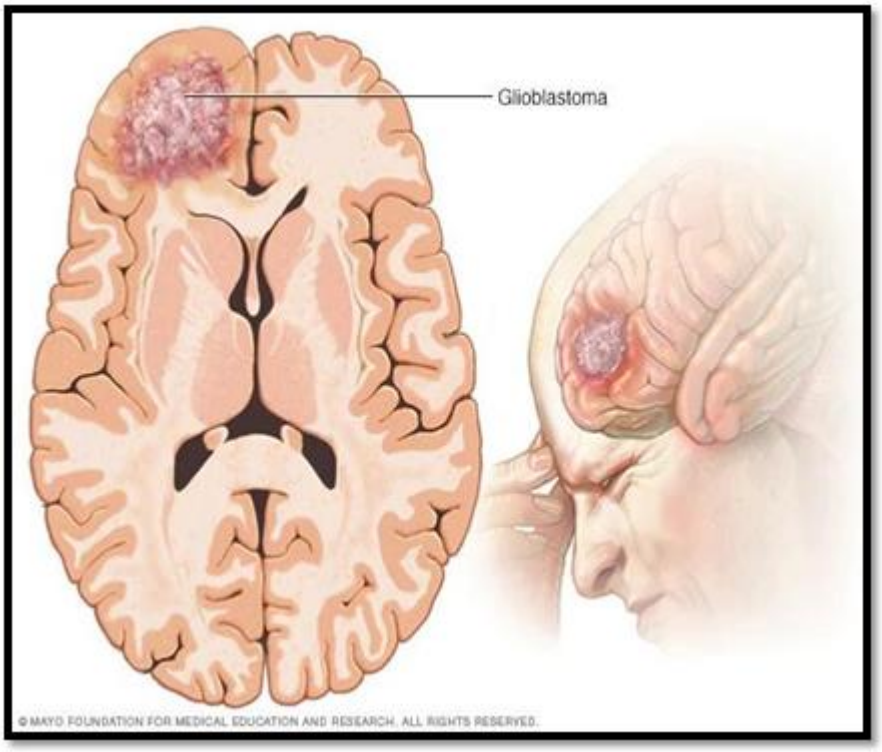


Figure (6) Glioblastoma.

tumors Choroid plexus tumors : begin in the cells that secrete the fluid that surrounds the brain and spinal cord. This fluid is called cerebrospinal fluid. Choroid plexus tumors are located in fluid-filled cavities in the brain, called ventricles. Choroid plexus tumors can be benign or malignant. Choroid plexus carcinoma is the most malignant form of this type of brain tumor. It is more common in children. Embryonic tumors: Embryonic tumors begin in the remaining cells of a developing fetus. These cells, called embryonic cells, remain in the brain after birth. Embryonic tumors are malignant brain tumors that occur most often in infants and young children. The most common type of embryonal tumor is medulloblastoma . It usually occurs in the lower back part of the brain called the cerebellum. Sex cell tumors: Sex cell tumors begin in the reproductive cells — also known as germ cells — that turn into sperm cells and egg cells. Sex cells are found mostly in the ovaries and testes, but sometimes they are found in other parts of the body, such as the brain. When germ cell tumors occur in the brain, they often appear near the pineal gland or pituitary gland. Most germ cell tumors are benign. It is more common in children. Pineal tumors: Pineal tumors begin in the pineal gland in the brain and around the gland. The pineal gland is located in the middle of the brain. It produces a hormone called melatonin that helps sleep. Pineal tumors can be benign or malignant Pineoblastoma is a malignant type of pineal tumor and is more common in children.

Meningiomas :Meningiomas are brain tumors that begin in the membranes surrounding the brain and spinal cord. Meningiomas are mostly benign, but sometimes they can be malignant. Meningiomas are the most common type of benign brain tumor. tumors Neuromas :are abnormal growths that occur in and around nerves. The most common type that occurs in the head is an acoustic neuroma , also called a schwannoma. This benign tumor occurs on the main nerve that connects the inner ear to the brain.

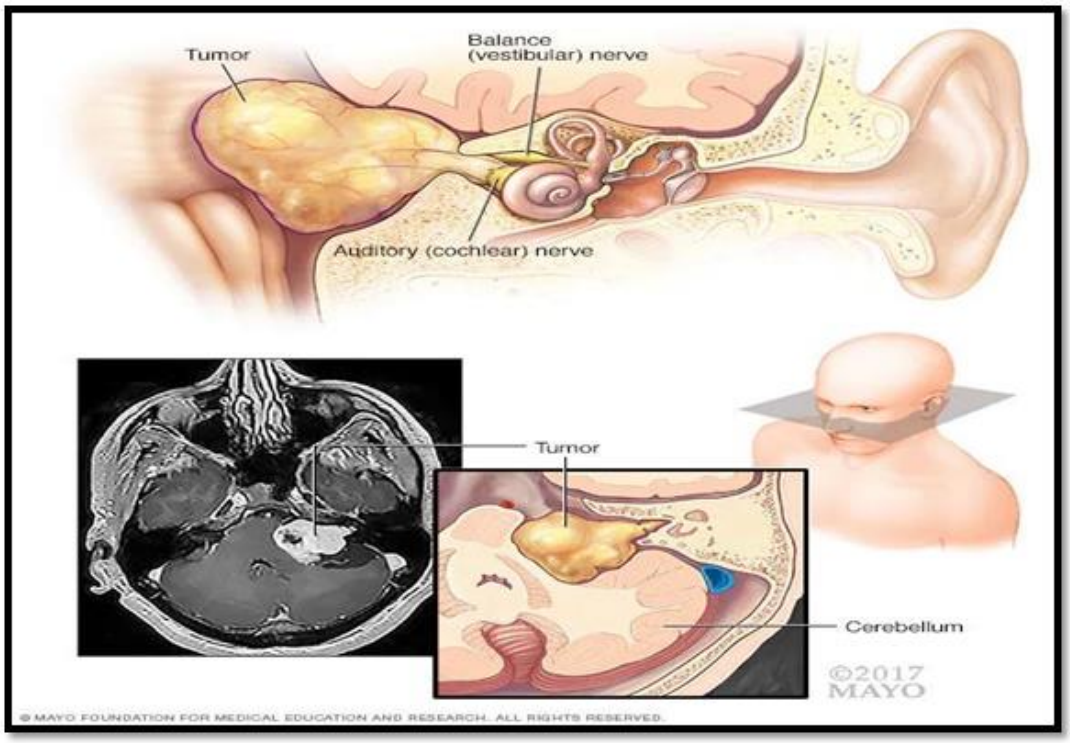


Figure (7) Acoustic neuroma (vestibular schwannoma).

7. Pituitary tumors: Brain tumors can start in and around the pituitary gland, a small gland located near the base of the brain. Most tumors that occur in and around the pituitary gland are benign, and pituitary adenomas occur in the pituitary gland itself. One of the brain tumors that occur near the pituitary gland is craniopharyngeal tumor .

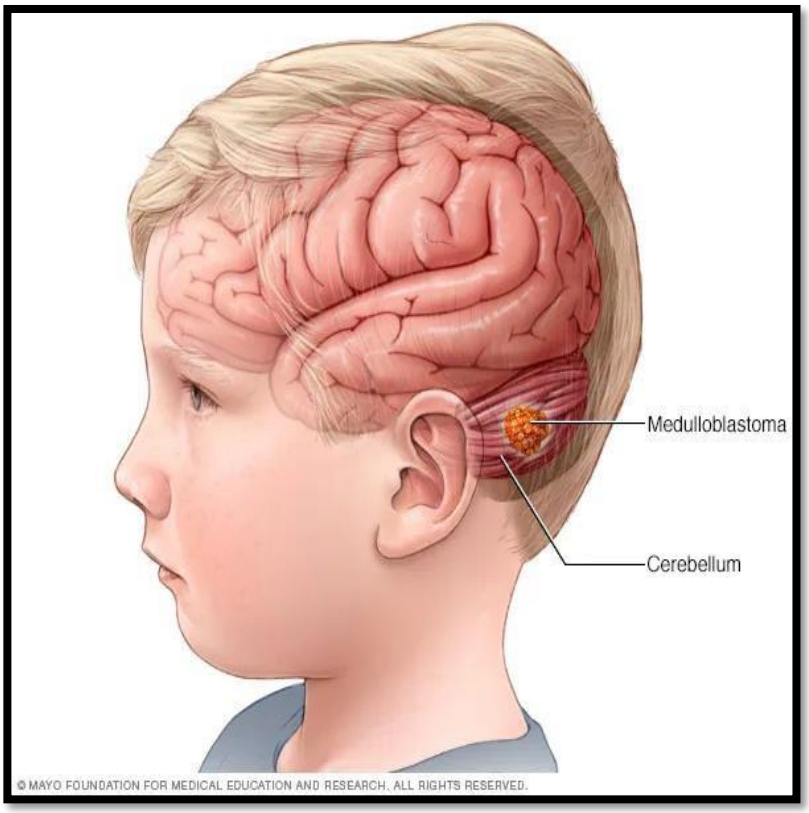


Figure (8) Medulloblastoma

*Other brain tumors. Many other types of rare tumors can occur in and around the brain. These tumors may begin in the muscles, blood vessels, and connective tissue surrounding the brain. Tumors can form in the bones of the skull. Malignant brain tumors may start from germ-fighting immune system cells in the brain. This type of brain cancer is called primary central nervous system lymphoma.

Symptoms of brain tumors

Signs and symptoms of a brain tumor vary, depending on the size and location of the brain tumor. Symptoms may also depend on how fast a brain tumor is growing, also called the grade of the tumor. General signs and symptoms caused by brain tumors may include: Headache or pressure in the head that is worse in the morning. A headache that comes more often and seems more severe. Headaches are sometimes described as similar to tension headaches or migraines. Nausea or vomiting. Eye problems, such as blurred vision, double vision, or loss of side vision. Loss of feeling or movement in an arm or a leg. Difficulty balancing. speaking problems, Feeling very tired., Feeling confused in doing daily things. memory problems, Having difficulty following simple commands. Changes in personality or behavior. Epileptic seizures, especially if there is no history of epileptic seizures. Hearing problems. Dizziness or the feeling that the world is spinning, also called vertigo. Feeling very hungry and gaining weight. Noncancerous brain tumors often cause symptoms that develop slowly. Noncancerous brain tumors are also called benign brain tumors. It may cause minor symptoms that you may not notice at first. Symptoms may worsen over months or years.

Cancerous brain tumors cause rapidly worsening symptoms. Cancerous brain tumors are also called brain cancers or malignant brain tumors. It causes symptoms that appear suddenly and get worse over days or weeks. Headache caused by brain tumors: Headache is the most ommon symptom of a brain tumor. About half of people with brain tumors experience headaches. Headaches may occur as a result of a growing brain tumor pressing on healthy cells around it. Or a brain tumor can cause swelling in the brain, which in turn increases pressure in the head and leads to headaches. Headaches caused by brain tumors usually get worse when you wake up in the morning. But it can be felt at any time. Some people get headaches that wake them up from sleep. Headaches caused by brain tumors often cause pain that gets worse with coughing or straining. People with brain tumors often report that their headaches are similar to a tension headache. While some people liken it to the sister (migraine). Brain tumors affecting the back of the head may cause headaches with neck pain. If the brain tumor is located in the front of the head, the headache may resemble eye pain or sinus pain.

Causes of brain tumors: Brain tumors that start in the brain, Brain tumors that begin as a growth of brain cells are called primary brain tumors. It may start directly in the brain or in nearby tissues. These nearby tissues may include the membranes that cover the brain called the meninges. Brain tumors can also appear in the nerves, pituitary gland, and pineal gland. Brain tumors occur when cells in or near the brain experience changes in their DNA. The cell's DNA carries the instructions that tell the cell what to do. The changes tell cells to grow rapidly and continue their life cycle when healthy cells die as part of their normal life cycle. This leads to many extra cells in the brain. The cells may form a growth called a tumor. It is not yet clear what causes the DNA changes that lead to brain tumors. For many who develop brain tumors, the cause is never known. DNA changes are sometimes passed from parents to children. The changes may increase the risk of developing a brain tumor. However, these hereditary brain tumors are rare. If you have a family history of brain tumors, please discuss this with your doctor. You might consider seeing a doctor trained in genetics to understand whether your family history increases your risk of a brain tumor. When brain tumors appear in children, they are most likely primary brain tumors. In adults, a brain tumor is most likely cancer that began elsewhere in the body and spread to the brain. Risk factors: Exposure to radiation: People who have been exposed to a strong form of radiation are more likely to develop brain

tumors. This powerful type of radiation is called ionizing radiation. This radiation is characterized by its strength, which is capable of causing changes in the DNA in the cells of the body. DNA changes, in turn, may lead to tumors and cancers. Examples of ionizing radiation are radiation therapy used to treat cancer and radiation exposure from atomic bombs. Low-level radiation from everyday items has not been linked to brain tumors. Low levels of radiation include energy emitted from cell phones and radio waves. There is no convincing evidence that cell phone use causes brain tumors. However, more studies are still underway to verify this. Age. Brain tumors can occur at any age, but they most often affect older adults. Some brain tumors affect mainly adults, and some appear more often in children. Ethnicity. Anyone can get a brain tumor. But some types of brain tumors are more common in people of certain races. For example, gliomas are more common among white people. While meningiomas are more common among black people.

METHODS AND MATERIALS

PURPOSE: To evaluate the temporal evolution and appearance of a radiosurgical lesion at magnetic resonance (MR) imaging and the clinical response in patients undergoing stereotactic radiosurgical pallidotomy or thalamotomy with the gamma knife.

MATERIALS AND METHODS:

Seventeen patients with medically refractory movement disorders underwent stereotactic radiosurgical pallidotomy (n = 2) or thalamotomy (n = 15). A single dose of 120–140 Gy was administered to a target in the globus pallidus interna or ventralis intermedius thalamic nucleus. Postprocedure gadolinium-enhanced MR imaging and clinical assessment were performed at 1 month and 3 months. CONCLUSION: Findings in this pilot study suggest that radiosurgical thalamotomy is a promising treatment for medically refractory tremor. Three-month follow-up MR studies show a ring-enhancing lesion surrounded by a variable amount of vasogenic edema. Visualization of the radiosurgical lesion and the clinical response are delayed compared to that with radio-frequency procedures. PURPOSE: To characterize the magnetic resonance (MR) imaging response of brain metastases after gamma knife stereotactic radiosurgery and determine whether imaging features and tumor response rates correlate with local tumor control and survival. MATERIALS AND METHODS: Serial MR examinations were performed in 48 patients (25 men, 23 women; mean age, 58 years) with 78 lesions. Pretreatment and follow-up enhancing lesion volumes and imaging features were assessed. Rates of response to stereotactic radiosurgery were calculated. Prognostic imaging features affecting local control and survival were analyzed.

RESULT AND DISCUSSION

1: Movement Disorders: For the radiosurgical treatment of tremor (e.g., benign essential tremor, Parkinson's disease), the target is the ventralis intermedius thalamic nucleus, which is a subnucleus of the ventral lateral nucleus. The ventral lateral nucleus receives projections from the contralateral cerebellum via the brachium conjunctivum. The ventralis intermedius nucleus is only 3-4 mm in anteroposterior thickness. These thalamic nuclei cannot be definitively identified on the basis of MR imaging characteristics. Hence, localization of these structures with stereotactic techniques is critical for optimal placement of the radiosurgical lesion. Stereotactic coordinates are calculated relative to a line connecting the anterior and posterior commissures. The target is 7-8 mm anterior to the posterior commissure along the intercommissural line, and 11-13 mm lateral and 2 mm superior to the intercommissural line. During a radiosurgical thalamotomy, a single dose of 120-140 Gy is administered to the target during a 45-60 min interval. In our experience, therapeutic effect usually begins approximately 4 weeks after treatment. At 3 months posttreatment, the radiosurgical lesion most commonly appears as a ring-enhancing focus 5 mm or less in diameter surrounded by vasogenic edema extending less than 7 mm in radius beyond the target (Figs. 1 and 2). Patients with ring-enhancing lesions 7 mm or more in diameter at 3 months after treatment may have already developed, or should be considered at risk for developing, more extensive radiation necrosis and

edema [1] (Fig. 9). The development of symptomatic radiation necrosis appears to be an idiosyncratic event. In our experience, it has occurred in approximately 20% of patients and it is usually treated successfully with corticosteroids.

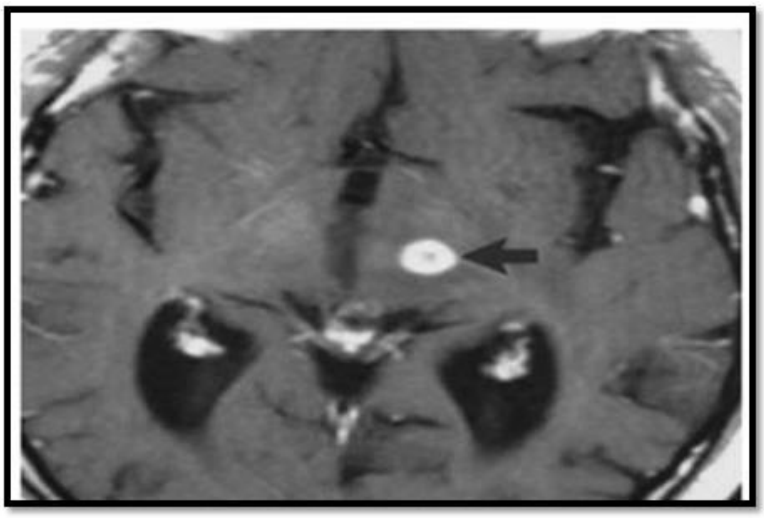


Fig. 9. Appearance of complicated radiosurgical thalamotomy in 78-year-old man with essential tremor who underwent single radiosurgical dose of 140 Gy to left thalamus. Enhanced axial T1-weighted MR image (500/16, TR/TE) obtained 3 months after thalamotomy shows 10-mm focus

2: For the radiosurgical treatment of trigeminal neuralgia, the target can be either the proximal root entry zone of the trigeminal nerve (Fig. 4A ,4B,4C) or the distal retrogasserian) portion (Fig. 5). In theory, the portion of the nerve closer to the brainstem is myelinated by oligodendrocytes and therefore should be more sensitive to irradiation than the retrogasserian portion of the nerve, which is myelinated by Schwann's cells [2]. The proximal root entry zone is irradiated such that no more than 20% of the 50% isodose curve includes the brainstem. However, recent data suggest that the retrogasserian portion of the trigeminal nerve is also an adequate target. Because the 20% isodose curve is at the brainstem surface when this target is used, higher doses (90 Gy, as compared with 70-80 Gy for the proximal root entry zone) can be given to the nerve, resulting in less exposure to the brainstem [3]. Onset of therapeutic effect begins from 3 weeks to 3 months after treatment. In our experience, no changes were identified in the trigeminal nerve or brainstem at 3-6 months posttreatment except in two patients with multiple sclerosis (a known cause of trigeminal neuralgia) (Figs10).

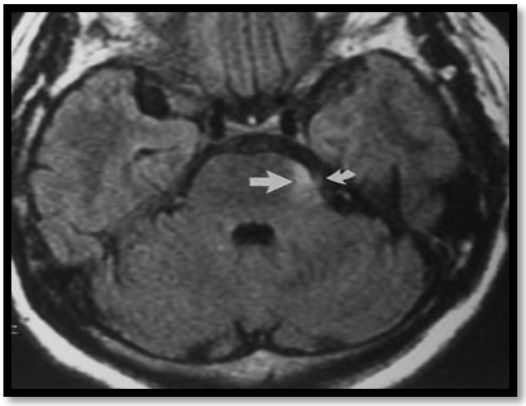


Fig. 10. —Radiosurgical treatment of root entry zone of trigeminal nerve in 56-year-old woman with left trigeminal neuralgia resulting from multiple sclerosis. Axial fluid- attenuated inversion recovery MR image (10002/142, TR/TE) shows hyperintensity (edema) in left pons (straight arrow). Left trigeminal nerve (curved arrow) is incompletely seen on image.

Successful treatment with the gamma knife may result in growth arrest, regression, or obliteration of the neoplastic lesion. Growth arrest has been reported in approximately 90% of benign neoplasms at the skull base and 85% of solitary metastases [4]. Tumor regression is uncommonly seen earlier than 3 months posttreatment and may take years to fully evolve. For example, the median time for regression of vestibular schwannomas is approximately 1 year, with a range of 3-33 months [5, 7] (Fig11). Tumor regression occurs more rapidly in malignant neoplasms Fibroblasts and myofibroblasts aid in tumor retraction.

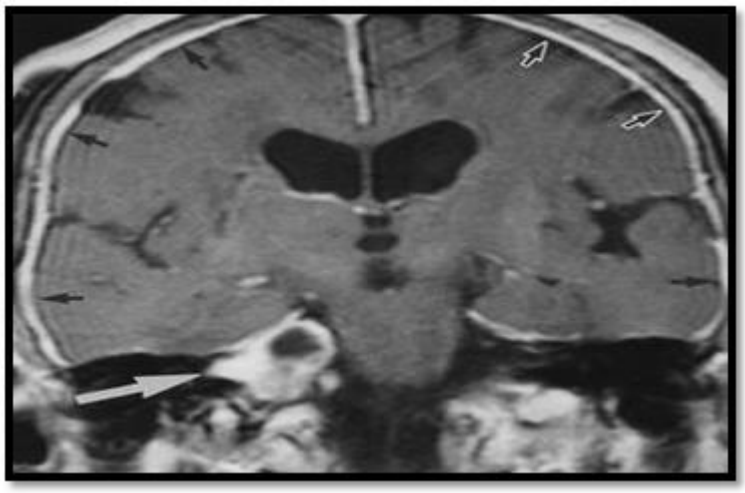
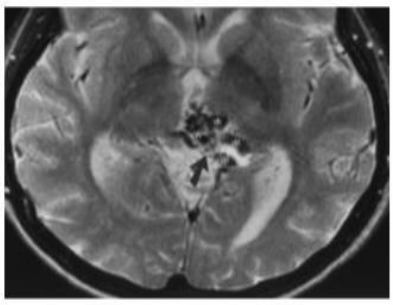


Fig. 11. —Late radiosurgical changes after treatment of benign neoplasm in 75-year-old woman who underwent single radiosurgical dose of 12 Gy to surgically proven right vestibular schwannoma. Enhanced coronal T1-weighted MR image (400/8, TR/TE) obtained before treatment shows enhancing, partially cystic mass in right cerebellopontine angle extending into right internal auditory canal (large arrow). Diffuse pachymeningeal enhancement (small arrows) is related to previous surgery.

Stereotactic radiosurgery is an effective treatment strategy for small arteriovenous malformations, and it can be the preferred treatment for high-risk lesions located in the basal ganglia, thalamus, and brainstem. After successful radiosurgery, injury to the endothelium and intervening brain tissue causes the transnidal blood flow to gradually decrease until the arteriovenous malformation is completely obliterated. MR imaging and MR angiography are accurate methods to follow up regression of the nidus, as well as to show the appearance of complications such as venous hypertension and radiation-induced vasogenic edema, demyelination, or gliosis [8] (Figs.**12** Most patients have a transient period before the arteriovenous malformation is obliterated, during which the transnidal blood flow is so slow that neither MR imaging nor MR angiography can accurately reveal patency of the malformation. Therefore, conventional cerebral angiography is usually required to exclude the presence of a small residual nidus.

Fig. 11A. —Evolution of radiosurgical changes after treatment of arteriovenous malformation in 40-year-old woman who underwent single radiosurgical dose of 20 Gy to arteriovenous malformation. Axial T2-weighted MR image (2120/80, TR/TE) obtained before radiosurgery shows nidus (arrow) and deep draining veins (asterisks) of arteriovenous malformation located in region of thalamus and posterior third ventricle.



Figs. 12

RESULTS: At 3 months, the radiosurgical lesion most commonly (n = 11) appeared as a ring-enhancing focus 5 mm or less in diameter surrounded by vasogenic edema that extended less than 7 mm in radius beyond the target. Five patients had ring- enhancing lesions 7 mm or more in diameter; four of these developed symptomatic perilesional edema at 3 (n = 2) or 8 (n = 2) months after the procedure. Onset of therapeutic effect began approximately 4 weeks after treatment. In the 15 patients with tremor, there was a mean decline of 2.1 on the Tremor Rating Scale. RESULTS: Local tumor control was achieved in 66 (90%) of 73 metastases at 20 weeks after stereotactic radiosurgery; 61% maintained local control at 2 years. A homogeneous baseline enhancement pattern and initial good response rate (>50% lesion volume reduction) predicted local control. Five metastases demonstrated a transient volume increase after treatment. The median survival time after stereotactic radiosurgery was 53 weeks and correlated with systemic disease burden and primary tumor.

5. CONCLUSION AND FUTURE WORK

CONCLUSION: COMPLICATIONS OF RADIOSURGERY FOR BRAIN METASTASES A

growing body of evidence suggests that radiosurgical treatment of single or multiple brain metastases may result in equivalent survival and fewer complications when compared to historical results from resection or whole brain radiotherapy. Acute side effects from radiosurgery occur in 10 to 20 percent of patients. They are generally mild and consist of nausea, headache, and mild seizures. Delayed side effects, occurring several months after treatment, are uncommon. Symptoms include increased seizures, headaches, or worsening neurologic deficits, and corticosteroid treatment is usually beneficial . However, 5 to 10 percent of such patients develop severe symptomatic necrosis and may require surgical resection. In one large series of patients treated with radiosurgery for brain metastases, mass effect necessitating surgery, and treatment-related cranial neuropathies were found in 7 and 1 percent of the patients respectively. In a second report of 97 patients suffering from multiple brain metastases peritumoral edema occurred in 5 patients and necrosis in one. CONCLUSION: Findings in this pilot study suggest that radiosurgical thalamotomy is a promising treatment for medically refractory tremor. Three-month follow-up MR studies show a ring-enhancing lesion surrounded by a variable amount of vasogenic edema. Visualization of the radiosurgical lesion and the clinical response are delayed compared to that with radio-frequency procedures. CONCLUSION: Baseline homogeneous tumor enhancement and initial good response correlate with local control. Initial lesion growth does not preclude local control and may represent radiation-related change. Recognition of these serial MR imaging findings may guide image interpretation and influence treatment in patients with stereotactic radiosurgery– treated metastases.

FUTURE WORK

Radiation dose recommendations for Kama knife radiosurgery vary according to the tumor and the size of the dose. The marginal dose is 55%. AVM is taken 15Gy from 15 to 16 minutes. The target site is 24 years. Acoustic neuroma is taken from 11 to 15Gy from 11 to 12 minutes 3cm. Meningioma The marginal dose is taken From 11-18Gy atypical 50-55Gy +12-16Gy target 14-15Gy metastases marginal dose 14-24Gy varies by size or combined with brain gliomas marginal dose 12-20Gy the EBT55-60Gy+15.5-16Gy inflammation The third nerve is 40 Gy, maximum 80 Gy.

Recommendations for the use of radiation doses according to the size of the tumor that will have a risk of 1% or 3% of radiation necrosis Diameter in mm parallel 12.5, 15.0, 17.5, 20.0, 22.5, 25.0, 27 .5,30.0 with the size in parallel also in cm. Cube 1.02,1.77,2.81,4.10,5.96,8.18,10.89,14.14 with a dose risk volume of 1% in parallel also 27.5,25.0 , 22.5, 20.0, 18.7, 17.5, 16.5, 15.0 with a dose

risk volume of 3% in parallel also 34, 29, 23, 18, 16.5, 14.5 13.5.13 Very important for improving radiation protection.

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