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Brain Tumour Foundation of India

Jascap
FIGHTING CANCER – LIVING WITH IT

Understanding Brain Tumours
A Guide for Patients and Their Families

JASCAP a registered charitable trust provides to patients & their families, information on various aspects of cancer and its treatment, in different Indian languages, since 1996.

The information in this booklet can help cancer patients and their families to understand the disease and its treatment and thus cope with it better.

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We hope that you found this booklet useful.

To help other patients and their families we need and intend to extend our Patient Information Services in many ways.

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This book is **DEDICATED** *to Patients with Brain Tumours & Their Families for their indomitable spirit and courage*

BRAIN TUMOURS

1. Knowing brain tumours

Brain tumours are quite diverse affecting all age groups. These tumours pose several challenges from treatment perspective including rehabilitation and support services of not only the affected person but also the care giver. However due to the improvement in neurosurgical, radiotherapy techniques and development of newer chemotherapeutic and biological agents, the outlook of these tumours have improved over the last decade period of time. Moreover, while long term survivors of brain tumours still have considerable issues in several aspects of their activities of daily living and quality of life, there are many of them, who are not only enjoying an excellent quality of life but are also integrating into the main stream and leading a good social life.

Epidemiology

The overall incidence of brain tumors is quite low (< 5 per 100,000 person years) worldwide, comprising only 1-2% of all cancers. However, the number of new brain tumor cases detected annually has increased steadily over time in the last three decades with China, India, and USA contributing maximally to this global burden. Reports from hospital-based cancer registries confirm that primary brain tumors are the second leading cause of disability and leading cause of death from cancer in children (< 14 years) and young adults (15-39 years) worldwide including India. Primary brain tumors can arise from different cell types based on which they are classified histologically into several types. Astrocytomas are the most common childhood brain tumors followed by primitive embryonal tumors such as medulloblastoma, whereas diffuse gliomas (astrocyoma, oligodendroglioma and glioblastoma) and meningiomas predominate in adults.

These tumours are quite diverse in nature ranging from benign to malignant tumours.

Benign (Non-cancerous) brain tumours do not contain cancer cells: Majority of the benign tumours can be removed, and they seldom grow back. Cells from benign tumours do not invade tissues around them or spread to other parts of the body. However, benign tumours can press on critical areas of the brain and cause serious and life-threatening neurological problems.

Malignant (cancerous) brain tumours contain cancer cells: They are likely to grow rapidly and crowd or invade the surrounding healthy brain tissue. Very rarely, cancer cells may break away from a primary brain tumour and spread to other parts of the brain, to the spinal cord, or very occasionally even to other parts of the body. Malignant brain tumour is generally more serious and often is life threatening.

These tumours affect all age groups right from the very young to the very old. Management of these tumours poses several challenges right from treatment to ancillary care including rehabilitation and support services.

In some patients, a low-grade tumour will develop into a high-grade malignant tumour. It is called malignant transformation or progression to malignancy.

Primary and secondary brain tumours

A primary brain tumour is a solid tumour, defined as an abnormal growth of cells within the brain or the central spinal canal. This abnormal and uncontrolled cell division usually occurs in the brain, in blood vessels, in the cranial nerves, in the brain envelopes (meninges), skull bone, pituitary gland, or pineal gland.

When cancer spreads from its original place to another part of the body, the new tumour has the same kind of abnormal cells as the primary tumour. Cancer that spreads to the brain from another part of the body is different from a primary brain tumour. When cancer cells spread to the brain from another organ (such as the lung or breast) doctors may call the tumour in the brain a secondary tumour or brain metastasis.

In India, primary brain tumours are far more common than brain metastasis which is in contrast to the western countries where metastatic brain tumours are more common.

Risk factors & Possible causes of brain tumours

There are no known causes of brain tumours. Unlike some of the tumours in the body it is not caused by any infection or infectious agent. Research in the area of causation of brain tumours is still ongoing.

Brain tumours are not contagious and cannot be transmitted from one person to another.

Age

Brain tumours can occur at any age. Certain brain tumours like gliomas usually occur in middle age and elderly individuals while certain tumours occur during childhood and adolescence.

Exposure to medical radiation

Exposure to radiation is the only definite risk factor for development of second cancers especially brain tumours. People who are exposed to radiotherapy, frequent CT scans or X-rays of the head are at higher risk of developing brain tumours like meningiomas and to a lesser extent, malignant gliomas Although medical exposure to radiation is kept as low as possible, X-rays and CT scans are important modalities in diagnosing diseases so that you have the right treatment.

Previous cancers

Children who have had cancer have a higher risk of developing a brain tumour later in life. For e.g. children who have had leukemia (a type of blood cancer) or Hodgkin or Non-Hodgkin lymphoma (a type of cancer of the lymph nodes) as an adult also have an increased risk of brain tumour. There is some evidence that there is an increased risk of brain tumours in adults who have had other types of cancer for e.g. breast cancer survivors who have been treated with chemotherapy may have an increased risk of pituitary adenomas. This increased risk has been postulated due to the treatment for the previous cancer, such as radiotherapy to the head. However, it should be kept in mind that the benefit of treatment for the original cancer far outweighs the risk of brain tumour.

Genetic conditions and family history

Less than 1% of brain tumours is associated with genetic conditions and occurs in members of a family. People who have one of these rare syndromes have an increased risk of getting a brain tumour. Patients with family history of any of brain tumours need to get themselves properly investigated with relevant investigations.

Examples of the syndromes associated with brain tumours are

- Neurofibromatosis types 1 & 2
- Tuberous sclerosis
- Li Fraumeni Syndrome
- Von Hippel Lindau Syndrome
- Turner Syndrome
- Turcot syndrome
- Gorlin Syndrome

If you have a parent, brother or a sister diagnosed with a brain tumour, your risk may be slightly higher than other people.

Other medical conditions and medicines

People with HIV or AIDS have double the risk of being diagnosed with a particular type of brain tumour called lymphoma of the brain which is also called as Primary CNS lymphoma. The HIV patients tend to have this form of brain tumour at a younger age.

These is a small risk of women developing brain tumours especially meningiomas. Post-menopausal women who are taking hormone replacement therapy (HRT) or younger woman who are taking oral contraceptive pills (OCP) may have slightly increased risk. However, this link needs to be proved by further research studies.

Mobile phones

Cell phones emit radiofrequency electromagnetic radiation. The amount of radiofrequency electromagnetic radiation a cell phone user is exposed to depend on the technology of the phone, the distance between the phone's antenna and the user, and the user's distance from cell phone towers. International Agency for Research on Cancer (IARC) have categorized the radiation emitted from cell phones

as category 2B carcinogen which means that there is inadequate evidence of carcinogenicity in humans but sufficient evidence of carcinogenicity in experimental animals. Studies thus far have not shown a consistent link between cell phone use and cancers of the brain, nerves, or other tissues of the head or neck. From the evidence so far, we still can't say that mobile phones pose a problem to health. There has been a concern about them causing brain tumours in particular. But there is no strong evidence that there is any link. More research is needed because cell phone technology and the way people are using cell phones have been changing rapidly. Even though there is no strong evidence suggesting that radiations emitted from cell phones increases the risk of brain cancer, individuals need to be cautious while using cell phones.

Do's and Don'ts of mobile cell phone use

Do's	Don'ts
• Use mobile phones in speaker or hand's free mode or Bluetooth headsets • Use mobiles of low SAR (specific absorption rate) value • Texting instead of talking on the phone • Limit the use of mobile phones as much as possible. Keep your conversations short and sweet. • When you use the phone, try to alternate the side of the face you are using. • Wherever possible Use the landline instead of mobile phone.	• Do not keep your mobile phones under your pillow while sleeping. • Avoid using mobile phones whenever there is a weak signal, as that's when it uses more power and so the energy deposition is much more. • Do not press the phone against your head to hear more clearly. • Avoid using the phone when your hair is wet and hold it away if you are wearing a metal spectacle frame, as water and metal are good conductors of radio waves. • Children should limit the use of mobile phones to avoid longer duration of exposure to radio waves, as their bones are thin because of which the absorption rate is higher.

2. The brain: its structure & its functions

How the brain works

The brain is the control centre of the body and mind. It controls the body by sending electrical messages along nerve fibres. The nerve fibres run out of the base of the brain and into the spinal cord. From the spinal cord the nerve fibres spread out to all areas of the body. The spinal cord also communicates messages and sensations from nerves in the body back to the brain. Together, the brain and spinal cord form the central nervous system. A clear fluid circulates around the brain and spinal cord and protects them. It is called cerebrospinal fluid also called CSF.

The brain is made of nerve cells called neurons. There are billions of these neurons. Also in the brain are other types of cells that support the neurons. These are called glial cells. There ar many different types of cells in the brain and these can develop into different types of brain tumours.

Different areas of the brain control different parts of the body as well as our thoughts, memories and feelings.

Brain tumours can develop anywhere in the brain. They can develop from

- The cells that make up the brain tissue
- The nerves entering or leaving the brain
- The coverings of the brain (the meninges)

Different symptoms due to brain tumours depend on the part of the brain they are located. So, to understand why brain tumours cause particular symptoms, it helps to know a little about the different structures of the brain.

Parts of the brain

The main areas of the brain include

- The cerebrum (forebrain)
- The brain stem
- The cerebellum (hindbrain)

The cerebrum

The cerebrum is the largest part of the brain. It is also called the forebrain and is divided into the right and left cerebral hemispheres. They control movement, thinking, memory, emotions, senses and speech. Special MRI scans done during specific tasks (functional MRI) have helped us to understand which areas of the brain relate to particular functions.

As the nerve fibres leave the brain, they cross over from one side to the other. This means that the nerves that come from the right side of your brain control the left side of your body. So, if you have a brain tumour causing weakness on the left side of your body, the tumour will be in the right side of your brain.

Each cerebral hemisphere is divided into 4 areas as illustrated in **figure 1**

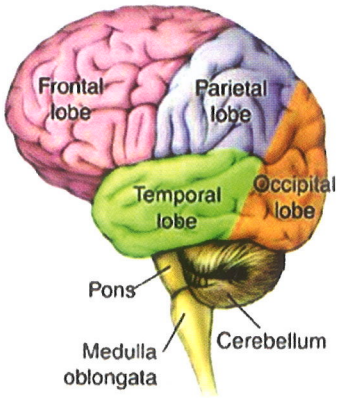


Figure 1: A simple diagram to illustrate the different cerebral lobes of the brain, brain stem and cerebellum

The frontal lobe contains areas that work with speaking, planning, problem solving, starting particular movements, and some aspects of personality and character. Towards the back of the frontal lobe are areas that coordinate movement and also process sensations.

The temporal lobe is where we process sounds and also where memory is stored. A tumour here can cause strange feelings of having been somewhere or done something before (also called déjà vu). It may also cause abnormal tastes or smells.

The parietal lobe controls touch, temperature, pressure and pain sensations. It is where we recognise objects in the world around us and store that knowledge. One area also processes the information when people speak to us. A tumour here can affect speech, reading, writing or the understanding of words.

The occipital lobe is the visual centre of the brain and processes what we see, including colour, shape and distance. A brain tumour in this area can cause problems in vision.

The brain stem

The brain stem controls vital body functions. Blood pressure, swallowing, breathing and heartbeat are all managed by this area of the brain. The brain stem has 3 main parts and are called the pons, and the medulla. The brain stem also includes a small area above the pons called the midbrain. The brain stem connects the cerebral hemispheres and the cerebellum with the spinal cord. All the nerve fibres leaving the brain pass through here to go to the limbs and trunk of the body.

The cerebellum

The cerebellum is also called the hindbrain. It controls balance and posture. It is also involved with coordination of skilled movements. For example, walking or movement of hands needs a lot of coordination. This is controlled by the cerebellum. Cerebellar tumours can cause loss of balance or difficulty coordinating your movements.

The pituitary gland and pineal gland

The pituitary gland is a small gland in the middle below the brain. The pituitary gland makes a lot of different hormones. And it controls many different body functions.

Pituitary hormones control

- Growth
- The speed of body processes (your metabolism)
- The production of natural steroids in the body
- Periods and egg production in women

- Sperm production in men
- Breast milk production after the birth of a baby

The pineal gland is a very small gland deep in the brain. It makes the hormone melatonin. These control sleep patterns.

The ventricles

Ventricles are spaces inside the brain, filled with the fluid called cerebrospinal fluid or CSF. The ventricles connect with the space in the centre of the spinal cord and with the membranes covering the brain (the meninges). So the fluid can circulate around and through the brain and around the spinal cord. A growing brain tumour can block the circulation of the fluid. The resulting increased pressure inside the skull from fluid buildup is called hydrocephalus and can cause symptoms. With some types of brain tumours cancer cells can spread in the CSF, causing symptoms similar to meningitis - headaches, sickness, and problems with sight and movement.

The meninges

The skull protects the brain. Inside the skull, and covering the brain, are 3 thin sheets of body tissue. These are called the meninges and they also help to protect the brain. This is illustrated in **figure 2**

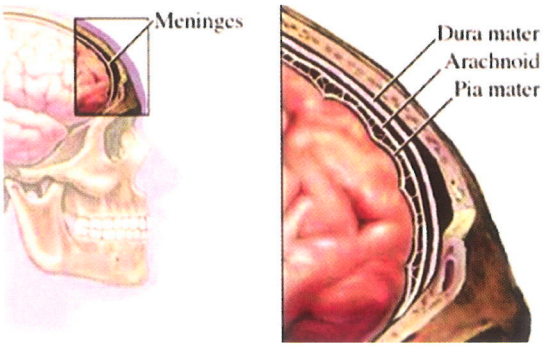


Figure 2: Diagram showing the three coverings of the brain

Some general signs & symptoms of brain tumours

Brain tumours cause symptoms for two reasons. Firstly, because they take up space inside the skull as they grow. Secondly, they can cause specific symptoms due to their position in the brain.

- A new seizure in an adult
- Gradual loss of movement or sensation in an arm or leg
- Unsteadiness or imbalance, especially if it is associated with headache
- Drowsiness.
- Loss of vision in one or both eyes, especially if the vision loss is more peripheral
- Double vision, especially if it is associated with headache
- Hearing loss with or without dizziness
- Speech difficulty of gradual onset
- Nausea or vomiting that is most severe in the morning, confusion and disorientation, and memory loss.
- Any abnormal change in behavior (increasingly irritable)
- infertility
- Irregular or loss of menstrual cycles in females

3. Specific symptoms based on the location of the brain tumours

Position of Tumour	Symptoms
Frontal Lobe	Changes in personality, Swearing or behaving in a way that you normally wouldn't, (loss of inhibitions) Losing interest in life, (apathy) Difficulty with planning and organizing. Being irritable or aggressive, Weakness in part of the face, or on one side of the body, Difficulty walking, Loss of sense of smell, Problems with your sight or speech.
Temporal Lobe	Forgetting words, Difficulty finding the correct word, short term memory loss, Fits associated with strange feelings, smells or déjà vu (a feeling you have been somewhere or done something before), Hearing voices in your head

Parietal Lobe	Difficulty speaking or understanding what is said to you, Problems with reading or writing, Loss of feeling in part of the body
Occipital Lobe	Visual problems and loss of vision of one side
Cerebellum	Poor coordination, Uncontrolled movement of the eyes, Neck stiffness, Dizziness
Brain Stem	Poor coordination, Drooping eyelid or mouth on one side, Difficulty swallowing, Drooling of saliva, Difficulty speaking, Seeing double (diplopia)
Pituitary Gland	Irregular or infrequent periods in women, Infertility in men and women, Lack of energy, Weight gain, Mood swings, High blood pressure, Diabetes, Large (overgrown) hands and feet.
Spinal Cord	Pain, Numbness in part of the body, Weakness in the legs or arms, Loss of control of the bladder or bowel
Meninges	Headache, Sickness, Problems in vision, Problems with movement

It is important to remember that there are many other causes for the symptoms mentioned above. If you are worried you need to go to a specialist doctor (neurologist or Neurosurgeon). In elderly people, vague symptoms of memory loss, personality changes and difficulty in walking can be put down to getting older. If several such symptoms develop in less than 6 months, it is worth checking in with a specialist doctor.

4. Types of primary brain tumour

Malignant Gliomas

Gliomas - Tumours arising from glial cells of the brain are called gliomas. Gliomas make up about 30% of all brain and 80% of all malignant brain tumours.

Glioblastomas (GBM) - These are highly malignant brain tumours. And are also the commonest primary brain tumours. Glioblastomas are highly cancerous as the tumour cells grow rapidly nourished by a meshwork of blood vessels feeding the tumour cell. As these tumours arise from normal brain cells, they can easily invade the normal brain but seldom do they spread beyond the brain. This tumour represents about 20% of all primary brain tumours and about 60-75% of all astrocytomas. They increase in frequency with age. Approximately 5% children are affected by glioblastomas. These tumours are commonly found in the cerebral hemispheres. GBM require a multimodal treatment approach. The mainstay of treatment is safe removal of as much tumour as possible through surgery followed by focal radiotherapy to the brain with simultaneous use of temozolomide (taken by mouth) and long-term use of temozolomide for six to twelve months. The prognosis of these tumours may not be as good as low grade astrocytomas but majority of them can be controlled for a long time. It has been shown that glioblastoma patients in whom the MGMT gene is shut off by a process called methylation also have prolonged survival rates.

Astrocytomas - The tumour arises from glial cells called astrocytes. In adults, astrocytomas most often arise in the cerebral hemisphere. In children, they occur in the brain stem, the cerebrum, and the cerebellum. Astrocytomas can be slow growing (low grade) or fast growing (high grade). Sometimes low grade astrocytomas can transform into high grade tumours. A grade- III astrocytoma is sometimes called an anaplastic astrocytoma. Grade-IV astrocytomas are also called GBM as described above. These are malignant (high grade) brain gliomas and can sometimes spread to other parts of the brain. Low grade astrocytomas are grade-I & II tumours and are indolent. These are generally seen in children and young adults. In children they are commonly called as pilocytic astrocytomas (Grade-I astrocytomas according to WHO classification). Primarily these tumours are treated by surgical resection. However, in some instances the tumour may be in critical location (near the optic nerve, thalamus or the brain stem) where radiation has to be employed. These tumours have a very good prognosis and usually do not transform to higher grade astrocytomas. Grade-II astrocytomas on the other hand exhibit a diverse spectrum of tumours. (e.g., are diffuse fibrillary astrocytoma

pilomyxoid astrocytoma, pilocytic xanthoastrocytoma, and gemistocytic astrocytoma). The prognosis of grade-II astrocytomas is not as good as grade-I astrocytomas and majority (50-80%) transform into higher grade tumours over a period of several years. Studies have shown that even grade-II astrocytomas can be observed after complete resection. However, such patients need to be observed carefully with yearly surveillance MRI and detailed studies of molecular markers of patients histopathology specimens. Sometimes, grade II tumours may have aggressive features on an MRI scan even though they look like low grade tumours under the microscope. In such a scenario, a careful decision regarding adjuvant radiation and/or chemotherapy should be taken in a joint multidisciplinary tumour board after consultation with the pathologist and radiologist who can give further inputs about the behavior of the tumour

Ependymoma - The tumour arises from cells that line the ventricles or the central canal of the spinal cord. These cells called ependymal cells. These tumours constitute approximately 10% of primary brain tumours. They are most commonly found in children and young adults and can occur in any part of the brain or spinal cord. In older patients they tend to occur in the lower part of the spinal cord. Ependymomas can be high or low grade. Rarely, ependymomas can spread to other parts of the central nervous system, through the fluid that circulates around the brain and spinal cord. Complete resection of tumour is the main stay of therapy followed by local radiation in case of high grade ependymomas. Low grade ependymoma (grade-I) can be observed after complete surgical excision.

Oligodendroglioma - This rare tumour arises from cells called oligodendrocytes that make the fatty substance called myelin that covers and protects nerves. It helps the nerve signals (impulses) to travel along the nerves more quickly. These tumours usually occur in the cerebrum especially in the temporal or frontal lobe. About 4% of primary brain tumours are oligodendrogliomas and represent about 10-15% of gliomas. They are most common in middle-aged adults. A low-grade oligodendroglioma is a slow growing tumour while an anaplastic oligodendroglioma is a more aggressive tumour and grows quickly. These tumours are treated by surgery followed by radiation and chemotherapy depending on the grade of the tumour. A special test called 1p19q chromosomal test is done in these tumours which

predicts treatment outcome. Patients who have loss of 1p19q have a better prognosis than patients who do not have any loss of the chromosome.

Brain stem glioma - The tumour occurs in the lowest part of the brain. Brain stem gliomas most often are diagnosed in young children and middle-aged adults. Biopsy is seldom done in these tumours. Hence these tumours are diagnosed and graded by imaging (MRI). These tumours are considered to have a poor outcome as they cannot be surgically resected. Radiotherapy is the only modality of treatment in these tumours. The average survival of these tumours is 1 year if they are diffuse and located in pons while small localised tumours located in mid brain and medulla tend to do well with average survival of several years.

Malignant Non-Glial tumours

Non-Glial Brain tumours: Some types of brain tumours do not begin in glial cells but from other types of cells in the brain. Common examples are

Medulloblastoma - This tumour usually arises in the cerebellum, but may spread to other parts of the brain. Medulloblastomas are malignant tumours formed from poorly developed cells at a very early stage of their life. It is one of the common brain tumours in children. Very rarely, medulloblastomas may spread to other parts of the body. If they do spread to other parts of the brain or to the spinal cord, this is usually through the cerebrospinal fluid (CSF). Patients who have had a complete resection of tumour and do not have any evidence of spread (standard risk) have a good prognosis; 5-year survival of 75-80% while in patients where the tumour is left behind even after surgery or has spread (high risk) have poor prognosis; 5-year survival is approximately 30-40%. Surgery is the main treatment followed by radiation to the entire brain and spine and chemotherapy. However, in very young children; who are less than 3 years, radiotherapy is not given. In such children, chemotherapy is given after surgery.

Primitive neuroectodermal tumour (PNET) - These tumours appear identical to medulloblastomas under microscope, these are very aggressive tumours and primarily occur in the cerebrum but can

spread to any part of the brain or spinal cord. These are rare tumours and often occur in young children. The treatment strategy is similar to Medulloblastomas.

ATRT- Is also called Atypical Teratoid / Rhabdoid Tumour - this is a rare and high-grade tumour that occurs most commonly in children younger than 2 years. These tumours tend to be aggressive and frequently spread through the central nervous system. They occur in about 1-2 % of children. As these are fast growing tumours, patient becomes symptomatic quite quickly which develops in days to weeks. Presently, ATRT is being diagnosed by testing the INI-1 gene mutation which is absent in these tumours. This is a new and expensive diagnostic test and is available only in few centres in India. These tumours are treated in the same way as medulloblastomas are treated although the prognosis of ATRT is not as good as medulloblastomas.

Lymphomas and Germ cell tumours

Germ cell tumour of the brain - The tumour arises from a germ cell. Most germ cell tumours that arise in the brain occur in people younger than 30. The most common type of germ cell tumour of the brain is a germinoma. A germ cell tumour grows from primitive developing cells that form in the embryo and develop into the reproductive system. They are also called embryonal tumours. Most occur outside the brain, in the chest or abdomen, but they can occur in the brain. In the brain they are most commonly found in the area close to the pineal gland and the pituitary gland. Germ cell tumours sometimes produce chemicals that can show in the blood. The chemicals include alpha fetoprotein (AFP), human chorionic gonadotrophin (HCG) and placental alkaline phosphatase (PLAP). So sometimes these tumours can be diagnosed with a blood test. They are often picked up when they are still small. They can block the circulation of fluid around the brain and so they tend to cause symptoms early on. Germinomas tend to good prognosis, as over 90% of patients can be effectively treated with radiation therapy. In general, they carry an excellent prognosis, with cure in well over 90% of patients in germinomas. However; non germinomas behave aggressively with survival rate of just 50%.

Lymphomas - Tumours which arise from the lymphatic system are called lymphomas. Although the brain and the spinal cord do

not have an inherent lymphatic system, lymphoma can start in the brain or spinal cord. This are called primary cerebral lymphoma or primary central nervous system (CNS) lymphoma. Fewer than 1 in 20 brain or spinal cord tumours (5%) are primary CNS lymphomas. Most are a type of lymphoma called diffuse large B cell non-Hodgkin lymphoma. Lymphoma is a cancer of the lymphatic system. These tumours are treated differently to other types of brain tumour. These tumours do not carry a good prognosis. Average survival of these patients is around 3 years.

Benign brain tumours

Pituitary tumours - The pituitary gland is a small gland on the underside of the brain. Tumours arising from the pituitary gland are called pituitary adenomas as most pituitary tumours are benign (non-cancerous), these are slow growing tumours that start in pituitary tissue cells. Tumours larger than 1 cm are called macroadenomas while tumours smaller than 1 cm are called microadenomas. Tumours larger than 4 cm are called giant macroadenomas. Some pituitary adenomas produce hormones and are called secretory tumours. Others do not produce hormones and are called non secretory tumours. The treatment depends on whether your tumour produces hormones or not.

Hormone producing adenomas

Prolactinomas - which cause milk production by the breasts, infertility or loss of sex drive.

Steroid producing tumours - which cause Cushing's syndrome (weight gain on the trunk of the body, a moon face, acne, mood Swings, diabetes, and high blood pressure).

Growth hormone producing tumours - which cause excess height in young people or acromegaly in adults (overgrowth of hands, feet, lower jaw and brows).

Thyroid stimulating hormone producing tumours - which cause an overactive thyroid gland leading to weight loss, feeling hot, irregular periods, moods swings and other symptoms.

Adenomas that don't produce hormones

Pituitary tumours that do not produce hormones are called non secretory adenomas. They usually press on the nerves and cause changes in your eyesight. They may also affect the normal pituitary gland tissue so that you have lower levels of some hormones.

Meningiomas -This tumour arises in the meninges. It usually grows slowly. They are more common in older people and in women. These tumours start in the tissues covering the brain (membranes). They are usually benign (not cancerous) but some are atypical. This means that they behave more aggressively than normally expected for meningiomas. They can grow into surrounding brain tissue and may come back after they have been removed. The estimated 5-year survival for low grade meningiomas varies from 70-90%. Malignant and atypical meningiomas have a far more aggressive clinical course with a 5-year survival of 40-60%.

Schwannoma - A tumour that arises from a Schwann cell. These cells line the nerve that controls balance and hearing. This nerve is in the inner ear. The tumour is also called an acoustic neuroma. They start in the nerve that runs from the ears to the brain and controls hearing and balance. They are nearly always slow growing, do not spread, and are thought of as benign brain tumours. Often, they have been there a long time by the time they are diagnosed.

Acoustic neuromas - are found most often in older people. Loss of hearing in one ear can be a sign of acoustic neuroma. Rarely, they are associated with one form of a genetic condition called neurofibromatosis type 2 (NF 2). In these cases, they are usually diagnosed at a much younger age, and are present on both sides (bilateral), and people affected may also develop meningiomas.

Craniopharyngioma - The tumour grows at the base of the brain, near the pituitary gland. This type of tumour most often occurs in children, teenagers and young adults. Craniopharyngiomas are very rare benign tumours. Craniopharyngiomas do not usually spread, but they occur close to important structures in the brain and can cause problems as they grow. They can cause changes in hormone levels and problems with eyesight. Children with craniopharyngioma can have weight gain and growth problems. A 5-year survival rate of 70-

80% is achieved with surgery and adjuvant radiation therapy. The 10-year overall survival is 60-75%.

5. Diagnosing brain tumours

Based on the above-mentioned symptomatology which is always backed up with a sound history taking, the next step is the diagnostic imaging techniques that have evolved immensely over the past years and have become a valuable asset in diagnosis of central nervous system tumours. These tests are done on an outpatient basis and you do not have to stay back in the hospital.

Computerized Axial Tomography (CAT scan)

A CAT scan is a computerized scan using X-rays. It is the First line imaging modality for brain tumours. Brain tumours usually show up on this type of scan. When you have your CAT scan, you will be injected with a chemical during or just before the scan. This is called a contrast medium. It is a dye that circulates in your bloodstream to the brain and makes the CT pictures of the brain clearer. It is not painful and is a day care procedure

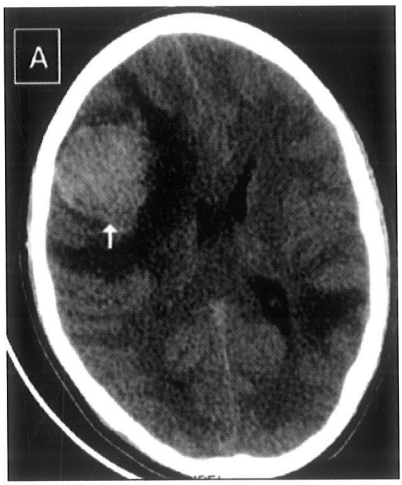


Figure 3: A CT scan showing the location of tumour as marked by the arrow.

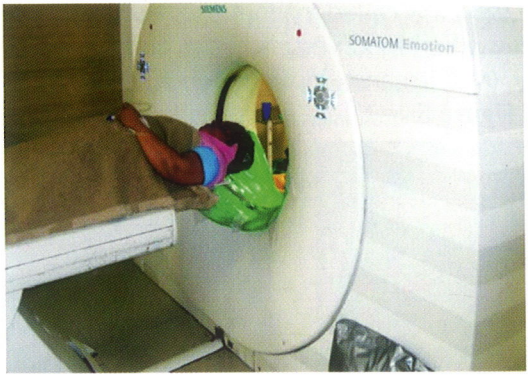


Figure 3 : B. Photograph of a patient undergoing a CAT scan.

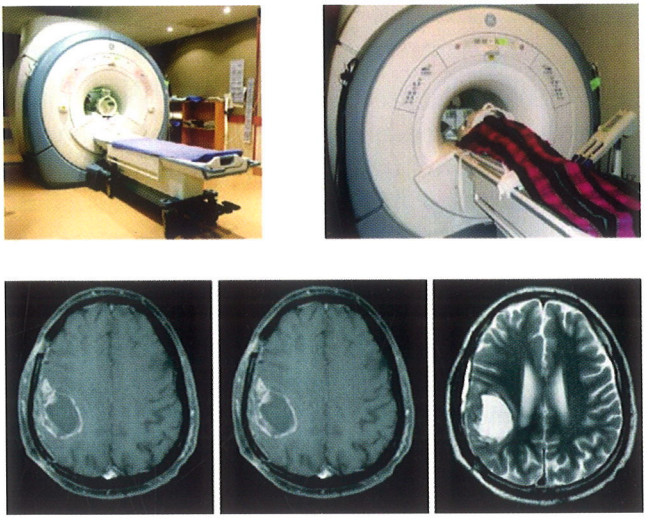


Fig. 4: Various sequences of MRI showing a clear picture of brain tumour

Magnetic resonance Imaging (MRI)

MRI scans use magnetic fields to create a picture of body structures. These scans usually give a very clear picture of the brain and will almost certainly show up any brain tumour that is present. You will be injected with a special dye called a contrast which will make the images clearer.

Specialized MRI scans called magnetic resonance angiography (MRA scans) can show the blood vessels in the brain. Magnetic resonance spectroscopy (MRS scans) looks at chemicals in the tumour as illustrated in **Figure 5**

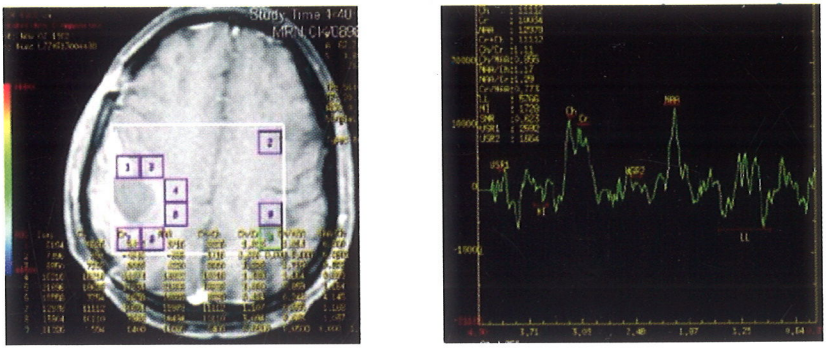


Figure 5: Magnetic resonance spectroscopy (MRS) scans

Perfusion MRI is a specialized MRI technique which measures the rate of blood flow and the amount of blood volume in the tumour vies-a-vies normal brain. The acquired data are then processed to obtain perfusion maps with different parameters, such as BV (blood volume), BF (blood flow).

A special type of MRI scan called a functional MRI (firm) is undertaken for planning complex surgeries. During this scan the doctor will ask you to do things like move your hand, speak or read. These scans are used to help plan surgery when the tumour is close to an area controlling one of these functions.

It is very important to tell your doctor if you have any metal inside your body as this may mean you cannot have an MRI scan.

Benefits and limitations of contemporary imaging modalities for brain tumours

Imaging	Pros	Cons	Remarks
CT Scan	Good anatomic visualization Cheaper & Faster More widely available Can be used with metal objects	Limited reconstruction ability Exposure to ionizing radiation Poor resolution Contrast reaction can occur	First line imaging modality

MRI	Unparalleled resolution True multilane imaging No exposure to ionizing radiation	Susceptible to motion artifacts Cannot be used with metal objects Claustrophobic, noisy, long times Expensive	Gold standard imaging modality
MR Spectroscopy	Useful for discriminating radiation necrosis from tumour	Limited utility near bone, vessels or air spaces Wide variability in interpretation	Assesses tumour metabolites
MR Perfusion	Generally, correlates with grade Useful to distinguish radiation necrosis from tumour progression	Limited utility near bone, vessels	Assesses blood flow & volume

Molecular pathology

Traditionally, histological typing and grading has been the basis for classifying primary brain tumors, estimating their prognosis, and assigning appropriate therapy. Although histo-morphological features are generally reasonable surrogates of disease biology, often they are insufficient to explain marked differences in clinical behavior and outcomes. Advances in molecular techniques have provided deeper insights into fundamental understanding of the biology of various brain tumors that has led to their updated classification and refined prognostication. Simple techniques such as immunohistochemistry (IHC) and fluorescence-in-situ-hybridization (FISH) are recommended in routine diagnostic work-up of brain tumors. Advanced techniques like Sanger sequencing, polymerase chain reaction (PCR), and molecular profiling that need more sophisticated infrastructure and expertise are generally restricted to tertiary-care centers and reference laboratories.

Test for markers in blood and CSF

You may have blood tests to check for specific chemical markers in the blood. Some tumours, such as pineal region tumours or germ cell tumours may change the level of particular hormones and your doctor will check for these markers. For example, if you have a germ cell tumour in the brain, your doctor will check for Alfa feta protein

(αFP), Beta Human Chorionic Gonadotropin levels (βHCG), Lactate Dehydrogenase (LDH) else in the CSF fluid and in your blood. CSF fluid is also tested for LDH levels in case PNET, Medulloblastomas and ATRT.

Biopsy

Usually, a biopsy is used to confirm the diagnosis. Very often a biopsy will tell the treating doctor the exact type of tumour. It is also done as a part of an operation to remove the tumour. The tumour tissue is then sent to the laboratory where it is examined by a pathologist (a doctor who specializes in examining cell or tissues under microscope)

Decision making process

Decision regarding the management of these tumours should always be taken in a multi-disciplinary meeting and the treatment plan formalized. Patients requiring multidisciplinary postoperative management, those with a diagnostic or therapeutic dilemma and patients eligible for clinical research study should be discussed by a multi-disciplinary team comprising of experienced neurosurgeons, radiation oncologist, medical oncologist, radiologists and pathologists. Such meetings usually take place at tertiary care cancer centres and in academic hospitals across India.

6. Treating Brain Tumours

Goals of management - The management of brain tumours requires multimodal approach. The basic goal of the treatment of brain tumours is to safely remove the tumour as much as possible (also called maximum safe resection) and to prevent it from recurring again by giving adjuvant treatment in the form of either radiotherapy or chemotherapy.

Treatment options for brain tumour

The most suitable treatment for a brain tumour depends on the type of tumour. It also depends on its location in the brain its size and grade. Your oncology team will work together to decide on the best treatment for you. Your specialists will also consider your age

and general health, and your own wishes about your treatment. In general, there are 3 types of modalities available for treating brain tumours.

Treatment for brain tumours is based on many factors, such as:

- Your age, overall health, and medical history
- The type, location, and size of the tumour
- How likely the tumour is to spread or recur
- Your tolerance for specific medications, procedures, or therapies

Surgery

Taking out a growing brain tumour is important because as the tumour gets bigger it increases the pressure inside the head. It is this increased pressure that causes some of the symptoms of brain tumours. The surgeon is sometimes able to remove the whole tumour but often this is not possible and they can only remove part of it. Even if your surgeon doesn't think your brain tumour can be completely removed, they are still likely to want to take out as much as possible.

Types of Neurosurgical procedures

1. **Craniotomies:** This type of surgery involves opening of a part of the skull bone to remove the tumour. After the surgery the bone is replaced back and fixed usually with screws and plates. The tumour removal is usually carried out using the operating microscope to magnify the operating area.

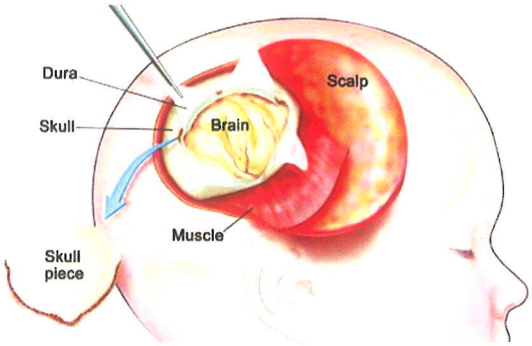


Figure 6 : Photograph showing how a craniotomy is performed to approach the brain

Depending on the amount of tumour removed during surgery, the procedure can be further classified as:

A. **Biopsy:** A very small amount of tumour is removed, for obtaining a diagnosis. A small amount of tumour is sent to the pathologist to confirm the type of tumour on histopathology. These procedures are done for tumours which are dangerous to remove, because they are very deep seated and close to functional areas. Removing tumour situated in these areas can cause damage to patient's condition e.g., hemiplegic (weakness of one side of the body). Biopsy is also done for tumours like lymphoma which responds well to chemo and radiotherapy. Biopsy may also be done in patients who are extremely sick to undergo major surgical procedure.

B. **Debulking surgery:** In this type of craniotomy procedure, the tumour is removed as much as possible, without causing damage to the patient's condition. This is also called as safe maximum resection. In malignant brain tumour, it is not possible to remove the tumour completely because tumour is present in functioning areas of brain. Hence the need to give radiation and chemotherapy to control the remaining tumour.

C. **Complete excision:** This is a type of surgery, where the tumour is completely removed. It is usually possible in benign (non-cancerous) tumours like meningiomas, schwannomas, grade 1 gliomas. Surgery is curative in these cases and radiotherapy and chemotherapy may be avoided.

After surgery, you may experience pain in the operated area or small fluid collection below the wound.

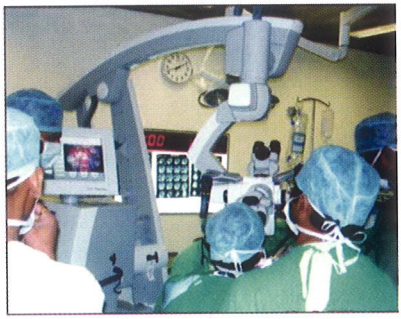


Figure 7 : Photograph showing neurosurgical procedure in progress

Sometimes a drain may be kept to remove the collecting fluid and a crepe bandage tied around the head. Most of the pain will be relieved by simple analgesic like paracetamol (crocin) or combiflam (Ibrufen+ paracetamol). You can take a head bath after a few days. If there is leakage from the wound, you are advised to immediately contact your surgeon. You will be discharged within 5-7 days, providing there are no complications.

2. **Shunts and CSF diversions:** The shunts are used to divert excess CSF (brain fluid) out of the brain usually to the abdomen. They help to reduce the pressure in the brain. A shunt is a tube made of inert silicone rubber. A shunt usually put, remains for life in the patient. Shunt procedure is done in case of hydrocephalus (fluid collection in the brain), arising due to tumour or infection.

3. **Endoscopic surgery:** These are surgeries carried out using an endoscope. A small scope (camera) with instrument is passed through the nose to operate specific tumour in the basal part of the brain, eg pituitary tumours. There are usually no external scar marks in this type of surgery. Endoscopes are also used to biopsy tumours in the ventricles (cuff containing spaces) and perform internal shunting procedures (endoscopic ventriculostomy)

4. **Stereotactic frame-based biopsies:** The stereotactic frame is used to biopsy deep seated lesion of the brain. A metallic frame (stereotactic frame) is fixed around the patient's head using local anesthesia. A CT/MRI scan is obtained after fixing the frame. Using this CT/MRI scan, a biopsy can be obtained in the operation theater using the frame. You (patient) will need to undergo a CT scan, after 4hrs of biopsy, just to make sure that everything is well. You will be discharged in a couple of days after the biopsy.

5. **Navigation guided surgeries:** This is a specialized machine (Navigation system) which helps guide the surgery. A special CT/ MRI scan is first loaded on to the machine. This navigation system works like a GPS (global positioning satellite), help to locate the tumour, planning incision, & guiding the surgeon during the surgery. A special ultrasound in this system helps the surgeon to know whether the tumour is fully resected (removed).

6. **Ultrasound guided surgeries:** This is a type of surgery where the

ultrasound in used to locate the tumour and also to know if any tumour is remaining behind.

7. **ALA guided surgeries:** This is a special type of surgery which uses a dye (ALA Dye). The patient consumes this dye before surgery. During the surgery, the surgeon can see the brain tumour as a bright fluorescent mass, using a special microscope. This helps the surgeon to remove maximum amount to tumour, some of which could be missed in normal light.

8. **Awake surgeries:** This is a type of brain surgery in which the patient is awake during the surgery. This type of surgery is used for tumour which are close functioning areas of the brain, hence at a high risk for problems after surgery. The patient is given local anesthesia to block the pain sensation, however he is conscious. The patient is asked to perform movement of limbs and speak during the surgery for monitoring. The surgery is stopped, if patient develop any complications, thereby limiting the damage.

What is the routine followed before brain surgery?

OPD:

Detailed history and examination is done

1. Radiology (CT scans & MRI scans) are reviewed.
2. Routine investigations: blood test, ECG, X-rays are ordered.
3. Repeat / New MRI may be ordered if previous MRI is old or incomplete.
4. PAC: A pre-anesthetic checkup is done by the anesthetist to check for anesthesia fitness before undergoing surgery. New investigations like echo cardiograph, stress test, etc. may be ordered if required for fitness. The patient is given a risk grade (ASA grade) which tells how risky the surgery is going to be for the patient.

Next Visit:

All the investigations are reviewed and decision for surgery is taken. The risk and complication rate for the surgery are discussed with the patient and his relatives. Date of admission for surgery is given.

Admission and pre-op preparation:

Patient is admitted usually a day prior to the surgery. All the medications are continued in the wards.

Consent:

The patient / or (his relative is patient is unable to consent) is explained regarding the surgery, which he will undergo, including the risk and complications of the procedure involved. After understanding the above, patient has to sign a consent form if he agrees to undergo the procedure or surgery.

Shaving:

The head is shaved partially or fully for the desired surgery. You may request your surgeon if you do not want to shave your head. An incision line shaving can be done in the operation theatre prior to surgery. You will be kept fasting overnight or as directed by the treating doctor, before the surgery. You may be given oral /intra venous medication in the morning of the surgery as advised.

Medications after surgery:

1. **Anticonvulsants:** These drugs are routinely started for patients undergoing cranial surgery except in cases of cerebellar or brainstem tumours. These drugs help to prevent seizure/fits in these patients. They have to be taken regularly and for long period of time. (>2 years). e.g. Valproate, levetiracetam.
2. **Anti-oedema:** These include steroid and injectable Mannitol. These help to decrease the swelling in the brain because of the tumour and help to temporarily stabilize the condition of the patient before surgery. They are also continued after surgery for a few days.

Risk /Complications of brain surgery

Brain is an extremely critical organ which controls all other parts of the body. Hence damage to brain structures by tumour or during surgery can give rise to deficits or problems in rest of the body. As with any surgery there are risk/complication associated with brain surgery. The risk varies from patient to patient depending on the clinical condition of the patient, type of tumour, location of tumour etc.

Risk of brain surgery includes:

1. Convulsion also called Fits
2. Inability to move the limbs
3. Infection (meningitis)
4. Blurring of vision (sight), hearing, swallowing or breathing.
5. Difficulty while balancing.

After Surgery

The patient after surgery is shifted to ICU (intensive care unit) for monitoring after surgery. Most patients will be awake after the surgery. Some of the patients may be electively put on a ventilator to help in the post operative recovery.

A CT scan / MRI brain is done on the day after the surgery to rule out any problem occurring during or after surgery. Patient may remain for a longer time in the ICU in presence of any complication.

Patient is sent to the wards after the stay in the ICU. If the patient is normal after surgery, he is encouraged to engage in normal activity and diet.

In case of any neurological deficits (problems), a Physiotherapist and later an Occupational therapist helps the patients in process of recovery, by various exercises and supporting splints (Devices to help maintain normal posture.)

Sometimes, the patient may need to see a speech/swallowing therapist, ophthalmologist, and endocrinologist for specific problem arising due to disease or after surgery.

Discharge and Follow-Up

Patients are usually discharged when they are stable and can be managed safely at home. They are given a discharge card which specifies what medications are to be taken and for how long. A date is given for suture (stitch) removal and collecting the histopathology report.

After the histopathology report, patients requiring adjuvant therapy (that is - radiation therapy and /or chemotherapy) are referred to the respective specialist doctors.

Patients are asked to follow up with the neurosurgical services after completion of the adjuvant treatment.

Radiotherapy

Radiotherapy is an integral component in the multimodality management of primary brain tumours with potential impact upon its control, symptom improvement, and even survival for malignant brain tumours. Following maximal safe resection, adjuvant radiotherapy is indicated for all high-grade primary brain tumours. For completely excised benign tumours, such as pituitary adenomas and benign meningiomas, currently there is no role of adjuvant radiotherapy. For low grade gliomas too, with no residual tumour on imaging, close observation alone is a reasonable option.

However, radiotherapy is recommended in such tumours either if a residual tumour is evident on post operative imaging or if tumour progression is documented on serial imaging. For tumours in the functional areas of the brain where only a partial excision or biopsy, if possible, radical radiotherapy is needed to improve outcome.

What is Radiotherapy?

It is a type of treatment by which cancer cells are destroyed by using high energy X-rays. This treatment is given by carefully planned radiation beams delivered from outside the body (external radiotherapy or teletherapy). The radiation is delivered such that only the tumour is targeted while sparing the surrounding normal tissue.

Radiotherapy is given as a series of short daily sessions from Monday to Friday with rest on weekends. The dose and duration of radiotherapy depends upon the type of tumour, grade of tumour and the goal of treatment (whether palliative or radical). Thus, the treatment may vary between 1 week to 6.5 weeks. Your treating oncologist will discuss about the entire treatment plan and the effects of treatment with you before starting the radiotherapy. Usually, radiotherapy treatments are outpatient procedures.

What to ask your doctor about brain tumour radiotherapy

You may wish to make a list of questions you would want to ask your treating oncologist before starting radiotherapy: -

- Is there a need for radiotherapy?
- Is there any other treatment I should have along with radiotherapy?
- What are the side effects of this treatment?
- What will be the duration of radiotherapy?
- What diet I should be having during radiotherapy?
- Is there anything I can do to help myself recover more quickly after radiotherapy?
- How often will I have to go to the hospital to have treatment?
- Will I be able to do my regular work during radiotherapy?
- Will I be able to go back to work after radiotherapy?
- Can radiation therapy be given again if my tumour comes back?

Planning for radiotherapy

Radiotherapy treatment is a planned procedure which involves multiple steps. You will have 2 or 3 outpatient appointments before you start radiotherapy. The first is usually to make a mask of your face to use during the treatment. The further appointments are so that the radiotherapy doctor (neuron oncologist) can carefully plan your treatment.

Treatment mask and treatment simulation

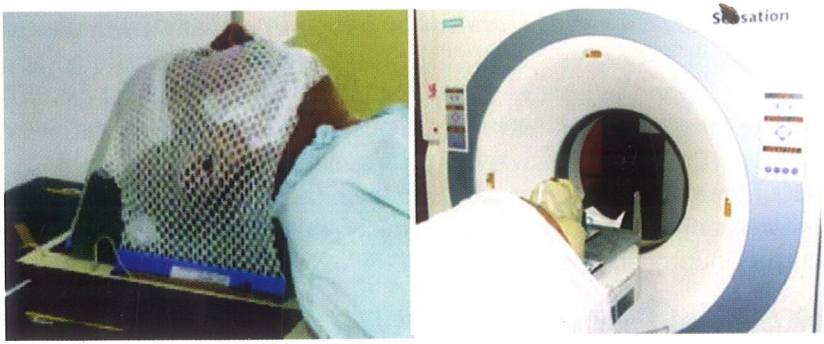


Figure 8: Left: Photograph showing an orfit (Thermoplastic) mask. Right: Photograph showing a simulation procedure on a CT simulator

Before you start your treatment, you go to the hospital mould room to have a mask made. The mask is sometimes called a shell or mould and is made of an orfit (a special type of mesh plastic). It covers the whole of your face and the front of your head. The mask keeps your head completely still while you are being treated. This is a sheet of plastic that is soft when warm but it hardens as it cools. The warmed plastic is draped over your face and shaped to your face and head. It has holes in the mesh so you can breathe easily. When the plastic cools it gives an exact impression of your face and head. The procedure of mask making takes around 20 to 30 minutes. The radiation personnel make marks on the mask to delineate the radiation fields.

Please remember that radiotherapy is a very accurate technique. The face mask will keep you steady so that radiation can be delivered accurately.

Planning for treatment

A team of oncologist, physicist and radiation technologists plan radiotherapy very carefully. Once the mask is made, you will be asked to lie under a CT scanner (CT simulator) which takes images of the area to be treated. You may be given an injection of dye (contrast) into a vein to help the doctor see this area more clearly. The photo shows a patient having a planning CT scan with the mask on in some patients and MRI is also taken. After the scan you can go home. Your treatment team use the CT images and the MRI images, and feed into a special computer called a treatment planning system (TPS). They use this information to determine

- The exact shape of the tumour
- Where important structures are in relation to the tumour (for example, your eyes, spinal cord)
- The direction to aim the radiation beams so that they avoid all the normal structures
- Radiation dose to the tumour vis-a vis and normal tissue.

In order to have an optimal plan, the physicist a nd the oncologist sit together using the images to works out the optimal treatment plan they aim to give a high radiotherapy dose to the cancer cells and keep the dose to the normal brain tissue as low as possible. They may use radiotherapy beams from a number of different angles.

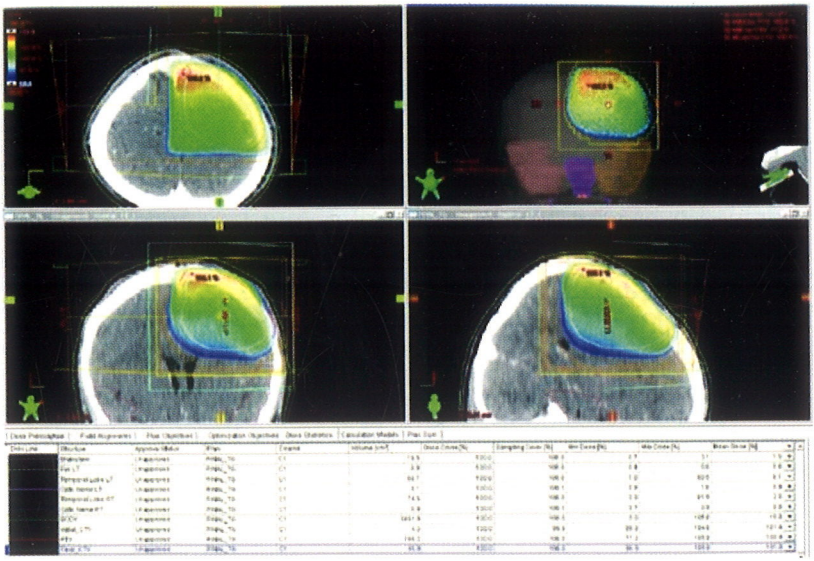


Figure 9: Photograph showing how radiation beams are planned for brain tumours on the Treatment Planning System (TPS)

Having brain tumour radiotherapy

Once your treatment plan is finalized by your treating team, on the day of radiation therapy, you will be asked to you lie on the treatment table. The radiation technologist fits your mask and attaches it to the table. The radiation technologist will help to position you on the couch and make sure that you are comfortable. Each treatment only takes a few minutes. Your radiation treatment will start once the radiation technologist is satisfied that you're positioned perfectly. All the personnel will have to leave the room for the minute or two when the machine is switched on. But the staff will be able to hear you through an intercom and see you on a TV screen, so you can call if you need them.

Initially, the radiation technologists take pictures of the tumour and compare them to your planning CT scan. The couch may then move as they adjust your position. They then turn on the machine to give the actual treatment. During treatment you may hear a buzzing sound. You will not be able to feel it at all. But you must lie very still for the few minutes it takes to treat you.

Types of radiotherapy techniques

a. **Focal radiotherapy:** Radiation is delivered to only a part of the brain where the tumour is located. This is undertaken with the help of 3-D planning systems so that the radiation beams are directed towards the tumour, sparing the normal brain.

b. **Craniospinal radiotherapy:** Radiation is given to entire brain and the spinal cord and its coverings (meanings). This type of treatment is undertaken in patients with medulloblastomas and germ cell tumours. It is a highly specialised type of radiotherapy technique and should be done under proper supervision of expert radiation oncologists.

c. **Whole brain Radiotherapy (WBRT):** Whole brain Radiotherapy (WBRT) is given to patients with secondary (metastatic deposits) brain cancer and patients with Primary lymphoma of the brain.

Radiotherapy delivery techniques

a. Three-dimensional (3D) conformal radiotherapy (3DCRT):

With the help of 3-D planning systems, we can see the tumour in Three dimensions (3D), width, height and depth, using CT scans and MRI scans. The information from these scans' feeds directly into the radiotherapy planning computer. So, doctors can see the treatment area in 3 dimensions. The computer programmed then designs radiation beams that follow the shape of the tumour more closely. So, the radiation beam avoids healthy tissue as far as possible. This is called 3D conformal radiotherapy (3DCRT).

The main benefit with conformal radiotherapy is that it is more precise, because it allows doctors to plan in 3D. Conformal radiotherapy can give a better chance of killing the cancer by delivering a higher dose of radiation straight to it. A very small volume healthy tissue is included in the radiotherapy field and so you are likely to have fewer long term side effects.

3D CRT treatment is delivered on linear accelerators with special attachments called multileaf collimators. Almost all the primary brain tumours are treated by 3D conformal radiotherapy.

b. Intensity modulated radiotherapy (IMRT):

One type of conformal radiotherapy is called intensity modulated radiotherapy (IMRT). Like conformal radiotherapy, IMRT shapes the radiation beams to closely fit the area where the cancer is. But it also changes the radiotherapy dose depending on the shape of the tumour also called as modulation of radiation intensity. This means that the central part of the cancer receives the highest dose of radiotherapy and a surrounding area of tissue gets lower doses.

IMRT can also create an indented (concave) area within the radiotherapy field to avoid structures that would be damaged by the radiotherapy. This is very helpful in brain tumours to avoid spillage of radiation dose to important functional areas of the brain.

Treatment is delivered using linear accelerators with special attachments called Multi Leaf Collimators (MLC). These are motorised MLC's that move dynamically around the patient during radiation treatment to modulate the intensity of radiation beam so that the centre of the tumour gets maximum radiation dose and the surrounding normal tissues are spared of the radiation.

c. Stereotactic conformal radiotherapy (SCRT) and Stereotactic radiosurgery (SRS)

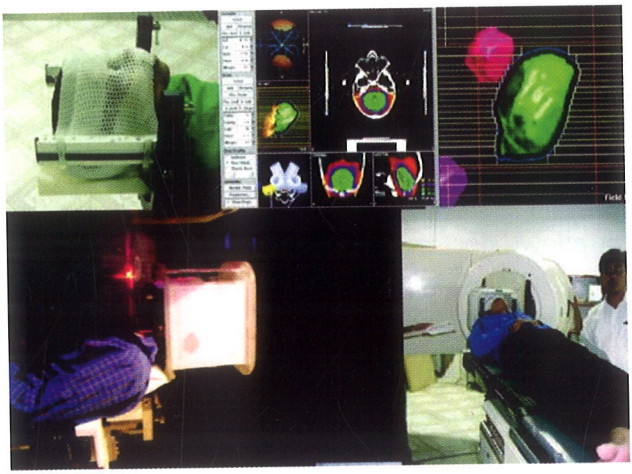


Figure 10: Photograph showing the various procedures (mask making, treatment planning and treatment implementation) involved in stereotactic radiotherapy and radiosurgery.

Stereotactic radiotherapy is a way of targeting radiotherapy very precisely at the tumour. You have the radiotherapy beams aimed at the tumour from many different directions around your head. This type of treatment is not available at all hospitals because it needs specialist equipment and skills. Since this treatment is very precise, your head should be immobilized in exactly the same position and should not move during treatment.

This treatment is delivered by a linear accelerator (LINAC) having special attachments called micro multiyear collimators (mMLC) or by specially designed cobalt-60 machines. Stereotactic radiotherapy treatment is usually divided into between 25 and 30 daily doses called fractions. If you only have 1 fraction of very high dose stereotactic radiotherapy, this is called radiosurgery.

Stereotactic radiotherapy planning is similar to external radiotherapy planning where images will be captured on a CT and MRI scan. These images are fed to a computer which has special software to plan stereotactic radiotherapy treatment. These computers are called treatment planning systems (TPS) during planning; your specialist uses the scans to work out how to shape the radiotherapy beam so that it exactly fits your tumour. This means that the normal brain tissue surrounding the tumour gets a very low dose of radiation. So, you will have fewer side effects than with conventional external beam radiotherapy.

You must understand that not all brain tumours are treated with stereotactic radiotherapy or stereotactic radiosurgery. Your treating radiation oncologist will discuss with you if this treatment is required or not. If this treatment is is being planned for you, your radiation oncologist will discuss in detail about the entire procedure. Should you have any questions regarding this treatment, you should discuss about it with you doctor.

d. Tomotherapy and Volumetric Arc Therapy

Tomotherapy is a combination of image guided radiotherapy and IMRT. The machine looks more like a CT scanner with an additional attachment of linear accelerator. The linear accelerator rotates in 360 degrees around the patient to deliver a highly conformal and intensity modulated radiation beam to the tumour. As the linear accelerator

rotates around the patient, it continually changes the intensity of the radiation beam to fit to the shape of the tumour. The CT scanner attached to it allows the radiographer to take CT images at the start of the treatment which can be used to verify the accuracy of the treatment.

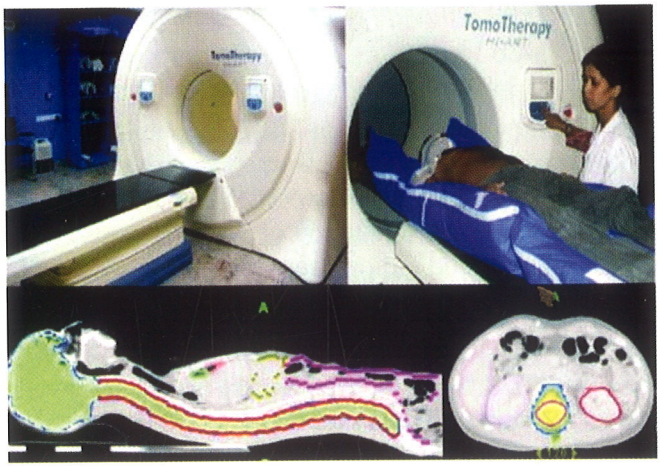


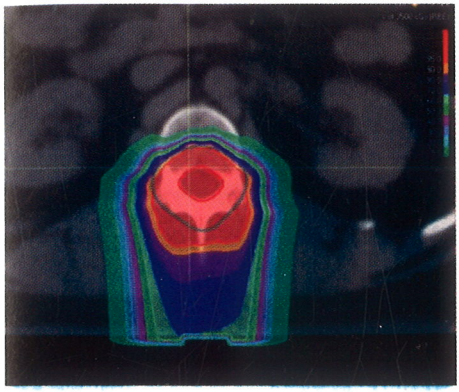
Figure 11: Upper panel photograph showing a patient being treated on tomotherapy machine. Lower panel photograph showing how the radiation dose fits to the tumour only with sparing of normal tissue.

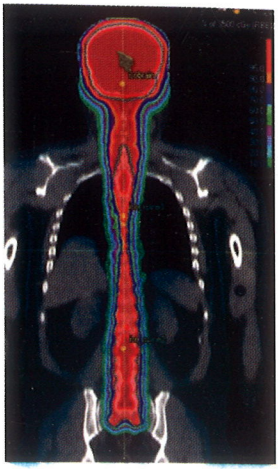
VMAT is a new type of IMRT technique. It can be given from a machine called RapidArc. The radiotherapy machine rotates around the patient during treatment. Similar to tomotherapy, the machine continuously reshapes and changes the intensity of the radiation beam as it moves around the body. Giving the radiotherapy in this way makes it very accurate, shortens the treatment time, and uses a lower overall dose of radiation.

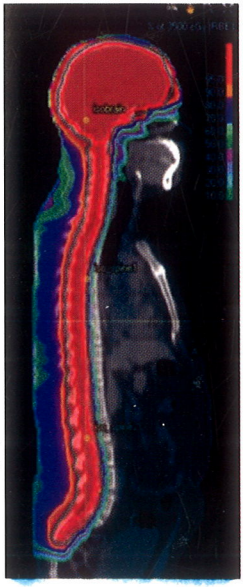
e. Proton beam therapy

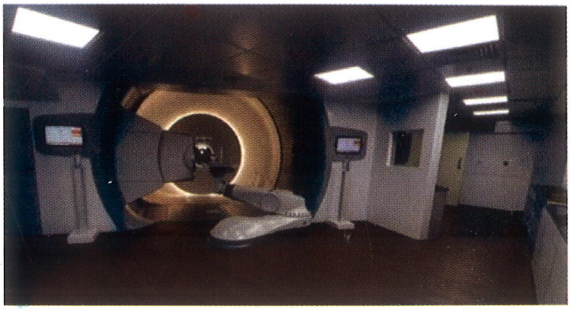
Proton beam therapy represents a cutting-edge advancement in the treatment of brain tumors. Particles such as protons have the property of stopping after traveling a precise distance in tissues and this property of particle beam is exploited for delivering lethal doses to tumors and limiting the exit doses to surrounding critical organs to negligible amounts. This is of particular benefit in the treatment of childhood brain tumors including medulloblastomas wherein we can deposit the planned dose of radiation into the tumor bearing tissues

while sparing critical organs deeper to the tumor, thereby reducing the side effects of irradiation. Proton beam therapy has been shown to preserve certain aspects of intelligence better in children and is the focus of much research in this area. Another proven application of proton beam therapy is for safe dose-escalation to radioresistant tumors such as chordoma and chondrosarcoma for better local tumor control.









Side effects of radiotherapy to the brain

Short term side effects

Nearly everyone will have some side effects during radiotherapy treatment to the brain which continues for a few more weeks after radiotherapy. These side effects can be mild or more troublesome depending upon the amount of radiotherapy given and if any simultaneous chemotherapy is given along with radiotherapy. Some of the important side effects that you may have during radiotherapy that may continue foe a few weeks after completion of radiotherapy are:

Tiredness: Fatigue or tiredness is a common side effect during radiotherapy. Try to get some rest after each treatment.

Somnolence (excessive sleeping): After completing your radiotherapy you may have loss of energy and feel much less active. This usually starts in the 3rd week of treatment and may persist for few weeks after completion of treatment. You might feel drowsier and spend more time sleeping. This gradually gets better over a few weeks.

Feeling sick: Some patients may feel sick. But this can be treated effectively by giving ant sickness medication (ondansetron). You might have altered taste and loss of appetite during radiotherapy. Even if you don't feel like eating, you can try replacing with drinks having high caloric value. You can ask your doctor to prescribe them for you.

Headache: Some patients may have headache during radiotherapy which can be controlled by giving low doses of steroids.

Hair loss: you will lose hair in the area being treated. You do not lose all your hair, as you do with chemotherapy. You will usually only lose patches where the radiation beam has entered and left your skull. Hair loss is minimal with IMRT and Tomotherapy techniques.

Skin changes on the scalp: Some individuals develop skin reactions similar to sunburns. This usually happens in the 3rd or 4th week of radiotherapy. The skin becomes a little itchy, red and sore. You will be reviewed by the treating physician weekly during radiotherapy. You will be given advice on skin care. Usually for mild skin reactions, alovera or Betnovate ointment is advised for local application. Since

the skin exposed to radiotherapy is very sensitive you should avoid overexposure to sunlight. you should also avoid shaving your hair during radiotherapy. (However, if you wish to trim it, you can do so)

Worsening of your brain tumour symptoms: Radiotherapy for brain tumours can sometimes make symptoms slightly worse before they get better. This is because the treatment can cause swelling inside the brain. Your doctor will give you steroids to prevent this. The symptoms will get better with time.

Long term effects

Radiotherapy techniques have evolved over time. Modern day radiotherapy techniques are designed to reduce late side effects. Late side effects only affect a small proportion of patients as delivery techniques have become precise. If you do develop late effects, they can come on from a few months to many years after you were first treated. Unfortunately, these late side effects are usually permanent. They may also slowly get worse over a long period of time. Late effects in the brain occur due to cause changes in the brain tissue. Small blood vessels may slowly become scarred and blocked, reducing the blood supply to some areas of the brain. The symptoms can be mild, moderate or severe, depending on amount of radiation damage. The effects may include

Effects on brain function

a. Problems thinking clearly
b. Difficulty managing tasks you previously found easy
c. Poor memory
d. Personality changes
e. Headaches similar to migraines that come and go (called SMART attacks)

If you have mild late effects, you are most likely to have treatment with steroids. Very rarely you may require surgery to remove the dead tissue. This is most likely after treatment with radiosurgery.

Hormonal changes

Hormonal changes can occur if pituitary gland is close to the treatment area. You could develop hormone imbalances in the future.

So, there is a possibility you could develop thyroid problems or low levels of steroids in the future. If you notice any of the symptoms, discuss this with your doctor.

A second brain tumour

In very rare cases, patients may develop another brain tumour many years after radiotherapy treatment (usually after 15-20 years after treatment). This is because, although radiation kills cancer cells, it is also a risk factor for developing them. Unfortunately, tumours caused by previous radiotherapy tend to be more aggressive and do not respond well to treatment. It is very rare to get another tumour caused by radiation to brain for brain tumours but one should be aware that this is a possibility.

Long term effects of radiotherapy in children

Unfortunately, long term side effects for children are more common than adults. This is because the nervous system is still developing in children when they are treated. Because it is still developing, the nervous system is more likely to be damaged by radiation. The present-day modern radiation delivery techniques have minimized the long-term effects in children. Some examples of late effects in children are: -

- Physical problems for example limb weakness, poor balance or shakes (tremors).
- Growth problems
- Early or late puberty and fertility problems-inability to bear children
- Educational problems- poor attention span, short term memory loss
- Behavioural problems

Chemotherapy

The role of chemotherapy and biological therapy in the multidisciplinary management of primary brain tumours continues to evolve rapidly. The goal of chemotherapy is to kill tumour cells directly by making them unable to replicate or to enhance normal process of cell death.

You may have chemotherapy for any of the following situations.

- To prevent the tumour from coming back.
- Simultaneously with radiotherapy and for some months afterwards to improve survival.
- To treat a brain tumour that has come back since it was first treated.
- In very young children (usually less than 3 years of age), when radiotherapy cannot be given.

Chemotherapy is not used to treat all brain tumours. Your treating oncologists will advise you about your requirement of chemotherapy.

There are different chemotherapy drugs available for treatment of cancer. However, only a few can be used for treating brain tumours as they are able to cross the blood brain barrier (a protective natural barrier of the brain). This is a natural filter within the body that only allows certain substances through from the blood to the brain tissues. Some brain tumours damage the blood brain barrier so that the chemotherapy can enter the brain.

Some common chemotherapy drugs used for treating brain tumours are

- Temozolomide
- Carmustine
- **PCV** Regimen
  - **P**rocarbazine
  - **C**CNU (Lomustine)
  - **V**incristine

Chemotherapy can be given as tablets or capsules or as injections into a vein. It is possible to inject some drugs into the fluid that circulates around the brain and spinal cord. Doctors call this intrathecal treatment. Your treating specialist will decide what chemotherapy is to be given and at what dose depending upon the type of tumour you have and your general condition.

Side effects of chemotherapy

Like radiotherapy, chemotherapy can damage the normal cells causing side effects which can be quite unpleasant. In general, it has

been seen that, fitter the individual, more likely he /she is going to benefit from chemotherapy and less likely to develop any side effects from it. You should discuss with your treating doctor, the possible benefits and side effects of chemotherapy in your situation. Not all patients will have side effects due to chemotherapy. If side effects do occur, they can be controlled by medicines. Some of the common side effects of chemotherapy drugs are described below with ways to reduce them.

Tiredness (fatigue)

Tiredness (fatigue) is the most common side effect for people having chemotherapy. It may continue for some months after your treatment ends. How quickly you get back to normal will depend on your general health, on the amount of treatment you've had, and on other treatments you have had.

Feeling sick (nausea) and vomiting

Some chemotherapy drugs may make you feel sick or make you sick. Sickness can usually be well controlled with anti sickness medicines called anti emetics. If your chemotherapy is likely to make you feel or be sick, your doctor will prescribe anti sickness medications. You may have them through your drip or as another injection along with the chemotherapy. You will then have some anti sickness tablets to take regularly at home for the next few days.

There are many different anti sickness drugs and some work better for some people than others. So, if you are still feeling or being sick, do tell your doctor straight away. They will be able to prescribe another one. Take your anti sickness tablets regularly, whether you feel sick or not. The drugs are much better at preventing sickness than stopping it once it starts. Commonly used anti sickness medicines are Ondansetron and Granisetron. In case of severe sickness, you need to be admitted and anti sickness medications have to be given through a drip.

Bruising and bleeding

Chemotherapy can reduce the production of platelets which aid in clotting of blood. Reduction in platelet number increases your chance of bleeding and bruising.

You should immediately inform your treating doctor if you have any unexplained bleeding such as nose bleed, bleeding gums, blood in urine or stool or blood spots on the skin. You may require platelet transfusion in such a case.

Anaemia (low haemoglobin)

Chemotherapy can also cause anaemia due to reduction of red blood cells in the blood. This will make you tired, lethargic and possibly breathless. If you are anaemic, you will require blood transfusion. Please inform your doctor if you have such symptoms so that appropriate care can be taken.

Lowered resistance to infection due to neutropenia

Many chemotherapy drugs apart from acting on the cancer cells also attack the bone marrow (blood forming organ) resulting in reduction of white blood cells (WBC). If the WBC are reduced, you are more prone to develop infections. During chemotherapy, your blood will be tested regularly and if required you will be prescribed antibiotics to treat infection.

If you develop a temperature above 38°C or think you have an infection, it is very important to contact the hospital immediately. You may need urgent treatment with antibiotics.

Targeted therapy (Biological therapy)

If you have been diagnosed with a recurrent malignant glioma, your doctor may suggest treatment with a drug called bevacizumab, also known as Avastin. Bevacizumab belongs to a class of drugs called monoclonal antibodies which are drugs designed to work with proteins found on the surface of tumour cells. Bevacizumab shrinks tumours by stopping the formation of new blood vessels that feed tumours and supply them with oxygen, a process known as angiogenesis. It does this by blocking the action of a protein called vascular endothelial growth factor (VEGF). Because VEGF is thought to play an important role in the formation of the new blood vessels surrounding tumours, blocking VEGF may help stop or control tumour growth. Bevacizumab appears to increase the duration of time until tumour regrowth in people with recurrent glioblastoma. It also is used in treating patients with radiation necrosis after stereotactic radiosurgery.

Research into how bevacizumab can best be used to treat brain tumours continues. Researchers do not yet know if it is safe to use bevacizumab in children. Bevacizumab is administered through veins (I.V) every 2 weekly or 3 weekly under the supervision of treating oncologist. Your treating oncologist will decide if you can have this therapy or not and will also explain to you about the benefits and potential side effects of this therapy before starting it.

Endocrine therapy

Hormone therapy plays an important adjuvant role in the management of pituitary tumours especially the secretory adenomas after surgery. While waiting for the radiotherapy treatment to work you need to take medicines to block the hormone production.

Prolactinomas are usually treated with medicines that reduce prolactin production by the tumour. Drugs that may be used include bromocryptine or cabergoline, which is the modality of choice for majority of prolactinomas. Bromocriptine or Cabergoline results in rapid normalization of prolactin levels in 90% of patients and modest reduction of tumour size in about 80% patients. Complete discontinuation of these medicines results in recurrent hyperprolactinemia in 80% to 90% of patients, but Tumour enlargement is observed in only 10% to 20%. Bromocriptine causes modest side effects like transient nausea and vomiting. Reduction in blood pressure (also called) hypotension may also occur at the initiation of therapy. Cabergoline is safer than bromocryptine but is more expensive.

For growth hormone secreting tumours, you may need to take medicines which suppress secretion of GH such as octreotide. Pegvisomant (a pegylated recombinant human GH analog) is a new hormone which is now being used in patients with growth hormone secreting pituitary tumours and acromegaly. Hormone therapy of patients with Cushing's disease is reserved for patients who fail either surgery or radiotherapy. It is lifelong and associated with important side effects. Agents that inhibit the synthesis of steroid hormones are commonly used such as Ketoconazole, mitotane, and metyrapone. However, these compounds have long term side effects, with and limited efficacy.

Thyrotropin-secreting tumours are rare, representing 1% of adenomas. These tumours respond to octreotide. However, the response is temporary. Hence these tumours are effectively controlled by surgery and radiation therapy.

Sometimes hormones therapy is used in the palliative settings to ameliorate symptoms in meningiomas which is growing despite surgery and radiation therapy.

Hormonal manipulation in pituitary tumours is an important modality of treatment. Hormone therapy requires long term treatment, may have long term side effects and can be expensive. Your treating doctor will discuss with you about the risks and benefits of the hormone therapy before starting them.

Role of anticonvulsants medicines in brain tumours

Management of seizures in patients with brain tumours is a very controversial issue. The incidence of seizures in patients with brain tumours varies from 20-75% depending on the age, location and type of tumour. The highest incidence is in young patients with low grade tumours of the temporal lobe. Moreover, a large proportion of patients who do not present with seizures initially, ultimately develop seizures during the course of disease. Management of patients who present with seizures: Following perioperative prophylaxis, these patients are continued on AEDs for at least 2 years. They are assumed to have an established epileptogenic focus secondary to tumour and need to be treated with antiepileptic drugs (AEDs) as any other patient with symptomatic epilepsy. The Anti-Epileptic Drugs (AEDs) can be discontinued if they have been continuously seizure free for 2 years.

Choice of Anti-Epileptic Drugs: Commonly used AEDs include phenytoin and valproic acids which are available as eptoin/epsolin. Valproic acid is available as encorate and valparin. Phenytoin until recently was s the most commonly prescribed AED. Serum levels should be monitored when the patient is on these medicines. These drugs can interact with other drugs resulting in reduced efficacy of the AED or increase in their side effects. Your treating doctor will advise you about the precautions you need to take while on AED's.

Presently Newer drugs like levetiracetam (most commonly prescribed

drug these days), oxycarbamazapine and clobazam are being used regularly due to lesser toxicity and better efficacy. Moreover, the serum level of these medicines need not be monitored regularly. In India, leviteracetam is available as Levipril (Keppra, Levera, Levefree etc.) while clobazam is available as Frisium or Cloba. Oxycarbamezapine is available as Oxcarb or Oxetal for patient use.

Sometimes a single AED may not be enough to control the seizure, you may then require multiple AED's. Your doctor will discuss with you about the requirement these medicines.

Role of steroid in brain tumours

Steroids are chemicals which are produced naturally in our body in small amounts and help to control many functions. They can also be made artificially and used as drugs. They are very powerful anti-inflammatory drugs that help to stop swelling. They reduce the leakiness of blood vessels around brain tumours and so reduce swelling in the brain.

Steroids are commonly used in the treatment of brain tumour.

Your treating oncologist will recommend steroids in any of the following situations.

- When you are first diagnosed
- Before and after surgery
- Before during and after radiotherapy
- For an advanced brain tumour

When your brain tumour is first diagnosed, your doctor is likely to prescribe steroids to reduce swelling around the tumour inside the brain. After successful treatment for the brain tumour, your specialist will slowly reduce your steroid dose. Surgery and radiotherapy can both increase swelling at first. So, your specialist will wait until this has reduced before tapering your steroid dose.

You should remember to take your steroid dose exactly as your doctor has told you. Steroids occur naturally in your body. When you take steroid tablets, the higher amounts in your bloodstream stop your body from making its own supply. So, if you stop taking

your tablets suddenly, the level of steroids will very suddenly drop and this can be very harmful. Never just stop taking your tablets. You must reduce the dose gradually, with the help and advice of your doctor. In case of advanced brain tumour steroids help to keep symptoms under control for as long as possible. Steroids should be taken after food along with anti acid medicines such as ranitidine (rantac) or pantoprazole (pantocid Steroids can be prescribed in the form of dexamethasone.

Side effects - Steroids can have side effects too. These include: -

- Weight gain and water retention
- You may feel like eating more (increased appetite)
- Sugar in your urine (diabetes), causing increased thirst, passing a lot of urine and if untreated, drowsiness and even unconsciousness
- Stomach irritation & Acidity leading to an ulcer
- Mood changes - high spirits or more rarely, paranoia, depression or hallucinations
- An increased risk of infection
- An acne type rash, stretch marks on the skin
- Muscle wasting with long term use
- Weakening of bones with long term use (osteoporosis)

Remember that steroids have important benefits too and you may only get a few of these side effects. The benefits of steroid use outweigh their side effects. Your side effects will disappear once you have finished your steroid treatment.

7. Research (clinical trials for brain tumours)

Why we need research

Any new therapy should be thoroughly researched before being applied and adopted as a standard treatment for patients. This is done through clinical trials. Trials help to improve knowledge about any disease and for developing newer therapies. Initially, any experimental therapy is tested in the laboratory under strict controlled conditions

before being tried in patients for ethical and safety reasons. For example, the use Temozolamide in glioblastoma started after years of lab research and clinical trials on patients. Because of this drug, the survival in GBM's has improved a lot.

Through these trials, we can be sure that the new treatment modalities do work. We can be sure they work better than the treatments that are available at the moment and that they are known to be safe.

What are clinical trials?

Tests in patients with new or investigational treatment modalities are called clinical trials. Your treating oncologist will discuss with you about ongoing clinical trials. Taking part in a clinical trial is voluntary. If you are interested in taking part in a clinical trial, the investigator (oncologist) will decide if you are eligible to participate in the trial. Then he will refer you to the research team which conducts the clinical trial.

Participating in clinical trial

While participating in a trial you will be asked to sign a consent form about your willingness to be a part of the trial. You will be given ample time to read and understand the contents of the consent form which describes in simple language about the clinical trial. The consent form will be written both in English, Hindi and also the vernacular language of the state in which the trial is being conducted.

Before you participate in the trial, the trial investigator will explain to you about the standard treatment and the experimental treatment. Kindly bear in mind that some investigational treatments may look promising at first but later on could be less effective or may have more side effects than the existing standard treatment. The only way to know this is by conducting a proper clinical trial under controlled conditions of which you will be a part. Once you a trial patient, you will be monitored carefully during and after the study. Sometimes, as a trial participant, you may not directly benefit from the experimental therapy.

If you decide not to be a part of a clinical trial, your decision will be respected and your treatment will be done based on the standard

existing therapy. Your decision of not participating in a clinical trial will not affect your treatment in any way and you will be monitored during and after the treatment according to the standard existing practices.

Fluid and tumour samples for brain tumour research

While blood, CSF (cerebrospinal fluid) and tumour samples are taken for diagnosis, a part of these tissue samples may be kept for future research purpose with your permission. These samples will not bear your name on it. Only a sample number will be assigned so that your identity is not revealed.

The research on these samples may be carried out at the same hospital where the trial is being conducted or at a separate research centre. The results obtained may not be available to you. The research carried out on these samples will be used to enhance our present knowledge about brain tumours and develop newer strategies to improve the outcome of brain tumour patients.

8. Surviving brain tumours

Living with a brain tumour presents many challenges for both patients and their families as both can find it difficult to cope with the diagnosis of a brain tumour due to both mental and physical stress. It is very important to get the right information about the type of brain tumour you have and how it is best treated.

Don't be afraid to ask your doctor questions if you don't understand something. You may find it hard to remember what you have been told. It helps to write questions down. You should not be worried about taking notes when you are given answers to your questions. You should understand that it is not the end of the road if you have been diagnosed with brain tumour as different brain tumours have different outcome, depending on the type and grade of tumour that you have. Many brain tumours are curable. Some are controllable for years. If you do want to know about your likely prognosis, the best person to discuss this with is your cancer specialist.

Try to remember that you don't have to sort everything out at once.

It may take some time to deal with each issue. You may need to have access to support staff, such as a social worker, physiotherapist, psychologist or a dietician. Usually, your treating oncologist will direct you to the concerned support staff whenever required.

Recovering after treatment of brain tumours

The treatment for a brain tumour can leave you physically and emotionally drained. You will need time to recover both mentally and physically.

You may also have physical after effects such as

- A weakness on one side of your body, in an arm or leg
- Difficulty walking or moving in other ways
- Difficulty with speech or understanding
- Fits (seizures)

You will be able to overcome some of the problems that remain after your treatment. The human brain is remarkable. In time, another area of your brain will learn to take over some of the functions that were affected by the tumour or its treatment.

It is best to start any therapy you need as early as possible. For example, physiotherapy or speech therapy. Your treatment team can arrange for you to see any relevant health professionals. Such therapy can make a lot of difference to your quality of life.

These support staff include:

Physiotherapists - people who treat illness by physical methods such as manipulating joints and muscles, massage and heat treatment. They can help you to get back movement in areas of the body

An occupational therapist - a person trained to help people with any sort of disability to manage day to day activities such as dressing, cooking, cleaning etc.

A speech and language therapist - a person trained to help people learn how to speak and swallow properly. If you have surgery to your brain, you may need to see a speech therapist to learn how to speak or understand language in a new way.

Psychologist: A person trained to evaluate, diagnose, treat, and study behavior and mental processes of an individual and provide mental health care. It is not uncommon for an individual diagnosed with brain tumour to have behavioral changes; hence you may need to see a psychologist which will be coordinated through your treating physician.

Driving after brain tumour treatment

Since brain tumours can result in neurological symptoms like seizure (fits), dizziness and weakness of limbs, you may not be allowed to drive for a while after you have had a brain tumour. This depends on the type of brain tumour you had and where it was in the brain. It may also depend on the type of treatment you had. You should always consult your treating physician if you wish to restart driving. Your treating physician will be able to advice you about your fitness to drive.

Going back to work after treatment

Some people make a complete recovery from their brain tumour and unfortunately others won't. It isn't really possible to tell beforehand how things will turn out. Whether you get completely back to normal and how soon that happens depends on

- The type of tumour you had
- The treatment you had
- Your type of job

Some people find that they have more difficulty concentrating or remembering things after having treatment for a brain tumour. If you had a job where your mental skills and abilities were very important, you should be aware that you may not be able to go back to the level you were at before your diagnosis and treatment. This is understandably devastating for many people. It will take time to come to terms with it and work out what else you would like to do.

If you have a job operating heavy machinery or which requires driving, you may not be able to go back to it straight away. You may ask your employee to give you lighter work. Your treating physician will advise you about the appropriate time when you can go back to work or drive. You can ask for a medical certificate from your treating doctor regarding your fitness to work.

Follow Up of patients after treatment

Once your treatment is completed, you will have regular checkups by the treating doctor and MRI scans. These follow-ups will be done at regular intervals which will be decided by your treating physician. The checkups will continue for several years. If you have any problems, or notice any new symptoms or recurrence of previous symptoms in between your follow-up visit, let your doctor know as soon as possible so that an appointment to meet him/her can be fixed as soon as possible. Brain tumour patients are advised to adopt a healthy lifestyle not only during treatment but also after treatment.

If brain tumour comes back

It is natural for you to be concerned while you are attending follow-up clinics as you are always anxious to hear from your doctor that everything is normal. Some brain tumours can recur at the same site or at a site distant from the original site within the brain or in the spinal cord. If it actually recurs, your doctor after studying the scans will explain to you the extent of the recurrence and the ways to treat the recurrent disease (treatment of recurrent disease is called salvage treatment). Learning that your tumour has comeback can be devastating however hope should not be lost as there are other treatments available to tackle the recurrent disease. Your doctor will explain to you the various treatment options available and will give you the best possible advice. Not everyone wants to get a second opinion. But if you do, then you should go ahead. It may be important for you and your family to feel that you have explored every option. Asking the opinion of another expert may help you to feel reassured that this has been done. All brain surgeons are specialists, and so are cancer doctors (oncologists). But some may have a particular interest in treating certain types of tumours. Or they may be experts in tumours in particular areas of the brain. To write the symptoms of recurrence of tumour.

The best way to go about this is to ask your own oncologist to refer you to another specialist for a second opinion. It will not surprise them; particularly if you have a tumour that they have said can't be cured. They will understand why you want to have a second opinion.

Information from internet or news papers

If you have found information about a treatment that you think is new, or that you think could be offered to you, it is always best to bring it to your specialist. You can then talk it through with them and find out how relevant it is to your own situation. Some people think that they may be able to get better treatment abroad. Often, this is because of stories in the papers or on the internet. It is in your best interest that you discuss about the information with your oncologist. The treatment may not be for your type of tumour. You need to think carefully about going overseas for treatment. Talk it over with your family and your doctors. Being treated overseas is a big commitment. It can be expensive in time and quality of life, as well as financially.

Rehabilitation of brain tumour patients

Brain and spinal cord tumours have a very high likelihood of producing long-term disabling effects owing to the tumour itself and the effects of treatment, including surgical complications effects of radiation, and debility caused by chemotherapy. It is important to understand that even small benign or low-grade brain tumours can cause significant residual functional deficits if it resides in a critical location. Lesions located near the brain stem can be particularly damaging to motor functions, sensory functions, coordination, and cranial nerves. Tumours located in the region of frontal lobe produces behavioral abnormalities while tumours located in the pituitary may produce visual disturbances. Balancing abnormalities are seen in cerebellar tumours. Cognitive deficits such as memory loss or reduced attention span are seen in temporal and parietal lobe tumours. These changes affect both the short term and long-term quality of life in brain tumour patients.

Thus, rehabilitation of physical, psychological, cognitive, speech and other deficits forms an important part in the multidisciplinary management of brain and spinal cord tumours.

Advantages of Rehabilitation

- Maximizing functional independence in his/her day-to-day activities.
- Helps coping emotional stress in patients and family
- Improves quality of life.

Management and prevention of co-morbid illnesses affecting normal functions of the patient. The rehabilitation of brain tumour patients involves a multidisciplinary team of the treating oncologist, neurologist, psychiatrist or a psychologist, physiotherapist, ophthalmologist (eye specialist), audiometrist and speech therapist. The main emphasis of the rehabilitation of brain tumour patients is on restoring or maximizing his mobility, make him independent with activities of daily living (ADL), improve his /her speech and communication, cognition, through pharmacologic interventions and behavioral and cognitive therapies. Your treating oncologist will coordinate your rehabilitation after completion of treatment with the assistance of the multidisciplinary team and your immediate family members. Sometimes, you may be asked to meet some support groups as well.

Societal support & Support groups

Diagnosis of brain tumour is a stressful situation. It can affect many areas of your life such as your finances, work, your emotions and relationships with you family members. Hence societal support and support groups play a pivotal role in individuals diagnosed with brain tumours. One such organization is the Brain Tumour foundation (BTF) of India. The foundation works in partnership with other organizations to develop and support services for people with brain tumour. The activities of this organization are being expanded slowly to help all patients in and around Mumbai and expand its services to involve the whole country. In order to know more about the activities of BTF you may log on to its website www.braintumourindia.org

9. Important brain tumour websites

www.braintumourindia.org

http://theibta.org/

http://www.isno.in

http://www.abta.org

http://www.cancerresearchuk.org/

http://www.btai.com.au/

http://www.braintumour.ca/

http://www.cbtf.org/

http://www.cbtrus.org/

https://tmc.gov.in/SBF/Nouro/FINAL%20Neuro_DMG.pdf

NOTES

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The Brain Tumour Foundation of India with the motto "We Shall Overcome" is a charitable organization, concerned with improving the care and treatment available to people with brain tumour and their families. We work in partnership with other organisations to develop and support services for individuals with brain tumour. The Foundation offers funds for treatment and care of brain tumour patients in financial need. It also funds research, nursing, and medical education programmes.

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