SMC Specialized Treatment Series No. 5
Samsung Comprehensive Cancer Center

Brain Tumor Treatment

We are setting forth standards for brain tumor treatment

through synergistic multi-disciplinary approach and
precision medicine tailored to individual patients

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Types, Symptoms & Diagnosis of Brain Tumors

Brain tumors may be primary or secondary(metastastic): Primary tumors grow from the brain or surrounding tissues and secondary(or metastatic) tumors begin in other parts of the body and spread to the brain.

Primary brain tumor:

Representative primary brain tumors include **gliomas** that start in the glial cells of the brain or the spinal cord and **meningiomas** that form on membranes that cover the brain and spinal cord. Vestibular **Schwannomas** that develop on the layer that surrounds and insulates fibers in the peripheral nerves and **pituitary tumors** that arise from the pituitary gland and affects hormone secretion with various symptoms are also primary brain tumors. Other than them, a craniopharyngioma, pineal region tumors, ependymoma and a medulloblastoma are also classified as primary brain tumors.

They are divided into several types depending on what cells they begin in and are graded based on the types. The higher the grade is, the more aggressive tumors are and the faster they grow.

Secondary (metastatic) brain tumor:

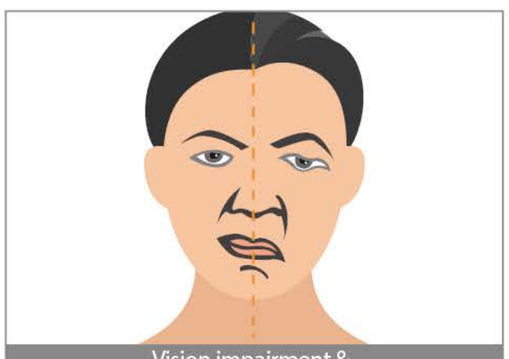
Cancer is known to spread to the brain in 30~50% of cancer patients, and these secondary brain tumors are referred to as metastatic brain tumors. At least two-thirds of patients with metastatic brain tumors display headaches, nausea, vomiting, impaired vision, loss of speech and various other symptoms in association with brain tissues pressed by the tumor. Primary cancer frequently leading to brain metastasis may originate in lungs, breasts, kidneys, colon or other body parts.

* Major Symptoms of Brain Tumors: Tumor growth increases brain pressure, pressing the neighboring nerves and creates other various symptoms.


Headaches & Vomiting


Paralysis of limbs

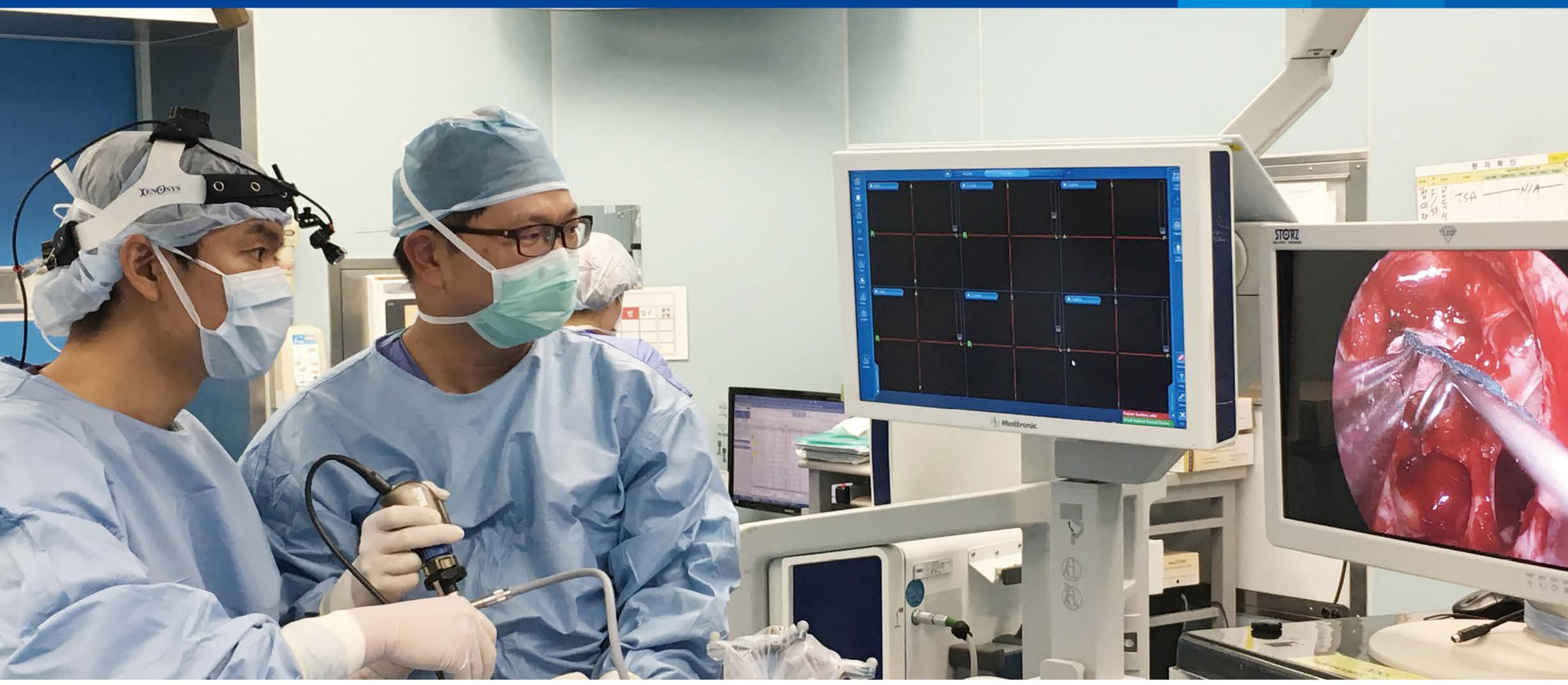

Epileptic seizure


Vision impairment &
Paralysis of nerves/muscles of the face

Diagnosis of brain tumor

When patients display symptoms suspected of brain tumors, diagnosis is done by a neurologic exam, CT(Computerized tomography), MRI (Magnetic Resonance Imaging) and, if necessary, for safer surgery, fMRI (functional MRI) and tractography.

A tissue sample exam by a pathologist is needed from the tumor removed by a neurosurgeon for a more accurate diagnosis. Recently, NGS (Next Generation Sequencing) has enhanced the accuracy of diagnosis and the sequencing results are sometimes utilized for cancer treatment



What are Treatment Options for Brain Tumors?

Surgery

- **Transcranial surgery:** By converting 3-dimensional MRI images of the patient into real-time intraoperative visual assistance, an incision is made on the scalp at a location which is closest to the tumor and minimizes brain function damage. After the smallest possible piece of bone is removed to expose the target area, the tumor is removed. The entire procedure is performed in the shortest time possible in the most protective manner for normal tissues and the nervous system with the help of ultrasonic surgical tools and electrophysiological monitoring equipment.

- **Skull-base surgery:** Surgical approach to tumors located in the bottom of the skull is a demanding procedure and complete removal of such tumors through surgery is extremely difficult because of its anatomical structure through which critical blood vessels and nerve fibers pass. All state-of-the-art, pre-surgical imaging technologies are utilized to ensure the highest safety during surgery. SMC has an outstanding experience and is leading the skull base surgery area in Korea.

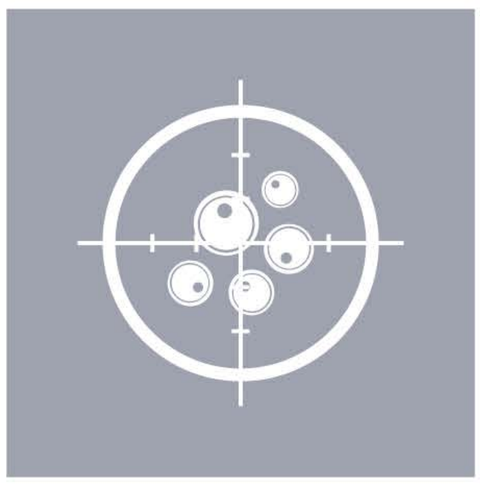
- **Endoscopic brain surgery:** It is a surgical procedure using an neuroendoscope to effectively and safely remove tumors located deep inside the brain through the nostrils or orbits. It involves no incision on the outer skin and thereby minimizes cosmetic complications. A sufficient surgical view offered by the neuroendoscope assists easier differentiation of tumors from normal tissues, so nullifies damage of other brain tissues surrounding the tumor. Patients can make a faster recovery and this advanced approach allows for reduced hospital stays. This technique is especially effective in removing pituitary and skull base tumors.

- **Awake craniotomy:** This type of operation does not require general anesthesia and is performed while the patient is awake. This is a preferred technique for removing tumors close to or involving functionally important regions of the brain such as motor cortex or language centers.
  The patient barely feels pain during the procedure and as the surgical team can communicate with the patient throughout the operation to closely watch whether the patient is able to perform given instructions or experience any neurological damage, it is effective in preventing postoperative neurological disorders.

Gamma Knife Radiosurgery

Gamma Knife radiosurgery is a state-of-the-art radiation surgical therapy that delivers intense beams of gamma rays on lesions in the brain with **no incision or opening of the skull** and achieves therapeutic outcome equivalent to that of conventional surgery. Combined use of advanced imaging- MRI and CT embedded in the equipment- enables precise delivery of radiation only to the designated target and, depending on the patient's condition, single session or hypofractionated treatment is possible. The procedure can treat almost all types of brain tumors including **metastatic or benign tumors, pituitary adenomas, vestibular schwannoma and meningioma** as well as conditions such as **arteriovenous malformation or trigeminal neuralgia.**

Proton therapy / Radiation therapy



Even after complete removal of the brain tumor, if it is malignant, postoperative radiation therapy is often necessary to treat the malignant cells invaded into neighboring normal tissues. Also, in a case where complete surgical removal is impossible, patients need radiation therapy after a tissue examination.

- **Proton therapy:** The procedure precisely targets the lesions of the brain without harming the surrounding normal tissue. It is a cutting-edge technology to minimize post-therapy brain function impairment.

- **Three-dimensional (3D) conformal therapy:** The procedure utilizes 3-D images of the tumor and the normal organs reconstructed through advanced software to tailor the angles and shapes of radiation beams to the size and location of the tumor. This exact targeting reduces risk of harming the healthy surrounding tissue while allowing higher levels of radiation to reach the tumor.

- **Whole brain radiotherapy:** The procedure is performed to treat malignant glioma or metastatic tumors spread across the brain.

Chemotherapy / Targeted therapy

Chemotherapy is performed in combination with surgical or radiation therapy for brain tumors. Its therapeutic outcome, even as monotherapy, can be remarkable especially for lymphoma in the central nervous system or germ cell tumor.

- **Temozolomide treatment:** It is one of the most frequently applied postoperative chemotherapy to prevent recurrence of malignant glioma. Taken by mouth, it accompanies relatively few side effects.

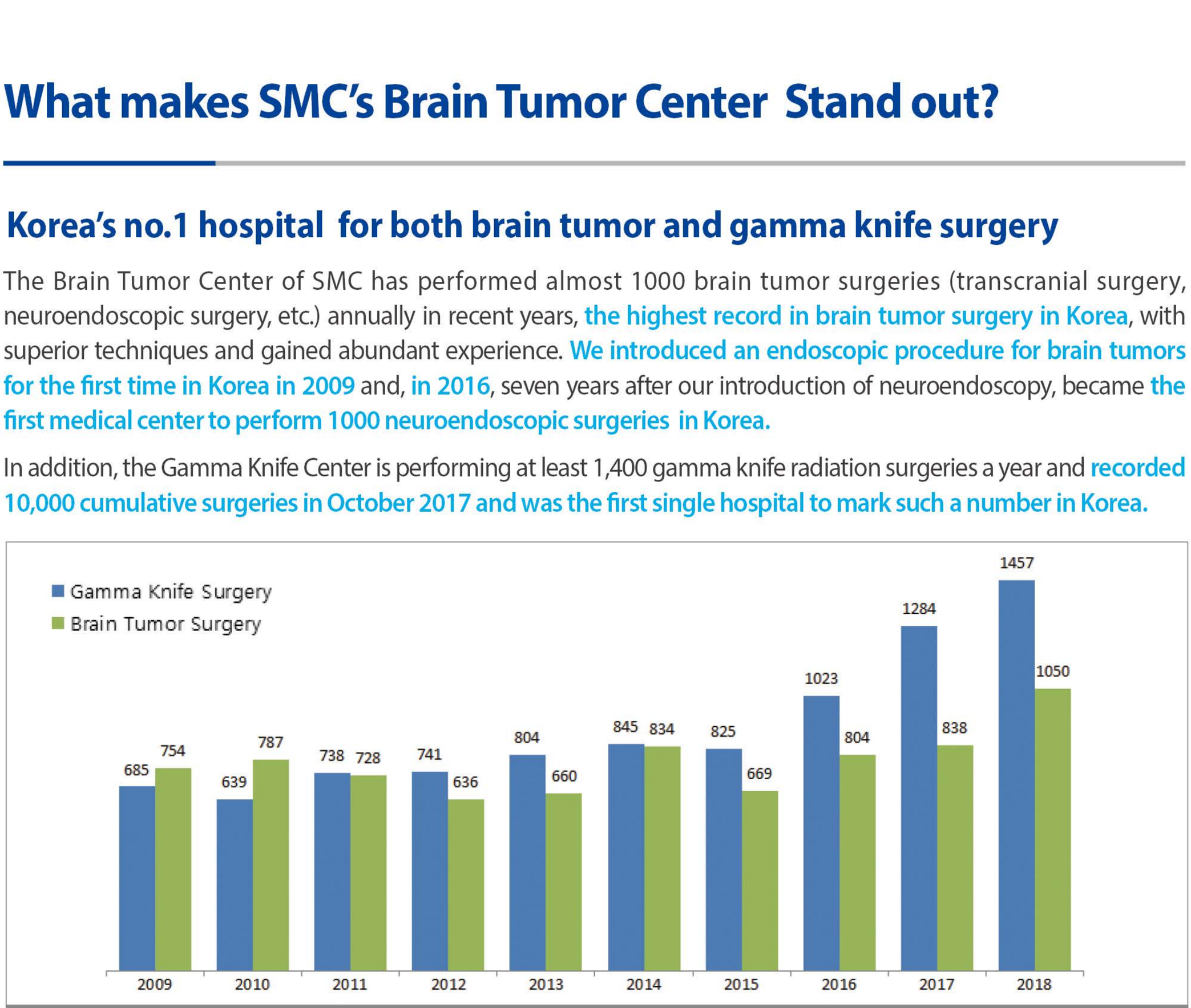
- At SMC, various chemotherapy clinical trials are underway by SMC alone or through partnerships with global pharmaceutical companies. Major trials involve Toca 511 (oncolytic virus, anti-cancer prodrug), GC1118 (EGFR-targeted drug), GX-I7 (immunotherapeutic drug), and DSP-7888 (WT1-based peptide vaccine).

What makes SMC's Brain Tumor Center Stand out?

Korea's no.1 hospital for both brain tumor and gamma knife surgery

The Brain Tumor Center of SMC has performed almost 1000 brain tumor surgeries (transcranial surgery, neuroendoscopic surgery, etc.) annually in recent years, **the highest record in brain tumor surgery in Korea**, with superior techniques and gained abundant experience. **We introduced an endoscopic procedure for brain tumors for the first time in Korea in 2009** and, **in 2016**, seven years after our introduction of neuroendoscopy, became **the first medical center to perform 1000 neuroendoscopic surgeries in Korea.**

In addition, the Gamma Knife Center is performing at least 1,400 gamma knife radiation surgeries a year and **recorded 10,000 cumulative surgeries in October 2017 and was the first single hospital to mark such a number in Korea.**



[Gamma knife/ Brain tumor surgeries performed at SMC per year (2009~2018)]

Best treatment options provided through synergistic team approach

The Brain Tumor Center comprises specialist doctors and nurses from the Department of Neurosurgery as well as from other relevant departments including the Department of Radiology, Department of Pathology and Translational Genomics, Department of Radiation Oncology, Division of Hematology-Oncology, Department of Otorhinolaryngology-Head and Neck Surgery, Division of Endocrinology and Metabolism, Department of Neurology, and Department of Physical and Rehabilitation Medicine. For faster diagnosis and better surgery/treatment planning, all relevant medical teams get together every week to collaborate and discuss treatment.

Clinics are divided into the pituitary tumor, skull base tumor, malignant brain tumor, and metastatic brain tumor. Each unit closely collaborates with others throughout the entire process of the treatment from treatment planning to drug/ surgical treatments and to postoperative follow-ups. This is in order to **provide structured and integrated medical services** throughout the course with an aim to achieve the best possible outcome from the therapy.

Pituitary tumor clinic	Skull base tumor clinic	Malignant brain tumor clinic	Metastatic brain tumor clinic

For higher success rates of pituitary tumor surgery, both neurosurgeons and otolaryngologists participate in the surgery. Pre- and post-surgical consultation is made to specialists in endocrinology and metabolism to minimize the patient's hormonal imbalances.

Accurate Diagnoses and Safe Surgeries through Cutting-edge Technologies and Equipment

To guarantee safer, minimally-invasive surgeries with fewer complications, SMC's Brain Tumor Center applies cutting-edge surgical techniques and utilizes our own state-of-the-art equipment including **neuronavigation systems, neurophysiological monitoring/neuromonitoring systems, full-HD endoscopes, stereotactic systems, functional MRI and mobile CT.**

Functional MRI is used in evaluating the tumor's impact on and distance from the functionally important areas of the brain to minimize postoperative complications.

Neuromonitoring systems enable intraoperative monitoring of the patient, and therefore reduce the risk of neurological impairment and enhance surgery success rates. For endoscopic brain surgeries, in particular, **high-definition endoscopic, auto navigation and neuromonitoring systems are applied simultaneously in the safest and the most precise manner in operating rooms exclusively dedicated to brain surgeries.**

In 2016, we introduced ICON, the most advanced gamma knife radiosurgery tool for the first time in Asia and now possess two units. Our Gamma Knife capacity is second to none in Asia, and only two other hospitals around the world have a capacity equivalent to ours

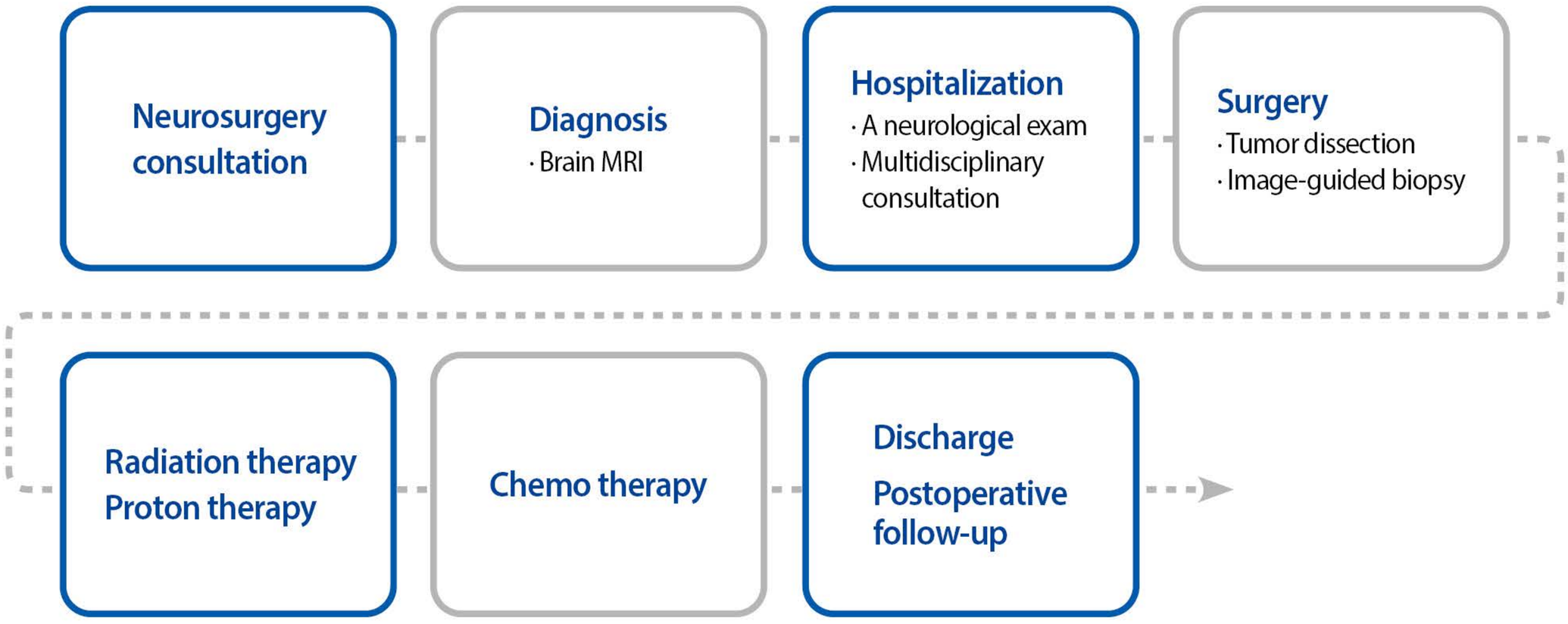
In many malignant brain tumor cases, surgeries are accompanied by radiation therapy and it is essential to apply the most technologically advanced equipment to ensure intactness of brain function and to provide precisely targeted treatment in radiation therapy.

We introduced a proton therapy system in 2015 to realize a "dream therapy" with the lowest currently possible side effects and have built a successful track record in proton therapy. The tools we possess to provide radiation therapies tailored to individual patients include **TrueBeam** that synchronizes imaging, patient positioning, motion management, and treatment delivery in real-time, a tomotherapy unit to adjust dose of radiation to ensure precise delivery of the beam to the tumor and a **Novalis** platform that allows radiation surgery based on image-guided and respiratory-gated therapy.

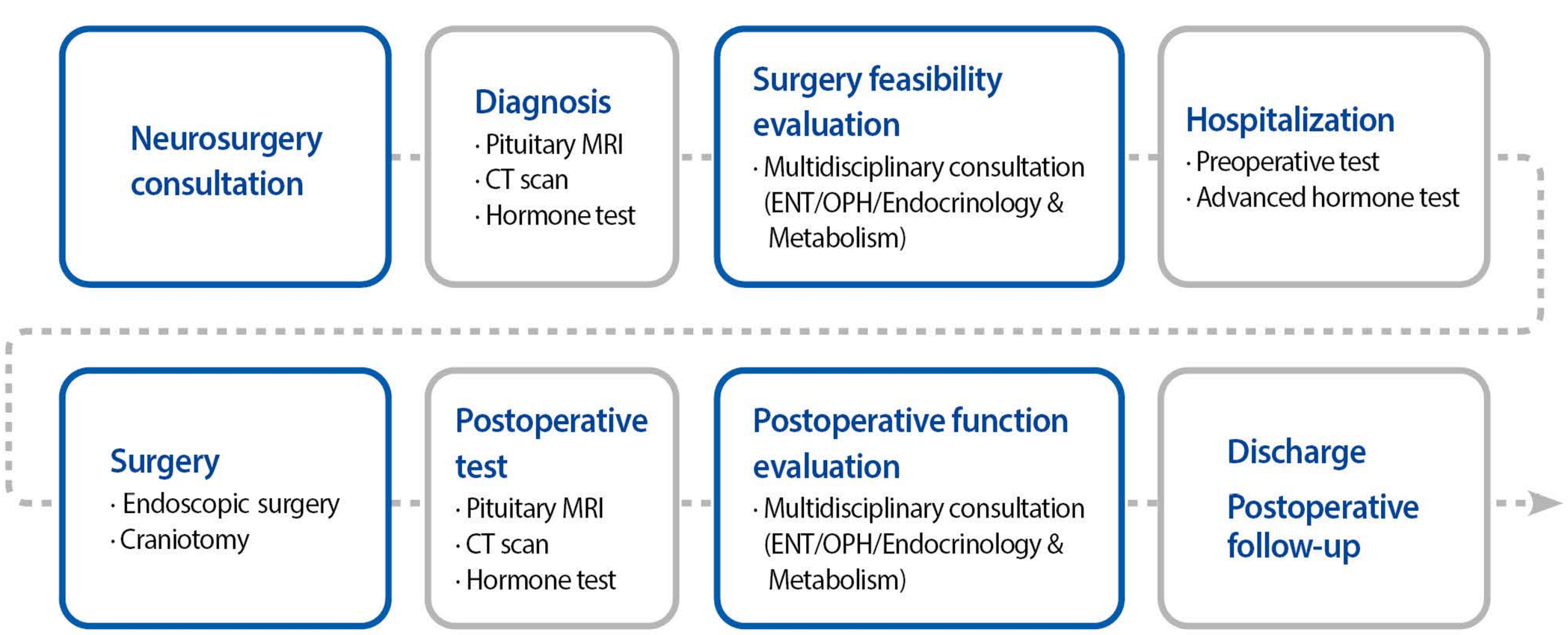
Precision Medicine and Research to Overcome Incurable Brain Tumors

Since its establishment of the **Samsung Genome Institute** in 2013, SMC has been applying genome sequencing techniques to individual patients for a higher therapeutic effect and enhanced quality of life for cancer patients. Using **CancerSCAN™, a genome sequencing platform based on NGS** (Next Genome Sequencing) developed by the institute, DNA from the patient is analyzed and relevant specialists of medicine, bioinformatics, physiology, genome and others review the results for in-depth, multi-dimensional analysis. Through the process, a targeted cancer therapy optimal to the case is identified and suggested to the patient

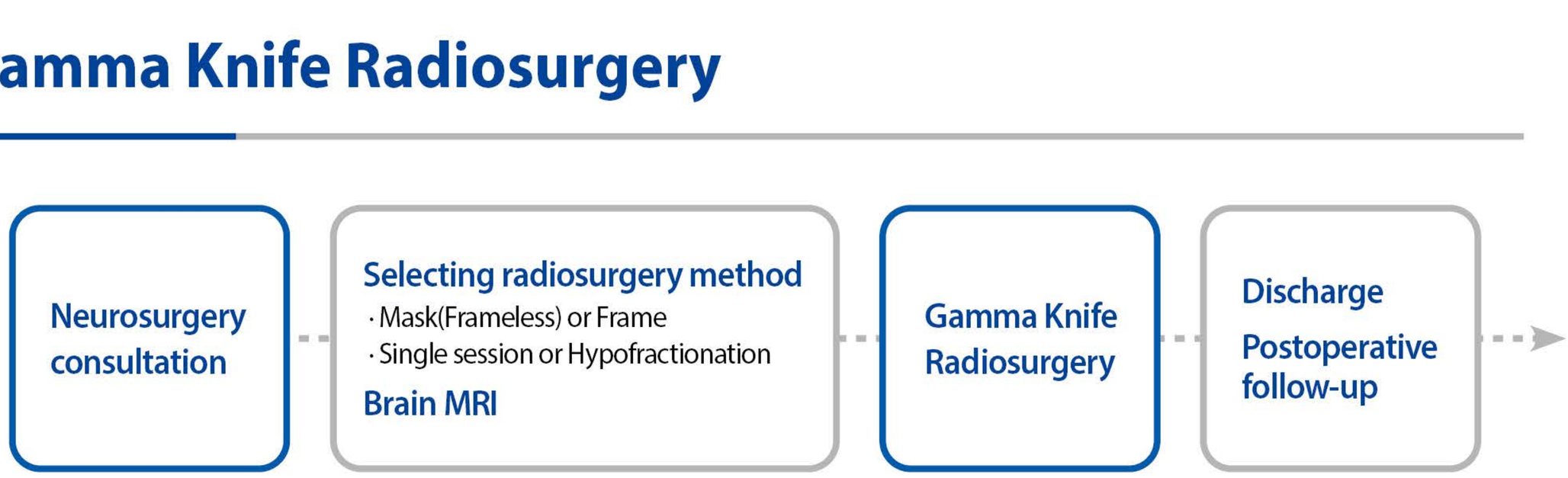
Malignant Brain Tumor (Malignant glioma, Glioblastoma)



Pituitary Adenoma



Gamma Knife Radiosurgery



* This process applies to standard cases and the treatment plan may be changed depending on the patient's actual condition after the consultation and evaluation.
* For more information, please contact us via International Healthcare Center at Samsung Medical Center

Best professors in brain tumor

Lee, Jung Il M.D., Ph.D
Neurosurgeon

Areas of Expertise:

Gamma Knife surgery
Brain Tumor Surgery
Parkinson's disease

Nam, Do Hyun M.D., Ph.D
Neurosurgeon

Areas of Expertise:

Endoscopic Pituitary surgery
Brain Tumor Surgery
Neuro-oncology

Seol, Ho Jun M.D., Ph.D
Neurosurgeon

Areas of Expertise:

Endoscopic procedures,
Skull base tumor, Glioma
Pituitary Tumor surgery
Gamma Knife surgery
Brain Tumor Surgery

Kong, Doo Sik M.D., Ph.D
Neurosurgeon

Areas of Expertise:

Endoscopic procedures,
Skull base tumors, Glioma, meningioma
Pituitary Tumor surgery
Gamma Knife surgery

Choi, Jung Won M.D., Ph.D
Neurosurgeon

Areas of Expertise:

Gamma Knife surgery
Brain tumors
Head trauma

Kim, Sung Tae M.D., Ph.D
Radiologist

Areas of Expertise:

Neuroradiology
MR Imaging

Seo, Yeon Lim M.D., Ph.D
Pathologist

Areas of Expertise:

Neuropathology
Pediatric & Placental Pathology

Do Hoon Lim, M.D., Ph.D
Radiation Oncologist

Areas of Expertise:

Stomach cancer, Pediatric cancer, Brain tumors, Sarcoma, Hematologic cancer

Kim, Won Seog M.D., Ph.D
Oncologist

Areas of Expertise:

Malignant Lymphoma

Lee, Se Hoon M.D., Ph.D
Oncologist

Areas of Expertise:

Brain tumor , Head and Neck cancer, Lung cancer, Esophageal cancer

Cho, Yang Sun M.D., Ph.D
Otolaryngologist

Areas of Expertise:

Skull base surgery, Facial nerve disease, Congenital Anomalies of Ear

Hur, Kyu Yeon M.D., Ph.D
Endocrinologist

Areas of Expertise:

Pituitary disorders, DM, Obesity and Metabolic syndrome

Jeong, Han Sin M.D., Ph.D
Otolaryngologist

Areas of Expertise:

Head and Neck Surgery, Salivary gland tumors, Thyroid cancer

Seo, Dae Won M.D., Ph.D
Neurologist

Areas of Expertise:

Epilepsy, Status epilepticus, Intraoperative neurophysiologic monitoring

Hong, Sang Duk M.D.,Ph.D
Otolaryngologist

Areas of Expertise:

Skull base surgery, Sinonasal tumors, Deviated nasal septum

Kim, Yun Hee M.D., Ph.D
Physiatrist

Areas of Expertise:

Brain Injury, Sensorimotor/ Cognitive/Speech Rehabilitation

Chang, Won Hyuk M.D., Ph.D
Physiatrist

Areas of Expertise:

Brain Injury, Stroke

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