FUNCTIONAL NEUROSURGERY

Presented By: Vamsi Krishna Yerramneni
Definition

• It is the surgical intervention designed to alter the physiological activity of the central nervous system.
• Has become an important instrument for research on functioning of the human brain.
• General neurosurgery tend to concentrate on lesion while the functional neurosurgery endeavours to concentrate on symptom.
• Often involve circuits of the nervous system.
History

- **Renie Leriche** used the functional neurosurgery to describe sympathetic neurectomies for pain and circulatory disturbances.
- **Werthiemer** one of the leriche’s disciples coined the name functional neurosurgery.
- **Sir victor horsley** considered the father of the functional neurosurgery excision of the epileptogenic brain tissue for treatment of the focal epilepsy.
Knowledge of the cortical localization from the perceptive studies were used to develop cortical resection by Foerster, Krause, Ballance.


Tic douloureux was later pioneered by Krause, Frazier and Dandy.

Third precursor was Horsley work in removing the motor cortex for the treatment of the movement disorders in early 1890.

Brucy and Buchanan extirpated the motor cortex for treatment of the athetosis in 1931, for treatment of the parkinsonism tremor in 1932, for cerebellar intentional tremor in 1937.

Putnam did extrapyramidal system lesioning with alleviation of the choreoathetosis by sectioning of the spinal cord below C4,5 in the anterolateral quadrant and anterior to the pyramidal tract.
Conti...

- **Russel Meyer**'s work of extirpation of the head of the caudate nucleus and adjacent structures in **1939** and sectioning of the ansa lenticularis has set the stage for stereotactic surgery.
- **Guiot and Brion** used free hand approach to coagulate the globus pallidus.
- **Irving Cooper** in **1951** while attempting pedunculotomy tore anterior choroidal artery accidentally and the patient postop got relieved of the tremor and the rigidity in the opposite side.
- He then directly targeted the pallidum for Parkinsonism and Dystonia using the pneumoencephalogram directed trans transtemporal approach and used a catheter to inject alcohol using a non stereotactica guidance system.
- The most successful patients autopsy revealed a lesion in the lateral thalamus. This serendipitous finding led to the discovery that thalamus is a better target for the tremor.
Birth of stereotactic surgery

- Sterotactic frames first designed by the **victor Horsley and Richard clarke (1908)** and pioneered by the **Spiegel and Wycis** added a new dimension to the functional neurosurgery.
- **Speigel and Wycis** performed the first stereotactic surgery on a patient with **Huntington's chorea**.
- In 1950 **Hassler and Reichert** reported the successful treatment of the Parkinson's disease by ventral thalamotomy while **Speigel** still advocated the pallidotomy.
- By 1954 **Hassler and Reichert** defined their thalamic targets more precisely with Vop recommended for the tremor and Voa recommended for the rigidity.
- Finally, the acceptable target has become ventralis intermedius.
- In 1968 L-dopa became generally available.
- **Lars leksell** coined the term stereotactic surgery and he developed gamma knife with the intention of using the system to interrupt the pathways for functional neurosurgery.
- **Bechtereva** first attempted the therapeutic DBS.
Evolution of DBS

- In 1985 Siegfried and Lippitz and Benabid and coworkers implanted the high frequency stimulating electrodes in the thalamus for treatment of the parkinsonism and essential tremor.

- Delong and colleagues determined that increased excitatory output of STN is responsible for parkinsonism symptoms.

- Benaid and colleagues attempted the electrical neuroinhibition of the STN.

- Introduction of the CT, MRI, computer for planning has revolutionised the whole stereotactic surgery.
Movement disorders

Classification.

• **Akinetic rigid forms**
  parkinsonism; parkinsonism ‘s disease ; parkinsonian syndromes. Stiffman syndrome.
• **Hyprekinetic forms**
  • chorea syndromes
  • Dystonias
  • myoclonus
  • Ballism
  • Tics
• **Atactic movement disorders**
  cerebellar ataxias
  Spinocerebellar degenerations
Approach

Movement disorder

↓
axial

↓
Head & neck

↓
trunk

↓
intentional movements

↓
with sustained postural movements

↓
appendicular

↓
at rest
Parkinsonism

15 per 100 000

Diagnosis is clinical; two of the triad of tremor, bradykinesia, rigidity and a favorable response to dopaminergic therapy.

May include anxiety, depression, hallucinations poor memory and concentration.

Differential diagnosis;

Parkinson plus syndromes, These degenerative disorders needs to be rerecongnised because they respond poorly to the current ablative surgery or stimulation techniques.
Pathology
Differential Diagnosis

Parkinson plus syndromes

- Shy Drager syndromes
- Sriatonigral Degeneration
- Progressive supranuclear palsy
- Olivopontocerebellar degeneration
- Multisystem atrophy disorders.
- Clinically signs of Autonomic Dysfunction Longtract signs, Cerebellar deficits, Extraocular movement abnormalities, increased axial tone, and lack of neurological response to L-dopa therapy are indicators of the parkinson plus disorders.
Tests

Tests; Clinical rating scales-UPDRS core assessment programme for intracerebral transplantation (CAPIT) 
Hoehn and yahr staging scale (defines the extent of the patients disability) 
Timed motor tests, 
A trial of l-dopa therapy 
CAPIT protocol is used to assess the continuous evaluation of the surgical intervention done.

• Preop MRI and CT are important to exclude the multiinfact dementia.

• PET useful to differentiate progressive supra nuclear palsy and corticobulbar degenerative procedures.
Current surgical recommendations of the parkinsonism

- Pallidotomy for patients mostly disabled by the Dopa induced dyskinesias, with and without tremor.
- Pallidotomy doesn’t consistently relieve the tremor.
- Tremor predominant – Thalamotomy or placement of the thalamic stimulator.
- Poor surgical risk patients – Stereotactic thalamotomy.
Current surgical options in parkinsonism

- Pallidotomy; indications;
  Drug induced dyskinesias
  Dystonia and pain, usually unilateral.
Subthalamic nucleus stimulation;
  Uncontrolled unilateral tremor,
  Advanced Parkinson's disease,
  Improves all features of PD-tremor, rigidity, bradykinesia, freezing and gait.
  Bilateral surgery feasible. Reduces L-dopa dose post operatively.

- Subthalamotomy;
  Unilateral & bilateral
  Tremor advanced PD.
Pallidotomy

• Pallidotomy is a patient of PD with 5-6 years of disease who has started experiencing on-off fluctuations. Off phase dystonia, pain and drug induced dyskinesias predominantly on one side of the body.

• Patients in more advanced state with predominant axial and bilateral symptoms will require alternative strategies.
STN stimulation

• Most recent surgery for advanced PD
• Advanced PD having frequent and unpredictable off periods, drug-induced dyskinesias, off phase dystonia and pain.
• There should not be any history of psychiatric symptoms like major depression or cognitive deficits.
• Disease should be responsive to levodopa treatment with good on.
• Unilateral uncontrolled tremors.
Cont..

- Stimulation of the STN relieves akinesia, L-dopa induced dyskinesias, tremor, rigidity.
- Many results can be achieved with the stimulation of the internal segment of the Globus pallidus (Gpi)
- Bilateral STN stimulation can be done with an acceptable rate of complications.
- Long-term experience with either STN or Gpi
chorea

• Brief irregular involuntary muscle contractions rapid, rhythmic and unpatterned with variable timing generally affecting the upper extremities and the lower extremities.

• Pallidotomy and thalamotomy can be tried but with variable results.

• needs to be evaluated further,
Dystonia

• Extreme variant of athetosis with co contraction of the agonist and antagonists resulting in abnormal posture.

• Cerebral palsy is the most common cause of the dystonia.

• Oral medication are successful in less than half of the affected patients Baclofen and Trihexphenidyl.

• Patient benefit to ITB is facilitated by a trial of continuous ITB infusion because dystonia often does not respond to intermittent bolus by lumbar puncture

• Botulinum toxin has changed the scenario in the management of focal dystonia and spasticity.
Surgical options

- Usually for hemi or generalised dystonia
- GPI is the target of choice.
- Pallidotomy in hemidystonia /pallidal stimulation for hemidystonia or generalised dystonia.
- Patients whose dystonia has stabilised for last six months.
- Severe pain from dystonia also an indication.
- Bilateral pallidotomy does carry a risk of cognitive impairment and hence pallidal stimulation is a better alternative. Several reports of dramatic improvement in dystonia after bilateral pallidotomy.
Tremor

- Thalamus functions as a relay nucleus in the corticobasal ganglia –thalamocortical loop in parkinson tremor and premotor cortex and cerebellar thalamic connections in cerebellar types of tremor.
- Benign tremor 4-8 hertz essential or benign tremor.
- 41% of the 100000 adults older than 40.
- Postural, may increase with age.
- Intention tremor or Kinetic tremor occurs with movement 2-4 hz hallmark is occurs.
- Etiology is variable including post viral encephalitis syndrome, trauma, multiple sclerosis, Wilson's disease.
Surgical options

• Patients can be considered for bilateral Thalamotomy or Thalamic stimulation.

• Part of the motor thalamus (ventralis oralis posterior and ventral intermedius) is considered the target of choice for tremor relief to stereotactic surgery.
Tremor

- Most common type of tremor amenable to stereotactic neurosurgery; PD tremor, essential tremor, tremors due to multiple sclerosis, stroke, post traumatic or writing tremor
- Ventralis intermedialis of thalamus is the preferred target
- Bilateral thalamotomy carries significant risk of speech and cognitive deficits.
- Tremor suppression occurs in around 80% of the cases.
Tremor

- PD - STN is the target of choice
  The parkinson tremor can be suppressed with the pallidal and STN stimulation may give both lasting suppression in a small proportion of parkinson patients with long history of tremor and slight bradykinesia.
- Vim – target of choice for other tremors.
- Thalamotomy for unilateral cases / thalamic stimulation for unilateral and bilateral cases.
- >90% tremor relief.
- Post traumatic and post hemiplegic tremor – postural and action tremor - vim nucleus is the target.
spasticity

- Velocity dependant increase in the resistance to passive movements that occur with injury to the corticospinal tract or motor cortex.
- Common causes: CP, MS, traumatic brain and spinal cord injuries.
- Selective dorsal rhizotomy has been a common treatment of the lower extremity spasticity.
- Alternative non-destructive therapy is infusion of baclofen by subcutaneous pump.
Injury → Diffuse Axonal Shear → Spinal cord response
          → Muscle Shortening/Inactivity
          → Limited Joint Excursion → Soft tissue fibrosis
          → Gamma Overactivity → Hyperreflexia
Descending pathways
Stereotactic grafting techniques

MPTP-induced parkinsonism needs implant action of the stem cells in the

Fetal stem cells are implanted in the striatum
Treatment of intractable vertigo

• Intractable vertigo - vestibular nerve resection by lateral suboccipital craniotomy

• By middle fossa approach to vestibular nerve in the internal auditory meatus.
Pain physiology

• Definition; Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage.

• Theories of Pain
Theories of Pain

**Specificity Theory**

- Descartes 1664, Muller 1840
- Pain occurs due to stimulation of specific pain receptors (nociceptors) with transmission by nerves directly to the brain
- Pain is *purely* an afferent sensory experience

**Intensity theory**

- Pain arises from excessive stimulation of any sensory end organ
- Pain can occur from summation above a critical at dorsal horn neurones
- but: intense stimulation of some end organs never produces pain and lesions of CNS can abolish pain exclusively
Primary afferent input

- Cutaneous mechanoreceptors
- low threshold mechanoreceptors
- via A α,β,Ad, C fibres
- terminate in all laminae except I
Nociceptors

- Widespread - somatic & visceral
- Mechanical, thermal, chemical
- Cell bodies in dorsal root ganglia
- Cutaneous nociceptors
  - Ad fibre mechanothermal
  - Brief, prickling pain
- C fibre polymodal
  - Dull, poorly localised pain
  - via Ad
  - Myelinated, 2-5µm diameter, 6-30m/s
  - terminate laminae I, V, X
- C fibres
  - Unmyelinated, 2µm, 0.5-2m/sec,
Ascending Pathways

- “spinal lemniscus” or “anterolateral fasciculus”
- Spinothalamic tract
- Originating neurones in laminae I, V, VI, IX
- Neospinothalamic tract
- Project to VPL, VPM
  synapse and project to somatosensory cortex
Paleospinothalamic tract

from deeper laminae

• to thalamus, midbrain, pontine and medullary reticular formation, periaqueductal grey and hypothalamus

• Somatotopically and contralaterally organised,

• Functions

• mostly high threshold and multireceptive

• small discriminative or whole body receptive fields
The human brain seen from the side, showing the SI and SII sensory cortex. SI is a thin strip made up of Brodman areas 3,1 and 2 posterior to the central sulcus, while SII lurks just above the lateral sulcus.
The temporal lobe has been retracted to reveal the insula in all its splendor - the anterior portion is probably concerned with pain perception.
The anterior part of the cingulate gyrus is important in the perception of 'affective' pain.
Medially we add the poorly-defined midline nuclei. Lateral to these we plonk on the dorsomedial nucleus (dm) and, more anteriorly the anterior nuclei (ant). The internal medullary lamina bounds the dorsomedial nucleus laterally, and separates it from the anterior nuclei. Within the internal medullary lamina are the intralaminar nuclei, including the centromedian (cm) and centrolateral nuclei.

Lateral to the internal medullary lamina (iml) lies the ventral posteromedial nucleus (vpm) and anterior to this is the ventral anterior nucleus (va). Even further laterally we have the lateral dorsal(lid), lateral posterior(lp), ventral lateral(vl) and ventral posterolateral nuclei. The pulvinar (grey) is situated posteriorly.
Descending connections that modulate incoming impulses.

Incoming painful stimuli are transmitted (A) to the dorsal horn, and from there (B) to the periaqueductal grey (PAG). Descending impulses pass (C) to the raphe nuclei, especially the nucleus raphe magnus, in the upper medulla, and thence back to the dorsal horn via reticulospinal fibres (D). The above shows only the serotonergic descending fibres. Other pain-suppressing impulses pass from the PAG to the locus coeruleus, and from there to the dorsal
Phylogenetically more modern pathways from cord to lateral thalamus and thence to the S I cortex. These pathways are discriminative pain pathways, and have little to do with perception of pain as a 'sore' stimulus!
Pathways from the spinal cord to the brainstem, and from there to the thalamus (diencephalon). Some fibres pass directly to the medial thalamus, while others end in (or send collaterals to) a variety of nuclei in the brainstem. Connections between the reticular system and thalamus are not shown for reasons of clarity.
Treatment of pain

• Anaesthetic techniques
• Neural blockade
• Trans foraminal technique
• Interlaminar technique
• Intra articular injections
• Radiofrequency ablation
• Injection of the lytic chemicals
• Sympathetic ganglion block
Facial pain

- Trigeminal neuralgia
- Atypical Facial Pain
- Dental Neuralgia
- Temporomandibular Joint Syndrome
- Anesthesia Dolorosa
- Cluster Headaches
- Migraine Headaches
- All involve the Trigeminal Nerve
Medications

- Medications
- Tegretol® (Carbamazepine)
- Trileptal® (Oxcarbazepine)
- Neurontin® (Gabapentin)
- Dilantin® (Phenytoin)
- Lioresal® (Baclofen)
What causes Trigeminal Neuralgia?

- **Trigeminal Nerve Hypersensitivity**

- Vast Majority, Vascular Compression of the Nerve Root Entry Zone

- Less common, multiple sclerosis at REZ

- Less common, tumor at REZ

- Less common, arteriovenous malformation at REZ

- All cause damage to the nerve covering (myelin sheath) which is susceptible at the REZ
Balloon Compression

• Injures Nerve by Compression with an inflatable balloon
  Not as accurate as RFL (no stimulation)

• Initially Effective

• Generally not as durable
Glycerol Injection

- Injures Nerve by injecting Glycerol into the Trigeminal Cistern
- Not nearly as accurate
- No stimulation
- Liquid can move into unwanted areas
- Generally not as durable
Radiofrequency Lesion (RFL)

**Advantages**
- Minimally invasive
- Allows Stimulation Testing
- Outpatient procedure, Quick Effective
- No recovery period
- Easy to repeat multiple times, if necessary
- Best for Non-Surgical Candidates

**Disadvantages**
- Facial numbness
- Does not cure disease
- Higher recurrence rate
- Sometimes needs to be repeated multiple times
- Some additional risks (anesthesia delorosa, corneal anesthesia, etc), 5%
Results of RFL

- 95-99% Excellent Pain Control Immediately
- Approximately 40-50% Cure Rate
- 50-60% Recurrence usually between 1 year and 3 years post-operative
- 5% Complication Rate
RF

- Radiofrequency -> 90% initial success rate only 58% had sufficient pain relief at 5 years.
- Complications – diminished corneal reflex, masseter weakness, paralysis, dysesthesias and anaesthesia dolorosa.
- Glycerol rhizotomies – initial success rate of 80-90% median time to recurrence is 16-36 months.
- Balloon microdecompression – initial success rate of 78-100% mean time to recurrence is 3.5 years.
Surgical Treatment Options

- Microvascular Decompression
- Injure the Trigeminal nerve so that doesn’t feel the pain
- Balloon Compression
- Glycerol Injection
- Radiosurgery
- Radiofrequency Lesion
Results of Surgery

- 95-99% Excellent Pain Control Immediately
- 75-80% Cure Rate
- 20-25% Recurrence usually between 1 year and 3 years post-operative
- 5% Complication Rate
Stereotactic radiosurgery

- Treats the nerve root entry zone with 60-90 gy of single dose radiation.
- Benefits with in 1-8 weeks.
- More than 75% pain relief at 2 years
- Mean recurrence rate is 13.4% over 15 months
Partial sensory rhizotomy

- 30-50% of the lower fascicles of the portiomajor are sectioned via a retromastoid craniectomy.
- Used for recurrent neuralgia after microvasular decompression.
- Can also be combined with trigeminal neuralgia.
Other modalities

- Stereotactic neurosurgery
- Peripheral neurectomy
- Alcohol injection
- Young and colleagues reported
- 95% in patients with n previous surgery
- 88% in previously surgically treated patients
- 69% at long term followup
- Good for patients who cant tolerate conventional surgical treatment and for those willing to accept the delay in pain relief
Patient selection for pain therapies

• Appropriate for those in whom more conservative therapies have not provided adequate pain relief
Augmentative therapies

• Spinal cord stimulation
• Peripheral nerve stimulation
• Intraspinal infusion
SCS

- Neuropathic pain in the extremity
- Persistent radicular pain associated with the failed back syndrome
- Pain of complex regional pain syndromes
- Post herpetic neuralgia affecting the trunk
- Refractory angina pectoris
- Phantom pain
- Peripheral neuropathy pain
- Peripheral vascular diseases
Intracranial stimulation therapies

- DBS of the somatosensory thalamus (VPL-VPM), PVG-PAG, Motor cortex
- Nociceptive pain and paroxysmal, lancinating or evoked neuropathic pain tend to respond best to PVG_PAG stimulation which activate opioid system.
- Continuous neuropathic pain responds to paraesthesia producing stimulation of the sensory thalamus.
- Failed back surgery syndrome, peripheral neuropathy, or trigeminal neuropathy (not anesthesia dolorosa).
- Central pain syndromes like thalamic pain, spinal cord injury pain, anesthesia dolorosa, Post herpetic neuralgia, phantom limb pain respond poorly.
- Motor cortex stimulation is an alternative to thalamic and pvg-pag stimulation. 50% have good long term pain relief.
- Those undergoing thalamus and other stimulations have success rate of 25-80%
- Neuraxial drug infusion has become a popular intervention treatment for intractable pain.
Intrathecal drug administration

• Failed back syndrome (has both nociceptive and neuropathic pain component).
• Can control both nociceptive and neuropathic pain
• Can be both focal or axial pain, below
• 60-80% achieve good long term relief.
• Outcome similar to both cancer and noncancerous pain.
Ablative therapies

- Last resort in the pain ladder
- These interrupt nociceptive input into the spinal cord.
- Most appropriate for treatment of the nociceptive pain.
- Neuropathic pain which is intermittent, paroxysmal or evoked (alloying, hyperpathia) responds better.
- Sympathectomy; used for pain of cancerous origin.
- Very inconsistent results in noncancerous pain.
- Neurectomy; useful in pain following peripheral nerve injuries.
- Utility limited as the pain is rarely of pure sensory root origin.
- Dorsal rhizotomy and ganglionectomy; serve similar purpose in denervating somatic and visceral tissues, ganglionectomy denervates completely. Used for treatment of pain in the abdomen, not used for the extremities unless until the function is already lost.
- These can be used in the treatment of the pain in the thoracic and abdomen and in pelvic cancers when the bladder, bowel, and sexual function is already lost.
Nerve root origin

- Sinovertebral nerve
- Ventral root
- PLL
- Dural sleeve
- Gray ramus communicans
- Ventral ramus
- Ligamentum flavum
- Dorsal root
- Dorsal ramus
- Sympathetic ganglion
Neurectomy

- Useful in pain following peripheral nerve injuries.
- Utility limited as the pain is rarely of pure sensory root origin.
- Dorsal rhizotomy and ganglionectomy; serve similar purpose in denervating somatic and visceral tissues, ganglionectomy denervates completely. Used for treatment of pain in the abdomen, not used for the extremities unless until the function is already lost.

These can be used in the treatment of pain in the thoracic and abdomen and in pelvic cancers when the bladder, bowel and sexual function is already lost.
DREZ lessoning of the spinal cord.

- DREZ (for trunk and extremity pain) or nucleus caudal is (for facial pain) can provide significant relief of pain.
- Sectioning of the second order neurons
- 70-80% pain relief.
- Reserved for localised pain.
- Very much successful in the neuropathic pain caused by root avulsion end zone or boundary pain following spinal cord injury.
- These pains can also be relieved by the SCS or intrathecal drug administration but DREZ can cause same long lasting relief with out the need for maintenance of the augmentative device.
• Nucleus caudal is lesioning is useful for the deafferentiation pain affecting the face (including the post herpetic neuralgia).
• Less helpful for facial pain of the peripheral origin. (traumatic trigeminal neuropathy).
• DREZ is effective in for relieving the paroxysmal rather than the continuous pain.
Cordotomy

• Pain related to malignancy.
• Intrathecal analgesics have largely replaced cordotomy for treatment of the cancer pain.
• Cordotomy offers several advantages; no long term follow up is needed.
• So important for individuals having difficulty in returning to the medical facility for refilling of the infusion system or for whom the cost of the medical care have become burdensome.
• Individuals with short life span also fit candidates.
cordotomy

- Used for the cancer related pain below the mid to low cervical dermatomes.
- Noncancerous pain patients are not fit candidates as the concerns regarding the potential loss of the pain relief over time,
- Occurrence of the post cordotomy dysesthesias.
- Can be performed as an open or closed (percutaneous) procedure.
- Level of the analgesia falls over time with in six weeks level has fallen by 3-6 spinal levels and by 6 months 6-8 segments.
Results and complications

• Level of the analgesia falls over time with in six weeks level has fallen by 3-6 spinal levels and by 6 months 6-8 segments.
• Lancinating neuropathic pain and evoked pain that some times occur following spinal cord injury and peripheral neuropathic pain syndrome can improve after cordotomy.
• Bilateral cordotomies have risk of weakness, bladder, bowel and sexual function and respiratory depression subsequent to unilateral procedure.
• Pulmonary functions should be assessed before.

• When bilateral cordotomies are necessary unilateral high cervical procedure followed by contralateral low cervical procedure.
• Cordotomy provides good pain relief in approximately 60-80% of the procedure.
• But the pain relief does not lost over time. Approximately one third of the patients have recurrence in 3 months and half at one year and two third at longer follow up.
Myelotomy

commissural myelotomy selectively the decussating fibres in the anterior commissure.

Limited midline myelotomy offers the same advantages of the bilateral cordotomy and minimizing the risks of the sectioning of the both the anterior quadrants of the spinal cord.
Brain stem ablative procedures

• **Mesencephalotomy** for intractable pain involving the head, neck, shoulder and arm.
• **Supraspinal version of the cordotomy.**
• **Used for cancer pain**, relief achieved in **85%** of the patients.
• **Main complication** 3\textsuperscript{rd} nerve palsy.
• **thalamotomy**
thalamotomy

- For both cancer related and the noncancer related pain.
- Can be accomplished by radiofrequency or radiosurgical techniques.
- Useful for individuals who have wide spread pain or who have midline, bilateral or head and neck pain.
- In patients with pain above the C5 dermatome or with pulmonary function where cordotomy is contra indicated.
- Pain relief is less than mesencephalotomy but complications are less.
- Lateral thalamus ablation produces dysesthesias and sensory loss.
- Relay site of spinothalamic fibres-parvocellular ventrocaudal nucleus has been used as the target.
- Medial thalamotomy is used for affecting nociceptive pain (cancer).
- Long term pain relief in 30-50% of the patients.
Cingulotomy and hyphophysectomy

• Less commonly used for pain treatment.
• Used when no other procedure has worked.
• 50-75% short term pain relief and 25% long term pain relief.
• Hypophysectomy; (surgical, chemical, radiosurgical); most effective in hormonally responsive cancers, may relieve pain related with other cancers.
• Relief occurs independent of tumor progression
• Mechanism unknown.
DBS for pain relief

- Selection of the patient
- Severe incapacitating pain as the main complaint.
- All other therapies have exhausted.
- Realistic patient expectation.
- Who can tolerate long awake procedures.
- No medical contraindications
DBS

• Patients who have neuropathic pain should undergo paraesthesia producing stimulation and those with nociceptive pain should undergo PVG and PAG stimulation.

• Intrathecal morphine;
• Patient must have failed to respond to an adequate trial of oral narcotics or he has unacceptable side effects of the mental confusion or somnolence.
• Before placement a trial of intrathecal morphine is necessary
• 90% pain relief
Intrathecal Morphine

• patient must have failed to respond to an adequate trial of oral narcotics or he has unacceptable side effects of the mental confusion or somnolence.

• Before placement a trial of intrathecal morphine is necessary

• 90% pain relief

• Side effects

• Itching, Nausea, Vomiting

• Sedation, Respiratory depression

• Constipation, Urinary retention

• Hypotension, Myoclonus

• Neuroendocrine effects
Psychosurgery

• Disorders benefiting are OCD and major affective disorders (unipolar major depression or Bipolar disorder).
• Mixed disorders combining symptoms of anxiety, depression and OCD.
• Not indicated in Schizophrenia.
• Personality disorder,
• substance use,
• Significant axis II symptomatology is relative contraindication.
Surgical procedures

- anterior Cingulotomy.
- Sub caudate tractotomy
- Limbic leucotomy
- Anterior capsulotomy

- All performed bilaterally and under stereotactic guidance
Indications

- Cingulotomy – major affective disorder, chronic anxiety states including OCD.

- Lesion targeting from a point in the cingulum 7mm from midline and 20-25 mm from the tip of the frontal horn.

- 62% patients have worthwhile improvement.
Sub caudate tractotomy

• Major depressive illness, OCD and anxiety states.

• Aim is to interrupt the white matter tracts between the orbital cortex and subcortical structures by placing a lesion in the substantia innominata just below the head of the caudate nucleus.

• Improvement in 2/3 of patients
Limbic leucotomy

- combines subcaudate tractotomy with anterior Cingulotomy.

- Designed to interrupt the orbito-fronto-thalamic pathway with the former lesion and interrupt and important portion of the papez circuit.

- relief in anxiety, OCD, depression.

- Better results than either of the procedures.
Anterior capsulotomy

- Popularized by leksell.
- Aims to interrupt the presumed fronto-thalamic connections in the anterior limb of the internal capsule where they pass in between the caudate nucleus and putamen.
- Current indication is OCD.
Thank you