Personal Reflections and Learning from the International Workshop on Functional Neurosurgery for Movement Disorders and Mental Illness & Commemoration of the 150th Anniversary of the Birth of Sir Victor Horsley.

Queen Square – London Feb 2007

The event organised by Professor Marwan Hariz attracted speakers from around the world acknowledged by peers as outstanding contributors in the field of Functional Neurosurgery and Neuroscience which attracted around 200 delegates from Australia, South Korea, America, Russia, Sweden, Norway, France, Germany, Scotland, Greece, Finland, The Netherlands, Italy, Switzerland, Denmark, Poland, Croatia, Dubai, Japan, Canada, Wales, England, Taiwan, Portugal, Ireland, Malta and Saudia Arabia

Faculty

Back Row from left to Right	**Front Row Left to Right**
Dr Lazaro Alvarez La Habana, Cuba	Professor Takaomi Taira Tokyo, Japan
Prof Peter Brown	Dr Jean-Luc Houeto
Dr Gun Marie Hariz	Professor Alim-Louis Benabid Grenoble, France
Dr Paul Krack	Professor Tipu Aziz Oxford, UK
Professor Pierre Pollak Grenoble, France	Professor Boulos-Paul Bejjani Byblos, Lebanon
Professor Bart Nuttin Leuven, Belgium	Professor Alan Crockard London, UK
Dr Roger Melvill Cape Town, South Africa	Professor Marwan Hariz London, UK
Mr Steven Gill Bristol, UK	Dr Carmelo Sturiale
Dr Patricia Limousin-Dowsey London, UK	
Professor Niall Quinn London, UK	
Professor John Rothwell London, UK	
Dr Veerle Visser-Vandewalle	
Professor Roger Lemon London, UK	
Prof Rees Cosgrove	
Professor Andres Lozano	
Dr Laura Cif Montpellier, France	
Mr Ludvic Zrinzo London, UK	
Professor Marjan Jahanshahi London, UK	
Dr Stephen Tisch London, UK	
Dr Hans Speelman	
Professor Philippe Coubes	
Pat Forsdick	

Faculty

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Mr Keyoumars Ashkan London, UK	**Professor Andrew Lees** London, UK
Professor Tipu Aziz Oxford, UK	**Professor Roger Lemon L**ondon, UK
Professor Alim-Louis Benabid Grenoble, France	**Professor Boulos-Paul Bejjani** Byblos, Lebanon
Professor Kailash Bhatia London, UK	**Dr Patricia Limousin-Dowsey L**ondon, UK
Professor Peter Brown London, UK	**Professor Andres Lozano** Toronto, Canada
Dr Laura Cif Montpellier, France	**Dr Roger Melvill** Cape Town, South Africa
Professor Rees Cosgrove Boston, USA	**Professor Bart Nuttin** Leuven, Belgium
Professor Philippe Coubes Montpellier, France	**Professor Pierre Pollak** Grenoble, France
Dr Hugo Critchley London, UK	**Professor Niall Quinn** London, UK
Professor Alan Crockard London, UK	**Professor John Rothwell** London, UK
Professor Antonio De Salles Los Angeles, USA*	**Dr Hans Speelman** Amsterdam,The Netherlands
Professor Richard Frackowiak London, UK	**Dr Carmelo Sturiale** Bologna, Italy
Mr Steven Gill Bristol, UK	**Professor Takaomi Taira** Tokyo, Japan
Professor Marwan Hariz London, UK	**Dr Stephen Tisch** London, UK
Dr Jean-Luc Houeto Poitiers, France	**Dr Franco Valzania** Bologna, Italy
Professor Marjan Jahanshahi London, UK	**Dr Veerle Visser-Vandewalle** Maastricht, The Netherlands
	Mr Ludvic Zrinzo London, UK
* abstract provided unable to attend	

An interesting dimension to the workshop was the integration of research and practical application. Speakers were rigorously questioned by peers and a real sense of passion to learn, share, and challenge to benefit patients around the world was evident. There was lively good humoured banter between the neurologists and neurosurgeons who traditionally had discrete roles, many speakers reinforcing the importance and necessity of collaborative, multidisciplinary approaches to developing treatments.

It was clear that the passion for excellence transcended geographical boundaries and several in the room could truly be classed as pioneers in the tradition of people like Sir Victor Horsley the “father of neurological surgery” for whom we should all be extremely grateful. All the speakers acknowledged the valuable contributions to their work from the teams at their respective centres.

A booklet of abstracts provided by each speaker from their presentations provides considerable details on each specialist topic. The paper does not intend to replicate the abstracts but instead will concentrate on providing a summary of the personal learning taken from each section of the programme.

Day 1

PHYSIOLOGY / IMAGING Moderator: M. Jahanshahi

- What can Local Field Potentials tell us about where to stimulate and why it works
  P. Brown

- Imaging of brain targets and electrode contact localisation
  L. Zrinzo
- Transcranial Magnetic Stimulation (TMS) in the treatment of movement disorders and psychiatric illness
  J. Rothwell

COMMEMORATION OF SIR VICTOR HORSLEY'S 150th ANNIVERSARY Moderator: M. Hariz

- Homage to Sir Victor Horsley
  A. Crockard
- The Victor Horsley Lecture . High Frequency Stimulation of Deep Brain Structures at its 20^{th} Anniversary: Is it a New Tool, or is it a new Concept?
  A-L Benabid
- Queen Square and early ideas about the function of the motor system
  R. Lemon

SURGERY FOR PSYCHIATRIC ILLNESS part I - Moderator: R. Frackowiak

- "OCD, Tourette Syndrome and functional imaging of emotions"
  H. Critchley
- DBS for Tourette Syndrome. What's new?
  J-L Houeto
- DBS for OCD. What's new?
  B. Nuttin

SURGERY FOR PSYCHIATRIC ILLNESS part II - Moderator: R. Frackowiak

- "DBS for depression, long term results"
  A. Lozano
- Is there still a place for capsulotomy and cingulotomy for OCD?
  R. Cosgrove
- PANEL DISCUSSION chaired by **V. Visser-Vandewalle**

Day 2

SURGERY FOR PARKINSON'S DISEASE part I - Moderator: A. Lees

- The very long term results of STN DBS
  P. Pollak
- Evidence-based surgery for Parkinson's disease
  H. Speelman
- Non-motor effects of STN DBS
  P. Krack
- Post STN-DBS Parkinson's disease. A new phenotype?
  B-P Bejjani

SURGERY FOR PARKINSON'S DISEASE part II - Moderator: K. Ashkan

- Surgery for movement disorders in South Africa
  R. Melvill
- Subthalamotomy for Parkinson's disease - pros and cons
  L. Alvarez
- PANEL DISCUSSION chaired by **P. Limousin-Dowsey**

SURGERY FOR PARKINSON'S DISEASE: NEW TARGETS - Moderator: N. Quinn

- The role of the pedunculopontine nucleus (PPN) in Parkinson's disease
  T. Aziz
- DBS of PPN in Parkinson's disease; when, why, how?
  S. Gill
- Motor cortex stimulation in Parkinson's disease; when, why, how?
  F. Valzania and C. Sturiale

SURGERY FOR DYSTONIA - Moderator: K. Bhatia

- Surgery for Dystonia. What's new?
  P. Coubes
- Surgery for Dystonia - long term results
  L. Cif
- Surgical strategies for cervical and task specific hand dystonias
  T. Taira
- Clinical and physiological effects of pallidal DBS for dystonia
  S. Tisch
- PANEL DISCUSSION

PHYSIOLOGY / IMAGING

Recordings

Models explaining the function of the Basal Ganglia have existed for many years but it is only recently the sophistication of recording and imagery techniques has enabled some of the models to be visualised and better understood as well as posing new unanswered questions.

Abnormal synchrony in the Basal Ganglia –cortical loop can be measured and in the frequency range 8-30 Hz related to PD. Abnormal synchronisation at frequencies under or around 10Hz seems to be related to mobile dystonias and this might explain why the same surgical procedure can be beneficial for more than one disease.

Imaging

The significance of imaging can be illustrated by the number of imaging pioneers awarded Nobell prizes. The improvements in the resolution of imaging now allows the visualisation of internal structures previously difficult to target such as the ventrointermediate thalamis (Vim).

Pre-operative stereootactic images are critical and common to targeting. However, post-operative Stereotactic images are equally critical in providing evidence of the actual rather than predicted electrode placement. Allowing the identification and elimination of minute systematic errors in actual v. planned electrode placements. The evidence is also invaluable in providing an audit trail for the comparative evaluation of target benefits.

Transcranial (External) Magnetic Stimulation

This non invasive method of applying magnetic pulses affects structures close to the surface like the cerebral cortex as it cannot penetrate deeply into the brain. The effects of multiple sessions of stimulation seemed to suggest a latency that brought effects after the stimulation has finished.

A large number of researchers are looking at ways of using this relatively inexpensive method of stimulation as a form of treatment. One area that looks is promising is in the area of stroke rehabilitation and interestingly another speaker presented how he uses implanted stimulation of the cerebral cortex along the same principles with great success.

COMMEMORATION OF SIR VICTOR HORSLEY'S 150th ANNIVERSARY

Victor Horsley

An amazing man who was ahead of his time, leaving many legacies for future generations to build on in the field of neurosurgery. Born in 1857 he studied medicine at UCL and Berlin Aged 23 in 1880 publishes first paper in Brain 3 113-6. Aged just 24 he was appointed House Surgeon and registrar at University College Hospital.

3 years later he was Appointed Professor Superintendent of the Brown Institute and published "Functions of the Marginal Convolutions"

1887 – First physician to remove a spinal tumour, and appointed Professor of Pathology UCL Incredibly he was appointed Assistant Professor of Surgery at the National Hospital for Paralysis and Epilepsy in 1988 and was co-author of "experiments upon the functions of the Cerebral Cortex"

1899 Professor of Clinical Surgery UCL. Receiving a knighthood in 1902

1908 developed with Robert H Clarke the Horsley-Clarke apparatus which is a sterotactic frame now held in the science museum and is the foundation of Functional Neurosurgery.

1915 posted as Colonel and Director of Surgery of the British Army Medical Service in Egypt and died a year later near Basra of heatstroke.

Remarkably the achievements made without the benefits of imaging technology. His research on the treatment of gunshot injuries to the brain was used in the First World war and observations still relevant in the modern era.

Astounding tales of surgery in front rooms homes and spectacular results, including an account from Professor Crockard of having had the privilege of seeing a man who described having had surgery in his own home 69 years previously.

Horsley was a very rounded individual who cared about social issues. Championed suffragettes, was responsible for the abolition of rabies, and campaigned against tobacco and alcohol.

High Frequency Stimulation (HFS) of Deep Brain Structures at its 20th Anniversary: Is it a New Tool, or is it a new Concept?

Professor Benabid's provocative and informative lecture was captivating, not least because he is the father of DBS. Observing that HFS of the thalamus seems to mimic the effect of lesioning during thalamotomy. The procedure has virtually replaced lesions of deep brain targets. HFS is now being used in functional neurosurgery to assist in the treatment of conditions such as movement disorders, epilepsy, cluster headaches, OCD and depression. Through a wide variety of targets.

The reversibility and adaptability of HFS is an attractive feature that has reduced risks and morbidity, providing confidence in treating delicate bilateral targets making it a new and useful tool in the stereotactic armoury.

The suppressive effect of HFS has led to a huge increase in research to understand the mechanisms. Current thinking is that HFS works through a complex combination of effects, including quite possibly different structures and sub-structures. Using a variety of measurement techniques it is possible to prove that even in very small structures such as the subthalamic nucleus the stimulation involves very precisely and functionally different micro circuits.

The blocking of abnormal patterns and events through HFS and its square pulses is crude and more sophisticated pulse patterns and frequency profiles might lead to even better results with more focussed suppression. Work from Peter Tass and the development of phase resetting pulse patterns might open new ways of improving the concept of HFS.

Queen Square and early ideas about the function of the motor system

As far back as the late 1800's Queen Square was a leading institution in the treatment of neurological conditions and cutting edge research into how the brain functioned. Famous names of pioneers at Queen Square in understanding the motor function included John Hughling Jackson, David Ferrier, William Gowers, CE Beevor, Charlton Bastian and Victor Horsley.

In 1884 Horsley was the first to use interoptive electrical stimulation of the motor cortex during brain surgery for epilepsy. Even then the technique was used by trainees to treat movement disorders including dystonia.

Even in those days the use of animals in research was controversial and Horsley fond himself the target of campaigners. Thanks to his courage and brilliance he continued to develop understanding that was to prove essential to inform future generations about the motor system worked. Including the concept that movement control is by interconnected motor centres. Recognising that stimulation of the brain could provoke movements of varying complexity.

SURGERY FOR PSYCHIATRIC ILLNESS part I
OCD, Tourette Syndrome (TS) and functional imaging of emotions

The advances in functional neuroimaging over the past 6 years has provided a detailed insight into how human emotions interact with attentional processes and conscious awareness.

Characterising the neurobiology that underpins emotional disorders is an important goal and the comparison of data from non-clinical populations has helped in finding potentially more appropriate targets like the subgenal cingulate cortex for treatment resistant depression.

OCD spans emotional dimensions. Anxiety, obsessive fixation, compulsions and repetitive actions. Depression and phobia are also common. Functional imaging shows the brain areas that are active / suppressed to be identified. Dorsal cingulated and insula hyperactivity is observed in response to the provocation of symptoms. After treatment with cognitive behaviour therapy a change in activity is observed in the orbitofrontal cortex and anterior caudate nucleus. The cortico-basal ganglia circuitry is the target of neurosurgical intervention for severe treatment resistant individuals.

TS has motor, psychological and behavioural features. Attention deficit affects over 50% of TS children. OCD, mood and anxiety are common. Imaging and neurobiological investigations have shown primary frontostratial dysfunction with a suggestion that it arises from under expression of inhibitory neurons within the striatium. DBS is being used by a few teams with success to target the motor symptoms of treatment resistance TS patients with severe motor symptoms.

DBS for Gilles de la Tourette Syndrome. What's new?

Characterised by repetitive behaviour, motor and vocal tics with self injury behaviours. Severe tics have been treated with various surgical procedures such as cingulotomy, median thalamotomy and infrathalamotomy but all have side effects.

Recent studies from 2003 to 2006 suggest that associative ond or limbic parts of the thalamus and or pallidum can improve the tics by 60-70% and importantly self injury behaviours by 100%. The extent of the injuries pre DBS was truly appalling with many showing severe facial injuries.

Key questions about the best target and patient selection criteria as well as the effect on personality and impulsive behaviour still remain unanswered.

SURGERY FOR PSYCHIATRIC ILLNESS part II

DBS for depression, long term results

Area 25 of the brain is activated during sadness and shown to have a reduced metabolic rate during treatment with antidepressant drugs. Using that foundation of knowledge DBS of Area 25 has been tried on a number of patients with severe refractory depression.

The 12 patients had all failed to respond to therapies including ECT. DBS electrodes were implanted bilaterally in area 25. PET scans showed a reduction in resting blood flow of area 25 and a normalisation of the cortical frontal areas. The changes on the scans were quite remarkable and clearly seen.

8 of the 12 patients responded better than 50% reduction in their Hamilton depression scores at 3 to 24 months follow up. No serious adverse effects from the treatment and the benefits showed it could be suitable for people with treatment resistant depression.

Is there still a place for ablative surgery in psychiatric disorders?

This was a complex lecture as it seems that much controversy exists on the principle of surgical interventions for psychiatric illness. In part it seemed to stem from what now seems obscene use of surgical procedures for conditions in the middle of the last century not even remotely possible to be treated.

There now seems to be a broad agreement that pre-surgical selection of patients is critical and must be performed by a multidiscipline team with experience in functional neurosurgical treatment of psychiatric illness. Diagnosis using formal classifications are essential and standardised long term trials are needed that look at pre and post op functional outcomes as well as the psychiatric symptoms being targeted.

The operations are not a cure and ongoing psychiatric treatment is still necessary. Overall may patients do get benefit and have few side effects. The challenge is ensuring only appropriate patients are treated and the historical issues of inappropriate surgery avoided.

SURGERY FOR PARKINSON'S DISEASE part I

The very long term results of STN DBS

Bilateral STN stimulation introduced in 1993 by the Grenoble team is currently the most frequently used surgical treatment for Parkinson's Disease (PD). Very long term results are related to several factors including the evolution of PD. Very long term results can only be compared to historical control groups.

Although STN stimulation patient management is difficult and time consuming post operatively in comparison with other surgical procedures in the short term it is not the case in the long term. Some side effects such as weight gain, cognitive, or manic behaviour are apparent in the first year but not later.

Improvements in motor symptoms are largely sustained in the long term. Over time some motor symptoms like akinesia in repetitive movements of hands, speech, postural reflexes leading to falls and freezing gait. Apathy may also get progressively worse.

Any hardware type problems such as extension lead breakage, skin erosion and infection tend to be seen in the first 3 years but are rare in the long term. Issues of extension lead pulling on the neck and providing discomfort can be avoided by deeper tunnelling of the cable under the skin.

Kinetra's built prior to 2004 were susceptible to sudden failure and resetting to factory defaults due to insufficient stiffness in the device. Replacement due to battery life typically occurs after 7 to 8 years of continous stimulation with the Soletra and a year less for the Kinetra with mean parameters of 3v, 60ms pulse width, 130Hz frequency.

Overall. In time the progression of symptoms closely resembles the natural progression of PD but without the motor complications.

Evidence-based surgery for Parkinson's disease

The description of evidence based medicine is "the conscious, explicit, and judicious use of current best evidence of the individual patient"

Evidence is classified into 4 categories according to the defined rules of validity. Randomised clinical trials as category 1, down to expert opinion the lowest level category 4.

Good evidence exists to show that:

- thalamus target improves tremor and rigidity, but has not a lasting improvement of bradykinesia. Thalamus DBS is as effective as thalamotomy but without less adverse events.
- Unilateral pallidotomy is efficacious as symptomatic adjunct to dopaminergenic medication, but less effective than bilateral STN DBS
- Antiparkinson medication can be reduced considerably after STN DBS, but not after DBS of other target structures.
- Predictors of symptomatic improvement of Parkinsonian motor symptoms appear preoperative UPDRS motorscore in off, average disease duration, and levadopa responsiveness.

Good evidence is still not available for questions like:

- Which is the best surgical target for the individual patient

- Predictors of outcome for behavioural and cognitive outcome
- Does the application of microrecording electrodes lead to better targeting or does it mainly increase the number of adverse events
- Is patient selection for surgery the main factor for the relative high number of reported adverse events
- Data on health economic outcome
- DBS how does it work
- Reconstructive surgery ofr PD, a routine treatment in the near future
- So far more than 35,000 DBS implants have been performed worldwide and still there is much to examine.

Non-motor effects of STN DBS

An extremely interesting lecture about some of the behavioural side effects of STN stimulation in PD including inappropriate and infectious laughter, hypomania, mania, hallucination, psychosis, hypersexuality, aggressive behaviour, anxiety and apathy.

The magnitude of change was really stark, for example someone started prolific paintings of nudes after surgery but had never previously painted nudes. The changes seemed almost inconceivable. It seemed that almost all the adverse behavioural side effects could be corrected with adjustments to medication.

A controlled trial with 6 months follow up did not confirm any change in depressive scores.

It seems that while treatable depression can occur in the context of dopamine withdrawl states, STN DBS dampens mood fluctuation with improvement in off-period related depression and decrease in on-period euphoria with no overall change in global depression scores.

A decrease in verbal fluency is the frequent cognitive change, and although there can be behavioural side effect is the motor benefits to improving quality of life is improved with STN DBS.

Overall STN DBS is cognitively safe although a decrease in verbal fluency is not uncommon and behavioural side effects controllable.

Post STN-DBS Parkinson’s disease. A new phenotype?

The development of treatments for Parkinson’s over the past 40 years has resulted in changes to the symptoms exhibited by patients. Principally the introduction of Levodopa and DBS.

James Parkinson’s description of Tremor, Rigidity, Akinesia followed by postural instability was commonly known by the mnemonic as TRAP

After the introduction of L-dopa a naturally occurring amino acid as a treatment in the 50’s the symptoms were greatly reduced using high level doses of L-Dopa. Although L-dopa was effective at resolving TRAP, it created a new set of disabling and difficult to control motor complications.

The use of STN DBS effectively helpoed reduce those problems but has brought with it other issues as the disease continues to progress. Namely Gait, Attention, Speech and Postural instability. (GASP)

This manifestation being fundamentally different from the original observations made by James Parkinson 200 years ago.

In essence the continued need for research still exists to understand the pathophsysiology and neural protection is still the final goal.

SURGERY FOR PARKINSON'S DISEASE part II

Surgery for movement disorders in South Africa

Imagine having to travel several thousand kilometres for treatment and follow up sessions. Well that's exactly what many patients in South Africa have to do in order to get Stereotactic surgery.

Movement disorders are not widely supported and few neurologists seem to be interested in the referral of patients for DBS.

All DBS operations are performed within the private sector although there is hope that some Stereotactic surgery movement disorder surgery will eventually become available in the public sector.

It was fascinating to see how the practical problems of distance were tackled by extensive telephone interviews. The ingenuity and determination of the speaker to raise awareness and ensure adequate disclosure provided a interesting insight into the challenges faced in areas of the world where easy access to facilities does not exist.

Subthalamotomy for Parkinson's disease - pros and cons

DBS is not used in Cuba due to the American ban on technology. Consequently the lecture focused on the alternative technique of lesioning the subthalamic nucleus. The evidence from 100 PD patients (68 unilateral, 32 bilateral) followed for at least 24-36months after surgery formed the basis of the lecture.

The data suggested that subthalotomy was a feasible alternative to DBS for PD but could benefit from some refinement based on the knowledge of the sub thalamic nucleus connectivity in order to reduce any adverse effects and increase benefits. Technically the procedure is rather more complicated than DBS and so DBS should be considered the procedure of choice.

The evidence is limited and it will take a double blind randomised study to properly evaluate the effects of the lesions compared to DBS and lesion of the STN.

SURGERY FOR PARKINSON'S DISEASE: NEW TARGETS

The role of the pedunculopontine nucleus (PPN) in Parkinson's disease

The importance of research using animal models was very clear during this presentation which sought to explore new targets to overcome drug resistant akinesia and poor balance.

The role of PPN in movement disorders has only been understood in the past 15 years and shown to be degenerative in Parkinson's disease and latterly the Dystonic DYT-1 brain.

Low frequency stimulation (5-10Hz) of the PPN reversed parkinsonsian akinesia in primates independently of L-Dopa. The L-Dopa and LF stimulation effects were additive implying perhaps that the two act via independent pathways.

The importance of the findings was then picked up and used clinically.

DBS of PPN in Parkinson's disease; when, why, how?

The STN region (subthalmic nucleus and Zona incerta) are the most common target for DBS stimulation and very effective at improving tremor, rigidity and bradykinesia BUT not so good with symptoms like gait disturbance and postural instability.

Building on the research findings from primates it was found that stimulation of the PPN in humans with frequencies of 20 – 25 HZ improved gait and postural stability in the on and off medication states as well as improvements in motor symptons such as sleep deprivation.

It was fascinating to see how the research in primates was directly applied to humans.

Practically a small improvement in tremor and rigidity (around 10%) compared to just STN stimulation was observed when the Caudal Zona Incerta and the PPN were stimulated.

So the challenge now is to determine whether the improvement justifies the additional issues of cost and difficulty with stimulating two simultaneous targets.

Motor cortex stimulation (MCS) in Parkinson's disease; when, why, how?
This fascinating technique builds on the use of transcranial magnetic resonance presented earlier. It came about because not every patient is suitable for the invasive technique of DBS.

In essence a quadripolar electrode is implanted over the dura. The target area of the hand knob of the motor cortex. The procedure is quick, minimally invasive and offers a real alternative for patients not suitable for DBS.

The results are encouraging with virtually no complications. Improvements in the UPDRS global score after 6 months were typically 60.1% using a combination of MCS and levodopa.

Clearly more basic research is needed to understand the cortical and subcortical mechanisms involved in the genesis of PD to give more information about the motor cortex to help understand the optimum parameters for MCS in PD.

SURGERY FOR DYSTONIA

Surgery for Dystonia. What's new?
The Internal globus pallidus (GPi) is the most effective and widely used target for DBS in Dystonia patients.

A protocol for surgery for Dystonia is different to PD in by involving direct visualisation of the target using axial T1 MRI sequences, without microelectrode recordings wit the whole procedure under general anaesthesia.

Since the early days the several changes have been made concerning the positioning of the leads within the target, of the stimulator, the number of targeted sites. All of which are crucial in optimising benefits.

Advances in DBS for Dystonia fall into 4 categories:

1. Range of Dystonic conditions and syndromes that are suitable for DBS
Primary generalised dystonia (PGD) is well reported but now other metabolic degenerative and secondary disorders could benefit. Such as PKAN, mitochondrial diseases, Lesch-Nyhan syndrome and post anoxic cerebral palsy. With focal dystonias (torticollis, writers cramp) unresponsive to other therapeutic approaches become indications for DBS

2. Network Modulation instead of target modulation
It appears necessary to have a preserved motor network to obtain the improvements in secondary and degenerative disorders. Evaluation of the integrity of motor networks is added to the pre-op assessments. Thalamic and cortical impairment are limiting factors for the clinical outcome in GPi stimulation.

3. Number of leads to be inserted and sites to be targeted
Typical GPi stimulation involves one 4 contact lead in each GPi. Usually motor symptoms can be controlled over time with one or two contacts . In several patients with primary dystonia despite the activation of a third electrode and an increase in the level of stimulation reoccurring or new symptoms could not be suppressed and required the addition of a second lead within the same target, the motor GPi.

In both cases of PGD the leads were implanted in the sensori-motor part of the GPi, whereas in Lesch-Nyhan syndrome the two leads were implanted into two functionally different targets, one in the sensori-motor part of the GPi and the other into the anterior part of the GPi in order to improve behavioural disorders.

4. Adaptation of the inserted devices and their position within the body
Moving the stimulator position according to the number of implanted leads and the size of the patients body.

DBS of the GPi is a validated procedure and over the years many improvements in the procedure and selection criteria of patients have been made and for the future 3D modelling of the volume to be stimulated and electrical field around the contacts, new leads designs better suited to multiple lead implantation in single or multiple millimetrical targets are needed.

Surgery for Dystonia - long term results
DBS of the GPi was first used to treat Dystonia in November 1996 and now sufficient people have been treated to enable long term results to be reported on for Primary Dystonia. The concept of long term follow up should be considered according to the medical condition. For example in PGD the evolution consists only in the presence of movement disorders, whereas in others it is the metabolic and degenerative disorders.

Unlike PD the delay in obtaining response following DBS is usually longer
1. Hours to days in tardive dystonia
2. Days to several weeks or even months in primary dystonia
3. Even longer and the most difficult to predict in secondary dystonia.

Long term results of DBS are highly dependant on the etiology which influences the outcome.

The effect of DBS seems not to be linked to the severity or spread of the symptoms in primary dystonia and dyskinesias. Improvements in DYT1 dystonia and other forms of primary dystonia are comparable.

Although no vanishing of benefits was found in PGD over time it was clear that people fell into one of three categories;

1. benefits maintained 8 -10 years after surgery
2. new symptoms appear often facial in young adults or reoccurrence of symptoms seen prior to DBS and is corrected with slight changes to the stimulation settings ie voltage, additional contact
3. incomplete control of symptoms despite several years of being symptom free. Requiring implantation of additional leads into the GPi

Myoclonus dystonia (DYT11) showed consistent benefits in 3 out of 4 patients. Longest follow up is five years and no changes in settings for 4 years.

Tardive and dyskinesias get consistent benefit from Gpi stimulation (longest follow up is 3 years)

Most patients are stimulated at 130Hz, simple or double monopolar.

No changes in mood or psychiatric side effects were recorded in the population followed.

One patient gave birth without complication.

The most frequent complications were infections and lead extension breakage. Mean life of stimulators was 3.5 years. When IPG are at the end of the battery life the symptoms reoccur with a delay of seconds up to several weeks, independently of the duration fot he DBS.

In several patients daily living with DBS becomes comparable with that of the general population.

Surgical strategies for cervical and task specific hand dystonias
A fascinating presentation on how an established denervation technique had been modified to form a useful option in the treatment of Cervical Dystonia (CD) and task specific focal hand dystonia experienced regularly by musicians and writers.

CD is the most common form of Dystonia with a prevalence of 10/100,000 of the general population. Two major approaches are used, chemodenervation (Botox) although some patients are resistant to this treatment, and the second is Stereotactic surgery.

The most common surgical procedure is the selective peripheral denervation known as the “Bertrand” procedure. However this procedure is complex, involves large incisions, heavy blood loss.

Professor Taira has modified the procedure to avoid sensory loss in the C2 region using a combination of intradural and extradural denervation.. Many patients reporting an instant “cure” state although in rare complex cases GPi DBS is also used to complement the surgery.

Focal hand dystonia treatment using MRI guided stereotactic coagulation of the ventrooralis (Vo) nucleus of the thalamus was amazing to see being done as it had some very special requirements of patients!

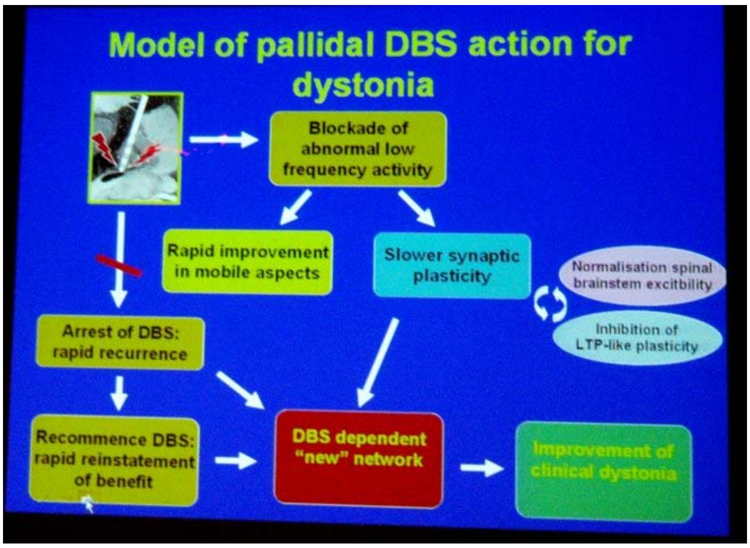
1. local anaesthesia
2. no sedatives
3. musicians had to bring their instrument into theatre to play during the operation

This last requirement was almost incredulous to see, with guitarists, drummers and flutists all being shown.

The resuts were very impressive and the longest follow up is 6 years with sustained benefits and the Vo thalamotomy impact on focal hand dystonias indicates the importance of the cortico-pallido– thalamic loop in the pathogenesis of focal dystonia.

Clinical and physiological effects of pallidal DBS for dystonia
The underlying pathophysiological defect is believed to be the abnormal basal ganglia modulation of cortical motor pathways. Abnormally excessive short term plasticity within the brainstem and cortex has recently been identified along with evidence of abnormal sensorimotor reorganisation.

Longitudinal studies of blink reflex and H-reflex reciprocal inhibition in patients with generalised dystonia have shown progressive normalisation of brainstem and spinal cord excitability in parallel with clinical improvements.



The recent work has identified the GPi DBS modifies short term plasticity within the motor cortex which may provide an additional mechanism for long term reorganisation. Exerting its effects by altering the basal ganglia output, leading to modification of the thalamocortical and subcortical activity.

The changes in brainstem and spinal excitability after DBS suggest brain plasticity may provide a physiological explanation for progressive improvements.

Also identified was a fascinating correlation between improvements measured using the BFM scale over time which shows a near perfect logarithmic fit.

$Y = 19.1 + (-2.91 \log x)$ $p = 0.0001$