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# *1 Establishing the Role of Deep Brain Stimulation in the Treatment of Intractable Cluster Headache*

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## **Introduction**

Cluster headache is one of the most painful of the primary headache syndromes. Respite from the pain comes for months or years in the episodic form of the condition. If there are cluster headache attacks for more than 1 year without remission, or with remissions lasting less than 1 month, it is called chronic cluster headache. This form makes up about 15% of cluster headache. It occurs de novo, primary chronic cluster headache, in about 10% of cases and is secondary to the episodic form in about 5%. The prognosis of the condition has not been studied in detail but J. Keith Campbell summarised it as: “chronic cluster headache is often difficult to treat medically and, once established, tends to persist for years” (1).

Not surprisingly various invasive and surgical procedures have been tried. In this paper we will briefly look at some of the surgical options and concentrate on how we might establish the role for deep brain stimulation (DBS) – a procedure that is well established in our unit.

## **Intractable Chronic Cluster Headache: Some Treatment Considerations**

To date the surgical treatment options for cluster headache have not been investigated in a large-scale, rigorous, double-blind, placebo controlled way. About 20% of chronic cluster cases do revert to the episodic form of the condition. The placebo response rate in cluster has generally been assumed to be low but in the Sumatriptan 6mg subcutaneous acute

treatment study it reached 26% (2). In some patients acute medication is over-used but there does not appear to be a problem of medication overuse headache. Patients who have ineffective treatment may become depressed, some even suicidal, and their management can be a great challenge for the physician. All of us who work in headache clinics will have been in this position. What do we do for patients with medically intractable chronic cluster headache? We will illustrate some options and give some of our thoughts on this subject but first we will outline our first case that we treated by DBS.

### **Case History**

A 59 year old builder first experienced these headaches in 1994. They occurred over a 6 week period before settling. Later they would occur yearly, usually in September or October, and over a 3 to 6 week period. The pain was right-sided, centred on the eye, very severe, and would last 30-60 minutes. It was associated with some watering and redness of the right eye. Episodic cluster headache was diagnosed by a neurologist in 1996. Over the next 3 years his treatment included prednisolone 60mg (tapered doses), methysergide 1mg tds, cafergot, various analgesics, oral Imigran, and Maxalt melt. These treatments “helped for a while”. In 2003 his condition changed to the chronic form. By June 2004 he was “doing badly”. He was using Imigran subcutaneously most days with some benefit but prophylaxis with methysergide up to 3 mg tds, high dose steroids, and verapamil (up to 960 mg a day) was ineffective. He was tried on Topamax without benefit.

### **Neurosurgical Treatment Options**

Listed below are the main surgical options for cluster headache (and summarised in reference 3).

- Occipital nerve injection
- Occipital nerve stimulation
- Glycerol injection trigeminal ganglion
- Pontine trigeminal tractotomy

- Microvascular decompression
- Gamma knife tractotomy
- Sphenopalatine ganglionectomy
- Cutting trigeminal nerve
- Cervical rhizotomy
- Deep brain stimulation

Of course, we should look for what is the simplest, safest, most effective (both in the short and long term), and the cheapest therapy. Without this information it may be reasonable to offer what is available in your unit or else refer on to a centre with greater expertise (the black box solution!). We considered DBS to be perhaps the best option for this patient.

### **Deep Brain Stimulation**

Deep brain stimulation is now a well-established treatment for Parkinson's disease, tremor (BET, MS, trauma etc.) and certain types of dystonia. It is also used to treat epilepsy, intractable pain and depression. It is a non destructive technique which is expensive (£30,000 per patient) and has high follow up requirements.

The patient had a T-1 weighted axial MRI scan (2 mm thick slices parallel to the AC-PC line) prior to surgery to plan the surgical implantation route. For surgery, a 'Cosman-Roberts-Wells' base ring was applied to the patients' head under local anaesthesia. A stereotactic CT scan was then performed and using the Radionics Image Fusion® and Stereoplan® programs, the magnetic resonance (MRI) scan was volumetrically fused to the stereotactic CT scan. This technique has been used by us since 1995 to eliminate the errors of using MRI stereotaxy alone which arise from the spatial distortions intrinsic to magnetic fields. The co-ordinates for the posterior hypothalamus electrode implantation were: 6 mm posterior, 2 mm lateral and 8 mm below the mid-commissural point, as previously described by Leone. A double oblique trajectory was used with an entry point (2.7 mm twist drill skull perforation) just anterior to the coronal suture and laterality of approach dictated by ventricular width. A tract to the target was made with a Radionics® 'TM' electrode (2 mm exposed tip, 1.8 mm diameter) that

was removed and replaced with a Medtronic® 3387 electrode. Test stimulation caused diplopia but no other significant side effects.

The electrode was externalised for a week of trial stimulation. Whereas the patient had previously been having 3-4 attacks daily, during the week after the operation he had no further attacks. Given this, the electrodes were internalised and connected to a pacemaker (Synergy®, Medtronic). He was given a patient programmer to turn the stimulator on in the event of an attack with contacts 1 negative, 2 positive; frequency 180 Hz, pulse width 90 microseconds.

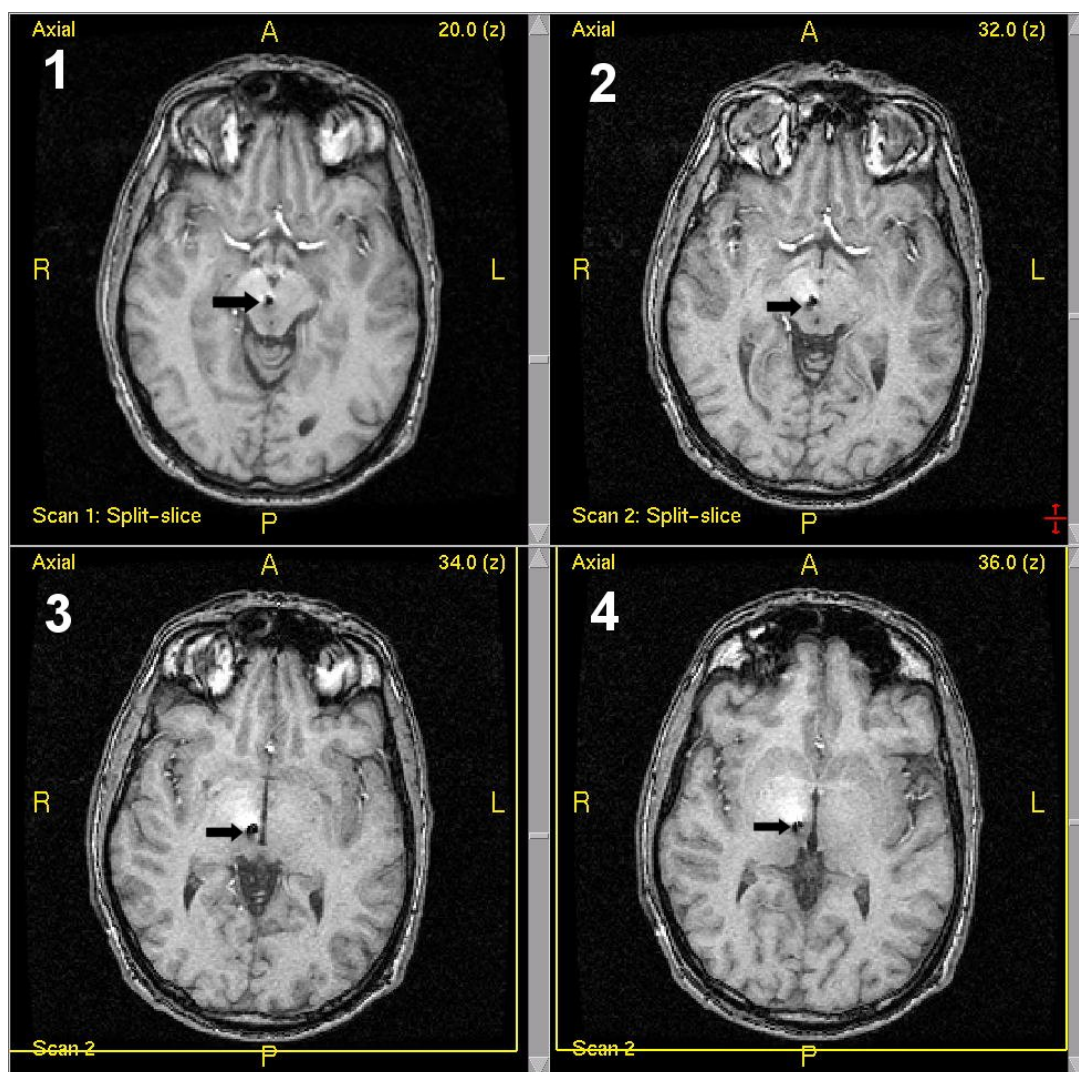


Figure 1. T-1 weighted axial MRI scan (2 mm, thickness, zero spacing) to confirm correct electrode placement.

Immediately post operatively the patient had a T-1 weighted axial MRI scan (2 mm, thickness, zero spacing) to confirm correct electrode placement (Fig.1).

In 1998 May et al (4) reported hypothalamic activation in cluster headache attacks ipsilateral to the side of pain. By analogy with the use of electrode stimulation for intractable movement disorders, it was reasonable to think that stereotactic stimulation of this area might interfere with this ‘generator’ and relieve the pain of cluster headache. In 2001 Leone et al reported successful treatment of acute attacks by stereotactic stimulation of the posterior hypothalamic gray matter (5). On several occasions, both known and unknown to the patient, the stimulators were turned off and in all cases the pain returned but settled relatively quickly when they were switched backed on. In 2004 they reported their long term follow up results on 16 patients (6). The results were encouraging and there were no complications.

However, another group reported on 6 patients with intractable cluster headache who underwent hypothalamic stimulation – one patient died post operatively with intracerebral haemorrhage (7).

### **Clinical Outcome**

Our patient has had no pain since operation 14 months ago and is absolutely delighted with result. He is off all medication and would be very happy to be an expert patient in the future. This is a surprisingly good result. He has not required stimulation – this effect may be similar to the ‘stun’ effect often seen in Parkinson’s Disease patients undergoing electrode placement in the subthalamic nucleus.

### **Conclusion**

DBS is becoming established as an effective and relatively safe treatment for intractable cluster headache. We should have some uniform definition of what is “medically intractable”. We need a better understanding of the prognostic factors for chronic cluster headache. Treatment with DBS

needs special expertise and a close link between the headache specialist and the treating neurosurgeon is essential. There should be recognised national units where the procedure is undertaken. In the absence of controlled trials the results should be collated, perhaps by national headache societies like BASH (the British Association for the Study of Headache), so that in the future we will know what is best practice.

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