Thalamic surgery for tremor

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Introduction

Tremor

Tremor is an involuntary, approximately rhythmic, oscillatory movement, that can affect the extremities as well as the axial structures of the body. Tremor can occur as resting tremor, in absence of voluntary motor activity, or as action tremor, during voluntary motor activity.

Resting tremor is a typical feature of parkinsonism. The first manifestation is often the classic “pill-rolling” tremor in the hands, developing into more widespread tremor of the extremities, and eventually the entire body can become affected. In Parkinson’s disease, initially the tremor can respond favorably to treatment with levodopa or dopamine agonists, but in later stages of the disease the tremor often cannot be suppressed adequately with medication.

Action tremor can occur during posture holding, such as the enhanced physiological tremor in a state of anxiety. When the tremor persists during movement or is exacerbated by voluntary movements, it is referred to as kinesogenic tremor. This is the typical feature of familial or essential tremor, which can be treated with the beta-adrenergic antagonist propanolol or the anticonvulsant primidone. However, pharmacological treatment is often insufficient with progression of the disease. There are many other causes of action tremor, most of which are notoriously resistant to pharmacological treatment, such as the postural and intention tremor seen in multiple sclerosis.

Tremor can add considerably to the physical and social disability produced by the underlying disease. In case of severe tremor refractory to medication, stereotactic neurosurgical treatment can be applied in order to produce suppression of the tremor and increase the functional abilities of the patient.

Stereotactic neurosurgery for tremor

The basic principle of stereotaxy is that the position of any structure in the brain can be accurately localized for an intervention, by superposition of a spatial coordinate system onto the brain. This is achieved by fixing a frame rigidly to the skull; the frame contains a geometrical reference system that can be recognized on any brain imaging modality, after which spatial coordinates of the target structure can be obtained.

In the surgical treatment of movement disorders, the stereotactic method is applied to localize the basal ganglia and the thalamus. In the case of pharmacoresistant tremor, deactivation of a small subnucleus in the thalamus can lead to suppression of the tremor. This can be achieved by producing a small thermolesion by heating the tip of an electrode introduced into the thalamus, a procedure called thalamotomy. Technological advances have led to the development of an alternative to producing a lesion in the brain: a permanent electrode can be implanted into the thalamus, which is connected to a subcutaneous stimulator that produces continuous electrical pulses which deactivates the neurons in the thalamus. This procedure is referred to as thalamic deep brain stimulation.

For the accurate localization of the thalamic target nucleus in both procedures, a stereotactic atlas is used which consists of microscopic sections through the brain. In this atlas, the position of the thalamic target is outlined relative to the position of the anterior and posterior commissures. These can be visualized in the patient during surgery using contrast ventriculography. Magnetic resonance imaging can replace ventriculography, if the potential problem of geometrical image distortion is ruled out.
Aims and outline

The main subject of this thesis is the comparison of thalamotomy and thalamic deep brain stimulation for the suppression of tremor, with respect to symptomatic and functional outcome of surgery. Chapter one provides a brief historical overview of the development of surgery for tremor, and reviews the effect of thalamotomy on tremor as described in the literature. Chapter two describes the symptomatic and functional outcome of a randomized clinical trial that was conducted to compare thalamotomy and thalamic stimulation in patients with pharmacoresistant tremor. In chapter three, the effects of both procedures on neuropsychological function are described. Chapter four presents the long-term follow-up of the patients in the clinical trial. In chapter five, the validity of the application of magnetic resonance imaging for these procedures is studied. Finally, the main findings of our investigations are summarized, along with some additional considerations.