

# Radiating multiple transections alone for refractory epilepsy

## Transecciones radiales múltiples para tratamiento de la epilepsia refractaria

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### Abstract

**Objective:** Multiple subpial transections (MST) represent a technical option of surgical treatment for patients with epileptogenic foci located in eloquent cortical areas. They could be performed in addition to other surgical techniques or alone. We report the clinical results of 10 patients who received as single MST surgery with a minimal follow-up of 5 years. **Methods:** The authors studied all patients who underwent a surgical intervention between 2007 and 2019 for refractory epilepsy. Among them, 10 had radiating MST (rMST) as the only surgical treatment with a follow-up of at least 5 years. **Results:** At 5-year follow-up, 80% of our patients were Engel class I, 20% were Engel class II, none were Engel class III, and none were Engel class IV. At last follow-up, 6 patients (60%) were free of seizures, two (20%) had an over 75% decrease, and two (20%) did not improve after the procedure. None of the Engel I patients had seizure recurrence, and those belonging to an intermediate class improved during follow-up, in some cases in association with an anti-epileptic drug modification. Two (20%) had a minor transient complication, and two patients (20%) had a minor permanent complication. **Conclusions:** MST performed alone gives a favorable outcome in 80% of the patients at a minimum 5-year follow-up with few minor complications. This procedure appears to be effective even with a prolonged follow-up in refractory epilepsy with the epileptogenic foci located in eloquent areas.

**Key words:** MST, refractory epilepsy surgery.

### Resumen

**Objetivo:** Las transecciones subpiales múltiples (MST) representan una opción técnica de tratamiento quirúrgico para pacientes con focos epileptogénicos ubicados en áreas corticales elocuentes. Podrían realizarse además de otras técnicas quirúrgicas o solo. Presentamos los resultados clínicos de 20 pacientes que recibieron una cirugía MST única con un seguimiento mínimo de 5 años. **Métodos:** Los autores estudiaron a todos los pacientes que se sometieron a una intervención quirúrgica entre 2007 y 2019 para la epilepsia refractaria. Entre ellos, 20 tenían MST radiante (rMST) como el único tratamiento quirúrgico con un seguimiento de al menos 5 años. **Resultados:** A los 5 años de seguimiento, el 80% de nuestros pacientes eran Engel clase I, el 20% eran Engel clase II, ninguno era Engel clase III y ninguno era Engel clase IV. En el último seguimiento, 12 pacientes (60%) no sufrieron convulsiones, cuatro (20%) tuvieron una disminución de más del 75% y cuatro (20%) no mejoraron después del procedimiento. Ninguno de los pacientes con Engel I tuvo recurrencia de ataques, y los que pertenecían a

una clase intermedia mejoraron durante el seguimiento, en algunos casos en asociación con una modificación farmacológica antiepiléptica. Cuatro (20%) tuvieron una complicación transitoria menor, y cuatro pacientes (20%) tuvieron una complicación permanente menor. **Conclusiones:** La MST realizada sola da un resultado favorable en el 80% de los pacientes (16) con un seguimiento mínimo de 5 años con pocas complicaciones menores. Este procedimiento parece ser efectivo incluso con un seguimiento prolongado en la epilepsia refractaria con los focos epileptogénicos ubicados en áreas elocuentes.

**Palabras clave:** MST, cirugía de epilepsia refractaria.

**Introduction**

Epilepsy is one of the most common neurologic disorders in the world. While anti-epileptic drugs (AEDs) are the mainstay of treatment in most cases, as many as one-third of patients will have a refractory form of disease indicating the need for a neurosurgical evaluation. Ever since the first half of the twentieth century, surgery has been a major treatment option for epilepsy, but the last 10-15 years in particular has seen several major advances. As shown in relatively recent studies, resection is more effective for medically intractable epilepsy (MIE) than AED treatment alone, which is why most clinicians now endorse a neurosurgical consultation after approximately two failed regimens of AEDs, ultimately leading to decreased healthcare costs and increased quality of life.

MST is a safe procedure with unclear specific efficacy. It has been used mainly in conjunction with cortical resection or lesionectomy, when the eloquent cortex is involved in the seizure activity<sup>1</sup>.

Multiple subpial transection (MST) is a surgical technique mainly used when epileptiform activity arises from eloquent or functional brain cortex. In the medical literature, there are relatively few studies reporting the efficacy and safety of this procedure in adults and in children. We review the scientific rationale, the indications, and the results of this procedure.

The authors presented their series of 20 cases and discussed the effectiveness, results and complications of MST

**Methods**

The authors studied all patients who underwent a surgical intervention between 2007 and 2019 for refractory epilepsy. Among them, 20 had radiating MST (rMST) as the only surgical

treatment with a follow-up of at least 5 years. They were 4 female patients and 6 male patients, with average age 28.5 year old (5 year old to 42 year old). The causes of epilepsy were Rasmussen encephalitis two cases, glioma in eight cases, subacute sclerosing panencephalitis in two and eight cases with focal dysplasia in eloquent area (one of them with Landau Klefner syndrome). The MST technique was described according to the number of transections performed and the Brodmann areas (BAs) involved. Any MST-related complications were registered and followed up. Clinical outcome was described in terms of seizure suppression or reduction according to the Engel modified classification.

**Results**

The effect on function was reviewed in 20 cases; only 40 cases were evaluated with respect to seizure control, since a follow-up period of 5 years or more (5 to 12 years) is required before conclusions can be drawn. Multiple subpial transection was applied to the precentral gyrus in 10 cases, the postcentral gyrus in two, Broca's area in 6 (1 with syndrome of Landau Klefner), and Wernicke's area in two. With respect

to function, the major finding was that none of the 10 patients has suffered a clinically significant behavioral deficit (although subtle deficits could be detected by careful neurological examination). Complete control of seizures has been obtained in 12 (60%) of the 20 cases evaluated. None of the patients developed recurrent seizures consequent to progressive disease unsuspected before operation (Rasmussen's encephalitis in two, tumor in eight, and subacute sclerosing panencephalitis in two).

**Discussion**

Neuroanatomic studies show that the basic functional cortical unit is arranged vertically, and epileptic activity spreads horizontally. Minimal cortical unit is essential for maintenance of cortical activity.

Vertical incisions in the cortex interrupt transverse synaptic connections, preventing seizure propagation while preserving the vertical column subserving neuronal function. In the past, it has been difficult to assess the efficacy of MSTs per se, as they have usually been performed together with cortical resection or lesionectomy. After MSTs, studies show that 33-46% of treated

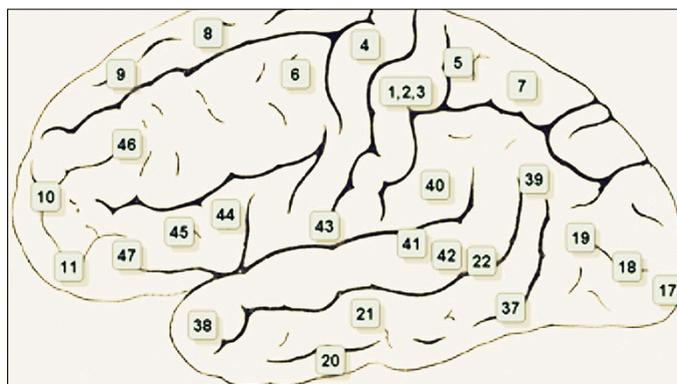


Figure 1a. Brodmann areas in external cortical surface.

children are in Engel class I or II. The permanent complication rate is low with no permanent language or motor disabilities

In the literature we found papers where patients who received MST alone, none became seizure free and despite of that they showed > 50% reduction of all seizure types<sup>4</sup>.

During the attempt to find the foci of epilepsy, we can stay in front of such situation: in the absence of visible lesions on MRI, recent improvements in secondary imaging modalities such as fluorodeoxyglucose positron emission computed tomography (FDG-PET) and single-photon emission computed tomography (SPECT) have lead to progressively better long-term seizure outcomes by increasing the neurosurgeon's visualization of supposed non-lesional foci<sup>7</sup>.

Histopathological examination can show as cause of epilepsy in eloquent area Rasmussen's syndrome, cortical dysplasia, cerebral tumor, and non-specific changes in five<sup>8</sup>.

MST can be accomplished preferentially mainly in precentral and postcentral regions. Sawhney et al, 1995, showed the three patients with Landau-Kleffner syndrome who were mute before operation and have shown substantial recovery of speech<sup>8</sup>.

This relatively new operative approach has been designed for the relief of medically intractable focal epilepsy.

It is intended particularly to be used in those cases where the epileptogenic lesion lies in "unresectable" cortex; that is, those cerebral regions subserving speech, memory, and primary motor and sensory function<sup>5</sup> (Figures 1 a 1b). The procedure is based upon experimental evidence indicating 1) that epileptogenic discharge requires substantial side-to-side or horizontal interaction of cortical neurons, and 2) that the major functional properties of cortical tissue depend upon the vertical fiber connections of the columnar units<sup>5</sup>.

The technique requires severing of tangential intracortical fibers while preserving the vertical fiber connections of both incoming and outgoing nerve pathways and of the penetrating blood vessels which also have a vertical orientation (Figures 2,3,4).

It is showed in literature that the efficacy and low morbidity of radiating MST is related to use of neuronavigation and intraoperative electrocorticography<sup>6</sup>.

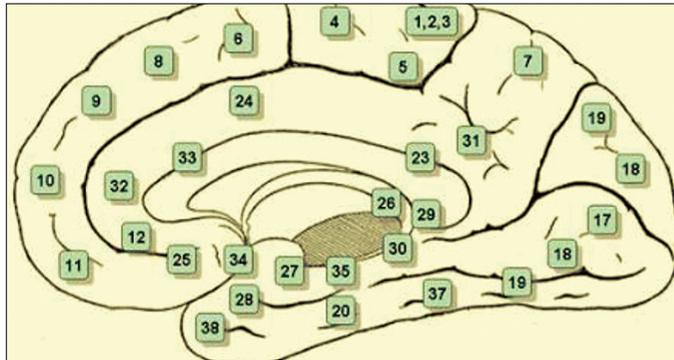


Figure 1b. Mesial cortical surface and Brodmann areas.

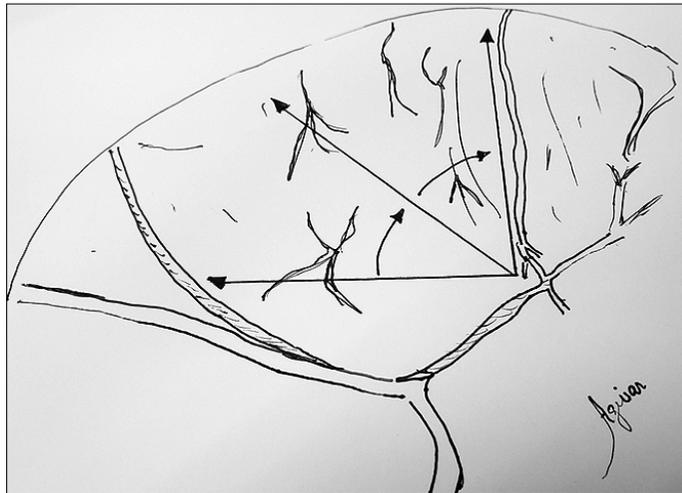


Figure 2. The angle of subpial transection. As a rule 90 degrees is enough.

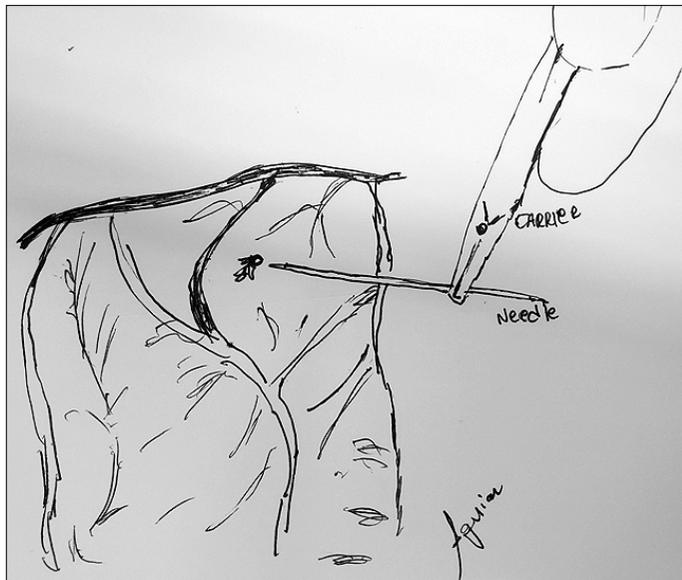
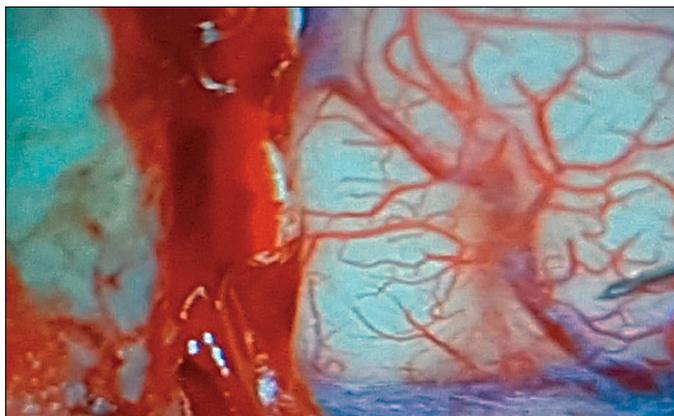


Figure 3. A needle held by a holder (carrier) used for insertion in cortical surface and radiating subpial transection.

MST performed alone gives a favourable outcome in 75% of the patients at a minimum 5-year follow-up with few minor complications<sup>3</sup>. However the same group in the beginning of their surgical procedures showed results less favorable,

According to Vaz et al, in the MSTs group, two patients (25%) were in grade I and five (62%) in grade II or III. In the MST+ group, six patients (27%) were in grade I and 13 (59%) in grade II or III. All patients showed some seizure reduction and some improvement in behavior or cognitive function with no permanent neurological deficit<sup>10</sup>. This series supports the notion that multiple subpial transections are associated with a significant seizure reduction (in 86.6% of the cases reported) and that the risk of permanent neurological deficit becomes very low<sup>10</sup>. Our series demonstrated a complete resolution of crisis in only 60% of the cases after a long follow up different from the initial results with 80% of seizure free.

According with Schramm et al, 2002, the alternative five-tiered classifica-



**Figure 4.** Cortical gyri with the pia matter punctured by a needle in right side of surgical view.

tion resulted in 50% with worthwhile improvement (excellent, good, or fair outcome), 45% with poor, and 5% with worse outcome. Lesions that are detectable on MR imaging, and large MST areas are predictive of worse results. Significant intraoperative problems may arise, but this happens infrequently<sup>9</sup>. The literature demonstrates that MSTs

can be performed with acceptable morbidity in children undergoing epilepsy surgery<sup>2</sup>. We have only one case in our series with 5 year old boy who was harboring of Landau Kleffner and recovered completely his speech after MST.

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