

Outcome of multimodal cortical electrical Stimulation (CES) in pre-surgical evaluation for medically refractory focal epilepsies: A single UK centre experience

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Introduction

CES is used to facilitate functional mapping during pre-surgical evaluation in patients with medically refractory epilepsy. Resection of the epileptogenic zone is performed with the ultimate aim of stopping clinical seizures. Occasionally, the epileptogenic zone may lie in or near to eloquent cortex in which case it is important to ensure that the resection will not leave the patient with a functional neurological deficit. CES is performed either: (a) during an awake craniotomy or (b) during intracranial video telemetry (VT) recording.

CES has been performed in the Department of Clinical Neurophysiology since 2009 and is a resource intensive procedure, requiring involvement of a multi-disciplinary team and patient comfort, assurance and co-operation. Unsurprisingly, therefore, the provision of CES has financial implications on departmental and directorate budgets.

Results

Table 1: Departmental CES parameters vs published guidelines

Published CES parameters^{1,2}: an alternating (biphasic), bipolar, 50Hz current at stimulus duration of 2-5 seconds, pulse width of 300-1000µs, stimulus intensity of 1-5mA and stimulus interval of 10-20 seconds

Patient ID	Do departmental CES parameters comply with published guidelines for CES settings?											
	Polarity	✓ or ✗	Frequency	✓ or ✗	Form	✓ or ✗	Width	✓ or ✗	Intensity	✓ or ✗	Duration	✓ or ✗
1	Biphasic/Bipolar	✓	50Hz	✓	Square	✓	300 and 500	✓	1-10	✓	4	✓
2	Biphasic/Bipolar	✓	50Hz	✓	Square	✓	300 and 500	✓	3-8	✓	4	✓
3	Biphasic/Bipolar	✓	50Hz	✓	Square	✓	300 and 500	✓	1-10	✓	4-5	✓
4	Biphasic/Bipolar	✓	50Hz	✓	Square	✓	300 and 500	✓	3-7	✓	4	✓
5	Biphasic/Bipolar	✓	50Hz	✓	Square	✓	300 and 500	✓	2-5 and 10	✓	3-5 and 2-3	✓
6	Biphasic/Bipolar	✓	50Hz	✓	Square	✓	300 and 500	✓	7	✓	4-5	✓
7	Biphasic/Bipolar	✓	50Hz	✓	Square	✓	300 and 500	✓	3-7	✓	4	✓
8	Biphasic/Bipolar	✓	50Hz	✓	Square	✓	300	✓	2-7	✓	4	✓
9	Biphasic/Bipolar	✓	50Hz	✓	Square	✓	300 and 500	✓	2-7	✓	3-5	✓
10	Biphasic/Bipolar	✓	50Hz	✓	Square	✓	300 and 500	✓	10	✓	5	✓
11	Biphasic/Bipolar	✓	50Hz	✓	Square	✓	500	✓	7-10	✓	5	✓
12	Biphasic/Bipolar	✓	50Hz	✓	Square	✓	300 and 500	✓	3-10	✓	4-7	✗
13	Biphasic/Bipolar	✓	50Hz	✓	Square	✓	1000	✓	7-10	✓	4	✓

Figure 1: EEG/Clinical outcome from CES

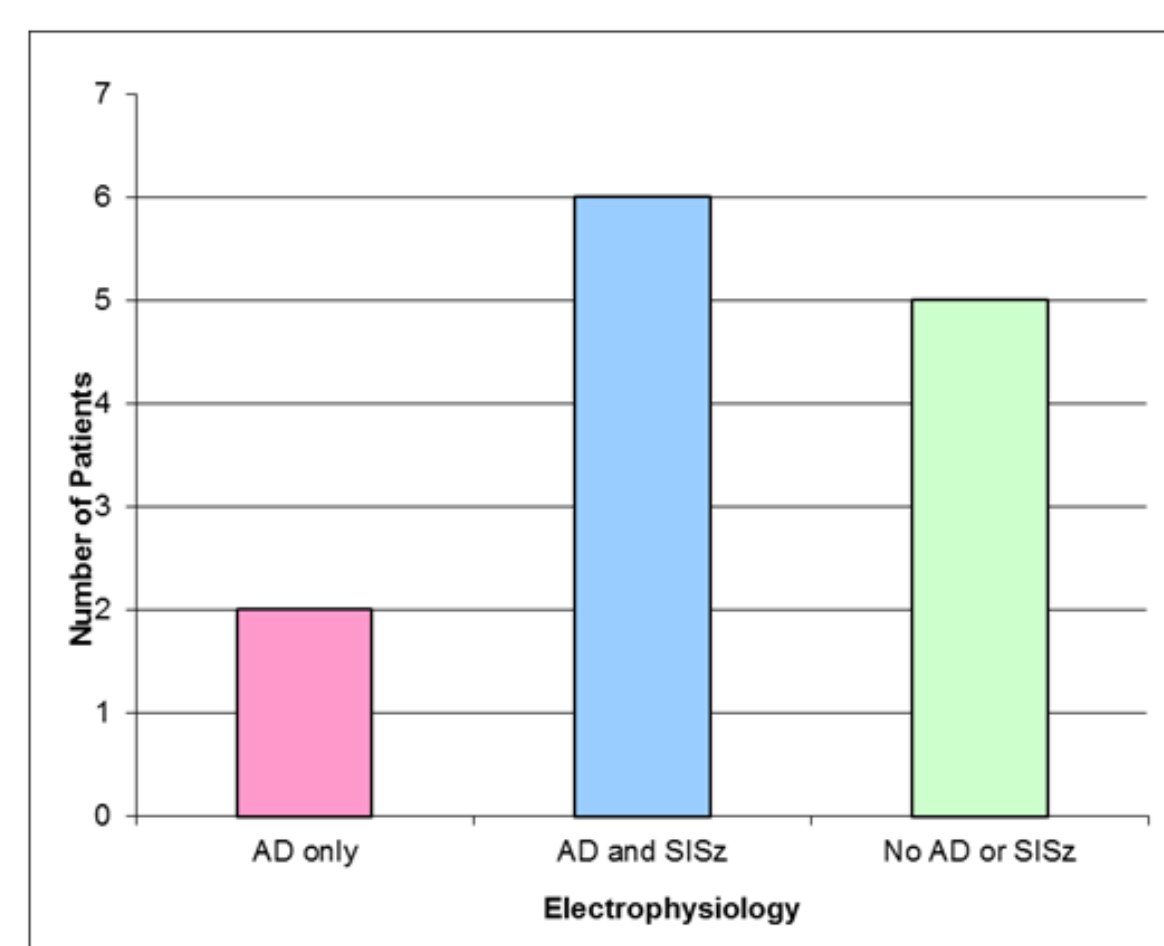


Figure 2: Eloquent cortical areas found during CES

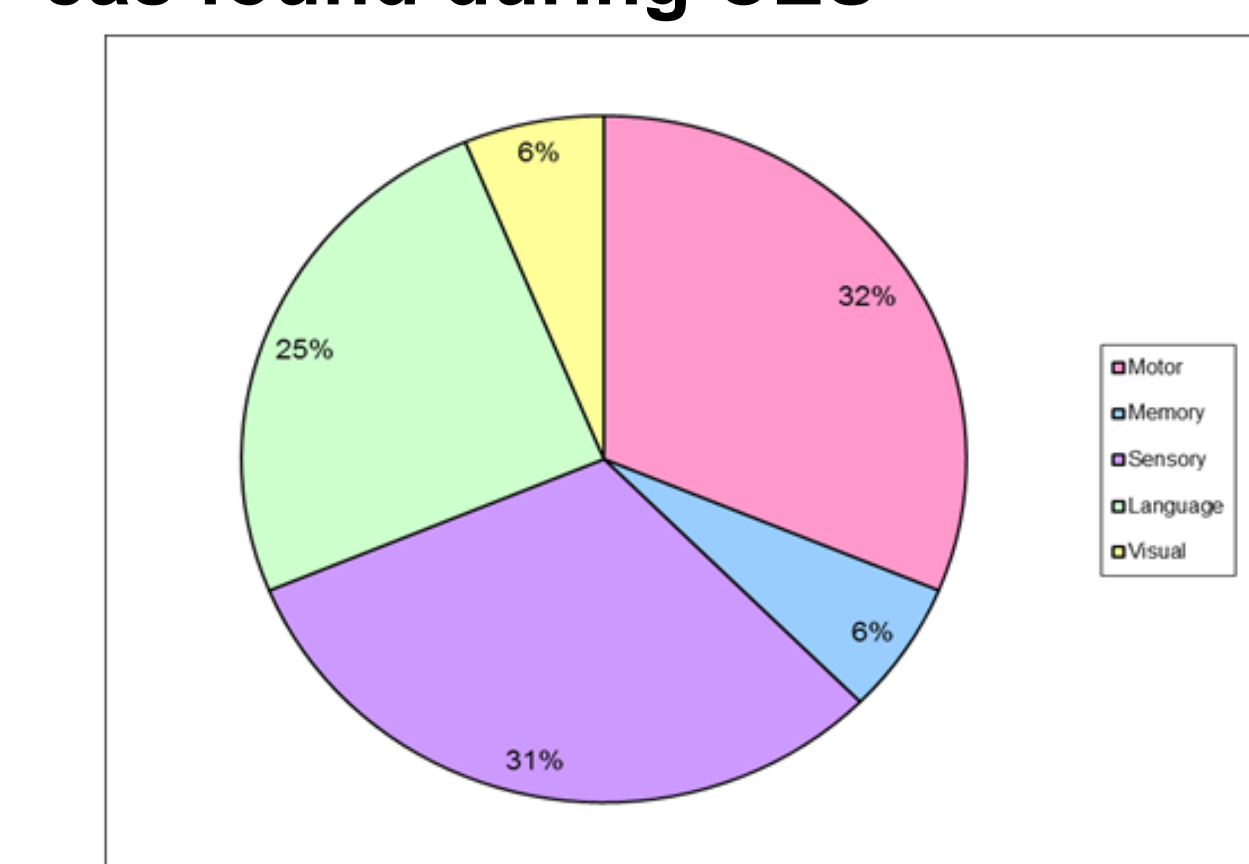


Figure 3: Stimulation induced sei

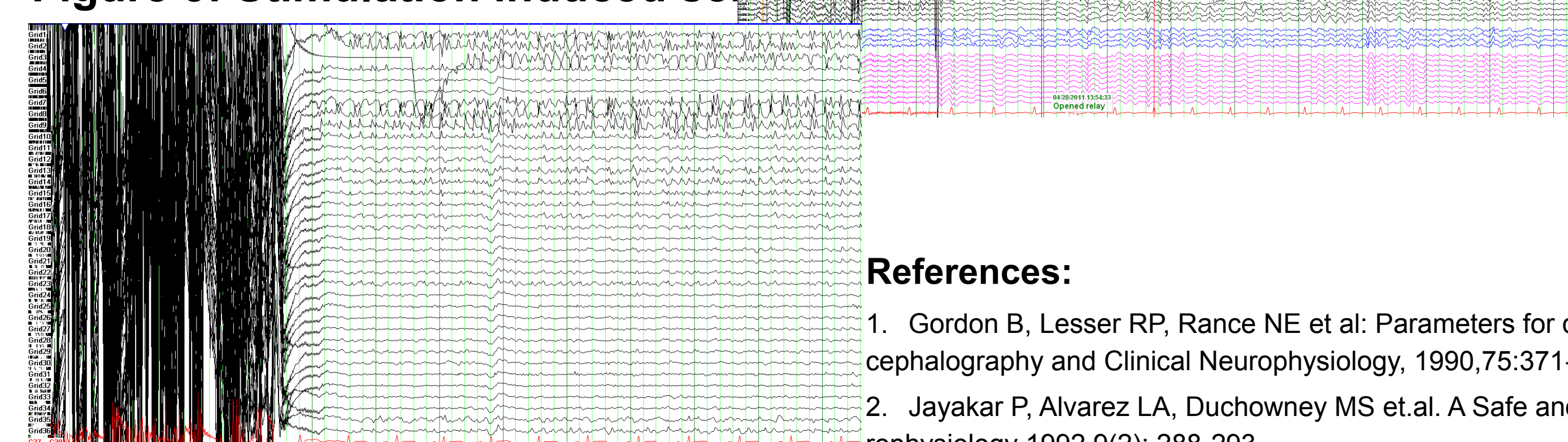
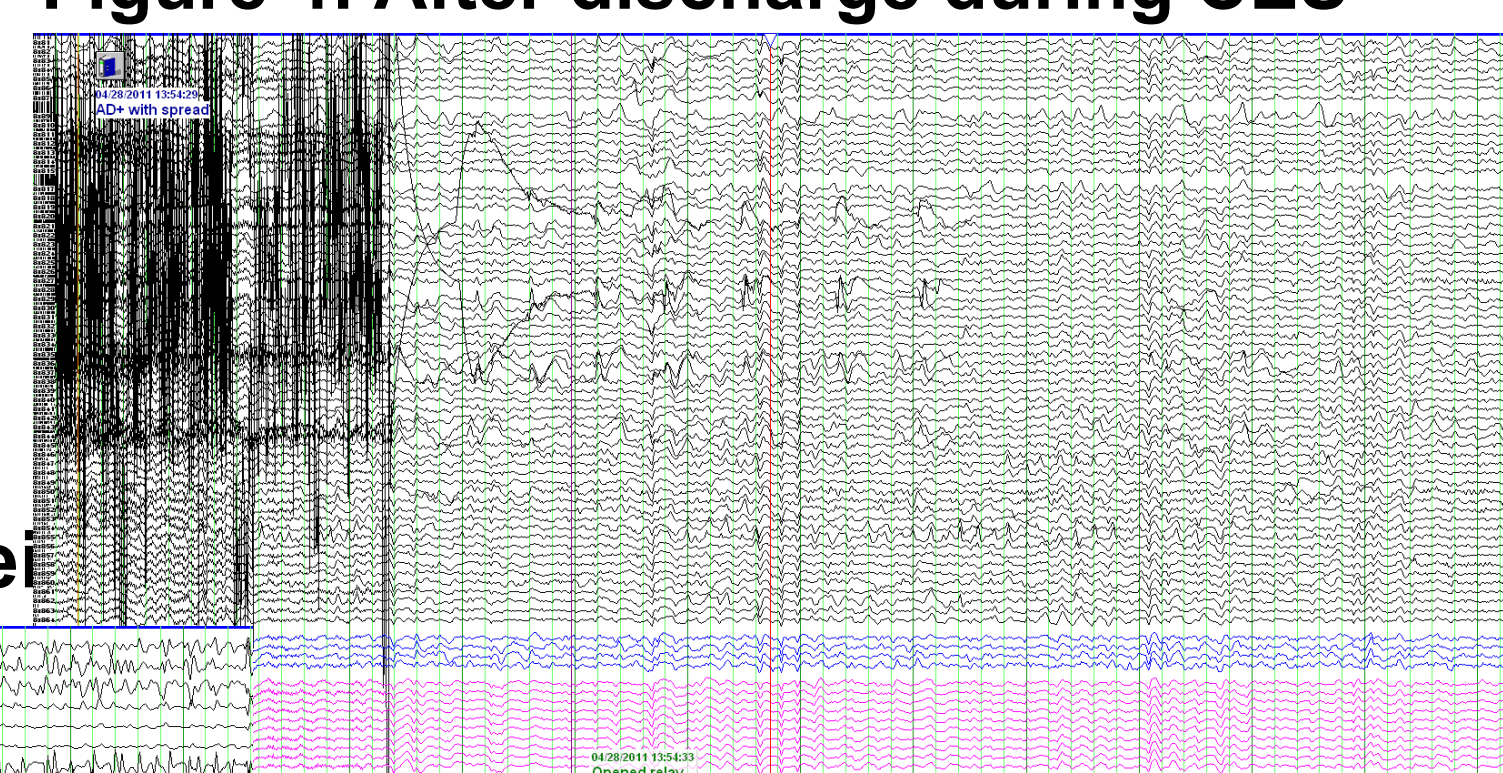


Table 2: Outcome from CES

Patient ID	CES Findings			Patient Experience		Outcome from CES
	Eloquent Cortex	After Discharges	Stimulation-Induced Seizures	Adverse Symptoms?	Comments	
1	Motor, sensory, language	Yes	Yes	No	N/A	Surgery
2	Motor, verbal memory	Yes	Yes	Yes	Tired; stimulation continued next day	Surgery
3	Language	Yes	No	No	N/A	Surgery
4	Motor, sensory	Yes	Yes	No	N/A	Surgery
5	Motor, sensory	Yes	Yes	No	N/A	Surgery
6	Language	Yes	No	No	Stimulation abandoned; eloquent cortex found	No surgery
7	Motor, sensory, language	Yes	Yes	No	N/A	No surgery
8	Sensory, visual	Yes	Yes	Yes	Found SISz unpleasant	Surgery
9	None	No	No	No	N/A	Surgery
10	None	No	No	No	N/A	Surgery
11	None	No	No	No	N/A	Surgery
12	None	No	No	No	N/A	Surgery
13	None	No	No	No	N/A	Surgery

Figure 4: After discharge during CES



Aims & Objectives

- (1) To evaluate the current departmental CES protocol, including comparison with published guidelines for CES
- (2) Assess the outcome of CES and its usefulness

Data Sample

- Consecutive sampling between 2009 and 2013
- Included all adult and paediatric patients undergoing CES during intracranial VT
- Sample size : 13 patients
 - : 10 males; 3 females
 - : 7 adults; 6 paediatrics

Summary

- (1) The results show that the departmental protocol for CES is consistent with published parameters.
- (2) CES was deemed useful in 100% of patients. The outcome contraindicated surgical resection in 15% of patients, thereby averting post-surgical neurological deficit. In the remaining 85%, the results supported surgical resection without residual functional deficit.
- (3) Multimodal CES helps to achieve positive clinical outcome in carefully selected patients with intractable focal epilepsies.

References:

- Gordon B, Lesser RP, Rance NE et al: Parameters for direct cortical electrical stimulation in the human: histopathologic confirmation. *Electroencephalography and Clinical Neurophysiology*, 1990,75:371-377.
- Jayakar P, Alvarez LA, Duchowney MS et al. A Safe and effective paradigm to functionally map the cortex in childhood. *Journal of Clinical Neurophysiology* 1992,9(2): 288-293.