Electrocorticography in the management of surgically treated epileptic patients

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ABSTRACT

Objective: To report our experience on 8 patients with mean age of onset of seizures of 8 years, who had intra-operative electrocorticography monitoring during the surgical treatment of their medically intractable partial epilepsy.

Methods: Post-resection electrocorticography grades were according to Jay et al and seizure outcome was a according to Kobayashi et al grades.

Results: Five patients had temporal lobe surgery and 3 patients had extra temporal surgery. Four patients had post-resection electrocorticography grade A (no residual epileptic activity), two of them had seizure outcome grade 1 (free of seizures) and the other 2 had grade 11 (free of seizures on medication). The other 4 patients had post-resection electrocorticography grade B (minimal residual epileptic activity) and all had seizure outcome grade 11 except one patient who had grade 111 (more than 50% reduction in seizure frequency).

Conclusion: Despite the small size of our study, our results suggest that intra-operative electrocorticography may be an important tool in the surgical management of medically intractable epilepsy.

Keywords: Electrocorticography, epilepsy surgery.

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Electrocorticography (ECoG) refers to acute recording of electrical activity directly from the cortical surface during the exposure in the course of surgical treatment of epilepsy.[1] It includes both pre and post- resection surveys.[2] Initial interests in ECoG started in 1940's.[1,2] Renewed interest in epilepsy surgery and use of different modalities of intracranial EEG monitoring have started in the 1980's.[1-5] Recent studies have emphasized the importance of intra-operative ECoG for the precise epileptic focus localization and good surgical outcome.[8,10-12] Tanaka et al stated that ECoG can improve the outcome of surgery for intractable epilepsy by localizing epileptic foci for resection.[10] The aim of our study is to report our experience on value of intra-operative ECoG monitoring during epilepsy surgery.

Methods. This is a retrospective study on 8 patients who had ECoG for the localization of the epileptic focus during the course of epilepsy surgery at Jordan University Hospital during the period of July 1994 - February 1999. All patients underwent pre-operative assessment according to the epilepsy surgery protocol of Jordan University Hospital which includes: patients with frequent seizures not less than one seizure per week not responding to at least 2 conventional anti epileptic drugs (AEDs) for 12 months, pre-operative and post-operative scalp electroencephalograms (EEGs) and video EEG (VEEG) monitoring in 6 cases. In cases ictal events were not recorded by VEEG, localized epileptic zone was documented in 2 separate scalp EEGs pre-operatively. Neuroimaging includes brain

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Table 1 - Clinical data and results of investigations on 8 patients who had intra-operative ECoG.

Case Number	Age (years) Sex	Seizures (O, TY, FR, PEEG)	Diagnosis	Procedure	Duration of Follow-Up (years)
1.	21 Male	11 CPS 3/week RAT	ganglioma	RT Lobectomy	4.5
2.	6 Female	0.5 CPS, SGS 1/day RFP	RF heterotopia	RF Lobectomy	3.5
3.	18 Male	15 CPS, SGS 3/week RAT	RT sclerosis	RT Lobectomy	1
4.	11 Female	10 CPS 1/day RPT	R low grade PT astrocytoma	Lesionectomy	1
5.	43 Female	22 CPS 4/day LAT	LT cortical dysplasia	LT Lobectomy	1
6.	21 Female	8 SPS, SGS 2/day LOc	LOc low grade astrocytoma	Lesionectomy	1
7.	20 Male	4 CPS, SGS 3/week LMT-LAT	LT sclerosis	LT Lobectomy	0.6
8.	4 Female	3.5 CPS 1/day LMT	LT sclerosis and calcification	LT Lobectomy	0.1

O	=	Onset	M	=	Middle
TY	=	Type	Oc	=	Occipital
FR	=	Frequency	T	=	Temporal
PEEG	=	Pre-operative EEG	F	=	Frontal
R	=	Right	SPS	=	Simple Partial Seizure
L	=	Left	CPS	=	Complex Partial Seizure
P	=	Posterior	SGS	=	Secondarily Generalized Seizure
A	=	Anterior			

computerized tomography (CT) and magnetic resonance imaging (MRI) (1.5 Tesla, T1 and T2 films). Protocol also includes pre-operative and post-operative psychological and ophthalmological assessments. Surgery was done under general anesthesia using isoflurane, fentanyl and nitrous oxide.13 Intra-operative pre-resection and post-resection ECoG monitoring was done using 23 SLE E9 flexible plate 15 electrodes and/or Ad Tech 4 and 6 electrodes strips according to the case except in patient 1 (Table 1). Pre-resection ECoG was used to delineate the margins of resection and post-resection ECoG was used again to detect any resectable epileptic focus and as a prognostic test to predict outcome. Post-resection ECoG was graded according to Jay et al: (A) no residual epileptiform

Table 2 - Results of pre-resection and post-resection ECoG and seizure outcome on 8 patients.

Case Number	Pre-resection ECoG	Post-resection ECoG**	Seizure outcome*
1.	+	A	1
2.	+	B	111
3.	+	A	1
4.	+	B	11
5.	+	B	11
6.	+	B	11
7.	+	A	11
8.	+	A	11

** = Jay et al grades (14)
* = Kobayashi et al grades (15)
+ = Epileptic focus identified

activity; (B) mild residual activity; (C) moderate residual activity; (D) unchanged from post-resection ECoG; and (E) undetermined due to drug effect.[14] The post-operative seizures outcome was graded according to Kobayashi et al: grade 1 (seizure free without AED), grade 11 (seizure free on AEDs), grade III (>50% reduction on seizure frequency), grade IV (<50% reduction in seizure frequency), grade V (not improved) and grade VI (worse).[15] Every patient was assessed at 1 month, 6 months and 1 year post-operatively by EEG studies and neurological evaluations. Follow-up MRI was done within 1 year post-operatively. Clinical follow-up ranged from 2 months to 4.5 years (Table 1).

Results. The clinical findings, diagnosis, surgical procedures and investigations are summarized in Table 1. Mean age of onset of seizures was 8 years (range: 0.5-22 years) and mean duration seizures of 9 years (range: 1-12 years). Neuroimaging demonstrated structural brain lesion in all patients. Scalp EEG Showed localized epileptiform focus corresponding to the structural brain lesion in all patients confirmed further by VEEG recording in 6 patients. Because scalp EEG did not demonstrate clearly the epileptic focus, patient 5 had subdural ECoG monitoring and patients 5 and 6 had sphenoidal electrodes monitoring to confirm further the epileptic focus. ECoG documented the pre-resection epileptic focus in all patients (Table 2). Post-resection grading according to Jay et al was ECoG grade A in 4 patients and ECoG grade B in the other 4 (Table 2) (Figure 1). Patients who had ECoG grade A had seizure outcome grade 1 in 2 patients and grade 11 in the other 2. Those who had ECoG grade B had seizure outcome grade 11 except one

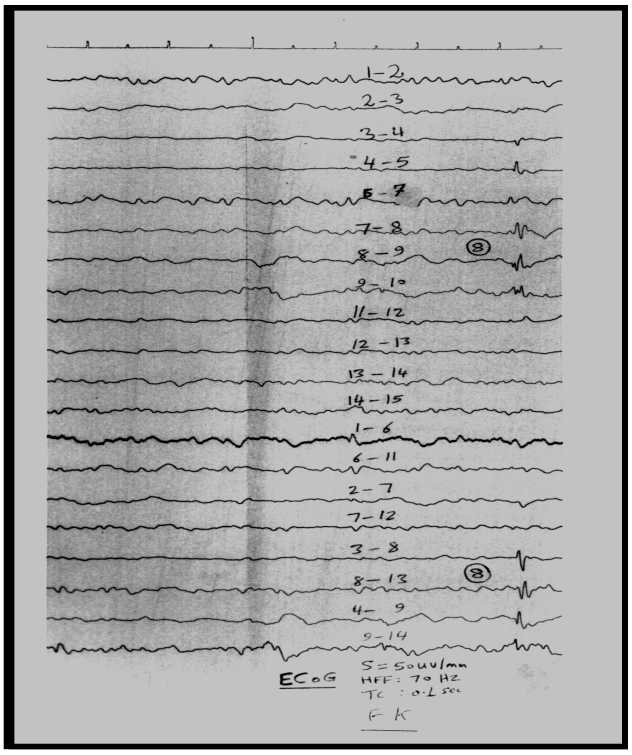

Figure 1a - Pre-resection intra-operative ECoG showing the epileptic focus at electrode 8 on patient.

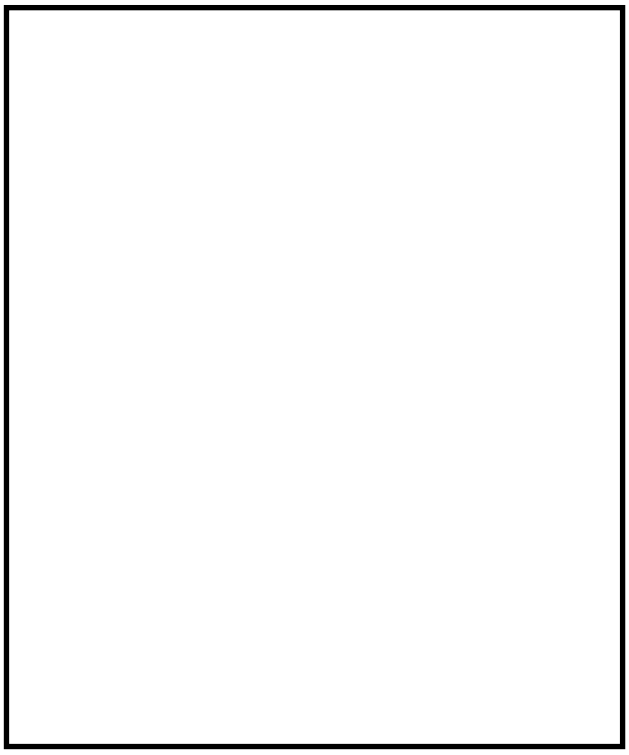

Figure 1b - Post-resection ECoG from the margin of the resection showing no residual epileptic activity on the same patient.

patient (Table 2). In patient 2 who had grade 111 seizure control, complete resection could not be done because epileptic activity involved the motor area. In patient 5 post-resection ECoG from the margin of the resection showed no residual epileptiform activity, however, an unresectable inactive epileptic focus in the posterior aspect of superior temporal gyrus was documented (Figure 1). In patients 7 and 8 however, follow-up was less than one year (Table 1).

Discussion. Surgical treatment of medically intractable epilepsy has gained a lot of momentum in the past 2 decades.[2,4,8,9] The experience on this modality of treatment using intra-operative EEG monitoring is still limited in the Arab World. We published the first report using ECoG during the course of surgical treatment of Sturge-Weber disease in 1993.[12] The present study has shown seizure free rate (grade 1 and 11) of 87.5% using ECoG monitoring during the course of epilepsy surgery. Two patients in our study were free of seizures without AEDs and had post-resection ECoG grade A. Five other patients had seizure outcome grade 11 and their post-resection ECoG was grade A (n=3 Table 2). Tanaka et al reported 17/20 patients (85%) benefited from epilepsy surgery using intra-operative ECoG. Thirteen of them had post-resection grade A, 2 patients had grade B and 2 patients had grade C.[10] Studies on children and adults have shown 60-80% seizure free rate of medically intractable temporal lobe epilepsy after epilepsy surgery.[2,3,5,10,14,16-21] Drake et al reported 16 surgically treated patients who had mass lesions in the temporal lobe. Nine patients were free of seizures with 4 of these 9 still on medication after one year, the other 7 patients had more than 50% reduction in frequency of seizures.[5] Silvenius reported that results were following temporal lobe excision, with 68% of patients becoming seizure free and 24% having an improvement. Extra temporal surgery results in 45% of patients seizure free and 35% improved.[22] Our study has shown that 5 patients had temporal surgery with grade 1 seizure outcome (n=2) and grade 11 (n=3) and 3 patients had extra temporal surgery, 2 of them had seizure outcome grade 11 and the third patient had grade 111 outcome (Table 1 and 2). Despite the small size of our study, our results were promising and comparable to other studies.[2,3,10,23] To conclude, our study was small but results were encouraging and showed that ECoG may improve outcome of surgery for intractable epilepsy by localizing precisely the epileptic foci for resection. A prospective study with larger number of patients is required to reach into definite conclusions.

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References

1. Daley DD, Pedley TA. Current practice of clinical EEG, second edition, Raven press Ltd., New York 1990; 535
2. Ojemann GA. Surgical therapy for medically intractable epilepsy. J Neurosurg 1987; 489-499.
3. Green RC, Adler JR, Giuseppe E. Epilepsy surgery in children. Journal of Child Neurology 1988; 3: 155-165.
4. Holmes GL. Intractable epilepsy in children. Epilepsia 1996; 37 (Suppl): 314-327.
5. Drake J, Hoffman HJ, Kobayashi J, Hwang P, Becker LE. Surgical management of children with temporal lobe epilepsy and mass lesion. Neurosurgery 1987; 21: 792-797.
6. Weiser HG. Epilepsy surgery. Bailliers Clinical Neurology 1996; 5: 849-875.
7. Ojemann GA. Treatment of temporal lobe epilepsy. Annu Rev Med 1997; 48: 317-328.
8. Malla BR, Obrien TJ, Cascino GD, SO EL, Radhakkrishnan KK, Silbert P, Marsh WR. Acute postoperative seizures following anterior lobectomy for intractable partial epilepsy. J Neurosurgery 1998; 89: 177-182.
9. Boling W, Olivier A. The current state of epilepsy surgery. Current Opin Neurol 1998; 11: 155-161.
10. Tanaka T, Hashzume K, Kunimoto M, Yonemasu Y, Chiba SH, Oki JI. Intraoperative electrocorticography in children with medically intractable epilepsy. Neurol Med Chir (Tokyo) 1996; 36: 440-446.
11. Engel J Jr, Van Ness P, Rasmussen T, Ojemann L: outcome with respect to epileptic seizures, in Engel J Jr (ed): surgical treatment of epilepsies, New York, Raven Press 1993: 609-621.
12. Tamimi A, Al-Qudah AA, Tamimi S, Ghanem S. Sturge-Weber disease without nevus, Jordan Medical Journal 1993; 27: 96.
13. Meyer FB, Marsh WR, Laws ER, et al. Temporal Lobectomy in Children with epilepsy. J Neurosurg 1986; 64: 371-376.
14. Jay V, Becker LE, Otsubo H Hwang PA, Hoffman HJ, Harwood-Nash D. Pathology of temporal lobectomy for refractory seizures in children. Review of 20 cases including some malformative lesions. J Neurosurg 1993; 79: 53-61.
15. Kobayashi J, Wong A, Hwang P, et al. Surgery for intractable seizures in infants and children. Canadian J Neurol Sci 1985; 12: 178.
16. Falconer M. Significance of surgery for temporal lobe epilepsy in childhood and adolescence. J Neurosurg 1970; 33: 233-252.
17. Fish D, Smith S, Quesney L, Anderman R, Rasmussen T. Surgical treatment of children with medically intractable frontal or temporal lobe epilepsy: Results and high lights of 40 years experience. Epilepsia 1993; 34: 244-247.
18. Patrick S, Berg A, Spencer SS. EEG and seizure outcome after epilepsy surgery. Epilepsia 1995; 36: 236-240.
19. Kellett MW, Smith DF, Baker GA, Chadwick DW. Quality of life after epilepsy surgery. J Neurol Neurosurg Psychiatry 1997; 63: 52-58.
20. Pilcher WH, Silbergeld DL, Berger MS, Ojemann GA. Intraoperative electrocorticography during tumor resection: impact of seizure outcome in patients with gangliomas. J Neurosurg 1993; 78: 891-902.
21. Mahera T, Shimiz H, Oda M, Arai N. Surgical treatment of children with medically intractable epilepsy. Outcome of various surgical procedures. Neurol Med Chir (Tokyo) 1996; 36: 305-309.
22. Silvenius H. Latest advances in epilepsy surgery. Acta Neurol Scand 1995; 162 (Suppl): 11-16.
23. Rasmussen T. Localization aspects of epileptic seizure phenomena, in Thompson R, Green J(eds): New perspective in cerebral localization. New York: Raven Press 1982: 177-203.