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Electroclinical Profile and Outcomes in Extratemporal Lobe Epilepsy Surgery Based on Intraoperative Electrocorticography

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ABSTRACT

Objective: To present pre and postsurgical electroclinical profile in extratemporal lobe epilepsy patients (ExTLE). Thirty-one patients with pharmacoresistant Ex TLE underwent comprehensive presurgical evaluations including multimodal neuroimaging as well as surgical resective and/or disconnective procedures tailored by sequential intraoperative Electrocorticography (ECoG). Postsurgical electroclinical outcome assessment for each patient was carried one year after seizure. During presurgical evaluation, the majority of seizure types were aware and non-aware focal seizure, which in some cases, evolved to bilateral tonic clonic seizures. Ictal EEG pattern was unilateral in 71.4 % of the subjects tested, and regional in 82.3 % of the cohort. Magnetic Resonance Imaging (MRI) did not indicate a distinct lesion in 51.6 % of the cases. In the latter group, subtraction of ictal and interictal SPECT co-registered with MRI (SISCOM) and ictal Electroencephalography (EEG) source imaging (ESI) allowed to estimate the epileptogenic zone. Resective surgical techniques were performed in 51.6% of the group followed by combined procedures in 45, 1 % of the patients. Frontal and occipital resection was the most common techniques. Furthermore, surgical resection encroaching upon eloquent cortex was accomplished in 43 % of the ExTLE patients. After one- year follow up, 54.8 % of the cases were categorized as Engel class I-II. Patients with satisfactory seizure outcome showed lower absolute spike frequency in the intraoperative preresection ECoG than those with seizures recurrence, (Wilcoxon Matched pairs test, p=. 0,001). The present study focuses on intraoperative ECoG and its utility in epilepsy surgery along with multimodal presurgical evaluation based on data derived from Video EEG, neuroimaging; particularly SISCOM and ESI, in subjects with pharmacoresistant extratemporal lobe epilepsy .

INTRODUCTION

Extratemporal lobe epilepsy (ExTLE) embraces a variety of seizures which can arise from the cerebral cortex outside of the temporal lobe [1]. Thus, epilepsy surgery constitutes an effective treatment for carefully selected patients with pharmacoresistant extratemporal lobe epilepsy, even when the outcomes of surgical treatment in ExTLE are less satisfactory compared to temporal lobe epilepsy [2,3]. Surgical treatment of ExTLE is still challenging due to hitches in defining the

epileptogenic zone. Nonetheless, current advances in noninvasive techniques such as epilepsy specific Magnetic Resonance Imaging (MRI) and functional neuroimaging - Single Photon Emission Computed Tomography (SPECT) and Positron Emission Tomography (PET) - have improved the diagnostic tools of ExTLE, facilitating surgical treatment [4-6]. Equally, intraoperative electrocorticography (ECoG) may provide significant information concerning electrographic activity modifying the resection extention [7]. Apart from the ambiguity regarding the choice of the most prospective candidates, surgical treatment of extratemporal epilepsies remains with difficulties in localizing and defining the extension of the epileptogenic zone. This paper summarizes the electroclinical pre and postsurgical assessment in both extratemporal lesional and non lesional lobe epilepsy patients, including presurgical multimodal neuroimaging as well as surgical resective and/or disconnective procedures tailored by sequential intraoperative ECoG.

SUBJECTS AND METHODS

Patients with pharmacoresistant epilepsy were referred from all regions of the country. Candidates were required to be non-responsive to at least two appropriate Antiepileptic Drugs (AEDs) trials due to inefficacy and intolerance; hence, recurrently compromised by seizures [8]. Family and patient´s consent was received in all cases. Subjects submitted to ExTLE epilepsy surgery with one-year follow-up after surgical procedures were included in this communication whereas those with prior brain operation were left out.

Presurgical evaluation included (a) prolonged Video-Electroencephalography (VEEG) monitoring with scalp electrodes and additional electrodes considering the epileptogenic zone presumed; (b) Magnetic Resonance Imaging (MRI) scans with a 1.5 T or 3T scanner (Siemens Magnetom Symphony); (c) a comprehensive battery of neuropsychological tests (executive functions, attention assessment and memory, higher verbal and visual functions) and; (d) multimodal evoked potentials, somatosensory, visual and auditive [9-11]. Interictal and ictal brain single photon emission computed tomography with EEG coregistration was also carried out in patients with non-visible lesion in MRI. Additionally, MRI post processing was performed in these patient group in accordance with our previously published protocol [10].

Video EEG - based diagnostics

Patients underwent Video-EEG monitoring for 8.7 ± 2.7-day range (1-18 days). The distribution of Interictal Epileptiform Discharges (IEDs) during prolonged video-EEG monitoring was assessed by (LM) analyzing fifteen- minute-interictal EEG samples every one hour. The data recorded in relation to events was identified by button presses or by seizure or spike detection programs. Furthermore, interictal epileptiform activity and ictal onset pattern were categorized as (1) regional involving one lobe, and ipsilateral contiguous or (2) non-regional. Ictal and interictal Video-EEG were examined by a highly qualified epileptologist involved in this study (LM). One year following surgery extracraneal prolonged EEG was also recorded.

Presurgical - neuroimaging - based diagnostics

Presurgical 1.5 (n= 13) or 3T (n = 18) MRI scans of the patients integrating T1- weighted images with and without gadolinium-DTPA, T2-weighted images, fluid- attenuated inversion recovery images and magnetization-prepared rapid gradient echo sequences were reviewed by a versed neuroradiologist (ZH).

Besides, MRI findings were classified as (1) MR visible / MR non-visible; (2) tumor, cortical development malformation, vascular and others; (3) eloquent cortex / non-eloquent adjacent to or overlapping with eloquent areas -the primary motor cortex or Broca's area, sensorial, language- based on anatomic landmarks; and (4) laterality- dominant hemisphere / non-dominant. Eloquent cortical areas were designated according to Chang et al ´s classification, which comprised the rolandic cortex (pre- and postcentral gyrus), the supplementary motor area (SMA), insula, and primary visual cortex as well as Broca and Wernicke´s areas [12].

SPECT and SISCOM

A brain perfusion SPECT was carried out in patients with non lesional extratemporal epilepsy. SPECT image acquisition was performed using a double- headed gamma camera (SMV DST-XLi, Buc Cedex, France) equipped with a fan- beam collimator. For co-registration with the MRI scan, the cerebral surface of the MRI volume was segmented from the extracerebral structures. Subsequently, the cerebral surface of the binary ictal SPECT was matched to the cerebral surface of the binary MRI. The resulting transformation matrix was then applied to the

subtraction SPECT to co-register it to the cerebral surface of the MRI. Further, each patient underwent two studies (Ictal and Inter-ictal) of brain perfusion SPECT using 99mTc-ethylene-cysteine dimer (ECD). In both studies, the subject remained monitored by EEG during the administration of the radiopharmaceutical. For ictal SPECT, the radiopharmaceutical was injected when the EEG seizures onset was identified. For inter-ictal SPECT, the dose was administered with the patient at rest and with a seizure-free period of more than 24 h.

Inverse solution from Ictal EEG

The cortical generators of EEG measurements can be estimated by solving an inverse imaging problem where the unknown sources are distributed on an individual's cortex. The methodology followed in our study for the estimation of the inverse solution of ictal EEG was published by our group [10].

SURGICAL PROCEDURES AND HISTOPATHOLOGY

The extension of resection in lesional and non lesional patients was adjusted according to presurgical evaluation and tailored by sequential pre and post resection electrocorticography. ECoG data acquisition was performed with a Medicid-5 digital Electroencephalographic system (Neuronic SA, Cuba) made in our country using AD-TECH subdural electrodes (grid and strips). In the pre and postresection ECoG Absolute Spike Frequency (ASF) was calculated, as well as the ASF variation percentage. The accurate identification of lesion localization relative to eloquent cortex was derived from intraoperative ECoG using cortical mapping with evoked potentials and electrical stimulation. Additionally, subtotal resection was intentionally performed when the lesion overlapped with eloquent cortex.

Histopathological findings comprised four chief groups: cortical development malformations, neoplasms, vascular lesions, and other nonspecific histopathological abnormalities. In cases of mycroscopic diagnosis, and focal cortical dysplasia classification, the system proposed by the International League Against epilepsy was used [13]. For central nervous system tumor histopathological diagnosis purpose, the World Health Organization classification (WHO) was employed [14]. On the other hand, unspecific histopathological abnormalities included gliosis, scars, among others.

Neoplasms were categorized as glial tumors -astrocytomas, oligoastrocytomas, and oligodendrogliomas- and neuroepithelial tumors - gangliogliomas and Dysembryoplastic Neuroepithelial Tumors (DNT).

SEIZURE OUTCOMES

Subjects were routinely evaluated twelve months following surgery. Seizure outcome assessment was based on the system proposed by Engel. [Engel class I, free of disabling seizures; class IA, seizure-free; class II, rare seizures (less than three seizures per year); class III, worthwhile improvement (reduction in seizures of 80% or more); class IV, no benefit] [15]. Patients classified as Engel class I or II were categorized as satisfactory seizure outcome while those included in Engel class III or IV were labelled as unsatisfactory.

STATISTICS ANALYSIS

Indicators were summarized with descriptive statistics for each variable comprising mean, median, and standard deviations for continuous variables and frequencies for categorical ones. STATISTICA (data analysis software system), version 8.0, www.statsoft.com.Tulsa, USA). Mann Whitney and Wilcoxon tests were applied for independent and dependent samples respectively. Statistical significance was set at $p < 0.05$. In addition, logit regression was used for post- surgical evolution prediction. Exact p values generated for small to moderate samples were taken for significance evaluation.

ETHICAL CONSIDERATIONS

The procedures performed followed the rules of the Declaration of Helsinki for human research from 1975. This study was approved by the scientific and ethics committee of the International Center for Neurological Restoration (CIREN37/2012).

RESULTS

Presurgical profile

Thirty-one patients (26 males) were included in this study (Table 1). Mean age at surgery was 25, 4 years (standard deviation 8.4, range 11–47). Average epilepsy duration was 17.8 years (standard deviation 9.2, ranged 3–42). Mean age at seizure onset was 7.6 ± 5.8 (ranged 5 months to 21 yr.) Table 1, and presurgical seizure frequency was 20/months or more in 75 %. Risk factors were considered in 80% of the cluster.

All patients were taking 2-4 antiepileptic drugs (AEDs). Lamotrigine, Carbamazepine, Clonazepan, Valproic Acid, Clobazan and Levetiracetan were the most frequent prescriptions. The mean number of antiepileptic drugs at surgery time was 2, 87 ± 0.83.

Table 1: Demographic, clinical and surgery profile.

Age at surgery(y)	Seizure onset (y)	Epilepsy duration (y)	sex	Epilepsy type	Epilepsy surgery type	Histopathological findings	Postperative complications	Post-surgery outcome
25	9	16	F	LFE	L parietal lesionectomy	Tumor		satisfactory
21	2	19	M	LFE/NESz	R frontal lobectomy	FCD IIa		unsatisfactory
35	20	15	M	LFE	R frontal lesionectomy	Cavernous angioma		satisfactory
47	5	42	F	LFE	L occipital lobectomy	Tumor	woundinfection (T)	un satisfactory
22	4	18	M	LFE	R frontal lesionectomy	FCD IIb		satisfactory
20	3	17	M	NLFE	R frontal resection	Descriptive	meningitisdeepveinthrombosis (T)	un satisfactory
44	6	38	M	LFE	L occipital lesionectomy	Meningioangiomatosys	sensitivydysphasia(T)	satisfactory
24	5	19	M	N LFE	R orbitofrontallesionectomy	FCD I	sightlessness (P)	un satisfactory
27	18	9	M	LFE	R pericentrallesionectomy plus MST	FCD IIb	L moparesis (T)	satisfactory
21	8	13	M	N LFE	R orbitofrontalresection	FCD I		un satisfactory
17	14	3	F	LFE	R pericentral resection	FCD IIb	cranialnervepalsies(T)	un satisfactory
26	3	23	M	LFE	R frontal resection plus MST	FCD IIb		un satisfactory
16	4	12	M	Lennox Gastaut Syndromeplus focal lesion.	anterior callosotomy plus L frontal resection	FCD I		un satisfactory
38	8	30	M	LFE	R premotor frontal resection plus MST	Non usefultissue		satisfactory
22	9	13	F	LFE/NESz	R parietotemporallesionectomy	Tumor		satisfactory
29	14	15	M	LFE	R frontal lesionectomy plus disconnection	FCD IIb	Cerebrospinal fluid leak (T)	satisfactory
22	5	17	M	NLFE	R midlle frontal gyrustopectomy plus MST	FCD I		un satisfactory
29	11	18	M	NLFE	R frontal resection	FCD 1c		satisfactory
24	0	24	M	NLFE	R frontal lobectomy	Descriptive		satisfactory
24	15	9	M	NLFE	R frontal Resection plus anterior callosotomy	FCD IIa		un satisfactory
23	22	1	F	NLFE	L frontal resection plus anterior callosotomy	FCD IIa		satisfactory
32	25	7	M	LFE	R occipital lobectomy and posterior temporal topectomy	FCD IIb	visual fielddefects (P)	satisfactory
29	26	3	M	LFE	L frontal lesionectomy	FCD IIa		satisfactory
32	11	21	M	LFE	L frontal topectomy	FCD Ia	Hemiparesis (P)	un satisfactory
37	31	6	M	N LFE	R superior frontal gyrus resection and midllegyrustopectomy plus callosotomy	FCD Ia	disconnectionsyndrome (T)	satisfactory
19	19	0	M	LennoxGastautSyndrome	anterior callosotomy	No tissue	disconnectionsyndrome (T)	un satisfactory
21	3	18	M	LFE	L superior frontal gyruscorticectomy and midllegyrustopectomy	FCD Ic		satisfactory
18	10	8	M	NLFE	L parietal topectomyand posterior disconnection	FCD Ia		satisfactory
18	15	3	M	NLFE	L frontal gyruscorticectomy plus callosotomy	descriptive	disconnectionsyndrome (T)	un satisfactory
14	6	8	M	LFE	L frontal lesionectomy plus callosotomy	descriptive	epidural hematoma (T)	satisfactory
11	10	1	M	Lennox Gastaut Syndrome plus focal lesion	R occipital disconnection	*polymicrogyria*		un satisfactory

y: Year, F: Female, M: Male, NESz: Non Epileptic Seizures, NLFE: Non Lesional Focal Epilepsy, LFE: Lesional Focal Epilepsy, FCD: Focal Cortical Dysplasia, R: Right, L: Left, MST: Multiple Subpial Transection, T: Temporary, P: Permanent, satisfactory: Engel Class I or II, unsatisfactory: Engel Class III or IV.

Multimodal pre-surgical assessment

During extracranial Video-EEG monitoring a mean of 20.6 ±15.9 seizures per patient was recorded with a mean Video - EEG monitoring efficiency equal 0.77. Data about awake and sleep seizures day-to-day were 1.55 and 0.9 correspondingly. Regional interictal EEG pattern was recorded in 53.8 % of the patients while 74% exhibited non-lateralized or bilateral Interictal Epileptiform Discharges (IED). In contrast, ictal EEG pattern was lateralized in 71.4 % and regional in 82.3 % of the subjects. Most patients showed non-aware focal seizures which then changed to bilateral tonic clonic seizures, whereas aware focal seizures evolved to non-aware or bilateral tonic clonic seizures. Non-epileptic seizures were also reported in two of the patients besides epileptic seizures. Further, in 80.7% of the cases studied, generalized tonic clonic seizures were recognized.

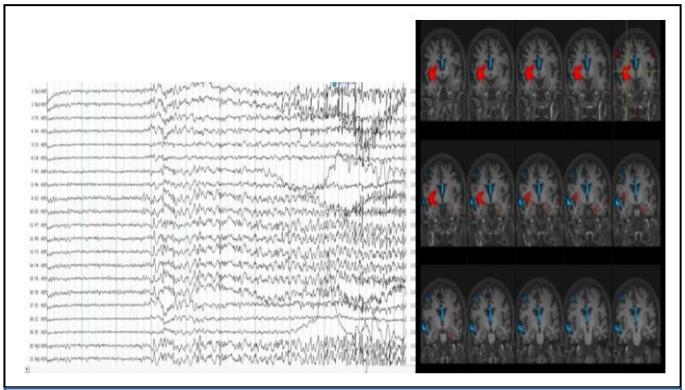

Figure 1: Multimodal evaluation in nonlesional extratemporal epilepsy patient. A. Ictal scalp EEG pattern at seizure onset during habitual non aware focal motor seizures which evolved to bilateral tonic clonic seizures. Visual EEG localization did not show a clear lateralized and localized seizure onset zone. B In red, computer- aided subtraction ictal SPECT coregistered to MRI (SISCOM) of the patient indicated localized areas of hyperperfusion (insula, inferior opercular frontal, putamen, amygdala, and anterior cingulum of the right hemisphere). In blue, estimation of ictal EEG source (ESI) discharges at seizure onset also demonstrated a localize ictal source in this patient (right middle frontal gyrus, right superior temporal and middle line).

Epilepsy surgery procedures and postsurgical profile

Regarding the surgical technique and the classification made taking into consideration whether they are resective, disconnective or combined. In the group of patients who underwent solely surgical resection, adjusted frontal lobectomy was the most common resection procedure (65.5%) as well as Magnetic Resonance Imaging did not indicate a distinct lesion in 16 patients (51.6%) - 11 of whom were submitted to a methodology combining non-invasive functional modalities Electroencephalography (EEG) and Single Photon Emission Computed Tomography (SPECT) to estimate the location of the Epileptogenic Zone (EZ) (Figure 1).

occipital and parietal. About 72 % of the surgeries was performed in non- dominant hemispheres whereas 43 % of the ExTLE patients undertook surgical resection encroaching upon eloquent cortex. Multiple subpial transection was done additionally to resection in eloquent areas in five of the subjects (three in frontal and two in pericentral cortex). In five of the cases both focal resection and anterior callosotomy were carried out. Three disconnective procedure one frontal and two occipital were also done (Table 1).

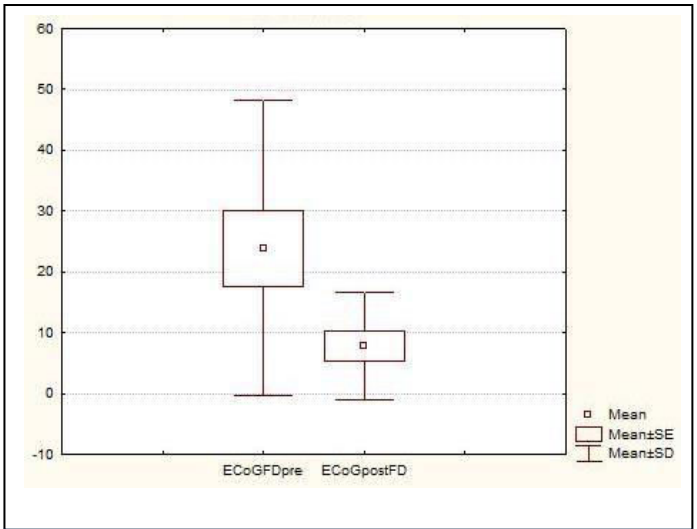

Figure 2: shows values of absolute spike frequency on the pre and postresection intraoperative Electrocorticography (mean and standard deviation SD) in extratemporal lobe epilepsy patients (p= 0,004892, Mann Whitney U test).

Postsurgical profile and Intraoperative ECoG

After one- year follow up, 17/31 (54.8 %) of the patients had a satisfactory seizure outcome (Engel class I-II). In this arm, the highest frequency was occupied by cases classified within class IA. All patients were submitted to pre resection and sequential postresection ECoG. Repetitive interictal spikes and other specific patterns were seen in 80, 6 %. Besides, the absolute spike frequency decreased significantly in the last post-resection ECoG, (Wilcoxon Matched pairs test, p=0,004) (Figure 2). Patients with a satisfactory seizure outcome showed a lower absolute spike frequency 3,50±3,82/min than patients with seizures recurrence 23,14±9,50/min, p=. 0,001 (Figure 3).

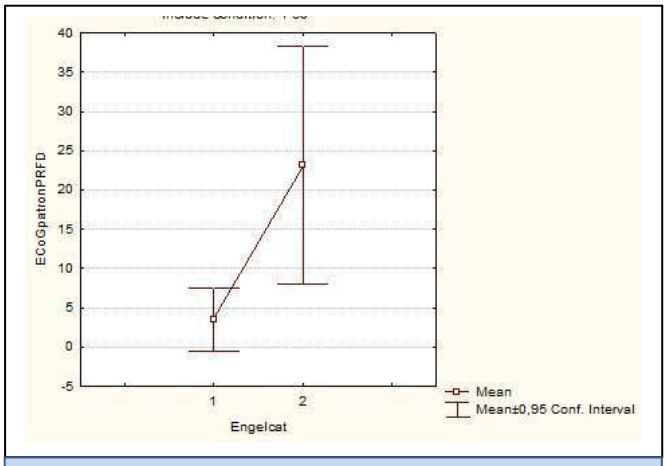

Figure 3: Illustrates values of absolute spike frequency on the preresection intraoperative Electrocorticography in extratemporal lobe epilepsy patients with satisfactory and unsatisfactory seizure outcome one year after surgery (mean and standard deviation SD) (p=. 0,001669, Mann Whitney U test).

Histopathological findings

As shown in Table 1, malformations of cortical development accounted for 75 % of all histopathological findings accompanied by neoplasms. There was similar proportion of patients with FCD type I (38%), and Type II (52 %), p=0.41. Neoplasms observed were glial tumors (astrocytomas, and neuroepithelial tumors (gangliogliomas and Dysembryoplastic Neuroepithelial Tumors [DNTs].

In the postoperative extracraneal EEG six months following surgery, there was residual interictal epileptiform activity in 55% of the operations performed. On the other hand, in the postsurgical IRM, 81, 2% of the individuals with lesional epilepsy showed complete resection. In our study, through multivariate analysis (Logit regression) both variables indicated a predictive value in seizure outcome, p=0.004 and p=0.01 respectively.

Operative complications

Permanent neurological morbidity was detected in three of the patients (9%), described as paresis, dysphasia, and sightlessness in one subject. As a whole, there was no mortality in our cohort see (Table 1) . One patient Engel Class I, died from cardiovascular disease fifteen months post-surgery.

DISCUSSION

The requirement for a resective surgical procedure to treat epilepsy is the presence of seizures that arise in a circumscribed area of the brain known as the epileptogenic zone, and the seizure semiology can provide important clues to their localization. Most of our patients exhibited non-aware focal seizures which then evolved to bilateral tonic clonic. During seizures, EEG pattern was lateralized in 71.4 % and regional in 82.3 % of the subjects. On the other hand, interictal EEG pattern was regional and non-lateralized in 53.8 and 74 % in that order. Evidence of focal seizure onset can also be derived from regional EEG slowing or spikes. Additional extremely suggestive, but not in itself conclusive, signs may come from the demonstration of a lesion on the patient's magnetic resonance scan.

There is indication that patients with a lesion in the MRI present the best seizure outcome after surgical procedure in temporal and extratemporal epilepsy. However, it is important to note that, in our series, half of the patients who had non lesional epilepsy were submitted to surgery without invasive EEG. Notably, intracranial EEG is often used to localize the area responsible for seizure, but as this technique is invasive it cannot sample the activity from the whole brain.

A multimodal evaluation, specifically the use of SISCOM and ESI, developed by our group facilitated attaining satisfactory outcomes without intracranial EEG. The brain perfusion ictal and interictal Single-Photon Emission Computed Tomography (SPECT) together with the subtraction of ictal and interictal SPECT co-registered with MRI SISCOM offer a high criterion of veracity in ictal onset detection represented by an increase in cerebral blood perfusion [10]. Previous studies have reported

a sensitivity of interictal SPECT of 44%, and ictal over 97% in temporal lobe epilepsy, contrary to a sensitivity of 66% in ictal and 40% interictal in extra-temporal epilepsy [5,6,10,11]. On the other hand, ESI allowed us to infer the configuration of neuronal sources responsible for ictal activity. A total of 11 non lesional epilepsy patients went through multimodal neuroimaging evaluation with SISCOM and ESI. Findings of both methodologies showed high relation with the resection zone in Engel I-II subjects. Recent progresses in neurophysiological techniques, structural MRI and advanced image analysis post-processing techniques, functional imaging Positron Emission Tomography (PET and SPECT co-registered to MRI), as well as functional MRI have not only significantly improved non-invasive presurgical evaluation, but also opened the choice of epilepsy surgery to patients previously not considered surgical candidates.

Notably, in our cohort, there was a similar proportion of non lesional and lesional epilepsy. In the latter group FCD was the most observable histopathological finding, with similar proportion between FCD Type I and Type II. Remarkably, FCD has been identified as a major cause of pharmacoresistant extratemporal resections, especially in children and adolescents [16-18], with a seizure free rate after resection between 52 to 68.9% [19-21].

As described in other studies, we found a relatively high incidence of FCD type I among operated patients with normal MRI [22-24]. In this framework, some authors have pointed out that even the invisible underlying pathology, namely FCD, may represent a favorable prognostic indicator in case of complete removal of the epileptogenioc zone when compared with all other etiologies [25-27].

In a recent extratemporal series, FCD accounted for 46.5% of all histopathological findings along with tumors, gliosis, and cavernomas [3]. Similarly, astrocytomes, gangliogliomas and DNTs were the tumors identified in our patients; being the latter, of the group of long-term - epilepsy - related tumors. With respect to histopathology, more favorable seizure outcomes have been described in patients with cavernomas and glioneuronal tumors (gangliogliomas and DNTs with 89% and 85% seizure-free (Engel I) patients, respectively. Consistent with previous information, 2/3 (66.6 %) our patients with tumor conditions remained seizure-free.

Even with the aforementioned histopathological profile, our seizure outcome is equivalent to other series. One year after surgery, 54.8% % of the extratemporal lobe epilepsy patients with lesional and non lesional epilepsy were categorized as satisfactory seizure outcome (Engel I-II class). Likewise, the surgical outcome in our cohort is also consistent with a large case series of surgery for extratemporal lobe epilepsies reported, in which 49% of the patients were Engel 1a at an average of 54 months postoperatively [3]. In Delev D ´s report, Engel I outcome after frontal and parietal resections was 65% and 71%, correspondingly, while other studies informed Engel I outcome ranging from 45.1% to 57.5% [28-30]. Our result is also in line with a meta-analysis described by Tellez-Zenteno et al and slightly better compared to other series [31-34].

Some specialists from developing countries involved in temporal and extratemporal epilepsy surgery have revealed Engel class I outcome in around 60 % at 12 months' follow-up. Other series have informed relatively stable Engel I rate over years in approximately 50% adults [33,35,36]. Equally, Vermeulen L have also stated good seizure outcome for at least one year at the last visit in 62 % for extra-temporal lobe interventions [37]. In general, between 70% and 80% of patients became completely seizure-free after temporal procedures, while 10% to 20% showed a significant reduction in seizure frequency. Nevertheless, extra-temporal procedures had somewhat lower success rates (medicina 2019 Andreas Schulze-Bonhage).

Most procedures carried out for extratemporal epilepsies were frontal resections [38], accounting for 65.5 % of our cohort; followed by occipital, parietal and pericentral resection, or combined with disconnection techniques. Comparable findings have been described in Delev D´s series, with 48% of frontal lobe operations, and 24% parietal, occipital, and insular resections [3].They also reported that the most positive epileptological outcomes were attained in individuals with frontal and parietal resections (Engel I 65.0 % and 71.4 %, respectively), in contrast to insular resections, revealing less auspicious results (Engel I 52.2 %). Outstandingly, such comparisons are limited by both referral patterns and selection criteria, which are likely to fluctuate from different centers in Latin American countries. In order to homogenize these criteria, our cases were discussed in an epilepsy surgery conference

including a multidisciplinary team of the epilepsy surgery program.

It is recognized that the success of epilepsy surgery depends upon accurate localization and complete resection of the epileptogenic tissue, which are both aided by intraoperative ECoG. A single operative procedure, with intraoperative electrocorticography implemented under the same general anesthesia as the resection, is often adequate, provided that the non-invasive EEG and MRI findings unequivocally show where the epileptogenic area lies [7]. The presence of persistent spikes on post-resection ECoG has been a significant statistical association with poor seizure freedom post-surgery [39]. This author concluded that the intraoperative ECoG is a valuable adjunctive test in epilepsy surgery to accomplish ideal seizure freedom in cases of mesial temporal sclerosis plus focal cortical dysplasia and tumors. In our study, a significant difference was observed between pre and post resection absolute spike frequency (ASF) during intraoperative ECoG.

In terms of complications, the rate is higher in extratemporal location compared to temporal resections with a reported perioperative mortality of 1.2 % in extratemporal resections [40]. Appreciably, permanent morbidity of extratemporal procedures varies in different series between 3 % and 43 %. The most frequent harms included visual field defects, hemiparesis, aphasia, as well as cranial nerve palsies. All types of neurological complication has been more commonly perceived among children, and after extratemporal procedures. There are other reports in which the neurological complications of resective surgery led to a temporary morbidity of 10.9% and a permanent morbidity of 4.7% [41-43]. In this study, there was no mortality, and permanent morbidities were observed in three of the cases (9%), regardless surgical procedures. Equally to Delev D´s series, we had no perioperative death; and permanent morbidity associated with surgical and neurological complications reached 9 % [3]. This number is similar to others reporting a permanent morbidity between 10% and 15 % [3,35,36,44].

Our results validate epilepsy surgery as an effective treatment for carefully selected patients with pharmacoresistant extratemporal lobe epilepsy. This study highlights intraoperative ECoG, and its usefulness in epilepsy surgery, in addition to multimodal presurgical evaluation based on data resulting from Video EEG, neuroimaging, especially SISCOM and ESI allowing to achieve durable seizure control in patients with pharmacoresistant extratemporal lobe epilepsy. However future investigations may be required in order to evaluate the predictive value of of the multimodal evaluation in ExTLE lobe epilepsy surgery [45,46].

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AUTHORS CONTRIBUTIONS

Dr. Lilia Morales was in charge of designing the project, analyzing the results, as well as writing the paper. All authors contributed to the work reported.

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