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Epilepsy surgery in the posterior part of the brain

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ABSTRACT

Posterior cortex epilepsy surgery is rarely performed and is associated with a high number of surgical failures, partly because accurate localization of the epileptogenic zone in the posterior part of the brain is extremely difficult.

We present the characteristics as well as the surgical outcome and its determinants of a cohort of 208 consecutive patients (adults/children: 125/83) operated on for drug-resistant posterior cortex epilepsy at the "Claudio Munari" Epilepsy Surgery Centre, Milan between May 1996 and May 2013 (mean postsurgical follow-up: 9.6 years). In addition, we highlight the differences in anatomoelectroclinical features and outcome between (i) patients who necessitated an invasive preoperative evaluation and those who proceeded directly to surgery and (ii) adults and children.

Mean age at epilepsy onset was 6.8 years (91.4% with onset before 14 years of age).

A high seizure frequency was reported by 51% of subjects, interictal and ictal EEG features were localizing in 16% and 28% of cases, and 86% of patients had a positive, judged as more or less informative, MRI. Invasive presurgical evaluation by stereoelectroencephalography was performed in 54% of patients; explorations may schematically be grouped in three main implantation patterns. Globally, 70% of subjects achieved seizure freedom, and further, 10% achieved Engel class II, with the patients operated on in childhood achieving significantly better postsurgical results in terms of seizure freedom and drug discontinuation.

Duration of epilepsy represented the most consistent predictor of surgical outcome, with early surgery being correlated with higher chances of surgical success. Therefore, we recommend an early surgical referral in cases of pharmacoresistant posterior cortex seizures. Furthermore, we suggest that surgical failure might be predicted very early, namely within the first 6 postoperative months.

We conclude that surgical management of posterior cortex epilepsy may attain excellent results.

1. Introduction

Posterior cortex epilepsies (PCE), namely the epilepsies originating from the parietal and occipital lobes and the parietooccipital borders of the temporal lobe, account for the minority of focal epilepsies [1].

Compared with temporal or frontal lobe resections, epilepsy surgery in the posterior part of the brain represents <10% of all epilepsy surgeries [2]. A main reason could be that the identification of the epileptogenic zone (EZ: the site of origin and of primary propagation of ictal discharges [3,4]) is particularly problematic in PCE because of rather nonspecific clinical seizure patterns [1,5–7].

Seizures that arise in the posterior cortex may propagate widely via multiple fascicular pathways resulting in clinical features more typical of secondary sites and be associated with a falsely localizing "pseudofocus" [8].

Furthermore, several studies have highlighted the poor lateralizing and localizing value of scalp EEG in PCE [6,9,10], related either to the rapid spread of the seizures originating from the occipital lobe to the neighboring regions [11] or to the fact that most of the occipital lobe is buried, making the identification and precise localization of interictal discharges challenging [12].

Moreover, a great number of the underlying lesions responsible for PCE are represented by relatively "restricted" ill-defined cortical dysplasia [13], which exhibit multifocal dysfunctional features and poorly delineated pathways [14] and might intersect with functionally eloquent areas.

In this regard, accurate localization of the EZ in the posterior part of the brain is extremely difficult, noninvasive information is frequently insufficient for surgical planning, and individually tailored surgery has more of a chance to be curative when guided by invasive investigation.

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In the present report, we present the longitudinal seizure outcome and its predictors in a large cohort of patients operated on in the posterior part of the brain for pharmacoresistant PCE at the "Claudio Munari" Epilepsy Surgery Centre, Milan. We also highlight the differences in anatomoelectroclinical features and surgical outcome between (i) patients who necessitated an invasive preoperative evaluation and those who proceeded directly to surgery and (ii) adults and children.

2. Patients and methods

We retrospectively analyzed a consecutive series of 1356 patients operated on for pharmacoresistant focal epilepsy between May 1996 and May 2013. All data were prospectively stored in an in-home relational database. Among these patients, 652 subjects underwent tailored resections confined in the temporal lobe; from the 704 remaining subjects, we selected the patients included in the present study on the basis of the following criteria: (i) surgical resection encompassing the occipital and parietal lobes separately, in combination and/or in association with the temporal lobe and (ii) at least 24 months of postoperative follow-up at the moment of the selection.

Two hundred and eight subjects were identified.

All subjects underwent to an individualized presurgical diagnostic protocol, including (i) video-EEG monitoring; (ii) high-resolution MRI with a dedicated protocol [15–17] and, when necessary, functional imaging; and (iii) neuropsychological evaluation with standardized tests applied according to the age of the patient.

In cases where noninvasive data were discordant or inconclusive with regard to the identification of the EZ, a SEEG evaluation was performed (SEEG methodology has been extensively described in previous contributions [16,17]). Postoperative seizure outcome was assessed according to Engel's classification [18].

Six months after surgery, all subjects had a first follow-up visit with EEG, MRI, and neurologic and neuropsychological evaluation; further follow-ups were repeated annually for at least 5 years.

For the purpose of the study, the following variables were analyzed in relation to the postoperative seizure outcome:

- age at epilepsy onset;
- age at surgery;
- duration of epilepsy;
- neurological examination: normal and pathological;
- seizure pattern: frontal, temporal, and spasms;
- presence of secondarily generalized seizures (SGS);
- presence and type of aura;
- complication with status: presence of at least one episode of status epilepticus within the year before the presurgical evaluation;
- seizure frequency: low (<8 seizures/month), mid (8–25 seizures/month), and high (>26 seizures/month);
- ictal and interictal EEG features, classified according to the distribution of the paroxysmal activity in (i) localized: location at no more than 2 contiguous electrodes, (ii) regional: involvement of multiple electrodes over the posterior quadrant, (iii) posterior bilateral: involvement of both posterior quadrants, (iv) only-lateralizing: involvement of multiple electrodes over one hemisphere, and (v) bihemispheric/diffuse: involvement of multiple electrodes over both cerebral hemispheres;
- preoperative MRI, classified as (i) negative: absolutely normal, (ii) suspicious: unclear/ill-defined alterations likely coherent with the electroclinical picture, (iii) positive lobar/sublobar: unique lesion confined within the anatomical limits of one lobe, (iv) positive multilobar: unique lesion extending over the anatomical limits of one lobe, and (v) positive multiple: multiple lesions;
- invasive presurgical evaluation by SEEG;
- type of surgery: corticectomy, lesionectomy, and disconnection;
- localization and extension of surgical resection: O: occipital, P: parietal, PT: parietal–temporal, OP: occipital–parietal, OT: occipital–temporal, OTP r: restricted occipital–temporal–parietal resection, i.e., encompassing limited areas in the temporal and/or parietal cortex adjacent to the occipital lobe, and OTP e: extended occipital–temporal–parietal resection;
- histological result: focal cortical dysplasia [19,20], tumor lesions, gliosis and nonspecific changes, and other pathologies;
- presence of acute postoperative seizures (APOS), defined as ictal events with the exception of auras occurring within the first postoperative week [18]; and
- postoperative seizure pattern: (a) complete absence of seizures from surgery (auras allowed); (b) progressive reduction of seizures until disappearance (running-down pattern); (c) reappearance of seizures within the first 6 postoperative months (early-recurrence pattern) — in patients with APOS, the timing of the first seizure occurring beyond the first postoperative week was considered as the timing of recurrence; (d) reappearance of seizures after 6 postoperative months of seizure freedom (late-recurrence pattern); (e) consistent reduction in frequency but persistence of seizures; and (f) no modification in seizure frequency [21].

Statistical analysis was performed to investigate the variability of seizure outcome, which was categorized as a dichotomous variable: Engel class I versus Engel class not-I (classes II–IV).

The Kruskal–Wallis rank-sum test was used to analyze numerical variables, and the Fisher two-tailed exact test was applied to analyze categorical (binomial or multinomial) variables. An initial bivariate analysis identified potential prognostic factors. Binary logistic regression analysis was then used to define the associations between a dichotomous dependent variable and a set of independent variables. The dependent variable was Engel class I, and the statistically significant preoperative patient-related variables were used as predictors. A backward stepwise logistic regression analysis was performed using IBM SPSS Statistics 22, with inclusion ata probability value of 0.05 and exclusion at 0.10. We used the logistic regression coefficients of the explanatory variables to estimate ORs with CIs.

3. Results

The anatomoelectroclinical features of our series of 208 subjects are summarized in Table 1.

Mean age at epilepsy onset was 6.8 years, with 91.4% of patients presenting with seizure onset before 14 years of age.

Thirty-nine subjects exhibited neurological impairment consisting in hemiparesis of variable severity for 17 subjects, dyspraxia for 6, and minor neurological signs for a further 4 subjects; 20 patients (17 children) presented an oculomotor deficit, mainly consisting in convergent strabismus of the eye contralateral to the epileptogenic side, and 38 patients presented a more or less clinically significant visual-field impairment. A formal perimetry evaluation of the visual field was not available for 21 subjects.

Frontal and temporal seizure pattern concerned an equal proportion of patients while 10 children presented exclusively spasms. Aura, mainly of visual and somatosensory type, was reported by 66% of patients, 29% of whom reported multiple prodromal symptoms.

Eighty-six percent of patients had a positive MRI. One hundred and thirteen patients underwent surgery after a SEEG procedure (SEEG group, 54.3%), whereas 95 subjects proceeded to surgery without any invasive presurgical evaluation (non-SEEG group). Familial antecedents positive for epilepsy were found in 20% of the cohort and were almost equally distributed among the two groups, while personal antecedents concerned 32% of patients – mostly including perinatal hypoxic–ischemic insult (34 patients), maternal pregnancy complication characterized by threatened miscarriage (12 patients), and previous brain surgery (11 patients) – and prevailed slightly among the subjects undergoing of SEEG.