Epilepsy Research (2013) **105**, 245—249

journal homepage: www.elsevier.com/locate/epilepsyres

SHORT COMMUNICATION

Tracking the source of cerebellar epilepsy: Hemifacial seizures associated with cerebellar cortical dysplasia

Agustina M. Lascano[a], Alia Lemkaddem[b], Cristina Granziera[c], Christian M. Korff[d], Colette Boex[a], Benoit Jenny[e], Thomas Schmitt-Mechelke[f], Jean-Philippe Thiran[b,g], Valentina Garibotto[h], Maria Isabel Vargas[i], Karl Schaller[e], Margitta Seeck[a], Serge Vulliemoz[a,*]

[a] *EEG and Epilepsy Unit, Department of Clinical Neurosciences, University Hospitals and Faculty of Medicine of Geneva, Switzerland*
[b] *Signal Processing Laboratory (LTS5), Ecole Polytechnique Fédérale de Lausanne, Switzerland*
[c] *Department of Neurology, University Hospital Center (CHUV) and University of Lausanne (UNIL), Switzerland*
[d] *Pediatric Neurology, Child and Adolescent Department, University Hospitals and Faculty of Medicine of Geneva, Switzerland*
[e] *Neurosurgery, Department of Clinical Neurosciences, University Hospitals and Faculty of Medicine of Geneva, Switzerland*
[f] *Pediatric Neurology, Children's Hospital, Luzern, Switzerland*
[g] *Department of Radiology, University Hospital Center (CHUV) and University of Lausanne (UNIL), Switzerland*
[h] *Department of Nuclear Medicine, University Hospitals and Faculty of Medicine of Geneva, Switzerland*
[i] *Department of Neuroradiology, University Hospitals and Faculty of Medicine of Geneva, Switzerland*

Received 4 September 2012; received in revised form 29 November 2012; accepted 1 December 2012
Available online 1 February 2013

KEYWORDS
Subcortical epilepsy;
Diffusion spectrum MRI (DSI);
Electric source imaging (ESI);
Hemifacial spasms;
Gangliocytoma

Summary Traditionally, subcortical structures such as the cerebellum are supposed to exert a modulatory effect on epileptic seizures, rather than being the primary seizure generator. We report a 14-month old girl presenting, since birth, with seizures symptomatic of a right cerebellar dysplasia, manifested as paroxystic contralateral hemifacial spasm and ipsilateral facial weakness. Multimodal imaging was used to investigate both anatomical landmarks related to the cerebellar lesion and mechanisms underlying seizure generation. Electric source imaging (ESI) supported the hypothesis of a right cerebellar epileptogenic generator in concordance with nuclear imaging findings; subsequently validated by intra-operative intralesional recordings. Diffusion spectrum imaging-related tractography (DSI) showed severe cerebellar structural abnormalities confirmed by histological examination. We suggest that hemispheric cerebellar lesions in cases like this are likely to cause epilepsy via an effect on the facial nuclei through ipsilateral and contralateral aberrant connections.

* Corresponding author at: EEG and Epilepsy Unit, Department of Clinical Neurosciences, University Hospitals of Geneva, 4 Rue Gabrielle-Perret-Gentil, CH-1211 Geneva, Switzerland. Tel.: +41 22 372 83 52; fax: +41 22 372 83 40.
E-mail address: Serge.Vulliemoz@hcuge.ch (S. Vulliemoz).

0920-1211/$ — see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.eplepsyres.2012.12.010

Introduction

The so-called ''cerebellar epilepsy'' is a rare and debated entity. To our knowledge, only 20 cases presenting with hemifacial seizures related to cerebellar dysplastic lesions have been reported so far. Intralesional electroencephalographic recordings (iEEG) of ictal/interictal discharges and hyperperfusion observed on ictal single photon-emission computed-tomography (SPECT) within the cerebellum support the hypothesis of a cerebellar origin of epileptic seizures (Harvey et al., 1996). We here present the case study of an infant with a cerebellar lesion and contralateral hemifacial seizures, investigated using multimodal non-invasive functional and structural imaging techniques validated with subsequent intraoperative electrophysiology.

Case report

A 14-month-old girl was referred to the epilepsy unit for the evaluation of paroxysmal hemifacial contractions. She was born after a 38-week gestation by normal uneventful vaginal delivery. From the second day of life, she presented with paroxysmal episodes starting with hyperventilation, abnormal vocalization (groaning), followed by contractions of the left orbicularis oris and orbicularis oculi muscles, drooling, fixed gaze but no nystagmus. During most episodes, right sided-facial weakness and decreased movement of the right hemibody were observed. Post-ictally, she promptly recovered level of alertness and adequate response to stimulation. These episodes occurred spontaneously at a rate of at least 10—15/day during 60—180 s and were refractory to multiple antiepileptic drugs. She had global moderate developmental delay. Neurological examination showed mild hypotonia, predominant on the right hemibody, but deep tendon reflexes were present and symmetrical. She rarely smiled and played only upon stimulation. The remaining physical examination was unremarkable.

Structural brain MRI disclosed a 2.0 cm × 1.6 cm × 1.9 cm lesion located in the superior and medial portion of the right cerebellar hemisphere, extending to the right middle and superior cerebellar peduncle, suggestive of focal dysplasia or low grade tumour (Fig. 1A). This lesion appeared hyperintense on FSE-T2-weighted and FLAIR images and was not enhanced by gadolinium injection. Long-term video-EEG monitoring showed interictal right posterior slow waves and ictal right posterior rhythmic delta slowing, but no epileptiform discharges were observed. ^{18}FDG-PET performed during a cluster of frequent daily seizures, showed concordant ''ictal'' right cerebellar hypermetabolism (Fig. 1B) and ictal SPECT showed concordant hyperperfusion (Fig. 1C).

Additionally, high-resolution EEG recording was performed using a 256-electrode system. Given the absence of spikes, Electric source imaging (ESI) analysis was carried out on the EEG scalp voltage map at the 50% rising phase of the averaged right posterior slow waves ($N = 12$). A linear distributed inverse solution and the patient's individual brain were used (see Brodbeck et al., 2011 for methodological details). The maximum source was located in the right anterior quadrangular lobule of the cerebellum (Fig. 1D). In addition, we performed MRI tractography based on Diffusion Spectrum Imaging (DSI), a high angular resolution diffusion imaging technique that allows disentangling of crossing fibres and mapping of cerebellar white matter connections (Granziera et al., 2009). Technical details of acquisition and processing are detailed elsewhere (Lemkaddem et al., 2012). Tracts seeded from the middle cerebellar peduncle showed a connectivity pattern extending further than the visible lesion and affecting most of the ipsilateral cerebellar hemisphere, while climbing and parallel cerebellar fibres showed a normal anatomy in the contralateral side (Fig. 1E).

The infant underwent partial surgical resection of the lesion, sparing the middle and upper right cerebellar peduncle. Intra-operative electrophysiology included central scalp EEG, facial EMG electrodes and one depth electrode inserted into the lesion which showed pseudo-periodic 2 Hz epileptiform discharges. Despite lowering the level of anaesthesia, no ictal muscle activity could be recorded. Averaging of the simultaneously recorded scalp EEG centered on iEEG abnormalities showed predominantly left pericentral activity time-locked to the intralesional activity with a latency suggesting cerebello-cortical propagation (Fig. 2). Histology revealed a dysplastic gangliocytoma with a severe disruption of the cerebellar folia architecture. Post-operatively, the child quickly recovered to her pre-operative level. She has remained seizure-free for 8 months under the same antiepileptic treatment (oxcarbazepine 300 mg/d) showing mild developmental delay (moderate impairment of verbal abilities) and EEG normalization.

Discussion

In this patient, multimodal non-invasive imaging, including ESI, with subsequent invasive electrophysiology and post-operative outcome, give strong evidence of a cerebellar seizure onset and epileptogenic zone. Severely abnormal structural connectivity supports the hypothesis that aberrant connections between the lesion and the facial nuclei might play a role in this condition.

Since initial descriptions by Langston and Tharp (1976) in the mid-1970s, only rare isolated cases have reported the association of hemifacial spasms with cerebellar lesions in infants. Similar to previous reports, ictal SPECT and PET in our patient revealed focal hyperactivity within the lesion. However, SPECT and PET are only indirect measures of neuroelectrical activity and hyperperfusion could also affect areas of seizure propagation and, moreover, hypometabolism is typically more extensive than the seizure onset zone. Therefore, the concordance with source analysis of high density EEG, for the first time in a cerebellar epileptic focus, is of particular relevance (Fig. 1D). Intralesional EEG recordings (Delande et al., 2001; Harvey et al., 1996; Yagyu et al., 2011) have been performed in some cases and have shown direct correlation between intralesional rhythmic activity and ipsilateral hemifacial seizures (Yagyu et al., 2011). Furthermore, DSI tractography, portrayed an anatomical disruption at the lesion level (Fig. 1E) and of a major cerebellar fiber bundle: the middle cerebellar peduncle (MCP), as compared to the contralateral side. However, DSI was not able to reveal the superior and inferior cerebellar peduncles when seeding from deep cerebellar nuclei in both hemispheres, as opposed to tractography results