Bitemporal Lobe Epilepsy Versus Unitemporal Lobe Epilepsy

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Introduction

Temporal lobe epilepsy (TLE) is the commonest form of focal epilepsy syndrome ranging in surgical series, between 60 - 75% of patients operated on for drug resistant epilepsies (Blumcke et al., 2002; Lahl et al. 2003). Starting from the fifties, following Falconer’s observations (1964) and later on Margerison and Corsells (1966) neuropathological work, hippocampal sclerosis (HS) has been recognized as the most frequent pathological finding in TLE surgical series related to the so-called mesial temporal epilepsy and characterized by drug-refractory focal epilepsy, strong association with febrile convulsions (FC), complex partial seizures, anterior temporal interictal epileptic EEG abnormalities, anterior temporal interictal epileptic EEG abnormalities, anterior temporal interictal epileptic EEG abnormalities, and good post-surgical outcome (French et al 1993; Williamson et al 1993; Wiebe et al 2001). Almost 70% of patients with medically refractory temporal lobe epilepsy have MTLE-HS. Surgical therapy is often indicated for medically refractory temporal lobe epilepsy. Most evidence suggests that the best candidates for surgery are those subjects in whom all seizures originate from one side, and in whom all clinical, interictal EEG, neuroimaging, and neuropsychological findings are concordant with ictal onsets.

Controversy arises when evidence exists for bitemporal epilepsy, defined here as clinical seizures arising independently from both temporal lobes, based on scalp EEG (Holmes at al 2003). About 10-20% of all TLE patients suffer from bitemporal epilepsy (R.Kuba, I.Rektor: EJN 2003). Bitemporal lobe epilepsy is a particular group of focal epilepsy with a poor temporal lobe surgery prognosis. (Hirsch et al, 1991; Hufnagel et al,1994).

Clinical seizures semiology as assessed during prolonged video EEG monitoring can provide important information on the lateralization of the seizure onset. The distinction between uni and bitemporal patients seems to be important because in bitemporal disease a more rapid contralateral seizure spread with consecutive wrong clinical lateralization can be expected. In MTLE-HS the interictal EEG abnormalities are anterior temporal spikes and sharp waves, and these can be bilaterally independent in up to 1/3 of patients.

Clinical Criteria (Baumgartner; Neurology,1998; 50; 742-747)

Ipsilateral signs:
1. Unilateral upper extremity
2. Nonversive (early) head turning
3. Postictal nosewiping
4. Unilateral eye lid blinking

Contralateral signs:
1. Tonic dystonic posturing
2. Mouth deviation
3. Version, tonic position of the head and eyes
4. Postictal paresis

Dominant hemisphere:
1. Postictal dysnomia

Nondominant hemisphere:
Ictal speech

Sometimes we can find other clinical features: automatisms with preserved responsiveness, ictal vomiting/retching, ictal spitting, peri-ictal urinary urge, peri-ictal water drinking, postictal coughing, ictal smile, peri-ictal crying.

Seizures are classified clinically lateralized if at least one of the mentioned symptoms could be identified. If these ictal features are pointed to different sides or none occurred, seizures are regarded as not lateralized. Pataria showed that more than 70% of seizures could be lateralized and lateralization was correct in the unitemporal group, while in the bitemporal group, lateralization was possible in only 51.4% of seizures, and was correct in only 58.3% of them. (Pataria et al.1998)

Methods

Electroencephalographic markers of bitemporal affection

Prolonged surface (scalp) Video-EEG recordings are
used in presurgical evaluation often with additional electrodes. The most common additional electrodes are anterior temporal and sphenoidal.

**Bitemporal interictal spikes**

Interictal EEG abnormalities present in TLE are anterior temporal spikes and sharp waves. In about 30% of MTLE patients scalp EEG recordings fail to demonstrate an unambiguous unilateral onset, showing contralateral, bitemporal independent interictal discharges. “The degree of lateralization is defined as the number of IEDs originating from one hemisphere as compared with the total number of IEDs originating from both hemispheres. Epileptiform activity has often been considered “lateralized” in TLE by many investigators if more than 80-90% of the discharges originated from one temporal lobe”.

Bilateral IED are present in 20-35% of patients with TLE adding the difficulty in the lateralization of the side of the primary epileptic zone. The presence of bitemporal independent spikes does not necessary mean that the epilepsy arises from both sides. More than 70% of patients with bitemporal IED in the scalp EEG had predominant unitemporal seizure onset in several depth EEG studies. (Luders; 1995).

It has been shown that in patients with bitemporal spikes in surface recordings 44% of cases seizures recorded with depth electrodes, originated in only one TL and that in an additional 33% of cases more than 80% of seizures arose from one side. (So et al; Ann.Neurol.1989).

**Figure 1: Bitemporal IEDs**

**Bitemporal ictal EEG changes**

The ictal EEG consist of a characteristic unilateral 5-7 Hz rhythmic discharge and usually has lateralized features, with seizures originates from one temporal lobe.

On occasion seizures arise independently from both temporal lobes. Bilateral independent ictal patterns on surface EEG should always prompt the concern that both temporal structures are epileptogenic.

In about 3% of case with unilateral MTLE the ictal pattern is first seen in the contralateral TL on surface recording. In these cases invasive recordings are indicated. (Luders; 2000).

**MRI**

MRI is characterized by hippocampal atrophy in T1 and signal increase in T2 weighted images and FLAIR. MRI hippocampal atrophy determined by visual analysis or volumetric assessment has been shown to correlate well with the presence of MTS (Watson; Arch. Neurol. 1997) and is a predictive of good outcome after lobectomy. Less than 50% cell loss is difficult to recognize by visual analysis so quantitative cell counts may be necessary to document that the characteristic pattern of cell loss in hilus and CA1 in particular are greater than 30% which appears to be sufficient for diagnosis of this condition.

1. Unitemporal structural alterations
2. Bitemporal structural alterations
3. bilaterally symmetric hippocampal volume loss on MRI (volumetric studies).
4. bilaterally asymmetric MTS

**Figure 2:** a. BTLE- Bilateral Hippocampal Sclerosis; b. Left HS

**Functional methods**

Functional methods such as SPECT support the diagnosis of unilateral MTS with findings of interictal hypoperfusion and ictal hyperperfusion. The diagnostic value of interictal SPECT is very limited. It has 70% sensitivity compared to pathological findings with a specificity of only 36%. Ictal SPECT has a diagnostic sensitivity of 90% for TLE with specificity 77% always bearing in mind that ictal SPECT particularly if the injection is not achieved within the first 30 s after EEG onset may reflect only a spread pattern of the electrical activity.

PET shows unilateral decreased glucose metabolism interictally with a particularly high yields in TLE. The PET sensitivity is 84% with a specificity 86%. Bilateral temporal hypometabolism (BTH) is found in 10% of cases. (Blum et al; Epilepsia 1998)

In TLE symmetric or asymmetric BTH may indicate:

- bilateral independent seizure onset in 50% of pts
- Advanced stage of the disease process characterized by a break down of the inhibitory mechanisms in the contralateral hemisphere.(Koutramanadis et al; Neurology 2000).

Greater severity of the preoperative abnormality visualized by PET is associated with better postsurgical seizures control.

**Noninvasive neuropsychological evaluation** is
particulary valuable because it may:
- Predict memory function after temporal lobectomy
- Predict the localization of the epileptogenic zone.

Poor performance in verbal memory tasks is seen in patients with MTS of the dominant hemisphere whereas non-verbal visual spatial abilities are affected by nondominant hemisphere MTS.

Bilateral temporal dysfunction can result in poor memory functions in general (Schulz et al; Epilepsy Research 2001).

WADA Procedure- Intracarotid Amobarbital Procedure (IAP)
The intracranial amobarbital WADA procedure permits assessment of verbal and nonverbal memory function and language by selectively anesthetizing each hemisphere with intracarotid injection of a barbiturate. Poor performance after injection of the contralateral hemisphere is associated with good surgical result.

A difference > 4 points (22%) between both sides is defined as lateralizing sign. As a measure of total recognition memory, the total score for both sides is calculated. (Koutramanidis et al; Neurology 2000).

If neuroimaging reveals MTS not lateralized (bilateral), and independent seizure were recorded, and if functional imaging and neuropsychology suggests bitemporal disease then it must be presumed that the mesial structures in both temporal lobes are epileptogenic and even without invasive recordings no surgery is indicated.

Any way, when noninvasive studies remain nonconcordant or uncertain regarding the localization of seizure onset invasive studies such as those with depth electrodes are needed.

Invasive recordings:
1. FO electrodes technique
2. Subdural strip electrodes and subdural grids
3. SEEG

1. FO electrodes technique
Foramen ovale electrode recording technique was developed in Zurich 1983 (Wieser et al). The goal was to make less invasive and simplify the neurophysiologic part of the presurgical evaluation for candidates for selective amygdalohippocampectomy (AHE).

The nature of the FO electrode recording techniques implies that only restricted questions can be answered by this technique:
1. Do the seizure originate at the mesiobasal TL structure.

If yes:
a. Are they constantly lateralized
b. Whether the seizure is more anterior or more posterior.

FOE record only from MTL structures and the indication “par excellence” is determination of left or right mesial temporal onset.

FO Electrodes insertion
Commercially available FOEs with four contacts at 5 mm intervals are implanted percutaneously with the aid of a fluoroscope under light general anesthesia. Electrodes are positioned in such a way that the tip (contact 1) is located at the end of the ambient cistern with contact 4 placed just above the level of foramen ovale. A skull radiograph will confirm whether the FO implantation positions are adequate and bilaterally symmetrical.

The most reliable seizure onset pattern recorded with FO electrodes is the high –frequency low amplitude discharge pattern and the so-called hypersynchronous seizure-onset pattern, (Wieser et al). A very local decrement at the FO electrodes is the most frequently observed initial seizure pattern followed within 3-5 sec by a high-frequency discharges at the same localization.

Complications
1. temporary facial pain
2. hypoesthesia in trigeminal territory
3. temporomandibular joint dysfunction
4. retromandibular hematoma

In patients in whom the result of FO electrodes shows bilateral independent or nonlateralized ictal onset, further recordings with depth electrodes are needed.

SEEG
In the understanding of the “St. Anne” (Paris) school SEEG is the simultaneous recordings of surface and depth electrodes. Prior to electrodes implantation the brain and its vessels must be known in the stereotactic reference system. Depth electrodes are multicontact arrays with 5-18 contacts, MRI compatible, that are inserted into the brain through twist-drill holes under
stereotactic guidance. These are considered an effective means of studying deep epileptogenic foci.

**Subdural grids**

Subdural grids are most suitable to identify “eloquent cortex” and to differentiate these zones from the epileptic focus and to define the extent and distribution of neocortical epileptogenic zone within TL. Grids require large craniotomies (H.O. Luders Epilepsia 2000;41). Subdural trips are used when less crucial areas are investigated.

**Conclusion(s)**

**Predictive features for surgical outcome:** Patients with independent ictal discharges has been shown to have an unfavorable surgery outcome. Concordance of interictal, ictal EEG and MRI is well correlated with favorable surgical outcome. When none of the non-invasive features are concordant with side of surgery independently of results from intracranial EEG, there is a poor surgical outcome. (Holmes et al; Epilepsia 2003). If neuromaging reveals bilateral MTS nonlateralized, independent seizures are recorded and if functional imaging and neuropsychology suggest bitemporal disease then it must be concluded that the mesial structures in both temporal lobes are presumably epileptogenic. In this case even without invasive recordings, surgery is not indicated. (Luders; Epilepsia 2000).

**References**

Illustrations

Illustration 1

Figure 1: Bitemporal IEDs

Illustration 2

Figure 2: a. BTLE- Bilateral Hippocampal Sclerosis; b. Left HS