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Hippocampus and epilepsy

Morphological imaging of the hippocampus in epilepsy

Imagerie morphologique de l'hippocampe dans l'épilepsie

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ABSTRACT

The hippocampus is a structure frequently involved in epilepsy, especially in partial drug-resistant forms. In addition, some hippocampal pathologies are associated with specific types of epilepsy presenting specific clinical courses and requiring specific treatments. Considering these major implications for treatment, morphological investigations of the hippocampus are crucial for epileptic patients. Indeed, discovery of hippocampal sclerosis may (depending on the clinical and electrophysiological findings) lead to the diagnosis of mesial temporal lobe epilepsy (MTLE). If the diagnosis of MTLE is retained in a case of drug-resistance, surgery may be proposed without invasive phase II investigations such as stereoelectroencephalograpy. In other instances, hippocampal abnormalities may be associated with epilepsy, but without the same value for localizing the ictal onset zone. Hippocampal dysgenesis is a strong argument for non-temporo-mesial ictal onset ipsilateral to the malformation. We describe here the specific MRI modalities adapted for hippocampal investigations and the radiological signs of hippocampal pathologies associated with epilepsy (especially hippocampal sclerosis and hippocamal dysgenesis). Hippocampus morphological investigations in epilepsy require specific MRI modalities and appropriate knowledge of the specific signs of each pathology. Careful analysis is crucial since the results may have a major impact on the therapeutic management of epileptic patients.

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RÉSUMÉ

L'hippocampe est une structure fréquemment impliquée dans l'épilepsie, notamment dans les formes partielles pharmacorésistantes. De plus, certaines pathologies hippocampiques sont associées à des formes d'épilepsie dont le traitement et l'évolution sont spécifiques. Compte tenu de l'importance de ces implications en termes thérapeutique, l'imagerie morphologique de l'hippocampe est incontournable chez ces patients. En effet, la mise en évidence d'une sclérose de l'hippocampe conduit (en accord avec les données cliniques et électrophysiologiques) au diagnostic d'épilepsie du lobe temporal mésial (ELTM). Un tel diagnostic permet de proposer une chirurgie de résection de foyer chez les patients pharmacorésistants sans nécessité de bilan de phase II tel une stéréo-électro-encéphalographie. Par ailleurs, d'autres anomalies hippocampiques peuvent être associées à une épilepsie mais sans valeur localisatrice du foyer aussi précise que dans le cas précédent. Une dysgénésie hippocampique est ainsi un argument fort pour un foyer extérieur aux régions temporo-mésiales du côté homolatéral. Nous décrivons dans ce travail les modalités IRM spécifiques à l'exploration morphologique de l'hippocampe ainsi que les signes radiologiques des pathologies de l'hippocampe associées à l'épilepsie (notamment la sclérose et la dysgénésie hippocampique). Les investigations morphologiques de l'hippocampe dans l'épilepsie requièrent des modalités spécifiques de réalisation de l'IRM et une connaissance précise des signes des pathologies associées. Ces explorations sont d'une grande importance en raison de leur impact majeur sur la prise en charge thérapeutique des patients épileptiques.

1. Introduction

Hippocampus has an important implication in epilepsy and its morphological imaging is crucial in the diagnostic management of epileptic patients. First report of an association between temporal lobe epilepsy and the hippocampus dated from 1889 by J. Hughlings Jackson [1]. In the first part of the xxth century, the hippocampus role in epilepsy grew up until it was considered as a fulcrum for all kinds of epilepsies, so that when W. Scoville performed a bilateral hippocampal ablation in 1957 on patient HM, his purpose was to treat epilepsy by removing the critical structure underlying seizure generation [2]. In the second part of the xxth century, the development of depth electrodes recording and stimulation [3,4] led to a better understanding of the hippocampus role in epilepsy and in 1989, one century after J. Hughlings Jackson's first report, the International Classification of Epileptic Syndromes (ICES) distinguished the temporal lobe epilepsy from other epilepsies and introduced a separation between the mesial and the lateral temporal lobe epilepsies [5]. The hippocampus was clearly not anymore a fulcrum for all types of epilepsies but was considered as the origin of a specific epileptic disease namely the mesial temporal lobe epilepsy (MTLE) syndrome. However, the implication of hippocampus in epilepsy does not appear to be confined to MTLE in temporal lobe epilepsy. Indeed, almost every seizures with an onset located in the extra-mesial temporal lobe involve the hippocampus, during its development [6].

As most parts of MTLE involve lateral temporal lobe in seizure development, and almost every temporal lobe seizure with extra-mesial origin affects hippocampus in a second time, it may be difficult to differentiate these epilepsies on the basis of clinical symptoms [7] and anatomical explorations only.

The MTLE syndrome has a better surgical prognosis than every other drug-resistant partial epilepsy, making its diagnosis so important [8–11]. Beside this, after decades of invasive exploration of MTLE, data are now sufficient to propose a surgical treatment only based on phase I non-invasive evaluation [12]. Such a strategy has been applied to a large population in India, where phase II invasive investigations are largely unavailable, and confirms its pertinence [13,14]. Obtaining data on pathology of the hippocampus is thus crucial in temporal lobe epilepsy investigations.

For this purpose, MRI anatomical exploration is the method of choice. In the last two decades, MRI technical improvements have highly increased sensitivity in detecting epileptogenic lesions. Since 1990, it has been recognized that MRI could detect hippocampal sclerosis, the most frequent lesion in patients referred for surgery for an MTLE syndrome with great sensitivity (93%) and specificity (86%) [15,16]. More than 20 years later, detecting an epileptogenic lesion on MRI remains demanding and needs specific MRI modalities and skills. Indeed, in 2002, more than 50% on non-trained radiologists failed to detect epileptogenic lesion [17].

2. How to explore hippocampus on morphological imaging

On standard cerebral MRI, the axis defined by anterior commissure and posterior commissure (AC-PC) is used to characterize the plane for axial slices. Coronal slices are then produced by using a bi-perpendicular plane to the axial and sagittal axis (Fig. 1).

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