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Characterization of Incomplete Hippocampal Inversions in a large dataset of young healthy subjects

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INTRODUCTION

Incomplete hippocampal inversion (IHI) is an atypical anatomical pattern of the hippocampus.

It has been mostly described in patients with epilepsy, malformations of cortical development and in temporal lobe epilepsy (Bajic et al. 1998; Beranacov et al. 2005). Bajic et al. 2009, with a prevalence of 30%-50%. IHI are also found in healthy subjects, although with an apparently lower frequency (Bajic et al. 2008). However, these studies include a small number of subjects or included patients without epileptic seizures but referred for other neurological conditions.

The purpose of our study was to investigate the prevalence of IHI in a large population of normal subjects.

METHODS

We studied 2008 subjects of the European database IMAGEN (Schumann et al. 2010). IHI was assessed using a visual scale on T1-MR. We adapted existing criteria to make feasible the evaluation of a large dataset. Each criterion have a note between 0 and 2.

A global criterion C0 indicates the presence of IHI on the global aspect of the hippocampus: 0 if there is no IHI, 2 if there is an IHI and 1 if the IHI is not obvious.

- **criterion C1**: roundness of the hippocampal body and its verticity. Atypical if C1a α C1b and C1c, verticalized.
- **criterion C2**: verticality and depth of the collateral sulcus relatively to the size of the hippocampus. Atypical if C2a is verticalized and crosses C2b.
- **criterion C3**: medial positioning of the hippocampus. Atypical if C3b is short compared to C3b.
- **criterion C4**: thickening of the subiculum. Red area.
- **criterion C5**: evaluated with one of the sulci that limits the fusiform gyrus crosses the level of the subiculum. Atypical if one of them crosses the subiculum.

The sum of individual criteria C1 to C5 to produce an IHI score between 0 and 10, indicating the degree of IHI.

IHI of the hippocampi of the database were assessed by 2 raters (CC and FC). 42 subjects were randomly selected to assess intra- and inter-rater reproducibility.

A kappa test were used to estimate the reproducibility of the criteria.

RESULTS

- The reproducibility was beyond 0.64 (substantial agreement).
- Very strong agreement (>80) were observed in the majority of cases.

**Frequency of IHI, according to the global criterion C0, for left and right hippocampi.**

<table>
<thead>
<tr>
<th>C0</th>
<th>No IHI</th>
<th>Partial IHI</th>
<th>IHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>70.9%</td>
<td>11.9%</td>
<td>17.1%</td>
</tr>
<tr>
<td>Right</td>
<td>84.6%</td>
<td>9.0%</td>
<td>6.5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Left vs Right</th>
<th>No IHI</th>
<th>Partial IHI</th>
<th>IHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>No IHI</td>
<td>65.9%</td>
<td>3.3%</td>
<td>3.1%</td>
</tr>
<tr>
<td>Partial IHI</td>
<td>7.9%</td>
<td>3.5%</td>
<td>0.5%</td>
</tr>
<tr>
<td>IHI</td>
<td>10.8%</td>
<td>2.3%</td>
<td>4.0%</td>
</tr>
</tbody>
</table>

- Based on criterion C0, we computed the frequency of IHI.
- IHI were more frequent for the left than for the right hippocampus ($\chi^2$ test = 129.2, $p=8.5e-29$).
- IHI did not differ between males and females nor depend on handedness.

CONCLUSION

Our results demonstrate that IHI are a common phenomenon in healthy subjects. Thanks to the study of a large dataset of over 2000 subjects, we were able to provide reliable estimates of the frequency.

We also proposed a visual scale of IHI that is applicable to large datasets.

IHI were much more frequent in the left hemisphere.

The IHI score shows a continuum between the absence and the presence of IHI and therefore using a IHI score seems to be more adapted for the study of IHI than a global criterion.

REFERENCES


