The Meningioma Surface Factor: Correlation of Histopathological Grading and Shape Irregularity on Preoperative Imaging

Methods

A retrospective, single-center study was conducted at the University Hospital St. Poelten, Austria. We included convexity, falcine, parasagittal and tentorial meningiomas operated in between 2010-2018. Using standardized preoperative MRI imaging, volume and surface was calculated. In order to quantify the degree of shape irregularity of the tumor, the Surface Factor (SF) was created. Under the assumption that benign tumor growth leads to a homogenous sphere-like tumor shape, the deviation of the actual tumor shape to a sphere was calculated. This was done by following formula:

\[ SF = \frac{SA_{sphere}}{SA_{tumor}} \]

SF... Surface Factor; \( SA_{sphere} \) ... Surface area of a sphere with the same volume as the tumor; \( SA_{tumor} \) ... Surface area of the tumor

Results

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Mean Surface Factor</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHO I</td>
<td>74</td>
<td>0.838</td>
<td></td>
</tr>
<tr>
<td>WHO II - III</td>
<td>28</td>
<td>0.754</td>
<td>p &lt; 0.001</td>
</tr>
</tbody>
</table>

A total of 102 patients met the inclusion criteria during the study period. Of these, 72% were graded as WHO I, 22% as WHO II and 6% as WHO III meningiomas. There was a statistically significant difference in the mean SF of benign and high-grade meningiomas (WHO II-III) with 0.838 and 0.754 respectively (p<0.001). A cutoff value for the SF of 0.777 produced a sensitivity of 86.5% and a specificity of 64.3% (AUC 0.784, p<0.001).

Introduction

Meningiomas are one of the most common primary intracranial tumors. Around 15-18% are atypical meningiomas, while 1-3% are graded as anaplastic meningiomas [1, 2]. Characteristics on preoperative MRI imaging correlating with the WHO grade have been studied before. An irregular tumor shape has consistently been associated with atypical or anaplastic meningiomas [3]. However, in these studies the tumor shape was assessed by a subjective classification.

Therefore, the aim of this study was to objectively quantify the irregularity of meningiomas on preoperative MRI in order to try to predict high grade histology in a novel approach.

To the best of our knowledge, this has not been published before.