Value of SSTR2A and Claudin-1 in differentiating Meningioma from Schwannoma and Hemangiopericytoma

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Keywords: Meningioma, Hemangiopericytoma, Schwannoma, Claudin-1, SSTR2A
Abstract

Background: The distinction between meningioma, schwannoma and solitary fibrous tumor / hemangiopericytoma can be challenging in some cases. This study evaluates the expression of Somatostatin receptor 2A (SSTR2A) and Claudin-1 in these different tumors.

Material and methods: 35 cases of meningioma, 10 cases of intracranial schwannoma and 10 cases of hemangiopericytoma were assessed. The immunohistochemical expression of SSTR2A and Claudin-1 was evaluated and scored according to the percentage of immunostained tumor cells (0; 1+, 2+ and 3). The intensity of staining was classified as weak, moderate and strong.

Results: Positivity for SSTR2A and Claudin-1 was encountered in 89% and 49% of meningiomas respectively. None of the schwannomas or hemangiopericytomomas was positive for any of both markers. All grade I and II meningiomas were positive for SSTR2A and only 20% of grade III showed positive staining (p<0.05). Claudin-1 positivity was detected in 50%, 43% and 60% of grade I, II and III meningioma respectively, with significantly higher intensity in grade III (p<0.05).

Conclusion: SSTR2A is highly sensitive and specific for meningioma. Claudin-1 is highly specific for meningioma, with low sensitivity. The adjunctive use of both markers can be very helpful in the diagnosis of meningioma and its distinction from schwannoma and hemangiopericytoma.

Key Words: Meningioma, Hemangiopericytoma, Schwannoma, SSTR2A, Claudin-1
Introduction

Meningiomas are the most common primary central nervous system (CNS) tumors accounting for 36% of all primary CNS tumors [1].

Since the first classification of meningioma introduced by Cushing in 1920 [2]; according to anatomical location; different classification schemes, adopted histology as the main factor in grading meningioma [3]. The recent WHO 2016 classification system, has grouped meningioma according to biological behavior into two groups, (1) Meningiomas with low risk of recurrence and aggressive behavior, including variants of WHO grade I meningiomas, and (2) Meningiomas with greater likelihood of recurrence and aggressive behavior, including variants of WHO grade II and grade III meningiomas and any subtype with high proliferation index, defined in one study as > 20 mitosis /10 HPF [4].

Both schwannoma of the cranio/spinal axis and meningeal Solitary fibrous tumor/Hemangiopericytoma occur at a much lower frequency than meningioma. However, the distinction between these entities and meningioma can be challenging in some cases. Additional immunohistochemical studies are needed to resolve such cases [3]. The traditionally used immunohistochemical markers show some overlap in the expression between these entities [5-7].

Somatostatin receptors (SSTR) belong to a family of seven alpha helical transmembrane spanning domains G protein-coupled receptors. They mediate the action of Somatostatin [8]. Somatostatin (SST) exerts inhibitory actions on a number of physiologic processes including pituitary and pancreatic hormone secretion, gastrointestinal peptide secretion and motility. In the CNS, it plays a role as a neurotransmitter and neuromodulator affecting behavior and cognition [9]. Finally,
SST has a potent antiproliferative and antiangiogenic activity, thus it can be used as an anti-neoplastic agent in tumors that express Somatostatin receptors [10-11].

The expression of somatostatin receptors is known to be frequent in meningioma [12] There are 5 subtypes of somatostatin receptors (SSTR1-5). Among the five subtypes, SSTR2A was the most frequently detected in meningioma [8,13].

Claudin-1 is one of the main components of tight junction, normally expressed in epithelial, endothelial and arachnoid cap cells, functioning as a regulator for paracellular space; controlling the barrier function of the cells and preserving cellular polarity and integrity [14].

Claudin-1 has been recently identified as a tumor marker expressed in many tumors; e.g.: renal cell carcinoma, colonic adenocarcinoma and melanoma, where its increased expression and mislocalization were correlated with the bad behavior encountered in such tumors, e.g. metastatic potential [15]; through its inhibitory effect on E-cadherin and Beta-catenin inducing epithelial-mesenchymal transmission; a major step in metastatic process [16].

This study evaluates SSTR2A and Claudin-1 immunohistochemical staining in meningiomas versus cranio-spinal schwannomas and meningeal solitary fibrous tumors/ hemangiopericytomas, to determine if these two markers can help in this differential diagnosis and to add specific markers for meningioma that can be targeted therapeutically.

**Materials and methods**

A total of 55 cases of CNS tumors were retrieved from the neuropathology files at
Cairo University Hospital between 2012 and 2015. The ethics committee of Cairo University Hospital approved the study. The cases include 35 meningiomas (22 females, 13 males), 10 schwannomas (5 females, 5 males) and 10 solitary fibrous tumors/hemangiopericytomas (6 females, 4 males). The mean age of patients was 42 years in cases of meningioma, 40 years in cases of schwannoma and 44 years in cases of solitary fibrous tumors/hemangiopericytoma. All cases were previously diagnosed by examination of Hematoxylin and Eosin stained sections and by routine immunohistochemical markers.

**Histological review:** Five microns-thick tissue sections were cut from the archived paraffin blocks and stained by Hematoxylin and Eosin for histological re-evaluation according to the WHO criteria [3], the cases of meningioma are classified as grade I (n=16), grade II (n=14) and grade III (n=5). Among grade I meningiomas, 5 were transitional, 4 fibroblastic, 3 meningothelial, 2 psammomatous, 1 microcystic and 1 angiomatic. Grade II meningiomas included 10 atypical and 4 chordoid and grade III meningiomas included 3 papillary and 2 rhabdoid variants.

**Immunohistochemical staining and evaluation:** Additional cuts were prepared from the paraffin blocks, heat mediated antigen retrieval was performed (with low pH for SSTR2A and high pH for Claudin-1) in automated water bath (Dako PT Link) and sections were stained with antibodies for SSTR2A (Abcam, UMB1, rabbit monoclonal, 1:100) and Claudin-1 (Cell Marque, rabbit polyclonal, ready to use). Staining was performed in an autostainer (Dako autostainer link 48) using a polymer-based detection system (Dako EnVision FLEX™, K8000).

Immunohistochemical staining for SSTR2A and Claudin-1 was scored according to the percentage of immunostained tumor cells (0: less than 5%, 1+: 5% to 25%, 2+:...
26% to 50%, 3+: more than 50%). The intensity of staining was classified as weak, moderate and strong. In claudin-1 evaluation, the perineurial cells in peripheral nerves are used as a control for moderate intensity [14].

**Statistical methods:** Comparison of numerical variables between the study groups was done using Mann Whitney U test for independent samples. For comparing categorical data, Chi square ($\chi^2$) test was performed. Exact test was used instead when the expected frequency is less than 5. $P$ values less than 0.05 was considered statistically significant. All statistical calculations were done using computer program SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) release 15 for Microsoft Windows (2006).

**Results**

- **Somatostatin receptor 2A:**
  
  Positive immunohistochemical staining for SSTR2A was encountered in 31 of 35 (89%) cases of meningioma (Table 1). All positive cases showed cytoplasmic and/or membranous staining. Among the positive cases, 24 of 31 (77%) showed diffuse staining in more than 50% of tumor cells (scored as 3+). Among these 24 cases, 16 showed strong immunostaining intensity, 7 showed moderate intensity and only 1 showed weak staining (Figure 1).

  In contrast, none of the cases of schwannoma and solitary fibrous tumor/hemangiopericytoma showed any positive staining for SST2A (Table 1). Therefore, the expression of SSTR2A was statistically significant in meningioma versus schwannoma or solitary fibrous tumors/hemangiopericytoma ($P <0.05$) (Figure 2).
### Summary of immunohistochemical staining results for meningioma, schwannoma and Solitary fibrous tumors/Hemangiopericytoma [number (percentage)]

<table>
<thead>
<tr>
<th></th>
<th>Meningioma (n=35)</th>
<th>Schwannoma (n=10)</th>
<th>Hemangiopericytoma (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSTR2A positive</td>
<td>31 (89)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Claudin-1 positive</td>
<td>17 (49)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>SSTR2A &amp;/or Claudin-1 positive</td>
<td>34 (97)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

SSTR2A, somatostatin receptor 2A

**Table (1):** Summary of immunohistochemical staining results for meningioma, schwannoma and Solitary fibrous tumors/Hemangiopericytoma [number (percentage)]

Regarding the different grades of meningioma, a significant correlation was found between the positive expression of SSTR2A and the lower grades of meningioma (grades I and II) (P <0.05) (Table 2). In grade I, all cases (16/16) showed positive SSTR2A expression. Among these cases, 13 showed diffuse staining in more than 50% of tumor cells (Score 3+). The majority of these cases displayed strong immunostaining intensity. In grade II, all cases (14/14) showed positive SSTR2A expression. 10 out of these 14 cases showed diffuse staining in more than 50% of cells (Score 3+) but only 4 of them showed strong intensity. In grade III, only a single (1/5) case of papillary subtype showed positive SSTR2A expression. The staining in this case was diffuse in more than 50% of tumor cells (Score 3+); however, the intensity was weak.

<table>
<thead>
<tr>
<th></th>
<th>Grade I (n=16)</th>
<th>Grade II (n=14)</th>
<th>Grade III (n=5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSTR2A positive</td>
<td>16 (100)</td>
<td>14 (100)</td>
<td>1 (20)</td>
</tr>
<tr>
<td>Claudin-1 positive</td>
<td>8 (50)</td>
<td>6 (43)</td>
<td>3 (60)</td>
</tr>
</tbody>
</table>

**Table (2):** Summary of immunohistochemical staining results for different grades of meningioma [number (percentage)]
Figure (1): Transitional meningioma, WHO grade I (A: H&E, x400) showing strong diffuse SSTR2A immunostaining (B: SSTR2A, x400). Rhabdoid meningioma, WHO grade III (C: H&E, x200) showing strong diffuse Claudin-1 immunostaining (D: Claudin-1, x200)
• **Claudin-1:**

Positive immunohistochemical staining was encountered in 17 of 35 (49%) cases of meningioma. Tumor cells showed cytoplasmic and/or membranous staining. Unlike SSTR2A, Claudin-1 showed only focal staining in less than 50% of tumor cells in all positive cases (Figure 1). However, a significant expression of Claudin-1 was still detected in meningioma in comparison to schwannoma and solitary fibrous tumor/hemangiopericytoma (P< 0.05) since none of them showed any positive staining (Table 1) (Figure 2).

As for the three grades of meningioma, positive Claudin-1 expression was detected in 8 out of 16 grade I cases, 6 out of 14 grade II cases and 3 out of 5 grade III cases. The intensity of Claudin-1 staining was significantly stronger in grade III than in grades I and II (P <0.05) (Table 3). Interestingly, the 3 positive cases of grade III were negative for SSTR2A. More details of SSTR2A and Claudin-1 staining in different grades and subtypes of meningioma are shown in (Table 4).

<table>
<thead>
<tr>
<th>Grade I (n=16)</th>
<th>Grade II (n=14)</th>
<th>Grade III (n=5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative</td>
<td>8 (50)</td>
<td>8 (57)</td>
</tr>
<tr>
<td>Weak</td>
<td>2 (13)</td>
<td>3 (21.5)</td>
</tr>
<tr>
<td>Moderate</td>
<td>5 (31)</td>
<td>3 (21.5)</td>
</tr>
<tr>
<td>Strong</td>
<td>1 (6)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

**Table (3):** Intensity of immunohistochemical staining of Claudin-1 in different grades of meningioma [number (percentage)].
**Figure (2):** Hemangiopericytoma (A: H&E, x400) showing negative immunostaining for SSTR2A (B: SSTR2A, x400). Schwannoma (C: H&E, x400) showing negative immunostaining for Claudin-1 (D: Claudin-1, x400)
<table>
<thead>
<tr>
<th>Case</th>
<th>Grade</th>
<th>Subtype</th>
<th>SSTR2A</th>
<th>Claudin-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I</td>
<td>Transitional</td>
<td>3+</td>
<td>Strong</td>
</tr>
<tr>
<td>2</td>
<td>I</td>
<td>Transitional</td>
<td>3+</td>
<td>Strong</td>
</tr>
<tr>
<td>3</td>
<td>I</td>
<td>Transitional</td>
<td>3+</td>
<td>Strong</td>
</tr>
<tr>
<td>4</td>
<td>I</td>
<td>Transitional</td>
<td>3+</td>
<td>Moderate</td>
</tr>
<tr>
<td>5</td>
<td>I</td>
<td>Transitional</td>
<td>1+</td>
<td>Weak</td>
</tr>
<tr>
<td>6</td>
<td>I</td>
<td>Fibroblastic</td>
<td>3+</td>
<td>Strong</td>
</tr>
<tr>
<td>7</td>
<td>I</td>
<td>Fibroblastic</td>
<td>3+</td>
<td>Strong</td>
</tr>
<tr>
<td>8</td>
<td>I</td>
<td>Fibroblastic</td>
<td>3+</td>
<td>Strong</td>
</tr>
<tr>
<td>9</td>
<td>I</td>
<td>Fibroblastic</td>
<td>3+</td>
<td>Strong</td>
</tr>
<tr>
<td>10</td>
<td>I</td>
<td>Meningothelial</td>
<td>3+</td>
<td>Strong</td>
</tr>
<tr>
<td>11</td>
<td>I</td>
<td>Meningothelial</td>
<td>2+</td>
<td>Moderate</td>
</tr>
<tr>
<td>12</td>
<td>I</td>
<td>Meningothelial</td>
<td>2+</td>
<td>Moderate</td>
</tr>
<tr>
<td>13</td>
<td>I</td>
<td>Psammomatous</td>
<td>3+</td>
<td>Strong</td>
</tr>
<tr>
<td>14</td>
<td>I</td>
<td>Psammomatous</td>
<td>3+</td>
<td>Strong</td>
</tr>
<tr>
<td>15</td>
<td>I</td>
<td>Microscystic</td>
<td>3+</td>
<td>Strong</td>
</tr>
<tr>
<td>16</td>
<td>I</td>
<td>Angiomatous</td>
<td>3+</td>
<td>Strong</td>
</tr>
<tr>
<td>17</td>
<td>II</td>
<td>Chordoid</td>
<td>3+</td>
<td>Moderate</td>
</tr>
<tr>
<td>18</td>
<td>II</td>
<td>Chordoid</td>
<td>3+</td>
<td>Moderate</td>
</tr>
<tr>
<td>19</td>
<td>II</td>
<td>Chordoid</td>
<td>3+</td>
<td>Moderate</td>
</tr>
<tr>
<td>20</td>
<td>II</td>
<td>Chordoid</td>
<td>2+</td>
<td>Moderate</td>
</tr>
<tr>
<td>21</td>
<td>II</td>
<td>Atypical</td>
<td>3+</td>
<td>Strong</td>
</tr>
<tr>
<td>22</td>
<td>II</td>
<td>Atypical</td>
<td>3+</td>
<td>Strong</td>
</tr>
<tr>
<td>23</td>
<td>II</td>
<td>Atypical</td>
<td>3+</td>
<td>Strong</td>
</tr>
<tr>
<td>24</td>
<td>II</td>
<td>Atypical</td>
<td>3+</td>
<td>Strong</td>
</tr>
<tr>
<td>25</td>
<td>II</td>
<td>Atypical</td>
<td>3+</td>
<td>Moderate</td>
</tr>
<tr>
<td>26</td>
<td>II</td>
<td>Atypical</td>
<td>3+</td>
<td>Moderate</td>
</tr>
<tr>
<td>27</td>
<td>II</td>
<td>Atypical</td>
<td>3+</td>
<td>Moderate</td>
</tr>
<tr>
<td>28</td>
<td>II</td>
<td>Atypical</td>
<td>2+</td>
<td>Moderate</td>
</tr>
<tr>
<td>29</td>
<td>II</td>
<td>Atypical</td>
<td>2+</td>
<td>Weak</td>
</tr>
<tr>
<td>30</td>
<td>II</td>
<td>Atypical</td>
<td>1+</td>
<td>Weak</td>
</tr>
<tr>
<td>31</td>
<td>III</td>
<td>Papillary</td>
<td>3+</td>
<td>Weak</td>
</tr>
<tr>
<td>32</td>
<td>III</td>
<td>Papillary</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>33</td>
<td>III</td>
<td>Papillary</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Table (4): Details of immunohistochemical staining of SSTR2A and Claudin-1 in all cases of meningioma.

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>34</td>
<td>III</td>
<td>Rhabdoid</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>35</td>
<td>III</td>
<td>Rhabdoid</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Discussion**

Although the diagnosis of most meningiomas can be based merely on routine examination of Hematoxylin and Eosin stained sections, the histologic mimicry between certain subtypes and other CNS tumors warrants the use of immunohistochemical tests. A common example is the distinction between meningioma, particularly the fibroblastic subtype, and schwannoma, especially if arising at the cerebello-pontine angle. This differential diagnosis should also be considered in patients diagnosed with Neurofibromatosis type 2 since these patients are prone to develop both tumors. Histologically, fibroblastic meningioma and schwannoma are formed of spindle cells with variable collagenous background. Occasionally, well-formed whorls that are characteristic for meningioma are seen in schwannoma. On the other side, meningioma can show Verocay body-like structures similar to those seen in schwannoma. Although most meningiomas express epithelial membrane antigen (EMA), a small subset of cases does not. Also, S100 - which is routinely used for diagnosis of schwannoma- can stain up to 70% of fibroblastic meningiomas [5].

Another problematic case is the differential diagnosis of meningioma versus solitary fibrous tumor/ hemangiopericytoma. Some meningiomas develop branching staghorn vessels like those encountered in solitary fibrous tumor/ hemangiopericytoma [5]. Previous studies had shown that occasional cases of solitary fibrous tumor/
hemangiopericytoma might focally express EMA [7]. Also, CD34, which is a marker of solitary fibrous tumor/hemangiopericytoma, can be expressed in up to 60% of fibroblastic meningiomas [6].

In the present study, we compared the immunohistochemical expression of SSTR2A and Claudin-1 in meningioma versus their expression in schwannoma and solitary fibrous tumor/hemangiopericytoma.

The expression of somatostatin receptors is known to be frequent in meningioma [12]. Among the five subtypes of somatostatin receptors, SSTR2A was the most frequently detected in meningioma [13]. This wide expression has made it a useful tool in tumor imaging by PET/CT using radiolabeled somatostatin analogues [17].

In our study, we detected the immunohistochemical expression of SSTR2A in meningiomas with a sensitivity of 89%. This is comparable with the findings detected by Bacchi et al [18], Agaimy et al [19] and Menke et al [20] in their studies that showed sensitivities of 100%, 87% and 100% respectively. Lower sensitivities of 74%, and 63% were stated by Barresi et al [21] and Durand et al [22] respectively. This difference may be because they used polyclonal antibodies in their studies, in contrast to the monoclonal antibody used in the current study.

We further analyzed the expression of SSTR2A in different grades and subtypes of meningioma. The highest expression was linked to lower grades of meningioma (grade I and II) (p<0.05). It was also noted that despite the positive expression of SSTR2A in all cases of grade I and II, there was still a difference in the intensity of immunostaining among the grades. Most of the cases of grade I (75%) showed strong staining intensity while only 28% of grade II cases showed strong intensity and the rest showed moderate or weak intensity. As for grade III meningiomas, only one case
was positive for SSTR2A and the intensity of staining was weak.

Our findings are in concordance with those reported by Durand et al [22] who analyzed the expression of SSTR2A in meningiomas by both immunohistochemistry and RT-PCR. By immunohistochemistry, the expression of SSTR2A was negative in grade III meningiomas. By RT-PCR, the SSTR2A mRNA was detected in all grades of meningioma with higher levels expressed in grade I more than in grade II and III.

Since the expression of SSTR2A was more intense in grade I meningiomas and became totally lost in most of grade III cases, we suggest that detection of strong immunohistochemical staining of SSTR2A may predict a better outcome. Previous studies done on other types of tumors also reached the same conclusion. For example, Sestini et al [23] and Raggi et al [24] studied SSTR2A expression in neuroblastoma and found out that it was inversely related to the tumor stage and was shown to be an independent good prognostic factor. Similarly, in colorectal carcinoma, SSTR2A expression was increased in well and moderately differentiated tumors and with lower proliferation indices [25].

In all cases of schwannoma and solitary fibrous tumor/ hemangiopericytoma selected for the present study, SSTR2A showed negative staining. Accordingly, the specificity of SSTR2A for meningioma is 100%. This was statistically highly significant. Bacchi et al [18] and Menke et al [20] reported slightly lower specificities of 90% and 88% respectively.

Regarding Claudin-1, its sensitivity for meningioma was 49% in our study. Previous study done by Rajaram et al [7] included anaplastic (grade III) meningiomas only and showed a sensitivity of 54%. Hahn et al [14] included grade I and II meningiomas and showed a sensitivity of 53 %, which is relatively close to our results. Slightly lower
sensitivity (22%) was reported by Soini et al [26] who included all grades of meningioma. This difference may be because they used tissue micro-array blocks with a 2 mm diameter.

Despite of its low sensitivity for meningiomas, Claudin-1 did not stain any of the schwannomas or solitary fibrous tumors/hemangiopericytomas included in our study, denoting a very high specificity (100%) for meningioma. Similar to our results, Singh et al [27] reported negative Claudin-1 staining in the 50 cases of schwannoma included in their study. Hahn et al [14] also reported negative Claudin-1 staining in all the studied cases of meningeal solitary fibrous tumor/hemangiopericytoma and schwannoma. Rajaram et al [7] studied Claudin-1 expression in 15 cases of meningeal solitary fibrous tumor/hemangiopericytoma and found positive staining in 2 cases.

We detected positive expression of Claudin-1 in the different grades of meningioma without a significant difference in positivity (50% of grade I, 43% of grade II and 60% of grade III). Soini et al [26] also reported no difference in the Claudin-1 expression among the three grades of meningioma. However, we detected that the intensity of staining was significantly higher in grade III than in grades I and II (p>0.05).

In the current study, we found out that 34 of 35 meningiomas expressed either SSTR2A or Claudin-1, or both of them, i.e. the sensitivity of both markers combined together is 97%. Interestingly, the cases of grade III meningiomas that showed positive Claudin-1 staining were negative for SSTR2A. On the other side, the single case of grade III meningioma (papillary subtype) that was positive for SSTR2A did not stain for Claudin-1. Thus SSTR2A and Claudin-1 can be used as complimentary markers with high sensitivity.
Therapeutic strategies in meningiomas include mainly surgery and radiotherapy, while chemotherapy has been used for patient with progressive disease, and patients with histologically malignant meningioma as adjuvant for radiotherapy, however the response to chemotherapy was disappointing; so the targeted therapy in such cases can be a new hope [28]. In vitro studies proved that somatostatin analogues have cytostatic effect on tumor cells and inhibits the tumor growth [10][29]. However, the efficacy of the use of somatostatin analogues in a clinical setting is still debatable with some trials showing benefit for their use and others do not [30][31][32]. The loss of expression of SSTR2A in malignant meningioma, as shown in the present study, may explain the failure of some clinical trials to prove the efficacy of somatostatin analogues in treating recurrent high grade meningioma [33].

Recently, Hashimoto and his colleagues generated mouse anti-Claudin-1 monoclonal antibodies and assessed their activity on mice bearing human Claudin- 1 expressing tumors. They concluded that one of these antibodies might be of benefit in cancer therapy [34]. So Claudin-1 can be one of the targeted therapy lines in meningioma therapy.

In summary, our study demonstrates that SSTR2A is highly sensitive and specific for meningioma. Claudin-1 is highly specific for meningioma; however its sensitivity is low. The adjunctive use of both markers can be very helpful in the diagnosis of meningioma and its distinction from schwannoma and solitary fibrous tumor/hemangiopericytoma. Further clinicopathological studies are recommended to correlate the pattern of SSR2A and Claudin-1 expression in meningiomas with their potential prognostic and predictive roles in such tumors, specifically aggressive and recurring ones.
References


