**Major Paper**

**Characteristics of Rathke’s Cleft Cyst in MR Imaging**

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**Purpose:** Symptoms, macroscopic appearances and microscopic findings of Rathke’s cleft cysts with magnetic resonance (MR) imaging.

**Patients and Methods:** We analyzed the data from 31 patients with pathologically confirmed Rathke’s cleft cysts. MR appearances were evaluated on T1WI, T2WI and contrast T1WI. Symptoms, macroscopic appearances and pathological findings were obtained from available medical records. We analyzed the images according to the following criteria:

1. findings on the location and shape of the lesions and form of the lesional wall;
2. the relationship between the maximum diameter of the lesions and symptoms;
3. the relationship between MR and macroscopic appearance;
4. the sites of adjacent contrast enhancement.

**Results:** The lesions were located mostly in both the intrasellar and suprasellar regions for a total of 87%. All lesions revealed either an oval or dumbbell shape with a smooth lesional wall. When correlated with physical symptoms, asymptomatic cases were associated with smaller lesions, while visual disturbances and dizziness were associated with relatively larger lesions. MR lesion signal intensity was related to the content of macroscopic appearance to some degree: the selected lesions showed shortening of T1 and T2 relaxation times in relation to the increase in protein concentration. This should have been macroscopically reflected in the color and turbidity of the liquid within the cyst. Adjacent contrast enhancement around the lesion was found at various sites, but anterior enhancement was most frequent. Circumferential enhancement was revealed to be derived from inflammatory changes.

**Conclusion:** Rathke’s cleft cyst exhibits a varied MR signal. It may be difficult to differentiate from craniopharyngioma from the intensity alone.

**Keywords:** Rathke’s cleft cyst, craniopharyngioma, MRI

**Introduction**

Recently, Rathke’s cleft cyst was observed in 11.3% of a non-selected autopsy series of 1,000 patients.1 It is more commonly present in female adults ranging in age from six months to 90 years.1–19 The lesions show various intensities in magnetic resonance (MR) imaging,2–19 with contrast enhancement in variable sites.2–8,20 With the introduction of CT and MRI, Rathke’s cleft cyst is being diagnosed much more frequently. However, preoperative diagnosis of Rathke’s cleft cyst remains difficult because of several variable MR features. In this study, the MR characteristics of Rathke’s cleft cyst were investigated and correlated with reported symptoms and macroscopic appearances.

**Patients and Methods**

We retrospectively analyzed MR findings of 31 patients comprising 14 males and 17 females who underwent surgery and who also had a pathological diagnosis of Rathke’s cleft cyst. The patients ranged in age from 14 to 71 years with a mean age of 46.1. Chief patient complaints were obtained from available clinical records. In 28 patients, information on the intralesional macroscopic appearance at surgery was obtained from surgical records. Pathological findings were obtained from histological reports.

Twenty-nine patients were scanned with a Magneton 1.5T (Siemens, Erlanger) and two
patients with a Signa 1.0T (GEMS, Milwaukee). Coronal spin-echo (SE) T\textsubscript{1}-weighted images (T\textsubscript{1}WI, TR 360–550 ms, TE 12–20 ms), coronal and sagittal SE contrast-enhanced T\textsubscript{1}WI, and SE or fast SE T\textsubscript{2}-weighted images (T\textsubscript{2}WI, TR 2500–4000 ms, TE 96.2–112 ms) were obtained. In five cases, sagittal T\textsubscript{1}WI were obtained instead of coronal T\textsubscript{1}WI. Three-millimeter-thick sections with a 0-mm gap and a 256×256 matrix were selected. For the contrast-enhanced studies, 0.05 mmol/kg of gadodiamide hydrate (Omniscan\textsuperscript{®}, Daiichi, Tokyo, Japan) or meglumine gadopentetate (Magnevist\textsuperscript{®}, Nihon Schering, Tokyo, Japan) was intravenously injected.

The following items on MR appearance, including MR types described below, and macroscopic appearance (macro groups described below) were examined in this study.

1. The locations and shapes of the lesions, and the form of the lesional wall, were observed on coronal and sagittal MR images.
2. The relationship between the maximum diameter of the lesions as measured on MRI and the symptoms was analyzed. The diameters of the lesions ranged from 1 to 4.5 cm, with a mean of 2 cm. Fourteen lesions (45\%) were less than 2 cm, 27 (87\%) were less than 3 cm, and 1 (3\%) was 4.5 cm. The relationship between the maximum diameters and symptoms is shown in Table 1. All but one of the asymptomatic cases were less than 2 cm in diameter; the mean was 1.6 cm. On the other hand, visual disturbances and dizziness were correlated with relatively larger lesions corresponding to a mean diameter of 2.7 cm.
3. The relationship between MR types and macro groups was analyzed.

**MR types**

The lesional intensity on T\textsubscript{1}WI was evaluated relative to the signal intensity of the white matter and categorized as either an area of hypointensity, isointensity, hyperintensity or heterogeneous intensity. The lesional intensity on T\textsubscript{2}WI was evaluated as hyperintense when it was similar to that of the cerebrospinal fluid (CSF), hypointense when lower than that of the CSF, and heterogeneous when intensity was mixed. From the patterns of signal intensities on T\textsubscript{1}WI and T\textsubscript{2}WI, the lesions were classified into five MR types: those that were hypointense on T\textsubscript{1}WI and hyperintense on T\textsubscript{2}WI (MR type 1), those that were isointense on T\textsubscript{1}WI and hyperintense on T\textsubscript{2}WI (MR type 2), those that were hyperintense on both T\textsubscript{1}WI and T\textsubscript{2}WI (MR type 3), those that were hyperintense on T\textsubscript{1}WI and hypointense on T\textsubscript{2}WI (MR type 4), and those that were heterogeneous on T\textsubscript{1}WI and/or T\textsubscript{2}WI (MR type 5) (Fig. 1).

**Macro groups**

The macroscopic appearance of the lesions was studied and classified according to the proportion of cystic and solid components. In addition, the color and turbidity of the cysts, when the lesions consisted exclusively of liquid-containing cysts, were also classified and analyzed. Among the cases with only a cystic lesion and no solid component, those with a clear cyst component, white turbid cyst component or yellowish turbid cyst component were classified as macro group 1, macro group 2 and macro group 3, respectively. Cases with both liquid and solid components were classified as macro group 4 and cases with only solid components were classified as macro group 5.

**Results**

1. **Location and shape of the lesions and form of the lesional wall**

   In four cases (13\%), the lesions were located exclusively in the sella turcica region; in 27 cases (87\%), they were located in both the intrasellar and suprasellar regions. Exclusively suprasellar lesions were absent. All intrasellar lesions had an oval shape, while lesions extending into both the intrasellar and suprasellar regions had either oval (nine cases) or dumbbell shapes with constriction at the diaphragma sellae (18 cases). All lesions had a smooth lesional wall without mural nodules.

2. **Maximum lesion diameters at MRI correlated with patient symptoms**

   Clinical patient symptoms included visual disturbances in nine cases, headaches in six, dizziness in three, diabetes insipidus in two, galactorrhea in one, systemic edema in one, and impotence in one. The remaining eight cases were asymptomatic.

3. **Relationship between MR types and macro groups**

   According to the intrallesional intensities, MR type 1 was found in eight cases (26\%), MR type 2 in six (19\%), MR type 3 in five (16\%), MR type 4 in six (19\%), and MR type 5 in six (19\%).

   Macroscopic information was available for 28 cases. Macroscopic appearances were classified into five groups: totally cystic lesions containing clear liquid (macro group 1) in nine cases; totally cystic lesions containing white turbid liquid (macro group 2) in six cases; totally cystic lesions containing yellowish turbid liquid (macro group 3) in five
cases; lesions containing both liquid and solid components (macro group 4) in four cases, and exclusively solid (macro group 5) in four cases. In two cases, operators identified the liquid component as a hemorrhage in macro types 3 and 4.

Every specimen of the intralesional solid components obtained from one case of macro group 4 and from two cases of macro group 5 pathologically comprised an alcian-blue-positive, PAS-positive, and acellular amorphous substance representing a mass of mucopolysaccharides.
Table 1. Maximum diameters of lesions and symptoms

<table>
<thead>
<tr>
<th>Maximum Diameter cm (No. of cases/%)</th>
<th>Asymtomatic</th>
<th>Diabetes insipidus</th>
<th>Galactorrhea</th>
<th>Systemic edema</th>
<th>Impotence</th>
<th>Head ache</th>
<th>Visual disturbance</th>
<th>Dizziness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ≤ &lt; 2 (14/45%)</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2 ≤ &lt; 3 (13/42%)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>3 ≤ &lt; 4 (3/10%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 ≤ (1/3%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Total (31/100%)</td>
<td>8</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>9</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Relationship between MR types and macro groups

<table>
<thead>
<tr>
<th>Macro-group (No. cases)</th>
<th>MR-type (No. cases)</th>
<th>group 1 (9)</th>
<th>group 2 (6)</th>
<th>group 3 (5)</th>
<th>group 4 (4)</th>
<th>group 5 (4)</th>
<th>Information unavailable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>type 1 (8/27%)</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>type 2 (6/19%)</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>type 3 (5/16%)</td>
<td></td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>type 4 (6/19%)</td>
<td>2</td>
<td></td>
<td></td>
<td>2**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>type 5 (6/19%)</td>
<td>2'</td>
<td></td>
<td>3**</td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

*Cases with liquid component macroscopically recognized as hemorrhagic fluid
*Cases with solid components pathologically representing masses of mucopolysaccharides

Table 2 shows the relationship between MR types and macro groups. MR type 1 corresponded exclusively to macro group 1; MR type 2 to macro groups 1, 2 and 5; and MR type 3 to macro groups 2, 3 and 4. Among four lesions of MR type 4 in which information on intralesional components was available, two were of macro group 3 and two were of macro group 5. MR type 5 corresponded to macro groups 3, 4 and 5, including two cases with hemorrhagic liquid of macro groups 3 and 4. Solid components in two cases of MR type 4 and one case of MR type 5 were considered pathologically as masses of mucopolysaccharides of macro groups 4 and 5.

4. Adjacent contrast enhancement sites

Contrast enhancement was present in or around the lesion sites in all but one undetermined case. The presence or absence of enhancement could not be determined because of marked lesion hyperintensity on precontrast T1WI. The sites of contrast enhancement were classified into five types: anterior (11 cases, 37%), posterior (seven cases, 23%), inferior (six cases, 20%), both anterior and posterior (three cases, 10%), and circumferential (three cases, 10%) (Fig. 2). In all three circumferential enhancement cases, pathological examination revealed inflammatory changes that were infiltrated with neutrophil leukocytes or lymphocytes. In one of these cases, gram-positive bacteria were pathologically confirmed.

Discussion

1. Location and shape of the lesions and form of the lesional wall

Rathke’s cleft cysts usually occupy the sella turcica and often extend into the suprasellar region (46–81%). As shown in this study, these cysts occupied both the intrasellar and suprasellar regions in 87% of the cases. All lesions had an oval or dumbbell shape, with smooth lesional walls showing no invasion into the surrounding structures. Others have reported the same result.

2. Maximum lesion diameters at MRI correlated with patient symptoms

Rathke’s cleft cysts of varying sizes have been reported, the largest being 50 mm in diameter. In our study, the maximum lesion diameters ranged from 1 to 4.5 cm with a mean diameter of 2 cm. One-half of the cases with smaller lesions, less than 2 cm in diameter, were asymptomatic. Most of the cases with lesions greater than 2 cm in diameter presented with symptoms, especially visual disturbances and dizziness (Table 1). This is indicative of
Fig. 2. Contrast enhancement sites
Gadolinium-enhanced sagittal T1WI demonstrates the contrast enhancement sites (arrow).
A: Anterior enhancement, B: Posterior enhancement, C: Inferior enhancement, D: Both anterior and posterior enhancement, E: Circumferential enhancement
lesional compression on the surrounding structures.

3. Relationship between MR types and macro groups

Intralesional signal patterns from MRI of Rathke’s cleft cysts have been compared with macroscopic appearances. According to the experimental study of Hayashi et al., in which quantification of protein concentration and MR imaging of cyst fluids were performed, the MR intensity of Rathke’s cleft cysts depended on protein concentration. Higher protein concentrations led to shortened T1 and T2 relaxation times, increasing the intensity of T1WI and decreasing the intensity of T2WI. Indeed, in this study, MR types 1 to 4 followed the intensity in T1WI and T2WI, and therefore might have matched the protein concentrations of Rathke’s cleft cysts. However, MR type 5, representing a heterogeneous intensity on T1WI and/or T2WI, may not be explained by protein concentration levels alone.

The literature describes the appearance of macroscopic lesions in various ways. This variety may be ascribed not only to various lesion components but also to operator subjectivity. Variable descriptive were simplified in this study for subjective parameters such as liquid color, turbidity, and the proportion of liquid to solid states. Although biochemical analysis of intralesional cyst fluids was not undertaken in this study, we postulate that our classification system from macroscopic appearances might have reflected the increase in protein concentration and/or increased proportion of cellular debris or solid composition. Liquid color and turbidity should have been closely related to protein concentration within the cyst. The solid components of Rathke’s cleft cyst were described as a solid wax in Kucharzky et al., a brownish globular mass in Kuwahara et al., and mucinous masses in Woo et al. Similar solid components were also present in some of our cases, which were pathologically confirmed to be mucopolysaccharides in this study.

All seven cases of MR type 1 corresponded exclusively to macro group 1. Five of the six MR type 2 lesions corresponded to macro group 1 or 2 and four of the five MR type 3 lesions corresponded to macro groups 2 or 3. Two of the four MR type 4 lesions belonged to macro group 3. Thus, MR types 1 to 4 gradually corresponded, in this disorder, to macro groups 1 to 3. Five of the six MR type 2 lesions were pathologically confirmed as mucopolysaccharide masses. Solid components in other reports also appeared hyperintense on T1WI and hypointense on T2WI corresponding to MR type 4. MR type 5 lesions variably corresponded to macro groups 3–5. This probably reflected a mixed cyst composition comprising variably proteinaceous fluid and cellular debris or solid components. Hemorrhagic components or desquamative cellular debris may give rise to heterogeneous signal intensity. The cases of MR type 5 included two cases with hemorrhagic liquids consistent with characteristics of macro groups 3 and 4. MRI heterogeneous intensity, due to the paramagnetic effect, could possibly be derived from a case of previous hemorrhage.

4. Adjacent contrast enhancement sites

In this specific series, contrast enhancement sites were seen anterior to the lesion in 11 cases, posterior in seven, inferior in six, both anterior and posterior in three, circumferential in three, and unknown in one. Such enhancements adjacent to the Rathke’s cleft cysts have been investigated previously and are considered not to represent Rathke’s cleft cyst wall, but the normal pituitary gland compressed by the lesions. Some studies described the sites of “the enhancement” and the major site was variable. “Superior” enhancement was described in several other studies. This was not found in our study. On the other hand, “both anterior and posterior” enhancements were found in three cases, although such enhancement patterns have never been reported in the literature. This “both anterior and posterior” enhancement or splitting of the pituitary gland anteriorly and posteriorly may reflect the pathomechanism of Rathke’s cleft cyst. That is, it is occurring as a pathological enlargement of the primitive vesicles that lie between the pars anterior and the pars intermedia. Thus, at the site of the contrast enhancement, it represents a compressed normal pituitary gland. It may be seen in various portions along Rathke’s cleft cyst.

The circumferential enhancement found in three cases in this study may be in accordance with the circumferential or ring enhancement described in other studies. These three cases had pathologically inflammatory findings, one of which was positive for gram-positive bacteria. This was compatible with the results of several other reports where inflammatory findings were pathologically recognized in such enhancement cases.
al. reported that changes in mild, chronic inflammatory reactions, caused most probably by pressure against the intracystic component, were present in 25% of Rathke's cleft cyst walls. Therefore, circumferential or ring enhancements along the lesion could represent not only the compressed normal pituitary gland, but also the cyst wall with some inflammatory changes.

5. Differential diagnosis from craniopharyngiomas

Rathke's cleft cysts and craniopharyngiomas can extend to supra and intrasellar areas at diagnosis. This may make their differential diagnosis difficult only from the aspect of lesion location. Rathke's cleft cysts have an oval or dumbbell shape and thin and smooth lesional walls without any signs of invasion. In contrast, craniopharyngiomas, especially when large, appeared as multilobulated or as an irregular shape. The presence of solid nodules or tumors with heterogeneous or strong homogeneous enhancements determined to have an invasive behavior into surrounding structures are found in cases of craniopharyngiomas. MRI of Rathke's cleft cysts shows various intensities on T1WI and T2WI. Similarly, cystic components of craniopharyngiomas are known to exhibit various intensities on T1WI, with mostly high intensities on T2WI. It is thought that differentiating them could be difficult with MR signal intensity alone. CT studies for both Rathke's cleft cysts and craniopharyngiomas revealed that calcification on the lesional wall was present in 13% of Rathke's cleft cysts and 87% of craniopharyngiomas. Therefore, CT may remain necessary for the diagnosis of juxtasellar cystic lesions, although MRI is far superior to CT in exact localization and delineation of lesion contour.

References