Sympotomatic Rathke cleft cysts account for approximately 6%–10% of sellar and suprasellar lesions in neurosurgical series. Histologically, these cysts typically consist of a single or pseudostratified layer of cuboidal or columnar epithelium with an underlying layer of connective tissue. Occasionally, RCCs become sufficiently large to cause mass effect on the pituitary gland and surrounding structures. Indications for treatment generally include headaches, visual disturbances, and/or pituitary hormonal deficiencies.

Surgical therapy is the mainstay of treatment for symptomatic primary and recurrent RCCs. Transsphenoidal resection is the preferred approach, as described by Hardy and Vezina and Raithi et al., even in the setting of RCCs with suprasellar extension. Fager and Carter initially proposed a conservative method of liberal cyst wall fenestration, biopsy sampling, and content evacuation, whereas other neurosurgeons have advocated total cyst wall resection as a means to decrease recurrence rates. The association of complete RCC wall resection with high rates of postoperative DI and endocrine dysfunction, however, has limited the use of this approach at most neurosurgery centers.

Clinical article

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Object. The aim of this study was to report the results of a large clinical series of patients with symptomatic Rathke cleft cysts (RCCs) who underwent resection by a single neurosurgeon using intraoperative alcohol cauterization, and to review any possible differences in recurrence rates in those treated with this chemically ablative technique.

Methods. The authors performed a retrospective database review of 82 patients (age range 10–74 years) with symptomatic RCCs who underwent surgery between 1993 and 2009.

Results. Preoperative symptoms of headaches, vision disturbances, and hormone dysfunction were observed in 68%, 35%, and 56% of patients, respectively. All 82 patients underwent treatment by a single surgeon. Surgery consisting of simple cyst drainage followed by cyst wall biopsy without vigorous cyst wall removal was performed. A subset of these patients (62) received intraoperative alcohol instillation. Perioperative complication rates were low: CSF leakage, symptomatic hyponatremia, and permanent diabetes insipidus (DI) in 2%, 5%, and 0% of patients, respectively. Headaches and vision problems improved or resolved in 71% and 83% of patients, respectively. Hyperprolactinemia, hypothyroidism, panhypopituitarism, DI, and adrenal insufficiency improved or resolved in 94%, 90%, 50%, 33%, and 67% of patients, respectively. Recurrence, as defined by enlargement of the cyst as compared with its appearance on baseline 3-month postoperative MR imaging, was noted in 10.7% of the primary surgery group. There was a trend toward increased recurrence rates in the alcohol-treated (12.9%) versus no–alcohol treatment groups (0%), although not statistically significant (p = 0.20).

Conclusions. This large, single-surgeon/single-institution series of patients with symptomatic RCCs confirms that significant postoperative improvement in headaches, vision, and pituitary hormone dysfunction can be achieved via a conservative surgical approach, with low complication and recurrence rates. The data also demonstrate a limited role for alcohol cauterization in the treatment of symptomatic RCCs. (DOI: 10.3171/2010.7.JNS091793)

Key Words • Rathke cleft cyst • alcohol cauterization • recurrence rate
Alcohol cauterization in the treatment of Rathke cleft cysts

At present, controversy remains in the neurosurgical literature regarding the relative merits of complete cyst wall resection versus cyst drainage in RCC treatment and regarding the potential role of chemical cauterization on recurrence rates. Specifically, the value afforded by alcohol instillation, as a chemically ablative procedure, in terms of RCC recurrence and associated complications has not been well defined. Therefore, to determine whether alcohol instillation affects recurrence rates in symptomatic RCCs, we reviewed our experience with 82 patients surgically treated by the same surgeon (K.O.L.) between 1993 and 2009, and compared our results with those from 5 major surgical studies on RCC outcomes.

Methods

Patient Population

We conducted a retrospective study of patients with symptomatic RCCs treated at our institution in the 17-year period between 1993 and 2009. Eligible patients were queried from the University of Colorado Pituitary Tumor Database. Patients who underwent resection and had historical confirmation of an RCC were included. These 82 patients represented 8.1% of 1015 patients with pituitary disorders surgically treated by the same surgeon at the University of Colorado. This study was reviewed and approved by the Colorado Medical Institutional Board Review.

Preoperative Evaluation

All patients underwent a detailed neurological history and physical examination as well as a hormone evaluation. Pituitary hormone testing included basal levels for prolactin, luteinizing hormone, follicle-stimulating hormone, testosterone (in men) or estradiol (in women), free thyroxine, thyroid-stimulating hormone, insulin-like growth factor 1, cortisol, and adrenocorticotropin. If indicated by an equivocal morning cortisol, a cosyntropin stimulation test was performed to exclude central adrenocorticotropin deficiency. All patients underwent pituitary-dedicated radiological studies, most commonly contrast-enhanced, high-resolution MR imaging.

Surgical Technique

Eighty-two patients underwent 92 surgical procedures for the treatment of a sellar or suprasellar RCC. Of the 92 surgeries performed, 89 followed a transsphenoidal approach, while the remaining 3 procedures consisted of frontal craniotomy for isolated suprasellar lesions. The senior author (K.O.L.) performed all procedures. Seventy-five patients (91.5%) presented with RCC as the initial diagnosis (primary group) with no prior surgery, whereas 7 patients (8.5%) presented with recurrent disease (secondary group) following previous surgical interventions at an outside institution. In the primary group, 68 patients underwent a single surgery, 4 underwent a second surgery, and 3 underwent 3 surgical interventions. Prior to 1993, attempts were made to completely resect an RCC, along with stripping of the tumor capsule when possible (18 patients). Due to an unacceptably high incidence of transient postoperative DI (33%) and 1 case of permanent DI, however, all subsequent cases involved simple cyst drainage, removal of any intracystic debris, and cyst wall biopsy, followed by alcohol cauterization. This group was analyzed in the present study. Transsphenoidal procedures prior to 2003 were performed via the sublabial approach, with all subsequent cases conducted using an endonasal approach. Closure of the sellar floor in all cases involved placement of a Gelfoam pledget over the dural opening followed by a bone strut or LactoSorb plate (if no sphenoid bone was available). In some cases of intraoperative CSF leakage, fibrin glue was placed over the bone strut, with or without placement of a lumbar spinal drain. All spinal drains were left in place for 3–4 days. Placement of a fat graft within the sella or the sphenoid sinus was routinely avoided because of its undesirable appearance on postoperative MR imaging.

Alcohol Instillation

Following initial cyst drainage, if no significant communication with the CSF space was encountered, absolute alcohol was instilled into the resection cavity for 2 minutes. In certain instances, this process was repeated once or twice at the surgeon’s discretion. If a CSF leak was present, coming from over the anterior surface of the gland but not from within the cyst, and could be controlled, alcohol-soaked pledgets were cautiously placed into the cyst cavity and left for 2 minutes. Of the 75 patients presenting with the newly diagnosed RCCs (the primary group), 62 (82.7%) had alcohol instilled during their first surgery and 13 (17.3%) did not.

Pathology Analyses

Obtained tissue specimens were fixed in formalin, embedded in paraffin, sectioned, and stained with H & E.

Treatment Follow-Up

After surgery, all patients were initially hospitalized in the intensive care unit for 12–24 hours for close monitoring, followed by an additional 1- to 2-day stay on the surgical ward before discharge. Follow-up evaluations were performed by both Neurosurgery and Endocrinology staff to assess the persistence or recurrence of symptoms and endocrine function. Pituitary hormone testing was performed at 3 months and then 1 year after surgery. Postoperative radiological evaluation was routinely conducted at 3 months, every 6 months for 1 year, and then annually thereafter.

Statistical Analysis

Recurrence data were analyzed using 1-way ANOVA in independent samples, with p values < 0.05 considered statistically significant.

Results

Clinical Features and Outcomes

In our patient population, the average age was 37 years (range 10–74 years), with 5 patients (6.1%) younger than 16 years of age. The majority of patients were female (69%), and patients were followed up for a median
of 46 months (range 4 months–13.6 years). Presenting symptoms and their responses to surgery are described in Table 1. The majority of patients (68.3%) presented with headache, and 71.4% of them reported symptomatic improvement after surgery. Subjective visual disturbances were reported in 35.4% of patients, 82.8% of whom reported significant improvement after surgery.

The most common endocrine abnormalities were hypogonadism and hyperprolactinemia in 34.1% and 19.5% of patients, respectively. This abnormality was followed in relative frequency by hypothyroidism in 12.2%; panhypopituitarism, defined as the deficiency of 2 or more pituitary hormones, in 9.7%; DI in 8.5%; and isolated adrenal insufficiency in 3.6% of patients. Postoperative resolution or improvement in hyperprolactinemia, hypothyroidism, hypopituitarism, DI, and adrenal insufficiency was observed in 93.8%, 90.0%, 50.0%, 33.3%, and 67.0% of patients, respectively.

Pathology Features

The diagnosis of RCC was established by the identification of the epithelial lining in 43 cases (52.4%). In the remaining 39 cases (47.6%), the diagnosis of RCC was established by the presence of amorphous colloid material, which is specific for RCCs. The histopathological characteristics are described in Table 2 and are delineated by primary (nonrecurrence vs recurrence) and secondary surgical groups. Overall, 30 patients (36.6%) had a simple cuboidal and/or columnar epithelium, 8 patients (9.7%) had a pseudostratified epithelial lining, and 5 patients (6.1%) demonstrated squamous metaplasia. In 1 patient who presented with a recurrent RCC requiring 1 additional transsphenoidal resection followed by craniotomy, pathology at the time of the third surgery demonstrated a cystic craniopharyngioma.

Surgical Outcomes and Complications

Surgical complications for the entire series are described in Table 3 and are stratified into alcohol-treatment versus no–alcohol treatment groups. Although the numbers are small, the alcohol-treated group had a higher incidence of persistent CSF leakage requiring reoperation (2 patients), transient DI (3 patients), and hyponatremia requiring rehospitalization (3 patients). Although the alcohol-treated group had a higher incidence of postoperative spinal drainage for intraoperative CSF leakage (6 vs 1 patient), assessment of the leak and the need for a spinal drain was determined prior to instillation of the alcohol. Other complications included postoperative epistaxis requiring interventional radiology embolization in 1 patient. There were no deaths, and no patient suffered permanent DI or new visual problems. Although there seemed to be a slight tendency toward increased complications in the alcohol-treated group, these differences were not statistically significant.

Recurrence Rate

**Primary Surgery Group.** Recurrence was defined as enlargement of the pituitary cyst compared with its appearance on 3-month postoperative MR imaging or CT scanning, with or without symptoms. Recurrence rates were analyzed for the 75 patients whose initial operation was performed at our institution, and recurrence was observed in 8 cases (10.7%). On average, recurrences were observed 3.2 years after the initial surgery. Six (75%) of the 8 patients with recurrent cysts demonstrated symptoms, and 2 patients (25%) had only radiographic evidence of recurrence. All 6 symptomatic patients underwent repeat transsphenoidal surgery, and 2 of these patients subsequently required a third procedure for recurrence. Histological

<table>
<thead>
<tr>
<th>TABLE 1: Summary of presenting symptoms in 82 patients with RCCs*</th>
<th>No. (%)</th>
</tr>
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<tbody>
<tr>
<td>Symptom</td>
<td>Preop</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------</td>
</tr>
<tr>
<td>headache</td>
<td>56 (68.3)</td>
</tr>
<tr>
<td>visual disturbance</td>
<td>29 (35.4)</td>
</tr>
<tr>
<td>irregular menses</td>
<td>19 (23.2)†</td>
</tr>
<tr>
<td>asthenia</td>
<td>17 (20.7)</td>
</tr>
<tr>
<td>depression</td>
<td>11 (13.4)</td>
</tr>
<tr>
<td>polydipsia/polyuria</td>
<td>7 (8.5)</td>
</tr>
<tr>
<td>sexual dysfunction</td>
<td>8 (9.8)</td>
</tr>
<tr>
<td>galactorrhea</td>
<td>7 (8.5)</td>
</tr>
<tr>
<td>sleep problems</td>
<td>5 (6.1)</td>
</tr>
<tr>
<td>syncope</td>
<td>4 (4.9)</td>
</tr>
<tr>
<td>seizures</td>
<td>3 (3.7)</td>
</tr>
</tbody>
</table>

* Other symptoms present at lower frequencies include weight loss, weight gain, hirsutism, easy bruising, vertigo, dizziness, cold intolerance, hyponatremia, seizures, proximal muscle weakness, and cranial nerve V or VI palsy. — = no analysis done postsurgically.
† Six with amenorrhea.

<p>| TABLE 2: Histopathological results in 82 patients with RCCs |
|---------------------------------|---------------------|---------------------|---------------------|</p>
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Primary Op Group Presenting w/o Recurrence</th>
<th>Primary Op Group Presenting w/ Recurrence</th>
<th>Secondary Op Group Presenting w/ Recurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>no. of patients</td>
<td>67</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>diagnostic cyst contents</td>
<td>34</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>simple epithelium</td>
<td>26</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>pseudostratified epithelium</td>
<td>6</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>squamous metaplasia epithelium</td>
<td>1 (1.5)</td>
<td>1 (12.5)</td>
<td>3 (42.9)</td>
</tr>
</tbody>
</table>
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TABLE 3: Postoperative complications in 82 patients with RCCs

<table>
<thead>
<tr>
<th>Complication</th>
<th>Alcohol Treatment</th>
<th>No Alcohol Treatment</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>no. of patients</td>
<td>66</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>postop spinal drain due to intraop</td>
<td>6 (7.3)</td>
<td>1 (1.2)</td>
<td>0.72</td>
</tr>
<tr>
<td>CSF leak</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>recop for persistent CSF leak</td>
<td>2 (2.4)</td>
<td>0 (0.0)</td>
<td>0.48</td>
</tr>
<tr>
<td>transient DI</td>
<td>3 (3.7)</td>
<td>0 (0.0)</td>
<td>0.39</td>
</tr>
<tr>
<td>permanent DI</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td></td>
</tr>
<tr>
<td>hyponatremia requiring rehospitaliz-</td>
<td>3 (3.7)</td>
<td>0 (0.0)</td>
<td>0.39</td>
</tr>
<tr>
<td>ation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>delayed epistaxis</td>
<td>1 (1.2)</td>
<td>0 (0.0)</td>
<td>0.63</td>
</tr>
<tr>
<td>aseptic meningitis</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td></td>
</tr>
<tr>
<td>new visual symptoms</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td></td>
</tr>
<tr>
<td>death</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td></td>
</tr>
</tbody>
</table>

evaluation of the 8 patients with recurrence revealed diagnostic cyst contents in 5, simple columnar epithelium in 1, pseudostratified epithelium in 1, and squamous metaplasia in 1. In the alcohol-treated group, the cyst recurred in 8 (12.9%) of the 62 patients over the follow-up period. In the no-alcohol treatment group, none (0%) of the 13 patients had a recurrence (p = 0.20), favoring no alcohol treatment. Table 4 shows the impact of the surgical closure on recurrence. Since all cases had similar closures, the only variables were the use of fibrin glue, the presence of an intraoperative CSF leak, the use of alcohol cauterization, and placement of a postoperative spinal drain. Only the use of alcohol cauterization tended to be associated with recurrence, 12.9% versus 0%, but this association was statistically insignificant.

Secondary Surgery Group. On histological evaluation, 3 (42.9%) of the 7 patients in the secondary group had simple columnar epithelium, 1 patient (14.3%) had pseudostratified epithelium, and 3 patients (42.9%) had squamous metaplasia. Three (42.9%) of these 7 patients had a recurrence after our treatment, requiring a third surgical intervention. One patient (as mentioned previously) was found to have a cystic craniopharyngioma on follow-up craniotomy.

Discussion

The demographics and clinical presentations in our large series of patients with symptomatic RCCs are comparable with those in other major series (Table 5). Specifically, most studies show a mean age of onset in the 30s and an associated female predominance, as was observed in our study. In addition, most contemporary studies reveal headache as the most common presenting symptom (65%–86% of patients) and postsurgical improvement in most patients (> 80%). Our results compare favorably with the findings in these studies in that 68% of our patients presented with headaches, and 71% reported symptomatic improvement or resolution after surgery. Vision problems, which include disturbances of acuity and perimetry, occur in an estimated 20%–49% of patients and improve in a reported 64%–100%. Thirty-five percent of patients in our series reported subjective vision problems, and 83% reported postoperative improvement.

Endocrine dysfunction has been described in approximately 30%–60% of patients with RCC, with hyperprolactinemia being the most common abnormality. Panhypopituitarism and DI also occur in an estimated 5%–15% of patients. In our series, 56% of patients had a pituitary hormone abnormality, with hypogonadism and hyperprolactinemia being the most common in 34.1% and 19.5% of patients, respectively. Further analysis revealed...
preoperative hypogonadism in 26% of the premenopausal women tested and in 38% of tested males. These hormone abnormalities were followed in relative frequency by hypothyroidism (12.2%), panhypopituitarism (9.7%), DI (8.5%), and isolated adrenal insufficiency (3.6%). As has been reported in most series, hyperprolactinemia improves in most patients (77%–100%), but the recovery of other hormones varies as a function of the extent of the resection and the degree of preoperative panhypopituitarism.4,6,9,15,16 In our series, 64% of patients had an overall improvement in pituitary hormone dysfunction, with hyperprolactinemia resolving in 93.8% of patients. Interestingly, we also observed improvement in 5 (50%) of the 10 patients with panhypopituitarism, 2 (67%) of 3 patients with isolated adrenal insufficiency, and 3 (33%) of the 9 patients with preoperative DI. This trend is uncommon in the RCC literature, as these deficiencies are thought to reflect an inflammatory/destructive process with a low likelihood of improvement.6,7,9,12,16,28 although a limited number of studies have also documented a similar improvement in DI.15,16

The surgical complication rate noted in our series was low (Table 3) and compared favorably with that in other contemporary studies utilizing modern transsphenoidal techniques.2,4,16 The need for a postoperative lumbar drain for intraoperative CSF leakage, transient DI, and symptomatic hyponatremia requiring rehospitalization were the most common complications; these were seen in 9.8%, 3.7%, and 3.7% of patients, respectively. Two patients (2.4%) required reoperation for a persistent CSF leak. Interestingly, with this less-aggressive approach, permanent DI (0%) was much lower than in other surgical series (3.7%–9.0%). We did not encounter any complications resulting in new neurological deficits or new pituitary hormone deficiencies. In addition, our study did not demonstrate any significant differences in complication rates with the intraoperative use of alcohol, but may have been insufficiently powered to detect such differences.

The recurrence rate in our series of 75 patients with newly diagnosed RCCs who underwent resection was 10.7% over a median follow-up period of 43 months. This rate is significantly lower than the 33% recurrence rate reported by Mukherjee et al.20 in their series of 12 patients with RCC followed up for a median duration of 30 months. In addition, Shin et al.26 reported a 19% recurrence rate in 26 patients followed up for 24 months. In more contemporary series, Aho et al.2 reported an 18% recurrence rate in 118 patients followed up for a minimum of 5 years. Additional studies have revealed recurrence rates between 11% and 16%, with variable follow-up periods.4,16,28 Few studies have shown very low recurrence rates, but one such study did demonstrate a 2.3% recur-
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currence rate reported by Ross et al.\textsuperscript{23} in their study of 40 patients with RCC, and a 4.5% recurrence rate in the 22-patient series by Frank and colleagues.\textsuperscript{15} There are a number of important methodological differences that may account for these varied recurrence rates, including the number of patients, surgical approaches, study design (single center vs multicenter), duration of follow-up, and variable definitions of recurrence. For example, in the study by Aho et al.,\textsuperscript{2} as in our series, recurrence was defined by radiological evidence of cyst enlargement regardless of symptoms, and this difference may account for the relatively high recurrence rate (18%). In a study by Ross et al.,\textsuperscript{23} recurrence was defined by patients returning to the institution with symptoms but did not include routine patient or radiological follow-up. The significant strength of our study is its systematic, long-term clinical and radiographic follow-up and its single-surgeon/single-institution experience, which importantly eliminates the critical variable of differences in surgical techniques, which can exist in other studies.

Regarding the controversy on the optimal extent of RCC wall resection, in favor of complete resection, is the detailed study by Kim et al.\textsuperscript{16} who identified incomplete cyst wall removal as the second most significant risk factor for RCC recurrence. Of note, however, was the relatively high rate of permanent DI in that series (7.4%). Laws and Kanter\textsuperscript{18} have also advocated for total cyst wall resection, in favor of complete resection, as the basis for the use of alcohol cauterization is its theoretical ability to cauterize the single cell epithelial cyst lining, and thereby prevent cyst recurrence. Some have advocated this approach as an intermediate strategy between the most aggressive approach of radical resection of the cyst wall and the least aggressive one of simple cyst drainage.

In the first publication referencing the use of intraoperative alcohol cauterization, Ross et al.\textsuperscript{23} reported on 40 patients with RCC. Alcohol cauterization was used only in patients in whom a CSF communication was deemed not present, and the overall recurrence rate was 2.3%, although there was limited radiological follow-up (< 50%) in this study. Subsequently, Aho et al.\textsuperscript{2} performed intraoperative alcohol cauterization in 75 (65%) of 118 patients with RCC, with an overall recurrence rate of 18%. The recurrence rate between the alcohol-treated and no-alcohol treatment groups was not specified, but it was noted that the senior author adopted the alcohol instillation technique with no claims to its efficacy at reducing RCC recurrence. Lastly, in Benveniste and colleagues\textsuperscript{4} series of 62 patients with RCC in which 18 (29%) received intraoperative alcohol ablation, recurrence rates were similar (16.7%) between the alcohol-treated and no-alcohol treatment groups.

In our series of 75 patients treated primarily for RCC, alcohol was instilled in 62 patients, with a recurrence rate of 12.9% compared with no recurrences in 13 patients without alcohol treatment. No significance was noted between these groups (p = 0.20), suggesting no advantage to intraoperative alcohol use in RCC recurrence. In addition, no significantly increased complication rate along with alcohol use was observed in our series (Table 3), although the use of alcohol when there is a CSF communication can be potentially devastating, as noted in the case report by Hsu and colleagues,\textsuperscript{14} in which the use of alcohol resulted in injury to the optic nerves bilaterally with complete blindness, anosmia, and third nerve palsy. Collectively, the results of our large series and the neurosurgical literature indicate that chemically ablative alcohol use in RCC treatment is unwarranted and that the benefits do not currently outweigh the risks.

The issue of histopathological features as a potential risk factor for RCC recurrence was also evaluated in this study. To date, a number of radiological, surgical, and pathological factors have been implicated in recurrence, including squamous metaplasia.\textsuperscript{2,4,16} Specifically, Kim et al.\textsuperscript{16} identified squamous metaplasia as the greatest single predictor of recurrence on multivariate analyses of 14 factors. Similarly, Aho and colleagues\textsuperscript{2} reported a 32% risk of cyst recurrence in patients with this histological type. The presence of squamous metaplasia is thought to possibly represent a more aggressive pathological variant on the spectrum between RCC and craniopharyngioma. In our
series, 5 patients had histologically confirmed squamous metaplasia. In the 2 patients in the primary group, the cyst recurred in 1 (50%). The remaining 3 patients accounted for 42.9% of the secondary group, that is, those presenting with recurrence.

For patients with multiply recurrent RCCs, adjuvant radiation therapy is a consideration, although there are a limited number of studies examining this approach. Two patients in our series with multiply recurrent RCCs underwent fractionated radiation therapy. The cyst recurred in 1 of these patients 5 years after radiation and a craniopharyngioma was subsequently found on follow-up craniotomy. The second patient, who underwent 2 transsphenoidal resections and had evidence of a persistent cyst, completed radiation therapy approximately 1 year before the end of the study period and currently has a stable sellar/suprasellar lesion.

Conclusions

In summary, data in this large clinical series of 82 patients support simple cyst resection without the instillation of alcohol as the recommended surgical treatment for RCCs. This approach, in concordance with other surgical series, can be performed with a low surgical complication rate and a high level of improvement in clinical symptoms and hormonal dysfunction. Importantly, this series also demonstrated a low RCC recurrence rate while using a conservative surgical approach, as compared with a more aggressive resection.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Lillehei. Acquisition of data: Lillehei, Astete. Analysis and interpretation of data: Lillehei, Astete, Wierman, Kerr. Drafting the article: Lillehei, Widdel. Critically revising the article: all authors. Reviewed final version of the manuscript and approved it for submission: all authors. Statistical analysis: Lillehei, Astete. Administrative/technical/material support: Lillehei. Study supervision: Lillehei.

References

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