Results of stereotactic radiosurgery in patients with hormone-producing pituitary adenomas: factors associated with endocrine normalization

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Object. The goal of this study was to determine factors associated with endocrine normalization after radiosurgery is performed in patients with hormone-producing pituitary adenomas.

Methods. Between 1990 and 1999, 43 patients with hormone-producing pituitary adenomas underwent radiosurgery: 26 patients with growth hormone (GH)-producing tumors, nine with adrenocorticotrophic hormone–producing tumors, seven with tumors that produced prolactin (PRL) alone, and one with a tumor that secreted both GH and PRL. The median patient age was 42 years. Thirty-seven patients (86%) had undergone surgery earlier and in 30 (70%) there was tumor extension into the cavernous sinus. The product-limit method was used to calculate endocrine normalization while patients were not receiving any hormone-suppressive medication. The median follow-up period after radiosurgery was 36 months (range 12–108 months).

In 20 patients (47%) there was normalization of hormone secretion at a median of 14 months (range 2–44 months) after radiosurgery; no correlation was found between tumor type and cure. Actuarial cure rates were 20, 32, and 61% at 1, 2, and 4 years posttreatment. Multivariate analysis demonstrated that the absence of hormone-suppressive medications at the time of radiosurgery (relative risk 8.9, 95% confidence interval [CI] 1.2–68.7, p = 0.04) and maximum radiation doses greater than 40 Gy (relative risk 3.9, 95% CI 1.3–11.7, p = 0.02) correlated with an endocrine cure. A new anterior pituitary deficiency developed in seven patients (16%), temporal lobe necrosis was identified in two patients, an asymptomatic internal carotid artery stenosis was detected in two patients, and unilateral blindness occurred in one patient.

Conclusions. Radiosurgery provides an endocrine cure for many patients with persistent or recurrent hormone-producing pituitary adenomas. Further study is needed to determine whether pituitary hormone-suppressive medications have a radioprotective effect.

KEY WORDS • acromegaly • Cushing disease • pituitary adenoma • prolactin • radiosurgery

O verecretion of hormone from pituitary adenomas can result in significant incidences of morbidity and reduced life expectancies for affected patients. Whereas tumor control and preservation of pituitary function is adequate for nonhormone-producing tumors, correction of endocrinopathies is critical to good outcomes for patients with hormone-producing pituitary adenomas. Surgical resection of pituitary adenomas as a primary treatment, generally performed through a transsphenoidal approach, is able to normalize hormone levels rapidly for 57 to 91% of patients. Unfortunately, patients with persistent or recurrent endocrinopathies after surgical resection achieve biochemical remission less frequently after repeated surgery. Fractionated external beam radiation therapy results in clinical remission of symptoms for many patients with hormone-secreting tumors. Nevertheless, radiotherapy frequently causes hypothalamo pituitary dysfunction, typically requires several years to correct hormone overproduction, and is associated with the risk of radiation-induced neoplasms. In recent years radiosurgery has been increasingly used as an alternative to surgery or radiation therapy to manage cases of pituitary adenomas. In this report, we review our experience with radiosurgery in patients harboring hormone-producing pituitary adenomas and analyze factors associated with biochemical remission.

Clinical Material and Methods

Patient Population

Clinical, radiological, and endocrinological information obtained in 59 patients with hormone-producing pituitary adenomas was retrieved from a prospectively maintained computer database. All patients had undergone radiosurgery at the Mayo Clinic in Rochester, Minnesota, between January 1990 and November 1999. Twelve patients with ACTH-producing tumors who had undergone adrenalectomy previously were excluded, and adequate follow up was

Abbreviations used in this paper: ACTH = adrenocorticotrophic hormone; GH = growth hormone; ICA = internal carotid artery; IGF-I = insulin-like growth factor I; PRL = prolactin; UFC = urinary free cortisol.
TABLE 1
Characteristics of 43 patients who underwent radiosurgery for hormone-producing pituitary adenomas

<table>
<thead>
<tr>
<th>Factor</th>
<th>No. of Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>tumor type</td>
<td></td>
</tr>
<tr>
<td>GH-producing</td>
<td>26 (61)</td>
</tr>
<tr>
<td>ACTH-producing</td>
<td>9 (21)</td>
</tr>
<tr>
<td>PRL-producing</td>
<td>7 (16)</td>
</tr>
<tr>
<td>GH-PRL-producing</td>
<td>1 (2)</td>
</tr>
<tr>
<td>cavernous sinus extension</td>
<td>30 (70)</td>
</tr>
<tr>
<td>of tumor</td>
<td></td>
</tr>
<tr>
<td>prior operation(s)</td>
<td></td>
</tr>
<tr>
<td>none</td>
<td>6 (14)</td>
</tr>
<tr>
<td>transsphenoidal surgery</td>
<td>36 (84)</td>
</tr>
<tr>
<td>craniotomy</td>
<td>1 (2)</td>
</tr>
<tr>
<td>prior radiation therapy*</td>
<td>9 (21)</td>
</tr>
</tbody>
</table>

* Median radiation dose 48.5 Gy (range 40–54 Gy).

unavailable in four patients. The characteristics of the remaining 43 patients (17 men and 26 women) are outlined in Table 1. The median patient age was 42 years (range 17–75 years). Thirty-seven patients (86%) had undergone previous operations (range 1–3 operations each). Five of six patients who underwent radiosurgery as primary treatment were believed to be poor candidates for resection because of cavernous sinus invasion of tumor (four patients) or fibrous dysplasia (two patients). One patient with a medically unresponsive prolactinoma was considered to be an excellent candidate for microsurgery, but chose radiosurgery after discussion of the risks associated with resection of her tumor.

In the 26 patients harboring GH-producing tumors the median preoperative basal GH level was 8.3 ng/ml (range 1.2–120 ng/ml); in 22 of these patients the median IGF-I level was 305 ng/ml (range 133–900 ng/ml). The median preoperative 24-hour amount of UFC in the nine patients with ACTH-producing tumors was 154 μg (range 111–1000 μg); in five of these patients the median ACTH level was 82 pg/ml (range 57–200 pg/ml). The median preoperative PRL level in the seven patients with PRL-producing tumors was 123 ng/ml (range 35–460 ng/ml). In one patient with a GH-PRL-producing tumor, the preoperative GH level was 9.1 ng/ml, the IGF-I level was 232 ng/ml, and the PRL level was 41 ng/ml.

Pituitary hormone–suppressive medications for patients with GH- and PRL-producing tumors were given before and after radiosurgery at the discretion of each patient’s endocrinologist. Specifically, all patients with prolactinomas either were unable to tolerate or failed to respond to dopamine-agonist therapy before radiosurgery. Eighteen (69%) of 26 patients with GH-producing tumors continued to display signs of persistent acromegaly, despite a trial of octreotide (nine patients), dopamine-agonist therapy (five patients), or both (four patients). Eleven patients (26%) were receiving pituitary hormone–suppressive medications at the time of radiosurgery; eight of 26 patients with GH-producing tumors were receiving octreotide, whereas three of seven patients with PRL-producing tumors were receiving bromocriptine. No patient with Cushing disease was currently receiving pituitary hormone–suppressive medications. Patients receiving hormone-suppressive medications at the time of radiosurgery were similar to patients not receiving these medications with regard to age (36 years compared with 45 years, p = 0.08), sex (55% women compared with 34% women, p = 0.3), tumor volume (5.5 cm3 compared with 4.9 cm3, p = 0.7 cm3), and preoperative levels of GH (13 ng/ml compared with 24.6 ng/ml, p = 0.3), IGF-1 (445 ng/ml compared with 384 ng/ml, p = 0.6), and PRL (272 ng/ml compared with 167 ng/ml, p = 0.46).

Radiosurgical Dosimetry

Radiosurgery was performed with the aid of a gamma knife (Leksell Gamma Knife; Elekta Instruments, Norcross, GA). Stereotactic magnetic resonance imaging was used for dose planning in all cases. A median of seven isocenters of radiation (range 2–18 isocenters) was used to cover a median prescribed treatment volume of 4.3 cm3 (range 0.4–17.3 cm3). The median radiation dose directed to the tumor margin was 20 Gy (range 14.4–30 Gy), and the median maximum radiation dose was 40 Gy (range 30–60 Gy). There was no difference in mean radiation doses directed to the tumor margin (20.1 Gy compared with 20.1 Gy, p = 0.71) or maximum doses (40.9 Gy compared with 42.4 Gy, p = 0.66) between patients who were receiving pituitary hormone–suppressive medication at the time of radiosurgery and those who were not receiving medication at this time. The calculated dose to the adjacent optic apparatus was less than 8 Gy in five patients (12%), 8 to 10 Gy in 12 patients (28%), 10 to 12 Gy in 22 patients (51%), and greater than 12 Gy in four patients (9%).

Follow-Up Review and Definition of an Endocrine Cure

Neuroimaging, ophthalmological, and endocrinological follow-up examinations were typically performed at 6 and 12 months after radiosurgery, and then yearly thereafter. In all patients visual field testing was performed before radiosurgery. A comparison of pre- and posttreatment visual fields was available for 30 patients (70%); posttreatment visual function testing in the remaining 13 patients was based solely on clinical examination. Patients who received hormone-suppressive medications at the time of radiosurgery and those who received these medications after the procedure usually continued their medical regimen until their symptoms improved and biochemical remission was demonstrated. The medications were subsequently discontinued and repeated hormonal assays were performed. Endocrine normalization, or “cure,” was defined as the finding of normal or below normal hormone levels while the patient was not receiving any pituitary hormone–suppressive or cortisol-lowering medication. Specifically, patients with acromegaly were required to have a fasting GH level less than 2 ng/ml and normal age- and sex-adjusted IGF-I levels;24 patients with Cushing disease were required to have a 24-hour amount of UFC less than 90 μg, and patients with prolactinomas were required to have PRL levels lower than 23 ng/ml. Additional endocrinological testing to determine anterior pituitary dysfunction or recurrence of hormone overproduction was obtained at the discretion of the treating endocrinologist as required during the follow-up interval and was typically based on the patient’s symptoms. Specifically, levels of GH and IGF-I were not routinely tested in nonacromegalic patients after radiosurgery and, thus, the incidence of a new GH deficiency is likely to have been underestimated.
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Fig. 1. Graph demonstrating actuarial rate of endocrine normalization after radiosurgery in 43 patients with hormone-producing pituitary adenomas.

Statistical Analysis

The dependent variable for all analysis was endocrine normalization while the patient was not receiving any hormone-suppressive medication. The actuarial rate of endocrine normalization was determined using the Kaplan–Meier method. Univariate analysis was performed using the Fisher exact test. Factors associated with an endocrine cure at a significance level of 0.1 and less on univariate analysis were entered into a Cox proportional hazards model.

Results

Tumor Growth Control

No tumor enlarged after radiosurgery during a median imaging follow-up period of 36 months (mean 39.5 months; range 12–115 months). In 30 patients (70%) a decrease in tumor size compared with the time of radiosurgery was demonstrated.

Endocrine Normalization

Endocrinological follow-up data were available at a median of 36 months after radiosurgery (mean 42.4 months; range 12–115 months). Normalization of hormone secretion while patients received no suppressive medication can be broken down according to tumor type by the following: 11 (42%) of 26 patients with GH-producing tumors; seven (78%) of nine patients with ACTH-producing tumors; two (29%) of seven patients with PRL-producing tumors; and zero (0%) of one patient with a GH–PRL-producing tumor. Overall, endocrine normalization was achieved in 20 (47%) of 43 patients after radiosurgery (mean 39.5 months; range 12–115 months). One patient with a GH-producing tumor met the criteria for cure at 30 months after radiosurgery, but repeated testing performed 1 year later revealed a recurrence of elevated IGF-I levels and the patient was placed on a regimen of octreotide which later resulted in normalization of IGF-I levels. Of those patients in whom endocrine normalization was not achieved in response to radiosurgery alone, seven patients (16% of all patients), five with GH-producing tumors, and two with PRL-producing lesions, were found to have normal levels of hormone in response to continued pituitary hormone-suppressive medications.

Incidence of Morbidity and Later Treatment

Eleven patients (26%) sustained treatment-related morbidity. The most frequent complication after radiosurgery was a new anterior pituitary deficiency. Seven patients (16%) were found to have hypogonadism (six patients), and/or hypothyroidism (six patients), and/or hypogonadism (two patients); three of these seven patients had received prior or fractionated radiation therapy previously. The average follow-up period of patients in whom new anterior pituitary dysfunction developed was longer than that of patients without new deficits (60.1 months compared with 39.1 months, p = 0.03); no other patient- or treatment-related factor correlated with new onset of pituitary dysfunction. No patient experienced diabetes insipidus. In two patients radiation necrosis developed in the adjacent temporal lobe. One patient had persistent Cushing disease after undergoing three earlier transphenoidal procedures and received 18 Gy at the 50% isodose line (volume 4.4 cm³). Forty-eight months after radiosurgery a small region of enhancement and increased signal was noted in the adjacent temporal lobe; the patient remains asymptomatic 43 months later. The second patient also had persistent Cushing disease and was treated with a combination of radiosurgery and fractionated radiation therapy (45 Gy). A tumor-margin radiation dose of 15 Gy at the 50% isodose line was prescribed to cover a volume of 12.2 cm³. Twelve months after radiosurgery, imaging changes consistent with those of radiation necrosis were noted. The patient later complained of headaches and repeated imaging revealed a mass effect. The patient required a temporal lobectomy 29 months after radiosurgery. This same patient suffered unilateral blindness; we estimated that the radiation dose directed to the optic nerve

<table>
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<th>Factor</th>
<th>Positive Predictor</th>
<th>p Value</th>
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<tr>
<td>patient age (yrs)</td>
<td>&lt;42</td>
<td>0.14</td>
</tr>
<tr>
<td>tumor type</td>
<td>ACTH-producing</td>
<td>0.05</td>
</tr>
<tr>
<td>prior surgery</td>
<td>no</td>
<td>0.36</td>
</tr>
<tr>
<td>prior radiation therapy</td>
<td>no</td>
<td>0.38</td>
</tr>
<tr>
<td>cavernous sinus extension</td>
<td>no</td>
<td>0.04</td>
</tr>
<tr>
<td>tumor volume (cm³)</td>
<td>&lt;4.2</td>
<td>0.22</td>
</tr>
<tr>
<td>tumor volume (cm³) as a continuous variable</td>
<td>decreasing</td>
<td>0.51</td>
</tr>
<tr>
<td>suppressive medications at time of radiosurgery</td>
<td>no</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>radiation dose (Gy)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tumor margin</td>
<td>&gt;20</td>
<td>0.33</td>
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<tr>
<td>maximum</td>
<td>&gt;40</td>
<td>0.04</td>
</tr>
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</table>

Univariate analysis demonstrated four factors related to endocrine normalization after radiosurgery: ACTH-producing tumors, no cavernous sinus extension, no hormone-suppressive medications at the time of radiosurgery, and a maximum radiation dose greater than 40 Gy (Table 2). Multivariate analysis demonstrated that the absence of hormone-suppressive medications at the time of radiosurgery (relative risk 8.9, 95% confidence interval 1.2–68.7, p = 0.04) and maximum radiation doses greater than 40 Gy (relative risk 3.9, 95% confidence interval 1.3–11.7, p = 0.02) correlated with an endocrine cure.
was 8 to 10 Gy. No other patient sustained any visual loss or other cranial nerve injury. In two patients asymptomatic stenosis of the ICA developed. The radiation dose directed to the tumor margin and the maximum radiation dose were 25 and 50 Gy, respectively, for one patient and 30 and 60 Gy for the other; one patient also had received previous fractionated radiation therapy (45 Gy).

Four patients (9%) have undergone additional surgery to treat persistent hormone oversecretion syndromes. Two patients (one with a GH-producing tumor and the other with an ACTH-producing lesion) underwent repeated radiosurgery 22 and 26 months, respectively, after the first procedure. In one patient craniotomy was performed 13 months after radiosurgery for a GH-producing tumor, followed by repeated radiosurgery 5 months later. Bilateral adrenalectomies were performed 53 months after radiosurgery for persistent Cushing disease in one patient with an ACTH-producing tumor.

Discussion

Radiosurgery has been performed in patients with pituitary adenomas for almost 50 years. According to early reports, authors found this procedure to be effective, especially for patients with Cushing disease. However, the information available from these studies had numerous flaws that make direct comparisons with published results of the best medical and surgical treatments difficult. For example, in some studies a cure for acromegaly described as GH levels lower than 10 ng/ml, despite a general acceptance within the endocrinological community that normal IGF-I levels are a more accurate determination of biochemical remission. Furthermore, a number of patients in whom a cure was reported continued to require either pituitary hormone-suppressive or cortisol-lowering medicines as of their last follow-up examinations. Other problems with most of these papers are the small number of patients and the relative short follow-up period presented. The importance of longer follow-up periods has become increasingly recognized because late complications after radiosurgery of the sellar region, such as anterior pituitary deficiency or vascular injury, typically occur only after a number of years have passed since the procedure. Nonetheless, this initial information has provided the impetus for better and more accurate reporting of the use of radiosurgery in the treatment of pituitary adenoma.

Fortunately, a number of papers have recently been published on contemporary techniques of radiosurgery performed in patients with hormone-producing pituitary adenomas, and the results reported in these papers follow more standardized criteria of endocrine cure. Landolt and colleagues reported on 31 patients who underwent radiosurgery for acromegaly that had persisted after previous surgery. In 27 patients (87%) at least 25 Gy was delivered to the tumor margin and a maximum of 50 Gy was recorded. Two years after radiosurgery, GH levels were less than 5 ng/ml and there were normal IGF-I levels in 14 (45%) of 31 patients. Of note, these authors found that octreotide treatment given at the time of radiosurgery significantly decreased the likelihood of an endocrine cure (cure rate 60% compared with 11%, p = 0.04). Ikeda, et al., examined 17 patients with GH-producing tumors who received a median dose of 25 Gy (range 16.7–35 Gy) to the tumor margin after previous surgery had failed to provide an endocrine cure. With a median follow-up duration of 48 months, 14 patients (82%) were found to have GH levels lower than 1 ng/ml after the oral glucose tolerance or to have normal IGF-I levels. Sheehan, et al., reviewed cases of Cushing disease treated by radiosurgery at the University of Virginia between 1990 and 1998. Previous transsphenoidal surgery had failed to elicit an endocrine cure in any of those patients. The mean radiation dose to the tumor margin and the maximum radiation dose were 20 and 47 Gy, respectively. Normal 24-hour UFC amounts were measured in 27 (63%) of 43 patients in 12.1 months after radiosurgery. Three patients experienced recurrence of their Cushing disease after initial remission of symptoms from 19 to 38 months after radiosurgery. Landolt and Lomax treated 20 patients who harbored PRL-producing adenomas with radiosurgery, 16 of whom had undergone previous surgery. The maximum radiation dose exceeded 40 Gy (median 50 Gy) in 19 patients (95%). Only five patients (25%) were found to have normal PRL levels of dopamine while not receiving agonist therapy after radiosurgery; however, the endocrine cure rate was significantly affected by the use of dopamine agonists at the time of radiosurgery. No patient who received dopamine agonist therapy was found to have a normal level of PRL while not taking medications during the follow-up interval, whereas five (45%) of 11 patients who did not receive dopamine agonist therapy had successful endocrine outcomes. Thus, it appears that radiosurgery can produce biochemical remission, according to modern criteria, in many patients with hormone-producing pituitary adenomas, the vast majority of whom experienced recurrent or persistent hypersecretion, despite having undergone prior tumor resections.

Our results confirm that radiosurgery can effectively normalize oversecretion of hormones for patients with hormone-producing pituitary adenomas. Overall, we found that radiosurgery achieved endocrine normalization in 20% of patients at 1 year, 32% at 2 years, and 61% at 4 years posttreatment. Multivariate analysis demonstrated two variables that were associated with an endocrine cure: absence of suppressive medications at the time of radiosurgery and a maximum radiation dose greater than 40 Gy correlated with a hormonal cure. This supports the concept of Landolt, et al., and Landolt and Lomax that pituitary hormone-suppressive medications may act as radioprotective agents. In fact, no disease in our series was cured if the patient was receiving pituitary hormone-suppressive medications at the time of radiosurgery. Conversely, endocrine normalization was achieved in 20 (63%) of 32 patients who were not receiving these medications. Despite these findings and the similarity between the two groups with regard to patient- and treatment-related characteristics, a prospective randomized trial is needed to validate this hypothesis. Nonetheless, a radioprotective effect from pituitary hormone-suppressive medications could possibly explain the poor results of radiosurgery in patients with prolactinomas that have been published, because in the majority of such patients, regimens of dopamine agonists were not discontinued prior to radiosurgery. Although the small numbers in our study make our findings susceptible to Type I errors, our results correlate well with published results from other centers at which radiosurgery has been performed in patients with hormone-producing pituitary adenomas. Moreover, in

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this study we used the accepted criteria of an endocrine “cure,” even though we recognize that these standards are open to discussion and change.12,25,43

New endocrine deficiencies were the most frequent complication (16%) that we noted after pituitary adenoma radiosurgery. Other centers have reported that new pituitary hormone insufficiency occurred in 0 to 69% of patients.13,14,27,32 Although we were not able to demonstrate any correlation based on our data, there is likely a direct correlation between the prescribed treatment volume and the chance of new endocrine deficits, because the amount of irradiated normal gland would increase as well. Moreover, the time required for such deficits to develop may be more prolonged, compared with the time for cranial nerve deficits and other well-described complications after radiosurgery. Höybye and coworkers13 found that additional hormonal deficiencies appeared in 11 (69%) of 16 patients 12 to 22 years after radiosurgery for ACTH-producing tumors. We did find that the incidence of new onset anterior pituitary dysfunction increased with a longer follow-up period after radiosurgery. Therefore, diligent endocrinological follow-up examinations are necessary for these patients to ensure that new hormonal deficits are recognized and appropriately managed.

Two other complications we noted are worthy of further discussion. First, one patient in our series suffered unilateral blindness after radiosurgery. This patient had persistent Cushing disease, despite having undergone previous transsphenoidal surgery and fractionated radiation therapy (45 Gy). In this case the tumor margin (boundary 12 cm²) received a radiation dose of 15 Gy (maximum dose 30 Gy). The calculated radiation dose to the affected optic nerve was estimated to be between 8 and 10 Gy. Although this appears to support the notion that radiation doses to the optic apparatus should be limited to 8 Gy or less,11,30 the overall incidence of optic nerve injuries for our patients in whom 8 Gy or more was delivered to the adjacent optic structures was only one (3%) of 38 patients. Thus, we feel that limiting the optic nerve dose to less than 8 Gy is an overly conservative decision, and agree that radiation doses of 10 Gy or more are acceptable over small volumes of the optic apparatus.21 This is especially relevant for radiosurgery of hormone-producing tumors, in which the choice of an endocrine cure increases with higher radiation doses.17,28 Second, asymptomatic ICA stenosis in two patients developed after radiosurgery. This finding has been observed by others after pituitary adenoma radiosurgery23 and radiosurgery of cavernous sinus meningiomas.31,35 Based on our experience, we now attempt to limit radiation coverage of the ICA to no more than 50% of the vessel diameter whenever possible. Last, radiation-induced tumors that appear after radiosurgery has been performed in patients with arteriovenous malformations,15 meningiomas,45 and vestibular schwannomas46 have been reported. Thus, we need additional long-term follow-up review of patients who undergo radiosurgery for benign tumors to determine accurately the true risk of this complication. Most likely, the risk of radiation-induced neoplasms after radiosurgery will be a log factor less than the 1 to 3% risk reported after fractionated radiotherapy.2,34

How does radiosurgery compare with resection and radiotherapy for patients with hormone-producing pituitary tumors? It has been convincingly shown that resection performed by an experienced surgeon provides an endocrine cure for 78 to 91% of patients with microadenomas.2,8,14,33,41–43 Moreover, surgery provides an immediate cure without a latency interval. A delay in hormone normalization can have devastating effects for patients with oversecretion of ACTH or GH. Nevertheless, the success of resection declines as tumor size increases, if there is invasion of the cavernous sinus, or if the patient experiences recurrent or persistent hormone oversecretion, despite having undergone previous surgery. In these cases, the endocrine cure rate is significantly less. Laws, et al.,19 have argued that the ability of radiosurgery to provide endocrine normalization for a large proportion (63%) of patients with Cushing disease in whom prior transsphenoidal surgery has failed was encouraging. We agree that an endocrine cure rate of approximately 50% after radiosurgery is rather good, if one considers that in the vast majority of these patients previous surgery has failed and that many of these patients harbor tumors extending into the cavernous sinus.

Radiosurgery appears to be associated with a higher rate of biochemical remission than radiotherapy for patients with hormone-producing pituitary adenomas. Tsang, et al.,40 found that elevated hormone levels were measured in 61% of patients after radiation therapy (median dose 50 Gy) at a median follow-up period of 7.3 years. Barkan and associates4 found that, although many patients with acromegaly were found to have a decreased GH levels, normal age- and sex-adjusted IGF-I levels were achieved in only two (5%) of 38 patients at a mean follow-up period of 6.8 years. Landolt and colleagues17 compared 16 patients who had undergone radiosurgery with 50 patients who had undergone radiotherapy for persistent acromegaly. In their study, despite the fact that the number of patients in whom an endocrine cure was achieved was similar after radiosurgery or radiotherapy, the mean interval to biochemical remission was significantly shorter among those who underwent radiosurgery (1.4 years compared with 7.1 years). The authors concluded that radiosurgery was preferred over fractionated radiation therapy for patients whose disease was not successfully treated by the initial surgery.

Conclusions

Surgical resection should remain the initial primary treatment for the majority of patients with hormone-producing pituitary adenomas. Nonetheless, radiosurgery provides biochemical remission for many patients with persistent or recurrent hormone oversecretion syndromes caused by the tumor’s size or location.

References


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