Combination of Surgery and Gamma Knife in the Management of En Plaque Meningioma

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Objective: The aim of this study was to determine the results of using gamma knife in resection of en plaque meningioma after subtotal surgery resection.

Materials and Methods: All patients with en plaque meningioma in spheno-orbital area, who were subject to this experiment in the Neurosurgery Clinic of Shahid Rajai Hospital (affiliated to Qazvin University of Medical Sciences, Qazvin, Iran), were operated for tumor resection. Gamma knife was used to resect the tumor tissue in patients who underwent subtotal surgery resection. Patients were followed up for recurrence.

Results: Of the 22 patients with average age of 53.82 ± 11.03 years who participated in this study, 7 (31.82%) were male and 15 (68.18%) were female. Proptosis was the prevalent symptom with 77.28% prevalence. Tumor tissue was totally resected in 6 patients (26.1%), and the remaining patients were treated by gamma knife after undergoing subtotal resection. Visual acuity, tumor size, and the distance between the interzygomatic line and the interior surface of the eyeball had significant improvement after 3 months (*P*-value of changes of all 3 variables was <0.001). Recurrence in 6 patients (27.27%) was diagnosed on average 41.18 ± 5.77 months after follow-up, and it was significantly lower in patients treated using gamma knife (*P*-value <0.01). Recurrence was caused by involvement of orbital cavity and cavernous sinus (*P*-value < 0.01).

Conclusions: Using gamma knife is useful in the treatment of en plaque meningioma patients after undergoing subtotal surgery resection. It also reduces the risk of tumor recurrence.

Key Words: en plaque meningioma, gamma knife, sphenoid wing

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Meningioma is one of the most common tumors of the nervous system and it is usually benign in nature.[1] Meningioma is divided into 2 subgroups based on its growth pattern and appearance: the most common type of this tumor, which is called "meningioma en mass" is a benign, easily treatable, and, like other benign tumors, resection is the last step in its treatment.[2,3] The other type, which is called "meningioma en plaque," only forms 2% to 9% of all meningioma cases. Although this type is mostly benign in pathologic studies, because of its very special growth pattern and extensive involvement of surrounding tissue, the treatment of "en plaque meningioma" is very difficult. "En plaque meningioma" grows over the dura mater like a sheet and can spread through the skull and intracranial structures such as paraspinal region, cavernous sinus, sphenoid wing, orbital cavity, foramen magnum, etc.[4–7] In this particular type of meningioma, because of different growth patterns and the involvement of different structures in each patient, there is no fixed surgical approach and the procedure are different in each case. Residual malignant tissue, as well as the tumor size, increases the risk of recurrence and total resection surgery is very difficult and almost impossible because of the extensive invasion of the body's major organs, such as the orbit and cavernous sinus.[7–9] Thus, nonsurgical resection is considered as the adjuvant treatment. Gamma knife is a nonsurgical treatment proposed recently for the treatment of en plaque meningioma in which tumor tissue is not entirely resected by surgery.[7,9–11]

In this study, tumor tissue was surgically resected while preserving important structures and the tumors, in which complete surgical resection was impossible, were treated by the gamma knife and the results were studied.

MATERIALS AND METHODS

Patients

All patients admitted to the Neurosurgery Clinic of Shahid Rajai Hospital (affiliated to the Qazvin University of Medical Sciences, Qazvin, Iran) with any initial complaints and who were diagnosed with "en plaque meningioma" of spheno-orbital region, after further examinations, were a part of this quasiexperimental study.

Data Collection

Demographic and clinical information of the patients were collected by asking about their history and

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using their medical records. Visual acuity of all patients was assessed by a single ophthalmologist. For the evaluation of proptosis during imaging, first, the screen image was placed parallel to the head, the optic nerve, and lens. The patients were asked to keep their eyes open and to look directly without moving their eyes. If the distance between interzygomatic line and anterior surface of the eyeball was >23 mm, proptosis was confirmed.[12,13] Visual acuity, proptosis, and size of the tumor before and 3 months after surgery were analyzed.

Surgical Approach

For each patient, based on the findings of the medical imaging, the best surgical approach was chosen. Tumor tissue was removed as completely as possible. The primary factor limiting the surgical resection was the invasion of the major structures such as eye cavities because of the need to preserve them and/or severe complications of damaging them. Involved bone tissues were kept as much as possible while trying to maintain the overall structure. To maintain the performance and beauty, reconstruction was carried out using a combination of soft tissue, bone, and titanium mesh.

Gamma Knife After Surgery

In gross analysis, if surgical resection was impossible for the remaining tumor tissue, gamma knife was used to eliminate it. Because of the widespread of the tumor, surgery cannot ensure the complete eradication (microscopic) of the malignant cells, even in patients for whom the gross examination confirmed the elimination of tumor tissues. However, in this study, because of the limitations of using gamma knife, only the cases in which gross examination confirmed remaining tumor tissue after the surgery were treated using gamma knife.

Data Analysis

For analyzing the data, SPSS software (version 20) was used. Descriptive analyzes was reported as mean ± SD. To compare the qualitative and quantitative variables before and after the treatment, the Wilcoxon test and the paired *t* tests were used, respectively. Two-sided *P*-value below 0.05 was considered statistically significant.

Ethics

All patients filled a written consent form before participating in the study. All patients were assured that they could quit the study at any stage without any complications. Patients' identity and personal information were confidentially stored. Further, researchers were bound to the other principles outlined in the Declaration of Helsinki.[14] Finally, this study was approved by the ethics committee of Iran University of Medical Sciences.

RESULTS

Twenty-two patients with spheno-orbital meningioma were entered into this trial. Seven participants (32%) were male and 15 participants (68%) were female. Participants' average age was 53.8 ± 11.03 years within the range of 29 to 70 years. Patient sex ratio (male to female) was about 1:2. The initial symptoms in 77.3% of the patients (17 patients) was proptosis; in 13.6% (3 patients), decreased visual acuity; in 4.5% (1 patient), headache; and in 4.5% (1 patient), seizures. In 10 patients, tumor involved the right hemisphere and in 12 other patients it involved the left hemisphere. In 40.9% of patients (9 patients) sinus cavernous, in 45.4% (10 patients) hole orbitals, in 36.4% (8 patients) ethmoid sinus, in 22.7% (5 patients) external carotid, in 31.8% (7 patients) abducens nerve, and in 40.9% (9 patients) optic nerve were involved. Tumor size was measured in 3 dimensions, and before surgery the mean tumor size was 92.4 ± 12.6 cubic centimeters. Before the surgery, the mean visual acuity and the distance between the interzygomatic line and anterior surface of the eyeball were 0.23 ± 0.16 and 23.91 ± 2.07 mm, respectively. According to the World Health Organization grading system, 3 patients had grade IV, 5 patients had grade III, 6 patients had grade II, and 8 patients had grade I tumors. All patients underwent surgery for tumor resection, but we only (27.3%) achieved a complete resection of tumor tissue with 6 patients and the remaining 16 patients underwent gamma knife surgery after subtotal resection.

After resection and gamma knife surgery, patients were followed up for 63 ± 8.93 months (31 to 72 mo) and in this period, 6 patients (27.3%) in average 41.2 ± 5.77 months of follow-up, had tumor recurrence. With resection of the involved bone (in 16 patients) the overall structure of the head was damaged; therefore, to maintain the performance, safety, and beauty, reconstruction of the resected areas was performed using a combination of fascia grafts and muscle grafts. Further, titanium mesh was used in reconstructing the resected areas of 7 patients in this study.

At 3 months after treatment, visual acuity, tumor size, and the distance between interzygomatic line and anterior surface of the eyeball were 0.68 ± 1.50, 1.3 ± 1.08 cm^3, and 19.95 ± 1.73 mm, respectively, and these 3 criteria improved significantly (*P*-value were <0.01 in the changes in all 3 criteria). On the basis of the findings of our study, recurrence was significantly lower in recipients of gamma knife in comparison with the other patients (*P*-value < 0.01).

Further, the involvement of the orbital cavity and cavernous sinus were predisposing factors of tumor recurrence in patients (*P*-value of both variables were <0.01).

DISCUSSION

En plaque meningioma is a special kind of meningioma tumor that is usually benign.[1] The main feature of this tumor is how it grows. The particular form of the tumor grows like a sheet (sheet like) and involves with a great deal of tissues in the primary site of the tumor, which makes it difficult to choose a treatment approach.[5,6] Like all other tumors, total resection could be the last phase of treatment but because of the wide spread of the tumor and the involvement of different structures, such as bones, dura mater, soft tissues, and nerves, in most cases it is almost impossible to perform total resection without damage to

vital organs.[8,15] In this kind of tumor we cannot make a perfect microscopic safe margin for resection of the tumor, and total resection is performed only at gross level. Actually, the surgeons cannot ensure the total resection of this tumor even at the gross level. Gross total resection of the tumor is very difficult because of the involvement of critical structures such as the eye cavity, cavernous sinus, cranial nerves, etc.[7,15]

In recent years, gamma knife has been introduced as an adjuvant therapy for surgical resection of the tumor, which cannot be resected because of the high risk of damage to vital organs involved in the body.[9,11,16] In this study, gamma knife was used for only 16 patients of all patients in this study, and all the tumors were resected using the surgery alone or the combination of resection and gamma knife surgery. Patients were followed up for 6 months and 6 patients had tumor recurrence. Although the recurrence was not quick, and recurrence rates were lower than other studies, it was not negligible. This was because of the fact that complete resection was performed in gross scale and in microscopic scale; remaining tumor cells were probably not preventable.

Schick et al[8] operated on 67 patients who suffered from plaque meningioma but they could not perform total resection in 27 patients because of the complicated involvement within the eye and cavernous sinus. In that study, they performed radiotherapy after the surgery to prevent the increase in the tumor size. Their patients' tumor recurrence rate (10.4%) was less than ours, which may be because of less appearance complexity and tumor involvement of their patients in comparison with our cases. Further, radiotherapy was performed to prevent the increase in tumor size during the follow-up period and not with the aim of destroying tumor tissues.

Simas and Farias[15] studied 18 patients with "sphenoid wing en plaque meningioma," from whom 3 patients underwent radiotherapy right after the surgery and 3 other patients underwent therapy after the recurrence of the tumor. These 6 patients who underwent radiotherapy did have tumor recurrence during the follow-up period. The researchers showed that in patients with tumor involving cavernous sinus tumor and the superior orbital fissure (in these patients the recurrence rate was higher than other patients), radiation therapy was very effective after surgery for reducing tumor recurrence.

Boari et al[17] assessed the clinical outcomes of 40 patients with en plaque meningioma. At the end of the study, researchers concluded that the combination of radiation therapy and surgery in patients with tumors involving the cavernous sinus and superior orbital fissure reduces surgical morbidity and leads to controlled tumor growth. This study concludes that using gamma knife during surgery reduces the risk of damage to vital organs and increases the rate of total resection, which helps to reduce tumor recurrence.

According to the result of this study and similar studies, surgeon's expertise in resection of the tumor, as well as using gamma knife, reduced the recurrence rate significantly, but without total resection of macroscopic tumor, recurrence is not completely wiped out. Further, future studies should be focused on new methods that allow resection of the tumor tissues at the cellular scale.

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