Tratamiento Quirurgico de la Necrosis Por Radiacion Cerebral, Complicacion de la Radiocirugia Estereotactica en el Meningioma de Base de Craneo:

Surgical treatment of cerebral radiation necrosis complicating stereotactic radiosurgery in skull base meningioma

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RESUMEN

Aunque la radiocirugía estereotáctica se haya demostrado ser un tratamiento eficaz y no invasivo para algunos meningiomas de la base del cráneo, las complicaciones tales como el edema, la necrosis por la radiación, y la disfunción de nervios craneales - son posibles en algunos casos. En la actualidad, un tratamiento quirúrgico para la necrosis por radiación (inducida por radiocirugía estereotáctica), a fin de tratar un meningioma de base de cráneo ha sido reportado solo en pocos casos. Debido a la intolerancia de corticosteróides, se realizó en un paciente, una resección quirúrgica de la necrosis por radiación del tumor. Aunque es raro, los médicos que derivan a los pacientes la radiocirugía estereotáctica deben ser conscientes de dichas complicaciones.

Palabras Clave: necrosis por radiación, radiocirugía, tratamiento quirúrgico, complicaciones, la base del cráneo, meningioma.

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ABSTRACT

Although stereotactic radiosurgery has been proven to be an effective and noninvasive treatment for some skull base meningiomas, complications such as swelling, radiation necrosis, and cranial nerve dysfunction are possible in some cases. As to date, a surgical treatment for radiation necrosis (induced by stereotactic radiosurgery) in order to treat skull base meningioma has yet to be reported in few cases. Due to corticosteroid intolerance we performed in one patient a surgical resection of the radiation necrosis and tumor. Albeit rare, clinicians referring patients for stereotactic radiosurgery must be aware of such complications.

Key words: radiation necrosis, radiosurgery, surgical treatment, complication, skull base, meningioma

A Although stereotactic radiosurgery has been proven to be an effective and noninvasive treatment for meningiomas[1-10], complications such as swelling, radiation necrosis, and cranial nerve dysfunction are possible in some cases. In terms of treatment of radiation necrosis, there is a lack of data regarding the resection of symptomatic radiation-injured regions. This is due to the fact that imaging characteristics might indicate radiation necrosis once stereotactic radiosurgery for skull base meningiomas has already taken place.

CASE REPORT

A 74 year-old lady suffered from progressive headaches and lack of concentration 5 months after the LINAC knife radiosurgery (10 Gy were administered to the tumor margins) took place in another medical institution, in order to treat a small lesion located on the left anterior cranial base. There was no previous record of headaches or any other neurological symptoms. The physical examination detected anosmia in the left nostril, while the others cranial nerves remained intact. The ophtalmoscopic examination was normal and there was no motor, sensory, coordination, or gait alteration.

An enhanced magnetic resonance imaging (MRI) and a computed tomography (CT) revealed abnormal ring development and extensive brain edema around the lesion.

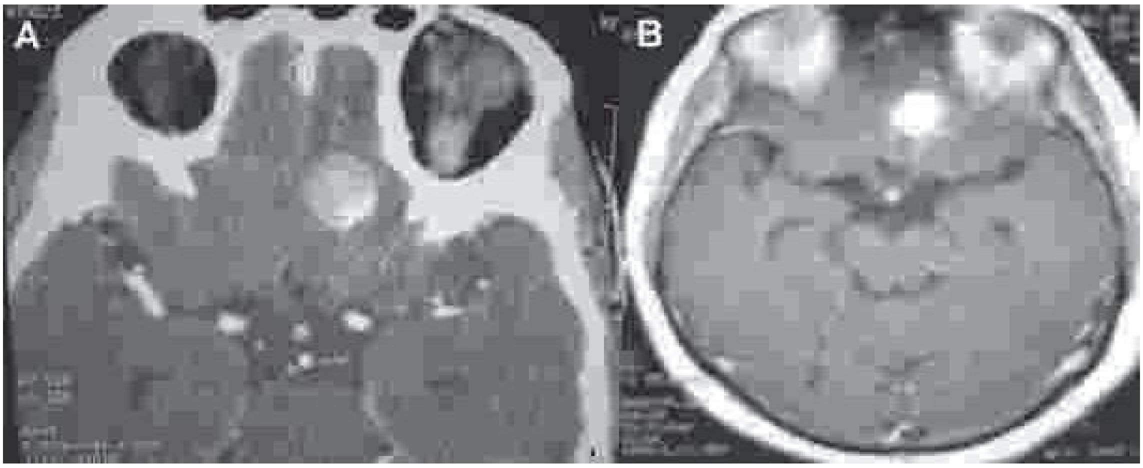

Fig 1: Contrast-enhanced CT (A) and MRI (B) showing small lesion in the left anterior cranial base with strong homogeneous enhancement.

Radiological studies prior to the LINAC knife treatment did not show any brain edema. The radiological characteristics presented were similar to those findings of a small olfactory groove meningioma. Based on the hypothesis of radiation necrosis, the patient initiated a dose of dexamethasone 4 mg BID, which showed to improve her symptoms. Two months later, a new CT did not reveal any edema. However, with the ongoing intake of dexamethasone, the patient developed glucose intolerance, weaknesses, and neuropsychiatric disturbances.

Eventually, the corticosteroid was reduced to 4 mg per day, but with no improvement. Thus, the medication was discontinued and, subsequently, a headache recurrence ensued. A new CT revealed a large left frontal edema. The corticosteroid was reintroduced, but the patient developed several side effects once again.

Based on this clinical evaluation, the patient was submitted to a surgical resection of the radiation necrosis. Thus, we performed a left fronto-orbital craniotomy with a subfrontal approach. First, the duramater the location of the tumor was ressected, as well as the tumor itself. Second, we executed a corticotomy at the lateral orbital gyrus and ressected the necrotic tissue extending from the orbital gyri to the anterior horn of the left lateral ventricle. We performed an anatomical resection based on the detailed examination of the necrosis topography revealed in the MRI. Finally, we ressected the tumor and the necrotic tissue surrounding the tumor.

There were no surgical complications and the corticoids were discontinued progressively during the postoperative period. The pathological examination showed necrotic tissue with thickened vessels, endothelial proliferation, and fibrosis associated with the infiltration of lymphocytes and macrophages. The tumor pathology showed meningioma. Six months later, the enhanced MRI revealed a resection of the meningioma and an absence of edema with no evidence of radiation necrosis. The patient is asymptomatic and undergoing follow-ups in our clinic without corticosteroid treatment.

DISCUSION

Radiation therapy is an important component of tumor management, with the goal being to control the tumor without damaging the healthy tissue. However, some degree of residual injury is not uncommon [11,12,13]. Among such complications, brain radionecrosis is the most serious and can result in significant morbidity and mortality. It is a progressive spectrum of injury ranging from early edema to total tissue necrosis. The type and dose of radiation received is correlated to its development. Symptoms, such as headaches, neuropsychiatric deficits, focal, motor, or sensory deficits, seizures, hypothalamic, and pituitary insufficiency, among others [13], depend on the location of the injury. Radiation necrosis can occur as early as a few months or even decades after treatment. It generally occurs 6 months to 2 years after radiation therapy.

Yet, stereotactic radiosurgery has been shown to be an effective, noninvasive treatment for a variety of intracranial conditions with lower rate of complications compared to a standard radiation therapy. Stereotactic radiosurgery is most commonly delivered using a LINAC-based system or a gamma knife unit. As with radiation therapy, delayed radiation injury is also a complication of the treatment. It commonly occurs 3 months or more after treatment and manifests itself as a necrotic lesion in the white matter. A small treatment volume and a small dose can minimize the risks of radiation necrosis [14] development. However, it is difficult to determine the parameter that most accurately describes this potential risk. The results of Chin, Ma and DiBiase [15] indicate that the margin and mean doses were not significant, but the tumor volume and total radiation dose was statistically significant. Repeated radiosurgery to the same lesion and glioma histological findings were considered risk factors to radiation necrosis. Gliomas were more likely to result in necrosis (17%) than brain metastases (5%) or benign tumors (7.5%). Its findings confirm previous reports [16-19]. Regarding the dose, Voges et al.[10], reported similar findings for prediction of radiation-induced imaging changes after LINAC-based radiosurgery in meningiomas, skull base tumors, and AVMs. They noted that 10-Gy volumes greater than 10 cm3 were associated with a greater

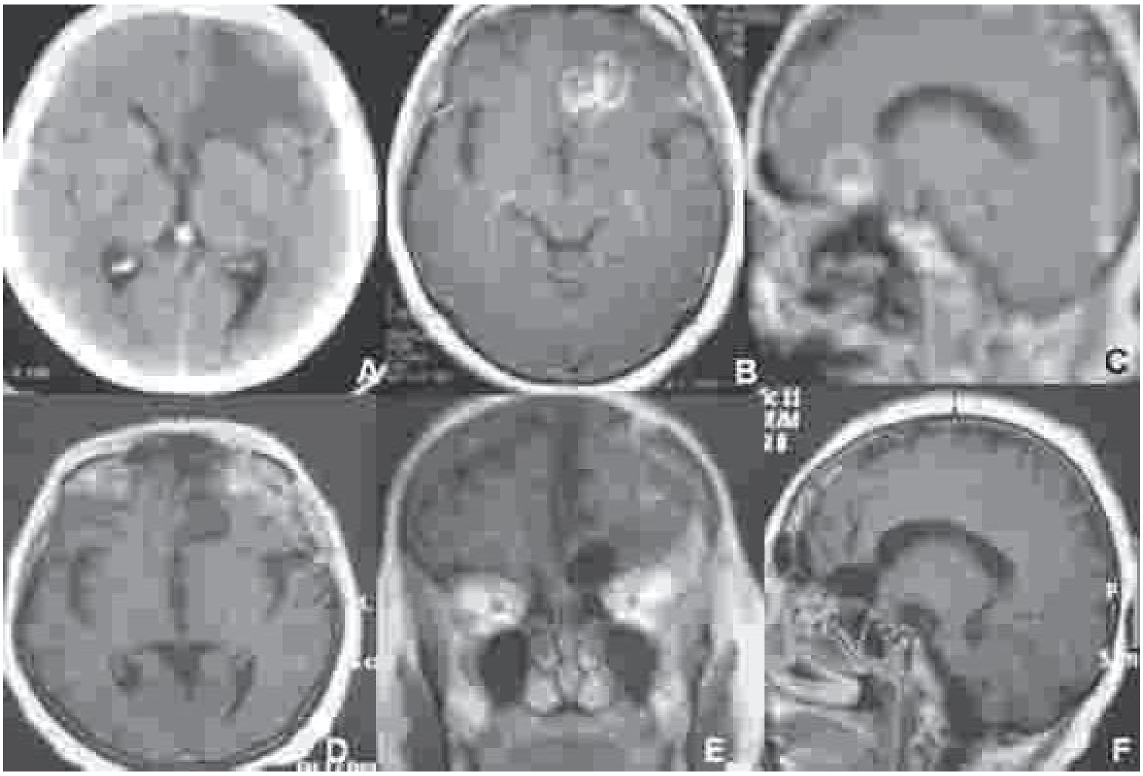

Fig 2: Pre (A,B and C) and postoperative (D,E and F) studies. A. Axial non Contrast-enhanced CT showing large left frontal brain edema. Contrastenhanced axial (B) and sagittal (C) MRI showing abnormal ring enhancement around the lesion after radiosurgical treatment. Postoperative contrast-enhanced axial (D), coronal (E) and sagittal (F) MRI showing total lesion resection.

risk of radiation changes.

Treatment of radiation necrosis is difficult. There are no high-level evidence-based studies regarding the best treatment modality and the current treatment itself possesses significant side effects. Corticosteroids acting as controllers of the cerebral edema are usually initiated at the first stage of medical management in an attempt to stabilize or improve neurological symptoms [20, 21]. The adverse effects of the corticosteroids can result in significant morbidity, if sustained over several months. Hyperglycemia, edema, osteonecrosis, myopathy, peptic ulcer disease, hypokalemia, osteoporosis, euphoria, psychosis, myasthenia gravis, growth suppression, and infections are a few examples. In one study, 65% of the patients had their steroid levels continually increased in a failing attempt to alleviate deteriorating clinical status and progressive neurological deficit [22]. Steroids cannot be increased indefinitely and their failure or the patient's intolerance is usually an indication for surgical resection of the affected neural tissue[23]. In dramatic cases in which steroids fail and surgery is not possible, the progression of the disease is fatal.

There are other options to treating radiation necrosis, but these are controversial for their results have not been promising. The use of nonsteroidal anti-inflammatory drugs in order to decrease vascular permeability and anticoagulation therapy are included in this group. Hyperbaric oxygen therapy has been studied and is an accepted standard of care for adjunctive treatment of radiation injury on bone and soft tissue. However, few data have been published on its effects regarding neural tissue exposed to radiation, and it is not yet an accepted standard treatment for brain radionecrosis [24, 25]. Generally, surgical resection of the affected portion of the brain is the only remaining option for stabilizing brain radionecrosis when medical therapy fails. This type of treatment is associated with high risk and significant cost. Additionally, patients are candidates for such surgery only if their lesion is located in a surgically accessible region. Previous studies have reported complications relating to the stereotactic radiosurgery and its treatment. Massengale et al[26], conducted a retrospective chart review of seven patients with AVMs of Spetzler-Martin Grades II (n = 1), III (n = 2), and IV (n = 4) who underwent helium ion, proton beam, or gamma knife stereotactic radiosurgery and required resection of radiation necrosis suspicious tissue 1 to 24 months after post stereotactic radiosurgery. The surgical treatment was beneficial in reversing neurological deficits and improving Karnofsky scores in selected patients. Other observations were related to the best prognosis with earlier and larger radiation necrosis resection[26]. In another study, 11 patients with malignant brain tumors underwent surgery for radiation necrosis and the authors concluded that frameless stereotaxis was helpful in guiding the surgeon for the surgical treatment of radiation necrosis; however, it was associated with high risks of complication or neurologic deficit [27].

The cerebral edema development after stereotactic radiosurgery is another complication that requires surgery in selected cases. In one study, two parasagittal meningioma patients who received gamma knife radiosurgery developed symptomatic peritumoral edema 3-4 months later. Both of them underwent surgical resection of the tumors with improvement of neurological function. An imaging performed 3 months after surgical resection revealed an alleviation of the brain edema [28] In a series of 48 cases of meningioma treated with Gamma Knife radiosurgery, four cases of radiation-induced edema in supratentorial meningiomas were observed [29].

Although radiosurgical complications are rare[1-10,18,19,30,31], our case states the importance of clinicians referring patients for stereotactic radiosurgery to be aware of such complications, to be able to recognize them, and treat them. We believe in this case that only surveillance or surgical resection could be the ideal initial treatment for patients once that small tumor was diagnosed. The development of a database that could track long-term complications of stereotactic radiation therapy would help patients in making more well-informed decisions in the treatment of benign meningiomas.

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