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ScienceDirect
Surgical Neurology 70 (2008) 570–575
SURGICAL NEUROLOGY
www.surgicalneurology-online.com

Technique

Radiofrequency thermocoagulation–assisted surgery for intracranial giant vasogenic tumors☆

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Received 7 March 2007; accepted 1 March 2008

Abstract

Background: We report the novel use of radiofrequency thermocoagulation to facilitate surgical excision of intracranial giant vasogenic tumors and detail the operative procedures and patient outcomes.

Materials and Methods: There were 2 patients with intracranial giant vasogenic tumors. The first was an extracerebral deep-seated cavernous angioma in the cavernous sinus (largest diameter: 8 cm), and the other was a hemangiopericytoma accreting the left confluence sinus (largest diameter: 9.2 cm). The tumors were well exposed during surgery and separated from the surrounding brain tissue by blunt dissection. The external surface of each tumor was devascularized. Radiofrequency thermocoagulation was applied in multiple cycles with each cycle encompassing a 3-cm-diameter volume to coagulate the inner tissue of the tumors prior to resection. The tumors were then resected in a piecemeal fashion starting from the thermocoagulated regions until complete removal was achieved.

Results: With radiofrequency thermocoagulation assistance, the 2 intracranial giant vasogenic tumors were removed completely with no bleeding. The surrounding brain tissue, cranial nerves, and vessels were kept intact. Patient recovery was uneventful. No complications and no tumor recurrences have occurred over a 2-year follow-up period.

Conclusions: Radiofrequency thermocoagulation is extremely effective in controlling bleeding during surgical excision of intracranial giant vasogenic tumors. This improves the ease and safety of such procedures and allows for complete removal of tumors.

Keywords: Radiofrequency; Brain tumor; Cavernous angioma; Hemangiopericytoma

1. Introduction

Highly vascularized intracranial giant tumors require resection because of their space-occupying nature. Surgical excision is typically extremely complex and occasionally abandoned because of massive blood loss from the exposed cut surface of the tumor [18,20,22]. In recent years, the technique of RF has been rapidly developed and successfully used to treat solid tumors including liver, lung, breast, adrenal, renal, bone, and retroperitoneal tumors [5,7-10,12,16,19,21]. However, the use of RF therapy for brain tumors has been limited due to edema in areas surrounding the RF treatment field that can exacerbate intracranial hypertension [1,15]. In this report, we describe a procedure for RF thermocoagulation–assisted surgery in the resection of highly vascularized intracranial giant tumors with very successful results. To our knowledge, this is the first reported use of RF thermocoagulation during surgery for intracranial giant tumors in the literature.

Abbreviations: CT, computed tomography; DSA, digital subtraction angiography; MRI, magnetic resonance imaging; RF, radiofrequency.

☆ This study was supported of the Jiangsu Province Health Department, P.R. China (No. RC2002075).

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0090-3019/$ – see front matter © 2008 Elsevier Inc. All rights reserved.
doi:10.1016/j.surneu.2008.03.004

2. Clinical materials

2.1. Patients

Case 1, a 70-year-old woman, presented with a 2-month history of headaches, dimness of vision, and progressive hypodynamia of the left lower extremity. She was admitted on November 16, 2004. Neurologic examination demonstrated obvious paraphasia and diminished muscle strength (V^-/V) in the left leg with a positive Babinski's sign. Computed tomographic scan of the head revealed a very large and homogeneously enhancing mass lesion (largest diameter: 8 cm) in the right middle fossa. Magnetic resonance imaging was not possible due to a preexisting metallic implant in her body.

Case 2, a 44-year-old woman, was admitted on December 13, 2004. She presented with pain in the nuchal region and a 1-year history of unstable gait. Four years previously, she had undergone an operation for a presumed meningioma of the cerebellar tentorium; however, only a partial resection was performed due to uncontrollable bleeding during the surgery. Neurologic examination revealed diminished muscle strength (V^-/V) of the left leg with deep tendon hyperreflexia and positive Babinski's and Romberg's signs. Computed tomographic scan and MRI of the head revealed a very large mass (largest diameter: 9.2 cm) with a heterogeneous pattern of enhancement, which was accreting the left side of the confluence sinus spanning from the upper to the lower cerebellar tentoria.

2.2. Operation with radiofrequency tumor thermocoagulation

The surgical approach was a right frontotemporal skin flap with temporal craniotomy for case 1 and a nuchal midline, occipital laevoelongation upside-down "L" incision with left occipital-suboccipital combined craniotomy for case 2. In both cases, the tumor was well exposed and separated from the surrounding parenchyma by blunt dissection. The tumor-to-brain interface was achieved and maintained by Surgicalpatties (neurostrips) to protect normal brain, vessels, and nerves from thermoconduction (Fig. 1). The surface of the tumors was devascularized by bipolar cautery (Fig. 2). Cool-tip 2000 RF System and PE3-D Cool-tip (Radionics, Tyco Healthcare Group LP, Burlington, Mass) were used to coagulate the interior of the tumors and to destroy and block the blood circulation within the tumors. The Association for the Advancement of Medical Instrumentation and Association of Perioperative Registered Nurses standards for application of grounding pads were strictly followed, in particular, ensuring full contact of the 4 pads with patient skin. The pads were positioned equidistant from the treatment area. An introducer was used to aid positioning of the clustered electrode and to avoid contact between the tips of the electrode probe. The electrode was connected via an adapter cable (C123) to the generator and the inflow and outflow tubing sets were attached to a chilled fluid delivery and collection system by disposable tubing. The PE3-D Cool-tip cluster electrode with three separate probes was then inserted 1.5 to 2.0 cm deep into the tumor tissue. Care was taken to maintain a distance from the probe tips to normal brain tissue of at least 1.5 cm (Fig. 2). Intraoperative B-mode ultrasound was used to verify this margin if necessary. Radiofrequency thermocoagulation with an output of 90 W was carried out for 12 minutes. At the end of the procedure, the temperature in the vicinity of the tips reached 100°C. The procedure was repeated for each 3-cm-diameter volume. Throughout the procedure, the temperature of the adjacent normal brain was monitored with a temperature probe and the thermocoagulated tissue was irrigated with normal saline cooled to 4°C as needed to prevent thermal damage to the surrounding tissue. Deep nasal temperature and urinalysis were also monitored. At the end of the third cycle of radiofrequency thermocoagulation, deep nasal temperature rose 0.8°C (36.8°C-37.6°C) in case one and 1.0°C (36.5°C-37.5°C) in case 2. In both cases, this measurement returned to baseline within 15 minutes.

At the conclusion of the RF thermocoagulation cycles, the tumors were excavated and curettaged, commencing from the core of the devitalized mass (Fig. 3). The tumor vasculature was found to be completely thermocoagulated. As the dissection proceeded, additional space was created, thus facilitating further removal in a piecemeal fashion. Care was taken to avoid traction or compression of the surrounding brain tissue. After complete tumor removal, the operating field was clear and clean (Fig. 4).

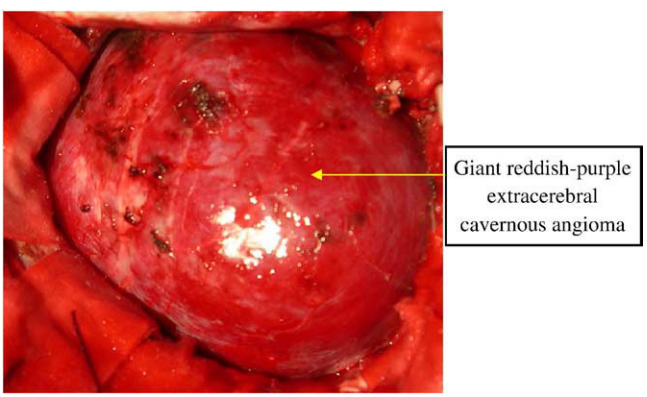

Fig. 1. The giant reddish-purple extracerebral cavernous angioma (case 1) in the middle fossa was well exposed and circumscribed.

3. Results

In case 1, intracranial extracerebral cavernous angioma was histopathologically verified. The tumor encompassed the dura and arose from the cavernous sinus field (cavernous sinus and anterior aspect of the cerebellar tentorium) in the middle fossa. In case 2, a diagnosis of hemangiopericytoma was confirmed on histopathology. This mass arose from