Clinical Neurology and Neurosurgery 119 (2014) 35–38

Contents lists available at ScienceDirect

Clinical Neurology and Neurosurgery

journal homepage: www.elsevier.com/locate/clineuro

Endoscope-assisted retrosigmoid resection of a medium size vestibular schwannoma tumor model: A cadaveric study

Nishanta B. Baidya, Moncef Berhouma, Mario Ammirati *

Department of Neurological Surgery, The Ohio State University Wexner Medical Center, Columbus, USA

ARTICLE INFO

Article history:
Received 27 August 2013
Received in revised form
20 November 2013
Accepted 25 December 2013
Available online 18 January 2014

Keywords:
Vestibular schwannoma
Posterior cranial fossa
Retrosigmoid approach
Cerebellopontine angle tumor
Tumor model
Flexible endoscope

ABSTRACT

Objective: To demonstrate a flexible endoscope assisted technique to perform microsurgical resection using a retrosigmoid approach of an artificial polymer tumor model that mimics a medium size (15–20 mm diameter) vestibular schwannoma.

Methods: Twelve bilateral retrosigmoid dissections were performed in 6 glutaraldehyde embalmed, colored silicone injected, adult cadaveric heads. Using a standard retrosigmoid approach, we first implanted the tumor model at the cerebellopontine angle (CPA) and then we resected the tumor under simultaneous endoscopic and microscopic visualizations. The resection was performed by first creating a corridor by removing the lower portion of the tumor and then by inserting through the same corridor the flexible endoscope mounted on a surgical instrument in order to accomplish early visualization of the VII-VIII complex. This early visualization of the VII-VIII complex made possible expeditious removal of the model with preservation of the VII-VIII complex.

Results: We were able to successfully implant the artificial tumor in all the specimens. The post-tumor implantation CT scan confirmed the optimal CPA location of the model with its intra-porus extension. The exposure of the facial and the adjoining neuro-vascular structures was excellent during all stages of the surgical removal and was accomplished with minimal cerebellar retraction, under intermittent endoscopic-assisted control. Early visualization of the facial and vestibular cochlear nerves complex led to unhindered removal of the tumor model.

Conclusions: The endoscopic-assisted microsurgical removal of a tumor model simulating a medium size vestibular schwannoma was feasible in our tumor model study emulating real surgery. Visualization of the acousticofacial bundle at the early stage of the surgical removal should theoretically decrease the risk of its inadvertent injuries as well as facilitate complete removal of the tumor. Clinical studies to validate this laboratory study are necessary.

1. Introduction

Surgical management of pathology within the cerebellopontine angle (CPA) region is challenging due to the presence of multiple vital neurovascular structures. One of the most challenging tumors is vestibular schwannoma (VS) because of its close relationships to the facial and acoustic nerves and the possibility of their inadvertent injury during tumor dissection. Specifically postoperative facial nerve malfunction is well documented in patients with medium and large tumors operated via the retrosigmoid approach [1–5]. Facial nerve monitoring is commonly used to avoid inadvertent injury to the nerve during surgery [6–14]. Recently MRI techniques have been developed to map out the position of the facial nerve preoperatively [15,16]; however the nerve position changes as the tumor is debulked. We reasoned that it could be feasible to create a hole in a medium/large tumor through which an endoscope introduced to peek at the position of the facial nerve throughout the surgery. To this effect we created a medium size vestibular schwannoma model in a cadaver model and developed an endoscopic assisted technique to test our hypothesis.

2. Materials and methods

2.1. Materials

Six glutaraldehyde embalmed, alcohol-preserved, colored silicon injected cadaveric heads were used in a total of 12 procedures. The procedures were performed using standard microsurgical instruments, a high-speed drill (Midas Rex; Medtronic, Inc., Minneapolis, MN, USA), Moller microscope (Möller-Wedel GmbH,

* Corresponding author at: Department of Neurological Surgery, N1025 Doan Hall, 410 W. 10th Avenue, Columbus, 43210, USA. Tel.: +1 614 293 1970; fax: +1 614 293 4024.
E-mail address: mario.ammirati@osumc.edu (M. Ammirati).

0303-8467/$ – see front matter © 2014 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.clineuro.2013.12.023

Wedel, Germany), BioPix (CLA Medical, Milford, OH, USA), camera for BiOpix (Ikegami Electronics, Maywood, NJ, USA), Budde-halo retractor system (Integra, Plainsboro, NJ, USA), RG Medical flexible endoscope (RG Medical, Nashville, TN, USA), Misonix bone scalpel (Misonix, Inc., Farmingdale, NY, USA) and Stryker neuronavigation system (Stryker; Kalamazoo, MI, USA). The artificial tumor material consisted of a polymer, Stratathane resin ST-504 polymer (Strata-Tech, Inc., Urbandale, IA, USA).

2.2. Methods

2.2.1. Dissection technique

We performed a standard retrosigmoid craniotomy [17] with the cadaveric head fixed in the semisitting position using a Mayfield skull clamp, flexed and turned 30° toward the side of the incision. The procedure was carried out in 2 stages.

2.2.2. Stage I: construction placement and CT verification of the tumor model

This stage consisted of 3 steps, namely the establishment of the tumor bed, the manufacturing and placement of the tumor model in the CPA and finally the post-implantation CT scan.

Step 1: Formation of the tumor model bed

It consisted of the exposure of the cerebellopontine and lateral cerebello-medullary cisterns and drilling of the posterior 10 mm of the porus acousticus with the 10 mm Misonix bone scalpel to allow intra-canalicular placement of the artificial tumor mimicking the intra-canalicular extension of the tumor as seen in patients. The tumor bed was created by placing a solid spherical ball of 25 mm diameter (Fig. 1A), under microscopic guidance, precisely at the edge of the facial nerve at its origin in the bulbo-pontine sulcus while the cerebellum was retracted. The ball was made with a mixture of 10 ml of water, 1 ml of polymer and 1 mg of *Curcuma longa* (turmeric powder). The ball was left in place for 48 h to mold the surrounding structures.

Step 2: Placement of the tumor model in the CPA

The tumor model we used was similar to the one described by Gragnaniello et al. [18]. The sphere described in stage 1 was removed and replaced by a spherical tumor model of about 15–20 mm diameter (Fig. 1B) that was manufactured by mixing 5 ml water, 1 ml of polymer, 1 ml of CT contrast agent and 1 mg of *Curcuma longa* (so as to mimic the yellowish color of schwannomas). The water/polymer ratio selected allowed for a tumor model with soft consistency similar to vestibular schwannoma. The tumor was placed into the cerebello-pontine angle under microscopic control in contact with the facial nerve so as to displace it anteriorly. The tumor was then glued to the nerve using an additional 1 ml of liquid polymer. Another 1 ml of polymer was dropped into the opened porus acousticus.

Step 3: CT scan of the tumor model

After implanting the tumor model in the CPA we carried out the CT scan (1 mm thickness contiguous non-overlapping slices, gantry setting, 0°; scan window diameter, 225 mm; pixel size, >0.44 × 0.44) of all the specimens to verify the desired location of the model (Fig. 1C).

2.2.3. Stage II: tumor model dissection stage

The neuronavigation system was calibrated in a routine manner and the tumor model was removed using the operating microscope via the same retrosigmoid approach used to implant it. A

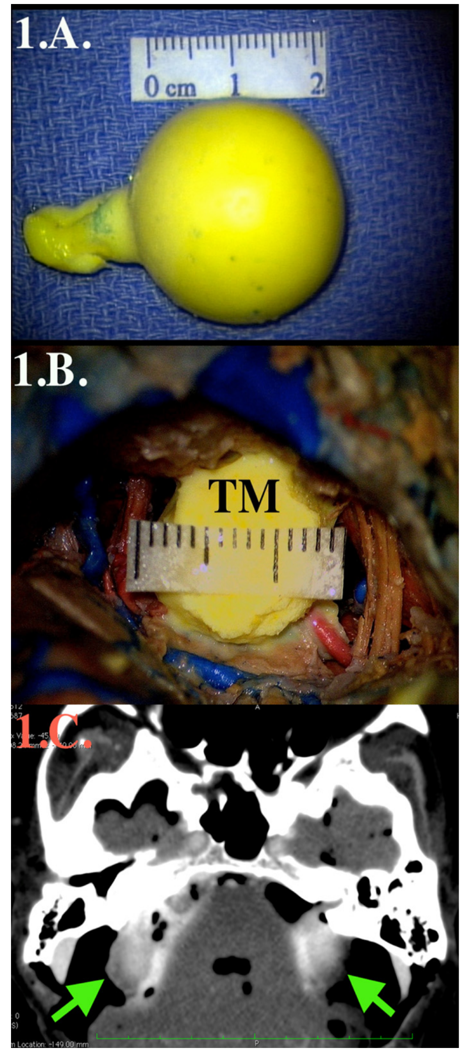

Fig. 1. (A) The 25 mm diameter spherical ball used to create the tumor bed is shown. (B) Microscopic view of the tumor model (TM), approximately 25 mm in diameter. (C) CT scan of the bilateral tumor model with its intracanalicular extension. The green arrow is pointing to the radio-opaque tumor model.

Budde-halo self-retaining retractor with one-fourth inch retractor blades supported the cerebellar hemisphere to expose the CPA. After removal of the inferior pole of the tumor the 0.5 mm outer diameter RG Medical flexible endoscope mounted on a non-tooth forceps was passed through the channel created by this removal to identify the VII-VIII complex anterior to the tumor initially below the tumor model to identify the course of the facial nerve on the anteromedial surface of the tumor (Fig. 2). The acoustico-facial bundle was identified either at its origin on the bulbopontine sulcus or at its entrance in the porus acousticus. Once the facial nerve was identified, removal of the tumor model was performed using steps similar to the ones used in a real-life surgery. The posterior margin of the porus acousticus was further drilled under microscopic control with a 10 mm Misonix bone scalpel in order to expose the extension of the artificial tumor within the internal auditory canal. The tumor was then progressively debulked in a classical fashion with micro-instruments leaving a thin capsule for handling, while it was dissected from the whole length of the facial nerve from the brainstem to the porus acousticus. The endoscope was used regularly during the dissection phase to assess the position of the facial nerve, the labyrinthine artery and the AICA loop. At the end of the tumor removal, the endoscope was brought in the CPA to check the