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Simultaneous supervision by microscope of endoscope-assisted microsurgery via presigmoid retrolabyrinthine approach: A pilot study

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ABSTRACT

Objective: To examine the impact of integrated hybrid operating rooms for endoscope-assisted microsurgery using the presigmoid retrolabyrinthine (RL) approach, and to determine the value of simultaneous supervision of skull base endoscopic procedures by microscope.
Material and methods: We retrospectively reviewed endoscope-assisted surgery using the RL approach at our institution between September 2013 and January 2017. The simultaneous supervision of endoscopic procedures by microscope was realized using the integrated hybrid system. Intra- or postoperative complications and surgical outcomes were analyzed. All patients were followed for at least 1 year.
Results: In total, 32 patients were studied: 4 vestibular schwannomas, 5 cholesteatomas, 8 hemifacial spasms, 5 glossopharyngeal neuralgias, and 10 Ménière's disease. In patients with vestibular schwannoma or cholesteatoma, complete removal was performed in all patients. In patients with Ménière's disease, hemifacial spasm or glossopharyngeal neuralgia, satisfactory symptom relief was achieved in all patients. Two (6.3%) patients had hearing loss after surgery which did not recover. One (3.1%) patient with vestibular schwannoma had mild facial palsy (HB III) at 2 weeks after the operation and recovered to near normal facial nerve function (HB II) at 1 year after surgery. No permanent or transient dysfunction of the trigeminal nerve or the lower cranial nerves was observed during follow-up. No complications such as cerebrospinal fluid (CSF) leakage or meningitis were observed.
Conclusion: The endoscope provided a clearer and larger view, which solved the limitations of surgery using the RL approach. Endoscopic surgery under simultaneous supervision by microscope was safe and efficient in hearing preservation as well as in preservation of facial nerve function. An integrated operation room provided better support and the ability to switch quickly between these various complex devices.

1. Introduction

Surgery in the cerebellopontine angle (CPA) is very challenging due to the presence of a great variety of vital neurovascular structures. Important blood vessels and nerves lining the skull base region increase the risk of intra- and postoperative hemorrhage and postoperative neurotic dysfunction. Cushing called the CPA the "bloody triangle", comparing it with the fence corner at the Battle of the Gettysburg because of the significant hemorrhage which can occur during vestibular schwannoma surgery [1]. With the rapid development of microscopy and intraoperative facial nerve monitoring, otologists and neurosurgeons can achieve a satisfactory rate of preservation of facial nerve function; however, hearing preservation remains poor for most patients.

In the hope of improving the rates of preservation of hearing and facial function, the presigmoid retrolabyrinthine (RL) approach was first described by Hitselberger and Pulec for vestibular neurectomy, and Darrouzet et al. reported its first application in vestibular schwannoma [2,3]. By skeletonizing the semicircular canals and sigmoid sinus, the CPA was directly accessed through Trautmann's

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triangle without removal of the labyrinthine complex and with minimal cerebellar retraction. However, the drawbacks of the RL approach were quite obvious. Bento et al. reported that, in 3 of 22 patients who underwent vestibular schwannoma removal through a RL approach, total removal could not be achieved due to the unreachable fundus of the internal acoustic canal (IAC) [3]. Darrouzet et al. stated that only two-thirds of the lateral wall of the IAC could be observed using the RL approach [4]. Limited operating space and unsatisfactory exposure of the IAC have prevented the RL approach from being adopted more widely.

The use of endoscopes in skull base procedures provides a wider and clearer view of the CPA and IAC. Although not widely reported, a major impediment to the application of the endoscope in skull base surgery was its probable mechanical and thermal injury to surrounding structures, similar to middle ear endoscopic surgery [5]. As a result of the development of the hybrid operation room, such as the STORZ OR1™ suite, endoscopic imaging and microscopic imaging could be merged and displayed on the same screen which allowed endoscopic manipulations to be performed under simultaneous supervision by microscope.

The aim of this retrospective, clinical pilot study was to present the outcomes of endoscope-assisted microsurgery using the RL approach within the integrated hybrid operation room, and discuss the convenience and value of simultaneous supervision by microscope while using the endoscope in skull base surgery.

2. Material and methods

2.1. Patients

Patients who underwent endoscope-assisted microsurgery using the RL approach within the integrated hybrid operation room of our institution between September 2013 and January 2017 were retrospectively reviewed. This study focused on the following surgery:

- functional microsurgery of the CPA, such as vestibular neurectomy for Ménière's disease, glossopharyngeal neurectomy for glossopharyngeal neuralgia, and microvascular decompression for hemifacial spasm;
- surgical removal of benign CPA tumors, such as small vestibular schwannoma (intracanalicular or CPA diameter ≤ 15 mm) and cholesteatoma.

Patients with less than 1 year of follow-up after surgery were excluded from the study.

The clinical records and operation videos of these patients were collected. All of the surgeries were performed by the same medical team, in which all intracranial manipulation procedures were performed by one surgeon (HW). Hearing level was evaluated using the American Academy of Otolaryngology – Head and Neck Surgery (AAO–HNS) guidelines and staged in four classes [6]. Facial nerve function was clinically evaluated using the House-Brackmann (HB) scale [7]. The pain intensity score was evaluated using the Barrow Neurological Institute (BNI) pain intensity score [8]. Control of vertigo was categorized into Class A–F using a numerical value according to the classification of Ménière's disease recommended by AAO–HNS [9]. Other postoperative complications including trigeminal nerve and lower cranial neurologic damage, cerebrospinal fluid (CSF) leakage and intracranial infection were also analyzed. The symptom relief rates as well as postoperative complications were evaluated at 2 weeks and 1 year after surgery. Patients who had undergone tumor resection were followed by an annual MRI scan.

2.2. Integrated hybrid operation room

The KARL STORZ Advanced OR1™ Suites (KARL STORZ GmbH & Co. KG, Tuttlingen, Germany) or Stryker iSuite (Stryker Communications, Flower Mound, Texas, USA) constituted our integrated hybrid operation room. The main modules of the OR1™ Suites contained Advanced Image and Data Acquisition (AIDA™), Storz Communication Bus (SCB) and Audio-Video system, and the Stryker iSuite contained similar modules.

The OR1™, as an example, its main function is intuitive control of the entire surgical environment. The SCB control system enables central control of devices, including image sources, ceiling lights, peripheral cameras and other KARL STORZ compatible devices. All these devices can be controlled from a central location within the sterile area. AIDA™ provides convenient archiving of multiple high-quality image sources from any signal, such as endoscope and microscope. It is therefore easier and quicker to record still image, videos and audio files of HD quality and to create documentation. Images from different signals can be displayed on the same screen (QUAD view or PiP) or on separate screens. With this system that offers intelligent routing and imaging solutions, interaction is possible from any location within seconds, e.g. from operating room to operating room, to the senior doctor's office, to the lecture hall or to any other external location. Theoretically, the medical equipment's' signal access to the OR1™ could include endoscope, microscope, anesthetic machine, PACS, surgical cameras and so on.

2.3. Endoscope-assisted microsurgery under simultaneous supervision by microscope

The RL approach was performed using a classic approach [4]. The semicircular canals, the facial nerve and the sigmoid sinus were thoroughly skeletonized under microscopic view. The mastoid bone was removed from the sinodural angle to the jugular bulb. The dura was opened by a "U"-shaped incision in the rear of the endolymphatic sac and presigmoid.

Then the endoscope (size of 4 mm, length of 17 cm) was brought into use, and the focal length of microscope was adjusted to about 400 mm. The Advanced OR1™ Suite was set to display the endoscopic and microscopic images simultaneously on its mobile screen (Figs. 1 and 2). The microscopic view was the minor image and was adjusted to observe the relationship between the endoscope probe and its surrounding tissue. If necessary, 0°, 30°, or 70° angled endoscopes were substituted during surgery. The intracranial manipulations were almost all performed under endoscopic view until dura closure, apart from certain two-handed gestures which were performed under microscopic view.

2.4. Ethics

This study was approved by the Human Subjects Committee of the Shanghai Ninth People's Hospital affiliated to Shanghai Jiaotong University School of Medicine.

2.5. Statistical analysis

Data are presented as mean ± standard deviation (SD) or % (n) for descriptive statistics. Fisher's exact or the χ^2 test was used for nominal variables. All analyses were done using SPSS 20.0 for Windows (IBM Corp., Armonk, NY, USA). Two-sided P-values less than 0.05 were considered to be statistically significant.

3. Results

In total, 32 patients were included in the study (15 males and 17 females), with a mean age at surgery of 41.8 ± 12.5 years (Table 1).

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