# Hybrid Microscopic-Endoscopic Surgery for Craniopharyngioma in Neurosurgical Suite: Technical Notes

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■ OBJECTIVE: **The best chance of curing craniopharyngioma is achieved by microsurgical total resection; however, its location adjacent to critical structures hinders complete resection without neurologic deterioration. Unrecognized residual tumor within microscopic blind spots might result in tumor recurrences. To improve outcomes, new techniques are necessary to visualize tissue within these blind spots. We examined the success of hybrid microscopic-endoscopic neurosurgery for craniopharyngioma in a neurosurgical suite.**

■ METHODS: **Four children with craniopharyngiomas underwent microscopic resection. When the neurosurgeon was confident that most of the visible tumor was removed but was suspicious of residual tumor within the blind spot, he or she used an integrated endoscope-holder system to inspect and remove any residual tumor. Two ceiling monitors were mounted side by side in front of the surgeon to display both microscopic and endoscopic views and to view both monitors simultaneously.**

■ RESULTS: **Surgery was performed in all patients via the frontobasal interhemispheric approach. Residual tumors were observed in the sella (2 patients), on the ventral surface of the chiasm and optic nerve (1 patient), and in the third ventricle (1 patient) and were resected to achieve total resection. Postoperatively, visual function was improved in 2 patients and none exhibited deterioration related to the surgery.**

■ CONCLUSIONS: **Simultaneous microscopic and endoscopic observation with the use of dual monitors in a neurosurgical suite was ergonomically optimal for the surgeon to perform microsurgical procedures and to avoid traumatizing surrounding vessels or neural tissues. Hybrid microscopic-endoscopic neurosurgery may contribute to safe, less-invasive, and maximal resection to achieve better prognosis in children with craniopharyngioma.**

## INTRODUCTION

Craniopharyngiomas are benign, slowly growing tumors that occur more commonly in children. The best chance of curing craniopharyngioma is achieved by microsurgical total resection of the tumor; however, its location in or adjacent to critical brain structures, such as the hypothalamus, pituitary stalk, optic pathway, the circle of Willis, or the third ventricle, hinders complete resection without neurologic deterioration.[1] Therefore, despite improved diagnostic methods and microsurgical techniques, total resection is a formidable undertaking even to the experienced neurosurgeon. The literature indicates that, even when it was attempted, total surgical resection was possible in at most 70%–90% of the children.[2] Moreover, recurrence is not a rare event even after surgical gross total resections[3,4] because of the invasive nature of the craniopharyngioma and the chances of unrecognized residual tumor in the blind spot of the surgical microscope.[5]

Many have attempted to accomplish safe, complete resection by various approaches or a combination of approaches[3,6]; however, in some cases there are always some limitations to complete visualization of the tumor as long as the neurosurgery is conducted microscopically. Although radiation therapy effectively reduces the rate of recurrence and tumor progression,[7,8] it may cause radiation-induced complications, such as neuronal damage, necrosis, or secondary neoplasm, especially in children.[9,10]

**Key words**
- Craniopharyngioma
- Endoscope
- Ergonomics
- Hybrid surgery
- Microscope
- Neurosurgical suite

**Abbreviations and Acronyms**
**MRI**: Magnetic resonance imaging
**3-D**: Three-dimensional

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*Citation: World Neurosurg. (2016) 85:340-348.
http://dx.doi.org/10.1016/j.wneu.2015.08.058*

*Supplementary digital content available online.*

*Journal homepage: www.WORLDNEUROSURGERY.org*

*Available online: www.sciencedirect.com*

Therefore, to improve patient outcomes and decrease treatment morbidity, new techniques are necessary to visualize blind spots.

The neuroendoscope was introduced for minimally invasive neurosurgery.[11,12] It can be inserted through a narrow corridor and provide close-up views of objects or views within the blind spot of the surgical microscope.[11,12] In this study, we present a hybrid microscopic-endoscopic neurosurgery to minimize blind spots of microsurgery and sought to preliminarily determine the safety and clinical usefulness of this technique.

## MATERIALS AND METHODS

### Patient Population

From 2007 to 2013, 4 children with craniopharyngiomas were diagnosed and treated by the hybrid microscopy-endoscopy surgery in a neurosurgical suite at Okayama University Hospital (Table 1). There were 2 male and 2 female patients, and their ages at diagnosis ranged from 2 years, 6 months to 11 years, 7 months, with a mean age of 6.4 ± 3.2 years. All the patients were evaluated clinically for their neurologic, ophthalmologic, and endocrine statuses as well as their magnetic resonance imaging (MRIs) at our institution before and after treatment. Histologic diagnosis of craniopharymgioma was confirmed in all patients. In addition to immediate postoperative imaging, follow-up images were obtained every 2 months during the first 2 years and every 4 months for the subsequent 3 years. All available information was collected through medical records, and pertinent neuroimaging tests were reviewed personally. This retrospective study was approved by the Internal Review Board of Okayama University Hospital.

### Endoscopic Instrumentation

An integrated neuroendoscope, mounted on an endoscope-holder system (EndoArm; Olympus Optical Co., Tokyo, Japan) was used to inspect and remove any residual tumor that remained unseen within the blind spot of the surgical microscope. The endoscope-holder system has a negatively actuated air-locking system so that the surgeon can perform microsurgery with both hands while simultaneously observing endoscopic and microscopic views on 2 parallel monitors. Two types of rigid endoscopes, with a 30- or 70-degree viewing angle, 2.7-mm outer diameter, and 225-mm length, were used.

### Video Monitor System

Our neurosurgical suite is equipped with a video routing system (AV Conference Premium or TEGRIS; Maquet, Rastatt, Germany), one 46-inch wall-mounted (Sony, Japan), and two 24-inch ceiling monitors (Ikegami, Japan). Video sources from the microscope, endoscope, and navigation system were assigned individually to separate monitors by the video routing system. Two 24-inch ceiling monitors were mounted side by side 200 cm in front of the surgeon to display microscopic and endoscopic views, enabling them to simultaneously view both monitors. Two operative views, under the microscope and the endoscope, were recorded with the mixing function of the surgical field video recording system (ADMENIC Server; Carina System Co., Ltd., Kobe, Japan).

### Neuronavigation System

A neuronavigation system was used in all cases to generate a fiducial spatial coordinate system for the entire extension of the tumor and to predict the area of the microscopic blind spot. Tumor shape was outlined and registered to the navigation system (CURVE; BrainLAB, Heimstetten, Germany, or Stealth Station TREON; Medtronic, Minneapolis, Minnesota, USA) preoperatively, and the tumor contour was superimposed in the microscopic view.

## RESULTS

### Surgical Procedures

All patients underwent craniotomies. Surgical total resection was intended in all patients via the frontobasal interhemispheric approach. The tumor mass was dissected from surrounding structures whereas intratumoral decompression was performed under the surgical microscope. If the tumor mass extended into the third ventricle, it was dissected and resected through the prechiasmatic cistern or the opening of the *lamina terminalis* as much as possible, providing a safe resection could be performed.

When the surgeons were confident that most of the lesion visible under the surgical microscope was removed but were suspicious of residual tumor within the blind spot of the microscope, such as the sella, ventral surface of the optic nerve and chiasm, or the third ventricle, the neuroendoscope was introduced to inspect and remove any residual tumor. At this step, neuronavigation and tumor contour superimposed in the microscopic view was

**Table 1.** Summary of Patient Information, Procedures, and Outcomes

| | | | | Residual Tumor on Endoscopic Inspection | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Patient | Age, years | Sex | Topographical Classification | Sella | Optic Nerve and Chiasm | Third Ventricle | Removal | Recurrence, months | Follow-up, months |
| 1 | 6.9 | M | Intraventricular | − | + | + | GTR | + (48) | 68 |
| 2 | 11.6 | M | Intrasellar and suprasellar | + | − | − | GTR | − | 36 |
| 3 | 4.5 | F | Intraventricular and extraventricular | − | − | + | GTR | − | 29 |
| 4 | 2.5 | F | Intrasellar and suprasellar | + | − | − | GTR | − | 9 |

M, male; GTR, gross total resection; F, female.