Technical Note

Infratentorial supracerebellar resection of a pineal tumor using a high definition video exoscope (VITOM®)

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A B S T R A C T

A telescope based high definition (HD) video system (VITOM®, Karl Storz GmbH & Co., Tuttlingen, Germany) has recently been proposed as an alternative to the operating microscope for microneurosurgery. It remains unclear which clinical situations will benefit from its advantages. In light of the uncomfortable surgeon position and fatigue often associated with pineal region surgery, we used the VITOM® HD exoscope system to perform an infratentorial supracerebellar resection of a pineal tumor. The VITOM® dramatically improved surgeon comfort and ease of operating by permitting the surgeon to stand upright and in a comfortable position and avoid the need to extend the arm or assume an awkward position commonly encountered when using the microscope for these approaches. The marked improvement in surgeon comfort afforded by the VITOM® exoscope indicates that this system may have significant advantages over traditional microscope based surgery for tumors of the pineal region approached using an infratentorial supracerebellar approach.

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1. Introduction

Due to a deep seated and relatively inaccessible location, many operative approaches to the pineal region have been developed including the infratentorial, occipital, transtentorial and intraventricular endoscopic approaches.1–10 The infratentorial supracerebellar approach remains the most widely used.10

The infratentorial approach can be performed with the patient in both the sitting and modified prone (Concorde) position.11,12 The sitting position, while less commonly used in modern neurosurgery due to the risks of air embolism and other complications, continues to enjoy some popularity because it permits gravity retraction of the cerebellar surface, creating a wider operating corridor to the pineal region.11,12 Utilization of the operating microscope in the sitting position, however, is generally uncomfortable due to the long focal distance and the need to operate with the arms outstretched. This awkward positioning results in surgeon fatigue and less than optimal comfort for dissection. Considering the many delicate structures in this region, any factor that contributes to reduced operative skills may have a negative impact on outcome. The Concorde position is perhaps slightly more comfortable, but nonetheless often results in the surgeon operating in a cramped and unnatural position with similar problems as in the sitting position.11,12 Ideally, any device which permits high quality magnification and illumination of the operative field but allows the surgeon to operate in a more upright position with flexed arms to improve fine motor control would be beneficial.

Previously, we have reported a new high definition (HD) video telescope operating monitor system (VITOM®, Karl Storz GmbH & Co., Tuttlingen, Germany) to perform open microsurgery.13–15 The VITOM® exoscope system provides superb image quality, good illumination, and up to 16x magnification. Because the telescope is lightweight (1.5 lbs) and sterilized, it is easy to set up and operate. When attached to a pneumatic floor-based endoscope holder (UniARM, Mitaka Kohki Co., Tokyo), the device demonstrates much of the same maneuverability seen with modern operating microscopes. Importantly, the VITOM® is not an endoscope, but rather an exoscope that sits extracorporeally and has a focal length on 25–60 cm. This focal distance allows the use of all standard microsurgical instruments similar to when using the microscope. Our initial experience with this device indicated it was ideally suited for most spinal surgery but more limited for cranial applications.14 Identifying cases in which the VITOM® offers a distinct advantage over the microscope is important to determine the role it can play in operative micro-neurosurgery.

We now report a case in which we used the VITOM® for the complete microdissection and resection of a pineal tumor using the infratentorial supracerebellar approach. For this surgery the VITOM® dramatically improved surgeon comfort without limiting other aspects of surgery, thus eliminating many of the problems inherent when utilizing the microscope for these procedures.
2. Case report

A 21-year-old male with a previous history of a suprasellar germinoma previously treated with chemotherapy and radiotherapy with a complete radiographic response underwent a routine surveillance MRI nine years later, demonstrating a recurrent enhancing lesion in the hypothalamus with a second lesion in the pineal region (Fig. 1). An extensive systemic work-up was unrevealing except for an elevated serum alpha fetoprotein (AFP). Due to the late pattern of recurrence and the presence of an elevated AFP, it was felt that the recurrent lesion might not be a germinoma and therefore, a biopsy was requested. Due to his previous surgery, the patient’s optic chiasm was low lying, obviating a transsphenoidal approach. The lateral and third ventricles were very small and it was felt that a transventricular biopsy would be difficult and potentially morbid. In light of these considerations, a biopsy of the pineal region lesion was recommended.

3. Description of procedure

A pre-operative gadolinium enhanced MRI was obtained for frameless stereotactic navigation. At surgery, the patient was positioned in a modified prone (Concorde) position as previously described.11,12 A midline incision was made from above the inion to the level of the foramen magnum and carried down to the suboccipital bone. A suboccipital craniotomy was performed from the level of the transverse sinus to above the foramen magnum and removed as a single piece. The dura was opened in a “V” shape and tacked up superiorly, exposing the superior cerebellar surface and tentorium cerebelli. During the opening of the craniotomy, the VITOM® camera was positioned approximately 35–40 cm above the operative field. This permitted video documentation of the surgical exposure although for this portion of the procedure, the surgeons operated with direct vision rather than from the VITOM® monitor.

Once the dura was opened, the VITOM® was positioned approximately 25 cm caudal to the opening and angled in a caudal-rostral orientation to provide direct visualization of the infratentorial supracerebellar corridor leading to the pineal recess (Fig. 2). The telescope was held in place using a pneumatic endoscope holder or restricted mobility more than the microscope. Third, while the VITOM® provided a superior depth of field than the microscope, on a miniaturized counter-balanced stand (UniARM, Mitaka Kohki Co., Tokyo) that provided finger-activated repositioning and did not interfere with the operative field. The telescope was connected to a 23-inch HD video monitor via a HD camera and standard video stack. The monitor was positioned just to the right of the patient’s head with the surgeon operating from the left and behind the patient (Fig. 2). This configuration allowed the surgeon to stand upright with arms in a bent and relaxed position during dissection, and operate from the video monitor.

All microdissection was performed using the video monitor for visualization only. The cisterna magna was opened and superficial bridging cerebellar veins were divided, allowing the cerebellum to retract inferiorly. A Teflon-coated self-retaining retractor was used to gently retract the cerebellum inferiorly. The pre-pineal arachnoid was dissected using standard microsurgical techniques and instruments (Fig. 3a). The pre-cerebellar vein was easily identified, dissected free and not sacrificed (Fig. 3b). Dissection then extended lateral to the pre-cerebellar vein down to the pineal tumor which was easily identified (Fig. 3c). Using standard sharp and blunt micro-dissection techniques, the arachnoid around the tumor was freed and the tumor was significantly debulked (Fig. 3d). The VITOM® provided excellent visualization of all relevant structures including surrounding veins and arteries, the back wall of the third ventricle, micro-vasculature, and the splenium of the corpus callosum. A portion of the tumor was adherent to the upper brainstem and was therefore not removed. The entire procedure was captured on digital HD video and was completed in approximately 3 hours. There were no post-operative complications and the post-operative MRI revealed a subtotal resection with no evidence of venous infarction, cerebellar injury, or other complications potentially related to dissection (Fig. 1).

Postoperatively, the patient recovered from surgery without deficit and was discharged in 3 days. Pathology was consistent with recurrent germinoma with a component of embryonal yolk sac tumor. Chemotherapy was planned for more definitive treatment of the residual tumor.

4. Discussion

We have previously described the use of a HD video exoscope system and our initial experience with this device in clinical neurosurgery.3,14 We have also utilized the VITOM® to perform transsphenoidal surgery in canines with pituitary tumors.15 Several other surgeons have used the VITOM® for spinal surgery, vascular and cardiac surgery, ENT surgery, hepatic surgery, and experimental small animal surgery.16 In most of these settings, the VITOM® has provided high quality imaging and facilitated surgical resection as an alternate to the operating microscope or loupes. In general, the VITOM® has proven extremely useful when the surgical field is largely perpendicular to the line of site of the surgeon because the anatomy can be well-visualized and the surgeon operating from the monitor maintains a head position similar to that with the microscope.

However, the VITOM® has had more limited acceptance for use in cranial microneurosurgery for the following reasons: First, surgeons are familiar with the microscope and therefore continue to use technology they feel confident with unless a distinct advantage to a newer technology can be demonstrated. Second, for cranial surgery, surgeons need to be able to position the microscope at oblique angles with rapid and frequent repositioning and refocusing. Early versions of the VITOM® utilized a pneumatic arm that was fixed to the operating room table (Mitaka Point-Setter, Mitaka Kohki Co., Tokyo); this fixation often got in the way of the surgeon or restricted mobility more than the microscope. Third, while the VITOM® provided a superior depth of field than the microscope, ...
the lack of true stereoscopic vision limited surgeon comfort for deep-seated lesions and those with complex neurovascular relationships. Therefore, the obvious advantages of the VITOM\textsuperscript{C210} over the microscope for most cranial cases was not apparent, and therefore there has been a general reticence to move to this newer technology.

There are several neurosurgical operations, however, in which patient positioning and anatomy require the surgeon to operate from awkward positions for prolonged periods of time. Perhaps most demanding of these are the infratentorial supracerebellar approaches to the pineal region. The sitting position, typically forces the surgeon to markedly extend his arms and work in a caudal to rostral orientation. Even the Concorde position, while slightly more comfortable, requires the surgeon to work with arms extended in a caudal to rostral orientation to accommodate for the upper sloping direction of the tentorium and the lower lying transverse sinus. Because the surgeon operates from eyepieces that are more distal to the surgical anatomy that the objective lenses of the microscope, the surgeon needs to reach around the microscope. This is particularly difficult when long focal lengths are required, such as with pineal or transsphenoidal approaches. Further, because the microscope oculars are largely "in line" with the objective lenses, the surgeon must often lean over the patient or position himself in a position that is fatiguing and unnatural.

For this procedure, the VITOM\textsuperscript{C210}, in combination with the UniARM endoscope holder provided a solution. The VITOM\textsuperscript{C210} exoscope was able to be brought in line with the surgical trajectory while permitting the surgeon to stand upright, very close to the anatomy, without contorting himself to the operating microscope. The VITOM\textsuperscript{C210} provided excellent optical images that closely rivaled those of the microscope, which permitted fine microdissection, similar to the dissection capabilities found using the microscope. We felt that the optics were rough equivocal to the microscope but that the marked improvement in physician comfort during fine microdissection made this technology a superior choice for this application.

A drawback of the VITOM\textsuperscript{C210} is the absence of stereoscopic vision.\textsuperscript{14} Much like with endoscopy, the visual field is two-dimensional. The process of adjustment to operating from a video monitor in the absence of stereoscopic vision requires a little patience and practice, although it is rapidly compensated for with relatively minimal experience.\textsuperscript{17,18} A typical period of adaptation will probably take an experienced surgeon approximately 60 minutes, and less for surgeons familiar with endoscopic methods. In exchange for the lack of stereoscopic vision using the VITOM\textsuperscript{C210}, there is a dramatic improvement in depth of field that minimizes the need for repositioning and refocusing. This improved depth of field, combined with marked improvement in surgeon comfort, seems to more than compensate for the lack of stereoscopic vision and surgeon familiarity provided by the microscope.

5. Conclusion

This is the first report of the use of the new HD video telescope system (VITOM\textsuperscript{C210}) to perform an infratentorial supracerebellar
resection of a pineal region. The VITOM® provided markedly improved surgeon comfort and ease of dissection compared to our experience with the microscope in either the sitting or Concorde position, without loss in image quality or ability to perform fine microdissection. It is our opinion that the VITOM® offers distinct advantages over the microscope for these procedures and may find similar utility for other procedures in which the surgeon is forced to operate in relatively distorted positions that increases fatigue and diminishes fine motor skills.

Conflict of interest

Dr. Adam Mamelak is a paid consultant to Karl Storz Endoscopy. Dr. George Berci has an unrestricted educational grant from Karl Storz Endoscopy. The other authors have no personal financial or institutional interest.

References


Fig. 3. Intraoperative views using the VITOM® system (Karl Storz GmBH & Co., Tuttlingen, Germany) to resect a pineal region tumor: (A) initial exposure of pre-pineal arachnoid; (B) initial exposure of tumor; (C) initial resection; (D) end of resection with residual tumor attached to brainstem.