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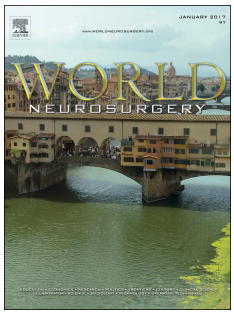
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Modified pure endoscopic approach to the pineal region: a proof of concept of an efficient and inexpensive surgical model based on laboratory dissections

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Title Page

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Modified pure endoscopic approach to the pineal region: a proof of concept of an efficient and inexpensive surgical model based on laboratory dissections

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Abstract

Objective: In the last decades endoscopic techniques have been increasingly used in neurosurgery as they may offer a valuable close-up view of the working area through a minimally invasive surgical corridor. Herein, we present an inexpensive and efficient endoscopic surgical model using a borescope, which was used for a "modified pure endoscopic approach" to the pineal region.

Methods: A borescope video camera was connected to a 16 inches personal computer monitor. A standard midline suboccipital craniotomy was performed on 2 cadaveric heads in the Concorde position. Then, a "borescopic" supracerebellar infratentorial approach was executed, thus reaching the pineal region which was exposed through an extensive arachnoid dissection.

Results: Using the above described model, we were able to provide excellent exposure of the main neurovascular structures of the pineal region, as showed by the intraoperative videos. In one of the specimen we identified an incidental pineal cyst that was meticulously dissected and removed.

Conclusion: Our proposed "borescopic" surgical model may represent an inexpensive and efficient alternative to conventional endoscopic techniques, and could be used for training purposes as well as even for clinical procedures, after a proper validation, particularly in economically challenging environments.

Keywords:

Borescope, Endoscope, Neuroendoscopy, Pineal region, Supracerebellar infratentorial approach, Surgical training

Abbreviations and Acronyms

MAPEnd, modified pure endoscopic approach

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Introduction

Pure endoscopic techniques represent novel minimally invasive procedures that have been developed during the last decades as alternatives to the conventional microsurgical approaches. Endoscopic techniques may provide an efficient visualization of deep neurovascular structures, a good illumination, and a valuable close-up view of the working area through minimally invasive surgical corridors. Moreover, endoscopic equipment is less expensive than surgical microscopes.[1,2]

Even though endoscopic techniques have been introduced years ago, first as endoscope-assisted and later as pure endoscopic procedures, the endoscopic surgical model is in continuous evolution pari passu with the technological development.[3] Nonetheless, few reports regarding the use of pure endoscopic techniques for pineal region lesions have been published so far.

In this paper we present an inexpensive and efficient endoscopic surgical model using a borescope, which was used for a "modified pure endoscopic approach" (MAPEnd) to the pineal region.

Methods

The study was performed on two embalmed adult cadaveric heads. Our surgical training model for the MAPEnd required the following tools:

-a waterproof Borescope ® Micro USB Inspection 3.5M Android, Video Camera 5mm;

-a portable computer;

-a conventional set for craniotomy;

-a set of long microinstruments. We have to remark that our microsurgical set was not fully equipped. Thus, we had to adapt some micro-curettes, sharp straight microdissectors, and blunt curved microdissectors (Figure 1).

The borescope video camera was connected to a 16 inches personal computer monitor. The borescope was held during the procedure by either the operator or an assistant.

Table 1 compares the costs of the traditional training systems to those of our training model.

Surgical Procedure

The head was placed in an adapted surgical pillow as for a Concorde position.[4] A standard midline suboccipital approach was executed. Next, a wide suboccipital craniotomy was performed, exposing the transverse sinuses, the torcular herophili, and extending inferiorly to the level of the cisterna magna. The dura was opened via a U-

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shaped incision based on the transverse sinuses. Then, a "borescopic" retractor-less approach along the upper surface of the cerebellar hemisphere was performed. Some bridging veins were cut in order to enlarge the route the pineal region which was exposed through an extensive arachnoid dissection.

Results

We were able to accomplish a wide exposure of the pineal region in both the specimens. The borescope allowed a satisfactory view of the main neurovascular structures of the region, namely the deep venous system (the internal cerebral and basal veins converging on the vein of Galen), the P3 segments of the posterior cerebral artery, the medial posterior choroidal arteries, the posterior wall and part of the roof of the third ventricle, and the pineal gland (Figure 2 and **Video 1**, illustrating our "borescopic" surgical model).

In one of the specimen we identified an incidental pineal cyst that was meticulously dissected and removed (**Video 2**, illustrating our "borescopic" surgical model).

Discussion

Our anatomic prosection demonstrated that the MAPEnd to the pineal region we performed using a borescope and a conventional set of long microsurgical instruments could represent an inexpensive and efficient neurosurgical model.

The endoneurosurgery was introduced by Griffith in 1975 for fontanelle and persutural ventriculoscopy and endoscopic ventricular surgery in infants.[5] Later, many authors used the endoscope during microsurgical operations, in the so-called endoscope-assisted procedures. As previously described, endoscopic assistance may be very helpful to better visualize the deepest extensions of intracranial lesions, while offering a better illumination and magnification compared to the microscope alone, particularly in some blind regions of the surgical field. In addition, the endoscope may allow a clearer distinction of the interface between the tumor and the surrounding eloquent structures.[6–17]

In 2008 Gore et al. reported the first application of a pure endoscopic supracerebellar infratentorial approach for dealing with a pineal cyst, a minimally invasive alternative to conventional microsurgical procedures that requires no exposure of the venous sinuses.[1,18,19] However, potential bleeding coming from bridging veins and/or highly vascularized lesions may be extremely hard to control with the endoscopic instrumentation. Later, endoscope-controlled procedures to the pineal region were introduced. In this last model the instruments are not

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routinely passed through the endoscope ports, but they are used independently of the endoscope over the cerebellar surface in order to reduce the risks of potential complications.[3,20]

Differently from the previous reports, in our model we used an inexpensive borescope, which was connected to a 16 inches personal computer monitor. The borescope offered a satisfactory view of the main neurovascular structures of the pineal region. Moreover, HD or 4K resolutions monitors could improve the quality of the system. In this regard, our model is designed for neurosurgical centers with low income resources where neuroendoscopic training using conventional neuroendoscopes would be expensive and almost impossible. Our proposed "borescopic" surgical model could effectively allow to train in performing different endoscopic techniques, in particular the so called modified pure endoscopic approaches where the instruments are passed over the cerebellar surface in order to reduce the risks of potential complications.

We used a conventional set of long microinstruments traditionally used in microscopic approaches. However, we believe that the development of dedicated endoscopic instruments is paramount to make safer endoscopic procedures.

For academic purposes, we performed a wide suboccipital craniotomy in order to illustrate the different steps of the standard supracerebellar infratentorial approach to our students. However, a small craniotomy of about 3-4 cm is enough to access to the pineal region through the MAPEnd we describe.[1,3,20]

The introduction of the endoscope under microscopic control is recommended in order to decrease the risk of accidental mechanical injury.[21] However, we did not experience any inadvertent damage of neurovascular structures even if a microscope was not available, thanks to a careful insertion of the borescope.

Nonetheless, we believe that the integration between the endoscope and the microscope has to be refined in order to reduce, in a clinical setting, potential risks and any increase in the operative time.[3,20]

Moreover, the learning curve to master endoscopic techniques is steep as a lot of dexterity in the so-called "eye-hands blind technique" is required.[2]

Limitations

This is a cadaveric prosection study and as such it carries all the well-known limitations of such study (brain consistency, lack of cerebrospinal fluid, etc.). Another limitation is represented by the absence, in our model, of a specific boroscope holder, and of proper microsurgical instruments that could allow more efficient procedures.

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Conclusion

In conclusion, the MAPEnd approach to the pineal region we developed using a borescope could represent an inexpensive and efficient alternative to conventional endoscopic techniques. Indeed, our model could be effectively used for training purposes, and, after a proper validation, even for clinical procedures, particularly in economically challenging environments.[22,23]

Disclosure

Prof. Juha Hernesniemi is an Aesculap consultant. The C. Ehrnrooth Foundation partially supports the present paper, which is part of the “Pineal region surgery” project. The authors have no personal financial or institutional interest in any of the drugs, materials, and devices described in this article.

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Figure Legends

Fig.1 Standard midline suboccipital approach (A). A borescope video camera was connected to a 16 inches personal computer monitor held by the operator (B). Adapted microinstruments to perform the MAPEnd to the pineal region (C). D, Intraoperative picture demonstrating: the tentorium (1), right and left P3 segments of the posterior cerebral artery (2, 3), the drainage of the vein of Galen into the straight sinus (4), and some cortical branches of both superior cerebellar arteries (5). E, Intraoperative picture demonstrating: the P3 segment of the left posterior cerebral artery (3), the pineal gland (6), the right superior colliculus (7), right and left basal veins of Rosenthal (8, 9), the left internal cerebral vein (10), the precentral cerebellar veins (11), the pineal vein (12).

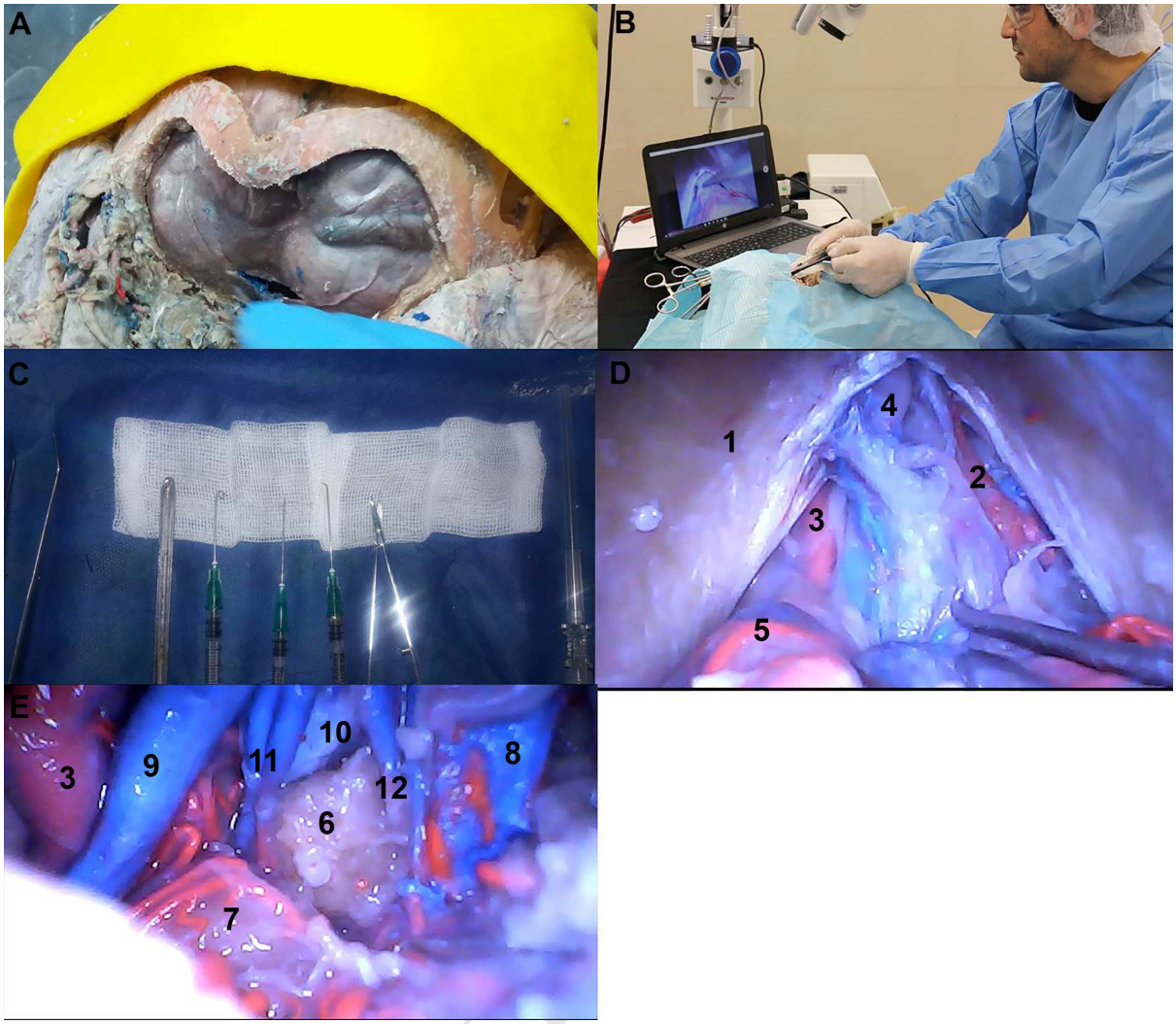
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Table 1. Comparison of the costs of the traditional training systems to those of our training model

Surgical Tools	Cost approx. (US Dollars)
1. Training surgical microscope	5000-10000
2. Endoscope set (0° and 30° scopes), endoscope camera and monitor	35000-60000
3. Our proposed system	
Waterproof Borescope	10-100
Portable computer	1000-1500
Total cost	1010-1600

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Highlights

We present an inexpensive endoscopic surgical model using a borescope

A “borescopic” supracerebellar infratentorial approach was executed

An excellent exposure of the main pineal region neurovascular structures was achieved

In one of the specimen an incidental pineal cyst was removed

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Disclosure

Prof. Juha Hernesniemi is an Aesculap consultant. The C. Ehrnrooth Foundation partially supports the present paper, which is part of the “Pineal region surgery” project. The authors have no personal financial or institutional interest in any of the drugs, materials, and devices described in this article.

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Abbreviations and Acronyms

MAPEnd, modified pure endoscopic approach

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