

### Introduction

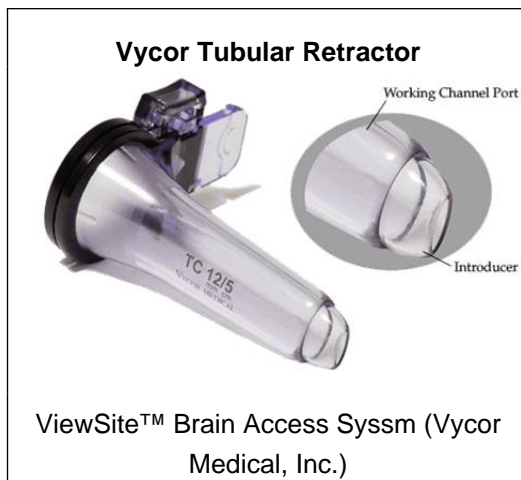
Minimally invasive surgical approaches have revolutionized surgical care and are becoming increasingly common and sought after in neurosurgery. Transtubular procedures, both microscopic and endoscopic, performed through smaller corridors, as opposed to large traditional openings of the skull, rely on surgical instruments that are gentler on the brain and cause less tissue damage. The adaptation of minimally invasive tubular retractors continues to expand in neurosurgery and new surgical landmarks need to be identified to help surgeons navigate this new and unfamiliar surgical field.

### Background

- Increased incidence of cortical damage from retractors held in place for > 15 mins with 20 mmHg of pressure
- Cellular damage includes hypoxic-ischemic injury, axonal disruption, chromatolysis
- Systemic intraoperative factors can increase vulnerability to retractor-mediated cortical ischemia leading to hypotension, hypoxemia, hypercapnia, etc.
- Resulting clinical complications include: parenchymal hematomas, aphasia, hemiparesis, numbness, seizures, venous complications, neuropsychological deficits, etc.

### Methods

We review our clinical and cadaveric experience and techniques in the most common percutaneous transtubular neurosurgical approaches and their respective modifications, including the interhemispheric, supraorbital, middle fossa, retrosigmoid, and pineal approaches. We also review integration of tubular retractors with different neuronavigation systems and trajectory planning.



### Results

#### Transtubular Interhemispheric Transcallosal

- Minimal cortical retraction
- Safe, effective, and facilitates blunt dissection of the corpus callosum that may minimize retraction injury

#### Transtubular Supraorbital Approach

- Provides good visualization of the anterior fossa and its neurovascular contents with minimal frontal lobe manipulation

#### Transtubular Middle Fossa Approach

- Can be performed through a percutaneous burr hole
- Provides excellent exposure of the internal acoustic canal from the porus to the fundus

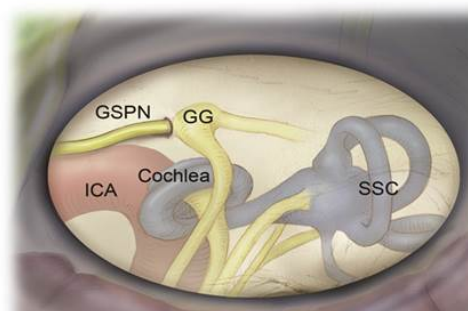
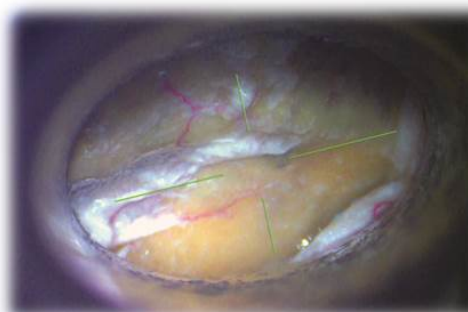
#### Transtubular Retrosigmoid Approach

- Can be performed through a percutaneous burr hole
- Useful for MVD in trigeminal neuralgia and effective for avoiding excessive cerebellar retraction

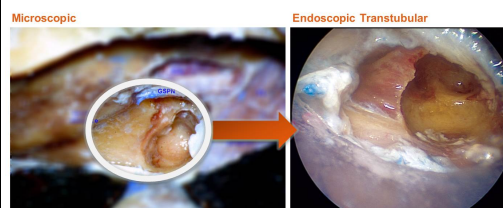
#### Transtubular Approaches to the Pineal Region

- Transtubular occipital approach provided excellent vitalization of the pineal gland and superior colliculi
- The transtubular supracerebellar infratentorial approaches offered excellent exposure of the pineal gland, quadrigeminal plate, and posterior ambient cistern

### Transtubular Middle Fossa Approach



### Microscopic Open vs Microscopic Transtubular Visualization



### Results

The use of tubular retractors in cranial surgery has been preliminarily shown to reduce pressure on cortical surfaces, minimize damage to white matter tracts, and reduce intraoperative iatrogenic injury. The elliptical shape of the retractor allows for binocular visualization and enhanced bimanual surgical maneuverability inside the tube, as well as for optimal light distribution. Additionally, by limiting the range of instrument movement and protecting the surrounding tissues from instruments within the working channel, the tubular retractor may reduce inadvertent iatrogenic instrumental injury and thermal injury from the endoscope light or electrocautery. Use of a neuronavigation-integrated tubular retractor enables appreciation of the surrounding tissue, specifically the distribution of subcortical fiber tracts, for achieving an optimal surgical trajectory.

### Conclusions

Tubular retraction in neurosurgery provides a safe and effective conduit for the application of percutaneous minimally invasive approaches. Advances in neuronavigation and surgical robotics will continue to expand the indications for tubular retraction in neurosurgery, especially for transcortical approaches to deep-seated intraparenchymal lesions.

### References

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Bernardo A, Evins AI, Tsiouris AJ, Stieg PE. A Percutaneous Transtubular Middle Fossa Approach for Intracanalicular Tumors. *World Neurosurg.* 2015;84(1):132-146.