Endoscope-controlled Access to Thalamic Tumors using Tubular Brain Retractor: An Alternative Approach to Microscopic Excision

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Abstract

Background   Surgery for thalamic lesions has been considered challenging due to their deep-seated location. Endoscopic excision of deep-seated brain tumors using tubular retractor has been shown to be safe and effective in prior studies; however, there are limited reports regarding its use for thalamic tumors. We present our experience of endoscope-controlled resection of thalamic tumors using a tubular retractor.

Material and Methods   This was a prospective observational case series done at a tertiary center specialized for endoscopic neurosurgery during the period from 2010 to 2019. Surgeries were performed under the endoscopic control using a silicon tubular retractor. Lesions were approached transcortically or trans-sulcally. Data were collected for the extent of resection, amount of blood loss, operative time, need for conversion to microscopy, and complications.

Results   Twenty-one patients of thalamic masses of 14- to 60-year age underwent the surgeries. Pathologies ranged from grade I to IV gliomas. Gross total and near-total resection could be done in 42.85% of cases for each group. The average blood loss and operative time were 164.04 ± 83.63 mL and 157.14 ± 28.70 minutes, respectively. Complications included a small brain contusion, two transient hemipareses, and one transient speech deficit.

Conclusion   Endoscopic excision of thalamic tumors using a tubular retractor was found to be a safe and effective alternative to microscopic resection.

Keywords
► endoscopic surgical procedure
► endoscopy
► glioma
► thalamic disease

Introduction

Surgery for thalamic lesions has been considered challenging due to their deep-seated location. Stereotactic tumor resection, with tubular retractors, is often used due to the increased morbidity associated with conventional microscopic tumor excision.[1,2] Several recent studies have shown that aggressive surgical resection is possible because of improved preoperative and intraoperative imaging along with better visualization methods.[3–5]

Surgical resection through craniotomies with a larger cortical opening is associated with a high risk of brain injury.[4,6] Role of the endoscope for thalamic lesion was limited to biopsy and endoscopic third ventriculostomy (ETV) for hydrocephalus in the majority of studies.[7–10] There are limited series regarding the endoscope-controlled removal of a thalamic lesion using tubular retractors.[11,12] Here we report our experience of endoscope-controlled excision of 21 thalamic tumors using a tubular brain retractor.

Material and Methods

This was a prospective study of 21 patients with thalamic tumors treated from January 2010 to March 2019. Inclusion criteria were patients of all age groups presenting with thalamic masses of more than 2 cm in size projecting in the lateral ventricle. Smaller lesions were advised stereotactic biopsy. Tumors involving the brainstem, peduncles, and arteriovenous malformations of this region were excluded from the study.

A detailed clinical history and thorough physical examination were performed. Preoperatively, all the patients underwent contrast-enhanced magnetic resonance imaging (MRI) scan (►Figs. 1, 2) and computed tomography (CT) scans. The center of the lesion was marked on preoperative MRI using a vitamin E capsule as a radio-opaque marker, and the center of tumor was marked on the skin. Intraoperatively, a line was drawn from the midpoint of incision to the marker. The head was positioned in such a way that this line became perpendicular to the floor (►Fig. 3). Although we agree that neuronavigation is very useful during this type of surgery, we did not use it as it was not available during our study period. The surgical approach was planned according to the location of the tumor. A transfrontal transventricular (TFTV) approach was used when the tumor was in the anterior thalamus (►Fig. 4), and a trans-superior parietotransventricular (TPTV) approach was used for tumors arising from the posterior thalamus (►Fig. 4). A trans-sulcal route was preferred to minimize brain parenchyma injury (in nine patients).

All the patients were evaluated postoperatively by a CT scan on the first postoperative day and contrast-enhanced MRI after 4 weeks (►Figs. 1, 2). CT scan was done mainly to rule out any hematoma and to get an idea about the extent of tumor resection (EOR) on the first postoperative day, or earlier if indicated. MRI could not be done on the first postoperative day due to financial constraints.

Data were collected for patients' history, physical examination, relevant investigations, intraoperative blood loss, operative time, EOR, brain contusion, infarction, or hematoma. EOR was measured on postoperative MRI. It was defined as gross total resection (GTR) if there was no residual tumor, near-total resection (NTR) if there was >95% resection, and subtotal resection (STR) if there was <95% resection on postoperative scans. The operative time was calculated from incision to closure of the procedure.

Surgical Procedure

A brief description of the technique is described here (detailed procedures have been given in prior publications).[11,13] Patients were positioned supine with the head-end elevation of ~30 degrees for anterior thalamic lesions, whereas they were placed in the prone position for posterior lesions. A linear incision of ~4 to 5 cm was made, and a craniotomy of ~3 × 3 cm was used (►Fig. 5a). The dura was opened in a cruciate manner. If the brain was found tense, the cerebrospinal fluid (CSF) was drained from the adjoining sulci and by tapping the ventricle. After splitting a sulcus or making a small
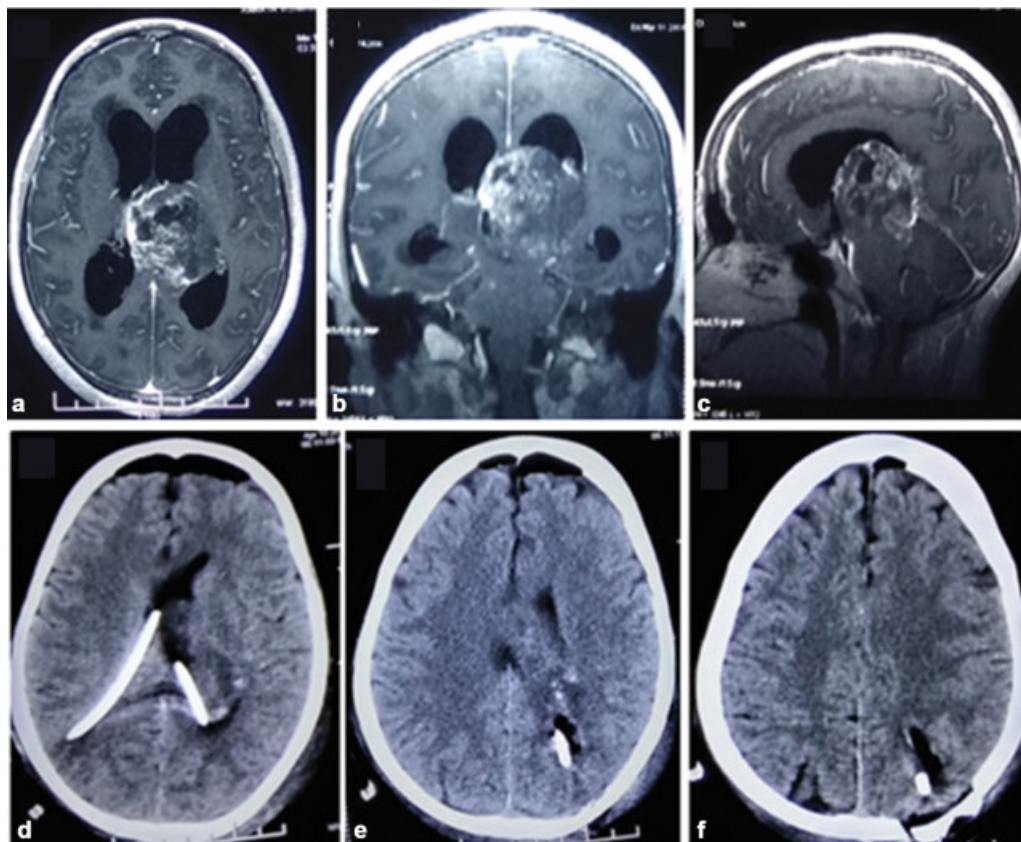

Fig. 1 (a–c) Preoperative magnetic resonance imaging showing left thalamic tumor and (d–f) computed tomography images 24 hours after surgery shows total excision of the tumor through a mini-craniotomy.
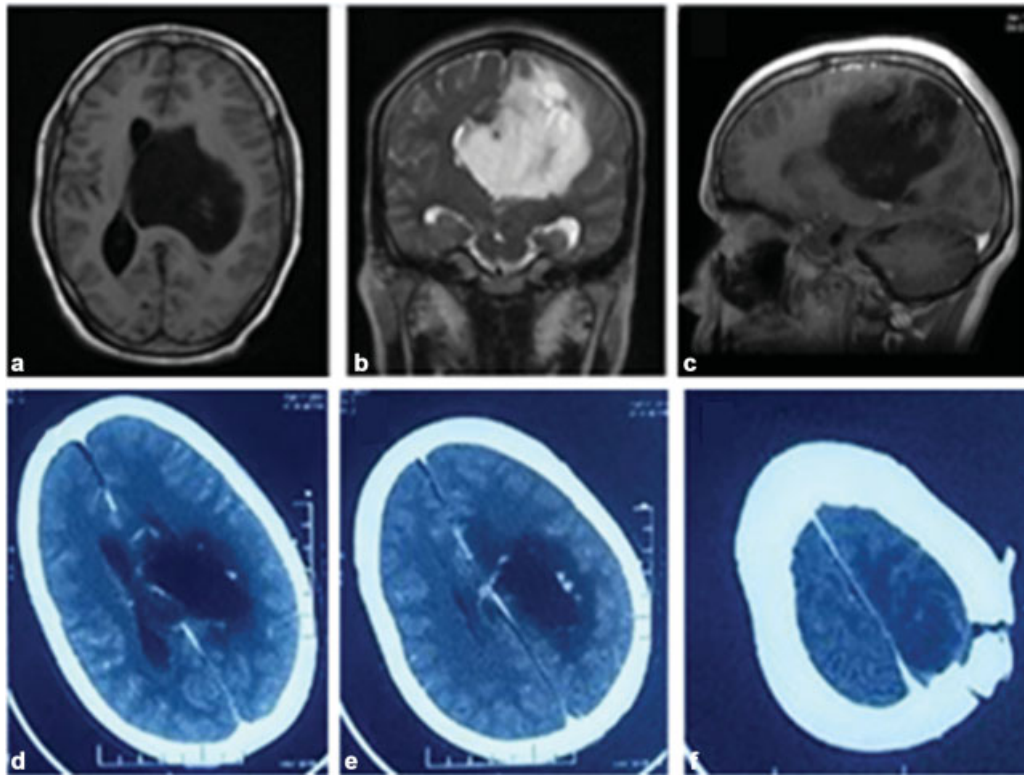
Fig. 2 (**a**) T1 axial, (**b**) T2 coronal, and (**c**) T1 contrast sagittal magnetic resonance imaging showing a large bilateral thalamic tumor. (**d–f**) Postoperative computed tomography scan done 48 hours later shows near-total excision of the mass.
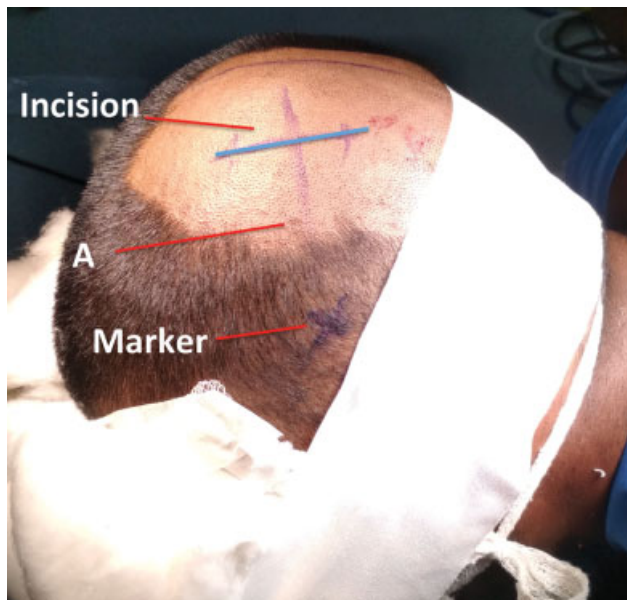

Fig. 3 Incision shown in blue line and marker location marked over the scalp for the tumor in ►**Fig. 1**. The line shown as A was drawn from the midpoint of incision to the marker. The head was positioned in such a way that this line became perpendicular to the floor.

Fig. 4 Diagrammatic presentation of surgical approaches for (**a,b**) anterior and (**c,d**) posterior thalamic tumor.

corticectomy, Killian's nasal speculum was inserted in a closed fashion along the planned trajectory. It was gently opened, and the folded indigenous silicon tubular retractor (18 mm diameter of appropriate length) held with tissue forceps was introduced inside the opened nasal speculum (►**Fig. 5b**). The tissue forceps and nasal speculum were removed, leaving the tubular
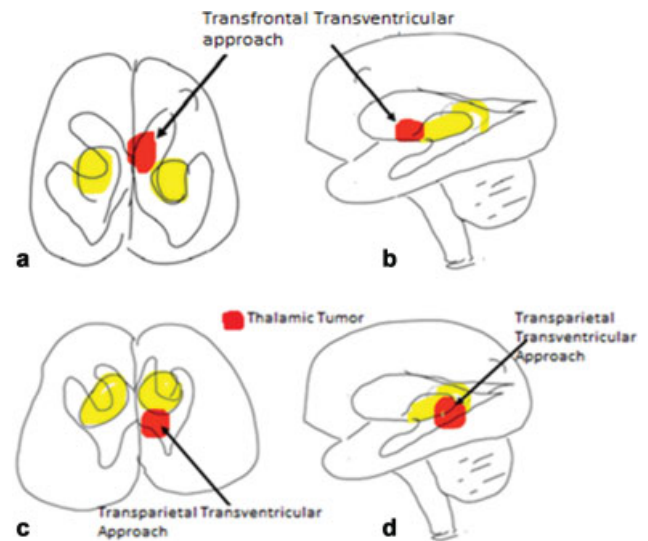
retractor in place. Proper positioning and incision were made to approach the lesion at 90 degrees to the operating room floor. This caused the normal brain to fall apart and keeping the retractor stationed on its own. This also prevented the distortion of the tubular retractor by the surrounding brain. The folded retractor expanded gradually to its natural round shape. Two microinstruments applied outward pressure in helping regain the normal round configuration of the retractor. The endoscope (Karl Storz, Tuttlingen, Germany; 30 cm long, 4 mm diameter, and 0-degree angle) was then brought in for
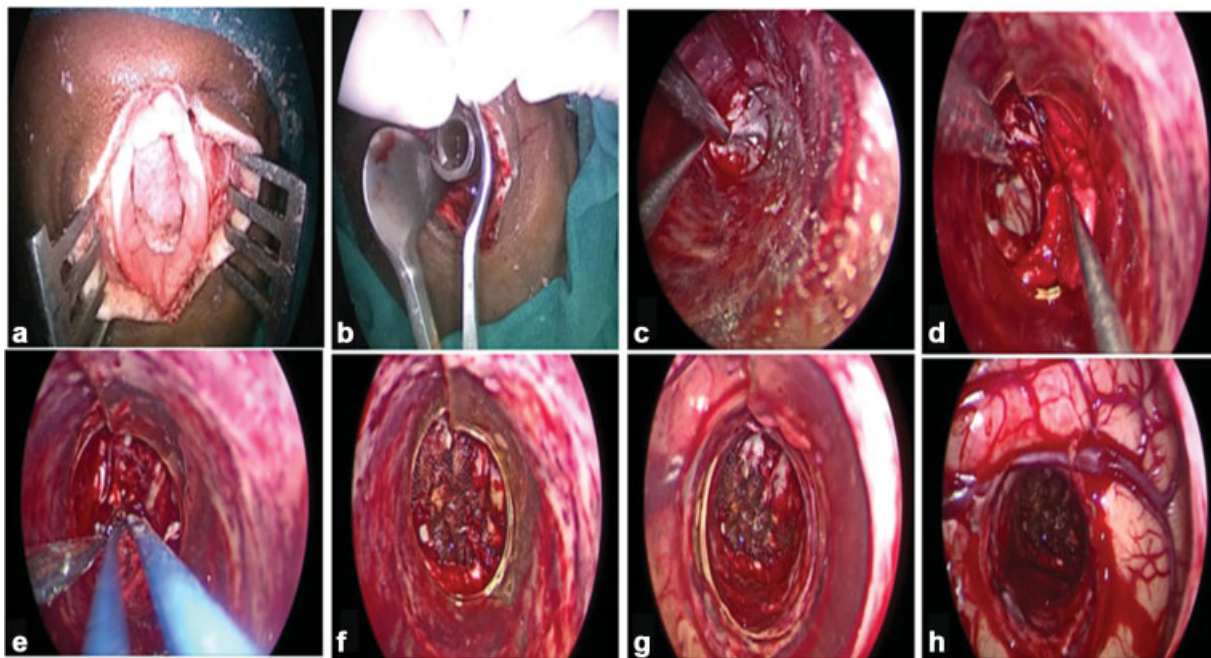
Fig. 5 Endoscopic removal of left thalamic tumor showing (**a**) small craniotomy, (**b**) introduction of nasal speculum and tubular retractor, (**c,d**) removal of tumor using bimanual technique, (**e,f**) hemostasis using bipolar cautery and absorbable hemostat, and (**g,h**) removal of tubular retractor under endoscopic visualization.

visualization and was fixed on a holder. The tip of the endoscope was placed ∼1.5 cm away from the tumor and was inside the tubular retractor. Tumor resection was performed using the conventional bimanual technique (suction in one hand and working instrument in the other hand) under the endoscopic control. The position of the endoscope was periodically changed to obtain triangularization and avoid instrument collisions. The tumor was internally decompressed in a piece-meal fashion (►**Fig. 5c, d**). The tubular retractor could be moved to the desired direction to obtain complete resection. After resection of the tumor, the tubular retractor was slowly withdrawn under the endoscopic vision, and hemostasis was achieved (►**Fig. 5e–h**). An external ventricular drain was left for 3 to 5 days. Scalp flap was closed in layers after the dural closure and replacement of the bone flap. The patients were observed in the intensive care unit postoperatively.

Results

From January 2010 to March 2019, 21 patients with thalamic tumors underwent endoscopic excision of the lesion using a tubular brain retractor. Patient age ranged from 14 to 60 years (mean of 34.14 ± 14.82). There were 12 females (57.14%).

Patients presented with symptoms of headache ($n = 18$, 85.71%), vomiting ($n = 10$, 47.61%), visual obscuration ($n = 10$, 47.61%), hemianopia ($n = 8$, 38.09%), speech disorder ($n = 5$, 23.80%), hemiparesis ($n = 15$, 71.42%), and sensory symptoms ($n = 15$, 71.42%). Hydrocephalus was observed prior to surgery in 14 (66.66%) patients and required shunts prior to the definitive surgery.

Eleven patients had a tumor on the right side (52.38%). A TFTV approach was performed in 7 patients (33.33%) and a TPTV approach in 14 patients (66.67%). A trans-sulcal route was used in 9 patients, whereas a transcortical route was used in 12 patients. ►**Video 1** shows the endoscopic TPTV approach through the superior parietal lobule using a silicon tubular retractor.

Video 1

Operative video of the endoscopic transparietal-transventricular approach through the left superior parietal lobule using a silicon tubular retractor. Online content including video sequences viewable at: https://www.thieme-connect.com/products/ejournals/html/10.1055/s-0041-1722966.

The demography of the patients, including their age, gender, location, histological grading, and follow-up, is shown in ►**Table 1**.

Proper visualization and good magnification were possible in all cases. None of the cases required conversion to open/microscopic excision. The blood loss ranged from 80 to 400 mL, with the average blood loss being 164.04 ± 83.63 mL. The operative time ranged from 110 to 210 minutes, with the average time being 157.14 ± 28.70 minutes. GTR, NTR, and STR were possible in nine, nine, and three patients, respectively. Resection, according to the type and location of the lesion, can be seen in ►**Table 1**. Headache, vomiting, and visual obscuration improved in all patients, and hemiparesis improved in two patients. No improvement was observed in sensory symptoms on follow-up. One patient had postoperative small brain contusion, which did not require evacuation. Two patients had transient worsening of the motor deficit, and one patient

Table 1 Patients' demography for the thalamic tumors

S. no.	Age (y)	Gender	Location	Approach	EOR	Blood loss (mL)	Operative time (min)	Histopathologic diagnosis	New deficit/complication	Follow-up (mo)
1	45	F	Left anterior thalamus	TFTV	GTR	90	135	PA	No	28
2	32	F	Left posterior thalamus	TPTV	NTR	140	150	PA	No	34
3	40	M	Right posterior thalamus	TPTV	NTR	200	155	AA	No	18
4	27	F	Left thalamus, corpus callosum	TPTV	STR	325	180	DA	Brain contusion	16
5	58	M	Right anterior thalamus	TFTV	GTR	100	130	PA	No	6
6	50	F	Right posterior thalamus	TPTV	NTR	150	160	PA	No	30
7	19	F	Left posterior thalamus	TPTV	NTR	130	150	GG	No	24
8	58	F	Left posterior thalamus	TPTV	GTR	90	110	PA	No	12
9	17	M	Right anterior thalamus, intraventricular	TFTV	GTR	250	175	PA	Transient motor deficit	36
10	32	M	Left posterior thalamus, corpus callosum	TPTV	STR	230	160	AA	No	14
11	48	F	Left anterior thalamus	TFTV	NTR	90	115	AA	No	11
12	60	M	Right posterior thalamus	TPTV	NTR	400	135	GBM	No	8
13	24	M	Left posterior thalamus	TPTV	GTR	80	150	PA	No	28
14	38	F	Right posterior thalamus	TPTV	GTR	90	115	DA	No	5
15	14	F	Right anterior thalamus	TFTV	NTR	130	140	GG	No	2
16	25	M	Right anterior thalamus	TFTV	GTR	100	180	AA	Transient speech deficit	24
17	25	M	Left Posterior thalamus and corpus callosum	TPTV	STR	120	180	GBM	Transient motor deficit	12
18	19	F	Left posterior thalamus	TPTV	GTR	200	210	PA	No	18
19	45	F	Right posterior thalamus	TPTV	NTR	180	180	AA	No	21
20	20	M	Right anterior thalamus	TFTV	NTR	200	210	AA	No	24
21	21	F	Right posterior thalamus	TPTV	GTR	150	180	PA	No	12

Abbreviations: AA, anaplastic astrocytoma; DA, diffuse astrocytoma; EOR, extent of resection; GBM, glioblastoma multiforme; GG, ganglioglioma; GTR, gross total resection; NTR, near-total resection; PA, pilocytic astrocytoma; STR, subtotal resection; TFTV, transfrontal transventricular; TPTV, transparietal transventricular.

developed transient speech deficit, which improved after 2 months. There was no venous injury, infarction, or infection. There was no procedure-related postoperative mortality. The follow-up period ranged from 2 to 36 months, with an average of 18.23 ± 9.71 months. Three patients died during follow-up (two glioblastoma multiforme and one anaplastic astrocytoma), and the rest are alive. There were 9, 6, 2, 2, 2 patients with pilocytic astrocytoma (42.85%), anaplastic astrocytoma (28.57%), diffuse astrocytoma (9.5%), ganglioglioma (9.5%), and glioblastoma (9.5%), respectively.

Discussion

Management of thalamic tumors has always been a great challenge in microsurgery. These lesions were once considered inoperable because of the high risk of postoperative morbidity and mortality.[14–16] Resection of thalamic tumors often requires retraction of the overlying brain. There are various retraction options available in the literature, which include fixed blades and tubular retractors. Fixed blades can cause brain contusions and venous injuries due to excessive localized pressure.[17,18] The tubular retractors provide circumferential equal pressure distribution on a larger surface area and thus are less likely to cause brain injury. These retractors can be metallic or silicon based. Evidence for endoscopic excision of thalamic tumors using tubular retractors is limited in the literature.[11,13,19] The senior author (Y.R.Y.) has described a malleable silicon tubular retractor that has proven beneficial in hematomas, colloid cyst, intraventricular tumors, and deep-seated brain tumors.[11,15,16] It provides equal pressure to the surrounding brain. The literature regarding the safety and efficacy of endoscopic excision using tubular retractors in thalamic masses is limited.

In our study, endoscopic excision with tubular retractors provided excellent visualization of the underlying pathology, resulting in 85.71% total or near-total removal of the tumors. The resection rates found in our study were comparable to the other microscopic studies in the literature.[20–22]

Safety

The tubular retractor was found to be safe in our study for all age groups and pathologies. There was a single incidence of small brain contusion that did not require any surgery. There was no venous injury or postoperative mortality. There was no incidence of uncontrolled bleeding or difficulty in visualization. There was no conversion to a microscopic approach. The retractor was found safe for both transcortical and trans-sulcal routes.

We were able to perform all surgeries using a mini-craniotomy of $\sim 3 \times 3$ cm size. Our tubular retractor has the advantage of a small cortical opening due to the longitudinal cut, which helps in the folding of the tube. This technique permits good visualization and does not allow the collapse of the overlying brain.

The blood loss was less in our study and varied according to the type of histology and vascularity of lesions. The tubular retractor helped in reducing the bleeding by the tamponade effect. Gentle pushing of the tube helped in reducing bleeding due to pressure on bleeding vessels. The transparent walls of the retractor also helped in the diagnosis of bleeding points and in hemostasis.

Complications

The complications in this series were minimal due to a small incision, better visualization, soft nature of the tube, and effective removal of the tumor using the bimanual technique. One patient had a contusion, two had transient motor deficits, and one had transient speech deficit.

Advantages of Technique

The tubular retractor was transparent, lightweight, and does not need a holder when used with a proper trajectory. It could be moved to the desired direction by suction or any microinstrument, thus avoiding time wastage in repositioning when the holder is used. Its soft nature prevented injury to the surrounding brain while also reducing bleeding. There was good visualization due to the endoscope.

Limitations

The technique discussed in this study was associated with some limitations. The endoscope lacks a stereoscopic vision. This procedure is also associated with a significant learning curve and should be performed after acquiring proper experience and training on simpler cases of endoscopic surgery and endoscope-assisted microsurgery. The endoscope takes some space in an already limited space and can cause an obstruction in instrument manipulation. Proper positioning of the endoscope and the instruments is required to prevent difficulties in instrument manipulations, especially during the learning curve. Repeated cleaning of the lens due to blood staining/fogging may be needed. Proper planning of trajectory is required; otherwise, the overlying brain may fall over the retractor system leading to its collapse. Finally, the patient cohort was small in our study, and thus larger series and randomized controlled trials are required to establish the safety and efficacy of the technique.

Conclusion

Endoscopic excision using a tubular retractor of thalamic tumors was found to be a simple, safe, and effective alternative to microscopic resection.

Conflict of Interest
None declared.

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