



# Anterior communicating artery division in the endoscopic endonasal translamina terminalis approach to the third ventricle: an anatomical feasibility study

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## Abstract

**Background** Endonasal endoscopic approaches (EEA) to the third ventricle are well described but generally use an infrachiasmatic route since the suprachiasmatic translamina terminalis corridor is blocked by the anterior communicating artery (ACoM). The bifrontal basal interhemispheric translamina terminalis approach has been facilitated with transection of the ACoM. The aim of the study is to describe the anatomical feasibility and limitations of the EEA translamina terminalis approach to the third ventricle augmented with ACoM surgical ligation.

**Methods** Endoscopic dissections were performed on five cadaveric heads injected with colored latex using rod lens endoscopes attached to a high-definition camera and a digital video recorder system. A stepwise anatomical dissection of the endoscopic endonasal transtuberulum, transplanum, translamina terminalis approach to the third ventricle was performed. Measurements were performed before and after ACoM elevation and transection using a millimeter flexible caliper.

**Results** Multiple comparison statistical analysis revealed a statistically significant difference in vertical exposure between the control condition and after ACoM elevation, between the control condition and after ACoM division and between the ACoM elevation and division ( $p < 0.05$ ). The mean difference in exposed surgical area was statistically significant between the control and after ACoM division and between elevation and ACoM division ( $p < 0.01$ ), whereas it was not statistically significant between the control condition and ACoM elevation (NS).

**Conclusion** The anatomical feasibility of clipping and dividing the ACoM through an EEA has been demonstrated in all the cadaveric specimens. The approach facilitates exposure of the suprachiasmatic optic recess within the third ventricle that may be a blind spot during an infrachiasmatic approach.

**Keywords** Anterior communicating artery · Cadaver · Endoscopic · Endonasal · Lamina terminalis · Third ventricle

## Abbreviations

ACA	Anterior cerebral artery	GTR	Gross-total resection
ACoM	Anterior communicating artery	ICA	Internal carotid artery
EEA	Extended endonasal approach	ICG	Indocyanine green
		LT	Lamina terminalis

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TCA	Transcranial approach
TV	Third ventricle

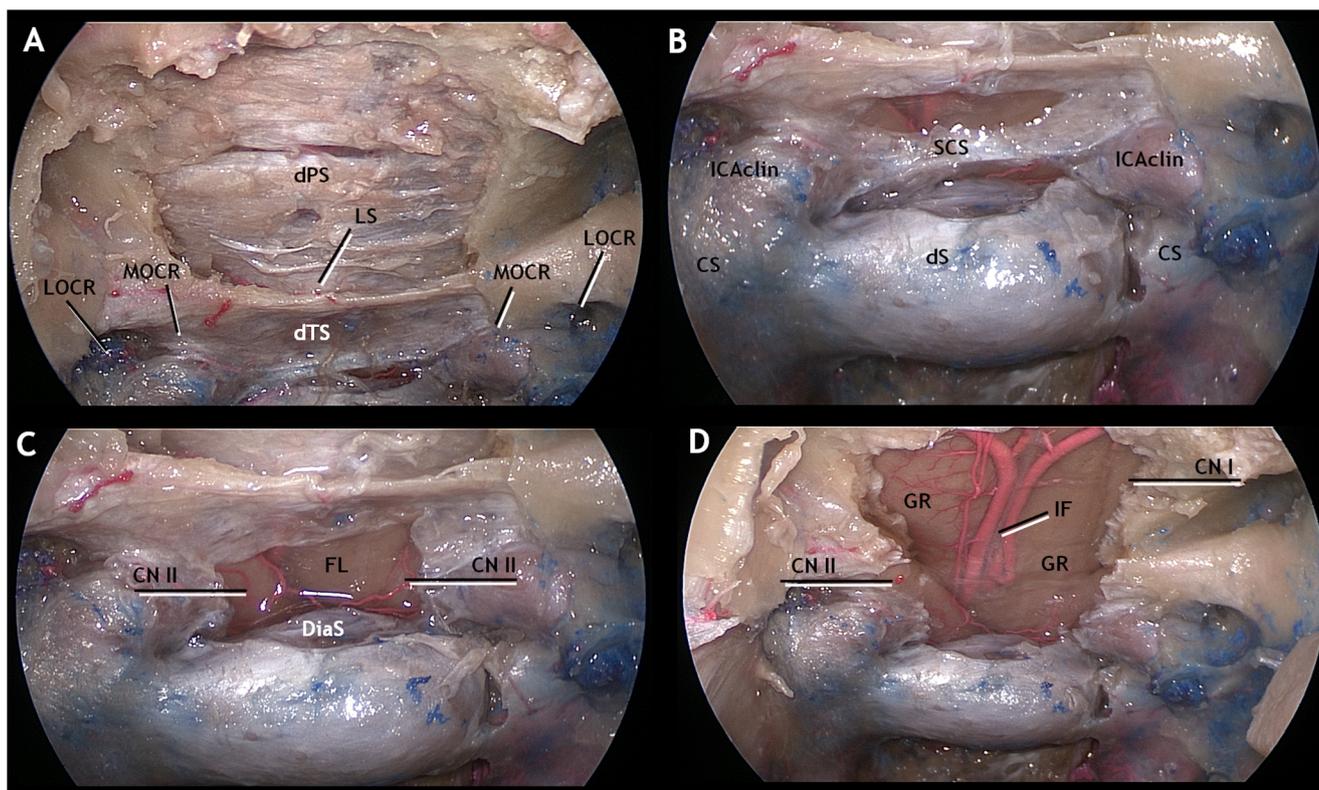
## Introduction

The third ventricle is a midline cavity filled with cerebrospinal fluid enclosed by the diencephalon. It communicates with each lateral ventricle through the foramen of Monro and with the fourth ventricle through the mesencephalic aqueduct of Sylvius. Several pathologies can affect this region such as primarily intraventricular lesions (i.e., colloid cysts, choroid plexus papillomas and carcinomas, ependymomas, sub-ependymomas and central neurocytomas) or secondary lesions that originate from the surrounding structures (i.e., craniopharyngiomas, pituitary tumors, optic pathways-hypothalamic gliomas, skull base meningiomas, pineal region tumors and metastases) [30].

The third ventricle is a deep and challenging area to reach surgically. Several traditional approaches to the third ventricle have been described: anterior and posterior interhemispheric

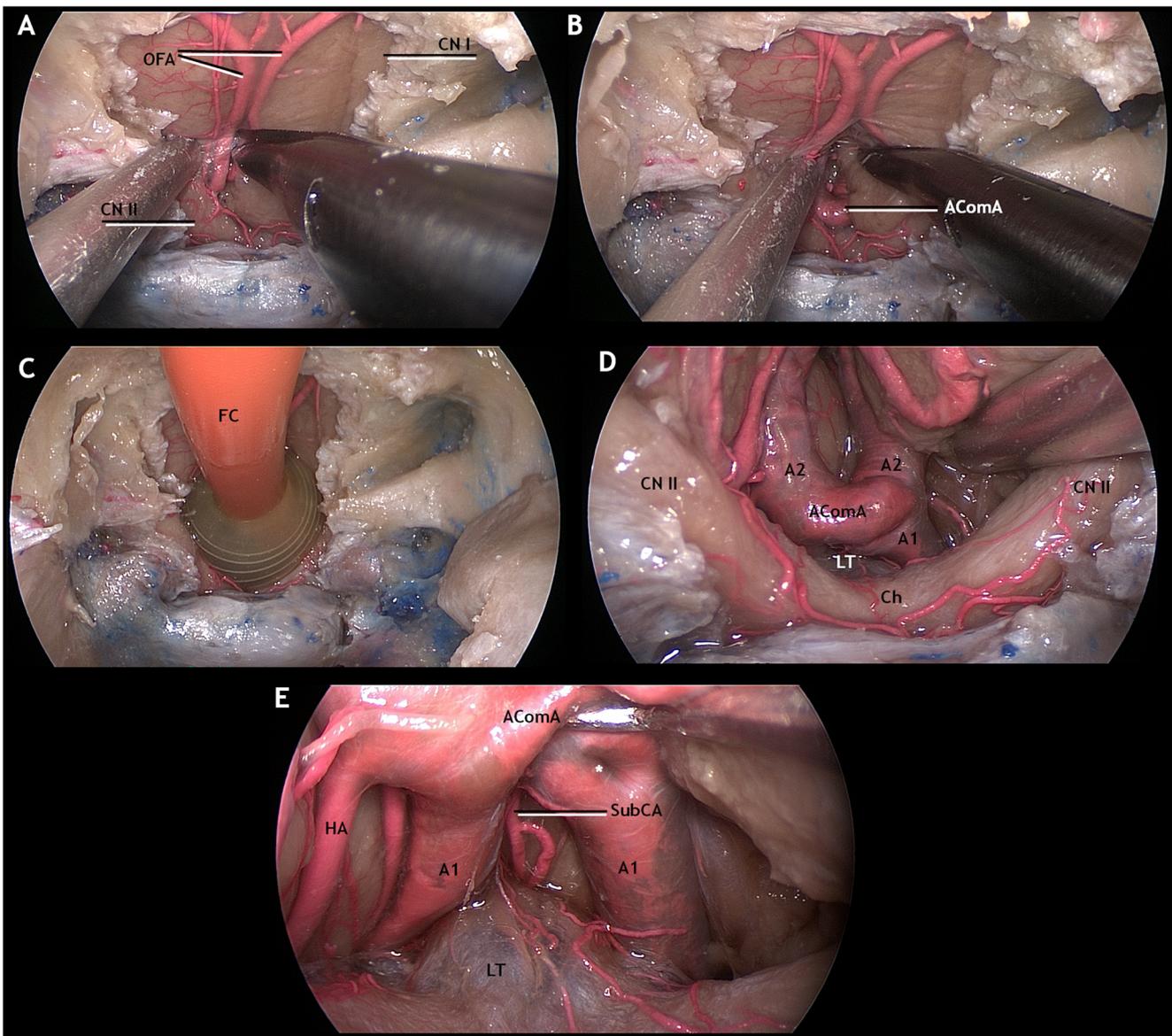
transcallosal, transcortical, occipital transtentorial and supracerebellar infratentorial, interhemispheric sub-frontal translamina terminalis, and frontotemporal approaches [30]. These craniotomy approaches may be morbid due to the need for brain retraction and manipulation of important neurovascular structures before reaching the target [6, 7, 16].

The advancement of endoscopic techniques and instrumentation has enabled surgeons to expand the indications of endoscopic endonasal approaches (EEA) to the third ventricle from pathologies mainly involving the sella to lesions that are purely intraventricular [4, 9, 13, 20, 21, 33, 41]. The EEA has significantly reduced the invasiveness and rate of complications of third ventricular surgery and improved the surgical view and extent of tumor resection [7, 11, 18, 24, 31]. The suprachiasmatic translamina terminalis and the infrachiasmatic supradiaphragmatic represent the two available EEA corridors to address third ventricular pathology, such as craniopharyngiomas [1, 14, 32]. The infrachiasmatic approach, which passes through the pituitary–chiasmatic corridor, is preferred since the surgeon can work below the chiasm, which permits visualization of the majority of the third



**Fig. 1** Cadaveric dissection demonstrating the osteo-dural steps of the endoscopic endonasal suprachiasmatic translamina terminalis approach. **a** The bone of the tuberculum sellae and planum sphenoidale are removed to expose the overlying skull base dura mater. The limbus sphenoidale represents the dural fold that separates the dura of tuberculum sellae and planum sphenoidale. **b** Two incisions are made above and below the superior intercavernous sinus. **c** The superior intercavernous sinus is resected and suprasellar content is exposed. **d** The dura of the planum and limbus sphenoidale are resected and the inferior surfaces of the frontal

lobes are exposed. The pictures also show the removal of the bone of the sella, cavernous sinuses and clivus related to a different anatomical project. CN I, olfactory nerve; CN II, optic nerve; CS, cavernous sinus; DiaS, diaphragm sellae; dPS, dura of planum sphenoidale; dS, dura of sella; dTS, dura of tuberculum sellae; GR, gyrus rectus; ICAclin, clinoidal segment of internal carotid artery; IF, interhemispheric fissure; LS, limbus sphenoidale; LOCR, lateral optic-carotid recess; MOCR, medial optic-carotid recess; SCS, superior intercavernous sinus



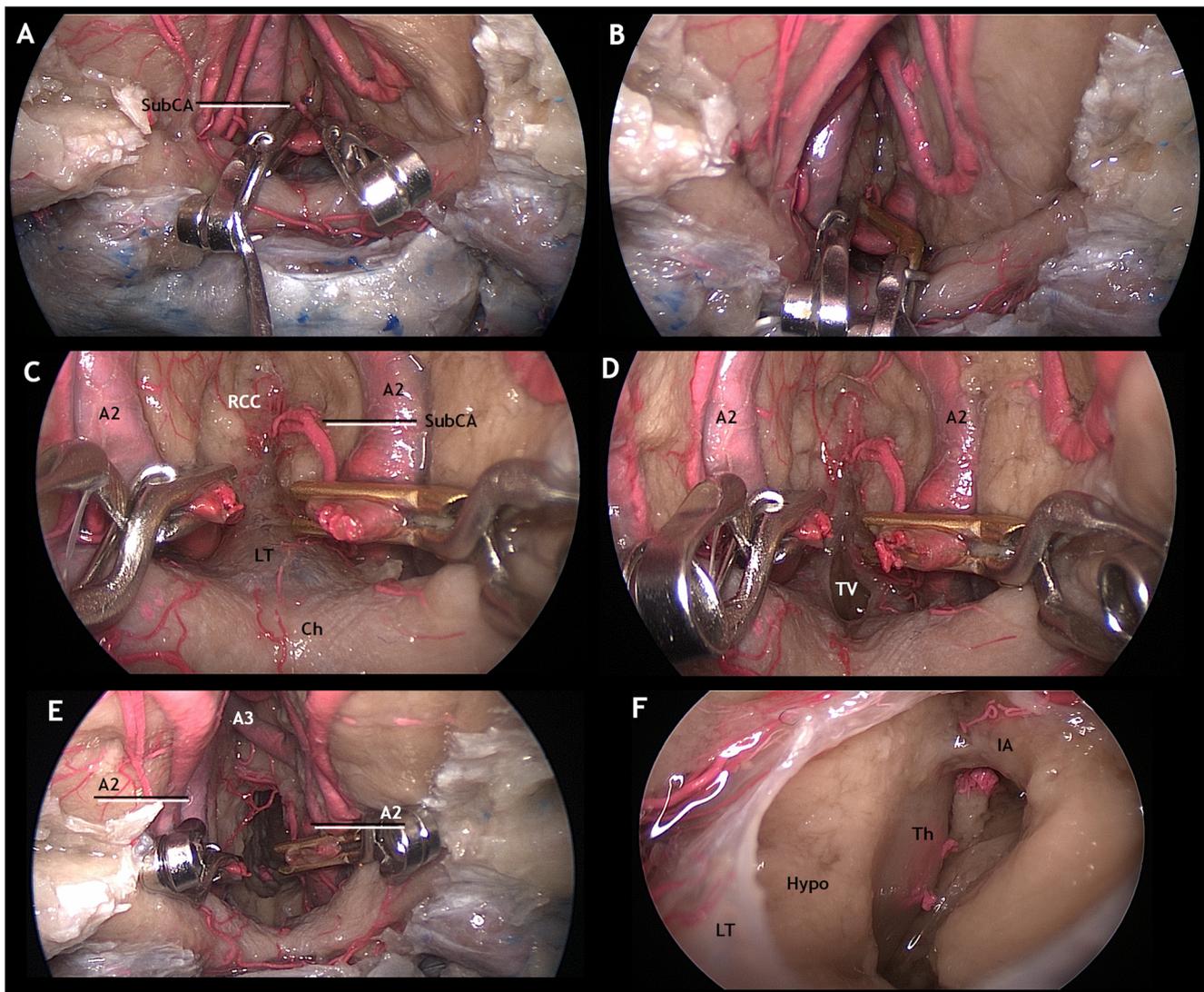
**Fig. 2** Cadaveric dissection demonstrating the arachnoidal steps of endoscopic endonasal suprachiasmatic translamina terminalis. **a** The orbitofrontal arteries are recognized and the interhemispheric fissure is dissected with sharp microscissors. **b** The opening of the interhemispheric fissure lead to the exposure of the suprachiasmatic cistern. **c** Brain retraction is gently achieved with a 12-french Foley catheter water-filled. **d** The optic chiasm and nerves, lamina terminalis, anterior communicating artery, and A1 and A2 segments of ACA were fully exposed. This represents the “control” situation where all the exposure measurements

are made. **e** The anterior communicating artery is gently elevated to improve the rostral exposure of the lamina terminalis and carefully visualize the perforators arising from anterior cerebral artery–anterior communicating artery complex. The anterior communicating presents a dimple configuration (asterisk). A1, first (or precommunicating) segment of anterior cerebral artery; A2, second (or post-communicating) segment of anterior cerebral artery; AComA, anterior communicating artery; CN I, olfactory nerve; CN II, optic nerve; FC, Foley catheter; HA, Heubner’s artery; LT, lamina terminalis; OFA, orbitofrontal artery; SubCA, subcallosal artery

ventricle and medial walls of the hypothalamus [26]. However, the optic recess may be a blind spot, depending on whether the chiasm is pre- or post-fixed.

The lamina terminalis is a thin layer of gray matter and constitutes the anterior wall of the third ventricle [10, 30, 39]. It is often opened to better address lesions within the third ventricle or in patients with subarachnoid hemorrhages to decrease the incidence of delayed vasospasm [8, 17, 37].

The translamina terminalis approach has been classically described as a transcranial approach but in the last decades, some anatomical and clinical studies have highlighted its significance also through the EEA suprachiasmatic corridor [1, 7, 14]. The main structure that limits the translamina terminalis approach is the Anterior Communicating Artery–Anterior Cerebral Arteries (AComA–ACA) complex. Some authors advocated the surgical clipping and



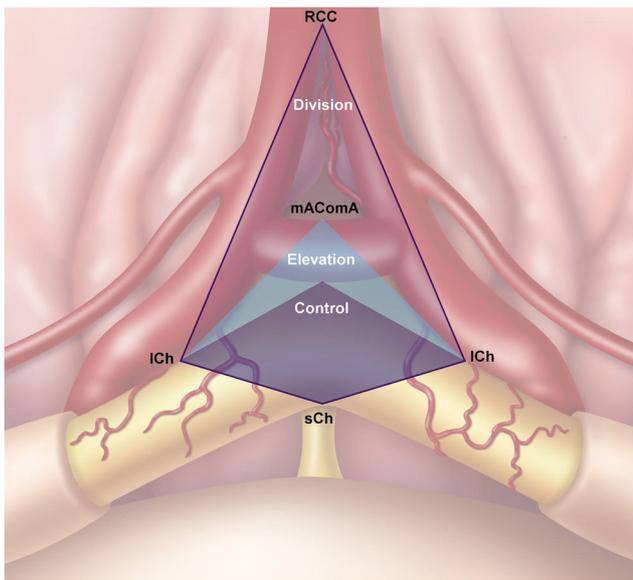
**Fig. 3** Cadaveric dissection demonstrating the anterior communicating artery clipping and division through an endoscopic endonasal suprachiasmatic translamina terminalis approach. **a** Two straight surgical titanium mini-clips are applied with a single shaft applicator in the midportion of the anterior communicating artery. After a careful inspection of the subcallosal artery–anterior cerebral artery complex, the subcallosal artery appears clipped as well. **b** The decision of positioning a left-curved surgical titanium mini-clip is made and the subcallosal artery is now preserved. **c** The anterior communicating artery is divided with the use of microscissors. The subcallosal artery is the main perforating artery arising from the anterior communicating artery supplying the rostrum and genu of corpus callosum. **d** After clipping and

division of the anterior communicating artery, the translucent lamina terminalis is incised in its midline avascular area with sharp and blunt instruments. **e** After the opening of the lamina terminalis, the third ventricle is exposed. **f** Close inspection of the structures of the third ventricle lateral walls. A1, first (or precommunicating) segment of anterior cerebral artery; A2, second (or post-communicating) segment of anterior cerebral artery; A3, third (or precallosal) segment of anterior cerebral artery; AComA, anterior communicating artery; Hypo, medial surface of hypothalamus; IA, interthalamic adhesion; LT, lamina terminalis; RCC, rostrum of corpus callosum; SubCA, subcallosal artery; Th, medial surface of thalamus; TV, third ventricle

division of the AComA in selected patients through the bifrontal basal interhemispheric approach to achieve a better visualization with reduced complications [35, 38]. The AComA also limits the rostral exposure of the EEA suprachiasmatic translamina terminalis approach to the third ventricle [14, 32]. In the present study, we describe the anatomical feasibility and limitations of the extended endoscopic endonasal translamina terminalis approach to the third ventricle facilitated with AComA surgical ligation.

## Materials and methods

Five cadaveric heads injected with colored latex (red for arteries and blue for veins) and preserved in a customized embalming fluid (70% water, 14% ethyl alcohol, 8% formalin and 8% glycerin) were used in the present study. The ICAs and the jugular veins were cannulated and injected with colored latex. All the heads were normal without any known brain abnormality. The cadaveric specimens were neutrally



**Fig. 4** Illustration demonstrating the method used for quantification of the vertical and surgical area exposure. The target points for the measurements are the superior (sCh) and lateral aspects (lCh) of the optic chiasm, the midpoint of the AComA (mACoMA), and rostrum of corpus callosum (RCC). The purple quadrilateral corresponds to the surgical area exposed before the elevation and division of AComA (Control); the light blue and pink quadrilateral correspond to the surgical area exposed after AComA elevation (Elevation) and after AComA division (Division), respectively

positioned in a three-pin skull clamp. Endoscopic dissections were performed using rod lens endoscopes (4 mm, 18 cm, Hopkins II, 0° and 30°, Karl Storz, Tuttlingen, Germany) attached to a high-definition camera and a digital video recorder system (Full HD camera platform IMAGE 1, Karl Storz, Tuttlingen, Germany). A stepwise anatomical dissection of the endoscopic endonasal transtuberulum, transplanum, translamina terminalis to the third ventricle was performed [20, 22, 33]. IRB was not required since the study involved only cadaveric specimens.

### Surgical technique

Under a 0-degree endoscopic view, the middle and superior turbinates were bilaterally removed. A bilateral naso-septal flap was harvested and placed in the rhinopharynx. After completing a bilateral uncinectomy, an anterior and posterior bilateral ethmoidectomy was also performed. A wide posterior septectomy and bilateral sphenoidotomy were performed with an electric high-speed drill (Midas Rex, Medtronic, Minneapolis, MN, USA). The sphenoid sinus mucosa was removed and bony septa drilled. The main sellar anatomical landmarks were identified. The medial optic-carotid recesses represented the lateral extent of the transtuberulum modular route. The posterior ethmoidal arteries represented the most anterior extent of the trapezoidal transplanum approach. The tuberculum and planum sphenoidale were removed with the

aid of high-speed drill, bone curette, and Kerrison rongeur (Karl Storz, Tuttlingen, Germany). The dura above and below the superior intercavernous sinus was incised with a sickle knife and the sinus was resected along with the diaphragm sella and planum sphenoidale dura (Fig. 1). The interhemispheric fissure was dissected with sharp instruments and brain retraction was gently achieved with a 12F Foley urinary catheter (B. Braun, Melsungen, GERMANY) filled with water to facilitate arachnoid dissection and third ventricle exposure. The optic chiasm and nerves, lamina terminalis, anterior communicating artery, A1 and A2 segments of ACA were fully exposed. The AComA-ACA complex was also identified and carefully inspected regarding the origins of the arterial perforators (Fig. 2). Two surgical titanium mini-clips (Sugita Mizuho America Inc., Union City, CA, USA) were applied with a single shaft applicator (Sugita Mizuho America Inc., Union City, CA, USA) in the midportion of the AComA and surgically divided with the use of microscissors (Karl Storz, Tuttlingen, Germany) while preserving perforator branches (e.g., subcallosal artery) (Fig. 3). We examined and quantified the degree of surgical exposure of the lamina terminalis before and after the surgical clipping and division of the AComA (Figs. 2, 3, and 4). We also examined and quantified the degree of surgical exposure after elevating the AComA-ACA complex (Figs. 2 and 4). The lamina terminalis was incised in the midline avascular region with blunt or sharp instruments and third ventricle exposed. The third ventricle was inspected by 0° and 30° endoscopes (Fig. 3).

### Anatomical qualitative analysis

In the suprachiasmatic para-terminal region, the position, the morphology and the variations of all significant neurovascular structures were analyzed. The relationships between the chiasm and the AComA-ACA complex was analyzed as well as to the relationship between perforating branches and lamina terminalis.

### Anatomical quantitative analysis

Measurements were performed using a millimeter flexible caliper in three specimens. Measurements were taken twice by two observers and the mean value was calculated for each specimen. The extent of the surgical area and vertical exposure were quantified (Fig. 4) by the use of ImageJ Software (NIH, Bethesda, Maryland, USA). Mean and standard deviation values were calculated. The measurements of the surgical area before the AComA division (control conditions) were compared with the measurements obtained after the elevation and after the surgical clipping and division of AComA.

**Table 1** Anatomical measurements—vertical and surgical area exposure

Vertical exposure			
Specimen	Control (mm)	ACoMA elevation (mm)	ACoMA clipping and division (mm)
1	4.23 ± 0.25	7.63 ± 0.24	10.70 ± 0.29
2	3.19 ± 0.15	5.32 ± 0.33	11.15 ± 0.39
3	1.69 ± 0.01	4.64 ± 0.17	7.27 ± 0.07
Surgical area exposure			
Specimen	Control (mm <sup>2</sup> )	ACoMA elevation (mm <sup>2</sup> )	ACoMA clipping and division (mm <sup>2</sup> )
1	23.55 ± 1.32	47.02 ± 1.32	75.51 ± 0.53
2	8.37 ± 0.31	15.83 ± 0.38	47.04 ± 0.45
3	13.83 ± 0.93	26.73 ± 2.01	49.51 ± 1.15

## Statistical analysis

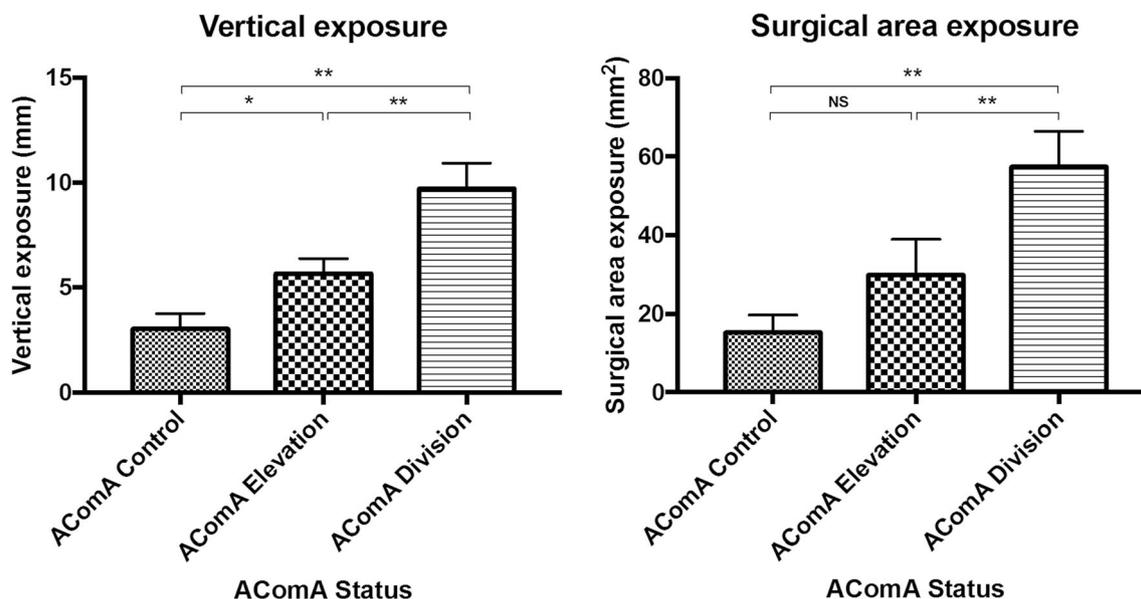
Descriptive statistics was used to analyze the surgical exposure before and after the elevation and division of ACoMA. Categorical values were described with percentages and continuous variables were described with means, standard deviations, and ranges. Statistical analysis between different groups was performed to determine if significant differences existed between the means of data. Ordinary two-way ANOVA test and Tukey's multiple comparison test was used. A  $p$  value < 0.05 was considered statistically significant. Statistical analysis was run on GraphPad (GraphPad Software, Inc., San Diego, California, USA).

## Results

The anatomical feasibility of clipping and dividing the ACoMA through an endoscopic transtuberculum transplanum

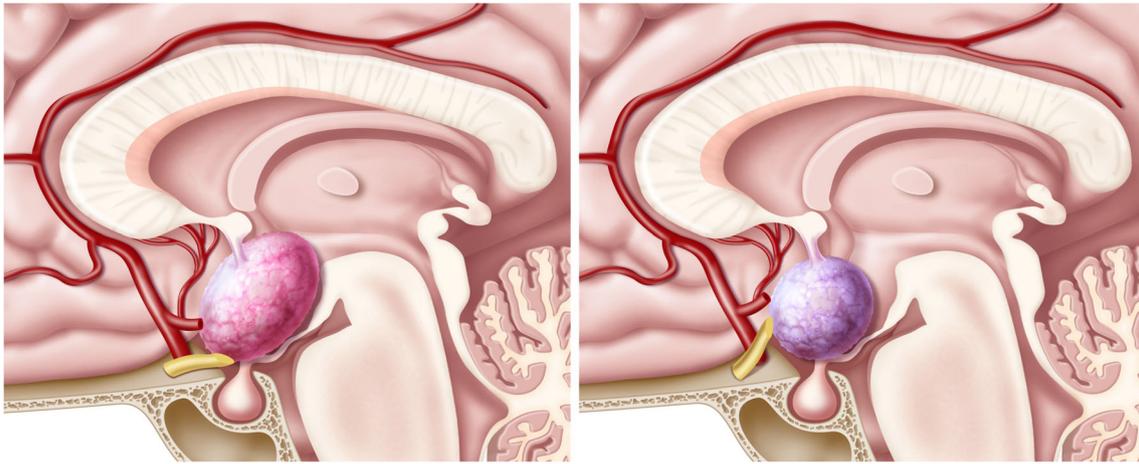
translamina terminalis approach was explored and successfully performed in all the cadaveric specimens. To fully expose the lamina terminalis and ACoMA complex, after completing a bone removal of the planum sphenoidale and tuberculum sellae, a dissection of the interhemispheric fissure was performed (Fig. 2).

The ACoMA was observed in all specimens. The ACoMA anatomical variations encountered were the following: duplication (1), dimple (1), duplication and fenestration (1). The junction of the ACoMA with the A1 segments was above the chiasm and in front of the lamina terminalis in all the specimens. The optic chiasm was post-fixed in 1 specimen. The ACoMA was oriented in the sagittal plane in one specimen and in the coronal plane in four specimens. The subcallosal artery was the most prominent ACoMA perforator and was present in every specimen. We did not find any chiasmatic perforators crossing the midline at the level of the lamina terminalis, so the laminar incision was made in the midline avascular plane. After the opening of the lamina terminalis, the endoscope was



**Fig. 5** Bar graphs showing the differences in the vertical exposure (left) and lamina terminalis surgical area exposure (right) between the control condition, after ACoMA elevation and after ACoMA division. ANOVA

analysis: \*statistically significant different with a  $p < .05$ ; \*\*statistically significant different with a  $p < .01$ ; NS, not statistically significant different



**Fig. 6** Illustrations depicting the suprachiasmatic and infrachiasmatic corridors to address third ventricular pathology. Left: the TV tumor extends above and behind and pushes downward the optic chiasm, greatly limiting the infrachiasmatic corridor. In such case, the main

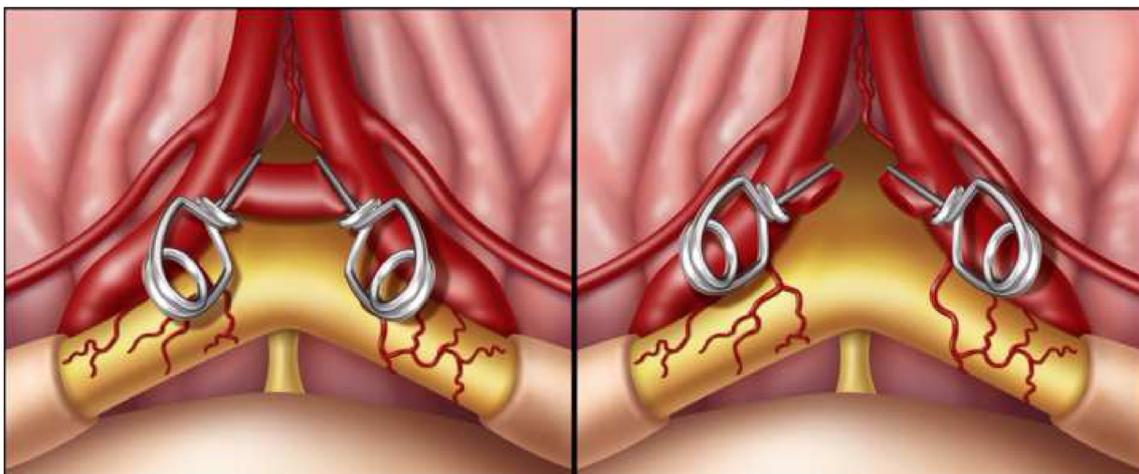
structure that limits rostral exposure in the suprachiasmatic corridor is the AComA. Right: the TV tumor extends below and behind and displaces the optic chiasm forward and favoring the use of an infrachiasmatic corridor

inserted to visualize the contents of the third ventricle. The clipping and division of the AComA provided a wider view of the most superior aspect of the third ventricle, namely, the anterior-superior portion providing a corridor above the interthalamic mass toward the most superior aspect near the fornices.

The detailed anatomical measurements are presented in Table 1. The mean distance between the midportion of the upper edge of the chiasm and the AComA was 3.04 mm (1.69–4.23). The mean lamina terminalis surgical area before the AComA elevation and subdivision was 15.25 mm<sup>2</sup> (8.37–23.55). The mean distance between the midportion of the upper edge of the chiasm and the AComA after its superior displacement was 5.67 mm (4.64–7.05). The mean lamina terminalis surgical area after superior elevation of AComA was 29.86 mm<sup>2</sup> (15.83–47.02). The maximal longitudinal

exposure of lamina terminalis measured from the midportion of the upper edge of the chiasm to the rostrum of the corpus callosum was 9.71 mm (7.27–11.15). The mean exposure of lamina terminalis surgical area after the AComA subdivision was 57.35 mm<sup>2</sup> (47.04–75.51).

With respect to the vertical surgical exposure, the “AComA status” (column) accounted for 81.52% of the total variance and its effect was statistically significant ( $p < .01$ ). The “specimen” (row) accounted for a 15.02% of the total variance and its effect was statically significant ( $p < .05$ ). On the multiple comparison analysis, there was a statistically significant difference in the vertical exposure between the control condition and after AComA elevation ( $p < .05$ ), between the control and after AComA division ( $p < .01$ ) and between the AComA elevation and division ( $p < .01$ ) (Fig. 5). With respect of exposed lamina terminalis surgical



**Fig. 7** Illustrations demonstrating the AComA clipping (left) and division (right). The subcallosal artery is preserved after the clipping. After AComA surgical division, the lamina terminalis is well exposed to enter

into the third ventricle through an endoscopic endonasal suprachiasmatic translamina terminalis approach

area, the “ACoMA status” (column) accounted for a 71.06% of the total variance and its effect was statistically significant ( $p < .01$ ). The “specimen” (row) accounted for a 26.18% of the total variance and its effect was statically significant ( $p < .01$ ). On the multiple comparison analysis, there was no statistically significant differences in the surgical exposure of the lamina terminalis between the control condition and after ACoMA elevation (N.S.). There was statistical significance between the ACoMA elevation and division ( $p < .01$ ) and between the control condition and after ACoMA division ( $p < .01$ ) (Fig. 5).

## Discussion

The ACoMA is a critical structure that may limit the surgical exposure of the third ventricle (TV) when approached through a suprachiasmatic translamina terminalis corridor. One surgical strategy described in the transcranial literature is the ligation and division of the ACoMA. However, this concept has never been described via an EEA [35, 38]. The aim of our work was to demonstrate first the anatomical feasibility of the ACoMA clipping and division through an EEA and to determine the advantages it may offer to increase the surgical exposure to address TV pathology.

Prior to the development of the EEA, the most commonly used approaches to the third ventricle had been transcranial approaches (TCA), performed through different routes such as frontotemporal, transcortical, sub-frontal interhemispheric and interhemispheric transcallosal [40]. With the modern advancement of endoscopic techniques and surgical expertise, the use of the transsphenoidal route expanded also to treat third ventricular lesions [5–7, 9, 11, 20, 21, 41]. The transplanum transtuberculum module is an extended EEA that significantly expands the transsphenoidal corridor to the suprasellar space [1, 20, 22, 33]. This approach is a minimally invasive alternative to craniotomy which was usually used in the past for lesions located above the diaphragm [20]. The EEA offers great advantages in terms of improved visualization of neuro-vascular structures and direct access to the tumor long-axis, especially to the suprasellar and retrochiasmatic areas, to achieve gross-total resection (GTR) with reduced brain retraction and complications compared to craniotomical approaches [9, 19, 24, 27, 31]. Our previous study reported higher rates of GTR and visual improvement with fewer complications and less brain retraction injury when using an EEA compared to pterional TCA for craniopharyngiomas [24]. The EEA is preferable to a TCA for tumors in the midline amenable to GTR but if tumor extends laterally into the middle fossa and Sylvian cistern, a frontolateral craniotomy is better indicated [18, 24, 27]. Although in the past, a purely third ventricular location represented an absolute contraindication for performing an EEA, there are several recent reports that

describe the feasibility, advantages, safety, and reduced complication rates compared to TCA [14–16, 25, 28, 41]. The endoscopic technique gives a wider and closer view of anatomical structures leading to the respect of small perforators, optic-chiasmatic structures, and a better definition of the relationships between the tumor and the surrounding pituitary stalk and lateral wall of the third ventricle. The most common endoscopic endonasal corridor to craniopharyngiomas involving the third ventricle is the infrachiasmatic approach (Fig. 6) [14, 16, 21]. In rare cases where the infrachiasmatic space is limited or in retrochiasmatic craniopharyngiomas where the tumor can extend above and/or push downward the optic chiasm, the suprachiasmatic translamina terminalis corridor, that is limited through EEA, is a possible alternative (Fig. 6) [14, 16].

The main structure that limits rostral exposure of the suprachiasmatic translamina terminalis approach is the ACoMA [14]. Few authors reported on the controlled surgical division of ACoMA in selected patients undergoing a basal interhemispheric translamina terminalis approach for retrochiasmatic craniopharyngiomas [2, 12, 35, 37]. This procedure provided a wider and safer surgical window, to minimize the blind spots and augment the tumor resection entity [12, 35]. The tumor depth and laterality significantly correlated with the need of clipping and divide the ACoMA in a recent analyzed cohort of patients [38]. All these studies did not show any complications related to the clipping and division of ACoMA, although it could be risky for tiny perforators that are not clearly visible through an anterior or even more an anterolateral approach [12, 35, 37, 38]. Identifying and respecting the singular subcallosal artery is imperative since its closure or injury could lead to memory disturbance, cognitive impairment, personality changes, and endocrine dysfunction [23, 29, 34].

Moreover, around 60% of patients present an anatomical variation of ACoMA such as plexiform, dimple, fenestration, duplication, string, fusion, or azygos variants [29, 34]. In some instances, the clipping and division of ACoMA could be therefore dangerous or impossible [38].

On the ground of the previous reports, we decided to describe the anatomical feasibility of the ACoMA division through an EEA (Fig. 7). We found that it provides a statistically significant wider vertical and surgical area exposure of the midline structures such as lamina terminalis, from the optic chiasm to the rostrum of corpus callosum ( $p < .05$ ). The opening of the lamina terminalis through such route adds a wider surgical exposure of the third ventricle to maximally resect tumor and minimize morbidity. A careful inspection and opening of the LT limits is of utmost importance to reduce accidental injuries to the contiguous superior anterior commissure and to the inferior-lateral optic-chiasmatic structures. Such technique could be employed in very selected patients presenting with retrochiasmatic tumors, where the optic chiasm is

pushed downward and limiting the infrachiasmatic surgical corridor. In such cases, the AComA ligation through EEA could widen the suprachiasmatic translamina terminalis approach. This technique needs to be used only by experienced skull base team and in selected centers after mounting an adequate learning curve based on tackling many cases with an incremental level of difficulty [36]. Dedicated endoscopic instrumentation is needed in such procedures, especially vascular mini-clips are mandatory to secure and divide shorter AComA. In some cases, AComA clipping and division may be impossible, such in the presence of fused or azygos or plexiform abnormal vessels. Preoperative four vessels angiography and/or quantitative magnetic resonance angiography with NOVA software (VasSol, Chicago, Illinois) analysis may be highly recommended to thoroughly preoperatively evaluate cranial circulation and collaterals to determine the feasibility of such technique in each specific patient and in cases where there is no better way of accessing a given TV tumor. In the present study, three specimens presented a dimple, duplicated, and fenestrated AComAs, and in every case, the AComA ligation and division were more challenging but the application of the mini-clips was feasible with a total preservation of the subcallosal artery and perforators. The size and dimensions of the mini-clips and clip applicators are relevant factors to consider in the appropriate preoperative surgical planning. These, once applied, may limit the subsequent surgical maneuverability during tumor resection. This was not specifically addressed in our study and a new investigation with the use of a tumor model may be done in the future. A wide transplanum approach together with a bilateral ethmoidectomy, wide posterior septectomy, and sphenoidotomy are required to let the instrumentation work properly. The use of straight and/or angled lens endoscopes equipped with ICG filters or hand-held micro-Doppler could be useful to visualize the viability of perforators after AComA clipping [3]. In the present study, no perforators were found to obstruct the clipping and the subcallosal artery was preserved in all the specimens.

The limitations of this study include those that are inherent to many anatomical cadaveric studies. The work was conducted on a small specimen sample and our findings should be therefore validated in larger studies taking into account the anatomical variability. Although the limited sample, our results proved to show the feasibility of such a surgical technique and the quantitative analysis showed valuable data in terms of statistical significance. All the specimens had normal anatomy and, therefore, the findings in this study should be validated in patients with a third ventricular pathology. Our study was conducted on fixed specimens and the tissue properties significantly differ from in vivo. Because of the above-mentioned reasons and chemical composition of the embalming solution, approaching and studying the third ventricle chamber was challenging.

## Conclusion

We present the concept of anatomical feasibility of clipping and dividing the AComA through an EEA that has been reproduced in all the cadaveric specimens. The present technique provides a significantly wider vertical and surgical area exposure to the lamina terminalis region. The approach is feasible and facilitates exposure of the suprachiasmatic optic recess within the third ventricle that may be a blind spot during an infrachiasmatic approach. The clipping and division of the AComA should be performed in only highly selected patients by an experienced skull base neuro-vascular team. Such findings should be validated in larger anatomical and clinical studies.

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. IRB was not required since the study involved only cadaveric specimens.

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