Occipital Bi-Transtentorial/Falcine Approach

Last Updated: April 7, 2021

ABSTRACT

OBJECTIVE: Direct surgical approaches to the posterior incisural space, including the pineal region, remain as challenges for neurosurgeons. The purposes of this study were 1) to compare the surgical views in the various posterior approaches to the posterior incisural space and 2) to propose a new approach, which is a modification of the occipital transtentorial approach.

METHODS: Ten adult cadaveric specimens (20 sides) were studied, using x3 to x40 magnification, after perfusion of the arteries and veins with colored silicone. Intraoperative views in the posterior approaches to lesions were examined in stepwise dissections. In addition, the efficacy of the occipital bi-transtentorial/falcine approach was studied.

RESULTS: The posterior incisural space has a roof, a floor, and anterior and lateral walls and extends backward to the level of the tentorial apex. The operative views defined by each approach differ in the extent to which they allow observation of the anatomic structures in the posterior incisural space. The occipital bi-transtentorial/falcine approach permits better observation of the contralateral half of the quadrigeminal cistern.

CONCLUSION: Precise surgical anatomic knowledge of each approach is required for the treatment of lesions in the posterior incisural space, because the operative fields obtained with different approaches differ significantly. The occipital bi-transtentorial/falcine approach provides greater contralateral exposure of the posterior incisural space than does the occipital transtentorial approach.

INTRODUCTION

The posterior incisural space lies posterior to the midbrain and corresponds to the pineal region (13). Lesions in the posterior incisural space include pineal tumors, meningiomas, gliomas, and arteriovenous malformations involving the medial occipital lobe or upper cerebellum. Despite recent technological advances in neurosurgical methods, direct surgical approaches to the posterior incisural space and avoidance of unexpected complications in this relatively small space remain challenges for neurosurgeons. Access to the posterior incisural space around the tentorial notch may be gained via two well-known approaches, namely the infratentorial supracerebellar and occipital transtentorial approaches (1, 2, 4, 6, 11, 12, 16–18) (Fig. 1).

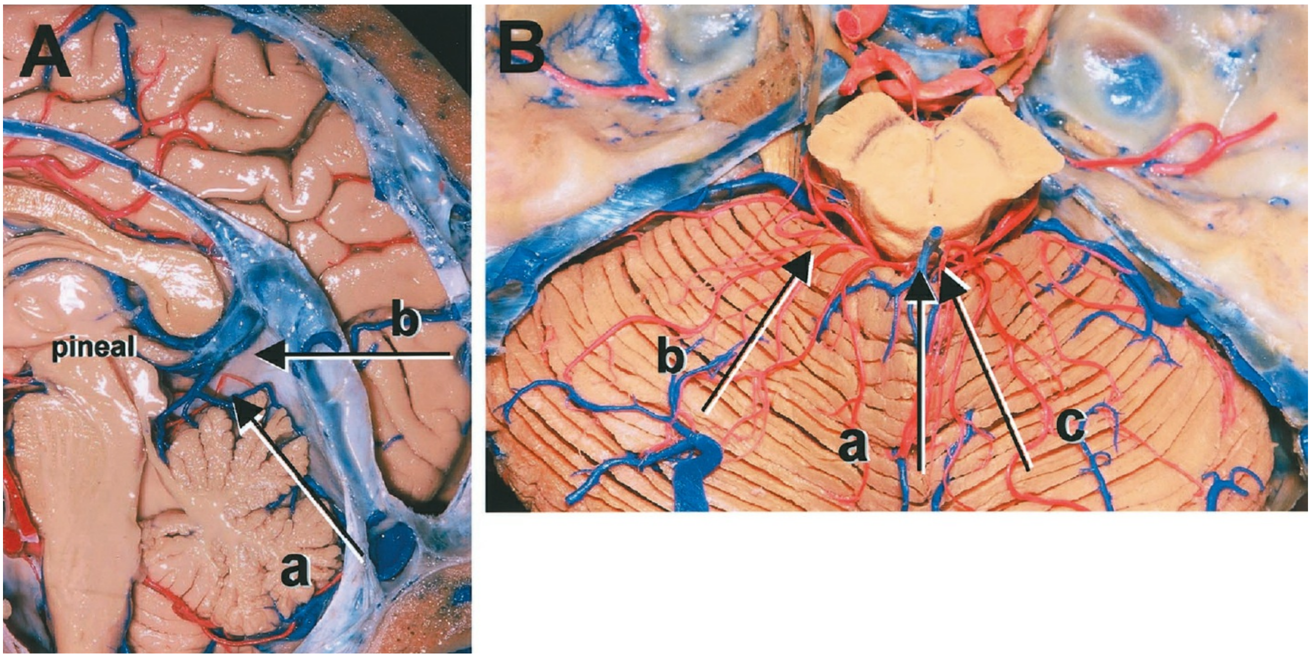

Figure 1. Photographs demonstrating a variety of surgical approaches to the posterior incisural space. A: a, infratentorial approach; b, supratentorial approach; a + b, combined supra-/infratentorial approach. B: a, median infratentorial approach; b, paramedian supracerebellar approach; c, occipital transtentorial approach. (Images courtesy of AL Rhoton, Jr.)

Each approach has advantages and disadvantages. The choice of approach depends on the location and extent of the target lesion and the preferences of the individual surgeon. Moreover, several modifications, including the paramedian supracerebellar, supracerebellar transtentorial, and combined supra-/infratentorial-transsinus approaches (Fig. 1), have been used to improve patient outcomes (9, 15, 19, 21, 22, 24). However, the anatomic structures that can be observed with each approach are not well understood. The purposes of this study, which involved examination of 10 adult cadaver brains using ×3 to ×40 magnification, were 1) to compare the various posterior approaches to the posterior incisural space, focusing particularly on the relationships between these approaches and anatomic structures, and 2) to propose a new approach that is a modification of the occipital transtentorial approach.

MATERIALS AND METHODS

Specimens

The posterior approaches to the posterior incisural space were studied in 10 adult cadaveric brain specimens (20 sides), using ×3 to ×40 magnification, after perfusion of the arteries and veins with colored silicone. The bone dissections were performed with a Midas Rex drill (Midas Rex Institute, Fort Worth, TX).

Surgical Approaches In this study, these posterior approaches, including the infratentorial supracerebellar, paramedian supracerebellar, supracerebellar transtentorial, occipital transtentorial, and combined supra-/infratentorial-transsinus approaches, and the anatomic features of the space were examined in stepwise dissections. All procedures were consistent with the clinical setting, and all observations were made from the surgeon’s view. The efficacy of a modified occipital transtentorial approach, i.e., the occipital bi-transtentorial/falcine approach, was also studied.

Evaluation of Exposure

The range of the operative field in the posterior incisural space and the extent of sacrifices of normal structures were evaluated for each approach by using a numerical grading system and the positive percentages of sacrifices of anatomic structures. A value of 0 refers to a structure that is not exposed, whereas a value of 3 indicates that the structure in question is fully exposed in 100% of the specimens. Values of

1 and 2 indicate that the structure is exposed in less than 50% or more than 50% of the specimens, respectively.

RESULTS

Anatomic Considerations

Neural Relationships

The posterior incisural space has a roof, a floor, and anterior and lateral walls and extends backward to the level of the tentorial apex (Fig. 2, A–D).

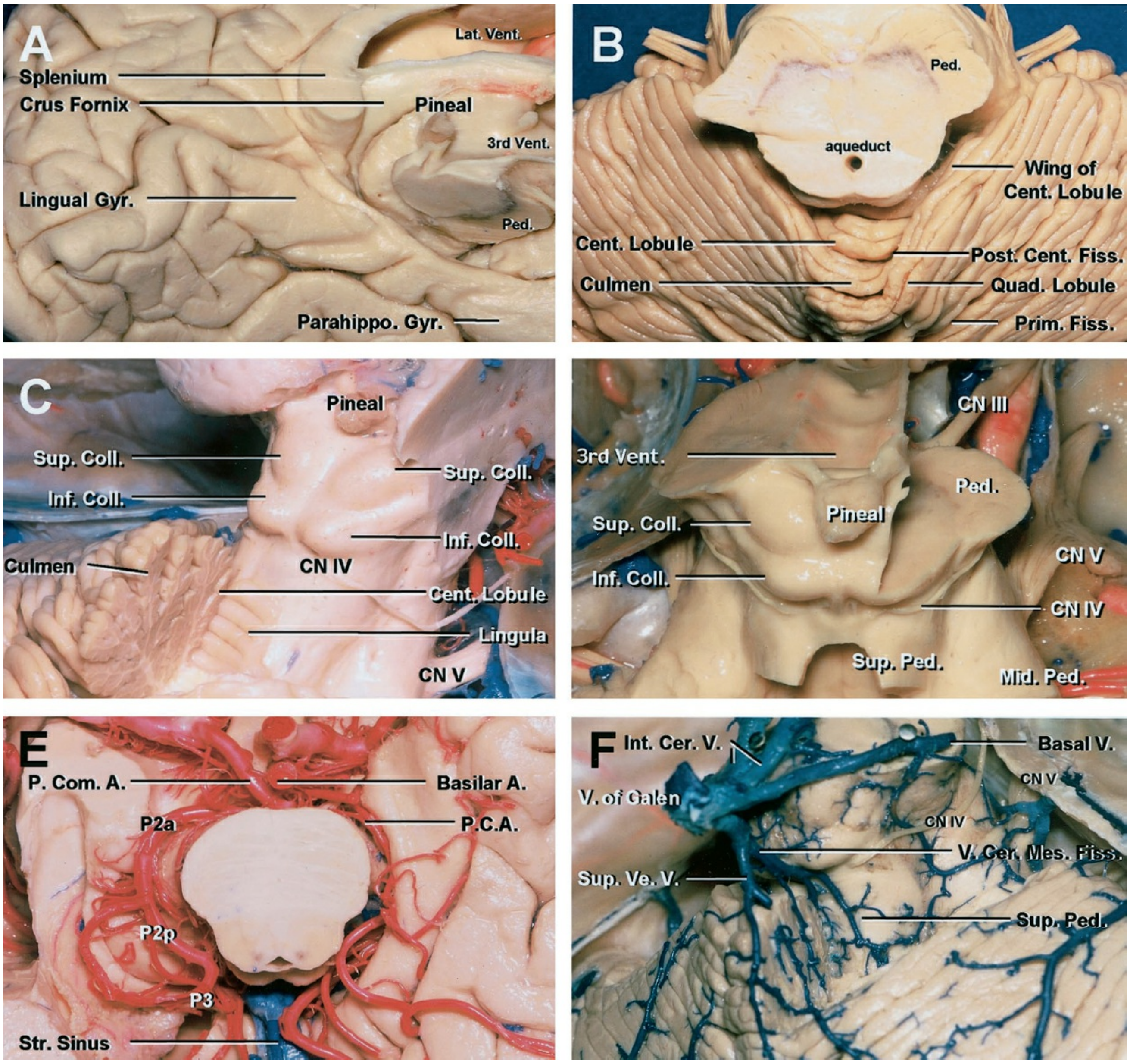

Figure 2. Photographs of the posterior incisural space, demonstrating neural, arterial, and venous relationships. A, the roof of the posterior incisural space is formed by the lower surface of the splenium and the terminal part of the crus of the fornix. The posterior incisural space

extends inferiorly into the cerebellomesencephalic fissure. The posteroinferior surface of the temporal lobe (parahippocampal gyrus and lingual gyrus) surrounds the posterior incisural space. B, the medial part of the anterior wall below the colliculi is formed by the lingula of the vermis. Between the postcentral fissure and the primary fissure lie the culmen medially and the quadrangular lobule laterally, which constitute the floor of the posterior incisural space. C, the superior surface of the superior vermis is divided, by short deep fissures, into the lingula, central lobule, and culmen. The white matter of the lingula is continuous with that of the superior medullary velum. D, the anterior wall consists of the posterior third ventricle, pineal body, and quadrigeminal plate (rostral to caudal). The lateral parts of the anterior wall below the colliculi are formed by the superior cerebellar peduncles. E, the segments of the PCA are classified according to our classification. The P2 segment extends from the posterior communicating artery to the point at which the PCA enters the quadrigeminal cistern. The P2 segment is subdivided into equal anterior (P2a) and posterior (P2p) halves. The P3 segment begins at the posterior midbrain, courses within the quadrigeminal cistern, and ends at the anterior limit of the calcarine fissure. F, the internal cerebral and basal veins and many of their tributaries converge at the vein of Galen in the posterior incisural space. The vein of the cerebellomesencephalic fissure crosses the quadrigeminal cistern anterior to the central lobule to drain into the vein of Galen, either directly or through the superior vermian vein. A., artery; Cent., central; Cer., cerebral; Cer. Mes., cerebellomesencephalic; CN, cranial nerve; Coll., colliculus; Fiss., fissure; Gyr., gyrus; Inf., inferior;Int., internal; Lat., lateral; Mid., middle; P. Com. A., posterior communicating artery; Parahippo., parahippocampal; Ped., peduncle; Post., posterior; Prim., primary; Quad., quadrigeminal; Str., straight; Sup., superior; V., vein; Ve., vermian; Vent., ventricle. (Images courtesy of AL Rhoton, Jr.)

Roof. The roof of the posterior incisural space is formed by the lower surface of the splenium, the crura of the fornices, and the hippocampal commissure.

Floor. The floor is formed by the superior surface of the superior vermis, which is divided by short deep fissures into the lingula, central lobule, culmen, and declive (anterior to posterior). Each of these divisions, except the lingula, is continuous laterally with the adjoining lobule of the cerebellar hemisphere. The central lobule is continuous laterally with the wing of the central lobule of the cerebellar hemisphere. Between the postcentral fissure and the primary fissure lies the culmen medially and the quadrangular lobule laterally, which together form the floor of the posterior incisural space.

Anterior Wall. When viewed from the posterior direction, the anterior wall consists of the posterior third ventricle, pineal body, and quadrigeminal plate (rostral to caudal). The part of the anterior wall below the colliculi is formed in the midline by the lingula of the vermis and laterally by the superior cerebellar peduncles as they ascend beside the lingula.

Lateral Wall. Each lateral wall is formed by the pulvinar, the crus of the fornix, and the medial surface of the cerebral hemisphere. The posteroinferior surface of the temporal lobe (parahippocampal gyrus and lingual gyrus) surrounds the posterior incisural space and the ambient cistern.

Arterial Relationships

The trunks and branches of the posterior cerebral artery (PCA) and superior cerebellar artery (SCA) enter the posterior incisural space from the anterior direction. In this study, the segments of the PCA were classified according to our previously proposed system (23). The P1 segment is proximal to the posterior communicating artery. The P2 segment extends from the posterior communicating artery to the point at which the PCA enters the quadrigeminal cistern. The P2 segment is subdivided into equal anterior (P2a) and posterior (P2p) halves. The P3 segment begins at the posterior midbrain, courses within the quadrigeminal cistern, and ends at the anterior limit of the calcarine fissure. The P4 segment is the distal branch of the P3 segment. The medial posterior choroidal arteries enter the posterior incisural space from the anterior direction, turn forward beside the pineal body, and enter the velum interpositum. The lateral posterior choroidal arteries that arise in the posterior incisural space pass around the posteromedial surface of the pulvinar and through the choroidal fissure (Fig. 2E).

The SCA courses within the cerebellomesencephalic fissure when it reaches the posterior incisural space. The branches of the SCA pass below the free edge of the tentorium to supply the tentorial surface of the cerebellum.

The perforating branches of the PCA and SCA and the medial posterior choroidal arteries supply the walls of the posterior incisural space. The tentorial arteries arise from the cavernous segment of the carotid artery, the SCA, and the PCA. The tentorial branch of the PCA arises as a long circumflex artery that courses around the brainstem and below the free edge to enter the tentorium near the apex.

Venous Relationships

The posterior incisural space has complex venous relationships. The internal cerebral and basal veins and many of their tributaries converge at the vein of Galen within this area. The vein of Galen passes below the splenium to enter the straight sinus at the tentorial apex. The vein of the cerebellomesencephalic fissure originates from the union of the paired veins of the superior cerebellar peduncle. The vein of the cerebellomesencephalic fissure crosses the quadrigeminal cistern anterior to the central lobule to drain, either directly or through the superior vermian vein, into the vein of Galen (Fig. 2F). Tentorial sinuses and/or bridging veins arise from four sources, including the cerebral hemisphere, the cerebellum, the tentorium itself, and bridging veins from the cerebral hemisphere or brainstem to the tentorial free edge.

Surgical Approaches and Operative Fields

The range of the operative field in the posterior incisural space and the extent of sacrifices of normal structures associated with each approach are summarized in Tables 1 to 3 and Figure 3.

TABLE 1. Observation of ipsilateral anatomic structures with

each approach[a]

	ITSC		SCTT	OT	CSIT	OBTF
	Median	Paramedian				
Neural structures						
Pineal gland	3	3	3	3	3	3
Sup. coll.	3	3	3	3	3	3
Inf. coll.	0	3	3	3	3	3
Parahippo. Gyr.	1 (right)	1	3	3	3	3
Splenium	3	3	3	3	3	3
Third ventricle	3	3	3	3	3	3
Sup. Cer. Ped.	0	3	3	3	3	3
Trochlear nerve	0	3	3	3	3	3
Arteries						
P2a	0	0	1	1	2	1
P2p	0	2	3	3	3	3
P3	3	3	3	3	3	3
Med. Post. Chor. A.	3	3	3	3	3	3
SCA	3	3	3	3	3	3
Veins						
Vein of Galen	3	3	3	3	3	3
Basal vein	3	3	3	3	3	3
ICV	3	3	3	3	3	3
V. Cer. Mes. Fiss.	3	3	3	3	3	3

[a] CSIT, combined supra-infratentorial-transsinus approach; ICV, internal cerebral vein; Inf. coll., inferior colliculus; ITSC, infratentorial supracerebellar approach; Med. Post. Chor. A., medial posterior choroidal artery; OBTF, occipital bi-transtentorial/falcine approach; OT, occipital transtentorial approach; Parahippo. Gyr., parahippocampal gyrus; SCA, superior cerebellar artery; SCTT, supracerebellar transtentorial approach; Sup. Cer. Ped., superior cerebellar peduncle; Sup. coll., superior colliculus; V. Cer. Mes. Fiss., vein of cerebellomesencephalic fissure. The scoring system is as follows: 0, no exposure in any specimen; 1, limited exposure, less than 50% in all specimens; 2, limited exposure, more than 50% in all specimens; 3, complete exposure in 100% of specimens.

TABLE 2. Observation of contralateral anatomic structures with each approach[a]

	ITSC		SCTT	OT	CSIT	OBTF
	Median	Paramedian				
Neural structures						
Sup. coll.	3	3	3	2	3	3
Inf. coll.	0	1	1	3	3	3
Parahippo. Gyr.	1 (left)	0	0	0	1	3
Splenium	3	3	3	3	3	3
Third ventricle	3	3	3	3	3	3
Sup. Cer. Ped.	0	0	0	3	3	3
Trochlear nerve	0	0	0	3	3	3
Arteries						
P2a	0	0	0	0	0	0
P2p	0	0	0	0	1	2
P3	3	0	0	1	3	3
Med. Post. Chor. A.	3	3	3	1	3	3
SCA	3	3	3	3	3	3
Veins						
Vein of Galen	3	3	3	3	3	3
Basal vein	3	3	3	1	3	3
ICV	3	3	3	2	3	3

[a] Abbreviations and scoring system are as in *Table 1.*

TABLE 3. Sacrifices of anatomic structures with each approach[a]

	ITSC		SCTT	OT	CSIT	OBTF
	Median	Paramedian				
Bridging vein	+ (100%)	+ (70%)	+ (70%)	–	–	–
V. Cer. Mes. Fiss.	+ (100%)	–	–	+ (100%)	+ (100%)	+ (100%)
Tentorial sinus	–	–	+ (75%)	+ (75%)	+ (75%)	+ (75%)
Splenium	–	–	–	+ (30%)	–	+ (30%)
Transverse sinus	–	–	–	–	+ (100%)	–

[a] Abbreviations are as in *Table 1.*

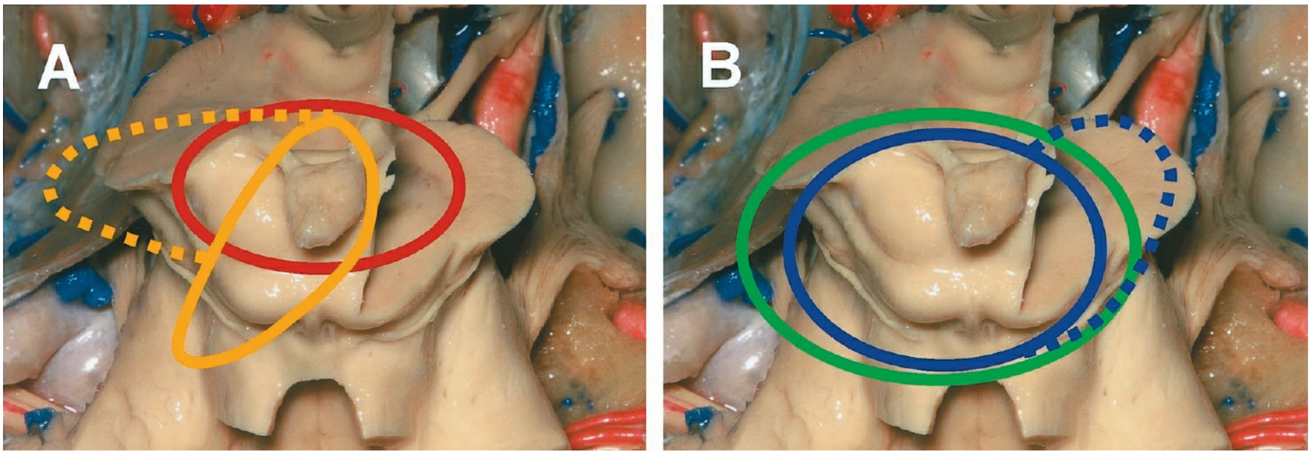

Figure 3. Representations of the mesencephalon and quadrigeminal plate, comparing the domains of exposure associated with posterior approaches to the posterior incisural space. A, infratentorial approaches. Red, infratentorial supracerebellar approach. Orange (broad line), left paramedian supracerebellar approach. Orange (broad and dotted lines), left supracerebellar transtentorial approach. B, supratentorial approaches. Blue (broad line), left occipital transtentorial approach. Blue (broad and dotted lines), left occipital bi-transtentorial/falcine approach. Green, left combined supra-/infratentorial-transsinus approach. With additional incisions of the tentorium or the tentorium and falx, the operative views become wider in both the infratentorial and supratentorial approaches (dotted lines). (Images courtesy of AL Rhoton, Jr.)

Infratentorial Supracerebellar Approach (Stein's Approach)

An approach to the posterior incisural space was made mainly over the superior vermis (Fig. 1) by sacrificing bridging veins draining into the torcular, which were located at the top of the posterior cerebellar incisura. After opening of the arachnoid membrane of the quadrigeminal region, it was possible to further define the region and the confluence of veins lying rostral to the straight sinus and the veins of Rosenthal laterally. The vein of the cerebellomesencephalic fissure was sectioned in this study, to yield a wider view.

Because of the tentorial notch and upper vermis, the operative field was very limited. Although bilateral SCAs and medial posterior choroidal arteries were clearly visible, the PCAs were not apparent (except for the

P3 segments). The venous complex could be gently displaced to expose the lower part of the splenium, the pineal body, and the superior colliculus, but the area below the level of the superior colliculus was not visible. The deep posterior third ventricle was easily recognized through the space between the pineal body and the internal cerebral veins. The lateral margin of the operative field was the pulvinar. With lateral retraction of the tentorial notch, only a part of the posterior temporal gyrus was observed in several cases (Fig. 4).

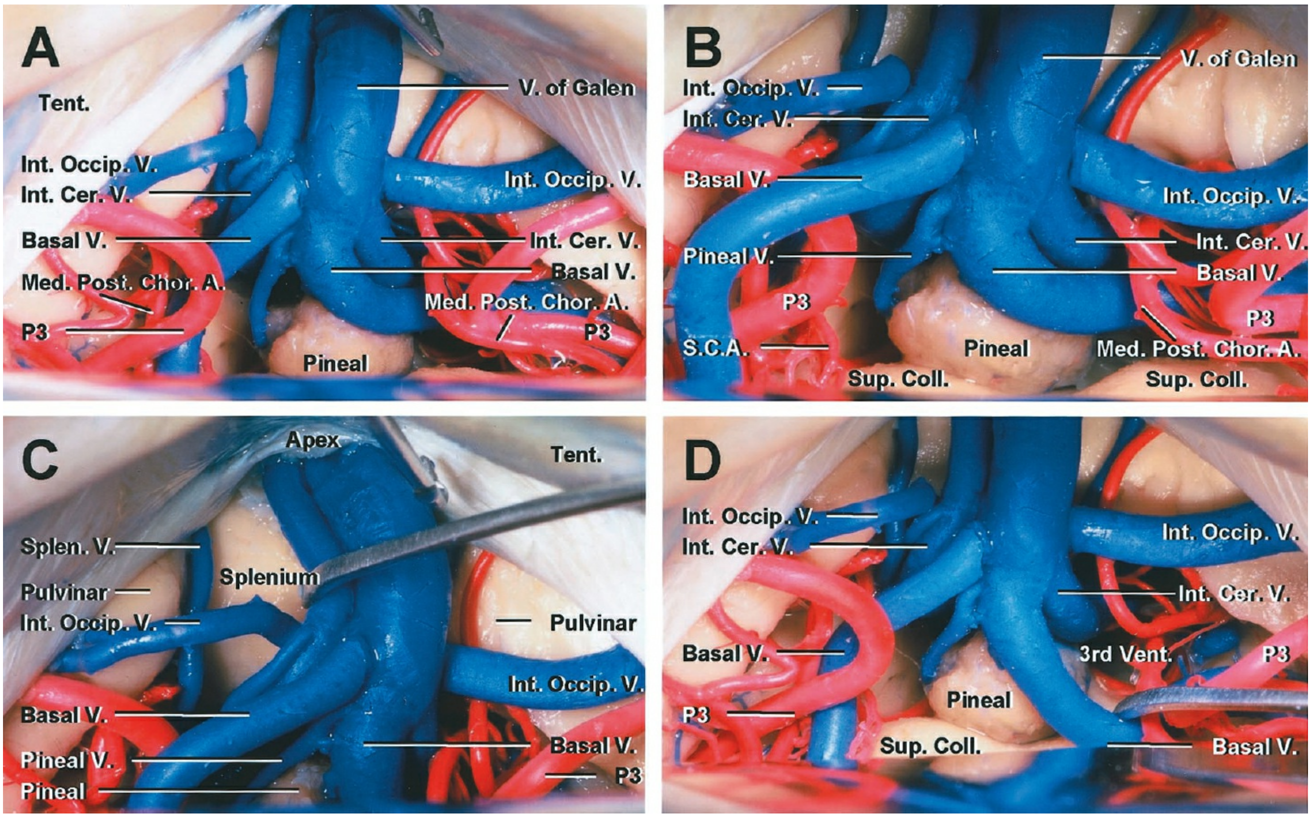

Figure 4. Photographs demonstrating the infratentorial supracerebellar approach. A and B, the venous complex emptying into the vein of Galen blocks access to the pineal region. This complex includes the internal occipital, basal, and internal cerebral veins and the vein of the cerebellomesencephalic fissure (already sectioned). Arteries, including the P3 portions of the PCAs, a tentorial branch of the SCA, and the medial posterior choroidal arteries, cross the exposure. The lower margin of the operative field is the superior colliculus. C, the vein of Galen has been retracted to expose the splenium. The lateral margin of the operative field is the pulvinar. D, the basal vein has been retracted to expose the posterior part of the third ventricle. Cer., cerebral; Coll., colliculus; Int., internal; Med. Post. Chor. A., medial posterior choroidal

artery; Occip., occipital; Splen., splenial; Sup., superior; Tent., tentorium; V., vein; Vent., ventricle. (Images courtesy of AL Rhoton, Jr.)

Paramedian Supracerebellar Approach

This approach is the paramedian variant of the median infratentorial supracerebellar approach (Fig. 1B). After opening of the dura, exploration between the tentorium and the cerebellum led to the ambient cistern, where the floor is the middle cerebellar peduncle and the medial wall is the midbrain. An approach was made over the cerebellar hemisphere by sacrificing bridging veins located in the lateral structures of the hemisphere. The paramedian supracerebellar approach provided access to the pineal region, the lower part of the splenium, the ipsilateral quadrigeminal plate, the superior cerebellar peduncle, and the trochlear nerve. The P2p segment was visible in the upper one-third of the operative field. Anatomic structures located on the contralateral side were not observed (Fig. 5).

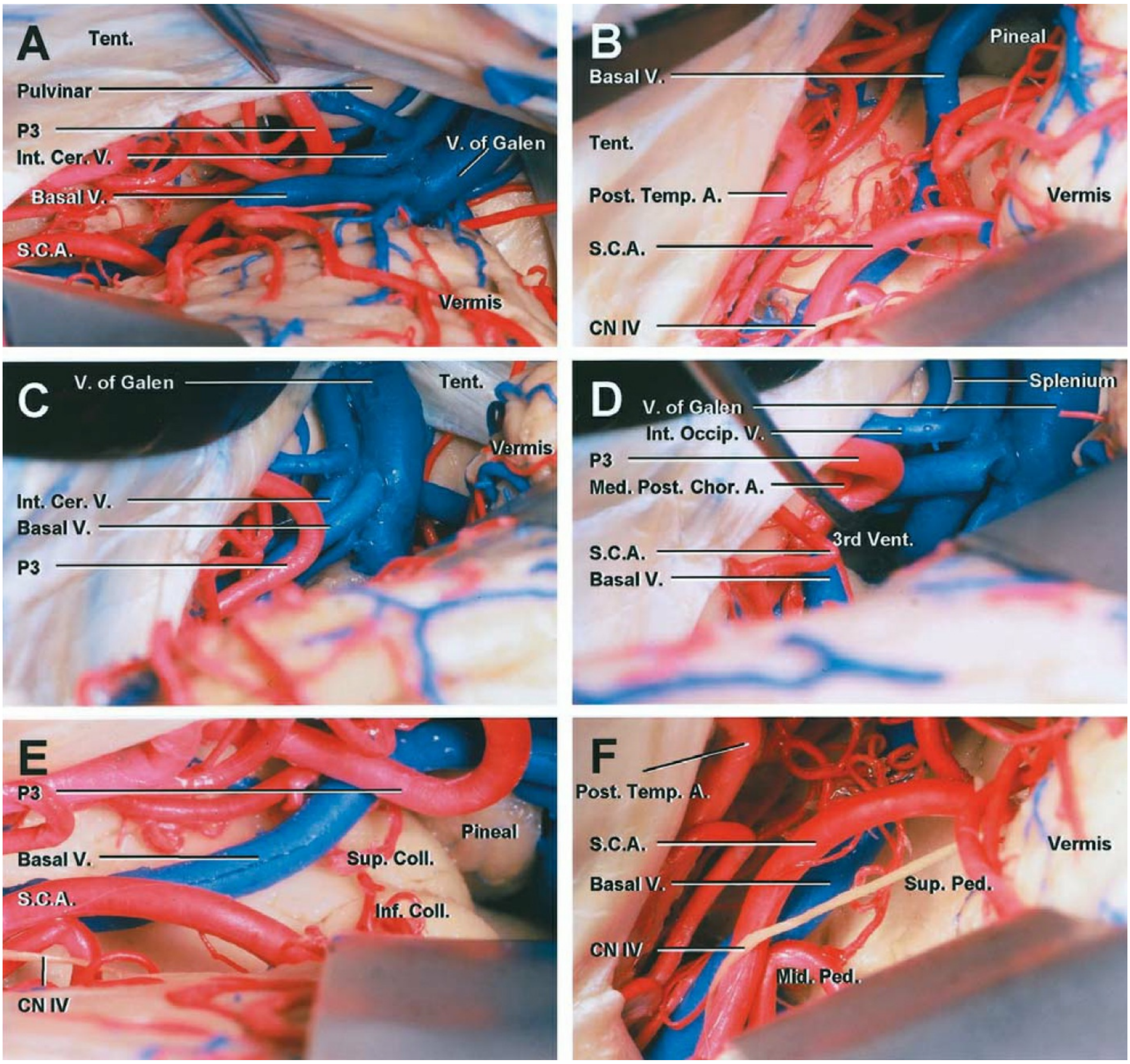

Figure 5. Photographs demonstrating the left paramedian supracerebellar approach, which is a paramedian variant of the infratentorial supracerebellar approach. In this variant, retraction of the cerebellum is shifted from the vermis and tentorial apex to the paramedian part of the hemisphere. The paramedian supracerebellar approach accesses the lateral part of the quadrigeminal cistern and the posterior part of the ambient cistern. A and B, the retraction for the paramedian approach has been shifted to the left of the vermis. C, the venous complex above the pineal body can be observed in the upper part of the view. The upper margin of the operative field is the tentorial apex. D, the basal vein, the P3 segment, and the medial posterior choroidal artery have been retracted to expose the posterior part of the third ventricle. E and F, the paramedian approach provides easy access to the pineal body, the ipsilateral quadrigeminal plate, the trochlear nerve, the superior and

middle cerebellar peduncles, and the P3 segment. A., artery; Cer., cerebral; CN, cranial nerve; Coll., colliculus; Inf., inferior; Int., internal; Med. Post. Chor. A., medial posterior choroidal artery; Mid., middle; Occip., occipital; Ped., peduncle; Post., posterior; Sup., superior; Temp., temporal; Tent., tentorium; V., vein; Vent., ventricle. (Images courtesy of AL Rhoton, Jr.)

Supracerebellar Transtentorial Approach

Proceeding upward along the undersurface of the tentorium, over the cerebellar hemisphere, the same operative field as described for the paramedian approach could be observed. The tentorium was then sectioned from below, beginning around the midportion and extending as posteriorly as possible in the direction of the posterior margin of the tentorial hiatus. The free cut edge of the tentorium was then retracted, together with the superior surface of the cerebellum. Compared with the median and paramedian infratentorial supracerebellar approaches, this approach demonstrated an advantage with respect to observation of the posteroinferior surface of the temporal lobe, the ipsilateral P2p segment, and the P2a segment. Observation of the contralateral half was difficult (Fig. 6).

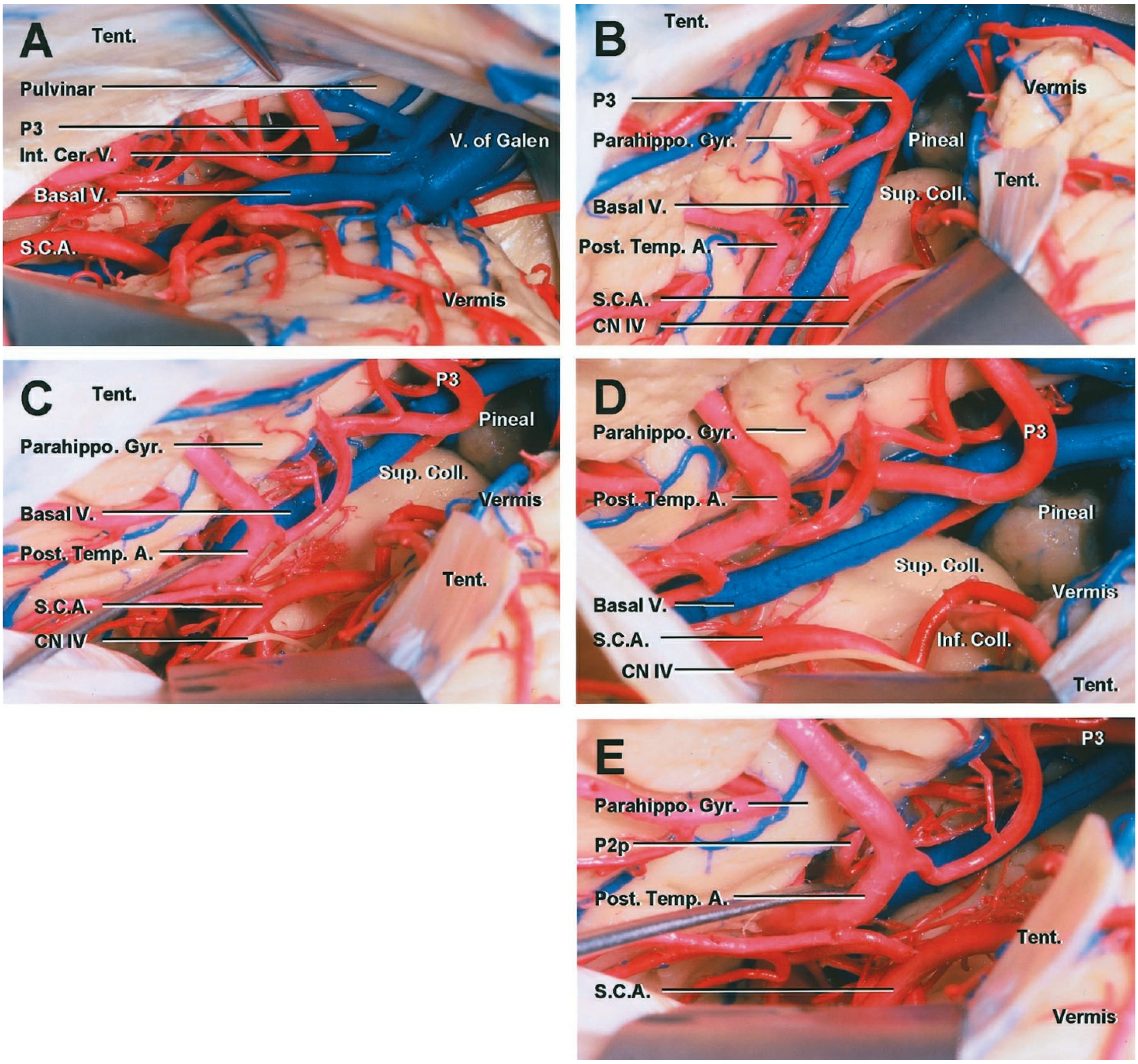

Figure 6. Photographs demonstrating the left supracerebellar transtentorial approach. After the posterior incisural space has been approached via the paramedian supracerebellar approach, the tentorium is sectioned from below, to yield additional operative views of the posteroinferior surface of the temporal lobe and the ambient cistern. A, the paramedian supracerebellar approach has been performed. B, the tentorium has been sectioned from below and the free cut edge of the tentorium retracted, together with the cerebellar hemisphere. C and D, the posterior temporomedial structures, including the parahippocampal gyrus and the posterior temporal artery, are revealed. E, the P2p segment passes through the ambient cistern. Cer., cerebral; CN, cranial nerve; Coll., colliculus; Inf., inferior; Int., internal; Med. Post. Chor. A., medial posterior choroidal artery; Parahippo. Gyr., parahippocampal gyrus; Post., posterior; Sup., superior; Temp., temporal; Tent., tentorium; V., vein.

(Images courtesy of AL Rhoton, Jr.)

Occipital Transtentorial Approach

The occipital pole was retracted rostrally. No bridging veins were observed around the occipital pole; however, the internal occipital vein was present in the deep medial portion of the occipital lobe. After further retraction of the occipital pole, the boundary of the tentorial notch was observed (Fig. 1B). After careful observation of the edge of the tentorium, with attention to the bridging veins, tentorial sinuses, and meningeal arteries, an incision was made parallel to and 1 cm from the straight sinus. Most of the tentorial sinuses belonged to Group III, receiving venous blood from the tentorium itself (8). The incised tentorium was then tented separately, to allow the posterior incisural space to come into microsurgical view. The vein of the cerebellomesencephalic fissure was sectioned in this study, to yield a wider view.

The occipital transtentorial approach provided access to the splenium above the vein of Galen; with gentle retraction of the venous complex in the posterior incisural space, the pineal body and the upper part of the cerebellomesencephalic fissure could also be observed. In addition, this approach provided a route to reach the ipsilateral posterior part of the ambient cistern. The P2a and P2p segments could be observed with this approach. Exposure of the lateral part of the contralateral half of the quadrigeminal cistern was limited. Parts of the superior colliculus, internal cerebral vein, basal vein of Rosenthal, and P3p segment on the contralateral side could be observed. For observation of the posterior third ventricle, splenia were sectioned in 30% of the cases examined (Fig. 7).

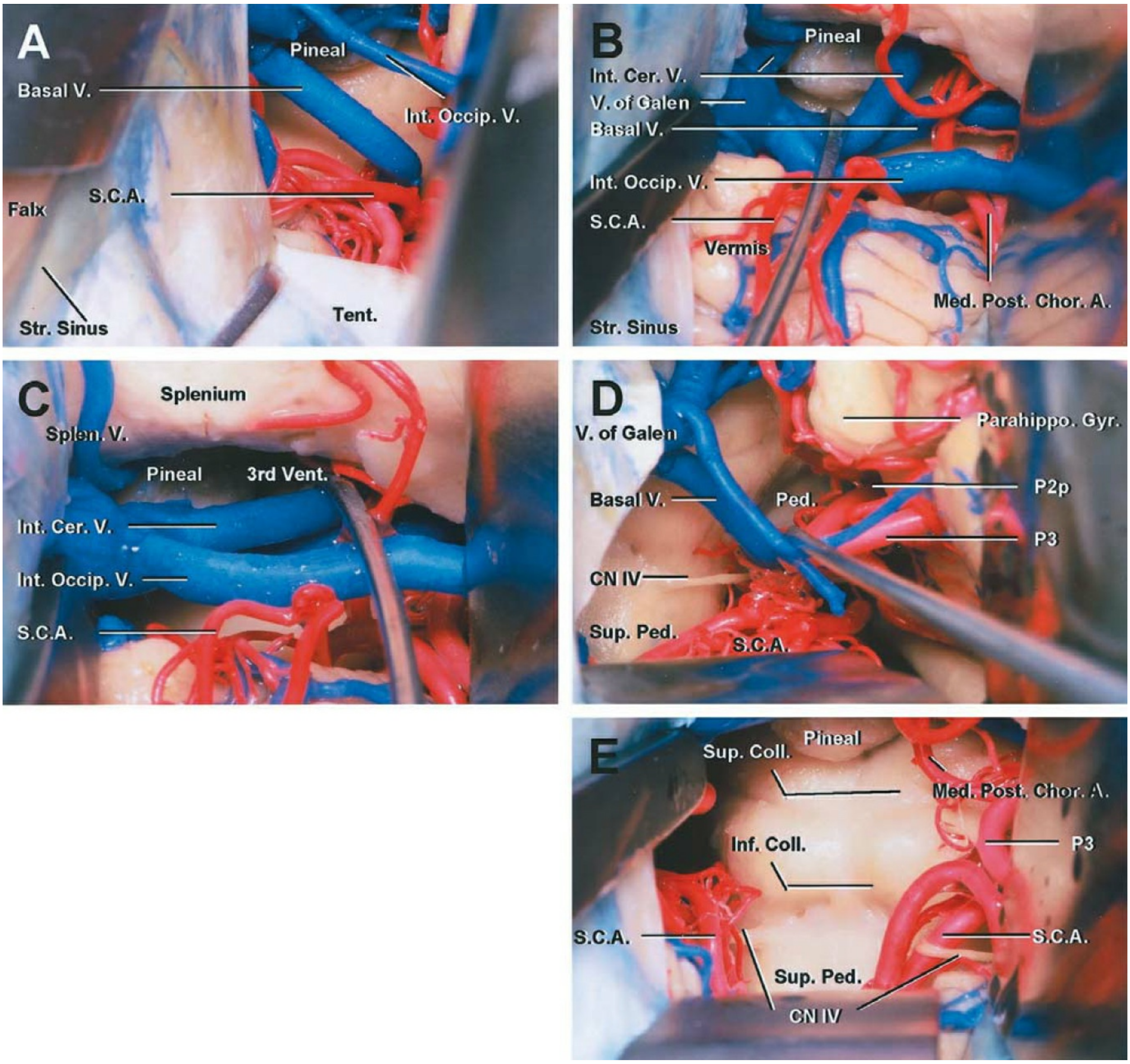

Figure 7. Photographs demonstrating the right occipital transtentorial approach. A, the occipital transtentorial approach is directed between the medial surface of the occipital lobe and the falx. This occipital lobe is commonly free of bridging veins to the superior sagittal sinus. The first vein encountered is the internal occipital vein, which passes from the anterior part of the medial occipital lobe to the vein of Galen. B, the tentorium has been opened lateral to the straight sinus, and the vein of Galen has been retracted to expose the pineal body from above. The exposure of the contralateral internal cerebral and basal veins is limited. C, the internal cerebral vein has been retracted to expose the posterior part of the third ventricle. D, the exposure has been directed laterally along the side of the brainstem to the ambient cistern, where the lateral margin of the cerebral peduncle and the P2p segment are exposed. E, the vermis has been retracted, and the vein of Galen has been displaced to

the left, to expose the pineal body, superior and inferior colliculi, trochlear nerves, and superior peduncles. The exposure of the lateral part of the contralateral half of the quadrigeminal cistern is limited. Cer., cerebral; CN, cranial nerve; Coll., colliculus; Inf., inferior; Int., internal; Med. Post. Chor. A., medial posterior choroidal artery; Occip., occipital; Parahippo. Gyr., parahippocampal gyrus; Ped., peduncle; Splen., splenial; Str., straight; Sup., superior; Tent., tentorium; V., vein; Vent., ventricle. (Images courtesy of AL Rhoton, Jr.)

Combined Supra-/Infratentorial-Transsinus Approach

This approach is a combination of supratentorial and infratentorial approaches that is achieved by dividing the transverse sinus in addition to the tentorium (Fig. 1A). The suboccipital dura was opened just inferior to the transverse sinus bilaterally. The occipital dura was then opened unilaterally (nondominant transverse sinus side) on the inferior side, medial to the superior sagittal sinus and superior to the transverse sinus, followed by division of the tentorium and the transverse sinus. Bridging veins were not encountered between the occipital lobe and the transverse sinus, but sacrifice of the tentorial sinus and the vein of the cerebellomesencephalic fissure was necessary.

This approach allowed greater exposure of the posterior incisural space, compared with other approaches. Compared with the occipital transtentorial approach, this approach yielded an operative field approximately 1.3 times wider, rendering visible contralateral structures such as the superior colliculus, basal vein of Rosenthal, and P3 segment. This approach also yielded a larger posterior incisural space than did the infratentorial supracerebellar approach. This approach provides a route to reach the ipsilateral posterior part of the ambient cistern (Fig. 8).

Figure 8. Photographs demonstrating the right combined supra-/infratentorialtranssinus approach. This is a combined supratentorial and infratentorial exposure with division of the transverse sinus and tentorium. A, division of the transverse sinus, if it is small and well collateralized, provides an exposure that combines both the supratentorial and infratentorial approaches. B to D, supratentorial views. B, the venous complex above the pineal body can be observed bilaterally from above. C, the vermis has been retracted, and the vein of Galen has been displaced to the left, to expose the pineal body, superior and inferior colliculi, trochlear nerves, and superior peduncles. Exposure of the lateral part of the contralateral half of the quadrigeminal cistern is better than can be achieved with the occipital transtentorial approach. D, the exposure, which is wider than that of the occipital transtentorial approach, has been directed laterally along the side of the brainstem to

the ambient cistern, where the lateral margin of the cerebral peduncle and the P2p segment are exposed. E, in this infratentorial view, the cerebellar hemisphere has been retracted to expose the posteroinferior surface of the temporal lobe. Cer., cerebral; CN, cranial nerve; Coll., colliculus; Inf., inferior; Int., internal; Med. Post. Chor. A., medial posterior choroidal artery; Occip., occipital; Parahippo. Gyr., parahippocampal gyrus; Ped., peduncle; Post., posterior; S.S.S., superior sagittal sinus; Str., straight; Sup., superior; Temp., temporal; Tent., tentorium; Trans., transverse; V., vein; Vent., ventricle. (Images courtesy of AL Rhoton, Jr.)

Occipital Bi-transtentorial/Falcine Approach

This is a new approach that is a modification of the occipital transtentorial approach. The skin incision, craniotomy, and dural incision were the same as for the occipital transtentorial approach. After incision of the tentorium parallel to the straight sinus, an additional incision of the falx was made parallel to and 1 cm above the straight sinus, followed by incision of the contralateral tentorium parallel to and 1 cm from the straight sinus. Sacrifice of the tentorial sinus and the vein of the cerebellomesencephalic fissure was necessary. By using this procedure, an operative view of the contralateral quadrigeminal cistern, which had been interrupted by the falx and the other tentorium, could be obtained. The superior colliculus, posterior temporal gyrus, P2p segment, P3 segment, internal cerebral vein, and basal vein of Rosenthal on the contralateral side above the tentorium were revealed more widely than with the standard occipital transtentorial approach (Fig. 9).

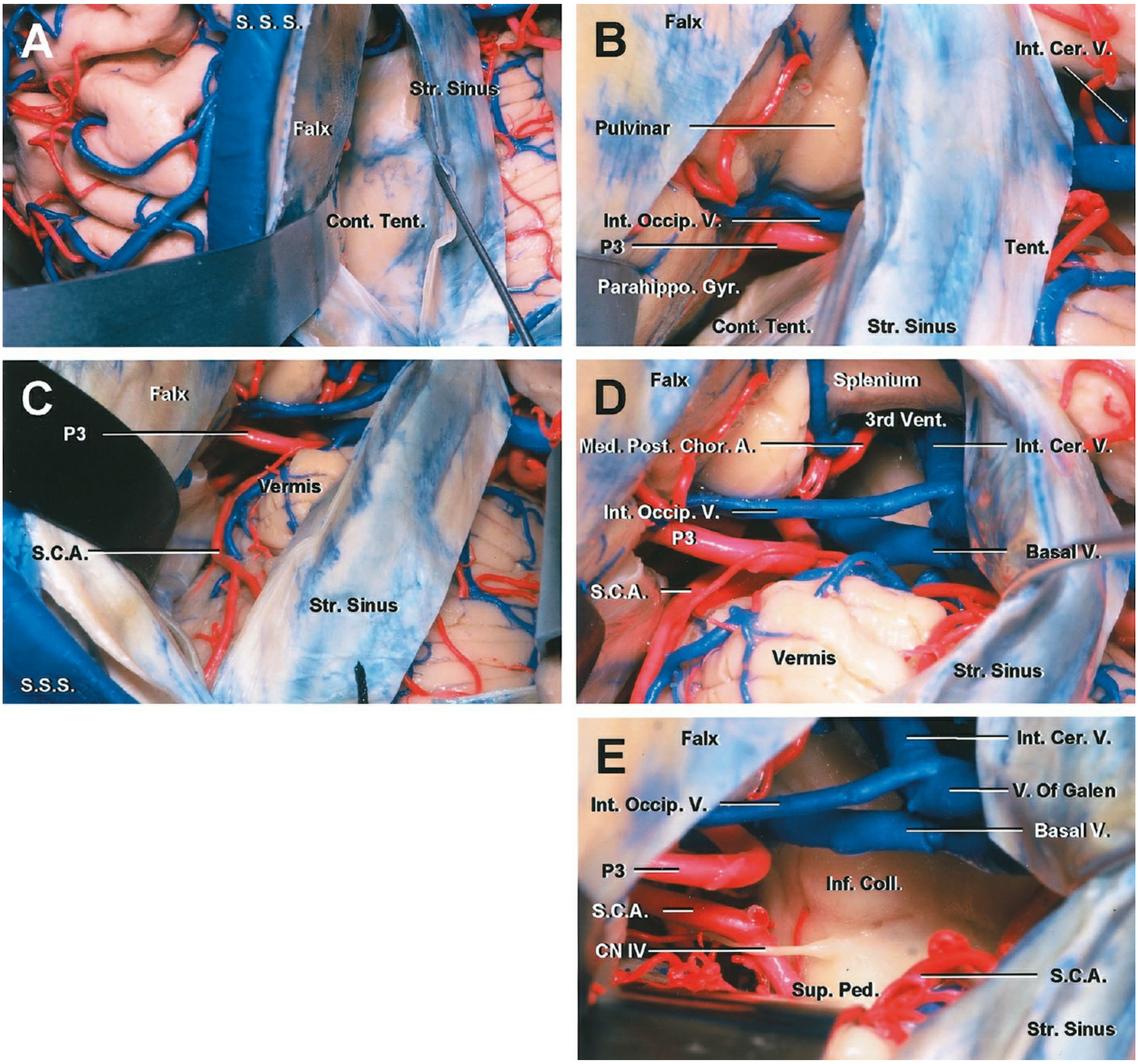

Figure 9. Photographs demonstrating the right occipital bi-transtentorial/falcine approach. This is a new approach, which is a modification of the occipital transtentorial approach with division of the falx and bilateral tentorium. This approach has a great advantage with respect to observation of the lateral part of the contralateral half of the quadrigeminal cistern and the posterior temporomedial structures. A, the occipital transtentorial approach has been completed, followed by an additional incision of the falx parallel to and 1 cm above the straight sinus. B, the division of the falx provides exposure of the posterior temporomedial structures. C, the contralateral tentorium has been sectioned parallel to the straight sinus, to expose the lateral part of the contralateral half of the quadrigeminal cistern. D and E, the straight sinus has been displaced to the right, to expose the lateral part of the contralateral half of the quadrigeminal cistern. The quadrigeminal plate,

trochlear nerve, internal occipital, basal, and internal cerebral veins, P3 segment, and SCA on the contralateral side can be observed. The exposure is better than can be achieved with the occipital transtentorial approach. Cer., cerebral; CN, cranial nerve; Coll., colliculus; Cont., contralateral; Inf., inferior; Int., internal; Med. Post. Chor. A., medial posterior choroidal artery; Occip., occipital; Parahippo. Gyr., parahippocampal gyrus; Ped., peduncle; S.S.S., superior sagittal sinus; Str., straight; Sup., superior; Tent., tentorium; V., vein; Vent., ventricle. (Images courtesy of AL Rhoton, Jr.)

DISCUSSION

In this study, a variety of posterior approaches to the pineal region were investigated, to identify the differences in intraoperative views, and a new approach, namely the occipital bi-transtentorial/falcine approach, was introduced. Because this study was based on findings from cadaveric brains and excluded pathological conditions such as tumors and hydrocephalus, the conclusions are not applicable to every clinical case. However, the differences among posterior surgical approaches are now more apparent.

Posterior approaches to the posterior incisural space are included in two major categories, according to whether the approach proceeds below or above the tentorium. These two categories are represented by two well-known approaches, i.e., the infratentorial supracerebellar approach (6, 16) and the occipital transtentorial approach (2), respectively. The choice of surgical approach for operations in this region has been an area of controversy (1, 12, 14, 20).

The infratentorial supracerebellar approach allows easy orientation, does not require destruction of important structures, and provides good visibility of the important veins (1, 3, 16–18). The main disadvantage of this approach is the limited exposure of the posterior incisural space, because of the tentorial notch. Lesions above the deep venous complex, below the superior colliculus, and lateral to the pulvinar would be difficult to treat in the center of the operative field obtained with this approach. Moreover, the P2 segment of the PCA was barely visible, and this approach is performed with the patient in the sitting position. It is well known that the sitting position increases the risk of air embolism for the patient and is uncomfortable for the surgeon (5).

The paramedian supracerebellar and supracerebellar transtentorial approaches are variants of the median infratentorial supracerebellar approach. The paramedian supracerebellar approach was developed by Yasargil (21). Because this approach is not as upwardly steep as the approach above the vermian apex, it allows observation of the inferior colliculus, superior and middle cerebellar peduncles, and trochlear nerves, which are not visible with the median approach. The contralateral operative view is more restricted than with the median approach, however. The inferior colliculus, trochlear nerve, and P3 segment on the contralateral side are barely visible. This approach is suitable for the limited area including the pineal region, the ipsilateral half of the cerebellomesencephalic fissure, and the posterior part of the ambient cistern. Ogata and Yonekawa (9) reported that lesions in the superior and inferior colliculi, superior and middle cerebellar peduncles, and quadrangular lobules of the cerebellum could be safely operated on via this approach.

The supracerebellar transtentorial approach was described by Voigt and Yasargil (19) in 1976. The major advantage of this approach is easy access to the posterior temporomedial region and the P2 segment. The supracerebellar transtentorial approach permits tumor removal, aneurysm clipping, and vascular bypass procedures in this region (22). We observed that the parahippocampal gyrus, P2a segment, and P2p segment could be more widely observed with this approach than with the infratentorial supracerebellar approach. This approach demonstrates the usefulness of sectioning the tentorium to obtain a wider view of the posterior incisural space. The difficulty of contralateral observation is the same as with the paramedian infratentorial supracerebellar approach.

The major advantages of the occipital transtentorial approach, compared with the infratentorial supracerebellar approach, are the possibility of greater exposure of the lesion and a better view of the floor of the quadrigeminal region. Bilateral trochlear nerves are always in the operative view. In addition, this approach can extend the operative view ipsilaterally to the posterior temporal gyrus, P2a segment, and P2p segment. However, there are some disadvantages of this approach. First, the contralateral half of the quadrigeminal region is difficult to approach. In this study, the superior colliculus, the internal cerebral vein, and the basal vein of Rosenthal on the contralateral side were difficult to observe with this approach. Second, a small part of the splenium is sacrificed to approach the posterior third ventricle. Third, retraction of the occipital lobe is necessary, which could lead to homonymous hemianopsia. Last, the lesion must be approached through the crucial deep venous complex that overlies and surrounds it.

The combined supra-/infratentorial-transsinus approach takes advantage of proceeding to the posterior incisural space above and below the tentorium. In addition, the space between the occipital lobes becomes wider than with the occipital transtentorial approach. This approach has been used for resection of certain large pineal region tumors (15, 24). In this study, almost all structures in the posterior incisural space except the contralateral parahippocampal gyrus and P2 segment were observed. The major disadvantage of this approach is the need for transection of the nondominant transverse sinus. Reconstruction of the transverse sinus may be necessary, especially for younger patients, in case of occlusion of the contralateral sinus later in life.

Much wider supratentorial operative views could be obtained with bilateral occipital transtentorial approaches. However, bilateral occipital transtentorial approaches require bilateral retraction of the occipital lobes, which could lead to serious visual disturbances. To achieve safer wider exposure of the posterior incisural space, we invented a new method, the occipital bitranstentorial/falcine approach, which is a modification of the occipital transtentorial approach. The major advantage of this approach is the possibility of greater exposure of the contralateral half of the quadrigeminal region. With this approach, the superior colliculus, parahippocampal gyrus, internal cerebral vein, basal vein of Rosenthal, and P3 segment on the contralateral side could be observed. The range of contralateral observation above the tentorium was wider than with the combined supra-/infratentorial-transsinus approach. The surgical technique is not much more difficult than those of the other approaches, although special care should be taken not to damage the straight sinus and the venous complex during sectioning of the falx and contralateral tentorium. Control of bleeding from the tentorial sinus and tentorial artery is also important (7, 8, 10). The disadvantages associated with the occipital transtentorial approach also apply to this approach. The bi-transtentorial/falcine approach emphasizes the usefulness of sectioning the falx and the contralateral tentorium to yield a wider view, as demonstrated with the supracerebellar transtentorial approach.

The infratentorial supracerebellar approach is usually chosen for lesions located below the deep venous complex in the posterior incisural space. The paramedian supracerebellar and supracerebellar transtentorial approaches provide access to more-limited areas, such as the superior cerebellar peduncle and the posterior temporomedial structures. Most of the infratentorial approaches require that the operation be performed with the patient in the sitting position. When lesions extend above and below the deep venous complex, the occipital transtentorial approach is preferred. Excessive compression of the occipital lobe and damage to the deep venous complex should be avoided. When lesions are large and extend contralaterally as well as above and below the complex, the combined supra-/infratentorial-transsinus or occipital bitranstentorial/falcine approach is preferred.

In conclusion, precise anatomic knowledge is required for the treatment of lesions in the posterior incisural space, because the operative fields obtained with different approaches differ significantly. The advantages and disadvantages of each approach should be considered. The occipital bi-transtentorial/falcine approach provides greater contralateral exposure of the posterior incisural space above the tentorium than does either the occipital transtentorial approach or the combined supra-/infratentorialtranssinus approach.

Contributors: Masatou Kawashima, MD, Albert L. Rhoton, Jr, MD, Toshio

Matsushima, MD

Content from Kawashima M, Rhoton AL, Jr, Matsushima T. Comparison of posterior approaches to the posterior incisural space: microsurgical anatomy and proposal of a new method, the occipital bi-transtentorial/falcine approach. *Neurosurgery* 2002;51:1208–1220; discussion 1220–1221. doi.org/10.1097/00006123-200211000-00017. With permission of Oxford University Press on behalf of the Congress of Neurological Surgeons.

The Neurosurgical Atlas is honored to maintain the legacy of Albert L. Rhoton, Jr, MD.

REFERENCES

1. Bruce JN, Stein BM: Surgical management of pineal region tumors. *Acta Neurochir (Wien)* 134:130–135, 1995.
2. Dandy WE: An operation for the removal of pineal tumors. Surg Gynecol Obstet 33:113–119, 1921.
3. Herrmann HD, Winkler D, Westphal M: Treatment of tumours of the pineal region and posterior part of the third ventricle. Acta Neurochir (Wien) 116:137–146, 1992.
4. Jamieson KG: Excision of pineal tumors. J Neurosurg 35:550–553, 1971.
5. Kanno T: Surgical pitfalls in pinealoma surgery. Minim Invasive Neurosurg 38:153–157, 1995.
6. Krause F: Operative Freilegung der Vierhügel, nebst Beobachtungen über Hirndruck und Dekompression. Zentralbl Neurochir 53:2812–2819, 1926.
7. Matsushima T, Rhoton AL Jr, de Oliveira EP, Peace D: Microsurgical anatomy of the veins of the posterior fossa. J Neurosurg 59:63–105, 1983.
8. Matsushima T, Suzuki SO, Fukui M, Rhoton AL Jr, de Oliveira EP, Ono M: Microsurgical anatomy of the tentorial sinuses. J Neurosurg

71:923–928, 1989.

9. Ogata N, Yonekawa Y: Paramedian supracerebellar approach to the upper brain stem and peduncle lesions. Neurosurgery 40:101–105, 1997.
10. Ono M, Ono M, Rhoton AL Jr, Barry M: Microsurgical anatomy of the region of the tentorial incisura. J Neurosurg 60:365–399, 1984.
11. Poppen JL: The right occipital approach to a pinealoma. J Neurosurg 25: 706–710, 1966.
12. Reid WS, Clark WK: Comparison of the infratentorial and transtentorial approaches to the pineal region. Neurosurgery 3:1–8, 1978.
13. Rhoton AL Jr: Tentorial incisura. Neurosurgery 47[Suppl 1]:S131–S153, 2000.
14. Rhoton AL Jr, Yamamoto I, Peace DA: Microsurgery of the third ventricle: Part 2—Operative approaches. Neurosurgery 8:357–373, 1981.
15. Sekhar LN, Goel A: Combined supratentorial and infratentorial approach to large pineal-region meningioma. Surg Neurol 37:197–201, 1992.
16. Stein BM: The supracerebellar infratentorial approach to pineal lesions. J Neurosurg 35:197–202, 1971.
17. Stein BM: Supracerebellar-infratentorial approach to pineal tumors. Surg Neurol 11:331–337, 1979.
18. Stein BM: Surgical treatment of pineal tumors. Clin Neurosurg 26:490–510, 1979.
19. Voigt K, Yasargil MG: Cerebral cavernous hemangiomas or cavernomas: Incidence, pathology, localization, diagnosis, clinical features and treatment—Review of the literature and report of an unusual case. Neurochirurgia (Stuttg) 19:59–68, 1976.
20. Yamamoto I, Kageyama N: Microsurgical anatomy of the pineal region. J Neurosurg 53:205–221, 1980.

21. Yasargil MG: Paramedian supracerebellar approach, in Yasargil MG (ed): Microneurosurgery: Microsurgical Anatomy of the Basal Cisterns and Vessels of the Brain. New York, Georg Thieme, 1984, vol I, p 242.
22. Yonekawa Y, Imhof HG, Taub E, Curcic M, Kaku Y, Roth P, Wieser HG, Groscurth P: Supracerebellar transtentorial approach to posterior temporomedial structures. J Neurosurg 94:339–345, 2001.
23. Zeal AA, Rhoton AL Jr: Microsurgical anatomy of the posterior cerebral artery. J Neurosurg 48:534–559, 1978.
24. Ziyal IM, Sekhar LN, Salas E, Olan WJ: Combined supra/infratentorial-transsinus approach to large pineal region tumors. J Neurosurg 88:1050–1057, 1998.