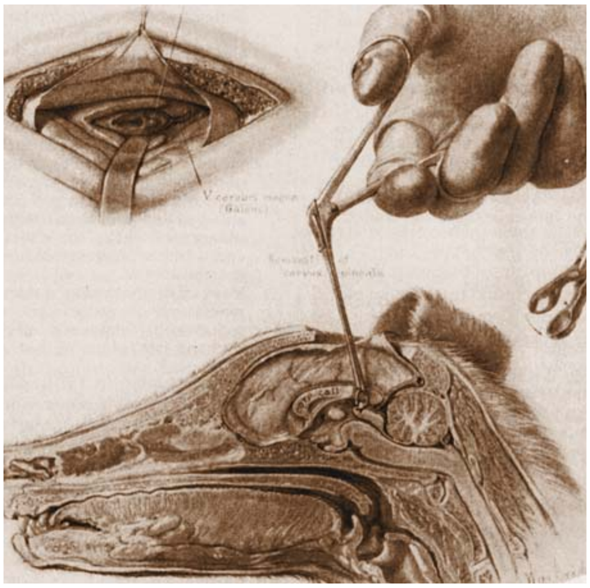


Fig. 7.0.1 *DANDY's interhemispheric approach published in 1915, using a dog model. In his paper entitled "Extirpation of the Pineal Body", he concluded that "the pineal is apparently not essential to life and seems to have no influence upon the animal's well being."*

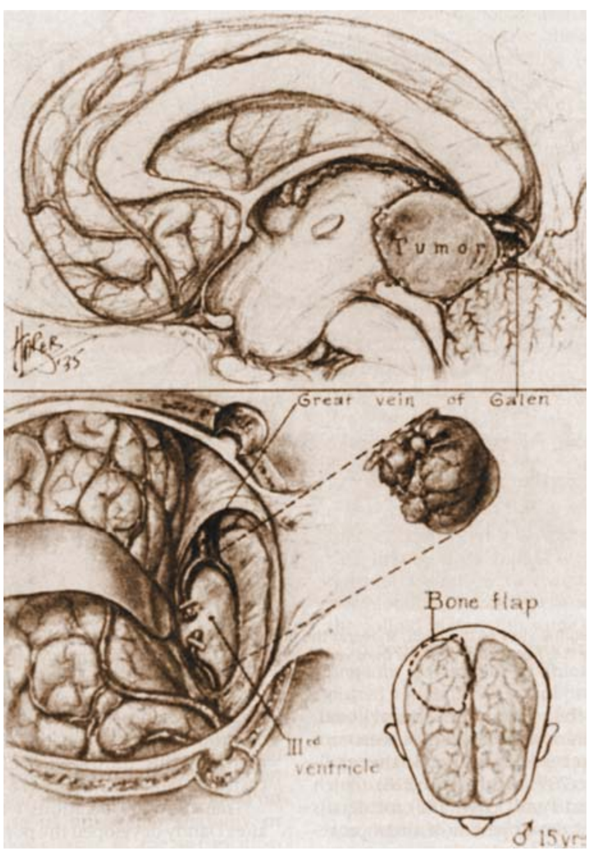


Fig. 7.0.2 *Surgical removal of a tumor from the pineal region reported by DANDY. Note the placement of the bone flap and the posterior interhemispheric approach exposing the pineal process.*

7.0 Interhemispheric approach

History of the interhemispheric approaches

The first interhemispheric transcallosal approach to the pineal region was originally described by WALTER E. DANDY in 1915 using a posterior exposure in an animal model (Fig. 7.0.1). His experience led him to suggest the feasibility of such an approach in humans, and six years later, he published his initial experience using this method in three cases of pineal region tumors [DANDY 1915, 1921]. DANDY returned to this subject in 1933 and 1936 (Fig. 7.0.2) as he was able to report on successfull removal of ten pineal lesions via a right parietal interhemispheric transcallosal approach [DANDY 1929, 1936]. This approach was the most favored for many years. ERNEST SACHS exposed a large cystic tumor in the pineal region and MAX PEET removed a pineal lesion through a right parieto-occipital transcallosal approach [SACHS 1926, PEET 1927]. One year later, OTFRID FOERSTER published his experience with the posterior interhemispheric exposure of the quadrigeminal plate (Fig. 6.0.5) His interhemispheric suboccipital transtentorial approach, performed successfully in three patients, was suggested by JULIUS TANDLER and EGON RANZI in their surgical anatomical textbook (Fig. 7.0.3) [TANDLER & RANZI 1920, FOERSTER 1928].

DANDY also used the posterior interhemispheric transcallosal approach for exposure of space-occupying lesions of the posterior third ventricle. In his monograph entitled "Benign Tumors in the Third Ventricle of the Brain: Diagnosis and Treatment", he described his surgical experience with intraventricular tumors and cystic lesions [DANDY 1931, 1933]. For anterior third ventricular tumors, DANDY preferred the frontal transcortical route (Fig. 8.0.2) and for posteriorly situated lesions the posterior transcallosal interhemispheric approach (Figs. 7.0.2, 8.0.1). The mid-sagittal interhemispheric transcallosal exposure, published initially in 1931, was used only for cystic lesions of the septum pellucidum and cavum vergae (Fig. 7.0.4). It is interesting to note that DANDY reported no neurological deficits occurring as a result of splitting the posterior part of the corpus callosum. However, there have been other suggestions showing that although sectioning the more anterior part of the corpus callosum is not associated with severe distinct symptoms, posterior and complete callosal section has in particular been shown to produce a broad array of behavioral abnormalities.

Accordingly, van Wagenen reported his experience of surgical exposure of the hypothalamic region via the anterior interhemispheric route [van Wagenen 1939]. A similar, strictly midline exposure was also published by Busch describing the anterior interhemispheric transcallosal interforniceal approach for removal of third ventricular tumors [Busch 1944]. Using microsurgical techniques, the surgical literature has contained an increasing number of reports emphasizing the efficacy of the anterior transcallosal approach (Fig. 7.0.5). Special attention should be given to Michael L. J. Apuzzo, who had a unique interest and enormous experience in the surgical treatment of third ventricular tumors [Milhorat 1966, Kempe 1976, Shucart 1978, Delandsheer 1978, Stein 1980, Apuzzo 1982]. Karl Ungersböck and Axel Perneczky, Michael Lawton and Robert Spetzler described the advantages of the contralateral exposure for approaching the lateral and third ventricles [Ungersböck & Perneczky 1986, Lawton & Spetzler 1996].

The first interhemispheric transcallosal approach for the treatment of a ruptured aneurysm of the ACoA was published by Wilhelm Tönnis [Tönnis 1936]. His technique required splitting of the anterior corpus callosum (Fig. 7.0.6). Wallace Hamby and Herbert Olivecrona used a very similar anterior transcallosal exposure [Hamby 1952, Olivecrona 1953]. In 1959, Lawrence Pool described a different, more frontobasally placed bifrontal approach to aneurysms of the ACoA. The region was exposed through an anteroinferior interhemispheric route and the suprasellar region could be effectively approached without splitting of the corpus callosum [Pool 1959]. For distal aneurysms of the ACA, a similar approach was described by Hugo Krayenbühl and Jiro Suzuki [Krayenbühl 1952, Suzuki 1977]. In 1991, Takanori Fukushima and co-workers reported on the unilateral interhemispheric keyhole approach for anterior cerebral artery aneurysms [Fukushima 1991].

This anteroinferior subcallosal interhemispheric approach was also used for tumorous lesions of the third ventricle and anterior midline skull base as described by Dean Lewis in a patient with a large craniopharyngioma [Lewis 1910]. Walter E. Dandy removed prechiasmal intracranial tumors using a bifrontal interhemispheric exposure. Harvey Cushing described the anterior interhemispheric and subfrontal approach for the treatment of olfactory groove meningeomas with the aid of electrosurgery [Dandy 1922, Cushing 1927]. Since these first reports, the anterior interhemispheric approach has been used for many different pathologies of the anterior fossa. Using

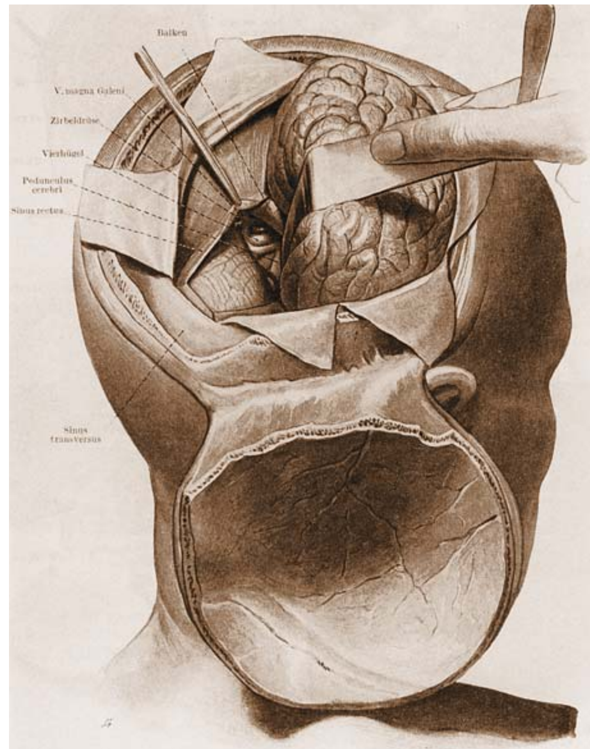


Fig. 7.0.3 *Exposure of the pineal region via the occipital interhemispheric approach, described by Tandler and Ranzi in their textbook published in 1920. Note the traumatic retraction of the occipital lobe, necessary to visualize the deep-seated area.*

Fig. 7.0.4 *Dandy's mid-sagittal interhemispheric approach "establishing communication between the cystic V. ventricle and lateral ventricle", reported in 1931. Note that for exposure of a space-occupying cavum septi pellucidi, Dandy used brain retraction against gravity.*

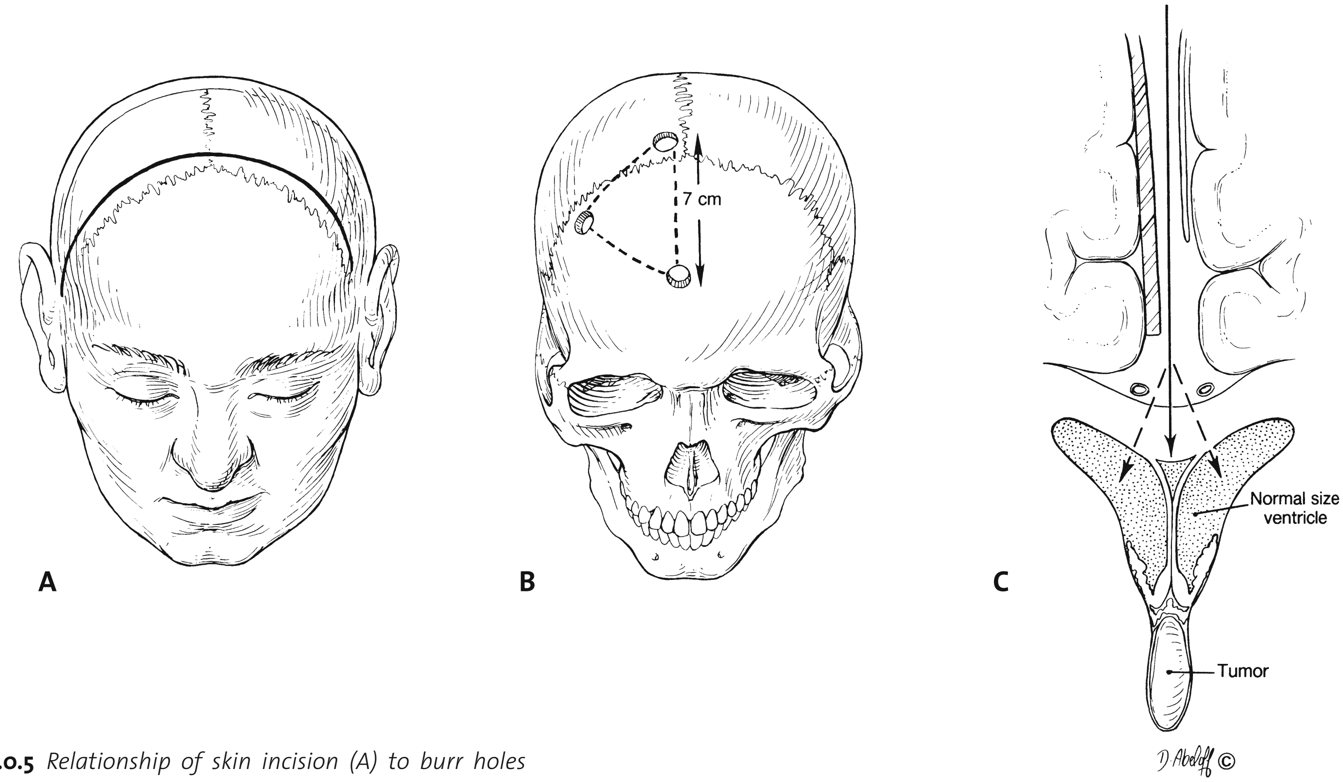


Fig. 7.0.5 *Relationship of skin incision (A) to burr holes and craniotomy (B) using the interhemispheric transcallosal approach reported by* William Shucart *in* Michael L. J. Apuzzo*'s comprehensive textbook "Surgery of the Third Ventricle", published in 1987 and 1998. This approach was used to visualize entire normal-size anterior ventricular system (C).*

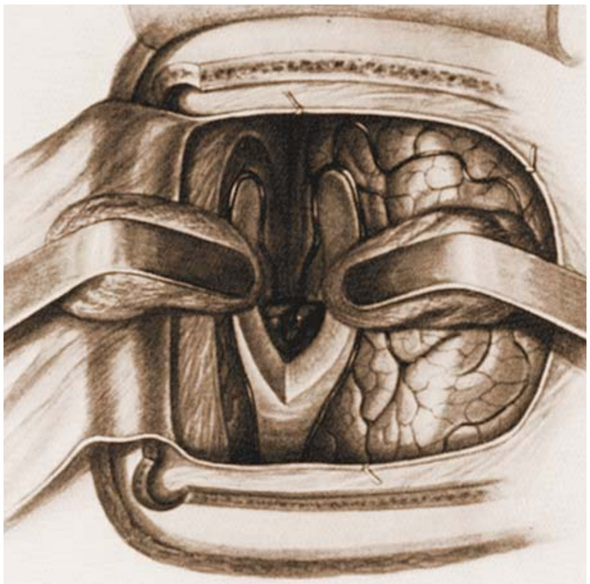


Fig. 7.0.6 Tönnis*' frontal interhemispheric approach for an aneurysm of the anterior communicating artery causing subarachnoid hemorrhage, reported in 1936. The anterior part of the corpus callosum was divided to gain exposure using a unilateral frontal craniotomy.*

microsurgical techniques, M. Gazi Yasargil, Gallingham Sekhar, Ossama Al-Mefty, Madjid Samii and Jiro Suzuki approached skull base meningeomas, craniopharyngiomas, third ventricle tumors and aneurysms from this anterior direction [Yasargil 1980, Sekhar & Al-Mefty 1985, Samii 1981, Suzuki 1981].

It can be seen that during the last decades many different interhemispheric approaches to the midline region have been described. However, in his first experiences, Walter Dandy already realized the importance of the route of the midline corridor: the use of the keyhole concept in interhemispheric approaches.

In the following, the essence of the keyhole concept in neurosurgery is discussed in detail using the anterior and posterior interhemispheric approaches.

Use of the keyhole concept in the interhemispheric approaches and general anatomical construction of the middle corridor

In 1944, Dandy reported on a successful surgical exposure of a ruptured aneurysm of the ACoA, causing severe intraventricular bleeding [Dandy 1944]. He approached the anterior third ventricle via a posterior interhemispheric exposure and diagnosed the ruptured aneurysm without using an operating microscope. It was possible because the interhemispheric fissure allowed an overview of the entire corpus callosum and third ventricle; a surgical dissection using the idea of the keyhole concept (Fig. 7.0.7).

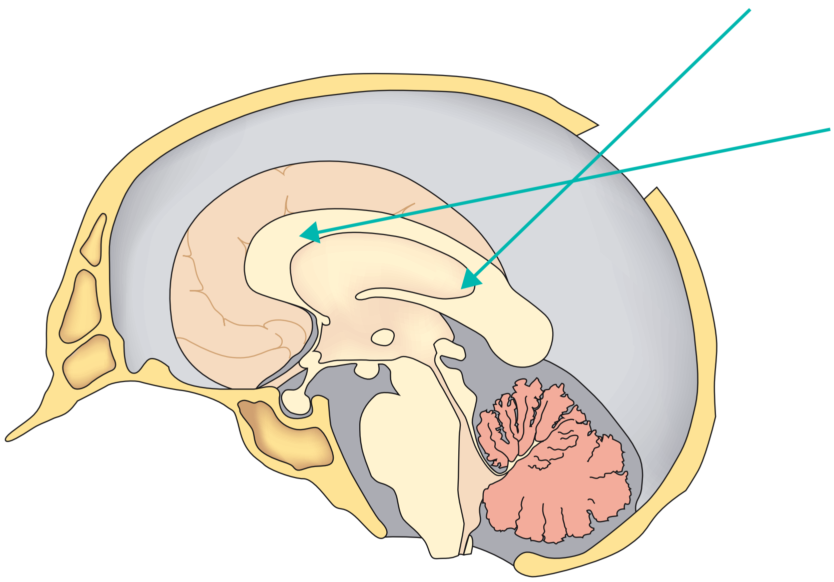


Fig. 7.0.7 *Use of the keyhole concept in interhemispheric approaches. Generally, lesions of the corpus callosum, the lateral and third ventricles, the pineal region and the midline skull base are deep-seated. The schematic drawing of the midline structures demonstrates that a limited exposure can be sufficient to visualize the deep-seated areas using the anatomical corridor of the interhemispheric fissure.*

In interhemispheric approaches, the major topographic elements of the midline corridor require identification and consideration, including the superior and inferior sagittal sinus, parasagittal veins, corpus callosum, pericallosal arteries, fornix, septum pellucidum, cisterna veli interpositii with the internal cerebral veins, lateral and third ventricles, and the anterosuperior part of the suprasellar area.

There is agreement among surgeons that preservation of the sagittal sinus and their venous tributaries is an important goal, creating an interhemispheric exposure. In particular, the combination of brain retraction and venous occlusion may result in extended

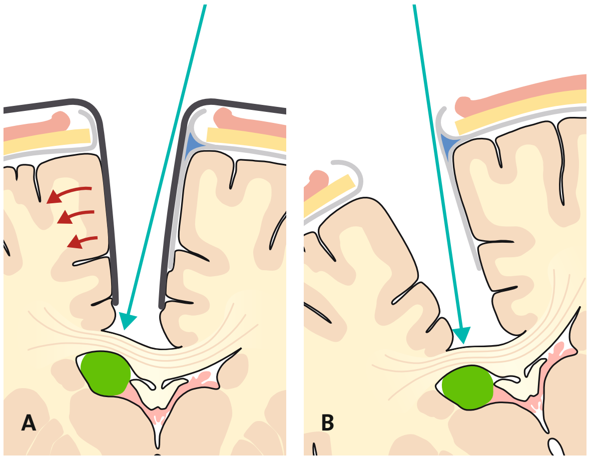


Fig. 7.0.8 *Ipsilateral investigation of the lateral ventricle for medially located lesions (A). With the help of elegant rotation of the head during positioning of the patient, the gravity-related self-retraction of the brain opens the interhemispheric fissure allowing atraumatic surgical dissection without using a brain spatula (B).*

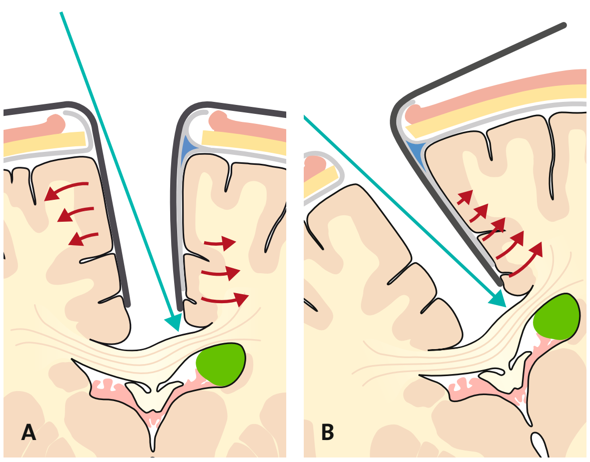


Fig. 7.0.9 *Schematic drawing of the contralateral interhemispheric approach for laterally situated intraventricular lesions (A). Using the contralateral technique, intraoperative traumatization of the side of the lesion can be effectively minimized in order not to jeopardize the frontal or parietal lobe. This is important especially for dominant sided lesions. Note the position of the falx covering and protecting the hemisphere from direct spatula pressure. Using adequate positioning, rough brain retraction can be avoided on both sides: the ipsilateral hemisphere deflates without using a retractor according to the gravity-related self-retraction; the contralateral hemisphere is retracted forcefully; however, protected by the falx cerebri (B).*

venous infarction with postoperative neurological deterioration. If a bridging vein is injured and must be sacrified, the following principle should be considered: cerebral veins are basically anastomotic vessels without valves, therefore to preserve the anastomotic points, the veins can be occluded. However, after occlusion of the bridging vein, the use of a retractor can cause severe compression of this venous anastomosis with subsequent infarction of the surrounding area. For this reason, cerebral retraction must be restricted to the necessary minimum, according to a limited and well-planned craniotomy. Note that only an appropriate placement of a limited bone flap according to preoperative visualization of the venous anatomy, combined with careful dissection and limited brain retraction can effectively minimize surgical damage.

After careful brain retraction and dissection of the pericallosal arteries, which may sometimes be hidden in the sulcus of the corpus callosum or may cross the midline, various modes of entry into the ventricular system are possible. However, it is important to note the possible severe neuro-physiological consequences of an operative commissural section as described in numerous publications [Apuzzo 1986]. An acute syndrome following sectioning of the anterior portion of the corpus callosum can be characterized by a decrease in the spontaneity of speech ranging from a mild slowness in initiating speech to frank mutism. Division of the posterior corpus callosum and splenium may cause a broad range of behavioral abnormalities. For this reason, commissural section should be restricted to the necessary minimum.

Lesions of the lateral ventricle located medially within the ventricular chamber can be optimally exposed through an ipsilateral interhemispheric approach. Using the ipsilateral dissection, the hemisphere can be gently mobilized and retracted away from the falx. Optimal positioning of the head enables nontraumatic exposure of the lateral ventricle after limited callosotomy. Note that retraction of the brain tissue can be effectively minimized: with adequate positioning of the patient the gravity-related self-retraction of the brain opens the interhemispheric route without rough retraction of the cerebral tissue (Fig. 7.0.8). Lesions located laterally in or adjacent to the lateral ventricle, especially within the dominant hemispheric side, should be exposed via a contralateral transcallosal approach. Retracting the falx and the opposite cingulate gyrus, the contralaterally situated lesion can be effectively approached (Fig.7.0.9).

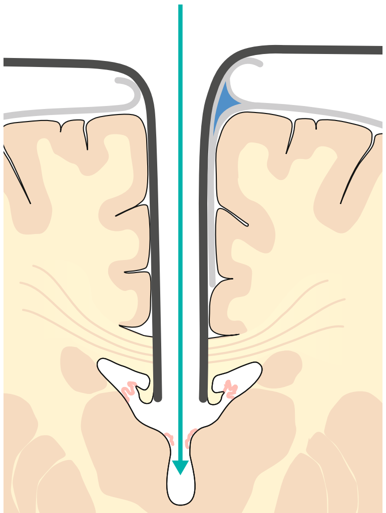


Fig. 7.0.10 *Interfornical investigation of the third ventricle using the interhemispheric approach. After dividing the fornical commissure, the third ventricle is entered through the velum interpositum and its choroidal roof. This approach allows wide exposure of the third ventricular chamber; however, contusions of both fornices may result in severe postoperative memory loss.*

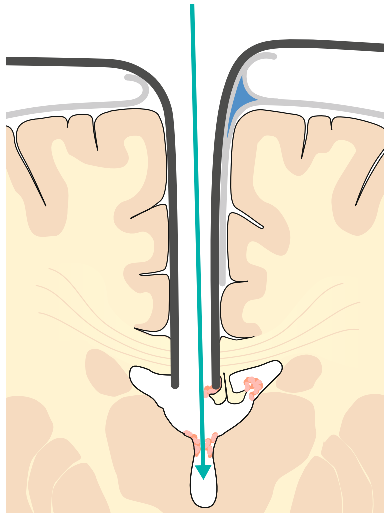


Fig. 7.0.11 *Using the subchoroidal or transchoroidal exposure, the fornix may be gently mobilized under protection of the covering choroidal tissue. The third ventricle can also be widely exposed without transfornical dissection.*

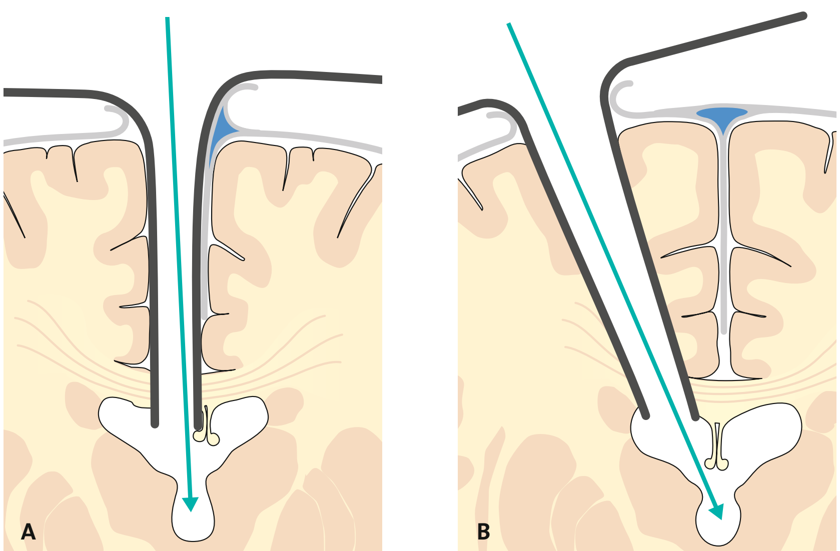


Fig. 7.0.12 *Using the transcallosal transforaminal exposure of the third ventricular chamber, the surgeon gains an overview into the third ventricle through the foramen of Monro; however, only after gentle retraction of the fornix (A). In comparison, using the transcortical route, one is able to investigate the third ventricular chamber without touching the fornical structures. The transcortical route should be used especially in the case of hydrocephalic configuration of the ventricles (B).*

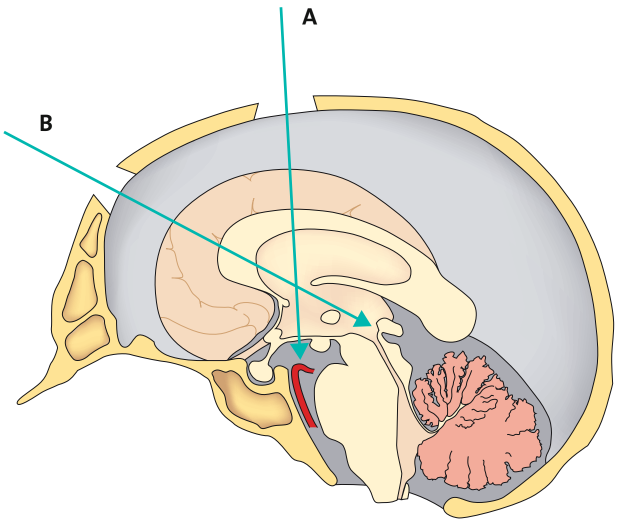


Fig. 7.0.13 *Using a transforaminal approach, optimum placement of the craniotomy is essential to avoid fornical contusion. With good preoperative planning, the individual anatomy of the foramen of Monro and the size and site of the interthalamic adhesion should be determined compared to the target point. Lesions of the anterior third ventricle and the basilar tip should be approached through a posteriorly placed craniotomy (A). The posterior chamber of the third ventricle can be optimally exposed through an anteriorly placed approach (B).*

Approaching the third ventricle using a transcallosal route, the third ventricular chamber can be approached via an interfornical, subchoroidal, transchoroidal or transforaminal path. Using the interfornical exposure, manipulation of the fornix must always be included; due to incision of the fornical raphe and contusion of both fornices, persistent memory loss may result (Fig. 7.0.10). In contrast to bilateral fornical dissection, unilateral damage seems to result in minor deficits, especially on the nondominant side. Therefore, in order to minimize the risk of amnesia, the subchoroidal or transchoroidal approach should be recommended for exposure of the third ventricle (Fig. 7.0.11). These exposures often require only minor mobilization of the fornical elements in addition to the displacement produced by the third ventricular mass lesion itself. The transforaminal approach may be better compared with the other perifornical routes in the case of enlarged ventricles due to chronic hydrocephalus (Fig. 7.0.12). Note that using this transforaminal approach, preoperative planning of the placement of the craniotomy is essential to avoid contusion of the fornix (Fig. 7.0.13).

However, as mentioned above in the historical overview, using the interhemispheric route not only the ventricular chamber but other very different intracranial regions can be effectively approached (Table 7.0.1). Compared with the anterior superior transcallosal interhemispheric approach for intraventricular exposure, the anterior inferior subcallosal interhemispheric exposure offers adequate visualization of the anterior skull base. In addition, the anterior part of the third ventricle can be well approached, dissecting through the lamina terminalis. By the posterior interhemispheric approach, lesions of the posterior third ventricle and the pineal region can be well exposed.

Of course, according to the individual pathoanatomical situation, the above-mentioned target regions can be also exposed using alternative approaches. An alternative approach to the anterior superior transcallosal exposure for intraventricular lesions can be the frontal transcortical approach, as described in chapter 8. Lesions of the anterior skull base and the anterior third ventricle can also be exposed via the subfrontal supraorbital approach, described in chapter 2. Instead of the posterior subcallosal interhemispheric exposure, the supracerebellar infratentorial route can be performed for approaching the pineal region and the posterior third ventricle, as discussed in chapter 6.

In the following, the basic surgical technique of the interhemispheric and transcallosal approaches are discussed exposing the lateral and third ventricles (Table 7.0.2). The anterior frontal subcallosal and the posterior (occipital) subcallosal interhemispheric approaches are described as variations of the main exposure.

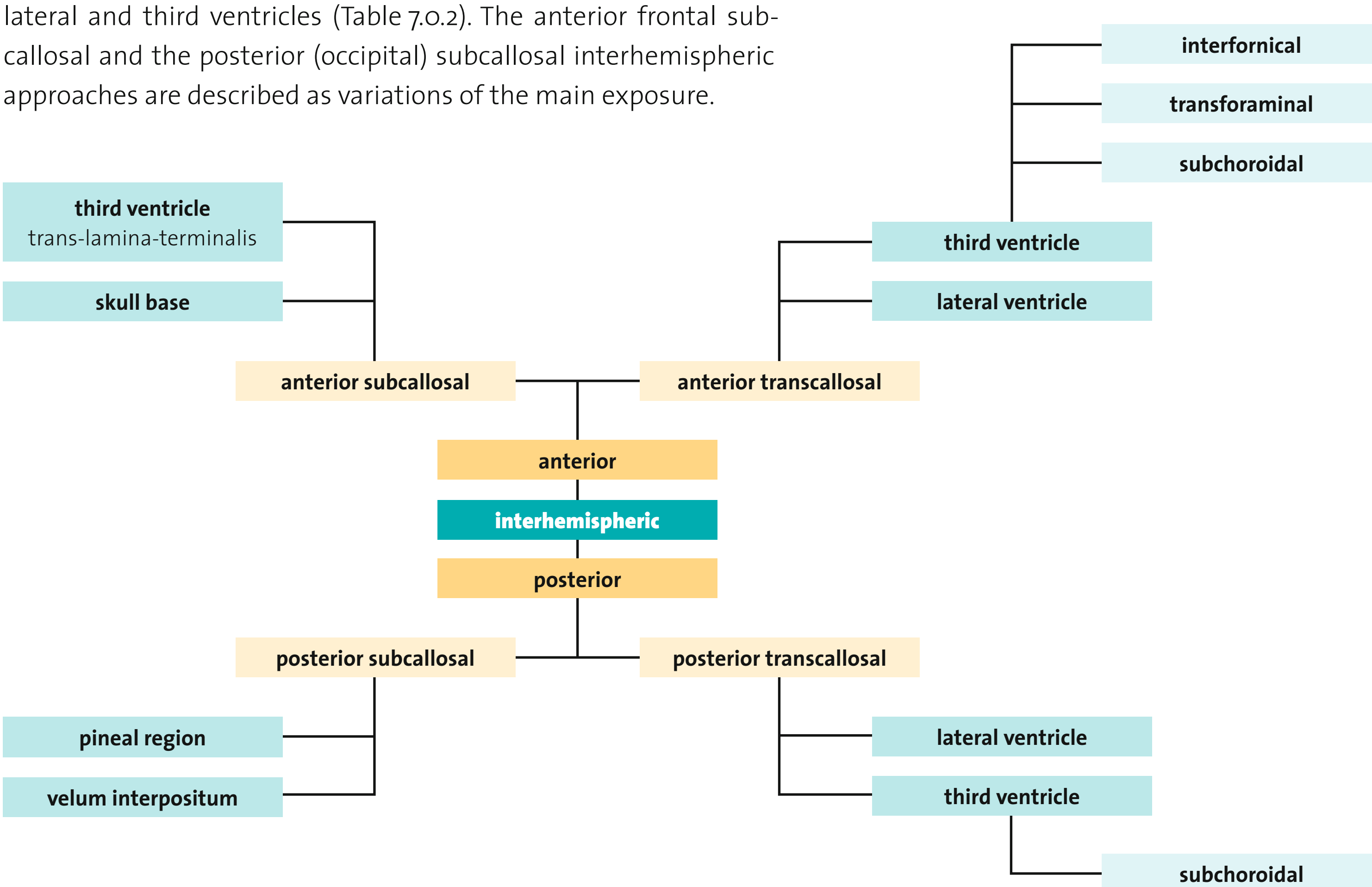


Table 7.0.1 *Different variants of interhemispheric exposures.*

Ipsilateral	Midline	Contralateral
Medial part of the frontal lobe Ipsilateral cingulate gyrus Frontal horn of the lateral ventricle Cella media of the lateral ventricle Foramen of Monro Septal vein Thalamostriate vein Choroid plexus	Superior sagittal sinus Anterior cerebral falx Distal (A3, A4) segments of the ACA Anterior corpus callosum Velum interpositum Third ventricle Interpeduncular fossa Tip of the BA, incl. perforators	Opposite cingulate gyrus Lateral aspect of the contralateral ventricle

Table 7.0.2 *Anatomical structures which can be approached through the anterior interhemispheric transcallosal procedure.*

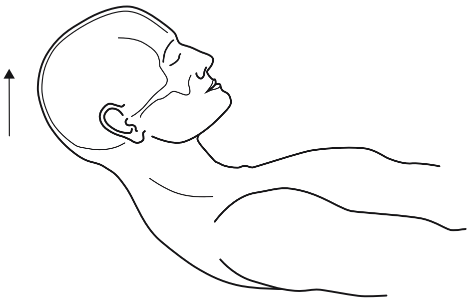


Fig. 7.0.14

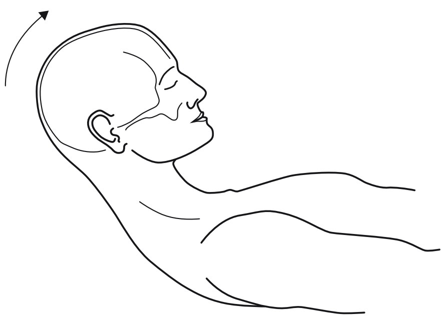


Fig. 7.0.15

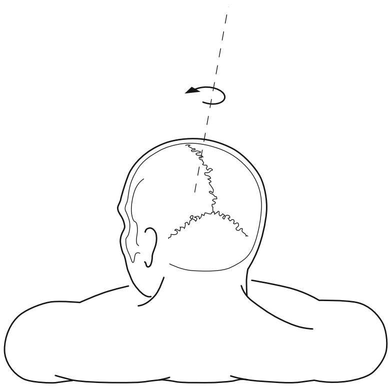


Fig. 7.0.16

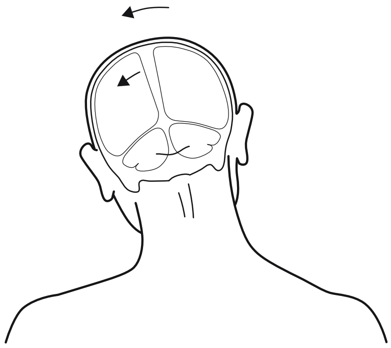


Fig. 7.0.17

Surgical technique

1. Patient positioning

With the patient in a supine position, the postition of the head should allow a surgical dissection near to the perpendicular plane. This provides an efficient surgical dissection and avoids an uncontrolled loss of CSF, which is an important complicating factor in all intraventricular procedures. The head is fixed using a Mayfield holder with the single pin of the head fixator placed on the opposite side to allow free surgical manipulation.

Step 1

As a first step, the head of the patient and the operating table are elevated approximately 15°, to provide sufficient venous drainage (Fig. 7.0.14).

Step 2

Thereafter, the head is carefuly anteroflected without compression of the larynx and the ventilation tube. With a flexion of ca. 15° to 45°, the craniotomy site is on the upper part of the positioned head, avoiding a large loss of CSF (Fig. 7.0.15).

Steps 3–4

Finally, the head is rotated ca. 10° to 30° (Fig. 7.0.16) and lateroflected to the side of the craniotomy (Fig. 7.0.17). This maneuvre of lateroflexion and rotation causes a significant relaxation of the frontal lobe away from the falx cerebri, allowing a minimum or even absent retraction of the cerebral hemisphere and resulting in an optimal access to the lesion. Approaching the ipsilateral side, a lateroflexion of ca. 30° and rotation of 10° is necessary, whereas exposure of the opposite side requires a lateroflexion of ca. 10° and rotation of 10° to provide an efficient working position for the surgeon.

2. Anatomical landmarks and orientation

For an optimal skin incision, the important anatomical landmarks of the osseous skull such as the coronary and sagittal sutures are precisely defined (Fig. 7.0.19).

After this basic orientation, the placement of the craniotomy is exactly defined according to the target area. Note that the borders of the trephination should cross the midline to gain control of the sinus sagittalis superior. After definition of the craniotomy, the individual optimum line of the skin incision is marked with a pen. The straight sagittal skin incision is placed in the precoronary region, just behind the frontal hairline (Fig. 7.0.18). After minimal or even absent shaving of the hair, the skin is carefully disinfected with alcohol solution. In bald patients or in special situations, the skin incision and the craniotomy may be placed anterior to the (imaginary) hairline. For this purpose, wrinkles in the skin may be chosen for the incision, the incision anterior the hairline should be transverse, according to the prominent wrinkles.

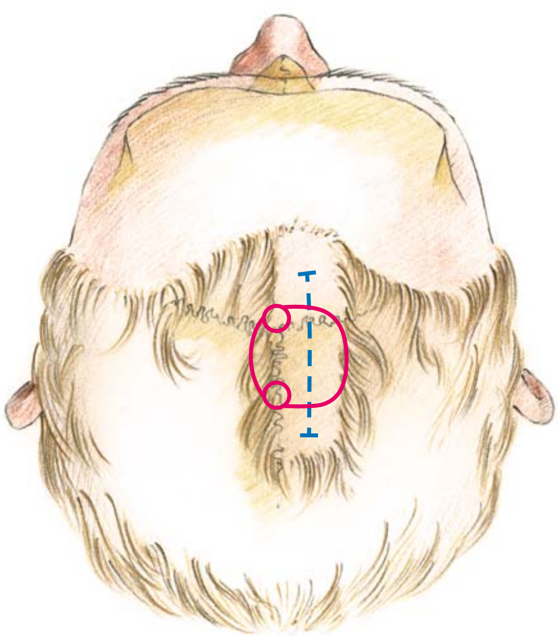


Fig. 7.0.18 *Definition of the craniotomy according to the anatomical landmarks of the frontal region. The paramedian placed craniotomy allows safe control of the midline and offers adequate interhemispheric dissection.*

3. Craniotomy

Step 1

Right side. After minimal or even absent shaving of the hair, a ca. 5 cm long straight skin incision is performed ca. 1.5 cm paramedian from the carefully defined midline (Fig. 7.0.19).

Fig. 7.0.19

Step 2

After mobilization of the subcutaneous tissue, the galea aponeurotica and the periosteal layer are incised in a curved fashion and retracted toward the midline. If necessary, this tissue can be used later for a watertight closure of the dura mater (Fig. 7.0.20).

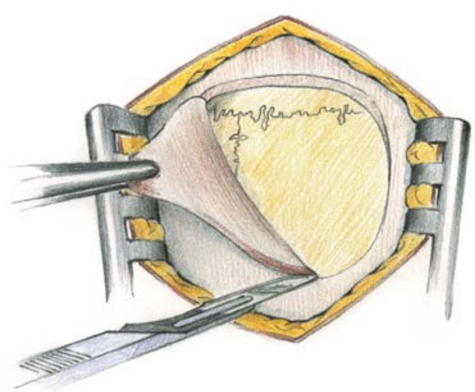


Fig. 7.0.20

Step 3

With a craniotome, two burr holes are performed according to the midline, just above the SSS. The main danger of any midline craniotomy is the tearing of the SSS; however, by this technique injury to the sinus can be effectively avoided. The first burr hole trephination should be placed frontally at the anterior-medial corner, the second burr hole parietally at the posterior-medial corner of the planned craniotomy. The argument for this form of craniotomy is that it appears to be safer to place the burr hole trephination exactly above the SSS and expose it over its full width, than to cross it with the craniotome, or to saw blind parallel to the sinus (Fig. 7.0.21).

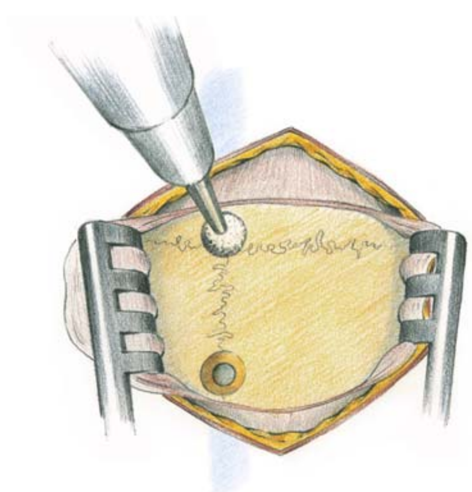
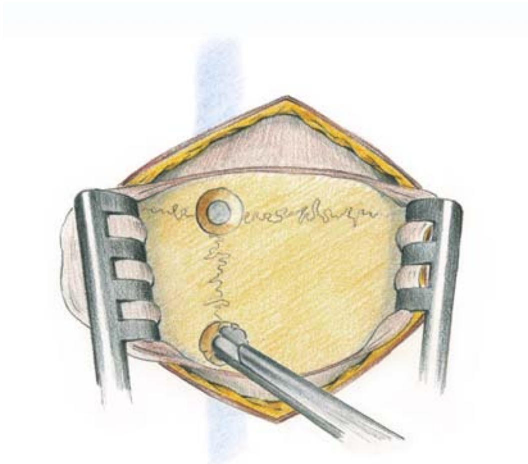


Fig. 7.0.21

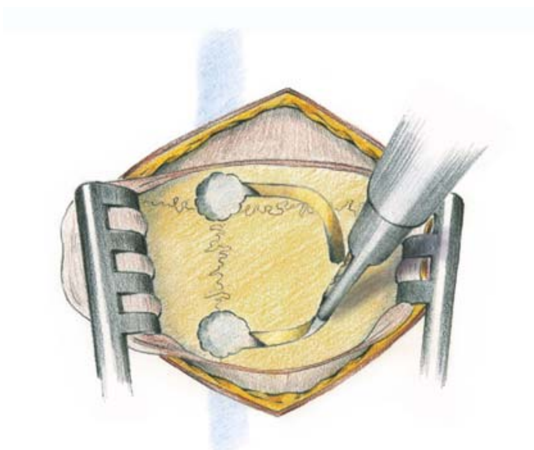
Fig. 7.0.22



Step 4

After mobilization of the dura mater with a blunt dissector, the burr holes should be enlarged using fine Kerrison rongeurs. By removal of the bony edges of the groove of the SSS, the lateral borders of the sinus can be effectively checked (Fig. 7.0.22).

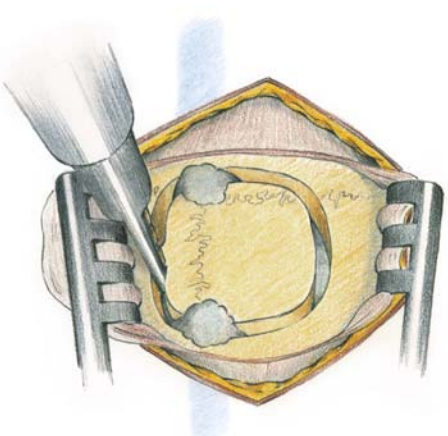
Fig. 7.0.23



Step 5

Using a craniotome, one never should cut in the direction of the SSS. According to this principle, a curved line is sawed from the frontal burr hole on the ipsilateral side. This ipsilateral cut is then completed from the parietal burr hole (Fig. 7.0.23).

Fig. 7.0.24



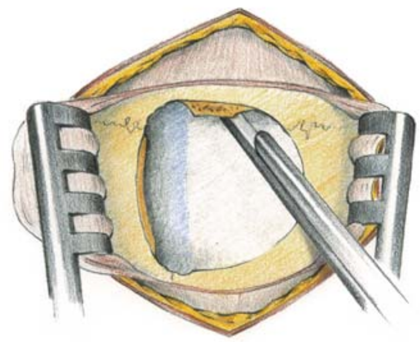
Step 6

Thereafter, the craniotome is used on the opposite side in a similar way, creating a paramedian craniotomy with an effective control of the SSS (Fig. 7.0.24).

Step 7

After removal of the bone flap with a diameter of ca. 2.0 to 3.0 cm, the inner edge of the bone should be removed using fine punches. Due to careful removal of the tabula interna anteriorly and posteriorly, the angle for intracranial visualization can significantly increase. In the further course of the operation, this trick can greatly facilitate the application of conventional microinstruments through the limited craniotomy (Fig. 7.0.25).

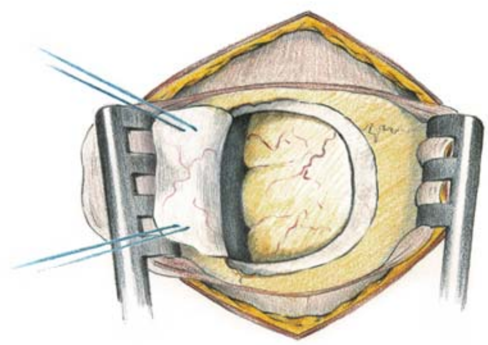
Fig. 7.0.25



Step 8

The dura should be opened in a semicircular fashion with the base of the dural flap toward the SSS. The free dural flap is fixed with two sutures; other dural elevation sutures are not required. Occasional injuries to the SSS cannot be occluded with bipolar coagulation because shrinking of the dural tissue enlarges the hole. For this reason, hemoclips and carefully placed sutures can be effective (Fig. 7.0.26).

Fig. 7.0.26



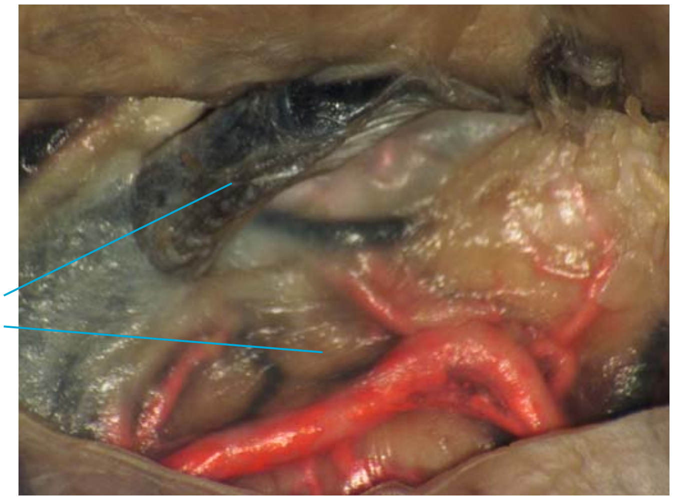


Fig. 7.0.27

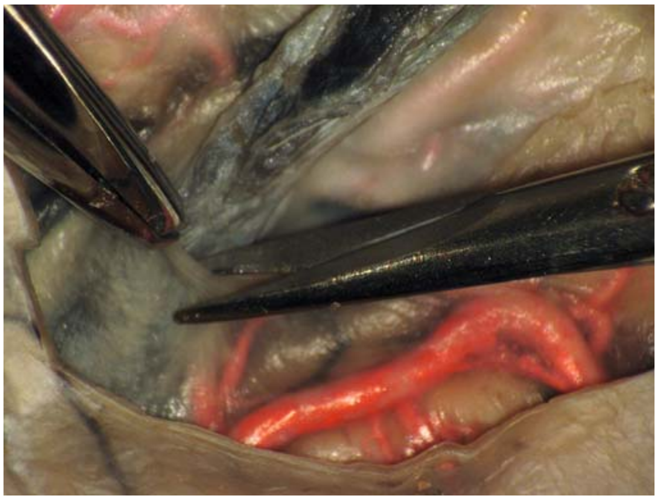


Fig. 7.0.28

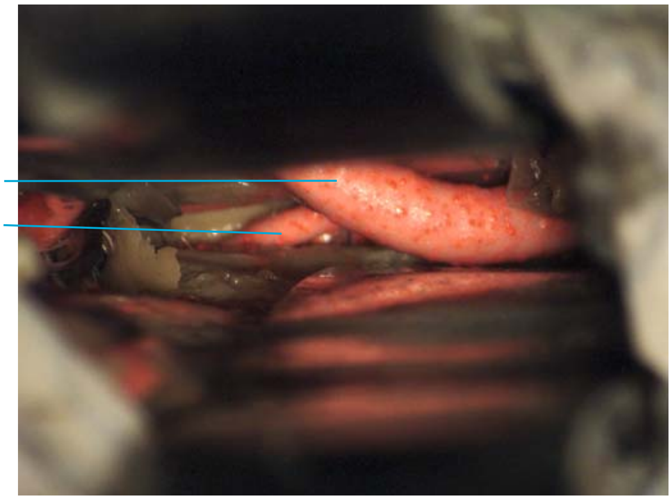


Fig. 7.0.29

4. Intradural dissection

Step 1

Right side. Dissection using a formaldehyde-fixed human specimen. Arterial vessels are prepared with a red latex solution. After dural opening, the superior frontal gyrus should be carefully dissected from the midline. If present, bridging veins run some millimeters within the convexity-dura or within the falx before entering the SSS. Using microinstruments, this part of the vein should be dissected away from the dura, allowing exposure of the interhemispheric fissure (Fig. 7.0.27).

Step 2

In addition, the superficial bridging vein should be carefully dissected from arachnoidal adhesions, gaining useful additional mobilization of the superior frontal gyrus. If the vein is injured and must be occluded, cerebral retraction should be restricted to the absolute minimum avoiding compression of the surrounding venous anastomoses. Mobilization of the frontal lobe can be successfully supplemented with a correct positioning of the head offering effective relaxation of the brain, which then, due to gravity, sinks spontaneously away from the falx cerebri (Fig. 7.0.28).

Step 3

After mobilization of the frontal lobe and the falx cerebri, the interhemispheric fissure is carefully approached. Note the callosomarginal artery; the pericallosal artery appears in the background (Fig. 7.0.29).

Step 4

With further dissection within the interhemispheric fissure, the corpus callosum is approached. The cingulated gyrus is carefully retracted on both sides. Note the indusium griseum on the surface of the corpus callosum and the mobilized arteries (Fig. 7.0.30).

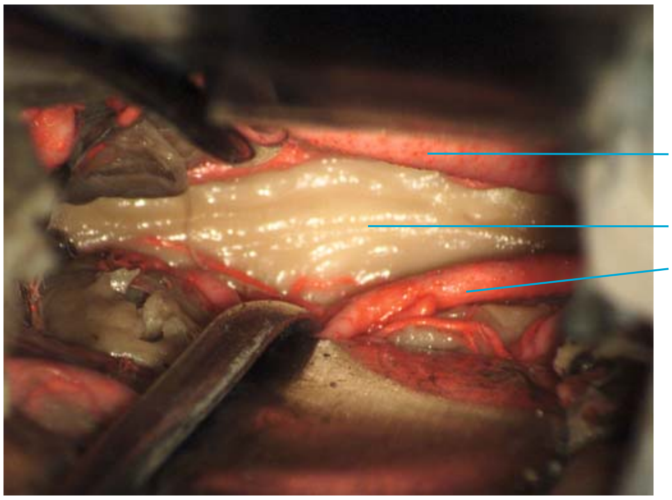


Fig. 7.0.30

Step 5

After limited callosotomy, the chamber of the right lateral ventricle is entered. The choroid plexus disappears within the foramen of Monro, the anterior part of the ventricle without plexus corresponds to the frontal horn of the lateral ventricle. Note the fornix, the head of the caudate nucleus and the lamina affixa thalami. Because of the interhemispheric approach, the foramen of Monro appears in an oblique view from above (Fig. 7.0.31).

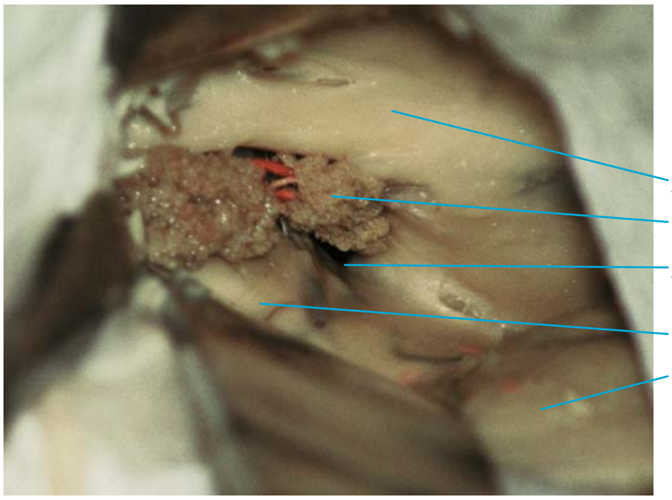


Fig. 7.0.31

Step 6

Focusing anteriorly, the foramen of Monro and the frontal horn are exposed. Note the fornix; the choroid plexus disappears into the foramen of Monro (Fig. 7.0.32).

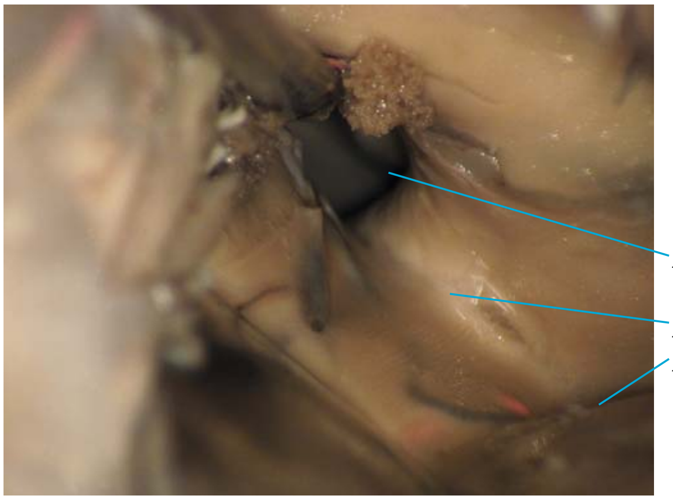


Fig. 7.0.32

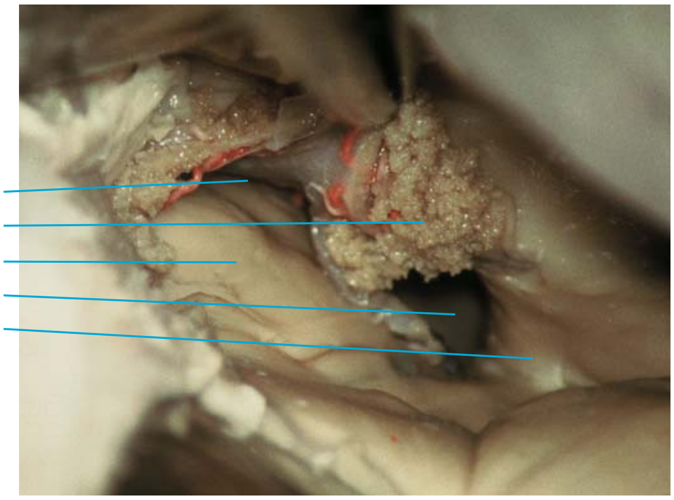


Fig. 7.0.33

Step 7

Exposure of the foramen of Monro and the cella media of the lateral ventricle. The choroid plexus is gently retracted with a microsucker allowing visualization of the choroidal fissure between fornix and thalamus (Fig. 7.0.33).

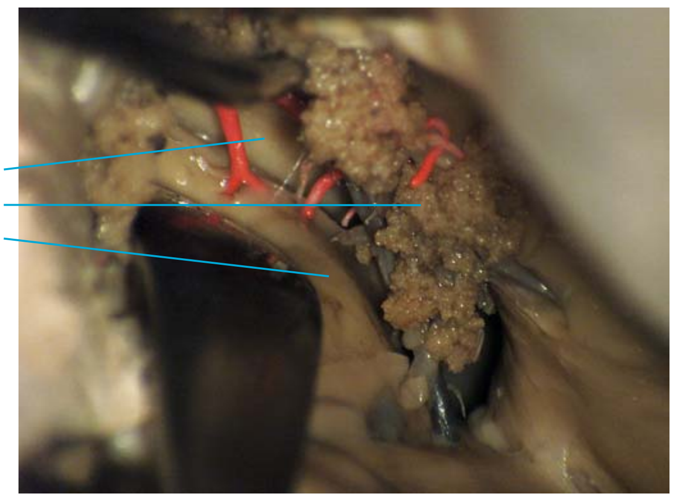


Fig. 7.0.34

Step 8

The choroid plexus is carefully dissected from the tenia thalami allowing subchoroidal exposure of the third ventricle. Note small perforators of the choroidal arteries supplying the thalamus (Fig. 7.0.34).

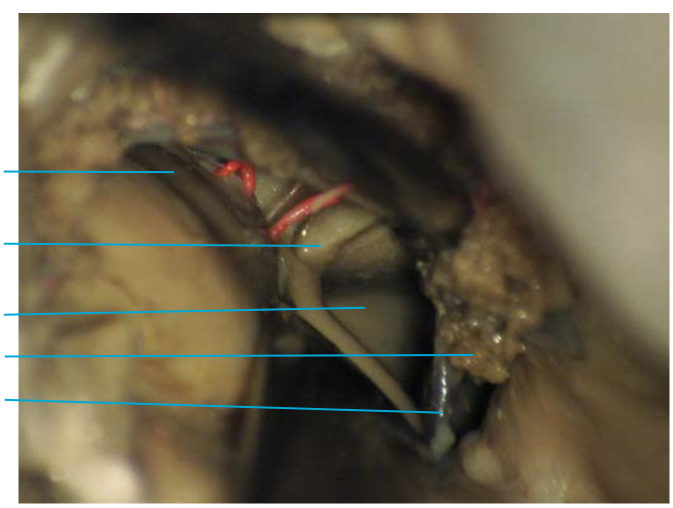


Fig. 7.0.35

Step 9

The choroid plexus and the internal cerebral vein are retracted for approaching the middle and posterior parts of the third ventricle. Note the interthalamic adhesion and the floor of the third ventricle (Fig. 7.0.35).

5. Dura, bone and wound closure

After completion of the intracranial procedure, the intraventricular and intradural space is filled with artificial CSF solution at body temperature. For this purpose it is useful if the craniotomy is placed at the highest point of the head, otherwise severe postoperative pneumocephalus can occur. The dural incision should be closed with watertight sutures. If tension has developed in the dural plane, tissue of the galea aponeurotica can be used for sufficient closure. A plate of gelfoam is then placed extradurally; note that this gelfoam plate should not compress the superior sagittal sinus. After fixation of the bone flap and after final verification of hemostasis, the periosteum, subcutaneous layer and the skin are closed each with interrupted sutures. Due to the limited approach, a suction drain is not necessary.

Potential errors and their consequences

Most of the complications after intraventricular surgery are related to the location and nature of the primary lesion itself rather than to the surgical approach. However, some typical surgical errors and their consequences should be discussed in detail.

- Incorrect preoperative planning with insufficient intracranial exposure.
- Injury to the SSS during craniotomy, in some cases with severe consequences. Compression of the SSS by hemoclips may cause sinus thrombosis and subsequent venous infarction of the frontal lobe.
- Venous infarction may also occur due to occlusion of large bridging veins running into the SSS.
- Excessive frontal lobe retraction against gravity due to poor positioning of the head. Akinetic mutism can develop after rough retraction against both cingulate gyri.
- Decrease in spontaneous speech ranging from a mild slowness to frank mutism due to extended sectioning of the anterior portion of the corpus callosum.
- Contusion of the fornix approaching the third ventricle may result in temporary or in some cases persistent amnestic syndromes.
- Inadequate intracranial hemostasis with postoperative intraventricular rebleeding. Temporary insertion of a ventricular drain can be recommended.

- Incorrect positioning of the head during dural closure with severe pneumocephalus after surgery.
- Inadequate dural closure with postoperative CSF fistula.
- Inadequate positioning and fixation of the bone flap with compression of the SSS and subsequent venous infarction.
- Poor hemostasis during wound closure with postoperative soft tissue hematoma.

Fig. 7.0.36

Tips and tricks

- Take time for preoperative planning. The reward is excellent intracranial visualization of the target area.

- Adequate positioning of the head results in a gravity-supplemented self-retraction of the frontal lobe, avoiding excessive brain retraction (Fig. 7.0.36).

- Make careful anatomical orientation and use the three steps of planning the approach: 1. osseous structures; 2. placement of the craniotomy; 3. skin incision.

- Creating the burr hole trephination, the lateral borders of the SSS should be checked, avoiding injury during craniotomy (Fig. 7.0.37).

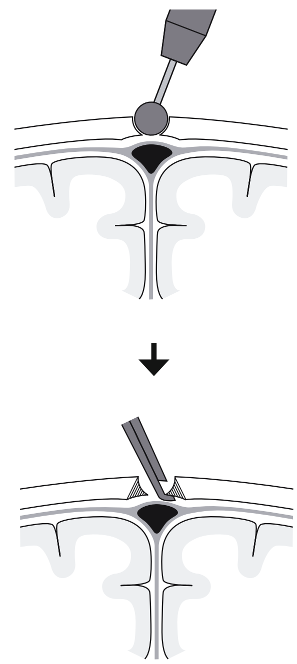


Fig. 7.0.37

- Stages of craniotomy (Fig. 7.0.38): 1. frontal and 2. parietal burr hole trephinations with effective control of the SSS; 3. ipsilateral and 4. contralateral cutting from the burr hole trephinations with a high-speed craniotome.

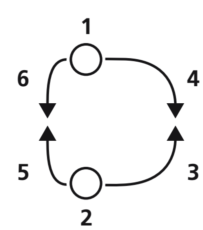


Fig. 7.0.38

- Another variation allowing safe exposure of the SSS corresponds to four burr hole trephinations on both sides of the sinus. By this technique, the groove of the SSS is explored laterally without danger of sinusoidal bleeding during the trephinations.

- Due to removal of the inner edge of the craniotomy anteriorly and posteriorly, the angle for intracranial visualization significantly increases (Fig. 7.0.39).

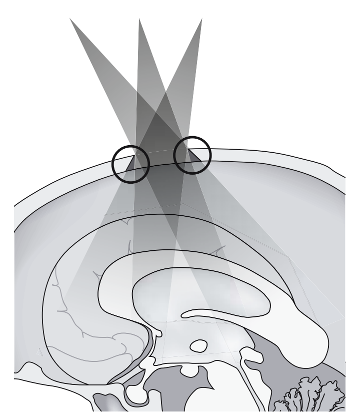
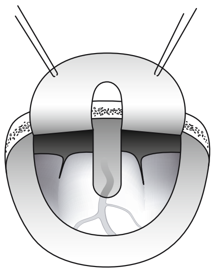


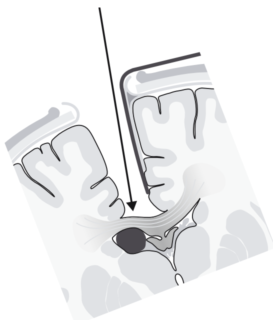
Fig. 7.0.39

Fig. 7.0.40



- The dura should be opened in a "C" shaped, semicircular fashion with the base of the dural flap toward the midline. Preservation of bridging veins is essential to avoid cerebral venous infarction. If a large bridging vein is present, the vein should be dissected from the arachnoidea of the cerebral surface and from the dural surface of the falx cerebri. If possible, the vein should be carefully protected with a special dural opening (Fig. 7.0.40).

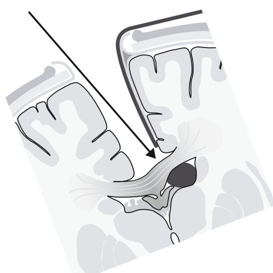
Fig. 7.0.41



- Ventricular lesions located medially within the ventricular chamber should be exposed via ipsilateral interhemispheric approach (Fig. 7.0.41).

- Lesions located in the lateral part of the lateral ventricle can be effectively exposed via a contralateral interhemispheric approach (Fig. 7.0.42).

Fig. 7.0.42



- During wound closure, the dura should be closed with watertight sutures. If necessary, tissue of the galea aponeurotica can be used for this purpose (Fig. 7.0.43).

- The bone flap should be fixed without compression of the SSS avoiding sinusoidal thrombosis (Fig. 7.0.44).

- The skin incision within the haired area can be closed with interrupted or running sutures.

- Due to the limited skin incision, a suction drain is not required.

Fig. 7.0.43

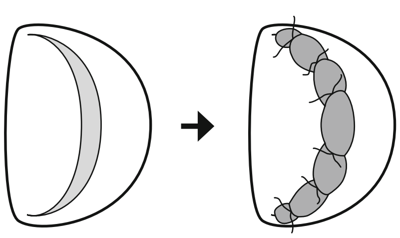
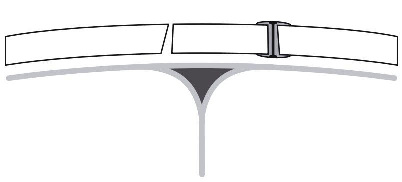


Fig. 7.0.44



7.1
The anterior (frontal) subcallosal variation of the interhemispheric approach

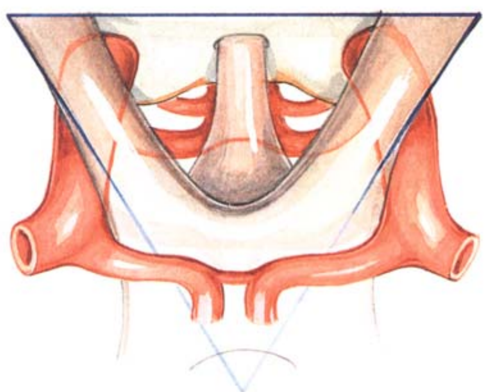


Fig. 7.1.1 *Schematic drawing of the suprasellar pyramid approaching from an anterior direction. The structures of the chiasm, the optic nerves, the pituitary stalk and the lamina terminalis can be well exposed. The carotid bifurcations, the anterior communicating artery and the proximal segments of the anterior cerebral arteries are also in direct relationship to this anterior suprasellar plane.*

The anterior inferior interhemispheric approach is one of the most frequently used techniques for lesions of the anterior cranial fossa. Using the interhemispheric exposure, extended lesions of the frontal skull base and anterior plane of the suprasellar region can be effectively approached (Fig. 7.1.1).

The exact placement of the midline craniotomy depends on the preoperative planning, taking into consideration the individual patho-anatomy, especially the relationship between the skull base and the corpus callosum, and the form of the genu and rostrum corporis callosi (Fig. 7.1.2.). Through a superiorly placed anterior interhemispheric craniotomy, the frontal skull base can be effectively approached (red arrow), and through a mid-positioned craniotomy, the anterior plane of the suprasellar can be exposed without severe retraction of the frontal lobe (green arrow). A basally placed approach (blue arrow) allows optimal access to the rostrum corporis callosi and through the lamina terminalis into the anterior third ventricle (Fig. 7.1.3).

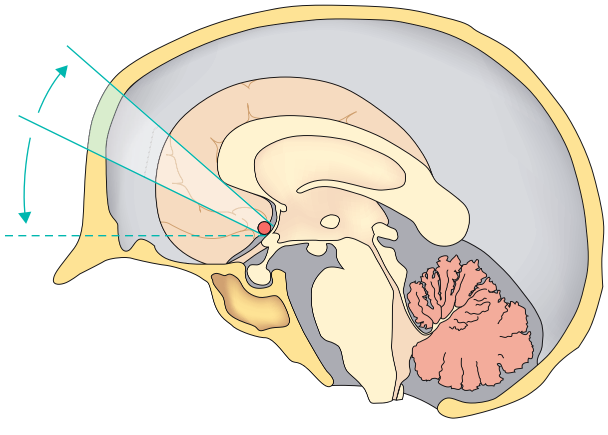


Fig. 7.1.2 *The individual form of the corpus callosum and the localization of the target area decide the placement of the midline craniotomy. After preoperative planning, the maximum height of the craniotomy should be measured from the nasion by MR investigations in the sagittal plane.*

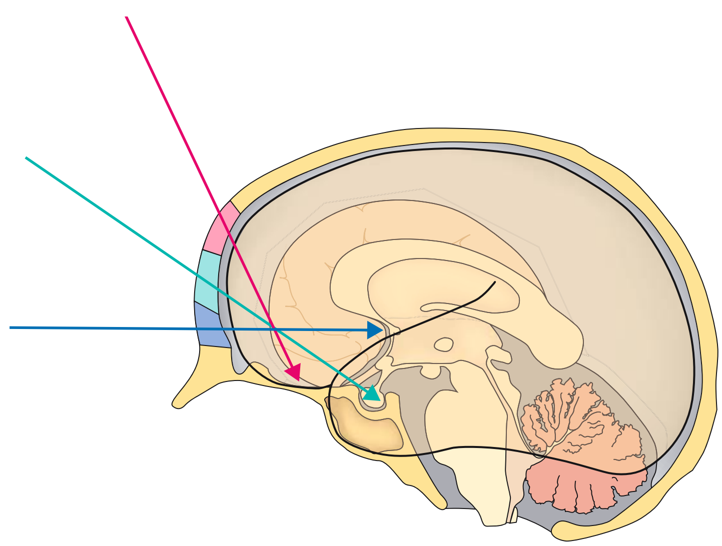


Fig. 7.1.3 *Through different variants of the anterior subcallosal interhemispheric approach, the median skull base (superior variant, red arrow), the suprasellar area (mid-variant, green arrow) and the anterior third ventricle (inferior variant, blue arrow) can be effectively approached without rough retraction of the frontal or temporal lobe.*

Superior variant	Mid-variant	Inferior variant
Anterior third of the superior sagittal sinus	Anterior superior sagittal sinus	Inferomedial frontal lobe
Anterior third of the falx cerebri	Anterior third of the falx cerebri	Anterior third of the falx cerebri
Frontal skull base	Frontal skull base	Rostrum of the corpus callosum
Tuberculum sellae	Tuberculum sellae	Lamina terminalis
Christa galli	Christa galli	Anterior third ventricle
Olfactory groove, lamina cribrosa	Olfactory groove, lamina cribrosa	Optic nerves and chiasm
Superior ethmoidal cells	Sella turcica, diaphragma sellae	ICA, A1, ACoA, A2, incl. perforators
Sphenoid sinus	Medial part of the frontal lobe	
Medial part of the frontal lobe	Genu of the corpus callosum	
Genu of the corpus callosum	Gyrus rectus	
Olfactory bulbs, olfactory tracts	Rostrum of the corpus callosum	
A3, A4	Olfactory tracts	
	Optic nerves and chiasm	
	Pituitary stalk, hypophysis	
	ICA, A1, ACoA, A2, A3, incl. perforators	

Table 7.1.1 *Anatomical structures approached through the different variants of the anterior (frontal) inferior subcallosal interhemispheric approach.*

The decision as to whether the craniotomy is placed left paramedian or right paramedian is made preoperatively with a careful analysis of the diagnostic imaging data. According to the keyhole concept for contralateral approaches (Fig. 7.1.4), deep-seated lesions located right of the midline are best exposed through a left paramedian interhemispheric approach; in contrast, lesions extending left of the midline are best approached via a right paramedian craniotomy.

In the following, the surgical technique of the anterior frontal subcallosal interhemispheric approach is described in detail.

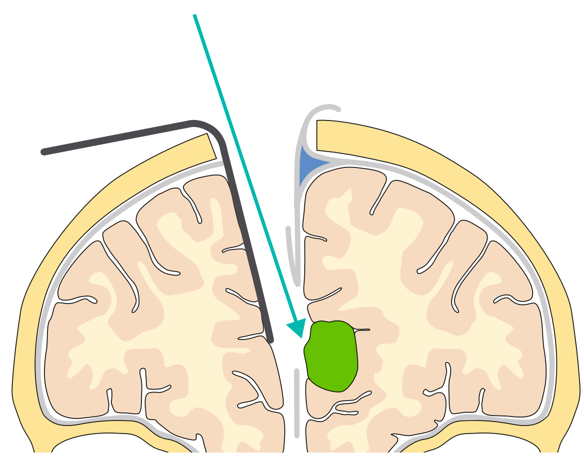


Fig. 7.1.4 *According to the concept of keyhole approaches, in selected cases deep-seated lesions can be best exposed through contralaterally performed craniotomies.*

Surgical technique

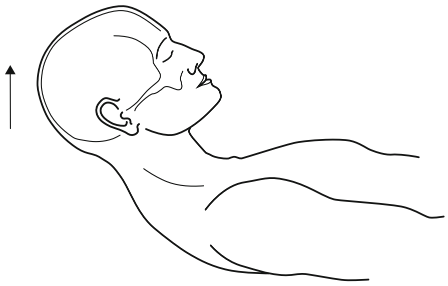


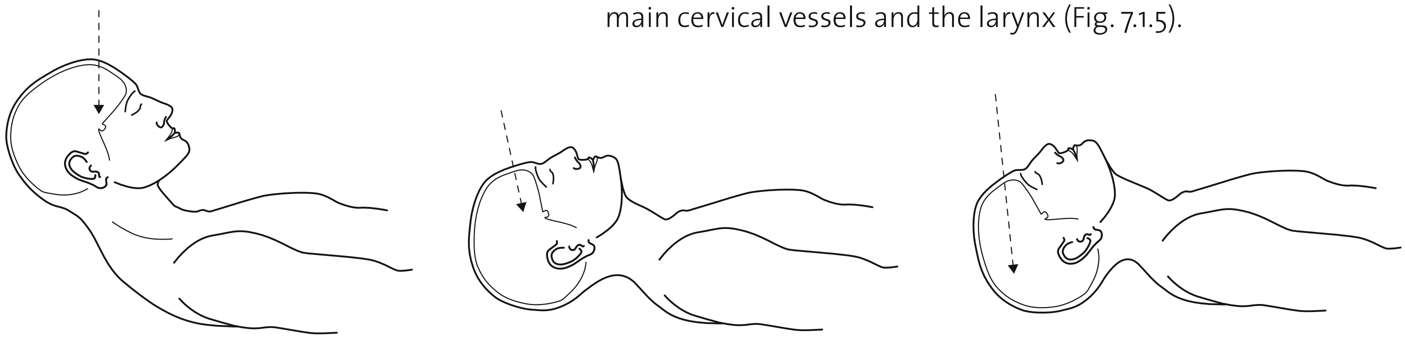
Fig. 7.1.5

1. Patient positioning

With the patient in the supine position, the head is fixed. If used, the single pin of the skull clamp should be placed allowing free dissection during surgery.

Step 1

The head of the operating table is elevated above the thorax, facilitating cranial venous drainage and avoiding compression of the main cervical vessels and the larynx (Fig. 7.1.5).



A B C

Fig. 7.1.6

Step 2

Thereafter, the head is retro- or anteroflected (Fig. 7.1.6). Basically, the more inferiorly the craniotomy is performed, the more retroflexion is needed to achieve an ergonomic surgical position. Thus, lesions with a close proximity to the frontal skull base, which can be exposed via the superior variant of the subcallosal interhemispheric approach, require a moderate anteroflexion of ca. 10° (A). For the mid-variation of the craniotomy exposing the sellar and suprasellar area, a retroflexion of ca. 10° to 20° is sufficient (B). Structures situated more cranially, for example, lesions of the lamina terminalis, rostrum corporis callosi and anterior third ventricle, can be approached through the inferior variant of the craniotomy (C) with a retroflexion of 30° to 45°.

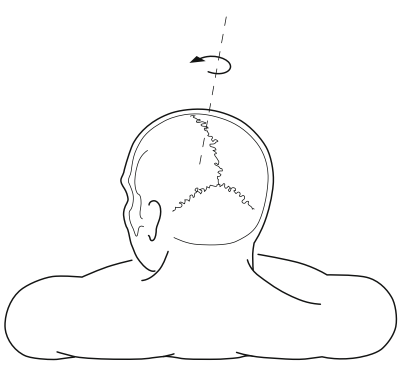


Fig. 7.1.7

Step 3

The head is rotated ca. 10° toward the side of the craniotomy. This maneuvre induces the frontal lobe to relax away from the falx cerebri due to gravity. Thus, access to deep-seated structures can be facilitated with minimum retraction of the brain (Fig. 7.1.7).

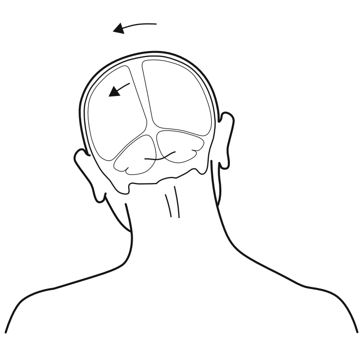


Fig. 7.1.8

Step 4

Finally, the head should be lateroflected ca. 5° to allow an ergonomic and efficient working position for the surgeon (Fig. 7.1.8).

2. Anatomical landmarks and orientation

For the appropriate skin incision, the important anatomical landmarks of the osseous skull, such as the midline, coronary suture, orbital rim, supraorbital foramen and the frontal paranasal sinus should be precisely defined and marked with a sterile pen (Fig. 7.1.9).

The borders of the craniotomy are marked exactly with the craniotomy usually crossing the midline and the anterior superior sagittal sinus. As mentioned above, placement of the craniotomy depends on the individual shape of the corpus callosum and on the localization of the target area. After definition of the craniotomy, the optimum line of the skin incision is marked; this horizontal skin incision is usually placed at the frontal hairline (A). For bald-headed patients or more basally planned craniotomies, a wrinkle of the skin may be chosen for this purpose, achieving a pleasing cosmetic result (B). For the inferior variant of the approach, for patients without any wrinkles in the frontal area, an extended standard bicoronar skin incision can be performed (C). The surface of the skin should be disinfected carefully.

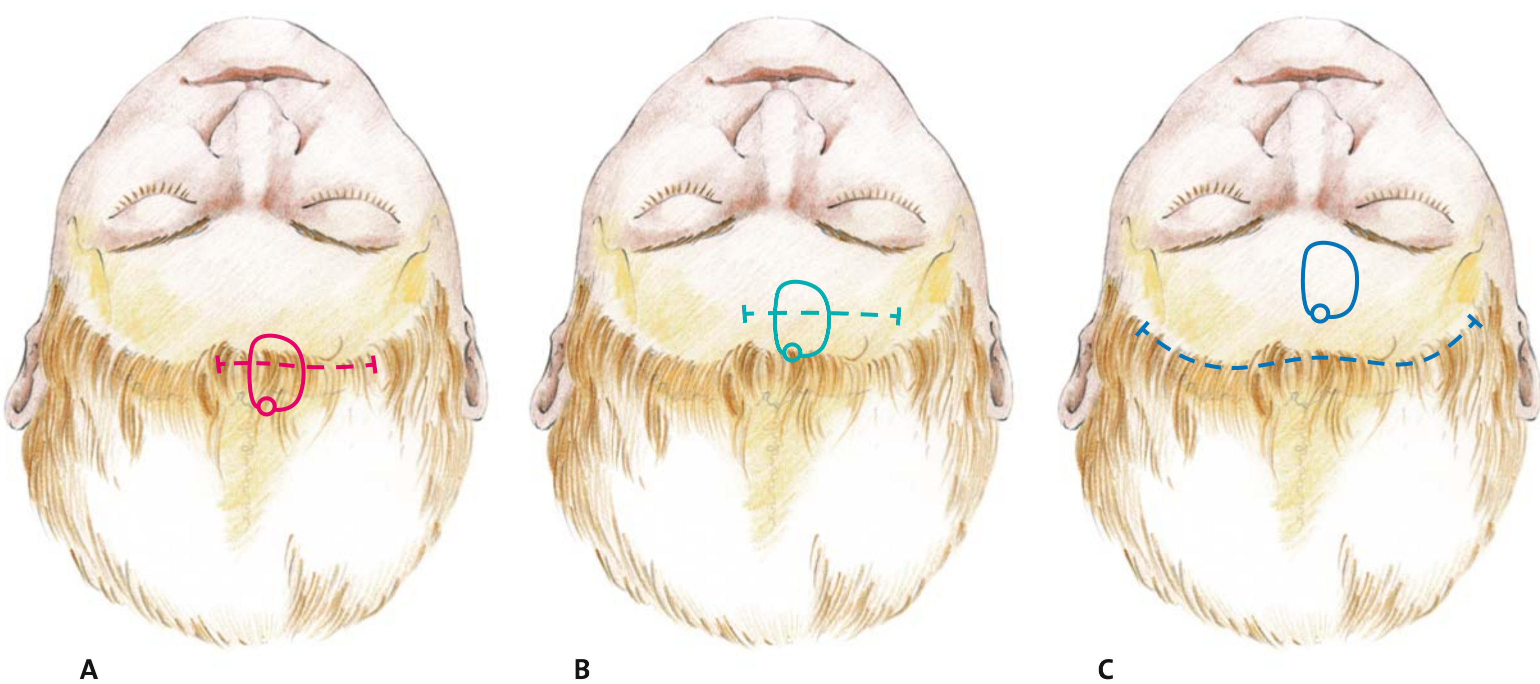


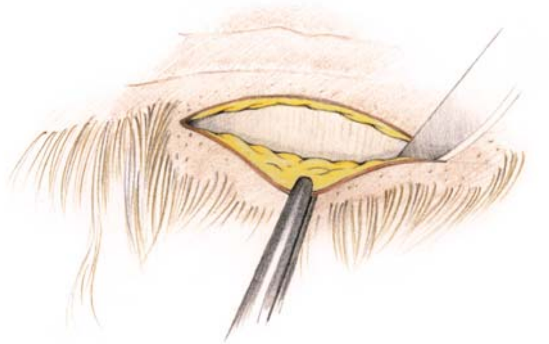
Fig. 7.1.9 *Definition of the craniotomy and skin incision according to the target region, anatomical landmarks and individual physiognomy of the patient. Superior variant with limited skin incision behind the hairline (A). Mid variant using a wrinkle for the skin incision (B). Inferior variant; for patients without any wrinkles in the forehead, an extended bicoronar skin incision can be performed (C).*

3. Craniotomy

Step 1

Right side. After minimal or even absent hair shaving, the skin is disinfected using alcohol solution. The skin and the subcutaneous tissue are incised and retracted exposing the galea aponeurotica and the frontal belly of the occipitofrontal muscle (Fig. 7.1.10).

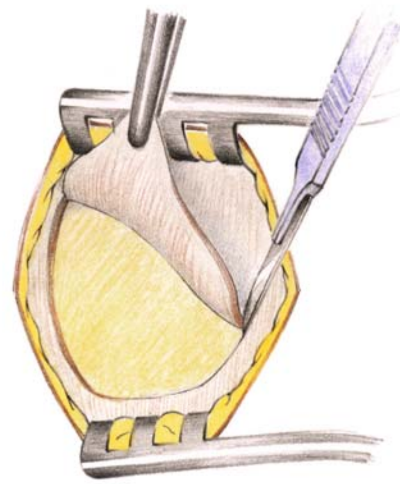
Fig. 7.1.10



Step 2

The galea and the periosteum are incised in a semicircular fashion and dissected as a common flap with the base toward nasal. This galea flap can be effectively used for dural graft as well as for closing the frontal paranasal sinus if necessary (Fig. 7.1.11).

Fig. 7.1.11



Step 3

After bilateral retraction of the soft tissue layers, a single midline burr hole trephination is created parietally at the postero-medial corner of the planned craniotomy. The dura mater is mobilized with a blunt dissector; the burr hole is enlarged using fine Kerrison rongeurs guiding the lateral borders of the superior sagittal sinus (Fig. 7.1.12).

Fig. 7.1.12

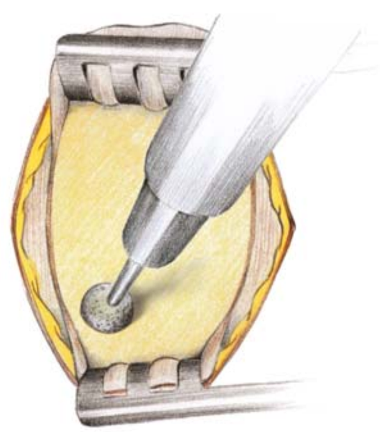
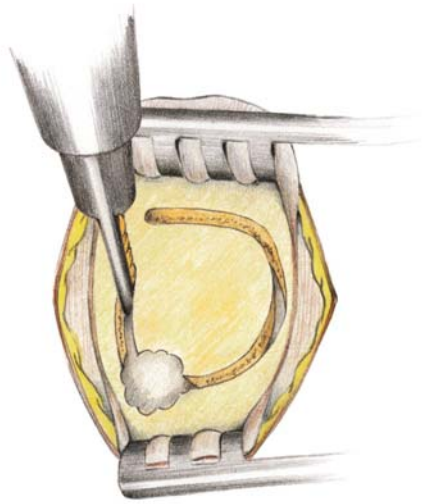


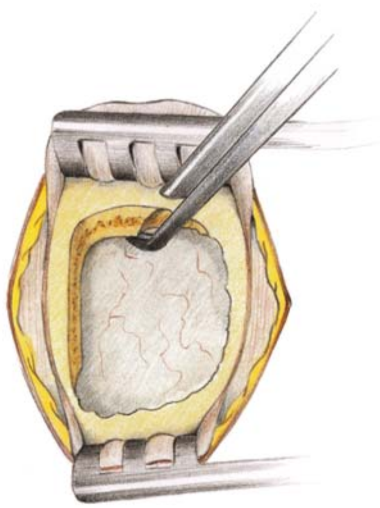
Fig. 7.1.13



Step 4

A semilunarly shaped line is then sawed with the high-speed craniotome on the ipsilateral side, from the posteriorly placed burr hole to the anterior mid-line. Thereafter, a second paramedian craniotomy line is sawed on the opposite side, just laterally from the superior sagittal sinus, thus creating a craniotomy with a diameter of 2.0–3.0 cm (Fig. 7.1.13).

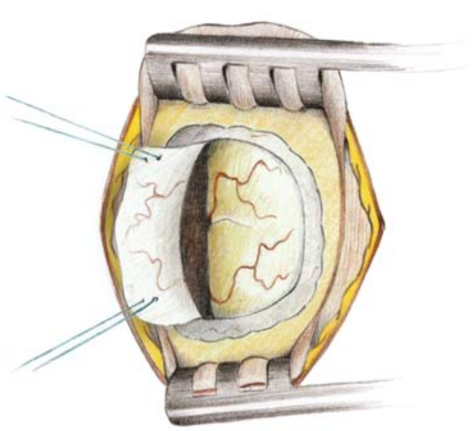
Fig. 7.1.14



Step 5

After removal of the bone flap, the inner edge of the tabula interna is removed using fine punches. Due to careful removal of this inner bone edge, the angle for intracranial visualization can be significantly increased (Fig. 7.1.14).

Fig. 7.1.15



Step 6

The dura should be opened in a semicircular fashion with the base of the dural flap towards the superior sagittal sinus. The free dural flap is fixed with two sutures; other dural elevation sutures are not necessary (Fig. 7.1.15).

4. Intradural dissection

Step 1

Right side. Dissection performed on a fresh human specimen; arteries are prepared with red, veins with blue colored latex solution. After opening the dura mater, the superior frontal gyrus and bridging veins toward the superior sagittal sinus are carefully exposed and, whenever possible, the bridging veins are preserved. The next step should be the sufficient drainage of CSF by opening the subarachnoid cisterns. In some cases, trapping of the lateral ventricle may be necessary. The frontal lobe is gently mobilized and the anterior interhemispheric fissure approached. Correct positioning of the head offers significant relaxation of the frontal lobe, which then, due to gravity, will sink spontaneously away from the falx cerebri. Therefore major retraction of the frontal lobe is usually not required. Note the microforceps gently retracting the superior frontal gyrus (Fig. 7.1.16).

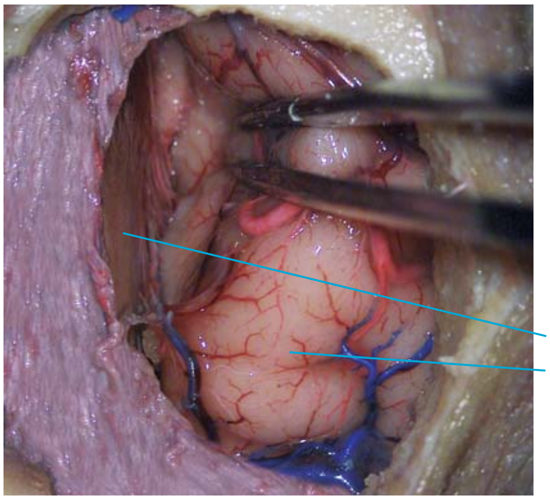


Fig. 7.1.16

Step 2

The frontal lobe is retracted with a brain spatula exposing the genu of the corpus callosum. Note the pericallosal and callosomarginal arteries. The opposite frontal lobe is protected by the falx. In the contralateral interhemispheric midline, the cingulated gyrus can be exposed (Fig. 7.1.17).

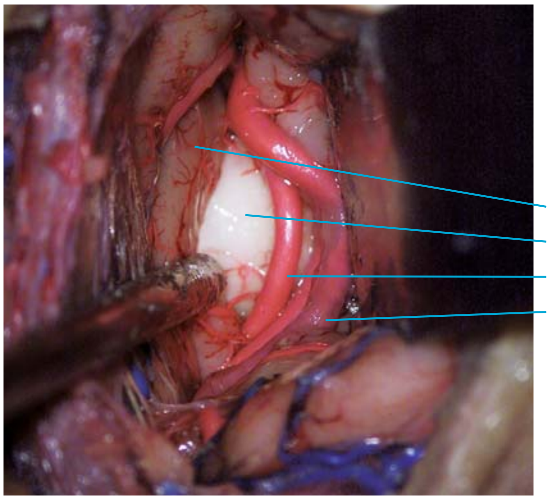


Fig. 7.1.17

Step 3

Anterior to the genu, the interhemispheric fissure is carefully opened. Note the A3 segments of both anterior cerebral arteries running around the genu of the corpus callosum (Fig. 7.1.18).

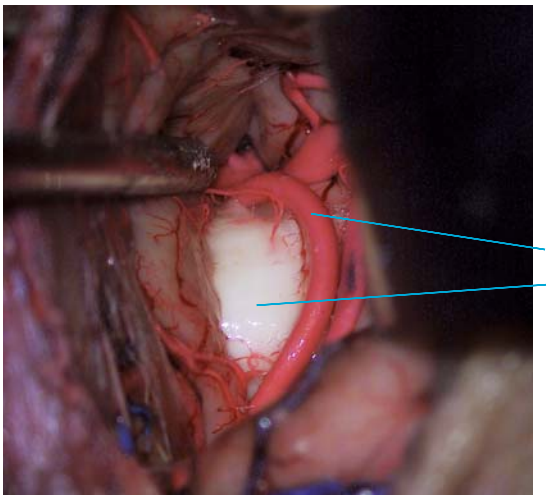


Fig. 7.1.18

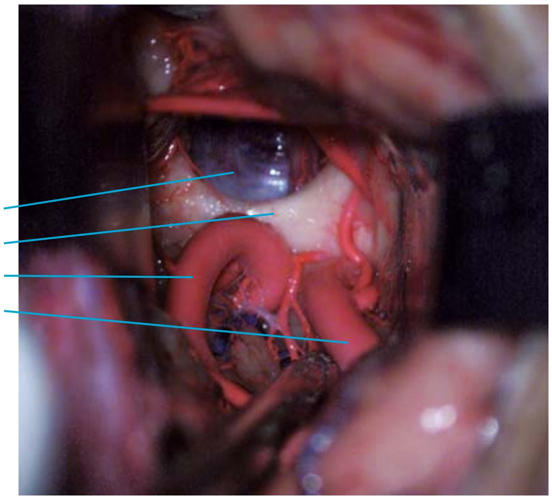


Fig. 7.1.19

Step 4

The anterior interhemispheric fissure is opened with brain spatulas, observing the base of the anterior cranial fossa through the midline route. Note the A2 segments of the anterior cerebral arteries. The optic chiasm and the diaphragma sellae appear in the background (Fig. 7.1.19).

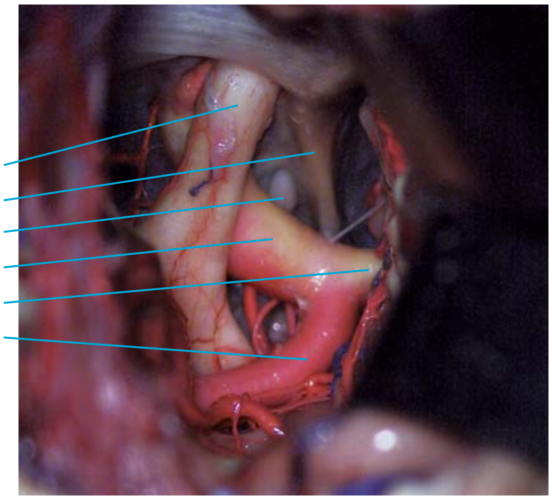


Fig. 7.1.20

Step 5

Exposure of the ipsilateral suprasellar area through the anterior interhemispheric route. Note the right optic nerve and tract and the division of the ICA into the ACA and MCA. Medial to the anterior petroclinoid fold, the CN III disappears into the roof of the cavernous sinus (Fig. 7.1.20).

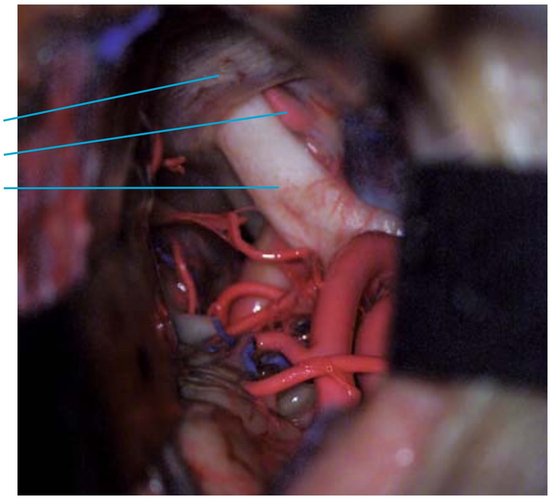


Fig. 7.1.21

Step 6

The falx cerebri and the contralateral frontal lobe are retracted, approaching the opposite CN II and ICA. Note the ophthalmic artery disappearing under the falciform ligament (Fig. 7.1.21).

Step 7
Observation of the optical chiasm and the lamina terminalis. Note the hypoplastic ACoA and the loop of the A2 segments of the ACA (Fig. 7.1.22).

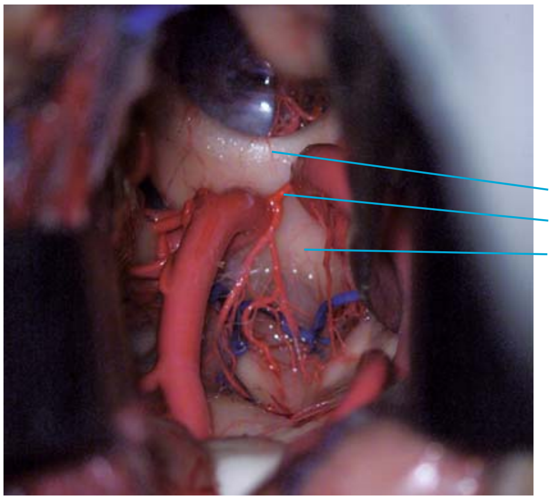


Fig. 7.1.22

Step 8
After opening the lamina terminalis and the floor of the third ventricle, the right P1 segment and the basilar apex are visualized within the interpeduncular fossa. Note the two mamillary bodies (Fig. 7.1.23).

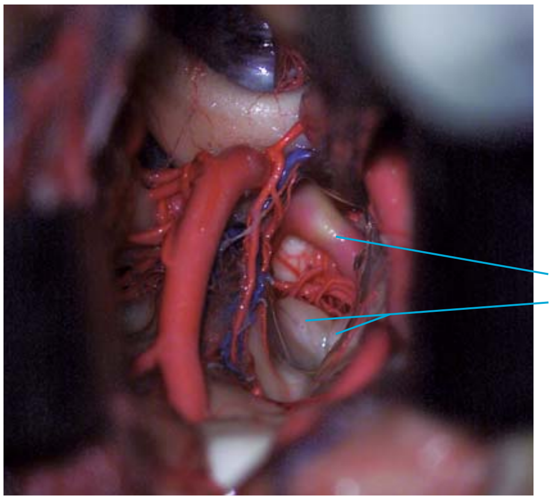


Fig. 7.1.23

5. Dura, bone and wound closure

After completion of the intracranial procedure, the intradural subarachnoid space is filled with artificial CSF solution at body temperature. The dural incision is closed watertight with interrupted or continuous sutures. Dura leaks can be repaired by using a galea-periosteum graft. If opened, the frontal paranasal sinus should be closed with the galea flap as mentioned previously. A plate of gelfoam is placed extradurally and the bone flap is fixed. The burr hole should be closed with a large-sized titanium plate, allowing a pleasant cosmetic outcome after frontal craniotomy. After final verification of hemostasis, the periosteum and the subcutaneous layers, each are closed with sutures and the skin with intracutaneous sutures or adhesive tapes.

Potential errors and their consequences

- Insufficient preoperative planning and positioning of the patient with subsequent insufficient exposure of the surgical field and significant deterioration in efficiency of excising the lesion. Planning and positioning is the task of the surgeon!
- Injury to the superior sagittal sinus or frontal bridging veins during craniotomy. Usually, occlusion of the anterior part of the superior sagittal sinus does not result in severe neurological damage; however, if possible, it should be avoided.
- Excessive frontal lobe retraction due to poor head positioning.
- Injuries to numerous neurovascular structures of the interhemispheric and suprasellar region during microsurgical manipulation with postoperative neurological deficits.
- Inadequate dural closure with postoperative CSF fistula.
- Inadequate positioning and fixation of the bone flap with poor cosmetic outcome.
- Inadequate intra- or extracranial hemostasis with subsequent rebleeding.

Tips and tricks

- Take time for preoperative planning and positioning of patients. The reward is an excellent overview of the target area and an efficient working position.

- Performing the craniotomy, a single burr hole trephination should be performed in the posteromedial corner of the planned craniotomy. After dural closure, the burr hole should be closed with a large titanium plate, providing optimal cosmetic outcome in the frontal area (Fig. 7.1.24).

- Creating the burr hole trephination, the lateral borders of the superior sagittal sinus should be checked, avoiding injury during craniotomy (Fig. 7.1.25).

- Stages of craniotomy (Fig. 7.1.26): 1. posterior burr hole trephination with monitoring of the superior sagittal sinus; 2. ipsilateral and 3. contralateral cutting from posterior to anterior using a high-speed craniotome.

- Removal of the anterior and posterior inner edges of the craniotomy provides increased intracranial visualization (Fig. 7.1.27).

- Adequate positioning of the head results in gravity-supplemented self-retraction of the frontal lobe, avoiding excessive brain retraction (Fig. 7.1.28).

- During wound closure, the bone flap should be fixed inferiorly without bony dehiscence for a better cosmetic outcome.

- Suction drain is not required.

Fig. 7.1.24

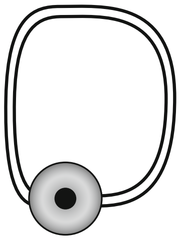


Fig. 7.1.25

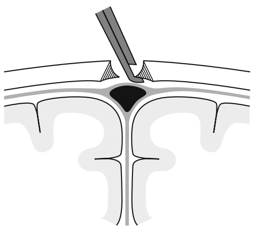


Fig. 7.1.26

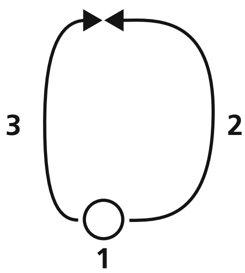


Fig. 7.1.27

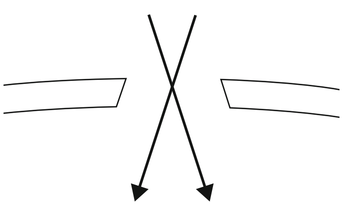


Fig. 7.1.28