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Chronic Subdural Hematoma

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Introduction

Chronic subdural hematoma (SDH) is defined as a blood collection in subdural space of more than 3 weeks old. In contrast, subacute SDH is the one that presents between 4 and 21 days after injury. However, these numbers are not definite, and imaging characteristics play a significant role in defining them.

Decision Making Regarding the Approach

Chronic SDH is uniquely diverse among all neurosurgical procedures as far as the technique is concerned, spanning from twist drill, single burr hole, double burr hole drainage, and craniotomy. The most recent inclusion in this list is endoscopic evacuation and middle meningeal arterial embolization. Many controversies exist in the literature regarding the optimal surgical technique for chronic SDH, and even then, there is no consensus. However, in the author's opinion, these surgeries complement each other, and the critical aspect of learning is their indications and judicious use.

- Twist drill drainage of even a small amount of chronic SDH will provide some time for surgical preparation in a rapidly deteriorating patient. It is a definitive surgery in one who is too frail to be taken up for surgery.
- A loculated chronic SDH can be drained effectively with a single appropriately placed (ideally navigation guided) burr hole. Still, one should always suspect and rule out the presence of membranes in such cases.
- The author always prefers double-burr-hole drainage in hemispheric chronic SDH, which is most accepted worldwide.
- At times surgical planning using computed tomography (CT) film makes it challenging to decide the surgical procedure in subacute SDH cases, which shows isodense to hypodense blood collections compared to the adjacent brain. It is the magnetic resonance imaging (MRI) brain which more accurately tells us regarding the age of blood in them. It remains hyperintense on all sequences in subacute blood,

whereas isointense on T1 and T2 and hyperintense on FLAIR sequence in a chronic subdural hematoma.[1] In patients with subacute hematoma, even with an isodense CT picture, it is more likely to found solid clots on the burr hole. Hence when planning for burr hole evacuation, one should always be ready with a backup plan for craniotomy, mini or standard, to evacuate the hematoma completely.

- In significantly symptomatic patients (severe headache, intractable vomiting, altered sensorium, and recurrent seizures) with imaging suggestive of significant mass effect but with thin chronic SDH, burr hole evacuation will not be a good option. As the swollen brain fills up the gap, making the proper drainage impossible. Furthermore, the fluid used for cavity irrigation gets accumulated inside and not drained out, further increasing the mass effect, making craniotomy a better option in such cases.
- Calcified chronic SDH is another subgroup that should not be dealt with burr hole drainage. Instead, a minicraniotomy, or the conventional craniotomy, depending on the extent and thickness of ossification with a primary aim to protect the underlying brain and secondary to excise the calcified adhered membrane, should be the approach in such cases. In other words, the surgical aim is to decompress the brain and not to excise the calcified membrane.
- Likewise, a multilayered chronic SDH is a common cause of the failure of the SDH surgery, and an endoscope/microscope assistance remains of great help in this seemingly simple but challenging situation.

Double Burr Hole Drainage

The patient may present with unilateral or bilateral SDH. In bilateral chronic SDH, operative steps are not going to change on any side. Both the surgeries are performed one by one in the same sitting, not in the same position and draping but as two different procedures, in two different positions and drape. The site with a more significant mass effect operated first, for the apparent reason. After completing

the first surgery, the author repositions the patient again for the second surgery on the contralateral side. In the author's experience, this approach reduces the chances of postoperative SDH recurrence and pneumocephalus.

Position

The patient is placed supine on the table with head turned toward the opposite side, with the operating area facing upward, in the horizontal plane. A small pillow is placed under the ipsilateral shoulder to avoid excessive neck rotation, but it will raise the head and require a pillow with a head ring to maintain head position. In patients with restricted neck mobility and short neck, a lateral position will be advisable. The head end is raised 10 degrees above the heart to improve the venous return and reduce the increased intracranial pressure (**Fig. 16.1**).

Skin Incision

Knowledge of surface anatomy and its correlation with CT Head location of chronic SDH helps a lot in planning skin incision. The most commonly used two frontoparietal linear skin incisions are a part of virtual standard/mini

Fig. 16.1 Image showing the head's lateral position turned toward the opposite side, with the operating area facing upward, in the horizontal plane with a pillow under the ipsilateral shoulder to minimize neck rotation.

frontotemporoparietal craniotomy flap incision (**Fig. 16.2**). In case of unexpected peroperative findings (subacute SDH, Empyema) or untoward complication, one can convert the two burr holes into the craniotomy. In loculated SDH, navigation helps to plan skin incision, and sometimes even raising of scalp flap might be needed.

Coronal suture, superior temporal line, and parietal eminence are the three most crucial surface landmarks, the relation of which, with hematoma, decides skin incision in almost all cases (**Fig. 16.3**).

The first incision is at the frontal burr hole site, 2 cm in length, full-thickness, linear, and just anterior to the coronal suture. The second incision is either at parietal eminence or at least 5 cm behind the first burr hole, depending on the hematoma's posterior extent (**Fig. 16.4**). Both skin incisions are made 5 mm above the superior temporal line to avoid violating the temporalis muscle, thus reducing blood loss and postoperative pain during chewing. Skin, galea, and pericranium are cut and retracted, and bleeding from scalp vessels is controlled with bipolar coagulation.

Burr holes are made first at the frontal, followed by parietal location (**Fig. 16.5**). It's easy to make burr holes with craniotome, but it strips off the dura from the surrounding bone and leads to bleeding. During a craniotomy, this bleeding remains unnoticed as we deliberately strip off the dura from the undersurface of the bone and take dural hitches to stop it. In chronic SDH, we have to work only with burr holes. Even a few millimeter dural stripping becomes a source of troublesome blood oozing throughout the surgery and even extradural hematoma.

The author always prefers Hudson brace 11-mm perforator and 12-mm burr to make burr holes in chronic SDH cases to prevent dural stripping, and it saves both blood loss and surgical time. Alternatively, one may use a 5-mm drill bit instead of a craniotome to create burr holes, serving the same purpose.

A 5-mm twist drill hole is sufficient to drain this liquid SDH, but in the author's experience, irrigation and at the same time inspection of the brain for membranes is easy using an 11-mm burr hole, thereby minimizing the recurrence chances.
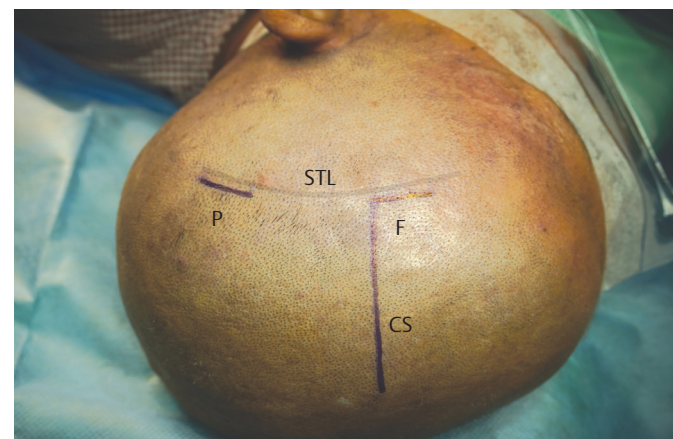

Fig. 16.2 The two frontoparietal linear skin incisions are a part of virtual standard/mini-frontotemporoparietal craniotomy flap incision.

Fig. 16.3 Coronal suture (CS), superior temporal line (STL), and parietal eminence (P) are the three most crucial surface landmarks, whose relation with hematoma decides skin incision in almost all cases. F, frontal incision anterior to CS.
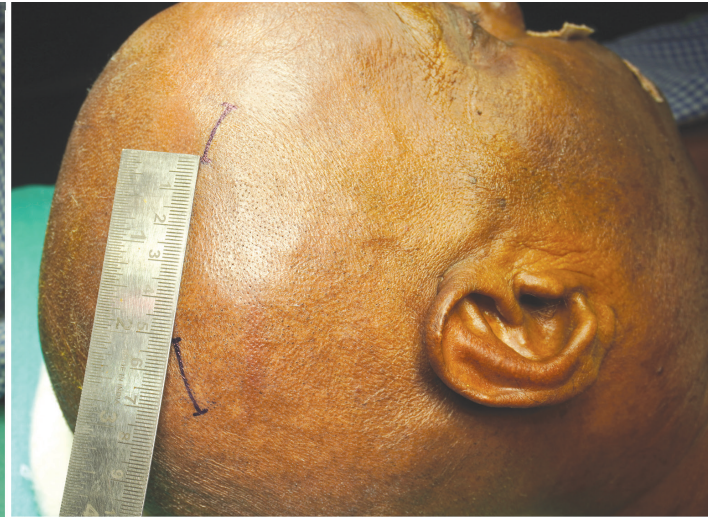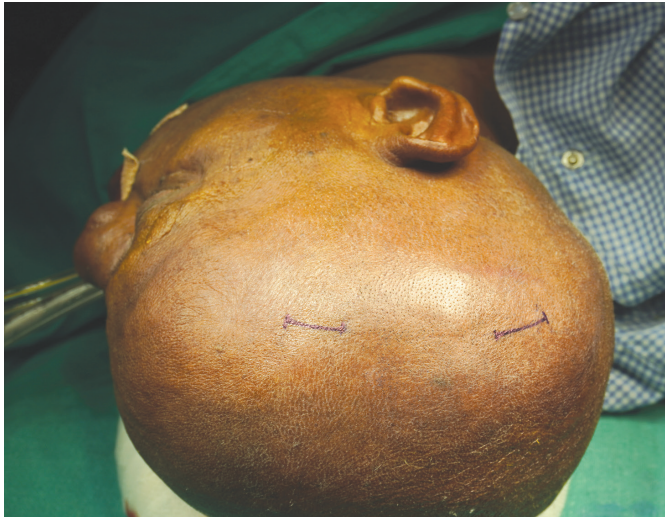
Fig. 16.4 Frontal incision just anterior to the coronal suture. The second incision is either at parietal eminence or at least 5 cm behind the first burr hole, depending on the hematoma's posterior extent.
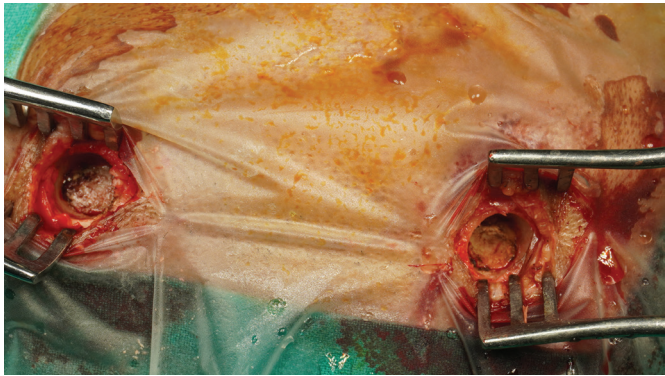

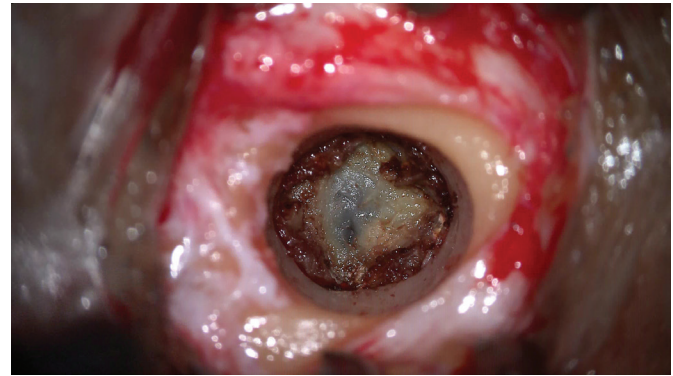**Fig. 16.5** Frontal and parietal burr hole sites.

Fig. 16.6 Coagulated dura from all around with visible and intact outer subdural hematoma (SDH) membrane.

Before opening the dura, bone wax application over bony bleeders and at the junction of the dura and bone (if needed), along with bipolar coagulation of dura, will make the field bloodless.

Intradural Surgery

A cruciate dural incision is given first at the frontal burr hole site. Then, after coagulating the dura from all around, the outer SDH membrane is incised (**Fig. 16.6**). A guarded hematoma evacuation with cottonoid's help is done for slow decompression to avoid a sudden change in intracranial hemodynamic, which may cause acute SDH, subarachnoid hemorrhage (SAH), or even contusion.

Following the initial drainage of liquefied clots, the membrane edges are coagulated until their bony margins. Similarly, at the parietal burr hole site, incising and coagulating the dura and outer SDH membrane is done. After the hematoma evacuation, the cavity is irrigated thoroughly in all directions with sterile warm saline until irrigation fluid becomes clear (**Fig. 16.7**). Some surgeons prefer shunt catheters for direct irrigation beyond the burr hole margin.

An evaluation of the presence of membranes is an essential step of chronic SDH surgery. Much of the time,

Fig. 16.7 The cavity is irrigated thoroughly in all directions with sterile warm saline until irrigation fluid becomes clear.

it remains evident on inspection. In patients with recent trauma diagnosed on serial CT head as chronic SDH, membrane usually remains very thin or even absent, and the brain remains visible. To avoid cortical injury, membrane is left intact in such cases (**Fig. 16.8**).
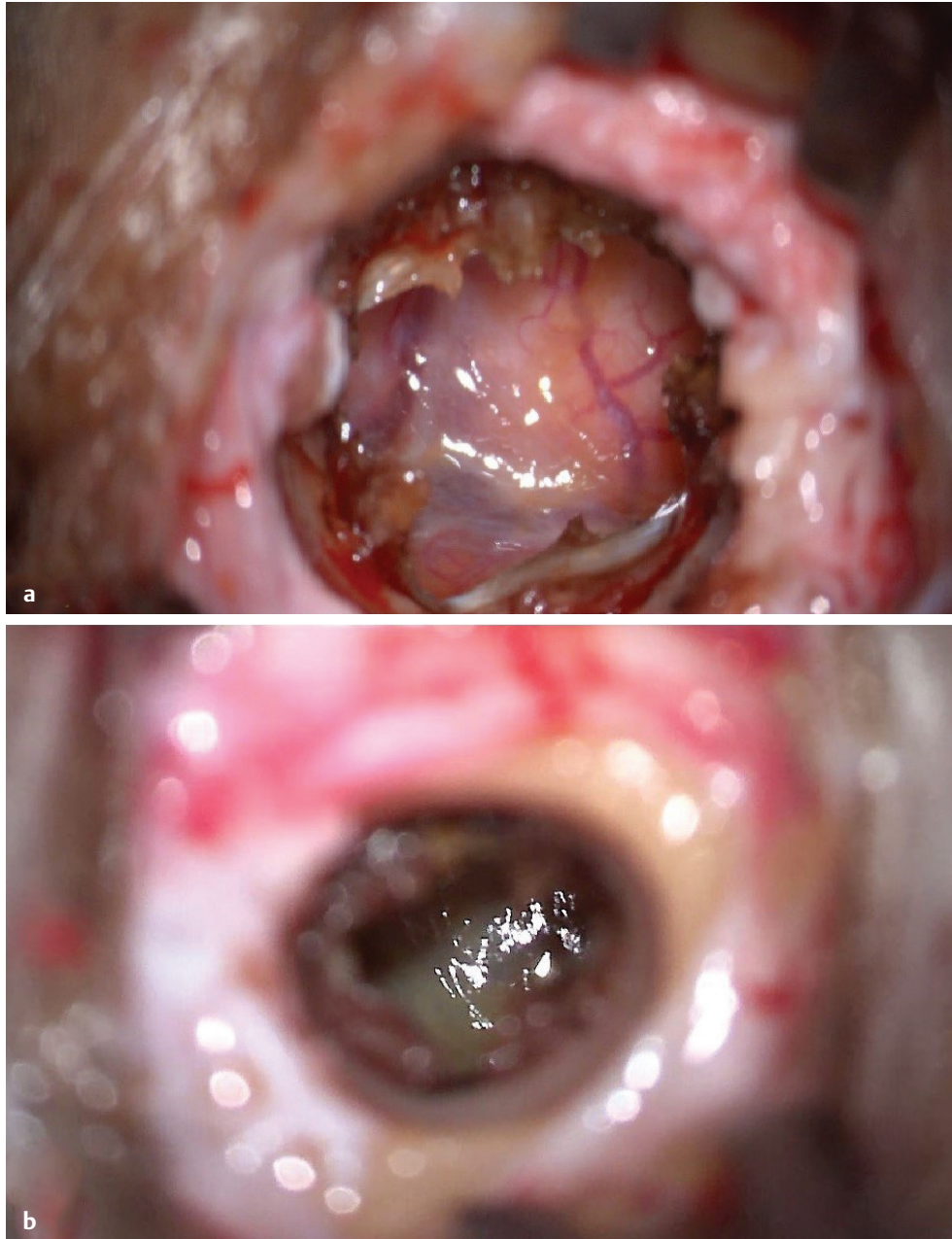
Fig. 16.8 **(a)** Thin inner membrane with visible brain underneath, **(b)** thick inner membrane.

Patients who present late with a history of old trauma invariably have thicker and multiple membranes where the brain remains invisible behind them. Therefore, if the brain surface is not visible, one should explore the inner layer for the presence of additional membranes following microsurgical techniques.

If present, under vision, bipolar coagulation and fenestration of membranes are done.

The membranes are fenestrated under vision (**Fig. 16.9**). Bleeding starts on the breach of the pia/cortex, and the tendency of chasing it to achieve hemostasis will lead to further brain dissection and bleeding. It may even cause a sizeable parenchymal bleed on the postoperative scan, which one may not anticipate during surgery. Therefore, bleeding, if any, should be controlled using a small surgicel and a cotton patty over the bleeding point, followed by warm saline irrigation and patience to achieve hemostasis, rather than chasing it.

Suppose fresh bleeding is noticed and continues despite proper warm saline irrigation. Then, one should immediately connect both the skin incision, retract the scalp flap and muscle with the mastoid retractor, and lift a minicraniotomy by connecting both the burr holes, followed by opening the dura in a cruciate manner. It will bring the bleeder in vision in just a few minutes, instead of struggling to control it blindly for a long time, at the cost of unnecessary blood loss and cortical injury.

following hemostasis, burr holes are covered with titanium plates and screws. A single Romo Vac drain catheter 12 F is placed at a subperiosteal position to drain both the burr holes. It passes from the frontal burr hole incision, undermined in subgaleal plain, and delivered in parietal burr

Fig. 16.9 A view of the fenestrated inner membrane.

Fig. 16.10 Burr holes covered with titanium plates.

Fig. 16.11 Romo Vac drain catheter 12 F covering both burr holes in the subperiosteal plane.

hole incision. Finally, via a separate stab incision tunneled at least 2.5 cm, it is brought out (**Fig. 16.11**).

A sequence of the closure of burr holes should be parietal followed by frontal burr hole. While performing closure, one should continuously irrigate the cavity with saline to ensure clean irrigant wash-out fluid and fill up the dead space with saline. The subperiosteal drain remains closed and is opened only after the closure of skin incisions and after connecting the catheter to a closed wound drainage system.

A horizontal head position, continuous saline irrigation during the closure, with closed drain until the completion of skin closure will minimize the chances of developing postoperative pneumocephalus.

The approaches, end-points of this surgery, and postoperative drainage are full of controversies in the literature. Should the drain be used or not? If yes, then what is the ideal position, subperiosteal or subdural? If subdural, what should be the perfect catheter position frontal, parietal, temporal,

or occipital? Postoperative patient posture? What should be the duration of postoperative drainage? Even today, this most commonly performed neurosurgical operation does not have a common consensus for all these issues.

In a meta-analysis published in 2014, Weiming Liu evaluated seven studies focused on postoperative drainage and gave the following conclusions[2]:

1. Irrigation and postoperative drainage is beneficial in reducing the rate of recurrence.
2. No significant difference was found in the recurrence rate of burr hole or twist hole drainage.
3. No significant differences were found in the literature among subperiosteal or subdural drainage, but in the latter case, frontal subdural catheter position is beneficial.
4. No definite advantage of postoperative supine posture.
5. Postoperative drainage of 48 hours duration is sufficient when compared to a more extended period.

Frontotemporoparietal Craniotomy (Minicraniotomy)

A critical difference between acute, subacute, and chronic SDH is the age and consistency of hematoma and the brain's condition. As time passes, the subdural hematoma volume and its mass effect on the surrounding brain increase because of rebleeding from cortical veins and fluid overpouring from the vascularized neomembrane. The reduction in diffuse cerebral 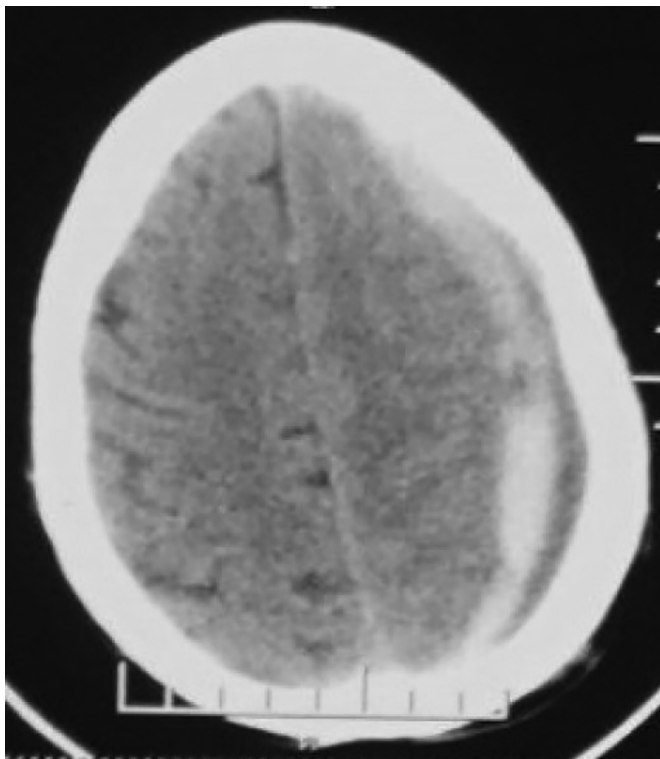edema simultaneously explains why less aggressive surgeries are needed to cure the patient as time passes. The standard craniotomy of acute SDH gets reduced to mere burr holes in chronic SDH. For patients of subacute SDH, a surgical requirement remains in between, and a minicraniotomy targeted on the maximum thickness of hematoma remains sufficient to fulfill the need.

Patients of acute on chronic SDH may present as subacute SDH with additional membranes, which can be anticipated beforehand by a critical radiology review (**Fig. 16.12**).

Position

Positioning in subacute SDH remains the same as described for chronic SDH.

Incision

A single curvilinear incision is given just above and parallel to the superior temporal line starting from the hairline till the parietal eminence (**Fig. 16.13**).

Skin, subcutaneous tissue, and galea are cut and retracted with the mastoid retractor. The loose areolar tissue and pericranium cut circumferentially along the exposed bone in a vascularized pedicle form with a temporalis fascia base (**Fig. 16.14**). Temporalis fascia and muscle cut are retracted inferiorly, leaving a small cuff at the superior temporal line for a later repair (**Fig. 16.15**). A small incision on the temporalis cuff is given near both the end of the skin incision for the craniotome cutter's passage (**Fig. 16.16**).

A single frontal burr hole just below the temporalis cuff at the anterior end of the incision is sufficient in most cases to lift a minicraniotomy with a craniotome involving the full extent of bony exposure (**Fig. 16.17**). However, dural adherence in elderly patients with associated dural tear risk requires this craniotomy to elevate with two burr holes. During minicraniotomy in the elderly, the author prefers to make the frontal burr hole just below the temporalis cuff at the incision's anterior end, and the parietal burr hole is made just above the temporalis cuff at the incision's posterior end to make two different semicircular cuts connecting both burr holes on two different bony contours.

Fig. 16.12 A layered appearance of inner hyperdense (acute blood) and outer hypodense (chronic component) blood, indicating the presence of membrane in between.

Fig. 16.13 Curvilinear skin incision just above and parallel to the superior temporal line starting from the hairline till the parietal eminence.
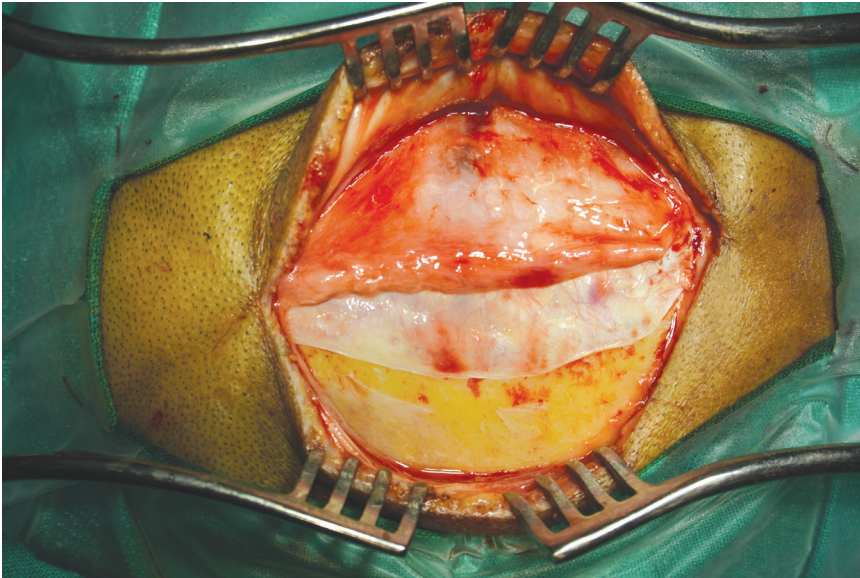
Fig. 16.14 The loose areolar tissue and pericranium cut circumferentially along the exposed bone in a vascularized pedicle form with a temporalis fascia base.
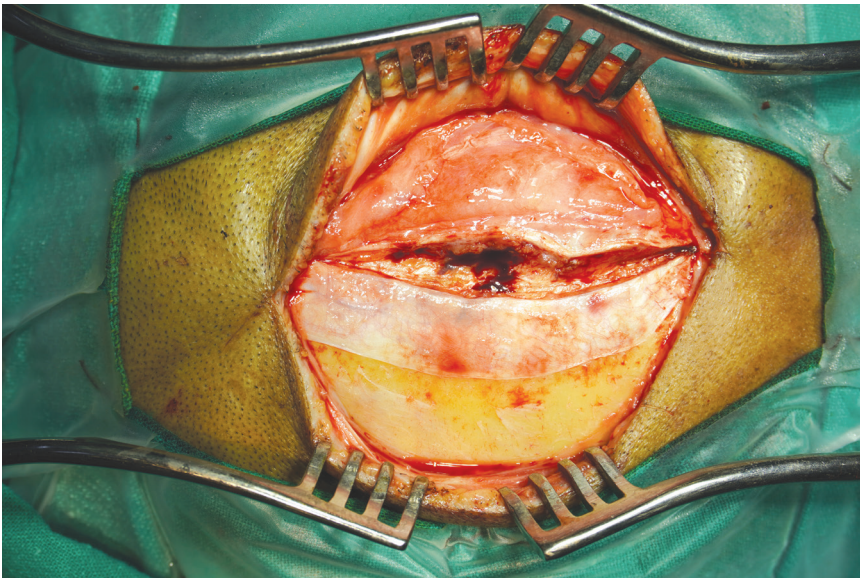

Fig. 16.15 Temporalis fascia and muscle cut and retracted inferiorly, leaving a small cuff at the superior temporal line for a later repair.
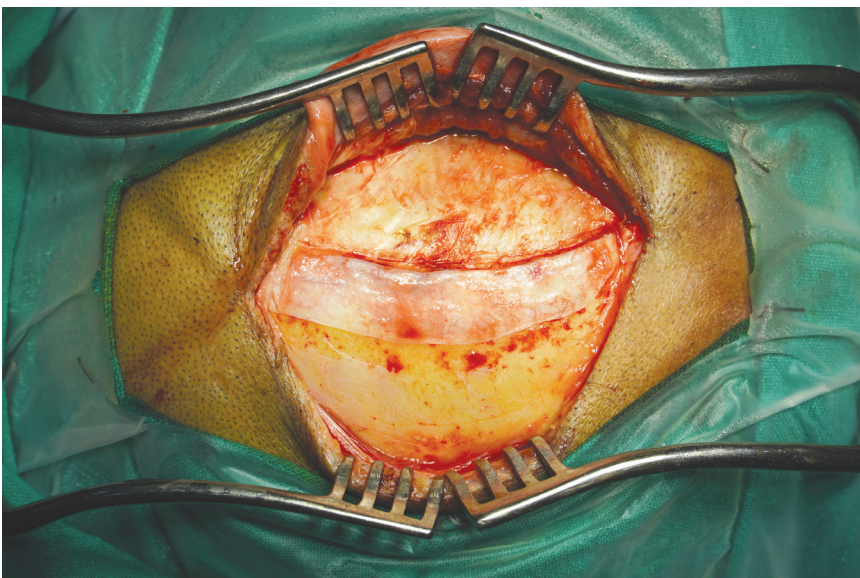

Fig. 16.16 A small incision on the temporalis cuff is given near both the end of the skin incision for the craniotome's passage.
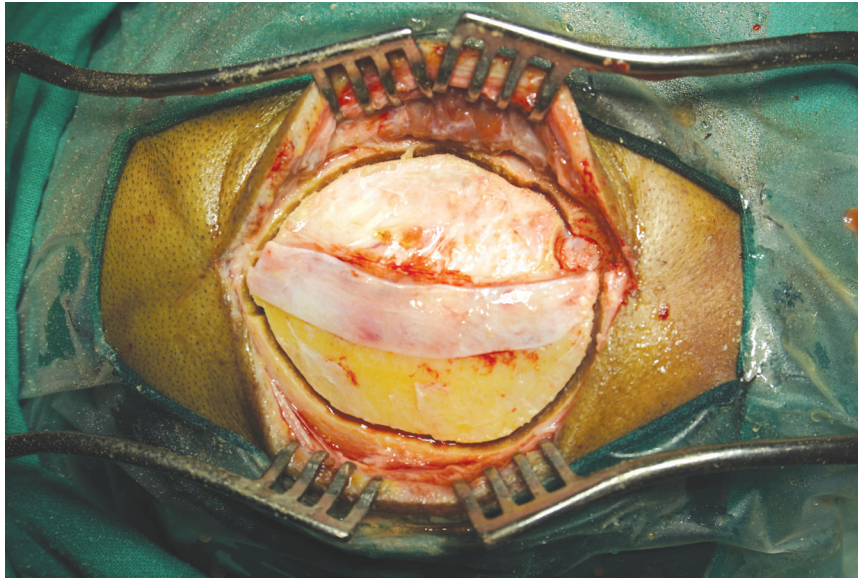
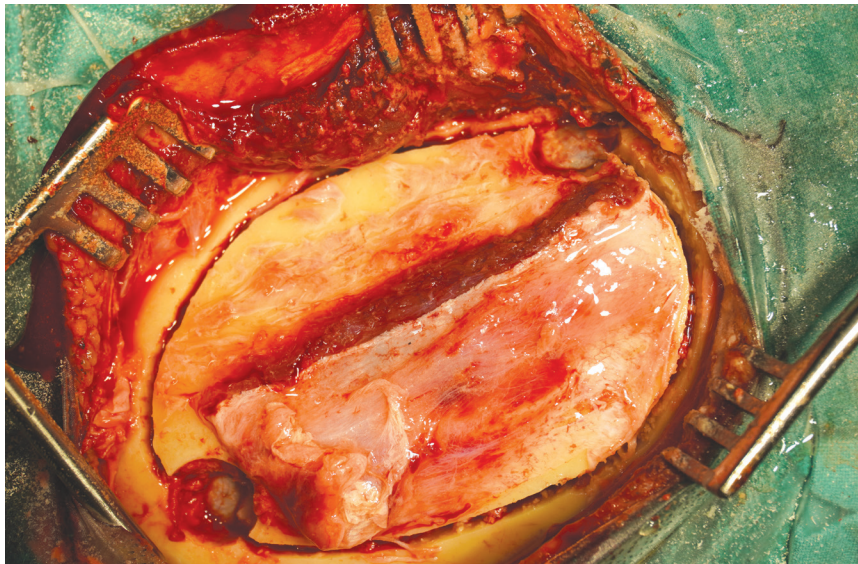**Fig. 16.17** Minicraniotomy with single burr hole.

Fig. 16.18 Minicraniotomy with double burr holes on opposite contours in yin and yang fashion.

Being situated below the superior temporal line, the bone cut from the frontal burr hole runs inferiorly from anterior to posterior in a circular fashion and connects with the parietal burr hole. Similarly, as the parietal burr hole is present above the superior temporal line, the bone cut runs superiorly from posterior to anterior to connect with the frontal burr hole in Yin and Yang style (**Fig. 16.18**).

After surface irrigation and removal of bone dust, dural hitches are taken depending on the need. After a cruciate dural incision, the dura is retracted with silk 3–0 sutures. Liquid SDH will drain out immediately with the dural opening, but clots adhered with the brain and the dural undersurface will remain (**Fig. 16.19a, b**). Even in subacute SDH, an outer membrane may be seen and, if present, resected with a visible and approachable margin. Its margins are coagulated circumferentially to prevent bleeding, recurrence, and postoperative acute SDH. Cavity inspected,

liquid SDH drains out immediately, but clots present on the brain surface and the dural undersurface will remain. This hematoma, which is not liquefied, requires removal with thorough irrigation and gentle suction under vision from all possible corners. Hemostasis is done with the coagulation of all bleeders and bleeding vascularized neomembranes under vision (**Fig. 16.20a, b**). If found, any additional membrane is also removed with the safe, visible margin. Loculated SDH develops in these additional membranes; hence, they are also removed, and their margins are coagulated to prevent the recurrence. After proper hemostasis, the dura is closed with silk 3–0 sutures (**Fig. 16.21**). The craniotomy flap is reposited and fixed with plates and screws on the parietal surface. The temporalis fascia sutured with the temporalis cuff left at the superior temporal line. The pericranium is reposited back, followed by two-layered skin closure with the drain in situ (**Fig. 16.22a, b**).
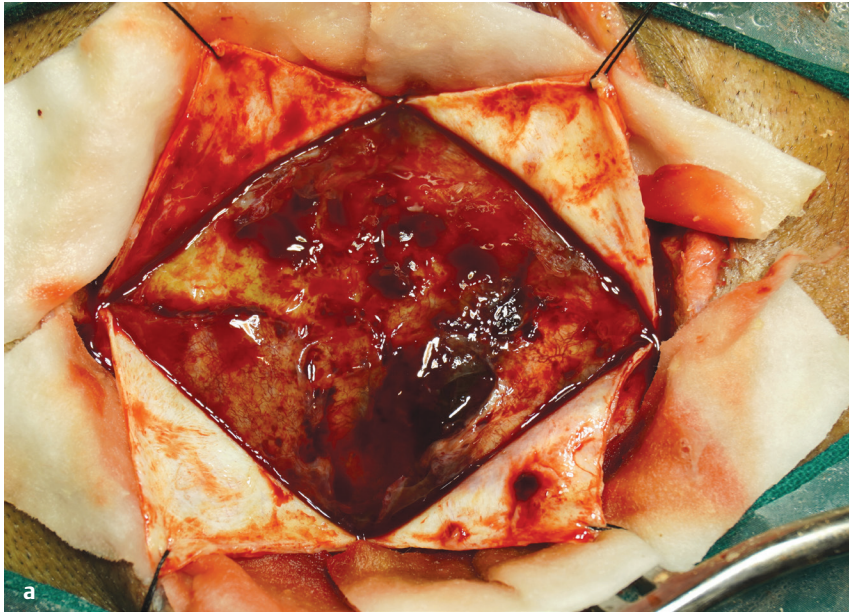
Fig. 16.19 View after giving a cruciate dural incision depicting intact outer membrane **(a)** and clots after opening the membrane **(b)**.

Fig. 16.20 (a) Retracted dura (D), outer membrane (OM), additional membrane (AM). (C*ontinued*)
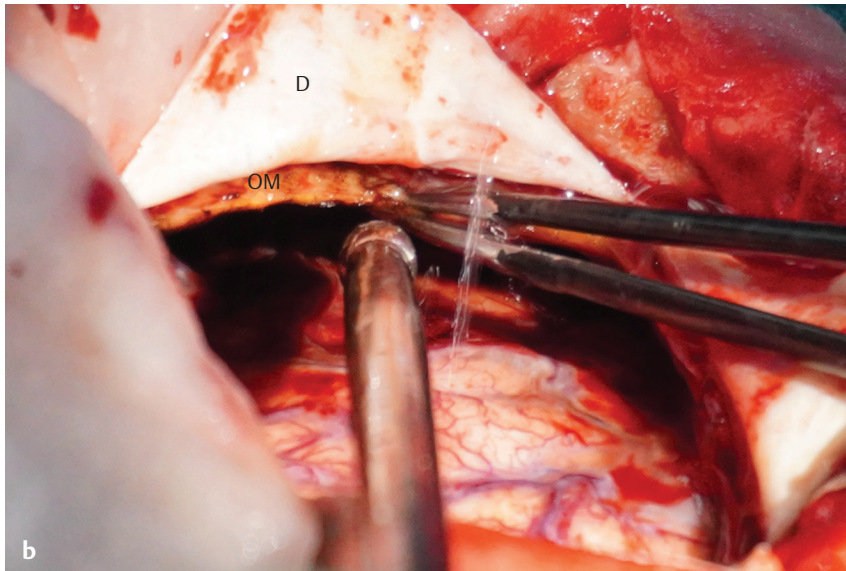
Fig. 16.20   (*Continued*) **(b)** Coagulation of cut visible margin of the outer membrane (OM). D, Dura mater.
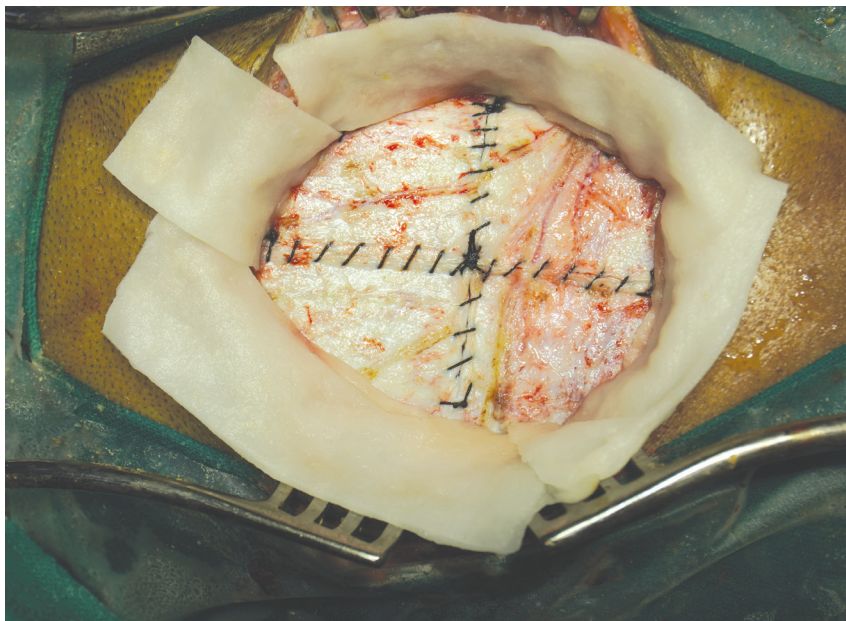

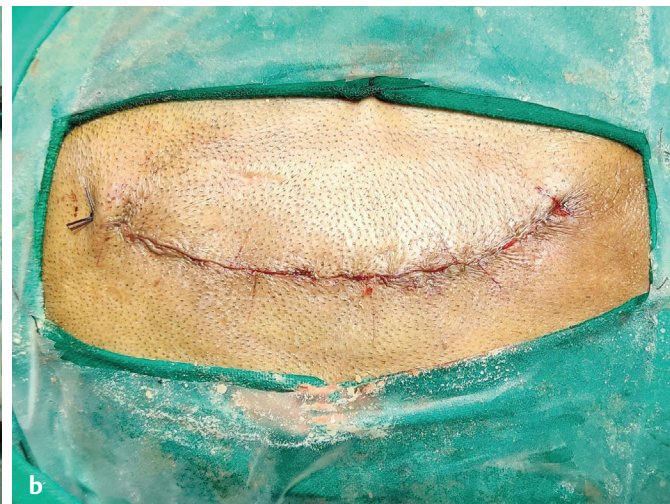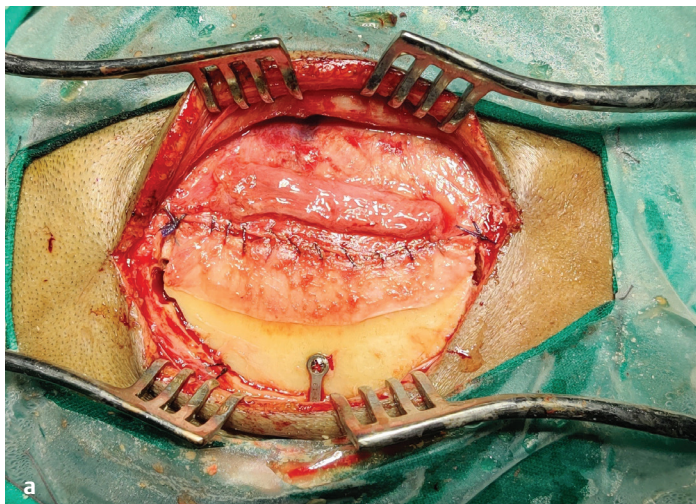**Fig. 16.21**   View after dural closure.

Fig. 16.22   **(a)** Temporalis suturing and **(b)** skin closure.

A proper anatomical dissection with due tissue respect to each layer brings a perfectly layered closure and positively impacts smooth convalescence.

Postoperative Management

For day 1, we advise a supine position, the resumption of normal activities from day 2 onward, and keep the drain for 48 hours.

Calcified Chronic Subdural Hematoma

One may rarely encounter calcified membranes in chronic SDH, with reported incidences ranging from 0.3 to 10%. This unique SDH subgroup is more common in children. Etiologically, it is the head injury in adults, while in the pediatric population, shunting for hydrocephalus remains the most common cause. The clinical presentations remain the same as those of chronic SDH but with increased seizure and mental retardation frequency. The radiological hallmark is the two hyperdense rims (outer calvaria and calcified inner membrane) seen separated by a hypodense area on the CT scan head. Rarely the "double skull" appearance, another concentric skull inside the cranium known as the Matrioska head, is also reported.[3]

Management

Seizure prophylaxis is given to all patients of calcified SDH, including the asymptomatic one; however, the surgery is indicated only in symptomatic patients. The surgical management of calcified chronic SDH remains challenging owing to the invariable adherence of the calcified membranes with underlying leptomeninges and surface cortex with chances of parenchymal injuries and acute subdural hematoma.

In patients with calcified SDH with a shunt in situ, in whom overdrainage is a cause of calcified chronic SDH development, revision shunt surgery is required.[3]

Demonstrative Case

A 53-year-old male presented in emergency with a history of sudden onset severe headache and vomiting for 6 days. CT head suggested left-hemispheric chronic SDH with midline shift toward right and a thin right-hemispheric SDH with a hyperdense rim below the calvaria, separated by a hypodense area. After double burr hole drainage on the left side and repositioning the patient, a minicraniotomy was done on the right side, and the dura was opened. A thick outer SDH membrane was found and resected with a

visible and approachable margin. Its margins are coagulated circumferentially to prevent bleeding. Next to this, a muddy inner thick membrane was encountered with calcification and adherence with the underlying surface cortex, which was resected under the microscope, with a visible margin and subsequent coagulation of margins. A postoperative scan on the second day was suggestive of routine postoperative changes with no evidence of recurrence, bleed, or significant pneumocephalus (**Fig. 16.23a–d**).

In the author's view, the calcified membranes should be handled with the same concept of routine additional membranes of multiloculated chronic SDH. As the brain does not expand because of chronic pathology, an aggressively extended membranectomy only creates problems instead of being beneficial. At the same time, partial membranectomy acts like fenestration, helps in the removal of any loculated fluid collection, and avoids cortical injuries. Therefore, in the absence of an ideal surgical procedure for an armored brain, one should customize the surgery as per the patient's need, aiming to get the maximum decompression, avoiding cortical injuries, and at the same time without recurrence.

Conclusion

Various authors described chronic SDH surgeries' technique, complications and possible reasons, and how to avoid them.[4,5] The author believes that all the recommended procedures for chronic SDH surgery have specific indications. However, double burr hole surgery is the worldwide most commonly accepted procedure and still the main workhorse, requiring its tenets to learn for complication avoidance.

Case Study 1: Recurrent Left Frontal Multiloculated Chronic SDH

A 43-year-old male with a history of fall five months back was operated on and underwent double burr hole drainage for left hemispheric chronic SDH 3 months back. The patient again presented with a progressively increasing headache for ten days. CT head suggested recurrence of chronic SDH but confined in the left frontal region with mass effect causing splaying of the ipsilateral frontal horn. With navigation guidance, the thickest part of SDH was found over the left frontal eminence. A frontotemporal skin flap was elevated, and a navigation-guided burr hole was made over the left frontal eminence. After dural incision, three membranes were found, one after the other, with loculated collections seen during each membrane's fenestrations. After thorough saline irrigation of the cavity, a burr hole plate was placed to prevent cosmetic defects. Two-layered closure was done with a subgaleal drain (**Fig. 16.24**).
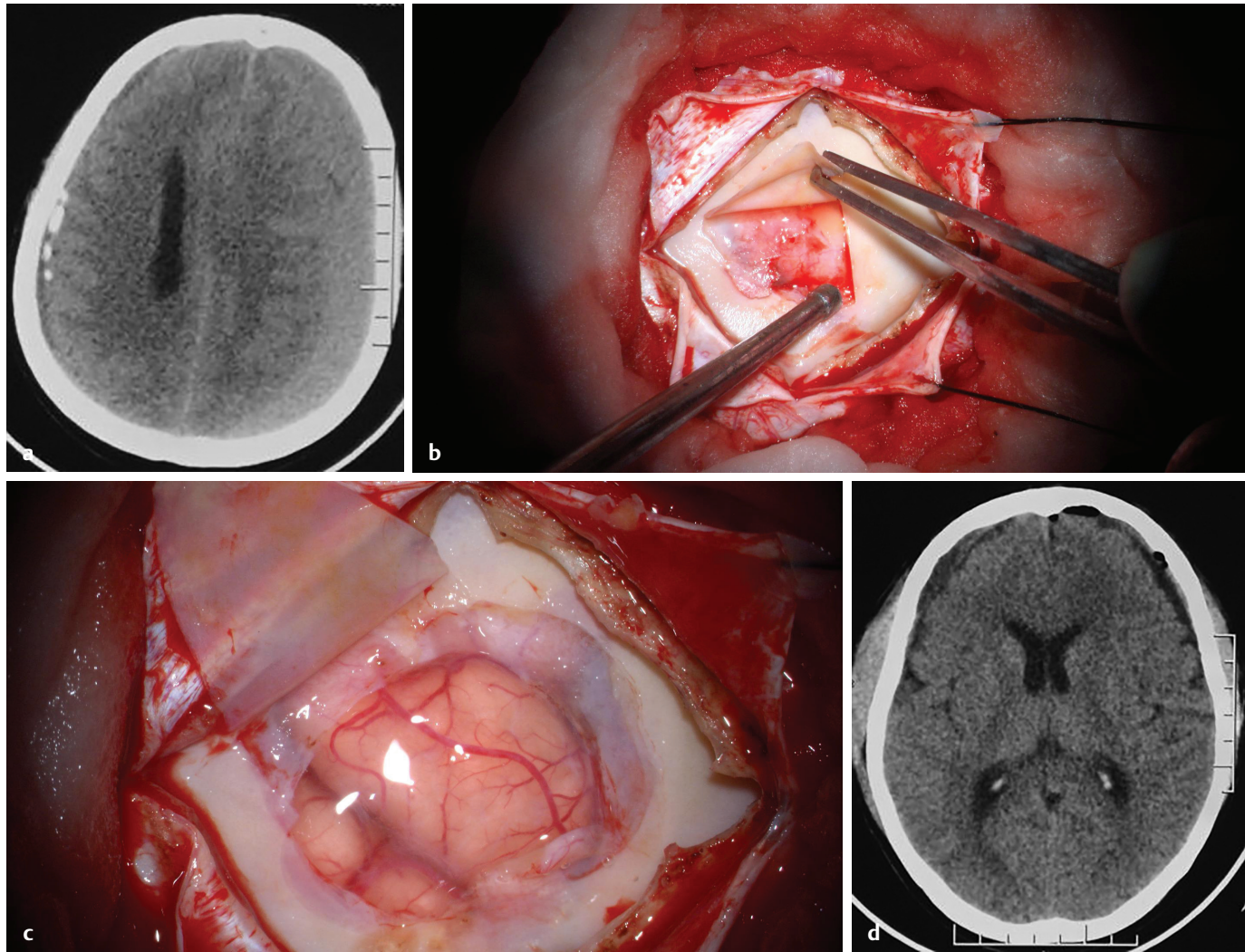
Fig. 16.23   A 53-year-old male presented with **(a)** bilateral chronic subdural hematoma (left hemispheric chronic subdural hematoma [SDH] with midline shift and right, thin calcified SDH). **(b)** After craniotomy, dural opening, and excision of the outer membrane, calcified muddy colored inner membrane found, adhered with the underlying leptomeninges. **(c)** View after excision of the visible calcified inner membrane. **(d)** Postoperative computed tomography (CT) head picture.

Case Study 2: Right Hemispheric Subacute SDH

A 43-year-old female with a history of a road traffic accident 14 days back presented in emergency with a severe headache. On CT scan head, there was a right hemispheric isodense SDH with midline shift toward left. In view of the short history and radiological findings, a subacute SDH was anticipated and a minicraniotomy was planned. A full-thickness curvilinear incision was made just above the superior temporal line, and the scalp flap retracted. Leaving a small cuff at the superior temporal line, the temporalis fascia, and muscle incised and retracted inferiorly. A single burr hole minicraniotomy was made. A cruciate dural incision is given and retracted with silk 4–0 dural tenting sutures. Extensively formed subdural clots were found after dural opening and evacuated with gentle suction and irrigation from all the visible safe margins. Subdural clots present beyond the craniotomy margins were removed with the four-hand technique described in the "Acute subdural hematoma" chapter. After SDH evacuation and ensuring proper hemostasis with a lax brain, primary dural closure was done. Craniotomy flap was reposited and fixed, followed by a layered closure. A postoperative CT scan showed complete evacuation of hematoma, resolving mass effect and minimal pneumocephalus (**Fig. 16.25**).
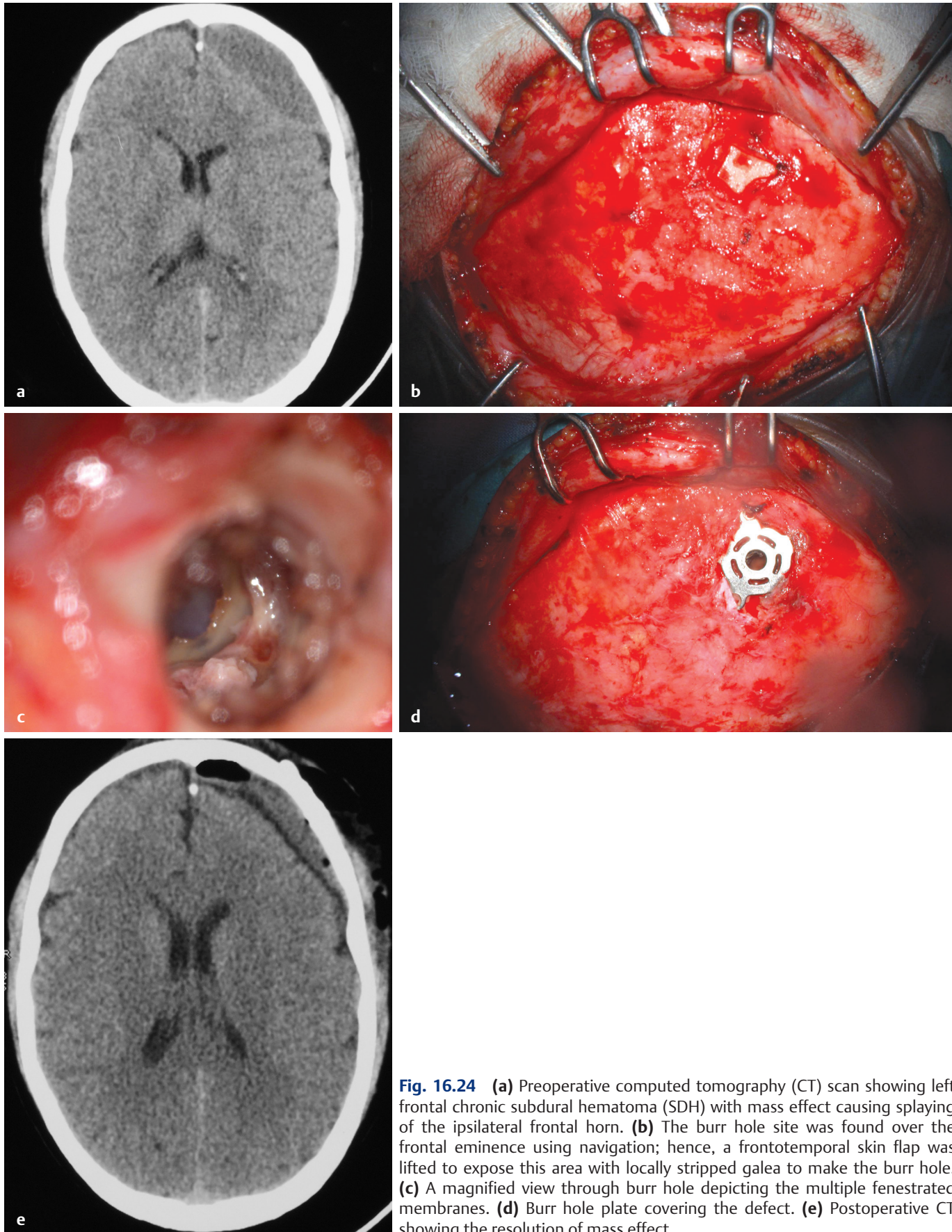
Fig. 16.24 **(a)** Preoperative computed tomography (CT) scan showing left frontal chronic subdural hematoma (SDH) with mass effect causing splaying of the ipsilateral frontal horn. **(b)** The burr hole site was found over the frontal eminence using navigation; hence, a frontotemporal skin flap was lifted to expose this area with locally stripped galea to make the burr hole. **(c)** A magnified view through burr hole depicting the multiple fenestrated membranes. **(d)** Burr hole plate covering the defect. **(e)** Postoperative CT showing the resolution of mass effect.
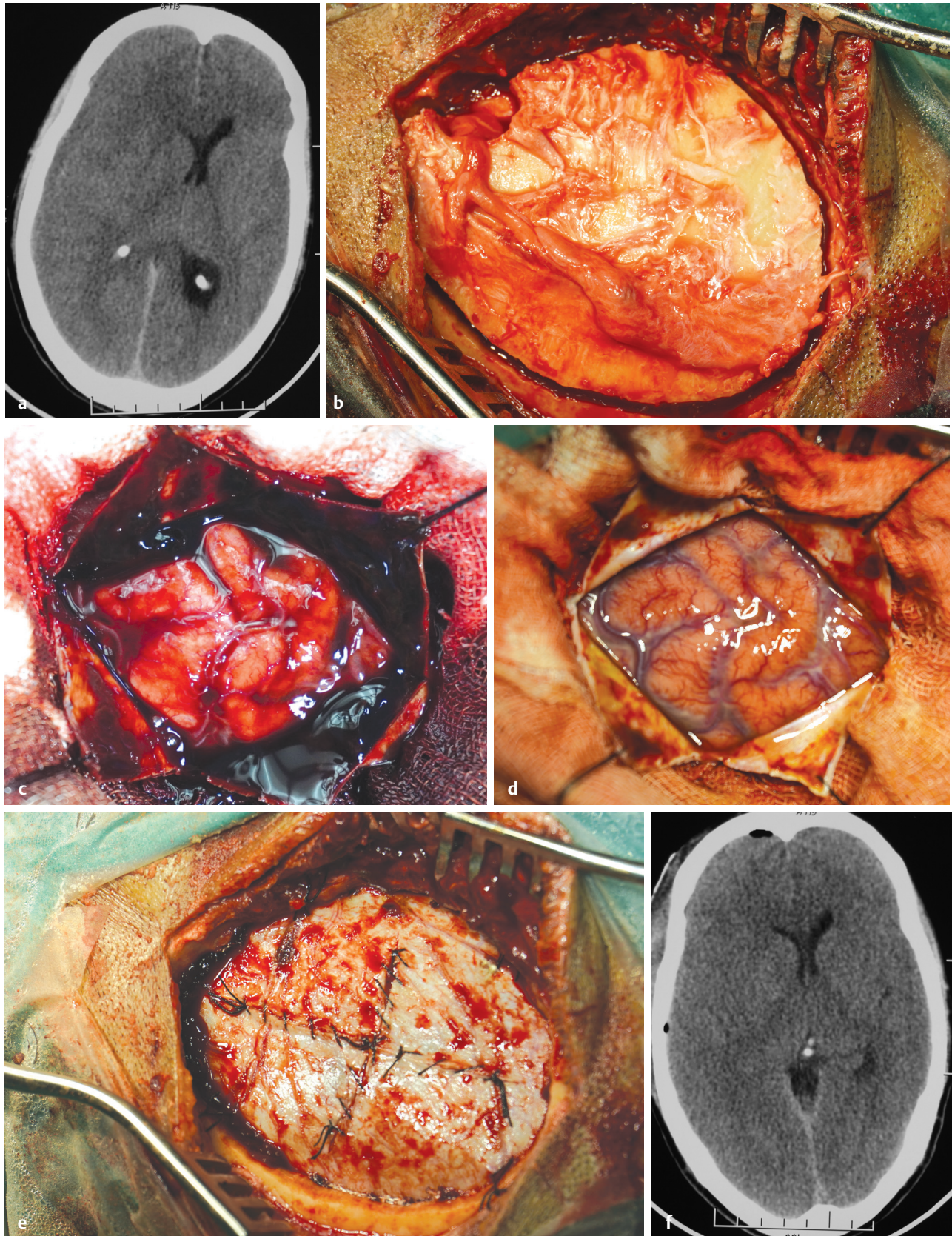
Fig. 16.25 **(a)** Preoperative computed tomography (CT) scan head was showing a right hemispheric isodense subdural hematoma (SDH), with midline shift toward left. **(b)** A mini craniotomy was done with a single burr hole (placed just below the superior temporal line at the anterior limit of skin incision). **(c)** Extensively formed clots are seen on the dural opening. **(d)** SDH evacuated, cavity irrigated with a lax brain at the end. **(e)** Primary dural closure was done. **(f)** Postoperative CT scan showed no residual clots, resolving mass effect, and small pneumocephalus.

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