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Complications of Posterior Cranial Fossa Surgery: A Report of 39 Cases and Literature Review

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Abstract

Objectives: This study aimed to report the main perioperative and postoperative complications specific to posterior cranial fossa (PCF) surgery based on a surgical series of 39 cases. **Materials and Methods:** This was a retrospective descriptive and analytical study conducted from January 2002 to December 2014, involving 120 medical records of patients operated on for PCF tumors at the Neurosurgery Department of Hassan II University Hospital in Fez. We analyzed the main perioperative and postoperative complications in this series. **Results:** The study included 39 patients, 22 males (56.41%) and 17 females (43.58%), with a mean age of 23.41 years. A suboccipital median approach in the prone position was performed in 32 patients (82.05%), while the retrosigmoid approach in a lateral position was used in 7 patients (17.94%). Medulloblastomas were the most common lesions (51.28%), followed by vestibular schwannomas (17.94%). Intraoperative hemodynamic instability occurred in 8 cases (6.66%). Postoperatively, one or more complications were noted in all 39 patients. Hydrocephalus was the most frequent complication (14 cases), followed by infectious complications (13 cases). The mortality rate was 4.16%, with 5 deaths recorded. **Conclusion:** Recognizing the main complications of PCF surgery can help prevent, diagnose, and treat them early. Mortality is primarily due to severe surgical site hemorrhages, brainstem edema with softening, and pulmonary complications. Effective management requires full cooperation between anesthesiologists and neurosurgeons.

Keywords

Surgery, Complications, Brain Tumor, Posterior Cranial Fossa Syndrom, Medulloblastoma, Cerebellar Mutism, CSF, VCS

1. Introduction

The posterior cranial fossa (PCF) is an osteodural, non-expandable cavity located in the posterior-inferior portion of the skull base, above the spinal canal. The mortality rate in the posterior cranial fossa procedures is higher than surgeries in other brain areas due to the complexity of its anatomical location and its dense content of neurovascular structures (cerebellum, brainstem, fourth ventricle, cranial nerves, venous sinuses, and arteries from the vertebrobasilar system), PCF tumor surgery remains a high-risk procedure with potential functional or life-threatening consequences. Understanding the various complications of this surgery is crucial to preventing, monitoring, and managing them effectively. Depending on the tumor's location, morphology, and the surgical approach, several operative techniques have been developed to minimize damage to healthy neural structures. This study is a retrospective review spanning 13 years, from January 2002 to December 2014, involving 120 patients who underwent PCF tumor surgery at the Neurosurgery Department of Hassan II University Hospital in Fez. The objective was to report the main perioperative and postoperative complications specific to PCF surgery, examine the epidemiological, clinical, and paraclinical profiles of patients who experienced complications, and compare the results with existing literature.

2. Materials and Methods

This was a retrospective study of 39 cases of complications following PCF tumor surgeries managed at the Neurosurgery Department of Hassan II University Hospital in Fez over a 13-year period (January 2002 to December 2014).

All patients operated on for PCF tumors during this period were included in the study. Non-operated cases were excluded.

Medical records were analyzed using a pre-established data collection sheet that recorded anamnesis, as well as clinical, paraclinical, therapeutic, and evolutionary parameters. We identified 39 cases of various complications from a total of 120 operated patients. An analytical statistical study was conducted to identify prognostic factors influencing the occurrence of postoperative complications following PCF tumor excision. Three parameters were evaluated: tumor size, tumor location, and patient age. Data analysis was performed using Epi-Info 2000 version 3.3.7. A p-value ≤ 0.02 was considered statistically significant.

3. Results

Frequency:

Between January 2002 and December 2014, 129 patients were admitted to the Neurosurgery Department of Hassan II University Hospital in Fez for PCF tumors. Among them, 120 underwent surgery. Of these, 39 patients developed complications, representing a complication frequency of 32.5%.

Age:

The mean age of patients with complications after PCF surgery was 23.41 years, ranging from 1 to 65 years. The most affected age group was under 15 years (43.58%). There were 22 male patients (56.41%) and 17 female patients (43.58%), with a male-to-female ratio of 1.29.

Table 1. Socio-demographic characteristics.

Characteristics	Frequency	Percentage
Age (years)		
0 - 15 years	17	43.58%
16 - 40 years	9	23.07%
≥40 years	13	33.33%
Sex		
Male	22	56.41%
Female	17	43.58%

History:

Patient interviews revealed the presence of diabetes in two patients (5.12%), hypertension in three patients (7.69%), chronic smoking (for more than 20 years) in two patients (5.12%), alcohol use in one patient (2.56%), and one case of breast adenocarcinoma treated surgically with adjuvant radiotherapy and chemotherapy (2.56%).

Clinical Presentation:

Table 2. Clinical symptoms presented by patients in our series.

Symptoms	Number of Patients	Percentage
Intracranial Hypertension (IH)	18 cases	46.15%
Infectious Syndrome	13 cases	33.33%
Facial Paralysis	07 cases	17.94%
Neck Stiffness	06 cases	15.38%
Consciousness Disorders	05 cases	12.82%
Mutisme	04 cases	10.25%
Ataxia	03 cases	7.69%
Swallowing Disorders	03 cases	7.69%
Neurological Deficit	02 cases	5.12%
Epilepsy	01 case	2.56%
Strabismus	01 case	2.56%

Complications:

The per- and post-operative complications recorded in our series concern both the initial surgery and surgery for tumor recurrence. Overall, one or more complications of varying severity were noted in 39 patients out of 120 patients who underwent surgery for PCF tumors (a complication rate of 32.5%). During the surgery, 8 incidents of hemodynamic instability (6.66%) were recorded, including one case that required the interruption of the surgical procedure.

Post-operatively, one or more complications were noted in our series. Hydrocephalus was the most frequent complication, observed in 14 patients, accounting for 11.66% of cases.

Cranial nerve impairments were found in 11 patients, or 9.16% of cases; among them, 7 patients (5.83%) had facial nerve paralysis, 3 patients (2.5%) had swallowing disorders due to mixed nerve involvement, 2 of whom underwent tracheotomy, and a single patient (0.83%) had an external oculomotor nerve impairment. Additionally, infectious complications were present in 13 cases (10.83%). These complications were mainly represented by meningitis, with 6 cases of purulent meningitis (5%), pulmonary infections with 4 cases of pneumonia (3.33%), 2 cases of cerebellar abscess (1.66%), and 1 case of extradural empyema (0.83%). Other surgical-related complications were noted, including 5 cases of meningoceles (4.16%), 2 of which were surgically revised, and the others managed with medical treatment and iterative lumbar punctures. Also, 5 cases of minor CSF leaks (4.16%) were recorded, which evolved well with repeated lumbar punctures.

Hematoma at the surgical site, and pneumocephalus were equally represented in 4 cases (3.33%), as well as transient mutism, which occurred in 4 patients (3.33%) from our series, all of whom had surgery for large PCF medulloblastomas. The worsening of ataxia was present in 3 cases (2.5%).

Delays in awakening and occipital bedsores occurred equally in 2 cases (1.66%), as well as postoperative motor deficits, which were observed in 2 patients who underwent surgery for a medulloblastoma and a pilocytic astrocytoma, both of whom had right and left hemiparesis, respectively.

Finally, epilepsy and surgical wound dehiscence were present in a single case (0.83%), as well as increased edema, noted in a patient operated on for a right vestibular schwannoma. The details of these various complications in our series are presented in the following table (Table 3).

Table 3. Distribution of the different types of complications.

Complications	Nombre of cases	Percentage/Operated cases
Neurological Deficit		
Cranial Nerve Impairments	11	9.16%
Motor long tract Deficit	02	1.66%
Worsening of Ataxia	03	2.5%
Cereballar Mutism	04	3.33%
CSF dystroubles		
Méningocele	05	4.16%
Hydrocephalus	14	11.66%
CSF Leak	05	4.16%
Infections		
Wound Dehiscence/Infection	01	0.83%
Cerebellar Abscess	02	1.66%

Continued

Meningitis	**06**	**5%**
Posterior fossa hematoma	01	0.83%
Others complications		
Occipital ulceration	02	1.66%
Cerebellar Hematoma	04	3.33%
Delayed Awakening	02	1.66%
Pneumonia	04	3.33%
Pneumocephalus	04	3.33%
Increased Eodema	01	0.83%
Posterior fossa Syndroms	01	0.83%
Hypotension	08	6.66%

Imagery:

Given the clinical findings and the suggestion of postoperative complications, a CT or MRI was systematically performed in all patients (39), *i.e.*, 100% CT with an additional MRI (8), or 20%, as illustrated in **Figures 1-5**.

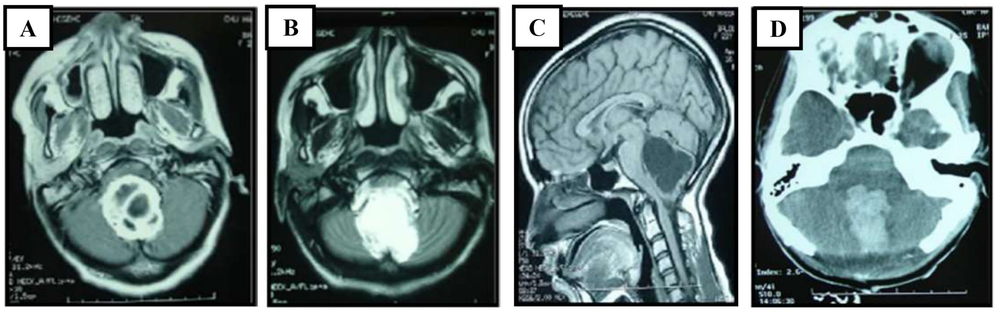

Figure 1. Brain MRI in axial cuts with T1-weighted sequence with Gadolinium (A), T2 sequence (B), and sagittal T1 cut without Gadolinium (C) showing a large tumor mass located at the level of the V4 floor, well-defined, heterogeneous, severely compressing the cerebellum and brainstem. Histology revealed it to be a Hemangioblastoma of the V4. Postoperative brain CT control scan in axial cut without contrast injection (D) showing spontaneous hyperdensity at the level of the V4 floor near the occipital craniectomy, indicating the presence of a hematoma at the surgical site.

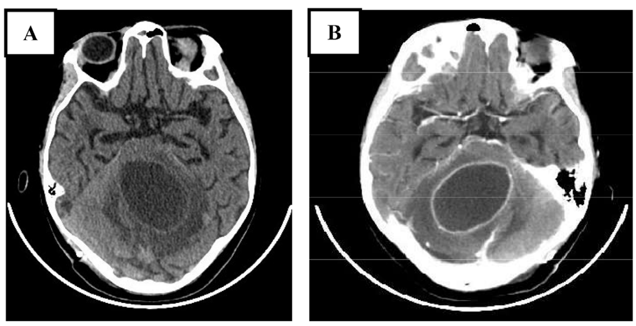

Figure 2. Postoperative brain CT scan in axial cut without contrast injection (A) after excision of a pilocytic astrocytoma of the left cerebellar hemisphere; showing a rounded hypodense left cerebellar image, taking contrast in a ring-like pattern (B), corresponding to a left cerebellar abscess with perilesional edema.

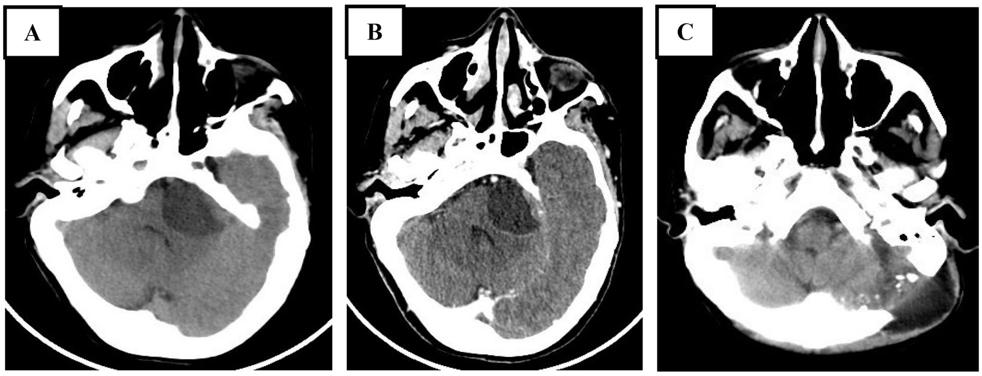

Figure 3. Brain CT scan in axial cut showing a cystic lesion in the left ponto-cerebellar angle with a thin wall (A), enhanced after contrast injection (B), with a fleshy component exerting a mass effect on the fourth ventricle, corresponding to a cystic acoustic schwannoma. A control brain CT scan, in an axial cut without contrast injection (C), showing a meningocele.

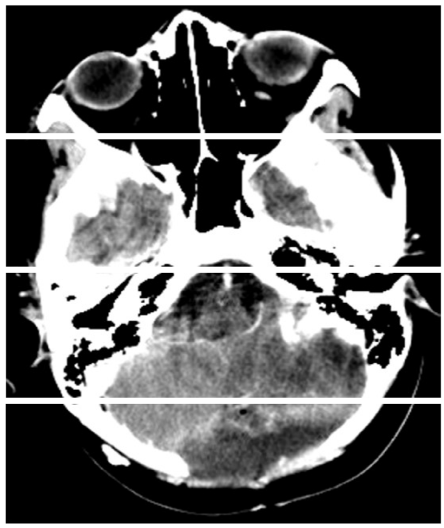

Figure 4. Brain CT scan in axial cut after contrast injection showing an extradural hypodensity in the FCP area at the site of the craniectomy opening, in a biconvex lens shape surrounded by peripheral contrast uptake, corresponding to an extradural empyema.

Figure 5. Postoperative occipital pressure ulcer associated with a large postoperative tissue loss at the site of the surgical approach. This is a child who underwent surgery for an ependymoma of the FCP and who died in the intensive care unit due to severe sepsis.

Analytical Study of Prognostic Factors:

- Tumor Volume: Data from our series shows a marked increase in complications for tumors with a diameter of 4 centimeters or greater, with a statistically significant difference ($p = 0.02$).
- Age: In our series, age does not influence the occurrence of postoperative complications, with a non-significant statistical difference ($p \leq 0.09$).
- Tumor Location: Tumor location also influences the occurrence of postoperative complications after excision of FCP tumors. The statistical difference in complications based on location (intra-axial, intraventricular, or extra-axial) is significant ($p \leq 0.02$).

4. Discussion

We conducted a retrospective descriptive and analytical study covering the period from January 2002 to December 2014. During this period, 120 patients underwent surgery for FCP tumors, 39 (17 aged 0 - 15 years, *i.e.,* 43.58%, 9 from 16 – 40, *i.e.*, 23.07% and 13 over 40 years, *i.e.,* 33. 33% therefore a total distribution of 22 males and 17 females) of whom presented various complications, representing a complication rate of 32.5%. The true frequency of postoperative complications in FCP tumors is difficult to estimate in the literature due to the rarity of studies conducted in this area. In our series, the frequency of postoperative complications is 32.5% (**Table 1** and **Table 2**), while Akhaddar *et al*. Reported a frequency of about 28.6% [1].

The average age of our patients was 23.41 years, with extremes ranging from 1 to 65 years. The most affected age group was under 15 years, accounting for 43.58%, representing the majority of the patients in our series, while in Akhaddar's series, the average age was 36.1 years, with extremes ranging from 9 to 74 years [1].

The gender distribution in our series showed a slight male predominance (56.41%) with a male-to-female ratio of 1.29.

In our series, the intra-axial location is a prognostic factor influencing the occurrence of postoperative complications after excision of FCP tumors. Despite the various advances made in the diagnostic and therapeutic management of FCP tumors, their surgical excision still carries significant functional and even life-threatening complications. These complications are mainly related to tumor volume, patient age, and preoperative clinical status. They can be schematically classified into two groups: perioperative complications related to anesthetic strategy and operative positioning, and postoperative complications (**Table 3**).

Regarding perioperative complications: Preoperative data remain essential. A thorough neurological examination is necessary, particularly to assess any cranial nerve involvement, as this will determine perioperative risks. These risks must be clearly explained to the patient [1] [2]. In most cases, the anesthetist has enough time to assess the patient's condition preoperatively and schedule any necessary additional investigations [3]. Indeed, as with any surgical procedure, the operability assessment will include a complete clinical examination, particularly a cardiopulmonary and general assessment.

Among the required preoperative tests are at least a blood ionogram, a complete blood count, blood typing, a coagulation profile, a chest X-ray, and a systematic electrocardiogram for patients over forty years old [1] [4]. However, it should be noted that some FCP tumors may sometimes present with more or less severe signs of intracranial hypertension, even though their volume is already significant. In such cases, anti-edema treatments (mainly corticosteroids and mannitol) can improve the patient's clinical condition, but surgery becomes necessary within a relatively short time, which does not allow for proper preoperative preparation or the use of additional investigations that require relatively long periods [3].

The patient positioning and setup in neurosurgery play a fundamental role in therapeutic management, both surgically and anesthetically [5]. Indeed, it determines access to the surgical site and can only be minimally adjusted during the procedure [6]. Several specific positions have been proposed for the excision of FCP tumors, such as the sitting position (PA) or its alternatives, represented by the group of horizontal positions, including prone (DV), lateral decubitus, and the Park-Bench [5]. The sitting and prone positions remain the most commonly used, though there is currently controversy regarding the use of the sitting position in FCP surgery. The choice of operative position is typically determined by surgical imperatives, particularly the approach, with the fundamental principles of improving accessibility to the surgical site and/or reducing bleeding [7].

The drainage of cephalic venous blood and cerebrospinal fluid (CSF) is an important parameters that must also be considered and vary depending on the chosen position [7]. These different operative positions address surgical needs but should not compromise the anesthetic imperatives of safety and maintenance of vital functions. Indeed, these positions induce physiological circulatory and respiratory changes that must be taken into account during general anesthesia [5,8]. Therefore, the patient's positioning should result from a compromise between the anesthetic imperatives and the surgical objectives [9].

Perioperative complications related to positioning: Gas embolism (GE) refers to the pathological manifestations associated with the migration of gas bubbles into the bloodstream [10]-[12]. Its incidence varies considerably depending on the detection methods and the different perioperative positions used. A recent literature review reports an incidence of 39% in FCP surgery in the sitting position (PA), whereas the incidence in other positions, such as prone or supine, is lower, ranging from 10% to 17% [13].

The gas embolism that may complicate FCP surgery is termed "passive" due to the combination of venous pressure at the surgical site being lower than the pressure in the right atrium, and the presence of open veins. This situation occurs when the surgical site is above the level of the heart, typically in the PA position [10] [14]. Thus, a 5 cm height difference between the venous breach and the right atrium can be enough to trigger a GE [10].

The clinical manifestations directly related to GE are highly variable in time, completely nonspecific, and usually sudden in onset [10] [11]. These include cardiorespiratory disturbances (tachycardia, dyspnea, chest pain) and neurological symptoms (isolated loss of consciousness or associated with motor deficits, seizures, delayed postoperative awakening) [10]. Unfortunately, these clinical manifestations are often masked by the general anesthesia context in the surgical setting or appear late, generally indicating a severe GE, which is why diagnosis should not rely solely on these symptoms but should be suspected early based on monitoring elements. The most commonly used methods include trans esophageal ultrasound, precordial Doppler, capnography, right heart catheterization, and the esophageal stethoscope, listed in decreasing order of sensitivity [3] [15].

Given the potential severity of GE, preventive measures must be taken to avoid its occurrence [10] [11]. These measures aim to increase venous pressure at the surgical site and prevent or quickly close any potential air entry points if they appear [11].

Some of these measures include:

- The use of positive end-expiratory pressure (PEEP), which remains a preventive measure, though its place is controversial since it could facilitate paradoxical GE in cases of GE from the reopening of a patent foramen ovale (PFO) through increased pressure in the right atrium, making the right-to-left shunt more likely [8] [16]. Indeed, many authors recommend not using ventilation with PEEP, although it is still used in France and Germany [15].
- The use of an anti-gravity suit that maintains sufficient central venous pressure to prevent the occurrence of GE. When combined with PEEP and vascular filling, it would increase right atrial and jugular venous pressure and reduce the incidence of perioperative GE [5].
- An optimal PA position is used, which involves a precise semi-seated setup to increase venous pressure at the surgical site. This positioning requires a combination of adjustments, using the mobility of the operating table, the patient, and positioning pads: elevation of the upper body and legs with maximal hip flexion of 90˚, knee flexion of 30˚, head flexion with a minimum of two-finger space between the chin and the sternum (to avoid hindering venous return), and tilting of the table to achieve a similar height between the patient's head and legs [7] [17].

Surgical preventive measures for GE focus on avoiding any venous injury during dissection and during high-risk stages of the surgery, such as craniectomy [18]. The detection of a patent foramen ovale (PFO): PFO is a cardiac anomaly, specifically in the septum between the atria. It is the persistence of the foramen ovale, located in the axis of the blood flow from the inferior vena cava, and its reopening can occur during general anesthesia with positive pressure ventilation, and may be exacerbated by PEEP [10] [19]. The presence of a PFO increases the risk of GE, which is why preoperative screening is important for patients undergoing neurosurgery in the PA position. Indeed, this screening relies on the use of transesophageal ultrasound, transthoracic ultrasound, and transcranial Doppler. Once a PFO is detected, the management in its presence is controversial, but most authors consider it an absolute contraindication to using the PA position [3].

The management of perioperative GE is a therapeutic emergency, with the goal of limiting the amount of air entering the body and thus the severity of the resulting lesions [11] [12].

The treatment for GE is well-defined and includes:

- Early identification and interruption of the air entry source by flooding the surgical field with saline and compresses, followed by identification (facilitated by bilateral jugular compression) and closure of any potential air entry points found (suturing or applying glue to a venous wound, applying bone wax to a bone slice) [18].
- Symptomatic resuscitation measures that involve bilateral compression of the jugular veins to increase venous pressure at the surgical site, ventilation with 100% oxygen, aspiration of air via the central venous catheter, and management of cardiovascular collapse or cardiac arrest [10].

No cases of gas embolism were noted in our series.

Operative Mortality: Operative mortality refers to deaths occurring perioperatively or within the first month following surgery [20]. Mortality in neurosurgery depends on the management of various perioperative stages: preoperative evaluation, neuroanesthesia, surgery, and postoperative care.

In our series, the operative mortality for FCP tumors is about 4.16%, with the majority being postoperative and no perioperative deaths. In fact, operative mortality for FCP tumors varies between teams, ranging from 0% to 30% [21]. In older series, this mortality ranged from 15% to 30%.

Postoperative Edema and Hydrocephalus: Surgical manipulation is a source of postoperative edema, regardless of the tumor location. Corticosteroids (2mg/kg/day of Methylprednisolone) are systematically used during the first three to four postoperative days. A systematic combination with sucralfate appears to be effective in preventing hemorrhagic digestive complications [22]. An increase in edema was observed in one patient in our series, accounting for 0.83% of the cases (**Table 3**). In contrast, Akhaddar *et al.* [1] reported three cases of edema increase, representing 4.76% of their cases.

Hydrocephalus, commonly associated with FCP tumors, is not automatically resolved after tumor resection. This has led some authors to recommend systematic ventriculocisternostomy (VCS) prior to tumor surgery in the presence of hydrocephalus. However, according to the study by Morelli *et al.*, regarding persistent hydrocephalus, routine preoperative VCS does not seem fully justified, provided that early tumor surgery is possible [23]. Moreover, the development of acute hydrocephalus after FCP tumor surgery remains a serious complication, particularly in cases of incomplete tumor resection. Postoperative edema constitutes a significant aggravating factor. In high-risk situations, an external ventricular drain (EVD) may be placed at the end of the procedure and only opened if needed. However, performing a VCS preoperatively usually resolves this issue but does not exclude the possibility of persistent or late-onset hydrocephalus, which may require the placement of a ventricular-peritoneal shunt (VPS) [23].

In our series, we observed 14 cases of hydrocephalus of all types, representing 11.6% of cases, including 13 cases of persistent hydrocephalus (10.83%) and one case of acute hydrocephalus (0.83%). In contrast, Morelli *et al.* [24] reported 11/107 cases of acute hydrocephalus, or 10%. Literature suggests that acute hydrocephalus can occur in 25% of cases, especially in cases of incomplete tumor resection [25]. Postoperative edema can be a negative factor that requires immediate management [26]. In about 20% of cases, a shunt is performed postoperatively due to acute hydrocephalus [25]

5. Conclusions

FCP surgery is a relatively complex procedure, with perioperative and postoperative complications, more or less significant, occurring in more than a quarter of cases. Therefore, it is important to be aware of these complications in order to prevent and detect them in time.

The high frequency of these complications means that FCP surgery remains a high-risk procedure, justifying close postoperative monitoring at all stages, especially during the immediate postoperative period, when most serious complications occur.

Nevertheless, early and rigorous management will allow for a favorable outcome in the majority of patients undergoing surgery. Mortality is mainly related to hemorrhage at the surgical site, edema increases with acute hydrocephalus, and infectious complications, particularly meningoencephalitis and pulmonary issues.

Preventing complications in FCP surgery involves a thorough understanding of these risks and, above all, good cooperation between anesthesiologists-intensivists and neurosurgeons, which is key to further reducing complication rates.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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