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Original Article

Non-watertight Dural Closure for Supratentorial Craniotomy Seems Enough: Technical Consideration

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Background: Watertight dural closure (WTDC) is traditionally regarded as standard practice in craniotomy, although postoperative cerebrospinal fluid (CSF) may still leak through small gaps and predispose to extradural fluid collection, incisional fistula, infection, and wound dehiscence. Non-watertight dural closure (non-WTDC), defined as low-tension approximation of the dural edges without pursuit of complete closure, may mitigate pressure gradients across the dura and reduce these complications in included cases.

Materials and Methods: We applied a standardized non-WTDC technique in 40 consecutive patients undergoing elective supratentorial craniotomy for a range of supratentorial lesions, including tumors, arachnoid cysts, ruptured and unruptured aneurysms, subdural hematoma, and arteriovenous malformations

Results: Three patients developed postoperative CSF collections; one resolved with conservative management, and two were successfully treated with secondary conversion to WTDC. No patient developed an incisional CSF fistula, meningitis, or wound breakdown.

***Conclusion*:** In this early experience, non-WTDC after supratentorial craniotomy appeared sufficient and safe in appropriately included patients and may offer practical advantages by simplifying dural reconstruction and obviating the need for dural grafts or sealants during the primary closure.

Keywords: Non-watertight dural closure; Supratentorial craniotomy; Cerebrospinal fluid leak; Subgaleal fluid collection; Duraplasty

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Introduction

Postoperative cerebrospinal fluid (CSF) fistula after cranial surgery is a major source of morbidity and has been associated with meningitis, wound infection, pseudo meningocele, low pressure headache and the need for reoperation, all of which contribute to prolonged hospitalization and increased healthcare costs (1-3). Within this paradigm, watertight dural closure (WTDC) after supratentorial craniotomy is widely regarded as standard practice to prevent CSF leakage and related complications, although it is often technically demanding and may lengthen operative time because grafts or sealants are frequently required

(6-8). To mitigate these risks, neurosurgeons have traditionally aimed for approximating dural and fascial layers rather than forcing a tightly watertight construct, without utilizing any dural grafts or synthetic sealants (4, 5).

At the same time, primary WTDC has been reported as achievable in only 30.2 percent of supratentorial procedures (6), and comparative series have not demonstrated statistically significant differences in CSF leak or wound complications between WTDC and non-WTDC in supratentorial surgery (9, 10). Despite this emerging body of evidence, there is no standardized and detailed description of a non-WTDC strategy specifically adapted to supratentorial tumor surgery. The objective of this technical note is to describe a simple and reproducible non-WTDC technique and to report its early feasibility in routine supratentorial craniotomies.

Materials and methods

Surgical technique

Non-WTDC was used as the default technique in patients undergoing elective supratentorial craniotomy for wide range of space-occupying lesions and vascular pathologies. Eligible candidates were adults scheduled for elective supratentorial surgery for a spectrum of intra- and extra-axial lesions, including superficial and deep-seated tumors, arachnoid cysts, ruptured or unruptured aneurysms, and arteriovenous malformations, in whom preoperative imaging and intraoperative assessment demonstrated satisfactory brain relaxation and no anticipated need for deliberate ventricular catheterization or extensive basal cisternal opening. (Exclusion Criteria removed)

Procedures were performed using standard supratentorial approaches under general anesthesia (11, 12). Positioning, craniotomy, and dural opening were tailored to lesion location and venous anatomy to provide a wide, low-tension operative corridor while preserving venous sinuses and minimizing cortical retraction. Throughout microsurgical resection, the dura and arachnoid planes were handled gently and maintained in a hydrated state to avoid edge necrosis and to limit inadvertent communication between the subarachnoid and subgaleal compartments.

At the end of resection and meticulous hemostasis, the dural leaflets were trimmed only as needed and re-approximated with interrupted 4-0 or 5-0 monofilament sutures placed at regular intervals. Sutures were tied with sufficient tension to approximate the dural leaflets and reduce epidural space, without attempting to achieve a completely watertight dural seal. Small inter-suture gaps were deliberately accepted, provided that no obvious pulsatile CSF egress was observed under physiological pressure. small residual dural defects were simply covered with a thin layer of gel foam as a passive interface, without the intention of achieving formal watertight closure.

In all cases, the bone flap was replaced and fixed using standard techniques. The galea and skin were then closed in multiple layers, with meticulous attention to a robust, well-vascularized galeal approximation and the routine application of a firm compressive head dressing during the early postoperative period to minimize subgaleal dead space. This strategy aimed to confine minor CSF escape to a self-limiting subgaleal collection rather than allowing formation of a persistent fistula.

Illustrative case series

Among 40 supratentorial craniotomies undertaken with non-watertight dural closure, three patients developed postoperative cerebrospinal fluid collections. Two were successfully managed with conservative measures and one required secondary conversion to watertight dural repair. These three patients are outlined below.

Figure 1. Occipital meningioma with small CSF collection

A 44-year-old woman presented with progressive visual field disturbance and occipital headaches. MRI demonstrated a right occipital convexity meningioma with local mass effect but no hydrocephalus. She underwent right occipital craniotomy and gross total tumor resection. After meticulous hemostasis, the dura was re-approximated with interrupted 4-0 monofilament sutures placed several millimeters apart, deliberately leaving small gaps and avoiding excessive traction. No dural patch or sealant was used. A subgaleal suction drain was left in situ and the bone flap and soft tissues were closed in standard layered fashion.

On postoperative day two, a small, soft subgaleal collection was noted over the craniotomy site, without wound erythema, CSF discharge, or new neurological deficit. Computed tomography demonstrated a thin extradural CSF layer beneath the bone flap without significant mass effect. The patient was initially managed with close clinical observation and application of a firm compressive head bandage, resulting in partial regression of the collection. Approximately one month later, she re-presented with recurrent occipital headache and enlargement of the subgaleal fluctuation. Repeat imaging again confirmed a persistent extradural cerebrospinal fluid collection in the absence of tumor recurrence or significant mass effect. In view of the symptomatic and non-resolving nature of this collection, revision craniotomy was undertaken. The initial non-watertight dural approximation was converted to a formal watertight duraplasty using an autologous pericranial graft, with circumferential anchoring to the native dura. Following revision, the extradural collection resolved completely, the patient's headaches subsided, and no further CSF-related or wound complications were observed during subsequent follow-up.

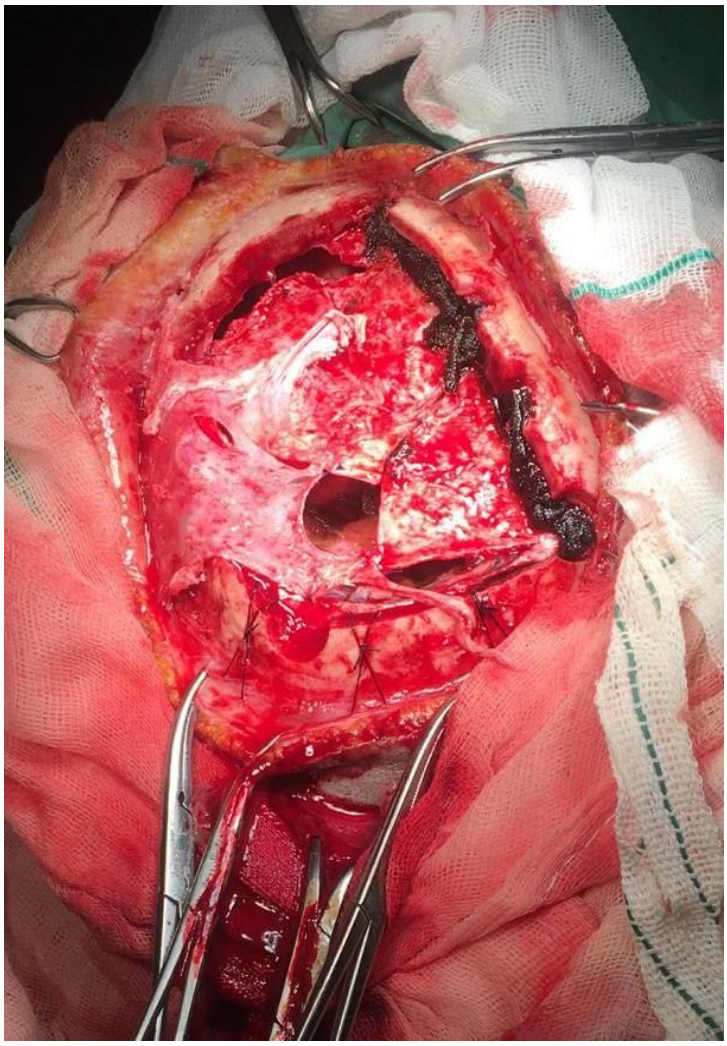

Fig 1. Low-Tension Non-Watertight Dural Approximation. Intraoperative non-watertight dural approximation using interrupted, low-tension monofilament sutures with small intentional gaps; no graft or sealant were used

Figure 2. Middle fossa arachnoid cyst with subdural hematoma and moderate CSF collection

A 42-year-old man presented with chronic headache and mild right-sided hemiparesis. Neuroimaging revealed a large left middle fossa arachnoid cyst with an overlying chronic subdural hematoma and moderate midline shift. A left fronto-temporo-parietal craniotomy was performed. The chronic subdural hematoma was evacuated, while the arachnoid cyst itself was left intact and was not fenestrated. At closure, the dura was loosely re-approximated using interrupted monofilament sutures with small inter-suture gaps, thereby preserving the non-watertight dural principle. No dural graft or sealant was employed, and a subgaleal suction drain was left in situ and the bone flap and soft tissues were closed in standard layered fashion.

By postoperative day three, the patient developed a moderate, ballotable subgaleal fluctuation over the craniotomy site, associated with local discomfort but no fever, wound discharge, or new neurological deficit. Computed tomography demonstrated a crescentic extradural CSF collection along the craniotomy margins without significant mass effect, and laboratory parameters did not suggest infection.

The collection was managed conservatively with close clinical observation and a firm compressive head bandage, while cautious head elevation and early mobilization were maintained. During serial clinical and radiological follow-up over a 6-month period, the subgaleal swelling showed progressive, steady regression.

Interval imaging at approximately one month documented partial reduction of the extradural collection, and subsequent studies confirmed its near-complete resolution. No recurrent CSF leakage, wound dehiscence, or infectious complication was observed throughout the 6-month follow-up.

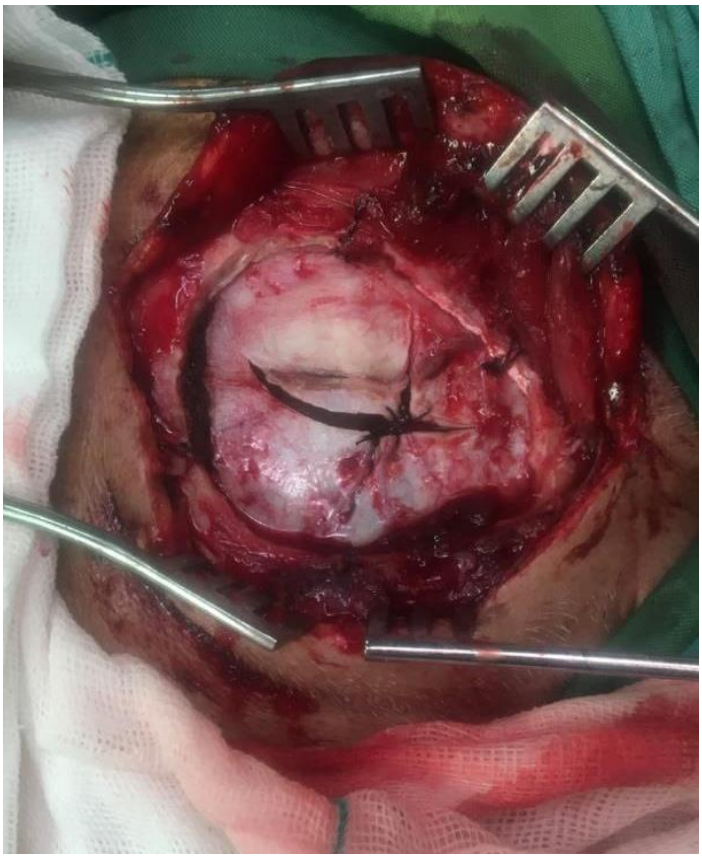

Fig 2. Final Configuration of Non-Watertight Dural Closure. Final appearance of non-watertight dural closure before bone flap replacement and layered soft-tissue closure, without visible CSF egress.

Figure 3. Sphenoid wing meningioma with persistent high-output CSF collection

A 51-year-old woman with progressive proptosis and focal seizures was found to have a large left sphenoid wing meningioma extending into the middle cranial fossa with substantial peritumoral edema, but without preoperative hydrocephalus. A standard pterional craniotomy was performed and near-total tumor resection was achieved. Skull base bone was drilled to decompress the orbit and optic canal. Due to the irregular dural defect and bone removal at the sphenoid wing, the dura was reconstructed using interrupted monofilament sutures bridging the native dural edges where possible, intentionally leaving small gaps over the skull base in accordance with the non-WTDC strategy. No dural graft, sealant, or subgaleal drain was used, and the bone flap and soft tissues were closed in layers..

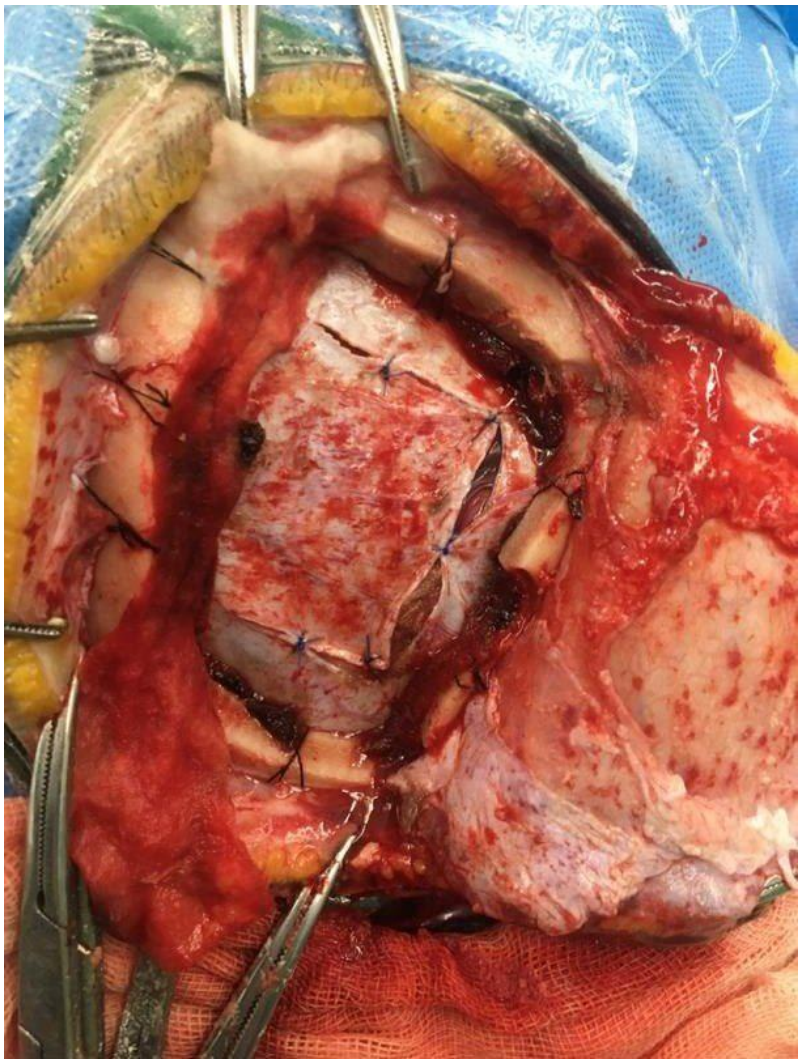

Fig 3. Non-Watertight Dural Reconstruction with Preserved Dural Continuity. Intraoperative view showing non-watertight dural re-approximation using interrupted monofilament sutures under low tension, with small intentional inter-suture gaps and without grafts or sealants.

Within the first postoperative days, the patient developed a modest, ballotable scalp swelling over the craniotomy site, associated with mild local discomfort but preserved neurological status and normal inflammatory markers. Imaging confirmed an extradural cerebrospinal fluid collection beneath the

bone flap with elevation of the overlying scalp, without relevant mass effect on the brain parenchyma.

The patient was managed conservatively with close clinical and radiological surveillance, a firm compressive head dressing, and cautious head elevation and mobilization. Under this strategy, the subgaleal collection gradually decreased in size over following weeks. Follow-up imaging demonstrated progressive reduction and eventual near-complete resolution of the extradural collection. No re-exploration or conversion to watertight duraplasty was required, and no CSF fistula, wound dehiscence, or infectious complication occurred during the follow-up period.

These three illustrative cases reflect the overall experience of the series, in which postoperative CSF collections were uncommon after non-WTDC, frequently amenable to conservative management, and in the rare refractory case effectively controlled by secondary watertight reconstruction

Results

This technical note presents a standardized non-WTDC strategy for elective supratentorial craniotomy, accompanied by early outcome data from a single-center retrospective case series conducted at (*Anonymized for peer review)* between 2024 and 2025, with cases identified through systematic operative log screening and electronic medical record verification. Forty patients with a mean age of 49.6 ± 10.3 years were included and underwent elective supratentorial craniotomy with non-WTDC for a range of pathologies, including intra- and extra-axial lesions, including superficial and deep-seated tumors, arachnoid cysts, ruptured or unruptured aneurysms, and arteriovenous malformations. Presenting features included headache, dizziness, vomiting, focal neurological deficits, and visual symptoms, reflecting the anatomical location and mass effect or vascular compromise of the underlying lesions.

In all procedures, gross total or near-total lesion removal or adequate vascular disconnection was achieved and the dura was approximated using the non-watertight technique described, followed by replacement of the bone flap and layered soft-tissue closure.

Postoperatively, three patients developed subgaleal CSF collections that illustrate the clinical spectrum of this closure strategy. One patient with an occipital meningioma developed a small subgaleal collection that initially regressed under compressive head bandaging but recurred with headache at approximately one month and was ultimately treated with delayed revision craniotomy and conversion from non-WTDC to formal WTDC. A second patient with a middle fossa arachnoid cyst and associated chronic subdural hematoma developed a moderate, low-pressure subgaleal collection after hematoma evacuation without cyst fenestration, which was managed conservatively with a firm compressive head dressing and close clinical and radiological follow-up over six months, during which the collection showed progressive regression and near-complete resolution. In the patient with a sphenoid wing meningioma, a modest postoperative subgaleal collection was likewise managed conservatively with compressive bandaging and surveillance, without the need for re-exploration or secondary conversion to WTDC. No patient in this series developed an incisional CSF fistula, meningetis, or wound dehiscence during follow-up.

Conclusion

Non-WTDC in carefully selected supratentorial craniotomies appears feasible and safe in our early experience, with a low incidence of clinically relevant CSF-related complications. This strategy may simplify dural reconstruction and obviate the need for dural grafts or sealants during the primary closure, but its role should be confirmed in larger, prospective, and comparative studies.

Declaration

Ethical approval and Informed consent

This study was conducted in accordance with the ethical standards of the institutional and national research committee and with the principles of the Declaration of Helsinki. Given the retrospective nature of the analysis and the use of anonymized data, the requirement for individual informed consent for inclusion in the series was waived according to institutional policy. Written informed consent was

obtained from all patients, or their legal representatives, for the use of intraoperative photographs and clinical information in scientific publications where applicable.

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Conflict of Interest Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author Contributions

Anonymized for peer review.

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