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Management of Post-Craniotomy Persistent CSF Subgaleal Collection in Skull Base Procedures: Local Experience

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Abstract

Background: Post-craniotomy CSF collection is a problem that may cause severe complications as meningitis, wound disruption, prolonged hospitalization, and additional surgeries. **Objective:** To evaluate our cases with resistant post-operative subgaleal CSF collection, trying to identify causes and optimal management. **Methods:** Retrospective review of elective skull base cases during the period of January 2104 to January 2019 identification of cases with post-operative CSF subgaleal collection, which either managed conservatively or needed a second surgery. **Results:** 219 patients, 30 of them suffered subgaleal CSF collection, 22 patients improved with non-operative measures, eight patients needed second surgery with pericranial graft augmentation, and obliteration of subgaleal space resulted in resolution of CSF leak with no morbidities. **Conclusion:** Meticulous tensionless dural closure, obliteration of subgaleal space, tethering of dural grafts to bone edges are useful techniques in preventing post-operative CSF leak.

Keywords

Subgaleal, CSF, Post-Operative, Dural Repair, Craniotomy

1. Introduction

Dural closure is an essential step after intradural neurosurgical procedures to prevent CSF leakage, subcutaneous collections, wound breakdown, intracranial hypotension, neural tissue herniation, meningitis, prolonged hospitalization, and even revision surgery [1]. Primary closure by sutures is the preferred economic technique when feasible. Different factors can make this simple closure impossible, as absent basal dural edges, dural resection due to infiltration by pathologies, and shrinkage after long surgeries secondary to dryness [2]. Different materials are used to compensate for dural defects that include autografts, allografts, xenografts, and synthetic materials [3].

Dural grafts have been used to repair dural defects for more than three decades. Synesthetic, autologous, and xenogeneic grafts are used with pros and cons for each. Synesthetic grafts have weak resistance to infection, costly, and challenging to suture, but, they are available in different sizes with no added wounds. Autologous pericranium has been used successfully for years. In addition to being autogenous with no risk of disease transmission, it is suturable, can be either free or pedicled in most approaches, it is with no added costs [4].

Despite advances in microsurgical techniques and dural grafts industry, post-operative CSF leakage still occurs in a non-negligible incidence. In a large data set analysis of 38,000 patients from the American College of Surgeons, Jennifer *et al.*, found CSF leakage complications following posterior fossa surgery to range from 3% - 12% [5]. Sade *et al.*, reported dural related complications of 2.3% of 439 meningioma patients, including 0.4% CSF leakage, extra-axial collection, infection, using not-water-tight closure by applying graft only technique [6]. Zachary *et al.*, found an overall incidence of post-operative CSF leakage was 6.7% [7].

We retrospectively revised our skull base cases in the period from January 2014 to January 2019 with post-operative subgaleal CSF collection that mandates a second intervention to close the fistula to find out the etiology behind persistent leakage.

2. Patients & Methods

This is a retrospective case study conducted at our skull base unit, Institutional Review Board approval was obtained to perform a retrospective analysis of patients who underwent elective skull base surgeries between May 2014 and June 2019. Patients' medical record were investigated and analyzed for persistent CSF subcutaneous collection that mandate second surgical intervention. Among 219 skull base procedures done during the study period, 30 cases suffered from post-operative CSF collection, 22 of them responded to conservative measures, and 8 of them required revision dural closure. Operative notes of the primary and second surgeries were revised to identify causes of persistent subgaleal leakage/collection.

Our basic dural closure was based on primary suture using polyglactin 4 - 0, if insufficient and dural edges are identified, interposition dural graft is sutured to dural edges. In cases with absent dural edges due to resection or deep location, an on-lay collagen-based dural substitute is used augmented with autologous fibrin sealant.

In cases with post-operative collection, firstly, we apply compressive dressing for 3 - 7 days plus Acetazolamide 250 - 500 mg TID, after assessment with contrast-enhanced CT scan of the head to exclude infections. If persistent, we apply lumber drain for 3 - 5 days, if failed to reduce the collection, exploration and dural re-closure is indicated. Intravenous antibiotics—Cefazoline one gm TID, routine post-operative prophylaxis—is usually for three days.

In five cases, water-tight dural closure was attempted using polyglactin 4 - 0; four of them were primary closure and one closed using pericranial patch sutured to dural defect. In two cases, the deficient basal dural edge was closed by applying glycogen based synthetic dural graft. The eighth case was a redo surgery for atypical meningioma at which dura was removed in the previous surgeries; on-lay synthetic glycogen based graft was applied. In the three non-water tight closed cases, fibrin sealant was sprayed to support closure.

We found dural suture tears to be the cause of CSF leak in six cases. Poor graft coaptation was found in three cases, especially at the lower basal border. In revision surgeries, in cases with available dural edges all around, a pericranial patch graft is applied and sutured over the primary closure with overlying sealant. In cases of absent one or more dural edges, on overlying pericranial patch is sutured to the dura and the bone edges if the dural border is missing through holes in the bone with sealant augmentation. In one case, the dura was missing, in which a fascia lata was tethered to the bone all around and sealed with fibrin sealant.

The subgaleal space was obliterated by tethering skin to the underlying bone using the technique described by Kato *et al.* [8], with a subgaleal drain under mild negative pressure.

3. Results

Out of 219 skull base procedures performed during the period of the study (from May 2014 to June 2019); thirty cases (13.7%) suffered post-operative subgaleal CSF collections. 22 cases out of them responded to non-surgical intervention. We found eight cases not responding to conservative treatment requiring revision surgery. The patients required revision surgery were two females and six males with age ranged from 19 to 70 years. The primary pathology was meningiomas in 7 cases (one of which was a recurrent case) and the 8^{th} case was an invasive pituitary adenoma (**Table 1**).

Dural tears caused by sutures found in 5 cases, and a closure defect (any length of free dural edge that could not be anchored to opposing dura and only graft was not enough to seal it) found in 2 cases, and a mix of the above etiology found in one case.

Three lesions were operated via fronto-orbital approach, two via fronto-temporal approach, one through frontoparietal craniotomy, one through suboccipital craniotomy, and one via retrosigmoid approach.

We did not encounter revision surgery-related complications. All patients were discharged 2 - 3 days after the second surgery except one patient who was kept for rehabilitation care because of left hemiparesis.

4. Discussion

Dura mater is a natural barrier, protecting the intracranial contents. Failure to

Table 1. Summary of patient clinical and operative data.

	Sex	Age	Primary pathology	Cause of CSF leakage	Initial dural closure	Revision dural closure
1	Male	67	Parasagittal meningioma	Dural suture tears	Primary dural closure	Onlay pericranial graft sutured to underlying dura augmented with sealant
2	Female	40	Spheno-orbital meningioma	Dural closure defects	Augmented dural closure with on-lay synthetic graft	Onlay pericranial graft sutured to underlying dura augmented with sealant and tethered to the basal bone with sutures
3	Female	45	Sphenoid ridge meningioma	Dural closure defect + dural sutures tears	Augmented dural closure with on-lay synthetic graft	Onlay pericranial graft sutured to underlying dura augmented with sealant and tethered to the basal bone with sutures
4	Male	37	Giant pituitary macro-adenoma	Dural sutures tears	Primary dural closure	Onlay pericranial graft sutured to underlying dura augmented with sealant
5	Male	70	Recurrent Sphenoid meningioma	Dural closure defect	On-lay synthetic graft	Fascial lata graft augmented by fibrin sealant and directly tethered to bone edge
6	Male	42	Infratentorial meningioma	dural sutures tears	Dural closure with sutured dural graft	Onlay pericranial graft sutured to underlying dura augmented with sealant
7	Male	62	Vestibular schwannoma	Dural sutures tears	Primary dural closure	Onlay pericranial graft sutured to underlying dura augmented with sealant
8	Male	19	Craniopharyngioma	Dural suture tears	Primary dural closure	Onlay pericranial graft sutured to underlying dura augmented with sealant

reclose dura after neurosurgical procedures constitutes a precursor for morbidities as meningitis, wound dehiscence, and meningocele formation. It is sometimes impossible to primarily repair dura due to intentional dural resection or shrinkage.

CSF leakage is possible after intradural surgery, as primary dural closure can be occasionally difficult. Nagata *et al.* found only 6% of standard suture closure was water-tight when tested using Valsalva maneuver [9]. Sekar *et al.* assigned post-operative CSF leakage to two leading causes: primarily to inadequate closure technique and also to the hydrostatic pressure of CSF in cases of basal location and advocated the necessity of water-tight dural closure [10]. On the other hand, Barth *et al.* found no significant difference between water-tight dural closure and edges approximation without dural patches or sealants in supratentorial craniotomies in terms of CSF related complications; hence they recommended non-water-tight closure in terms of decreasing financial burden of surgeries [11]. We tried tight dural closure in all cases when possible, yet, we found dural suture tears caused by either needles or closure under tension to cause holes through which CSF continued to collect subcutaneously.

When the scenario of post-operative CSF subgaleal collection is met and possible causes like hydrocephalus, wound hematomas, and infections are excluded, the responses are either conservative management as an outpatient, in-hospital observation, wound tapping, temporary CSF diversion, or wound exploration. In a survey study of post-operative cranial pseudomeningocele, included 241 responses, the initial proposed treatment conservative outpatient in 47%, 25% preferred in-patient follow up, and 4% considered surgical revision—0.5 of them was initial approach [12]. In light of our developing health system with inadequate patient service after hospital discharge and poor communication with primary care providers, such problems are dealt with before discharging the patient. We start with a non-invasive approach and upgrade to invasive maneuvers up to revision surgery if the problem persists.

Non-surgical management of post-operative subcutaneous CSF collections includes padded compressive bandage, which is released 3 - 4 times per day for 30 minutes to prevent flap ischemia and pressure ulcers, diuretics mainly Acetazolamide [13], decreasing CSF hydrostatic pressure through a lumbar puncture or lumbar drainage. Since introduced by Vourc'h, spinal CSF drainage has been used successfully in treating both spinal and cranial CSF fistulae [14]. The reported success rate for cranial fistulae is 85% - 88% [15]. We found this was successful in 22 out of our 30 patients, which go along with the general trend of the non-invasive approach [12]. Considering 73% of our patient who had a good response to non-surgical lines of treatment, one can argues for more prolonged conservative measures. However, as mentioned, we are trying to deliver all possible treatment before discharging patients because of poor follow up capabilities and to shorten hospital stay at the same time.

Fibrin glue, a tissue glue and hemostatic composed of fibrinogen and thrombin, is proved to be effective in reducing post-operative subcutaneous fluid collection through dural sutures [9] [16]. Although we tend to augment synesthetic graft closure with fibrin sealant, we found displacements in some points off the underlying bone edges. This might be due to interruption of the healing process of the graft as proposed by Zachary *et al.*, who found higher CSF leakage if bovine pericardium is combined with an overlying gelatin sponge [7].

The ideal dural graft should be available in terms of size, affordability, rapid tissue intake without rejection reactions. Pericranium has been used for decades with good results for years. It has advantages over the costly synthetic grafts: usually harvested from the same incision, inexpensive, free or pedicles, ease of application, and rapid uptake by tissues. Fandino *et al.*, in an in vitro mechanical testing of different dural grafts and sealants to repair a porcine dural defect, found the best combination is pericranium plus Tisseal [17]. We tend to use pericranial grafts whenever possible because of its superior tissue compatibility, rapid take-up by surrounding tissues, the feasibility of on-lay application or suturing it, and lower cost. We harvest the graft usually through the same incision after due undermining of neighboring flaps.

In the current study of eight cases necessitating redo surgery for persistent subgaleal CSF collection, we did pericranial graft augmentation directly sutured to underlying dura or underlying dura and adjacent bone in cases of absent dural edges augmented with fibrin sealant, in a tensionless manner. The subgaleal space was obliterated by tethering sutures to the underlying bone. We had successful repair with no morbidity related to second surgeries. Successful repair of CSF leakage depends on the identification of its etiology, accurate localization of

CSF source, presence or absence of increased intracranial hypertension as a determinant factor, careful preparation of repair site, and tensionless dural/graft closure [18]. Before revision surgeries, we excluded post-operative infections or hydrocephalus. The dural closure bed is explored to identify the leaking points. The bed is cleared from blood clots and hemostatic materials.

5. Conclusions

Although primary water-tight dural closure is debated in some studies, it is the trend to do it whenever possible to guard against serious preventable complications like pseudo-meningocele formation, wound dehiscence, meningitis, prolonged hospital stay, and additional surgeries, especially in skull base approaches.

Water-tight closure can be achieved through tensionless closure by applying dural release dissection and graft closure in case of shrinkage. Rounded needles of the smallest possible suture materials should be used.

In the cases of absent dural edges, tethering the graft to bone edge prevents graft migration and helps to prevent the leakage.

Obliteration of subgaleal space, by tethering skin to the underlying bone, releases the pressure of the skin closure and decreases the potential of developing subgaleal collection.

6. Limitation of the Study

There are some limitations to current study; mainly, the small sample size (number of treated patients). This might encourage to plan for future large multi institutional cohort to collect more data for more in-depth analysis. Other limiting factor is the heterogeneity of the different variables associated with CSF leakage/collection as regard the pathology, age, location of the lesion, and surgical approach; further research plan is considered to analyze each factor separately.

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Nil.

Conflicts of Interest

There are no conflicts of interest.

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Abbreviation

CSF = cerebrospinal fluid