Anterior Skull Base Reconstruction After Cranio-Facial Resections Using Galeal Pericranial Flap

P.G. Balagopal¹, N.A. George¹, R. Ajith², M.I. Ahamed¹, P. Sebastian¹

¹Department of Surgical Oncology, Head & Neck Division, Regional Cancer Centre, Trivandrum, India, ²Department of Neuro Surgery, Medical College, Trivandrum, India

Abstract

The tumors of the anterior cranial cavity can either be malignant or benign. They usually arise in the nasal or Para nasal sinuses. Treatment of these tumors includes major craniofacial resection and reconstruction to prevent cerebrospinal fluid leak and meningitis. In this study we are presenting a technique which is simple and cost-effective. We are reporting a series of nine cases in which this technique was tried out and we found that it can be used for dural repair and anterior cranial fossa reconstruction with no major complications.

Keywords:
Skull base reconstruction, cranio-facial resection, fascia lata graft, abdominal pad of fat, galeal pericranial flap.

Introduction

The tumors of the anterior cranial cavity can either be malignant or benign. Majority of tumors in this group include tumors that arise in the nasal cavity and paranasal sinuses like esthesioneuroblastoma or olfactory neuroblastoma, squamous cell carcinomas, osteogenic sarcomas, rhabdomyosarcomas and benign lesions like meningiomas ossifying fibroma, chondroblastomas, fibrous dysplasia, etc. Some of these tumors require major craniofacial resections and reconstruction.

Following tumor extirpation, skull base cranial defects require precise and durable reconstruction to: (1) Form a water tight dural seal, (2) Provide a barrier between the sinonasal space and subdural compartment (3) Maintain a functional sinonasal system and (4) To prevent air flow into the intra cranial space.

In any situation, failure to create adequate reconstruction harbors significant complications which include cerebrospinal fluid (CSF) leak and meningitis. Various techniques used for reconstruction of anterior skull base defects include autologous bone grafts, artificial bone substitutes, titanium mesh, free flaps, etc. There is no single gold standard technique that is both simple and reliable for reducing the morbidity and mortality associated with anterior skull base surgeries.

Background

Ketcham et al (1) have been credited with popularizing the craniofacial approach for tumors of the paranasal sinuses and anterior skull base. These techniques have evolved and become refined to a point where safe en bloc resection of cancers previously considered unresectable can be performed with improved survival rates (2). As the indications and, concomitantly, the extent of the resection expands, the associated morbidity and even mortality become a great concern. The key to diminishing the complication rate is the judicious use of reconstructive techniques that have likewise increased in sophistication.

As in any other reconstructive ladder, the reconstructive procedures in anterior CFR vary from no formal reconstruction, particularly if the defects are small, to sophisticated free flaps with micro vascular anastomosis in larger defects. In this article, we explain the feasibility of reconstruction after anterior craniofacial resection with an innovative method using galeal pericranial flap augmented with abdominal pad of fat.
Objective

To present our method for anterior skull base reconstruction after oncological resection for malignant tumours in a low resource set up with galeal pericranial flap and abdominal pad of fat augmentation.

Methods and Materials

From January 2007 to November 2009, 9 patients underwent anterior cranio-facial resections at the Regional Cancer Centre, Trivandrum, India for tumours of anterior skull base, nasal cavity and para-nasal sinuses. Limited dural defects were closed primarily. All patients underwent reconstruction with galeal pericranial flap augmented abdominal pad of fat. They were prospectively followed for complications.

<table>
<thead>
<tr>
<th>Site</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasal cavity</td>
<td>4</td>
</tr>
<tr>
<td>Ethmoid sinus</td>
<td>2</td>
</tr>
<tr>
<td>Maxillary sinus</td>
<td>1</td>
</tr>
<tr>
<td>Nasopharynx</td>
<td>1</td>
</tr>
<tr>
<td>Cribriform plate</td>
<td>1</td>
</tr>
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</table>

Table 1. Site of Tumor

<table>
<thead>
<tr>
<th>Pathology</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esthesioneuroblastoma</td>
<td>4</td>
</tr>
<tr>
<td>Squamous cell carcinoma</td>
<td>3</td>
</tr>
<tr>
<td>Sino nasal teratocarcino sarcoma</td>
<td>1</td>
</tr>
<tr>
<td>Meningioma</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2. Pathological Diagnosis

Pre-operative preparation

Operability and extent of tumor is assessed with the help of both CT and MRI. All patients who underwent anterior cranio-facial resections had mannitol infusion and lumbar drain pre-operatively to reduce cerebral edema and for ease of extra dural dissection. Deep Vein Thrombosis (DVT) prophylaxis is best achieved with sequential pneumatic compression stockings intraoperatively and in the post-operative period until ambulation is possible. All patients had induction dose anti-meningitis regimen which included broad–spectrum cephalosporin and aminoglycosides. Antibiotic prophylaxis is instituted 2 hours before skin incision. Antibiotic prophylaxis for 24 hours or less is associated with a significant increase in local infection (6,7).

Operative technique

Patient is positioned in supine on a Mayfield horseshoe head holder to improve access to face and scalp areas. A bicoronal scalp incision is made over the vertex of scalp to provide access to the right and left frontal areas. Care is taken to raise anteriorly based galeal pericranial flap separately. Lateral dissection is more meticulous to avoid injury to the superficial temporal artery and the temporal branches of the facial nerve. Three or four burr holes are placed and either a triangular or quadrangular piece of bone is excised. Care is taken to prevent injury to the duramater and superior sagittal sinus. By extradural dissection anterior cranial fossa is reached.

Figures 1: Harvesting of galeal pericranial flap

Figures 2: Harvesting of galeal pericranial flap
The frontal dura is carefully elevated from the roof of orbit and crista galli and cribriform plate. It may be necessary to incise the dura along the crista galli. Tumor operability is assessed and dissected. Rarely it may be necessary to resect a portion of the frontal lobe to obtain adequate tumor margin. After removal of bone dural “tack-up” sutures are placed at the margin of the craniotomy to prevent post-operative epidural dissection by blood or serous fluid. The lacerations of the dura may be repaired primarily or for large defects duroplasty is done with the use of fascia lata graft. Three of our patients received radiotherapy prior to surgery and in patients who received radiotherapy the dissection of dura was difficult and was more prone for laceration.

Through a Weber-Fergusson’s incision facial part of the tumor is dissected and tumor excision is completed. Specimen is removed from facial wound and assessed for adequacy of margins macroscopically.

**Reconstructive procedure**

After completion of cranio-facial resection defects of anterior skull base including the cribriform plate, planum sphenoidal and roof of the ethmoid sinus can be reconstructed with galeal pericranial flap. It is placed in the skull base defect through the cranial aspect. Fascia lata flap from thigh and abdominal pad of fat is harvested. Fascia lata graft is used for duroplasty if the defect is large. The mucosal remnant from the frontal sinus is removed to prevent post operative mucocele formation. Autologous bone piece which was excised initially is placed over the craniotomy wound along with abdominal fat pad and fixed with mini plates. Scalp wound closed with suction drain.

**Post-operative Care**

Antibiotics and lumbar drainage are continued post-operatively. Lumbar drain is usually kept for 3-4 days. Approximately 30-40 ml of CSF is drained every day. Patients were clinically examined for CSF leak and for signs of meningeal irritation. CSF was sent for both culture and sensitivity and microscopy every day whether patient was symptomatic or not till the lumbar drain is out. All patients have completed at least three years of follow up except two patients who...
died of metastatic disease within six months of surgery. The patient with sinonasal teratocarcinosarcoma developed recurrence within 2 months following surgery and was given whole brain radiation. He died one month later. The only female patient with squamous cell carcinoma developed distant metastasis including inguinal node metastasis was given both chemotherapy and radiotherapy and died within 6 months following surgery. All patients except the one with meningioma received radiotherapy.

Results

Male to female ratio was 8:1. The Mean duration of surgery is 7.5 hrs. (Range = 6 to 9 hours). The mean duration of hospitalization post-operatively is 12.9 days (Range = 9 to 18 days). There was no CSF leak and meningeal infection. Majority of patients complained of pain over the head which was treated with analgesics. Few patients complained of nasal block which was treated with nasal drops. No other postoperative complications were noted. No donor site morbidities were present. Morphine was not given during the post-operative period for pain control.

Conclusion

This technique is a simple and very effective method of anterior skull base reconstruction in a low resource set up. It can be used for dural repair and anterior cranial fossa reconstruction with no major complications.

Discussion

A wide variety of benign and malignant neoplasm may involve the anterior cranial base. Majority of the tumors arise either from the nasal cavity or paranasal sinus. Squamous cell carcinoma of the paranasal sinus however has been associated with exposure to nickel refining, soft wood dust, leather tanning processing, radium dial painting and isopropyl oils. Hardwood workers have an increased incidence of adenocarcinoma (8,9). The signs and symptoms of neoplasms involving the anterior cranial base are non-specific and they are not useful in predicting a histologic diagnosis. But they may be useful to locate the tumour and may be predictive of the extent of involvement of adjacent anatomic structures. The clinical presentation of skull base tumors varies greatly and relates directly to the location of the lesion and the growth rate. The common symptoms are unilateral or bilateral nasal obstruction, epistaxis, anosmia, headache and rhinorrhea. Invasion of the orbital structures may be associated diplopia. Intracranial extension of the tumour with involvement of frontal lobes may occur without the production of any particular symptoms. Sometimes they may present with personality changes or behavioral abnormalities.

Malignant tumors of the skull base represent a group of diverse and infrequent lesions. Unfortunately, even benign lesions may cause progressive and unrelenting deficits if located in an area where complete resection is not allowed and growth cannot be controlled with medical or radiation therapy (3).

Choice of treatment of benign tumours is surgery. For low grade malignancy like esthesioneuroblastoma, surgery may be coupled with radiotherapy. But high grade malignancies like squamous cell carcinoma require both surgery and radiotherapy. Contraindications to surgical correction of skull base tumors are based on the patient’s co-morbidities and his or her ability to tolerate surgery. They are treated with radiotherapy. The poor long-term prognosis for patients with malignancy often overshadows the use of a large skull base resection in favor of a less-invasive palliative approach (5). There is no standard chemotherapy regime for esthesioneuroblastoma.

Cranio-facial resections of anterior cranial fossa tumors are major surgical procedures which need major reconstructive techniques. Comprehensive oncological management requires a multidisciplinary team of neurological surgeons, otolaryngologists, radiation oncologists, plastic surgeons, and medical oncologists (4). Reconstruction with fascia lata graft, abdominal pad of fat and galeal pericranial flap is one of the most effective methods with good results. The reconstruction using patients own fascia is cheap and reliable. The risk of infection is more with titanium mesh and it
is also expensive. It may also interfere with radiotherapy.

The anterior skull base tumors are rare and constitute less than one percent of head and neck malignancies. We have only 9 patients over a period of three years. More number of patients are required to standardize the treatment protocol for anterior skull base tumours. One of the areas of controversy is whether radiotherapy should be given prior to or after surgery. Dural dissection is difficult and the dura is prone for laceration in patients who underwent radiotherapy. Hence we prefer radiotherapy following surgery.

References


5. Skull base Tumors. (Medscape)Todd C Hankinson, MD., MBA.


