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CASE SERIES

Anterior Craniofacial (Transcranial) Resection for Tumors of Nose and Paranasal Sinuses: Surgical Technique

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ABSTRACT

Background: Management of nose and paranasal sinus tumors involving the cribriform plate with or without invasion of anterior cranial fossa is complex due to the anatomic detail of the region and the variety of tumors that occur in this area. Anterior craniofacial resection is recognized as the best treatment for nose and paranasal sinus, tumors involving the cribriform plate with or without invasion of anterior cranial fossa. Craniofacial resection allows wide exposure of the complex anatomical structures at the base of skull permitting monobloc tumor resection.

Methods: Twenty-one patients underwent anterior craniofacial resection for nose and paranasal sinus tumors involving the cribriform plate with or without invasion of anterior cranial fossa at Himalayan Institute of Medical Sciences, Dehradun between 2000 and 2011 by a team of head-neck surgeons and neurosurgeons.

Results: The series included 16 malignant tumors of the nose and paranasal sinuses and five extensive benign lesions. The mean age was 47.4 years (range, 12 to 68 years). There were 16 men and five women (M:F- 3.2:1.0). Four patients had a recurrence after previous treatments (surgery and/or radiotherapy). The histological subdivision was as follows: Seven cases of squamous cell carcinoma, four cases of adenocarcinoma, three cases of esthesioneuroblastoma, and two cases of undifferentiated tumors. All tumors were resected by a combined bifrontal craniotomy and rhinotomy. The skull base was closed with a pediculated pericranial flap and a split-thickness free skin graft underneath. There were no postoperative problems of CSF-leakage or meningitis, two patients had wound infection. Recurrent tumor growth or systemic metastasis occurred in three (18.75%) out of 16 patients with malignant tumors, 6 months to 2 years postoperatively. The mean follow-up was 16 months.

Conclusion: An anterior craniofacial resection should be performed in cases of nose and paranasal sinus tumors involving the cribriform plate with or without invasion of anterior cranial fossa.

Keywords: Craniofacial approach, Anterior skull base tumor, Craniofacial resection, Cranial base surgery, Skull base tumors, Ethmoid tumors, Nose tumors, Paranasal sinus.

HISTORY

The combined transfacial and transcranial surgical approach for resection of tumors of the skull base has evolved considerably since its original description. In 1954, Smith reported the first anterior craniofacial resection in a patient presenting with a tumor arising in the frontal sinus. Ketcham et al reported the first series of patients treated with an anterior craniofacial resection for tumors arising in the ethmoid sinuses. This report included the indications, morbidity, and outcome of the procedure and included a systematic description of the surgical technique. The oncologic principles of anterior craniofacial resection remain as described by Ketcham and involve an enbloc resection of tumor, including the ethmoid sinuses, superior nasal septum, and floor of the anterior cranial fossa, corresponding to the interorbital area (i.e anterior craniofacial resection) or extended laterally to include part of the bony orbit or its soft tissue contents (anterolateral craniofacial resection).[6,7] Subsequent reports included larger series of patients and multiple modifications of Ketcham's original surgical technique. These latter reports incorporate technical advances brought to craniofacial surgery by Tessier, such as the use of the subfrontal technique adopted for oncologic surgery by Derome. These modifications improved the

visualization of the tumor, facilitating its total removal and decreased, although did not eliminate, the morbidity due to brain retraction.[14,15] Advances in neuroradiologic imaging, combined with improved surgical technique, the availability of microvascular reconstructive options, and the realization of the importance of multidisciplinary collaboration, have contributed to the widespread acceptance of craniofacial resection (CFR) as a preferred treatment option for patients with tumors of the skull base. In modern practice, CFR is performed for a variety of histologic types, both benign and malignant. Recently, endoscopic and endoscopic-assisted techniques have been developed to extirpate selected tumors that traditionally have been resected using a subfrontal approach.[5]

INTRODUCTION

Malignant tumors of the sinonasal tract comprise approximately 3% of the malignancies that arise in the upper aerodigestive tract. Approximately 10% of tumors that arise in the sinonasal tract originate in the ethmoid and/or frontal sinuses and are likely to involve the anterior cranial base. Most of the tumors involving the anterior cranial fossa arise from the nose, sinuses and orbits. Conservative surgery in these areas is fraught with local recurrence at the skull base. The tumors in this region have poor survival rate (8% overall at 5 years). The mortality is caused primarily by uncontrolled local disease, with only 10% dying as a result of metastasis. An overall 5-year survival of 60% is observed for those undergoing craniofacial resections for malignant diseases involving the anterior skull base.[8,9] The craniofacial approach has gradually evolved over the past five decades into a safe and reliable technique for resecting both benign and malignant tumors involving the anterior cranial base. It can be extended and incorporated as a part of a more complex resection involving the infratemporal fossa and anterolateral cranial base, as well as the middle cranial fossa, cavernous sinus, etc. The tumors most commonly requiring combined anterior craniofacial surgery usually begin in the nose or sinuses. Tumors with a primary intracranial origin, such as meningioma, chordoma or chondrosarcoma require combined resection when they clearly violate the anterior fossa floor.[1,2]

A wide variety of tumors occur in nose or paranasal sinus, such as cancers of endodermal, mesodermal and epidermal origins, including squamous cell carcinoma, melanoma, lymphoma, sarcoma, hemangiopericytoma, malignant giant cell tumor, basal cell carcinoma, plasmacytoma, adenoid cystic carcinoma, mucoepidermoid carcinoma, malignant meningioma and metastatic malignancies.[3,4]

PROCEDURE

The anterior craniofacial approach incorporates a combination of transfacial and transcranial procedures. The facial approach consists of a graduated greater exposure depending on the extent of disease. The basic is done through a lateral rhinotomy approach coupled with a low craniotomy. The lateral rhinotomy incision may be extended into a Weber-Ferguson incision, if a more extensive maxillary excision is required. If preoperative imaging studies confirm the presence of tumor in orbit, the soft tissues of the orbit, then orbital exenteration may be facilitated by extending the incision laterally to include a portion of the eyelids.

The craniotomy is tailored according to the extent of involvement of the anterior fossa floor, the subcranial tumor location, and the degree of dural or frontal lobe invasion. A bicoronal scalp incision is made running 2 to 3 cm behind the hairline. The flap is elevated in the subgaleal plane down to the eyebrows, then to the lateral orbital walls laterally and just below the nasal glabella medially. A large flap of pericranial tissue is created that will be used for later reconstruction. As the dissection proceeds the brows, the supratrochlear and supraorbital neurovascular bundles are exposed and preserved.

The anterior cranial fossa is then exposed by removing a segment of bone which may be pedicled on the temporalis muscle or completely separated. The lower horizontal bone cut should be kept low to lessen the need for subsequent brain retraction. Withdrawing 25 to 50 ml of CSF from the lumbar subarachnoid catheter, lowering PCO_2 through controlled hyperventilation, and occasionally administering mannitol or steroids further reduce the need for mechanical frontal lobe retraction.

The dura is then carefully dissected off the crista-galli and cribriform plate dividing the dural sleeves that extend along the olfactory nerves. The intracranial portion of the tumor extension is then assessed. If it involves the dura or in certain situations, frontal lobe this will have to be resected, together with the tumor. If the dura is intact, it is retracted back to the planum sphenoidale.

Once the head and neck surgeon has completed the exposure and mobilization of the tumor transfacially a chisel or drill is used either from above or below to make the necessary bone cuts to encompass the tumor and deliver the specimen (Figs 1A and B).

RECONSTRUCTION

The pericranium is used for anterior cranial fossa reconstruction. Unless a large amount of anterior cranial fossa bone has been resected and concern for brain herination exists, it is usually not necessary to place a bone graft across the bony defect.

In all cases, an exclusive nasal pack is placed for at least 5 days postoperatively and a lumbar drain may or may not be kept for the same duration. In significantly larger defects, particularly if orbital exenteration and facial skin is excised, a bulky free flap is considered.[16]

Imaging Studies

Imaging using CT scan and/or MRI is recommended to delineate the extent of the tumor, especially in areas that are not amenable to endoscopic examination, such as the cranial cavity, orbit, other paranasal sinuses, and soft tissues of the face, pterygopalatine, and infratemporal fossa. CT scanning is superior to MRI in defining the bony boundaries. Use of contrast during CT scanning can help estimate the vascularity of the tumor and demonstrates its relationship to the great vessels and other neurovascular structures, such as dura, brain and cranial nerves. MRI usually is reserved for patients presenting with invasion of soft tissues, most importantly orbit and brain. Positron emission tomography (PET) may help to identify the presence of metastatic or recurrent tumor that may escape detection by clinical examination or CT and MRI.

A metastatic workup including CT scan of the chest and abdomen and a bone scan is recommended for patients presenting with tumors that metastasize hematogenously, such as sarcomas, melanomas, or adenoid cystic carcinomas.[11,12]

COMPLICATIONS OF ANTERIOR CRANIOFACIAL RESECTION

Wound

- Scalp necrosis
- Wound infection
- Postoperative bleeding.

Intracranial

- Tension pneumocephalus
- Cerebrospinal fluid leak
- Meningitis/abscess
- Cerebral edema/contusion.

Orbital

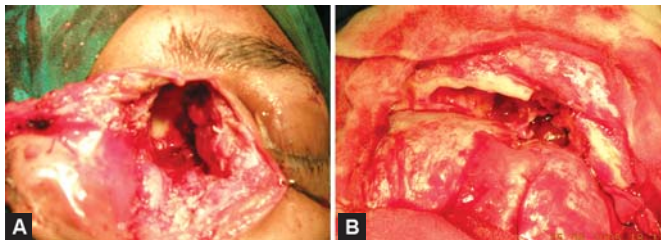
- Epiphora
- Extraocular muscle limitation
- Enophthalmos
- Blindness.

Endocrine/Electrolyte Abnormalities

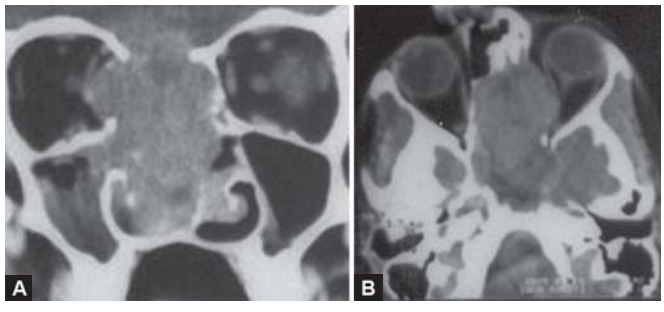
- Hyponatremia (serum sodium <130 mg/dl).
- Diabetes insipidus (DI)
- Hypocalcemia, hypomagnesemia and hypophosphatemia.

CASE SERIES

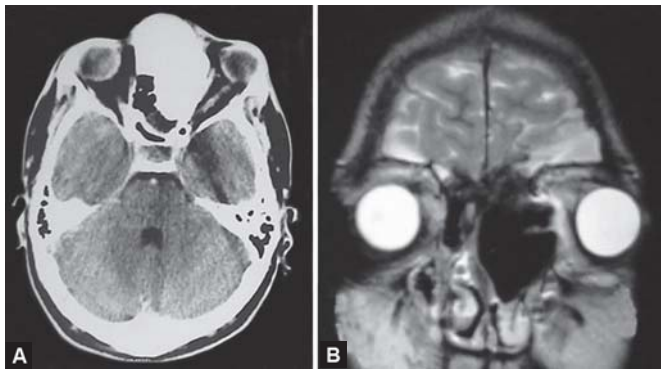
This study is a series of 21 patients of nose and paranasal sinus tumors involving the cribriform plate with or without invasion of anterior cranial fossa, treated by a team of head-neck surgeons and neurosurgeons from 2000 to 2011. The various pathological entities included 16 patients with malignant lesions and 05 with benign pathology. Age of patients ranged from 12 to 68 years (Mean age 47.4 years), with male predominance (M:F = 3.2:1.0). In all patients a detailed clinical and radiological assessment was made. Axial and coronal computerized tomographic scans (Figs 2 to 4) were done to assess extent of the tumor and for planning the surgical procedure. Eight patients had MRI also as radiological investigation, besides diagnostic nasal endoscopy and preoperative biopsy in all. Patients in malignant group with tumor extension into sphenoid sinus, orbital apex , infratemporal or pterygopalatine fossa or with brain parenchymal involvement were not considered for surgery. Out of 16 malignant tumors, squamous cell carcinoma was the commonest seven (43.75%), followed by adenocarcinoma four (25.00%), esthesioneuroblastoma three (18.75%) and undifferentiated two (12.5%).



Figs 1A and B: (A) Left lateral rhinotomy, (B) skull base defect, after tumor removal



Figs 2A and B: (A) CT scan coronal/axial view demonstrating a carcinoma of the ethmoid sinuses extending to the orbit and anterior cranial fossa



Figs 3A and B: MRI axial/coronal view demonstrating frontoethmoidal osteoma (presenting as proptosis)

Fig. 4: Coronal CT scan showing left frontoethmoidal osteoma with intracranial extension

Fig. 5: Markings for a bicoronal incision and lateral rhinotomy

Orbital invasion was evident radiologically in three (18.75%) cases, in which orbital exenteration was also done. Dural invasion was seen on MRI in three cases (18.75%), and they received radiotherapy after surgery. Amongst the 16 patients of malignant tumor an anterior CFR was combined with total maxillectomy in two and a partial maxillectomy in the remaining 14 cases. Orbital exenteration was performed concurrently in three cases (18.75%). The presenting features in benign lesions were proptosis of long duration, cosmetic deformity, diminished vision and headache. Benign lesions predominantly involved the fronto-ethmoid-orbital area (Figs 3 and 4). Most of the tumors had epicenter in nasal cavity (27.7%) or ethmoid sinus (22.22%). All tumors were resected by a combined bifrontal craniotomy and rhinotomy. The skull base was closed with a pediculated pericranial flap and a split-thickness free skin graft underneath. Hypotensive anesthesia was used in all cases in the present study. Thirteen of 16 patients with malignant neoplasms received radiotheraphy after surgery whereas, three were treated with surgery alone. There was postoperative problem of wound infection in two cases (9.5%) which responded to antibiotic treatment. No patient had CSF-leakage or meningitis. Recurrent tumor growth or systemic metastasis occurred in three (18.75%) (Figs 5 to 7) out of 16 patients with malignant tumors, (two patients had local recurrence and one had distant metastasis), within 6 months to 2 years postoperatively. However, 13 patients (81.25%) are surviving disease-free for periods ranging from 12 to 60 months (average 16 months).[13,17,18]

Fig. 6: Pre/Per/Postoperative photographs and coronal CT scan of 45 years male, patient of SCC involving nose, ethmoids, frontal sinus, left orbit with intracranial extension who had undergone anterior CFR with left orbital exenteration

Fig. 7: Pre/Postoperative photographs and coronal CT scan of 42 years female, of hemangiopericytoma who presented with mass involving left nose, ethmoids, orbit with intracranial extension and left proptosis and had undergone anterior CFR

FUTURE ASPECTS

Use of endoscopic techniques to complement or replace traditional approaches is rapidly expanding. Intraoperative navigational devices (computer-assisted surgery) and high-definition monitors and cameras, customized instruments, and new endovascular neurosurgery techniques that allow intraoperative control of the intracranial vasculature will contribute to the advancement of these techniques. Adjunctive techniques, such as brachytherapy, radiosurgery, intra-arterial chemotherapy, and chemotherapy combined with radiation, may have a role in treatment of these lesions. However, the role of these treatments remains undefined. Reports are mainly anecdotal, and their use should be limited to controlled protocols, palliative cases, or poor surgical candidates for whom conventional therapy has failed.[10]

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