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Case Report

The Transformative Impact of Preoperative Embolization and 3D Printing in Large Vascular Hyperostotic Calvarial Lesions: A Case Report

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Abstract

Calvarial hyperostosis is an uncommon type of skull tumor that is typically asymptomatic, often presenting only with swelling of the scalp. Managing complex calvarial hyperostotic lesions presents unique challenges for neuroanesthesiologists. In cases of large fibrous dysplasia, preoperative CT angiography is essential to assess the vascularity of the tumor. Additionally, creating a CT scan-guided 3D-printed model not only assists the surgeon in planning the surgical approach for large tumors but also aids in designing a customized titanium implant to improve the patient's aesthetic appearance. Intraoperative angioembolization of the feeder vessels was crucial in saving our patient's life, allowing for subsequent surgical excision and the 3 D printed titanium implant facilitated the ,reconstruction.

Keywords: Calvarial Hyperostosis, Angiography, 3D Printing, Reconstruction

Introduction

Calvarial lesions arises from skull and are rare, often presents with local pain, paraesthesia and neurological deficit. It can originate primarily from bone or as a secondary bony infiltration. Surgery and perioperative complications poses major challenge for a neurosurgeon. There is a lack of literature on the management of this rare lesion.

Anaesthesiologist plays a critical role in the perioperative management of the surgery. According to a definition by Charles Vincent, patient safety is 'the avoidance, prevention and amelioration of adverse outcomes or injuries stemming from the process of healthcare'.[2] Being a pioneer of patient safety, anaesthesiologist at times guide the surgeon for better patient outcome and safety. Informed consent was obtained from the patient for reporting of this case.

Case

A 45 years old female patient of African origin came to our institute with a big mass in the right fronto- temporal region. She had complaint of pain in right temporal region and reduced vision. The MRI revealed hyperostosis of right temporal bone, greater and lesser wing of sphenoid, obliteration of right optic canal involvement of roof and lateral wall of orbit and ethmoid (Fibrous dysplasia). She was planned for excision of tumour and reconstruction with platinum hemicranial 3D printed titanium prosthesis.

A detailed preanaesthetic evaluation was done. The patient was hypertensive and had diabetes mellitus for 5 years. Routine blood work, coagulation profile, and electrocardiogram (ECG) were within normal limits. She was shifted to the operation theatre after premedication of Rantac 150mg, Granisetron 2mg and Alprazolam 0.25 mg.

A 16-gauge iv cannula was inserted into an upper extremity vein and ASA standard monitors were applied in the operating room. Following preoxygenation with 100% oxygen, induction of general anaesthesia was done with propofol (2mg/kg), fentanyl (2microgram/kg) and atracurium (0.5mg/kg) following which 7.0mm cuffed endotracheal tube was secured orally. Invasive monitors including radial artery (left) and peripheral venous catheter were placed, and general anaesthesia was maintained with O2: Air (50:50), sevoflurane, propofol and atracurium infusions. Normothermia was maintained with a warmed-air blanket.

The surgery commenced and within 30 minutes, there was a significant blood loss of 1.5 liters. After contemplation and discussion, the surgeon agreed to angioembolize the tumour before proceeding further. After adequate resuscitation with three units of packed red blood cells, the patient was shifted to the catheterization laboratory on a portable ventilator. There angioembolization of the tumour feeder vessels (superficial temporal artery and the internal maxillary artery) was done. After the procedure, patient was shifted to the ICU and the surgery was scheduled for the next day under hypotensive general anaesthesia.

Right frontotemporal craniectomy, orbital osteotomy, right orbital exenteration and reconstruction was performed using 3D printed titanium implant.fig1 The procedure lasted for 6 hours with minimal blood loss of 250 ml. The hemodynamic parameters and blood lactate levels were within normal limits. Patient was shifted to ICU with stable vitals for elective ventilation.

On postoperative day (POD) 2, an extubation trial was attempted; however, the patient was drowsy and unresponsive to verbal commands. As a result, she was further ventilated for 48hrs. A follow-up MRI was done, which revealed a Right fronto-temporal epidural collection and pneumocephalus. She was extubated after she regained full consciousness on POD-4. She was shifted to ward on POD-5 after she began to accept orally and discharged from the hospital on POD-10.

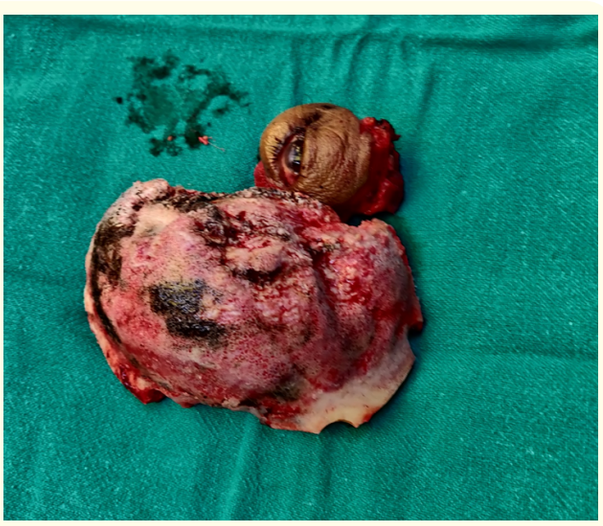

Figure 1: Excise calvarial lesion.

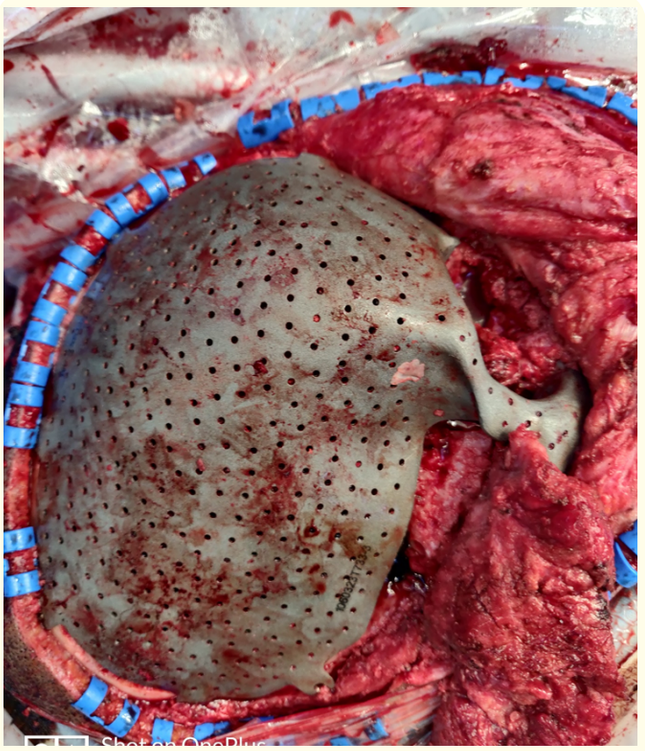

Figure 2: Titanium 3D printing customised implant.

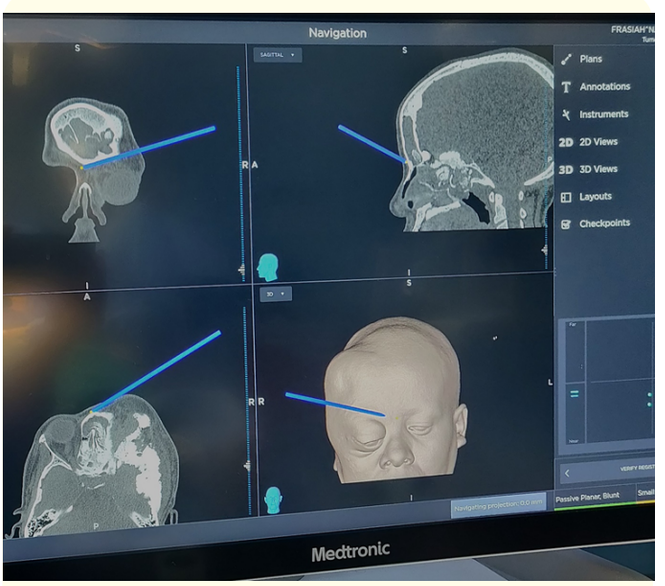

Figure 3: Neuronavigation guided location of the calvarial lession.

Discussion

The management of complex calvarial hyperostotic lesion poses unique problems and concerns for the neuro-anesthesiologist. Calvarial hyperostosis are uncommon skull tumours that are usually asymptomatic, commonly presenting with scalp swelling and occasionally with pain due to nerve compression. They are divided into three categories namely tumour like lesions, primary and secondary tumours [1]. Fibrous dysplasia (FD) is a tumour-like lesion, and its clinical behaviour and progression may vary. The management of this condition is difficult as there are few established clinical guidelines [2,3].

FD is a slow-growing and indolent lesion. However, rapid enlargement may cause compression of the adjacent structures, like the optic nerve, globe and auditory canal/structures and nasal airway resulting in functional deficits. Aggressive surgical resection have been advocated to avoid potential blindness or hearing loss [4-9].

Polyostotic fibrous dysplasia (PFD) around the eye, as in our case, are associated with proptosis, dystopia, and hypertelorism. Compression of the optic nerve may cause acute loss of vision [10,11].

Despite advances in microsurgical techniques, management of the complex, and hyperostotic lession requires multi-disciplinary approach [12,13]. Preoperative CT angiography not only demonstrate the vascularity of the tumor but can also guide the surgeon to embolize the feeding vessels of the lesion and thereby minimising blood loss and reducing operative time. Embolization of the feeding artery also enables maximal resection due to better visualization, reduces the risk of damage to adjacent tissue and decreases the risk of tumour recurrence [14,15]. Hence, decreasing the morbidity and mortality associated with the surgery. However, its application remains debatable. Randomized controlled trials comparing preoperative embolization and surgical resection of vascular tumours with resection alone are scarce.

In addition, a CT scan-guided 3D-printed model was devised to visualize the lesion and the surrounding tissues to help the surgeon in formulating various potential surgical approaches. The 3D print was also used to design and print a customized titanium implant according to the shape and size of a patient's calvarial defect. 3D-printed titanium implants improves cell proliferation and reduce operating time by better compatibility.

Conclusion

Preoperative CT angiography must be done in cases of large fibrous dysplasia to evaluate the vascularity of the tumour and accordingly angioembolization of feeder vessels decreases the blood loss during the surgery. The crucial important decision of intraoperative angioembolization of feeder vessels in the radiology suite saved the life of our patient and further surgical excision commenced in a relatively bloodless field. Additionally, the customised titanium implant created through 3D printing enhanced the patient's esthetic appearance.

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