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Case Report

Single Stage Cranioplasty with Customized Polyetheretherketone Implant After Removal of Eosinophilic Granuloma skull bone: Case Report

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Abstract

Eosinophilic granuloma is a localized form of Langerhans cell histiocytosis, most commonly involving the skeletal system. Their origin from the dura is rare with only a handful of cases on record. We present one such rare case of an eosinophilic granuloma originating from the Extradural with secondary osseous invasion in a 20 year old male who presented with a swelling in the right fronto orbital region.

A complete resection was scheduled with single stage reconstruction of the fronto-orbital bone by a polyetheretherketone (PEEK) specific implant. This implant was computer-assisted designed and manufactured and verified by the surgeon before the intervention.

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Introduction

Langerhans cell histiocytosis (LCH) is a group of idiopathic disorders which are characterized by an abnormal proliferation of histiocytes. Eosinophilic granuloma is an older term for unifocal LCH. It is a slowly progressing disease characterized by an expanding proliferation of Langerhans cells most commonly involving the skeletal system. [1] Many reports of eosinophilic granuloma of the skull and the brain have been reported. However, there are only a

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few reports of intradural LCH in literature. [2,3] We report a rare case of Extradural eosinophilic granuloma with osseous invasion. . As a consequence, cranioplasty with good cosmetic results can be challenging for the surgical team. Historically, many techniques with different materials have been used for cranioplasty, including autologous bone, titanium mesh, porous polyethylene, polymethylmethacrylate (PMMA) or hydroxyapatite. [9,10] . Polyetheretherketone (PEEK) implants are now widely used for cranioplasty [5,6], craniofacial defects repair [4] , or others parts of skeleton reconstruction[8]. PEEK prosthesis advantages are radiolucency, chemical inertness, robustness and comfort. It does not create artifacts on imaging and does not conduct temperature [5] . The recent advances in the era of computer-assisted design and computer-assisted manufacturing (CAD/CAM) prosthesis allow surgeons to consider the resection of large intraosseous meningioma with one-step reconstruction with a patient specific implant (PSI) designed using a preoperative three dimensional computerized tomography (3D CT) scan[11] .

This report describes the case of 20 year old male suffering from fronto Orbital Eosinophilic granuloma treated by surgical resection using a 3D printed resection template modelled on the 3D printed skull of the patient with a one-step reconstruction of the skull defect using a computer-assisted designed PEEK PSI.

Case Description

A 20-year-old man was admitted to our unit with a swelling above his right eye that had been gradually increasing in size over three months. He reported no history of trauma, pain, redness, discharge, or vision problems associated with the swelling. Upon examination, the swelling measured approximately 2x3 cm and felt firm to the touch, with slight tenderness. There was a bony gap above supra orbital ridge, but no pulsation, bruit, or protrusion of the eyeball was noted.

Figure 1: *Right supra orbital mass*

Figure 2: *X-ray of skull shows Osteolytic lesion*

Figure 3: *3D CT shows involvement of orbital roof*

Figure 4: *Contrast MRI shows intracranial extension*

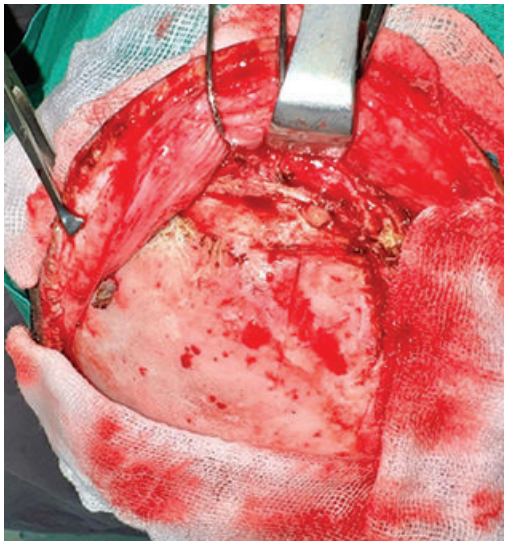

Figure 5: *Exposure of lesion*

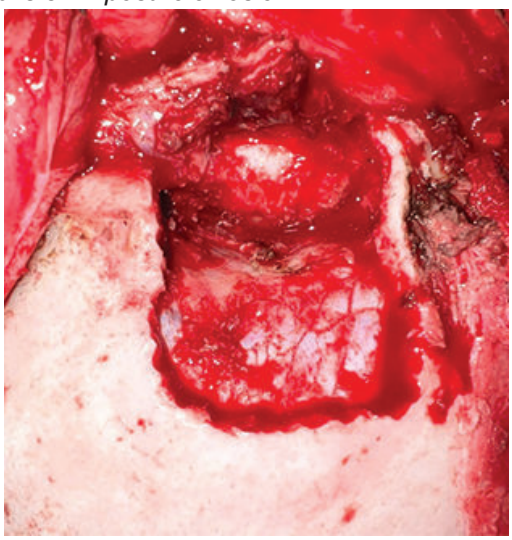

Figure 6: *Removal of lesion & completing bony work*

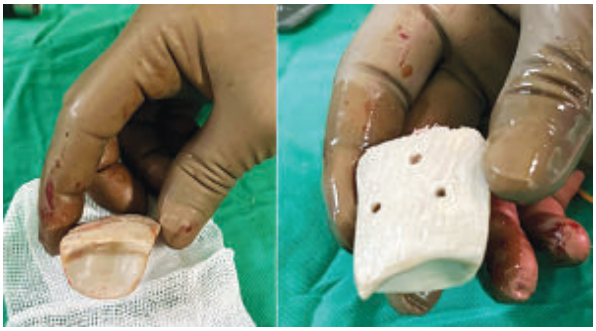

Figure 7: *PEEK material ready for Cranioplasty*

Neurologically, he was intact. Plain X-ray and CT scan revealed a round to oval osteolytic lesion in the right lateral supraorbital region, involving the roof of the orbit. MRI showed a non-enhancing soft tissue mass above the right eye, extended intracranially into the frontal

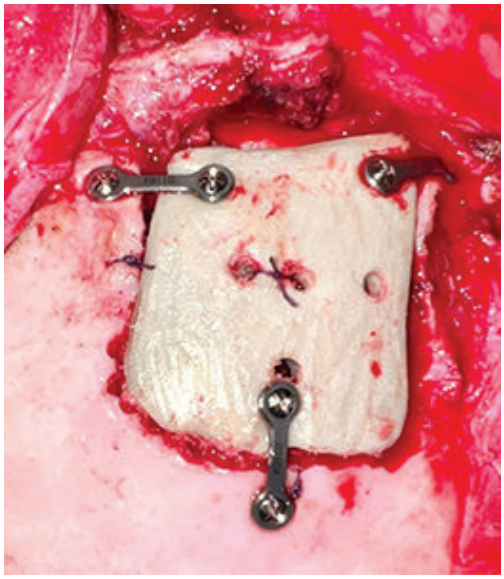

Figure 8: *Cranioplasty done*

Figure 9: *1st Post-operative day*

base. We diagnosed him as a case of Eosinophilic Granuloma involving the right orbit with intracranial extension to right frontal lobe. Surgical removal of the tumor and affected bone was performed, followed by reconstruction of orbital roof and Frontal bone by one step Customised PEEK Cranioplasty. Histological examination confirmed infiltration of Langerhans histiocytes with areas of necrosis and the presence of tumor giant cells, confirming the diagnosis of Eosinophilic Granuloma of the skull.

Figure 10: *Follow up after 4 months*

Discussion

Cranioplasty in the skull remains difficult for specialists in craniofacial and neurosurgery. Often, surgeries are done after a craniectomy, especially when it's done to relieve pressure on the brain or to treat infections. CAD/CAM technology enables surgeons to carry out single step reconstructions, particularly following extensive benign tumor removals without skin involvement, utilizing PSI. Numerous techniques have been devised over time for such resections. Some researchers have outlined the employment of a neuronavigation system fused with the virtual design of the implant to precisely demarcate resection margins, while others favors the utilization of a resection template or a blend of both approaches. CAD/CAM technology enables the creation of stereo lithographic models and 3D printed skulls. Some researchers have devised indirect methods involving molding PSI directly on the 3D printed models using PMMA, except for PEEK and PMMA materials. Previously hydroxyapatite or titanium were the main materials utilized for computer assisted allograft procedure. PEEK implants are highly suitable for computer assisted surgery because they offer excellent confirmation potential, can be drilled when necessary, and boast mechanical strength similar to cortical bone. Additionally they are biocompatible, comfortable for patients, and radiolucent, making surgery for these implants feasible. Their thermo stability is another significant advantage. The PEEK implant can undergo sterilization multiple times without losing its shape, making it useful for reuse after infection treatment. However, drawbacks include its high cost and lack of integration with bone tissue. The expense must be weighed against benefits such as reduced surgery time or the avoidance of additional procedures compared to other methods like intraoperative molding or two step procedures. Two recent meta-analysis have found that PEEK Cranioplasty carry a lower risk of infection compared to autologous or PMMA Cranioplasty, which addresses a major concern about their cost. While titanium mesh offer similar strength and cosmetic outcomes with low infection rates, it can deform under trauma and cause significant radiological artifacts.

Conclusion:

A single-step surgical method employing CAD/CAM technology to create a custom PEEK implant for individual patients is both safe and precise, yielding favorable cosmetic outcomes. This approach is expected to decrease surgical duration and minimize postoperative complications, notably infection.

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