Prosthetic Rehabilitation of Cranial Deformity in Hyperostotic Convexity Meningioma

Abstract

Cranial defects lead to unesthetic appearance and are a constant source of apprehension to the patient. Meningioma with calvarial extension requires the excision of the involved bone for complete excision. Such total excision would leave behind a bony defect which would need reconstruction. Presurgical fabrication of acrylic flap helps in reconstruction of such cranial defect following complete excision in single stage, thereby decreasing the cost and morbidity of surgery. Further, it facilitates the reproduction of the contours, and the tissue bed is not exposed to the heat of polymerization or to the free monomer. The authors report a case of hyperostotic convexity meningioma in a middle-aged female where heat-cured acrylic resin alloplastic implant was prefabricated and used successfully.

Keywords: *Acrylic resin, convexity meningioma, cranial implant, cranioplasty, hyperostosis*

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Introduction

Meningiomas are benign intracranial tumors. The association between meningioma and hyperostosis of the calvaria is well known. Complete excision of such hyperostotic calvaria associated with meningioma is recommended. Cranioplasty is carried out to achieve morphological and functional rehabilitation of the cranial vault defect. Factors that determine the outcome would depend on the appropriate selection of implant material, preparation of the recipient bed to optimize implant stability, and recognition of dead space that commonly results from the restoration of a collapsed cranial vault.[1]

Case Report

A 48-year-old female presented to the neurosurgical unit with a history of recent onset recurrent generalized seizures. There was no history of limb weakness and visual or speech disturbances. She gave a history of bony swelling in the left side of the head, which was first noticed at the age of 18 years. The swelling was painless and gradually increased in size [Figure 1]. She had no focal neurological deficit. Imaging studies revealed a large bony lesion over the left frontoparietal region, with contrast-enhancing soft-tissue component densely adherent to the pial surface of the brain. Perilesional edema with mass effect and midline shift was evident [Figure 2]. The findings were suggestive of convexity meningioma with diploic extension and hyperostosis. She was started on anticonvulsants and steroids. Preoperatively, customized acrylic flap was designed and sterilized, so that cranioplasty could be performed after tumor excision in single stage.

Polymethyl methacrylate implant fabrication procedure

The cleanly shaved cranial deformity was defined by gentle palpation and was demarcated using an indelible pencil on the scalp. Exposed hairs, particularly eyebrows and eyelashes, were coated with petroleum jelly, which prevents interlocking into the impression. Dental boxing wax was used to conform to the periphery of the skull deformity to demarcate the extension of flow of the impression material [Figure 3a]. Irreversible hydrocolloid was mixed with cold water which allows more working time without affecting the physical properties of the impression material. The mixed impression material was then spread over the skull deformity. When the plaster had set, the impression [Figure 3b] was removed and poured with Type III dental stone. The deformity was marked on the stone cast. Circumferential final

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marking for the flap was done 2 cm from the deformity, to allow for extension of the craniotomy during surgery. The deformity was then drilled to match the contour of the skull. Wax pattern was then fabricated to fit the dimension and contour on the stone cast [Figure 3c]. The wax pattern of the cranial implant was invested and processed with heat-cured acrylic resin using long curing cycle, so that the added heat of polymerization in thicker sections would boil away the unreacted monomer. Following curing, the acrylic prosthesis was trimmed, polished, and perforated using a bur. These perforations prevent the accumulation of fluid beneath the prosthesis and allow for ingrowth of fibrous connective tissue to assist in stabilization. The holes also provide a means of securing the cranial implant to the bony defect. The implant was then gas sterilized.

Surgical procedure

A large scalp flap was planned and carefully reflected taking adequate precautions for hemostasis [Figure 4a]. The cranial deformity was exposed [Figure 4b]. A rim of hypervascularity was noted for about a centimeter all around the deformity [Figure 4c]. A large bone flap was planned with 1 cm margin from the hypervascular zone. Using high-speed drill, craniotomy cuts were made [Figure 4d]. Severe blood loss was encountered during the procedure from the dural venous lakes within the bone from the inferior margin. A trough of bone was then removed, and the edges were waxed to attain hemostasis [Figure 4e]. The bone flap was then carefully dissected off the tumor attachment and the dura with a sharp periosteal dissector using the bone edge of the trough defect as fulcrum [Figure 4f]. Dura was reflected and the tumor edge defined. Dense pial attachment and vascularity were noted. Using microsurgical technique, the tumor was gradually dissected off the pial surface and excised in total [Figure 4g-i]. Following hemostasis, duroplasty was performed. The acrylic implant [Figure 5a] was then fashioned to fit the craniotomy defect [Figure 5b]. Cranioplasty was completed by securing the acrylic implant with miniplates and screws [Figure 5c].

Figure 1: Clinical photograph of the patient with cranial deformity (a) Frontal view (b) Posterior View

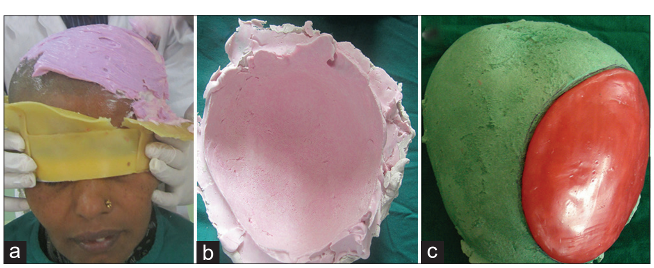

Figure 3: Procedures in impression making: (a) Defect boxed with wax to confine the impression material. (b) Impression of the cranial defect. (c) Trial wax pattern sculpted on the cast

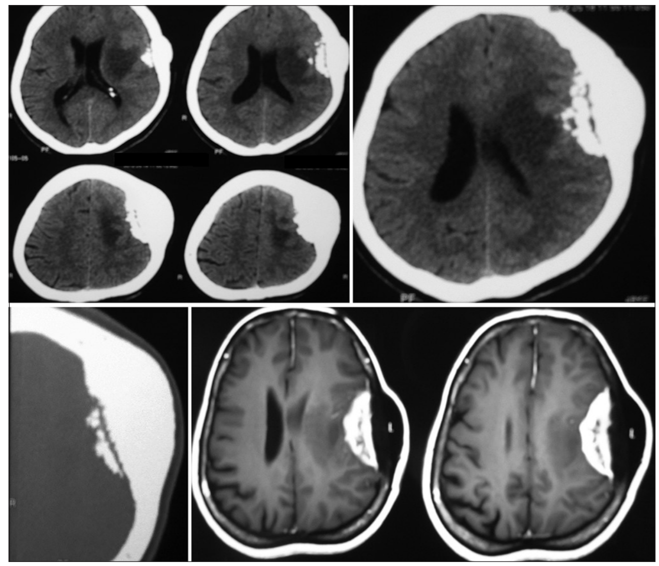
Figure 2: Imaging studies showing a large bony lesion over the left frontoparietal region, with contrast enhancing soft-tissue component densely adherent to the pial surface of the brain. Perilesional edema with mass effect and midline shift

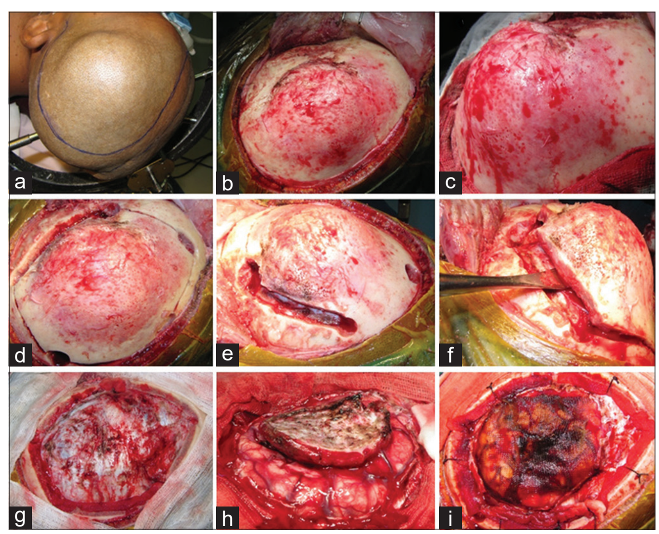

Figure 4: (a) A large scalp flap was planned and carefully reflected taking adequate precautions for hemostasis. (b) The cranial deformity exposed. (c) A rim of hypervascularity noted for about a centimeter all around the deformity. (d) Bone flap with 1 cm margin from the hyper-vascular zone. (e) A trough of bone. (f) The bone flap dissected off the tumor attachment and the dura. (g) Dura reflected and the tumor edge defined. (h and i) The tumor dissected off the pial surface

Follow-up

The patient at 1-year follow-up was asymptomatic and was satisfied with the cosmetic outcome [Figure 6]. Histopathology was reported as meningioma.

Discussion

Meningiomas are common intracranial tumors and make up 13%–18% of central nervous system tumors, but large hyperostotic meningiomas and those occurring in extracranial locations are rare.[2] The association between meningioma and hyperostosis is well known and was first described by Brissaud and Lereboullet in 1903. Hyperostosis is seen in 25%–49% of meningiomas. Various hypotheses explain the phenomenon of hyperostosis in meningioma which includes past trauma, irritation of the bone by the tumor without bony invasion, stimulation of osteoblasts in normal bone by factors secreted by tumor cells, production of bone by the tumor itself, and vascular disturbances caused by the tumor. As a common practice, neurosurgeons drill the hyperostotic bone and replace the bone flap in cases of intracranial meningiomas. To achieve higher Simpson grade of tumor excision, one should also remove the bone infiltrated by the tumor whenever feasible.[3] Excision of the tumor with the involved bone would leave behind a cranial vault defect that would need cranioplasty. The materials most commonly used to restore the cranial defect fall into four groups: autografts, allografts, xenografts, and alloplastic materials. Autologous bone graft is the "gold standard" material for reconstruction due to its mechanical properties and the low incidence of infections. It is also the most cost-effective reconstructive material. Nonetheless, bone graft often undergoes significant resorption apart from inducing a donor-site morbidity and length of the surgery time for harvesting and shaping the cranial piece.[4] Allografts and xenografts pose immunological and infective risks. As a result, alloplastic materials are chosen more often. Hydroxyapatite cements, acrylics, titanium, and carbon fiber-reinforced plastics are commonly used. The main disadvantage of alloplastic materials is their high susceptibility to infection, but they allow the repair of large defects with no donor-site morbidity.[5] Ideal synthetic material should be biocompatible, inert, nonthermal conducting, radiotransparent, nonmagnetic, lightweight, rigid, simple to prepare, easily applicable, and inexpensive.[6] Spence first reported the simple method of intraoperative fabrication of autopolymerizing methyl methacrylate implant in 1954. Since then, acrylics are most widely used implant

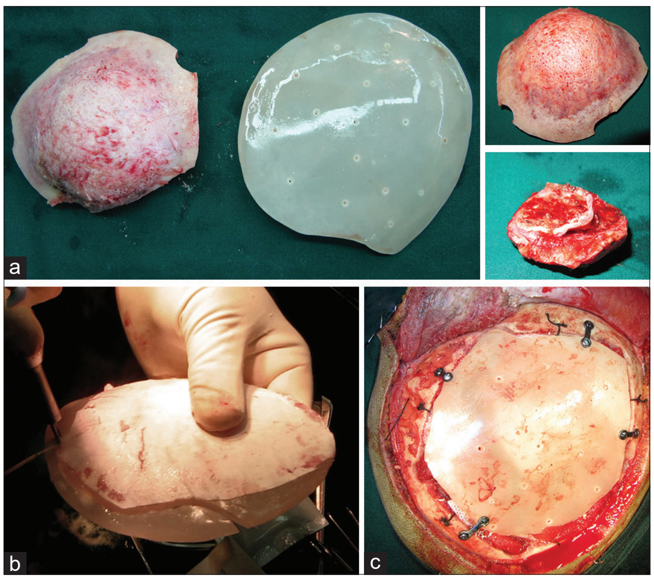

Figure 5: (a) The acrylic implant. (b) The acrylic implant was then fashioned to fit the craniotomy defect. (c) Cranioplasty completed by securing the acrylic implant with miniplates and screws

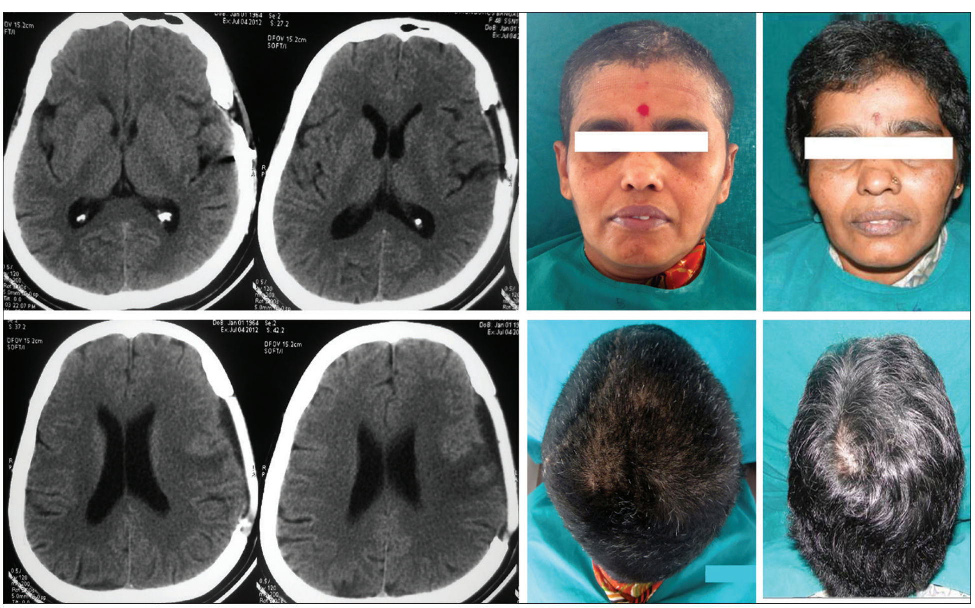
Figure 6: Radiographic and clinical photograph at follow-up

materials. Fabricating implants with autopolymerizing acrylic resin during surgery can be challenging for large or complex cranial defects. A neurosurgeon's ability to accurately shape an implant *in situ* can be compromised by hemorrhage, intraoperative swelling, location of the defect, or surgical drapes concealing the contour of the cranium. Sizable implants often appear flat, rough, asymmetrical, or cosmetically unacceptable. Forming implants directly with chemically accelerated methyl methacrylate exposes the cranial tissue to polymerization heat and residual monomer. Preformed implants simplify the restoration of complex cranial defects, reduce the surgical time necessary for implant placement, and decrease the risk of contamination that can occur when large implants are shaped intraoperatively. Preformed implant surfaces can also be polished, which can further reduce the risk of inflammatory tissue reactions.[7] Poly methyl meth acrylate (PMMA) has shown to be well tolerated without presenting biological side effects such as foreign body reactions.[8]

Severe blood loss is often encountered during craniotomy for diploic meningioma due to enlarged diploic vessels and the presence of venous lakes. Once the craniotomy cuts are made, the bone flap cannot be reflected immediately as there can be a severe cortical injury in the event of pial adhesion of the tumor. Time taken for dissection of the bone flap from the tumor can result in catastrophic blood loss. If a plan of cranioplasty has been decided, it is prudent to cut a ledge of bone along the craniotomy cuts where severe bleed is encountered, so that the bone edge can be waxed to attain hemostasis. The trough created can then be used to pass the dissector to separate the bone flap from the tumor with ease.

In the present case, a preplanned acrylic flap helped reduce the operative time, was cost-effective, and gave good cosmetic outcome. Multidisciplinary approach by the neurosurgeon and prosthodontist resulted in the rehabilitation of the cranial deformity with a prosthesis that restored the esthetic appearance and psychological well-being of the patient.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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