In situ cranioplasty with methylmethacrylate and wire lattice

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Abstract
Most techniques of cranioplasty are expensive and require advance preparation if a custom-moulded prosthesis is to be used. Technical problems with cranioplasties using synthetic materials include sinking, elevation and rotation, while those with hydroxyapatite or bone graft cranioplasties include resorption and harvest site disfigurement. We report our technique of in situ cranioplasty using methylmethacrylate and a wire lattice that is fast, inexpensive and avoids these technical problems.

Key words: Cranioplasty, hydroxyapatite, methylmethacrylate, wire lattice.

Introduction
Cranioplasties have probably been performed almost as long as the technique of trephining or, at least, soon thereafter.1 Common indications include de-compressive craniotomies, open traumatic skull defects, infectious loss of a prior craniotomy bone flap and bony involvement by tumours.2 Meticulous cranioplasty is important for good cosmetic results, as well as long-term protection of brain from external environment. Cerebral blood flow, brain metabolism, as well as neurological status are affected by the outside pressure in patients with skull defects and may improve after cranioplasty.3–5 Materials commonly used for cranioplasties include methylmethacrylate,6–11 hydroxyapatite,2,12 titanium,2,12–24 polyethylene,25–28 and allogeneic or autologous bone.29–32 Of these, titanium mesh cranioplasties, with or without bone, acrylic or hydroxyapatite reinforcement, are currently in wide use. Technical problems with cranioplasties using artificial materials include sinking, elevation and rotation. Technical problems with hydroxyapatite or bone graft cranioplasties include resorption and harvest site disfigurement. In addition, custom prostheses from three-dimensional computed tomography models of the defect are expensive and require significant preparation in advance. We describe a technique of cranioplasty using methylmethacrylate and wire lattice. This technique has the advantages of being less expensive than a preformed methylmethacrylate cranioplasty and does not have to be prefabricated.

Steps of cranioplasty

Donor site preparation
Donor site preparation is the first step. We start with the carving of dove-tail joints at three or four radial positions around the margins of the skull defect depending on its shape. These prevent any rotational movement of the cranioplasty. In situ moulded acrylic cranioplasties have been in use for several years with a low infection rate.6,33,34 Although the rate of infection with prefabricated methylmethacrylate implants may be lower than intraoperatively moulded cranioplasties,35 long-term comparisons with large number of patients are needed.
**Internal wire lattice formation**

In the next step, a fine gauge wire is placed through two opposing holes along the margins of the skull defect traversing the full thickness of the bone. This is done in a vertical ‘figure of 8’ configuration (Fig. 2). Another wire is placed through other opposing holes at right angle to the first wire. This forms a

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**Fig. 1.** Bevels in the edges of the cranial defect alternate between the inner and outer tables of the skull. The inner table bevel prevents elevation while outer table bevel prevents sinking in of the cranioplasty. The dove-tail joints resist rotational movement. A metallic malleable retractor is placed over the dura for protection during drilling.

**Fig. 2.** Cross-sectional view of the cranioplasty area. The alternating bevelled inner and outer tables prevent sinking or elevation of the cranioplasty.
radially-crossed lattice. The twisted ends of the wire are positioned to have a final position within the acrylic construct. The purpose of this lattice is to provide internal reinforcement for the methylmethacrylate.

**Methylmethacrylate implant formation**

A single layer of saline-soaked gelfoam is placed over the exposed layer of the dura. This helps insulate the dura from the exothermic reaction that takes place as methylmethacrylate hardens. Methylmethacrylate is then trowelled over the wire lattice once it has reached a mouldable viscosity. It is then contoured by the surgeon into a smooth surface imitating the normal contours of the skull in that region. The acrylic flows to fill the radial dove-tail joints, as well as the spaces created by the inner and outer table bevels. Continuous irrigation with cool antibiotic saline solution is done until the exothermic hardening reaction is complete. After the cranioplasty is complete, the wound is closed in a standard fashion.

**Results**

Six patients underwent cranioplasties using this technique. We had good clinical outcomes in all our patients. There was no immediate or delayed incidence of cranioplasty elevation, sinking or rotation with good cosmetic results in all cases (Fig. 3). Although magnetic resonance artefact from steel wire was minimal and did not interfere with postoperative imaging for tumour recurrence, using titanium wire or braided cable can reduce this still further.

**Conclusions**

The technique of cranioplasty described above is innovative, structurally sound and inexpensive. It provides excellent cosmetic results and does not require long preparation times in advance. Although a strong stand-alone construct by itself, it may also be supplemented by other means like titanium mesh implants in certain situations.

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**References**
