

Posterior Vault Distraction in Multisuture Synostosis

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The treatment of multisuture craniosynostosis involves early posterior vault distraction (PVDO)^{1,2} to address cephalocranial disproportion, expand intracranial volume, and delay forehead procedures. The benefits of this approach are many, including slow expansion with scalp accommodation, decreased blood loss, vascularized dural bone unit, and large volumetric expansion.³⁻⁶ Relative downsides include potential hardware complications and need to remove the devices. The purpose of this video vignette is to demonstrate the surgical technique of posterior vault distraction.

INDICATIONS AND MANAGEMENT

A 6-month-old infant with multisutural craniosynostosis is featured (**See Video, [online]**, which demonstrates the evaluation and treatment of a 6-month-old infant with multisuture craniosynostosis using posterior vault distraction osteogenesis). Examination demonstrates palpable, coronal, and sagittal ridges, with decreased anteroposterior cranial length. The management goal is to expand the cranial vault to increase intracranial volume at an early age. A secondary impact of this technique is vertex height lowering and increased forehead projection. Distracting the posterior cranial vault at least 3 cm enables delay in fronto-orbital advancement, leading to a more stable, longstanding advancement.

Three-dimensional planning is performed using a reconstructed computed tomogram and Virtual Surgical Planning (VSP; 3D Systems, Rock Hill, S.C.). Corticotomies are planned bearing in mind the torcula, volumetric topography, and planned vector of distraction. A surgical cutting guide is fabricated based on this plan and helps orient the distractor footplates to achieve planned vector.

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OPERATIVE TECHNIQUE

Intraoperative Details

Anesthesia is induced and the child prepped and draped in prone position. The incision is planned and scribed. We use tumescent (Kenalog-epinephrine) and blocking sutures (2-0 prolene) (according to the manufacturer). A 15 blade is used to make the incision in an oblique orientation, through the dermis to the subgaleal plane. Skin flaps are raised leaving the pericranium/periosteum down. Posterior and anterior pericranial flaps are raised.

The 3-dimensional (3D) guide is positioned to mark the planned corticotomies and help orient device placement. Cranial bone cuts are performed with a B-1 leaving the dura attached to the majority of the posterior plate. Barrel staves are created infero-occipitally. The distraction devices are assembled and brought onto the field, positioned with the arm exiting anteriorly. The footplates are bent and adapted to the cranium and 3+ screws are used per footplate side, both anteriorly and posteriorly. The device is activated 1–2 mm to ensure expansion and turned back to 0.5–1 mm. The ratchet is activated and the scalp flap drawn overtop. The lambdoid sutures are fixated with resorbable plates if patent, to prevent separation.

Following copious irrigation, the anterior and posterior pericranial flaps are re-draped over the devices, and surgical fibrillar (J & J, ethicon, Brudgewater, NJ) is added for additional padding. The scalp is closed in a layered fashion, using resorbable sutures for both the deep layers and skin. No drains are placed.

The patient is then returned to a supine position. Forty millimeter distraction extension arms are added. The distractors are activated 1 mm bilaterally to check for movement and ensure security of the ratchet. Xeroform and bacitracin are placed over the incision and dressed with 4 × 4 gauze and a Barton bandage.

Postoperative Course

The patient recovers in the pediatric postanesthesia care unit, en route to a monitored floor bed. Perioperative antibiotics and pain medication are administered in the immediate postoperative period. Distraction ensues on postoperative day 1, at a rate/rhythm of 1 mm in the morning and 0.5 mm in the evening (total of 1.5 mm/d until the distraction devices lock out at their maximal length). A lateral skull film is ordered before distraction and 1–2 weeks postoperatively to evaluate for symmetric bone transport. The distraction arms are removed dur-

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ing consolidation. The devices remain buried until post-consolidation, which may correspond to the timing of the planned fronto-orbital advancement, which avoids an added anesthetic exposure for device removal.

DISCUSSION

PVDO has allowed a paradigm shift in syndromic/multisuture synostosis infants. Rather than waiting for an older age (8–10 months) to address the forehead first, PVDO enables earlier intervention, during a critical period of brain growth, with greater volumetric expansion and less morbidity.

Patients with multisuture synostosis are at higher risk for raised intracranial pressure, which can manifest with neurodevelopmental and visual problems. PVDO obviates or lessens this risk by allowing significant intracranial expansion for normal brain growth.^{5–7} PVDO permits greater expansion than traditional remodeling techniques and allows for slow and controlled growth without bony devascularization.^{8,9} PVDO also decreases cranial height trajectory (turribrachycephaly) and improves the forehead morphology, preparing for fronto-orbital advancement at a delayed, later date.

PVDO has a perioperative safety profile comparable or better than conventional open cranioplasty for multisuture/syndromic indications (and even compared with conventional single-suture open cases). The PVDO risk profile decreases with increasing surgeon experience.^{10,11} Additional long-term advantages of PVDO require further study but may include improved coverage of osteotomy gaps with improved skeletal stability.¹⁰ In a 2-center series (Greives et al¹²), the most common PVDO complications were cerebrospinal fluid leak and dural injury, secondary to interactions of the device with the dura. Attention to protect the dura during device placement and screw fixation is important to limit complications.

3D planning has many advantages in craniofacial surgery.^{13,14} For PVDO, a normal skull can be superimposed to reveal the extent and magnitude of expansion required. Additionally, the major blood vessels (sagittal sinus and torcula) can be visualized and planned around. A printed guide shows the craniotomy outline and orients the devices at the planned position and trajectory.

CONCLUSIONS

PVDO is a powerful technique in the staged treatment of multisutural, syndromic craniosynostosis. It enables

earlier intervention with greatest volumetric expansion, delaying conventional forehead procedures. This video vignette highlights the operative steps and implementation of 3D analysis and planning.

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