Faculty Scholarship

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Titanium hardware extrusion following pediatric cranioplasty

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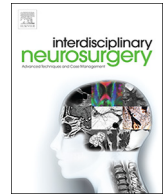Luke J. Grome

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Case Reports & Case Series (CRP)

Titanium hardware extrusion following pediatric cranioplasty

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A B S T R A C T

Aging pediatric cranioplasty patients with titanium implants are a population at risk for scalp breakdown and implant extrusion. Complications from titanium use in adult cranioplasty patients are well documented in the medical literature. Reports of complications focused on pediatric populations are sparse. In this case series, we report two examples of negative sequelae associated with titanium utilization in infant cranioplasty and discuss our treatment strategy for each case.

1. Introduction

Cranioplasty is the surgical re-contouring of the cranium. Indications for cranioplasty include congenital defects and traumatic injury. Autologous bone is the preferred medium for the reconstruction of large calvarial defects; alternatively, biomaterials are an option [1]. Patient age, limited donor site availability, defect size, history of bone graft resorption and/or site infection influence whether autologous bone or biomaterials are used [1]. When biomaterials are elected, titanium is a frequently used alloplastic material in adult cranioplasty [1–3].

Complications from titanium use in adult patients undergoing cranioplasty are well documented in the medical literature, the most severe of which necessitate explantation of hardware [4–6]. While the literature on the long-term outcomes in the pediatric population is sparse; authors do suggest that titanium is safe for use in pediatric and infant cranioplasty [7]. In this series, we report two cases of negative sequelae associated with titanium-based cranioplasty performed in infancy. Treatment strategies for each case are described. Each case presented with device extrusion necessitating hardware explantation.

2. Cases

2.1. Case 1

Patient 1 is a five-year-old male who presented with complaints of headaches and tenderness over several areas of the skull. Past history was significant for bilateral coronal craniosynostosis and anterior

cranial vault remodeling in infancy. Postoperatively, the patient developed a wound infection that resulted in loss of the bone flap, which gave rise to a large right frontoparietal skull defect. This defect was covered with titanium mesh.

On examination, the hardware was palpable beneath the sites of reported tenderness. Computed tomography (CT) of the head revealed titanium mesh (Fig. 1) with very thin scalp over its margins consistent with those areas of tenderness clinically. As he demonstrated no diploe on CT, a split calvarial graft was not an option for reconstruction. It was therefore decided to use a patient specific polyether ether ketone (PEEK) implant to obtain skull continuity after explantation of the titanium mesh. Via the previous bicoronal incision, the titanium hardware was explanted (Fig. 2) and the defect was filled with the custom PEEK implant (Fig. 3). He recovered without incident. He is two years post procedure and has since done well with resolution of headaches and scalp tenderness.

2.2. Case 2

Patient 2 is a 23-year-old male with a past medical history significant for hypothalamic pilocytic astrocytoma diagnosed at age 15. The tumor was initially excised via a frontal craniotomy. He recovered but suffered significant neurologic impairment post-procedure. His postoperative course was complicated by frontal bone loss with a resultant anterior calvarial defect that was covered by titanium mesh. He received a six-week regimen of radiotherapy, resulting in remission. At age 17, the tumor recurred, and aggressive chemotherapy was initiated. Imaging revealed cavitation and cyst formation within the mass, and he
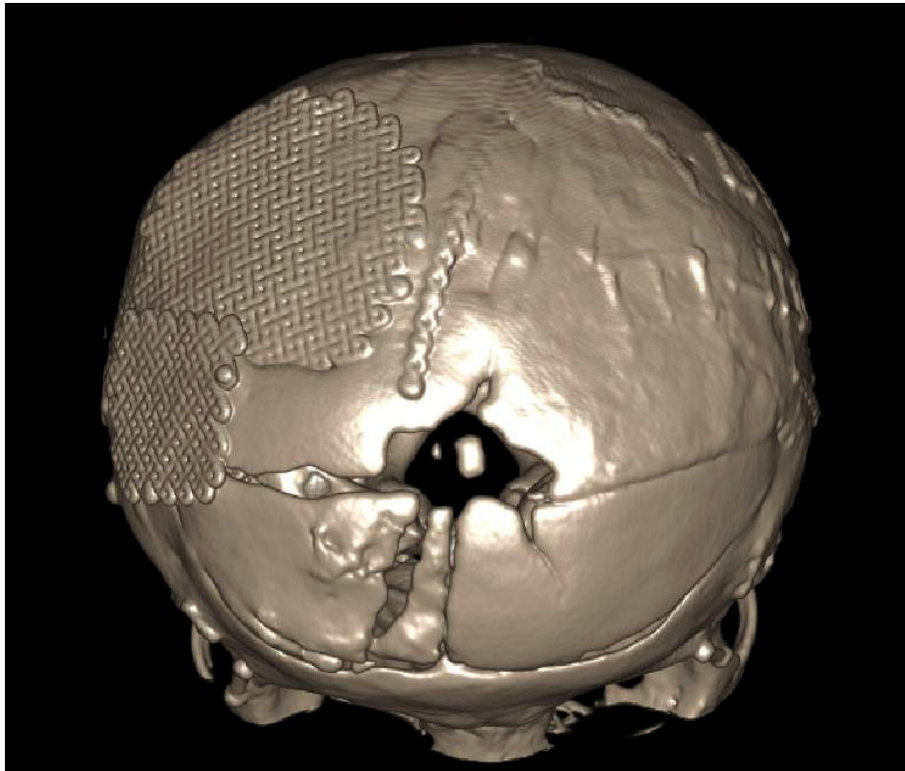
Fig. 1. Patient 1–3 dimensional CT scan reconstruction demonstrating titanium implant coverage.
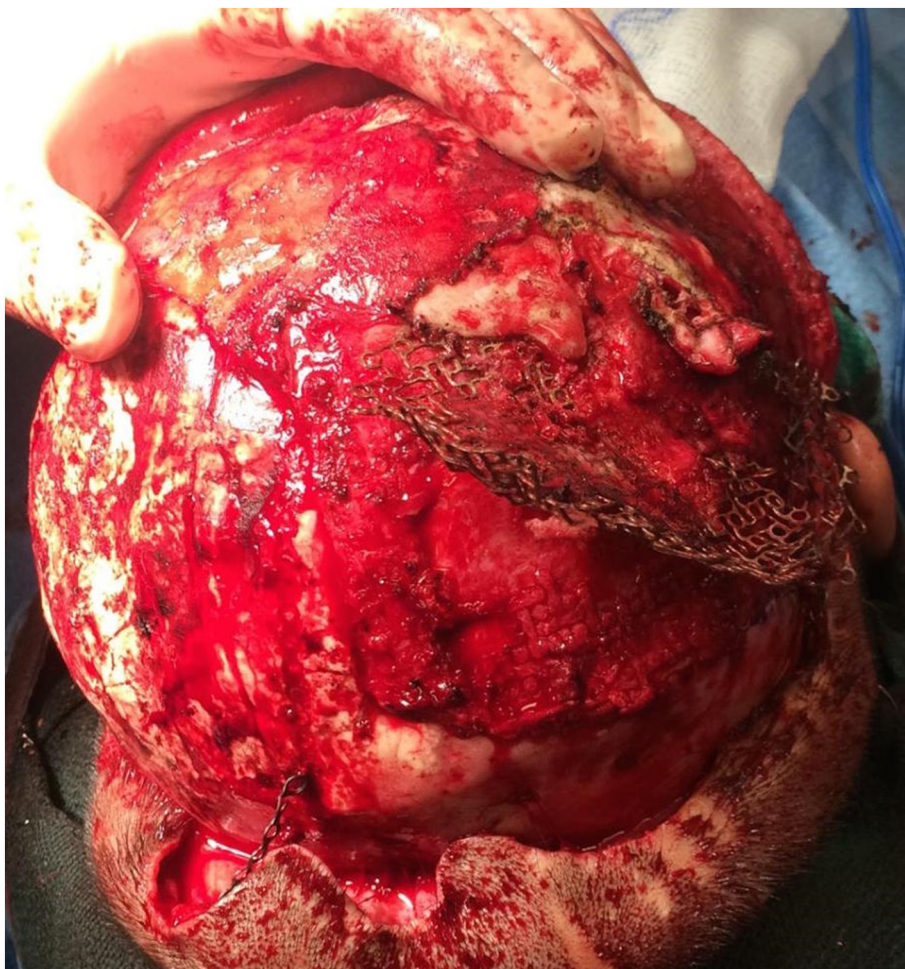

Fig. 2. Patient 1- Right frontoparietal skull defect covered with layers of titanium mesh.

Fig. 3. Patient 1- Calvarial continuity reestablished with a patient specific polyetheretherketone (PEEK) construct.
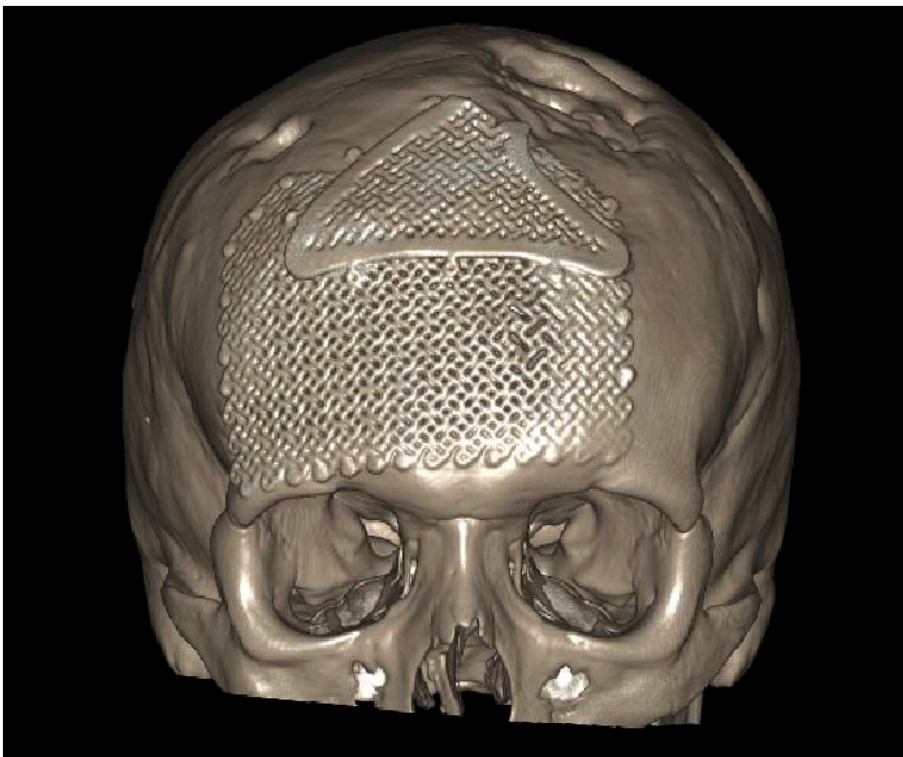

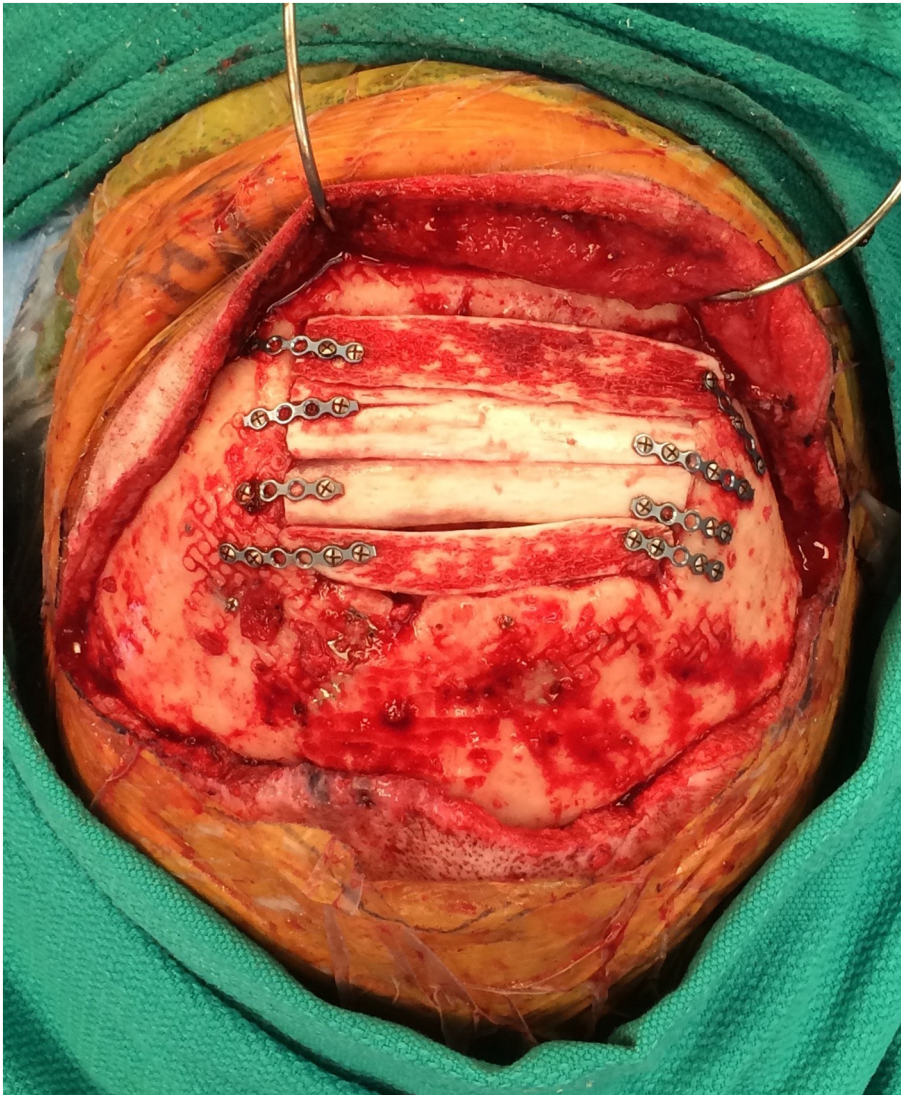**Fig. 4.** Patient 2–3 dimensional CT scan reconstruction demonstrating titanium implant coverage.

Fig. 5. Patient 2- Placement of cadaveric split-rib graft for calvarial continuity.

was treated with image-guided left frontal craniotomy and micro-surgical excision of the mass. He recovered and was disease-free for five years.

At age 23, he presented with new erythema and tenderness over the right frontal skull and forehead. On exam, he had evidence of extrusion of the anterior margin of the titanium mesh with a local cellulitis. CT scan of the head confirmed these findings (Fig. 4). Due to his significant neurologic challenges and his difficult to control self-deprecating behaviors, the family initially refused extensive intervention that would have included explantation of his titanium mesh, resulting in a large anterior defect. As such, a staged approach was offered that included initial local control with ultimate reconstruction in a second procedure. The presenting extrusion and cellulitis were targeted via local excision of the extruded margin of mesh and a two-week course of anti-microbials which effectively treated the local process.

Three months following the resolution of the cellulitis, he re-presented with the margin of the titanium extruding again. No obvious cellulitis was evident. As the family again declined a split calvarial graft, and because the soft tissues were not intact, it was decided that the plan would be to trial a cadaveric bone source en lieu of an allo-plastic material after removal of all titanium. As such, cadaveric split thickness rib bone grafts were fashioned for temporary continuity and interface over the brain (Fig. 5). It was recognized that long term en-graftment of the allografts would likely fail. The intent being to treat

any infectious process in preparation for a prosthetic implant. Indeed, he recovered without incident post titanium explantation and rib grafting, completed a course of antimicrobials, and remained with a solid construct for 6 months until the family noted a soft region evolving. CT confirmed resorption of the rib grafts. With no evidence of any inflammatory process, a patient specific PEEK construct was fashioned and placed in a final procedure to reestablished continuity of the cal-varium. The patient did well postoperatively with no further scalp or skull concerns. He was symptom free for 12 months at which time the tumor recurred. His parents decided that supportive care would be the way forward and he succumbed to his primary disease 14 months later.

3. Discussion

Titanium hardware exhibits high biocompatibility, low levels of both corrosion and toxicity and an established safety profile in the adult cranioplasty population [1–3,8,9]. In the pediatric population, titanium implants may not be tolerated as well. The distensibility of a thinner scalp and pressure injury in children with limited mobility secondary to neurodevelopment delay may complicate its use [10]. The presence of titanium beneath the soft tissues of the scalp may result in tissue injury recognized in patients as pain, redness, swelling, and ultimately ex-trusion of the hardware [4,6]. Once exposed to extrinsic microorgan-isms there is potential for local cellulitis and central nervous system

infection [6]. Treatment strategies for these patients can be challenging, as there is significant variability between patients at presentation. Functional status and ethical issues must be considered prior to relegating a patient and family to an extensive intra and postoperative course that may itself be fraught with obstacles. As such, an individualized approach merits discussion with families.

In the case of titanium extrusion with no underlying defect, hardware removal is the definitive treatment. The patient, who presents with imminent extrusion over a calvarial defect amenable to reconstruction, benefits from preemptive intervention prior to extrusion. Size of the defect, presence of a diploe, patient age, and neurodevelopmental status, are considerations before intervention. Autologous split-thickness calvarial graft is preferable if sufficient donor stock is present. Allograft and alloplastic alternatives are also viable options. The patient who presents with titanium extrusion, acute cellulitis, and a calvarial defect amenable to reconstruction can be managed with staged intervention. First, explantation of the offending hardware, local debridement and targeted antibiotic therapy sterilizes the field. While compliant patients may use helmets to protect the exposed brain beneath large calvarial defects, alloplastic bone graft for temporary coverage is an option for patients who cannot be compliant with helmet use.

4. Conclusion

Cranioplasty patients with titanium placed at infancy are a population at risk for scalp breakdown and implant extrusion. These two cases highlight this complication and offer two management strategies.

Declarations of interest

None.

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