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ORIGINAL ARTICLE

OssDsign cranioplasty in children: a single-centre experience

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Abstract

Introduction OssDsign have developed a new type of cranioplasty plate, consisting of calcium phosphate reinforced with titanium. Currently, there is little known about the cosmetic outcomes and infection rate when OssDsign cranioplasty plates are implanted into paediatric patients.

Methods A retrospective case series was performed to include all paediatric patients who received an OssDsign cranioplasty at a single centre, Sheffield Children's Hospital. The cosmetic outcomes were subjectively reported by the parents of the children.

Results We identified seven paediatric patients where OssDsign cranioplasty was performed. This included two bifrontal and five hemicranioplasties. However, there was failure to implant an OssDsign hemicranioplasty in one patient where a titanium plate was subsequently used. The median duration of follow-up was 15 months. The infection rate was zero. The parents of the patients who successfully received OssDsign cranioplasties were pleased with the cosmetic outcomes. There were cosmetic complaints from the parents of the one patient who received a titanium plate.

Conclusion Our early experience with OssDsign cranioplasty in paediatric patients indicates that it may potentially be associated with a low rate of infection and good cosmetic outcomes.

Keywords Cranioplasty · Decompressive craniectomy · Traumatic brain injury · Ventriculoperitoneal shunt

Introduction

Cranial reconstruction following craniectomy facilitates neurorehabilitation and can improve a child's psychological and social development. Cranial reconstruction can be carried out using autologous bone or synthetic materials. In the UK, it is common practice to use synthetic materials such as titanium or acrylic. In our experience, the titanium overlays can lead to a poor cosmetic appearance, particularly when used for bifrontal reconstructions. Furthermore, we have found the acrylic inlays can give a suboptimal fit, mainly due to their rigid structure.

Recently, the OssDsign cranioplasty has become available, which is a titanium-reinforced calcium phosphate inlay plate. There is some evidence in the adult population to suggest that the OssDsign cranioplasty is associated with a low rate of infection [1]. However, there is little evidence to suggest how the cosmetic outcomes using OssDsign compare against other synthetic materials.

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Methods

A retrospective case series was carried out at a single centre, Sheffield Children's Hospital. We included all paediatric patients who have undergone cranial reconstruction using an OssDsign plate up to July 2019. The total sample size was 7, with a male to female ratio of 1:1. The patients were aged from 3 to 14 with a median age of 10 years old (Table 1).

Two of the patients initially underwent a bifrontal craniectomy, indicated due to CNS infection. Furthermore, 4 patients had undergone a decompressive hemicraniectomy. The indication for hemicraniectomy was trauma in 3 patients and subarachnoid haemorrhage in 1. Prior to cranial reconstruction, 2 patients had ventriculoperitoneal shunts in situ. The parents of the children were contacted for their opinion on the cosmetic outcome.

Table 1 Pre-operative patient demographics

		Number of patients
Male:female		1:1
Age		10 (3–14)
Type of craniectomy	Bifrontal	2 (29%)
	Hemi	5 (71%)
Indication for craniectomy	CNS infection/empyema	3 (43%)
	Trauma	3 (43%)
	Aneurysmal subarachnoid haemorrhage	1 (14%)
VP shunt in situ		2 (29%)

Results

The median time from craniectomy to cranioplasty was 6 months (3–14). The mean duration of follow-up was 15 months (3–23). Our rate of infection, including superficial and deep, was 0. There were no cases of post op extra dural haematomas or cosmetic complaints from the parents. However, there was 1 patient where we failed to implant the OssDsign plate (Table 2).

Case 1

A 3-year-old male who underwent a right-sided decompressive craniectomy to treat a traumatic brain injury. Preoperatively, he had a pseudomeningocele with a full craniectomy defect. Intra operatively, there was difficulty fitting the OssDsign inlay plate due to the brain volume. Mannitol was administered and approximately 50 ml of CSF was removed via lumbar drainage. This enabled the plate to be fitted. However, immediately post op he was found to have an ipsilateral fixed and dilated pupil. He was taken back to theatre for a wound exploration, no extra dural haematoma was found and the plate was removed. The patient made a full recovery and had a titanium overlay cranioplasty implanted at a later date. In this case, the initial failure was more likely due to the surgical decision-making and not the OssDsign plate itself.

Table 2 Complications

	Number of patients
Superficial wound infection	0
Cranioplasty infection	0
Haematoma	0
Failed implantation	1 (14%)
Cosmetic complaints	0

Case 2

An 8-year-old male who had undergone a bifrontal craniectomy to treat subdural empyema associated with a left frontal brain abscess. Preoperatively, his craniectomy site was bulging. There were two attempts at a bifrontal reconstruction using acrylic inlay plates. Despite lumbar drainage of CSF, mannitol and opening basal cisterns, the fit was still too tight with the acrylic plate. The patient would become bradycardic when the plate was placed; therefore, the procedure was abandoned. On a third operation, the cranial reconstruction was successful using an OssDsign plate. This may have been due to the more optimal curvature of the plate which gave more space for the frontal lobes. The parent was pleased with the cosmetic outcome (Fig. 1).

Cosmesis

Subjective feedback on the cosmetic outcome was provided by the parents of 6/7 patients. Of these 6 patients, 5 had successfully undergone OssDsign cranioplasty, whereas 1 had received a titanium plate. The parents of 5 patients who had received OssDsign plates were very pleased with the cosmetic appearance, and they all stated that their child's head looked normal. This included 2 patients who underwent bifrontal reconstruction. On the other hand, the parents of the 1 child who had a titanium hemicranioplasty implanted were unhappy with the cosmetic outcome. They stated that the head looks asymmetrical and irregular due to bulging where the plate is. Furthermore, they were concerned that their child may be bullied as a result of his appearance. Despite this, they did not want a further operation to correct the defect, given the risks associated with surgery.

Discussion

Cranial reconstruction can be performed using autologous bone or synthetic materials [2–5]. Some centres prefer to use autologous bone grafts for the primary cranioplasty and reserve synthetic materials if this fails. The advantage of autologous bone is that it is more cost effective and enables the cranial reconstruction to be performed earlier which facilitates neurorehabilitation. Furthermore, autologous bone cranioplasty may be more suitable in patients with growing skulls, given the potential for osseointegration [6]. However, some centres have experienced high rates of complications with autologous bone cranioplasty in children [2], such as bone resorption and infection. The rate of bone resorption in children has been reported at 29–81% [2, 7–10] with 22–54% needing revision surgery due to the osteolytic bone flap [2, 9, 11]. Furthermore, younger age has been shown to be associated with an increased rate of bone resorption [2, 7, 11]. The

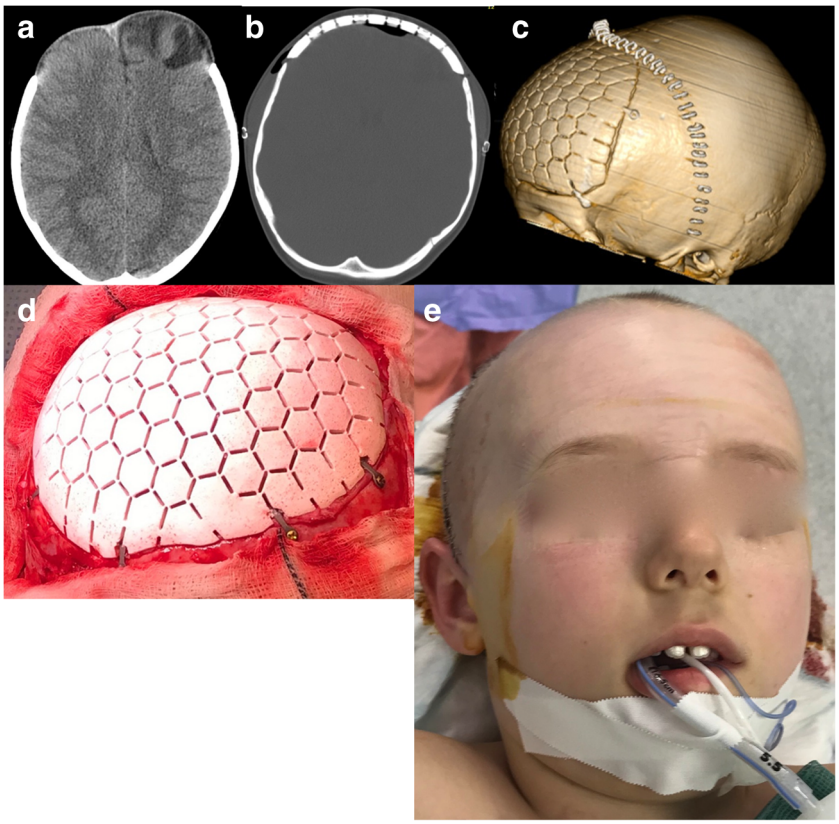

Fig. 1 **a** Pre-operative axial CT showing bifrontal craniectomy defect. **b**, **c** Post-operative axial CT and 3D reconstruction showing OssDsign inlay play in situ. **d** Intra-operative images of OssDsign plate being fitted. **e** Immediate post-operative photo showing excellent cosmetic appearances

rate of flap infection when autologous bone is used is 7–21% [5, 8, 10–12].

There is less evidence available comparing the cosmetic outcomes following cranioplasty in children. Wakas et al. found in a cohort of 36 paediatric patients that 28% of parents were unsatisfied with the cosmetic outcomes following autologous bone cranioplasty [5].

In the UK, it is common practice to carry out primary alloplastic cranioplasty using synthetic materials such as titanium and acrylic [3, 4, 10, 13, 14]. There have been reports of low complication rates with titanium plates and low rates of revision surgery in children [3, 13]. In particular, titanium cranioplasty has been associated with a low rate of infection [13–16]. However, given that the titanium plate does not grow with the patient's skull, some centres avoid titanium cranioplasty in young children [6].

There are other factors which may potentially increase the risk of cranioplasty infection. When a craniectomy is carried out due to CNS infection, early cranioplasty is associated with a higher risk of infection [9]. There is some evidence to suggest that the presence of a VP shunt is associated with a higher rate of cranioplasty infection [11, 17]. In our series, there were 2 patients with VP shunts in situ prior to cranial reconstruction and we did not observe cranioplasty infection in either of these cases.

The time delay from craniectomy to cranioplasty is variable [8, 9, 11] and the optimal timing is not clear. Performing early autologous bone cranioplasty may reduce the risk of bone resorption. Piedra et al. [8] found that their rates of bone resorption decreased from 42 to 14% when surgery was performed within 6 weeks of craniectomy. However, other studies have not demonstrated an association between time delay and bone resorption [9, 11]. Early cranioplasty has been associated with shorter operative times [18], likely due to reduced scar formation. Furthermore, early cranioplasty facilitates rehabilitation and can directly improve the neurological status of patients [19, 20].

We present a series of 7 paediatric patients who underwent cranial reconstruction using the OssDsign inlay plate. However, this includes 1 case where we failed to implant the OssDsign and needed to proceed with a titanium overlay at a later date. On the other hand, in 1 case, we successfully implanted an OssDsign cranioplasty where 2 acrylic plates had failed. The OssDsign cranioplasty is a calcium phosphate plate reinforced with titanium. There is evidence to suggest that this material promotes new bone formation and has a low rate of infection [1]. So far, in 6 cases, we have had no cases of infection, including superficial and deep infections. No patient required a course of antibiotics or removal of an infected plate.

The feedback we have received from the parents of children who successfully underwent implantation of OssDsign plates has been very positive. Furthermore, we have subjectively noted excellent cosmetic outcomes following bifrontal reconstruction, which has previously been more difficult to

achieve using other materials when compared with hemicranioplasty. However, there were cosmetic complaints from the parents of 1 child who received a titanium plate.

This study represents our preliminary experience using OssDsign cranioplasty. Given that it is a new material and there is little evidence regarding its efficacy in children, we have not yet implanted the plates into a large number of patients. Therefore, our study is limited by its small sample size and relatively short follow-up. Furthermore, we have not used objective criteria for assessing the cosmetic outcome. Given the impact that physical appearance can have on a child's psychological and social development, it would be of value to incorporate objective analysis of cosmesis into future prospective studies comparing different synthetic materials.

Conclusion

Our early experience with OssDsign cranioplasty in paediatric patients indicates that they may potentially be associated with a low rate of infection and good cosmetic outcomes.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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