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Primary and secondary reconstruction of complex craniofacial defects using polyetheretherketone custom-made implants

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ABSTRACT

Purpose: The aim of this study was to evaluate the surgical outcomes using polyetheretherketone (PEEK) patient-specific prostheses produced by computer-aided design and manufacturing for primary and secondary reconstruction in patients with craniofacial defects.

Material and methods: The study included 13 patients who underwent reconstruction for craniofacial defects using PEEK patient-specific implants (PSI). Eight patients underwent single-step primary reconstruction using individual custom-made surgical guides and custom-made prostheses during the same surgery; five patients underwent delayed reconstruction. The material used to manufacture the implants was PEEK in 13 cases. All patients underwent esthetic examination, ophthalmological examination, and radiological evaluation during the preoperative and follow-up periods. The operation duration and short- and long-term complications were recorded.

Results: The shape and global position of the implants were satisfactory in each case. Fitting of the implant during surgery required extensive adaptation in 1 case and minor in 11 cases.

Of 13 implants, 11 adequately restored a morphological complex area with satisfactory cosmetic results. No complications related to the implants were reported.

Conclusion: Reconstruction for cranio-facial defects using PEEK computer-aided designed and manufactured implants is a promising new technique that allows for accurate restoration of the complex 3D anatomy of the craniofacial region.

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1. Introduction

Defects of the craniofacial complex may result in esthetic deformities, functional damage, and psychological consequences (Scolozzi et al., 2007). Reconstruction with postoperative re-establishment of the contour and local shape has become a surgical priority (Habal, 2004). The difficulties in repair of the cranio-orbital region are related to the complex shape of such defects involving different curvature planes and different thicknesses. In cases necessitating resection of the orbital walls and rims, orbital reconstruction is advocated to avoid enophthalmos or persistent diplopia (Gaillard et al., 1997; Kelly et al., 2005).

Since 1995, improvements in medical imaging and computational modeling have allowed for the development of various computer-aided, prefabricated patient-specific implants (PSIs) (Eufinger et al., 1995). The use of alloplastic implants with specific digital designs is reportedly an effective technique for the treatment of craniofacial defects, reducing the need for manipulation in the intraoperative period and decreasing the surgery time (Kim et al., 2009; Eppley et al., 2002; Gerbino et al., 2013). Polyetheretherketone (PEEK) biomaterial has been used for many years in craniofacial reconstruction for numerous physical and handling properties that are favorable in this kind of reconstruction (Scolozzi et al., 2007; Gerbino et al., 2013; Jalbert et al., 2013).

In this study, we report our experience with the use of PEEK PSIs and describe the surgical planning and technique, as well as the esthetic and functional outcomes, of PEEK custom-made prefabricated implants using computer-aided design and manufacturing for primary and secondary craniofacial reconstruction.

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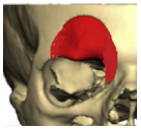
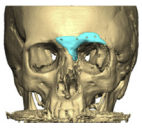
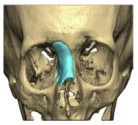
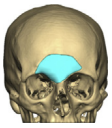
Table 1
Patient demographic and clinico-pathological features.

Patient	Age (y)	Sex	Diagnosis	Type recon	Cutting guide	Site/Resection	Material	Complication
1	40	M	Osteoma	Secondary	—		PEEK	No
2	68	F	Post tumor resection	Secondary	—		PEEK	No
3	72	F	Post tumor resection	Secondary	—		PEEK	No
4	28	F	Post tumor resection	Secondary	—		PEEK	No
5	52	M	Post traumatic deformity	Secondary	—		PEEK	No
6	62	F	Meningioma	Primary	Navigation-guided resection		PEEK	No
7	46	F	Hemangioma	Primary	Computer-generated physical cutting guide		PEEK	CSF leak – secondary procedure
8	56	M	Meningioma	Primary	Computer-generated physical cutting guide		PEEK	No
9	54	F	Meningioma	Primary	Computer-generated physical cutting guide		PEEK	No
10	46	M	Osteoma	Primary	Computer-generated physical cutting guide		PEEK	No
11	48	M	Osteoma	Primary	Computer-generated physical cutting guide		PEEK	No
12	51	F	Meningioma	Primary	Computer-generated physical cutting guide		PEEK	No

(*continued on next page*)

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