

Mandibular recontouring with polyetheretherketone (PEEK) patient-specific implants

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SUMMARY

The definition of the mandibular angle profile is a common challenge for oral and maxillofacial surgeons. Accurate diagnosis and treatment planning are mandatory in order to properly manage soft and hard tissues. The use of several biomaterials is described in the literature. The present paper reports the treatment of a defect in the right mandibular angle in otomandibular syndrome sequelae by positioning polyetheretherketone (PEEK) patient-specific implants (PSI) in a 25-year-old patient who previously underwent orthognathic surgery. Satisfactory aesthetic results were achieved with no complications 12 months after surgery. Considering its advantageous physical properties and the low rate of postoperative complications reported in the literature, PEEK can increase the treatment options for recontouring not only the upper third and the middle third of the face, but also of the lower third, in particular in cases of large three-dimensional defects.

BACKGROUND

Recontouring the mandibular angle profile is a surgical challenge of not easy resolution. This issue is found frequently in the context of treatment of facial asymmetries and cannot exclude accurate diagnosis referred both to what is due to hard tissues and what is due to soft tissues. Awareness of the various treatment suggestions is of pivotal importance. The literature, regarding defects relevant to hard tissues, describes the use of several biomaterials including porous polyethylene and titanium.¹⁻³ The literature also describes, limited to treatment of craniofacial defects, the use of polyetheretherketone (PEEK).⁴ Biocompatibility of PEEK is an established fact, validated by the existing literature. Its use has been described as part of reconstruction of skull defects and those in the orbital-maxillo-zygomatic district, both in post-traumatic and in postcancer situations. However, the use of this material to correct the lower third profile of the face is a practice that is still little described in today's scientific literature.^{5,6} It is the opinion of the authors that the use of PEEK patient-specific implants (PSI) developed using Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) methods can be a versatile treatment option, practical and effective even in mandibular recontouring. The following paragraph describes treatment of a defect in the right mandibular angle in otomandibular syndrome sequelae by positioning PEEK PSI.

CASE PRESENTATION

A 25-year-old patient suffering from Pruzansky-Kaban IIA otomandibular syndrome came to the



Figure 1 Patient (18 years old) affected by right otomandibular syndrome before orthognathic surgery. (A) Frontal view. (B) Submental view.

attention of the authors with a chief complaint of persistent asymmetry of the lower and middle third of the face. Five years earlier, at the age of 17, the patient had undergone osteodistraction surgery at the right half mandible to get greater bone quantity for osteotomy purposes. After 1 year, he then underwent Le Fort I osteotomy, Obwegeser/DalPont osteotomy with an Epker/Hunsuck modification, iliac bone graft at the upper jaw and genioplasty for the correction of severe class II dentoskeletal malocclusion associated with severe maxillomandibular asymmetry (figure 1). Stable occlusion was achieved following this surgery from the functional standpoint accompanied by good bone symmetry but an important symmetry deficit at the gonial level detectible both from a frontal position and from a lateral position remained due to severe underdevelopment of the right half mandible (figure 2). The patient was proposed with surgery for locoregional volumetric increase by positioning of revascularised fascioadipose free flap, which, however, the patient refused to consider given the invasiveness and potential complications. After obtaining informed consent, the patient was then candidate for locoregional reconstruction of the right mandibular angle and the ipsilateral lower mandibular margin by PSI in PEEK (Synthes GmbH, Oberdorf, Switzerland). The patient, consequently, underwent three-dimensional (3D) CT of the facial bones following the Synthes protocol. This was followed by programming the PSI (figures 3–5), done during a web conference between the practitioners and the



Figure 2 Patient after orthognathic surgery. (A) Frontal view. (B) Submental view. Residual soft and hard tissue right mandibular angle and body defect.



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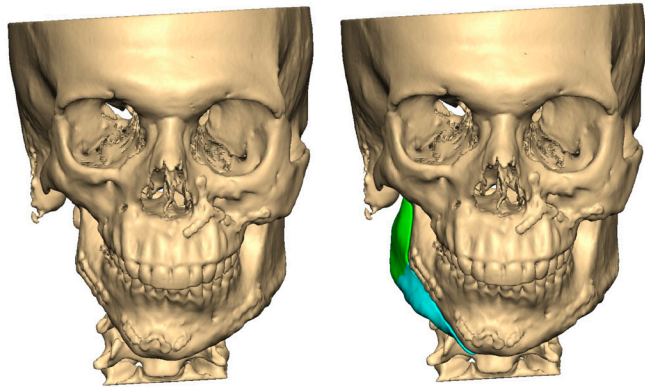


Figure 3 Patient-specific implant planning with mirroring technique, frontal view.

manufacturer and subsequent construction of the prosthesis. The patient then underwent surgery in general anaesthesia. Through submandibular access, following identification of the facial vascular pedicle, surgical exposure was performed of the right mandibular ramus–body from the subcondylar angle region up to the ipsilateral symphysis. This was followed by removal of the fixation devices positioned during the previous surgery. Correct fitting of the PSI was checked, and it was then stabilised by 2.0 mm thickness monocortical titanium screws and plates positioned on the vestibular surface of the mandibular bone body and the prosthesis itself (figures 6–8). This choice was dictated by the absence of masticatory stress forces on the PSI. Unlike other materials, this type of prosthesis, which does not overlap the native bone, does not permit stabilisation with transfixed screws. Suture of the overlying soft tissues, in spite of the considerable volume of the implant, was easy and without particular stresses.

OUTCOME AND FOLLOW-UP

The postoperative course took place without notable complications, and the patient was discharged on the second day after surgery. After 30 days of surgery, the patient underwent CT to monitor the facial bones through axial, coronal and 3D scans. Bone–PSI contact was assessed on the entire interface between the two surfaces and was found to be satisfactory. The patient shows good recovery of the mandibular angle projection, which is symmetrised with respect to the contralateral mandible, with the absence of significant functional deficits. A certain degree of asymmetry remains in the right cheek region, probably due to a lesser amount of soft tissues at that site (figure 9). The patient was proposed, to treat the residual deficit, with undergoing lipofilling but chose to pass up on this. The patient, 3 years after surgery, was once again contacted; having moved abroad for

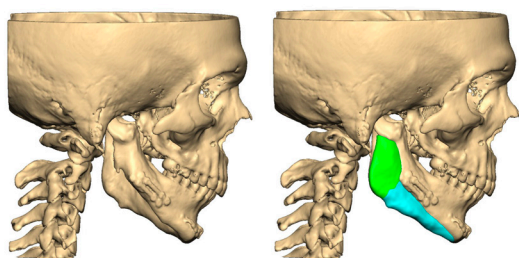


Figure 4 Patient-specific implant planning with mirroring technique, right profile view.

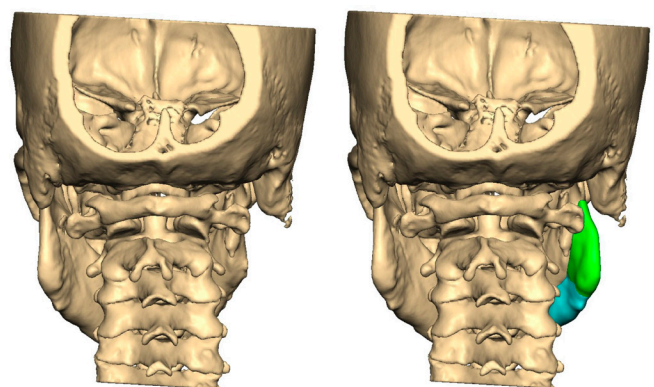


Figure 5 Patient-specific implant planning with mirroring technique, posterior view.

professional purposes, he was unable to come for a new clinical evaluation; however, he referred being satisfied with the aesthetic outcome and not having experienced issues with the implants.

DISCUSSION

Recontouring of the mandibular ramus and body can have a remarkable impact on the appearance of the lower third of the face, both from the frontal and lateral perspective. The majority of patients who benefit from this type of surgery present class I, II or III dentoskeletal deformities associated with asymmetry or syndromic conditions. Several authors have proposed, to patients with normal dentoskeletal relationships but who wish to increase the bigonial distance, sagittal osteotomy of the ramus with bone grafts interpositioned between the cortical bones.^{7 8} However, this procedure is technically complex, little predictable and has a non-negligible risk of incorrect positioning of the condyle in the glenoid fossa (condylar sag). Autologous bone grafts remain a good reconstructive option for small defects (less than 3 or 4 cm) with non-complex shapes in the craniofacial area.⁹ Less severe mandibular asymmetries may also be addressed with a chin-wing osteotomy.¹⁰ Anyway, augmentation of the mandibular angle with autogenous bone grafts was abandoned due to the unpredictable resorption rate of autogenous onlay grafts.^{7 11}

Use of prostheses made of hydroxyapatite–collagen^{2 12 13} was also described for the zygomatic area and for cases of facial recontouring with good results in terms of aesthetics and softness but always with the presence of small-moderate defects.

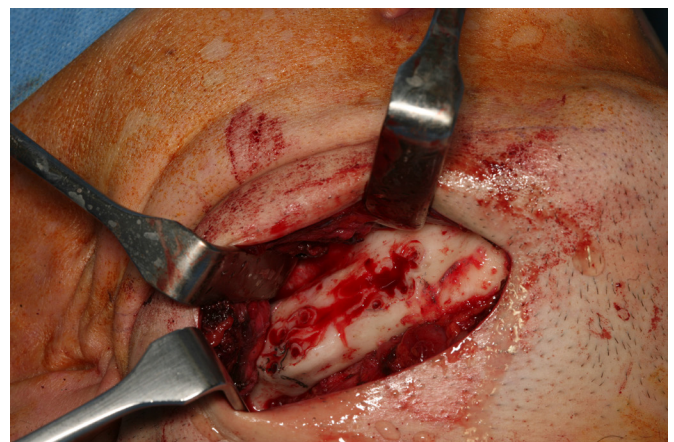


Figure 6 Intraoperative view of the recipient site.

Moreover, it is not possible to make patient-specific prostheses with these materials. Implant materials such as Medpor¹ have been used for recontouring of the mandibular angle. Most of the premolded or customised systems used to increase definition of the gonial region and the mandibular ramus–body are composed of polyethylene. The use of porous polyethylene implants in the maxillofacial region can be successful. The most frequently reported complication associated with the use of stock porous polyethylene implants is patient dissatisfaction with the aesthetic results, followed by infection.¹⁴ The literature has also described the use of silicone and polytetrafluoroethylene.^{7 15} The drawback of silicone is the occurrence of often progressive resorption of the bone below with consequent modification of the stability of the implant itself. PTFE, on the other hand, carries an increased risk of infections, seroma formation and extrusion. Computer-designed implants have revolutionised the approach to treatment of complex bone defects, becoming an excellent alternative to traditional techniques.^{16 17} The advances in 3D CT scanning techniques led first to improved evaluation and surgical planning of craniofacial reconstruction, and later to the possibility of manufacturing custom-made alloplastic prostheses. Currently, cranio-orbital defects are generally reconstructed using different biomaterials such as polymethyl methacrylate, titanium, PEEK and others.¹⁸ The advantageous physical properties of PEEK as a biomaterial provide surgeons with another

material for reconstruction of complex maxillofacial defects. The material is durable, yet intraoperative modifications can be performed with ease. The follow-up in the reported case was rather short; however, the literature has evidenced a very low rate of infectious complications even in the medium-long term.⁴ In addition, the ability to prefabricate an implant based on the patient's anatomy can result in decreased operation time and a more 'accurate' custom fit. Certainly, PEEK can expand to an important extent range of possibilities for recontouring not only the upper third and the middle third of the face but also of the



Figure 9 Patient after implant positioning. (A) Frontal view. (B) Submental view. Good symmetrisation of the mandibular bone contour and gonial angles.



Figure 7 Patient-specific implant, divided into two components to facilitate insertion.

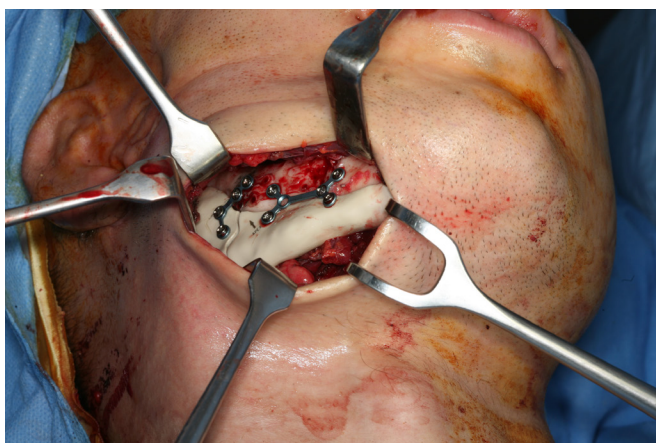


Figure 8 Implant positioning and stabilisation with monocortical screws and miniplates 2.0 mm.

Patient's perspective

As you may guess, surgery has always been at the centre of my life. Since childhood, my condition deeply influenced my existence, even though I can say I managed to have a satisfactory career at school and at university. Jaw surgery improved my quality of life, but after the first procedure, I felt there was still something that could have been done. The first thing I was proposed did not convince me; the surgeons would have taken a piece of fat from my belly to thicken my right cheek. I love sports and outdoor activities and I feared that surgery would have impaired me in my passions; moreover, the surgery was described to me as quite complex and there would have been also the chance of an unsuccessful outcome. The alternative plan was more convincing and involved the placement of a prosthesis attached to my mandible. I was happy to undergo another surgery to enhance the profile of my mandible; the virtual planning of the prosthesis was interesting and I was confident that this time surgery would have been easier and more straightforward when compared with my previous experiences and to the other surgical technique. Two days after the procedure, I was discharged; discomfort was minimal. Nowadays, I am quite satisfied with my appearance, despite some residual asymmetry left. I was proposed to have some fat injection to make up for it, but for the moment I am not interested.

Learning points

- ▶ Cranio-orbital defects are generally reconstructed using different biomaterials.
- ▶ Polyetheretherketone is a reliable biomaterial for patient-specific implants in facial recontouring, given its advantageous features.
- ▶ Correction of asymmetries must take into account for both hard and soft tissues.

lower third, thus representing a therapeutic option of pivotal importance especially in cases of large 3D defects.

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Case reports provide a valuable learning resource for the scientific community and can indicate areas of interest for future research. They should not be used in isolation to guide treatment choices or public health policy.

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