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Technical note

Three-dimensional planning and printing of guides and templates for reconstruction of the mandibular ramus and condyle using autogenous costochondral grafts

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Costochondral grafts are conventionally used for the reconstruction of the ascending ramus and condyle of the mandible.¹⁻³ Their main advantages are their biocompatibility and potential for growth, and disadvantages are the unpredictability of the pattern of this growth, and the large amounts of cartilage that are needed.^{4,5}

When we harvest the graft we estimate the amount of bone required intraoperatively and must be cautious not to remove excessive cartilage. Later we trim the graft and attempt to adapt it to the missing bony segment.

We use 3-dimensional planning and manufacture guides and templates for the optimal reconstruction of the mandible. The software used for planning applies mirroring technology and creates 3-dimensional printed stereolithographic templates of the planned graft, which results in precise harvesting and accurate reconstruction.

We used this technique on an 8-year-old boy with no right zygomatic arch, condyle, or ascending ramus, and on a 6-year-old boy, who had hemifacial microsomia, Pruzansky type III (Fig. 1).

First, the patients were scanned with spiral computed tomography. Digital imaging and communications in medicine (DICOM) data were then imported using OnDemand3D™ (Cybermed Inc, Seoul, Korea) software to



Fig. 1. Lateral view of a 3-dimensional reconstruction (with no right ramus or condyle) prepared from a computed tomogram of a 6-year-old boy with hemifacial microsomia.

analyse the facial skeleton. This segmentation is necessary to separate the mandible from the maxilla.

We created a stereolithography (STL) file using 3-dimensional volume reformatting software, then used the dental volume reformatting conversion and the 3-dimensional module in the OnDemand3D software to analyse it. We

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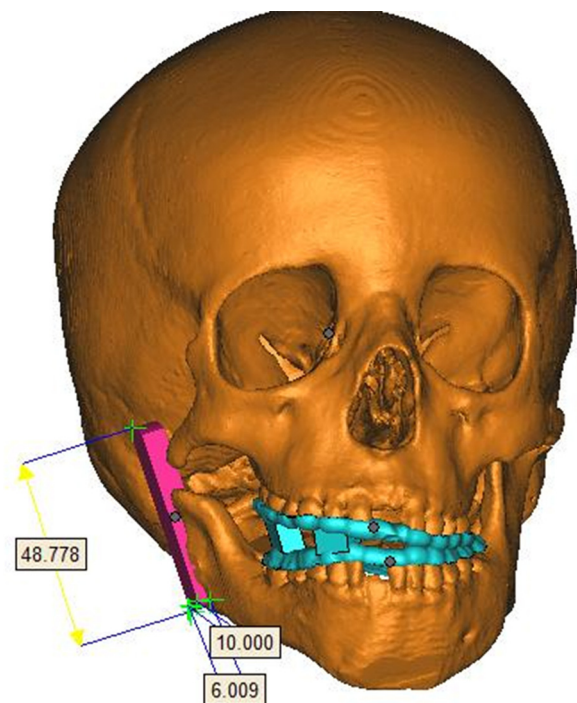


Fig. 2. Segmented 3-dimensional module numerical analysis of the mandibular vertical and horizontal deficiency and the angulations of the anterior-posterior jaw. An intraoral guide is designed for creating an open bite in the affected side of a patient with hemifacial microsomia. The custom-made template for the costochondral graft is also shown.

imported the STL file into Magics (Materialise, Leuven, Belgium) software to clean and align the mirrored parts.

The 3-dimensional planning was based on the measurements of the vertical and horizontal deficiency of each mandible and analysis of the posterior and anterior angulations (Fig. 2). In the case of the child with hemifacial microsomia, a surgically-created open bite was planned on the ipsilateral side to eliminate mandibular canting, so we prepared an intraoral guide (Fig. 2). For both patients, we constructed a template for the harvest of the graft using a 3-dimensional printer based on the virtual plan, taking into account the required overlap of the grafts to their mandibles for proper fixation.

Intraoperatively, we exposed the rib and harvested a segment using the 3-dimensional printed template (Fig. 3). We introduced the prefabricated 3-dimensional guide intraorally to the boy with hemifacial microsomia, then applied intermaxillary fixation for 10 days. The graft was introduced through a submandibular excision, then positioned and fixed according to the preoperative 3-dimensional plan (Fig. 4). We planned the location of the screws on the posterior border of the right mandible in the toothless area according to CT.

A prefabricated stereolithographic template reduces operating time and duration of exposure of the wound. The defect does not need to be measured during operation and two teams can work simultaneously but independently.



Fig. 3. The harvested costochondral graft next to the pre-planned 3-dimensional printed guide template.



Fig. 4. Intraoperatively an extraoral incision is made and fixation of the costochondral graft is completed according to the 3-dimensional plan.

Conflict of interest

We have no conflicts of interest.

Ethics statement/confirmation of patient's permission

This paper was approved by our institute's ethics committee and permission from the patients' parents was given to publish Figure 4.

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