Development of a 3-D digital common trunk “All-in-One-Planning-Solution” for orthognathic surgical procedures

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Orthognatic surgical planning is based on cephalometric imaging, model analysis and model surgery. Advances in computer-assisted surgery have increasingly facilitated the clinical application of three-dimensional (3D) imaging for traumatology, oncology and dentofacial deformities. These systems are proved to offer a more secure surgical procedure. Meanwhile some of them enable also a virtual planning of the dental occlusion. However, the precise fabrication of an accurate interocclusal splint is still a challenge. Since these systems do not represent a complete 3D planning software they have to be supplemented by additional software tools and hardware devices. In consequence, the handling of these systems is of experimental nature and the splint fabrication is not feasible in a daily routine. The purpose of this work is to develop, establish and clinically evaluate a novel, user-friendly 3D planning solution for orthognathic surgical procedures based on advanced autosegmentation and collision detection algorithms. A total of 22 consecutive adult patients with an indication for orthognathic surgery will be prospectively enrolled in this study. After 3D data acquisition by computerized tomography (CT) or cone-beam computerized tomography (CBCT) from patients with orthognathic deformations, virtual Le-Fort-I-osteotomy of the maxilla and bisagittal split osteotomy of the mandible (Obwegeser-Dal Pont) is prepared by autosegmentation algorithm. To enhance the imaging quality of the teeth, which is very important for the occlusion control and rapid-prototyping of interdental splints, plaster models of the patients maxillary and mandibular dental arches are scanned using a 3D dental surface scanner and imported into the initial CT or CBCT dataset. First step of virtual planning is to define the desired position of the maxilla. Secondly, by using collision detection, reasonable dental occlusion of the upper and lower jaw is calculated. And finally, after performing a boolean operation, tooth impressions are subtracted from a virtual pre-splint to get a definitive splint. This splint is then printed out by a 3D printer (CAD/CAM). For soft tissue prediction a photorealistic 3D surface scan of the patient's face is available and will be fused to the preoperative anatomical data. During surgery the pre-planned position of the upper jaw is guided by a navigation system. The complete workflow is used with intra-operative positioning of the condyle position.