BIOENGINEERING AND MEDICAL-SURGICAL SCIENCES

UNITO - Full Digital Workflow for Orthognathic Surgery: Predictability and Accuracy of Virtual Occlusion Tools.

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Context of the research activity	3D planning systems has revolutionized orthographic surgery, allowing to define osteotomies on a virtual skull, to evaluate multiple solutions and to determine the positioning of bone segments, enhancing the predictability and satisfaction of aesthetic results. However, occlusion planning is still predominantly performed using plaster casts or 3D-printed models, which is often time consuming. Further improvement may come from the use of virtual occlusion tools for occlusal prediction.
Objectives	Objectives Defining optimal occlusion is essential in the surgical planning process, as it establishes the relative positioning of the mandibular and maxillary bone fragments. Despite its importance, there is a paucity of studies which analyse the accuracy of digital occlusal planning with computer-aided systems. Current methodologies primarily rely on aligning upper and lower dental models based on manually indicated corresponding points. The accuracy of these methods is hard to confirm since the contact behaviour between the upper and lower dentition is not modelled and the impenetrability of teeth is not guaranteed. Other methods described include a rigid motion simulation engine that ensures the impenetrability of the dental models semi-automatically. Nonetheless, the resultant occlusion remains operator-dependent, lacking automated evaluation mechanisms. Consequently, the use of a full digital workflow continues to be a subject of debate, with limited integration into routine clinical practice. With the aim of bringing 3D imaging and computer-aided planning one step closer to practice, this research will investigate the accuracy and predictability of existing tools for virtual occlusion definition. The study will aim to establish guidelines to guide surgeons through the full digital planning process, including decisions regarding the need to execute segmental maxillary osteotomy without reliance on physical models' transverse diameter relationships (e.g. basing on digitally measurable parameters as the maxillary and mandibular intermolar distance ratio and the depth of the Spee Curve).

	This research will draw on data from surgical plannings and dental casts of patients who underwent orthognathic surgery between 2022 and 2026. Exclusion criteria will include patients under 18 years of age, surgeries that were not digitally planned in-house, cases involving secondary surgeries and craniofacial syndromes. The project will not involve experiments on animals or humans; instead, it will focus on comparing traditional occlusion planning with occlusions obtained through virtual occlusion planning tools. The aim is to evaluate the accuracy of currently available virtual occlusion tools, identify potential criticalities in the full digital planning process and develop guidelines that will assist surgeons in making comprehensive virtual planning part of standard clinical practice.

Skills and competencies for the development of the activity	Applicants must hold a degree in Medicine and Surgery and advanced knowledge in Maxillofacial surgery. Experience and publications in the treatment of facial deformities and application of digital technologies to maxillofacial surgery will be considered for selection.