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Observations on the role of surgical splints in orthognathic surgery

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ABSTRACT

Surgical splints can be used in orthognathic surgery, following orthodontic-surgical symbiosis. These splints are used to monitor the maxillomandibular region and three-dimensional intraoperative movements. The use of these splints is currently based on findings from a clinico-radiological analysis and preparation by the dental technician using tools like maxillomandibular occlusion waxes and articulator.

The results seen so far are all satisfactory. We will discuss the emergence of digital surgical splints and changing results.

KEY WORDS

Surgical splints, orthognatic surgery, digital impression

INTRODUCTION

As a three-dimensional surgical guide, the surgical splint being developed at the university hospital in Lyon is a key tool in orthognathic surgery. The result of collaboration between both the maxillofacial surgeon and the dental prosthetist, this splint is used in the preoperative phase and is integral to the preparation as well as providing important information regarding the desired bone-based movement[3].

Surgical preparation takes place during the week before surgical intervention. Once the orthodontic preparation has been satisfactorily completed, the surgeon then documents the information to create the prosthesis. This preparation includes a fresh study of the cast supplied by the orthodontist responsible for orthodontic preparation, a cephalometric analysis, and a clinical examination. After this, the task of developing the splints can be initiated[6,7].

The information given to the prosthetist by the surgeon concerns the type of surgery planned, whether it is monomaxillary or bimaxillary, as well as the direction and scale of the desired movements (to be represented three-dimensionally) as well as possible rotational movements of the

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occlusal plane[5-11]. Here we will describe in detail the different stages of splint preparation then we will discuss expected results and observations made with the use of a surgical splint.

PREOPERTIVE CONSULTATION

This takes place 3 months before the date scheduled for surgery. Once the patient has finished their orthodontic preparation, they are examined by the surgeon in the presence of the prosthetist. This involves an intraoral and facial clinical examinations. The radiographs are then analyzed.

The examination ensures the quality of the orthodontic preparation and confirms that the surgical preparation is correct.

STUDYING THE IMPRESSIONS

This study is an essential part of the clinical examination. Using the cast that has just been created by the orthodontist, the surgeon ensures that the orthodontic preparation is of a high standard. These casts also allow for a better visualization of the transverse dimensions.

These study models are also the foundation of creating the surgical splints. From this consultation onward, there should be no further orthodontic shifts. One final consultation some days before the date scheduled for surgery is conducted to prevent any medical complications during the surgery.

CREATING A WAX PATTERN OVER THE OCCLUSION

During this phase, the patient's preoperative articulated diagnostic cast in used, in centric relation. The criteria for quality at this point is to ensure that the wax completely covers all the triturating dental surfaces.

The wax occlusion ensures the stability of the arches on the plaster models. By the end of this step, the steps of the surgery are clearly established and the surgeon announces what surgical procedures will be carried out[10].

MEASURING THE FACE WITH THE ARTICULATOR

Using the initial occlusal splint in centric relation, models can be placed on the articulator (Fig. 1). Centering and mounting on an articulator are necessary when fabricating splints. Using an articulator is pivotal to anticipating the kinematics of the cuspids during closure movements once the splint is removed.

LAB WORK

This stage, carried out by the prosthetist, consists of using casts to fabricate intermediary and definitive bite planes (if the work to be done is bimaxillary; Fig. 2). These surgical splints are made by simulating movement (decided on by the surgeon) and are created according to the models in relation to the initial occlusion plane, which is integrated on the articulator by a face-bow.

THE RESULTS

In the preoperative phase, the surgeon has the surgical procedure, the casts mounted on the articulator and the surgical splints (Fig. 3).

Intervention by way of a bimaxillary osteotomy therefore traditionally begins with a LeFort 1 maxillary osteotomy. Once the maxillopalatine plateau is mobilized and transversally expanded to a certain extent, the surgeon employs the surgical splint and performs temporary maxillomandibular blocking using steel wire.

At this time, information relative to the preconceived maxillary movements is used to establish protocol. The surgeon can now complete his osteotomy to achieve a stable bone-based result compatible with the movements desired.

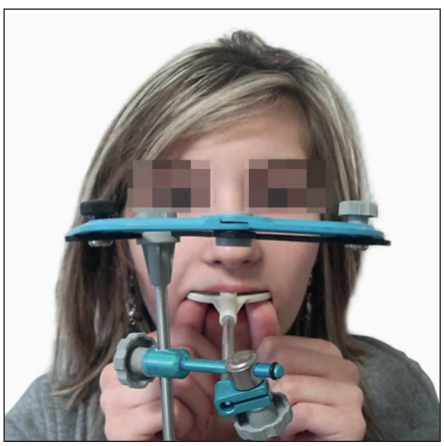

Figure 1
Facial arc positioned on the Frankfort plane adheres to the wax occlusion.

Figure 2
Measurements taken for the work to be done in the sagittal sense.

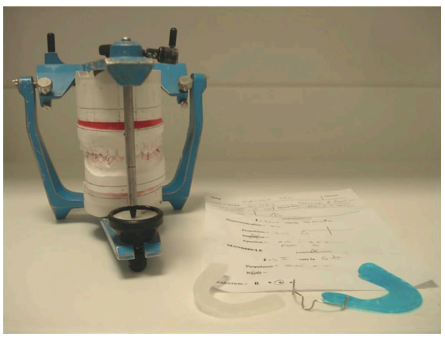

Figure 3
Definitive surgical splints, models mounted on the articulator, surgical protocol written.

The phases that follow are maxillary osteosynthesis and maxillomandibular unblocking to verify the articulated cast on the intermediate splint. Then the mandibular phase begins and ends with the verification of the maxillomandibular articulated cast once the osteosynthesis is completed on the definitive splint and then again without a splint. In the mandibular phase, other teams begin by identifying the condyles; a supplementary splint is now needed to serve as a reference point[2,4].

In terms of the surgery, we now have a definitive result, the patient must therefore present a surgical occlusion with canine and molar class I, interincisal midline alignment, a transverse canine and posterior diameter and an incisal overlap of 2 mm.

OBSERVATIONS ON THE DIGITAL EVOLUTION

The fabrication of quality surgical splints includes a series of procedures which require the clinical expertise of specialists. It is unlikely that a technician can perfectly master this series of procedures. Conventionally this falls within the sphere of specialized dental prosthetists who either work independently or in a hospital. This time-consuming procedure (2–4 hours in total per splint) is not interchangeable with the procedures carried out by maxillofacial surgeons or orthodontists.

Software and technological tools are now available and reasonably-priced so that it is much easier to develop computer-assisted surgical procedures. The goal is to fabricate splints for maxillomandibular repositioning by printing three-dimensionally from a 3D or cone-beam craniofacial scan of the patient. Some pilot studies have demonstrated the feasibility of fabricating and printing virtual splints[8,1]. The necessary steps in virtual splint fabrication are as follows:

– 3D acquisition of the maxillomandibuar complex in centric relation and without maximum intercuspidation, to permit segmentation of the maxillary and mandibular arches. This step can be performed v ia tomodensitometry or cone-beam radiography;
– 3D acquisition of the patient's occlusal surfaces. This step requires an intraoral optical scan;
– Inclusion (or *matching*): the occlusal record on the patient's TDM or CBCT, to obtain a complete record of the patient's dental occlusion;

– The use of an articulator to virtually reposition occlusal maxillary and mandibular articulated surfaces of dental class I after segmentation of the maxillary and mandibular arches;
– The creation of a virtual splint reproducing the corrected relative position of the maxillary and mandibular arches;
– Three-dimensional printing of the splint on a 3D printer using biocompatible material like PGA (*Poly Glycolic Acid*).

The fabrication of virtual splints seems extremely enticing and the necessary technology is actually available. Among the advantages of this technological evolution, we must cite the discontinuation of plaster impressions and the possibility for surgeons to take control, in terms of organizing the entire surgical procedure without depending on the prosthetist. The treatment plan will be determined by the exchanges between the surgeon and the orthodontist, together with the three-dimensional digital simulations (Fig. 4). There are still current drawbacks. The difficulty of defining a virtual surgical occlusion and the time required to learn how to create reliable surgical splints.

Conflict of interest: The authors have declared that they do not have any conflict of interest. The authors thanks Dr. Codridex.

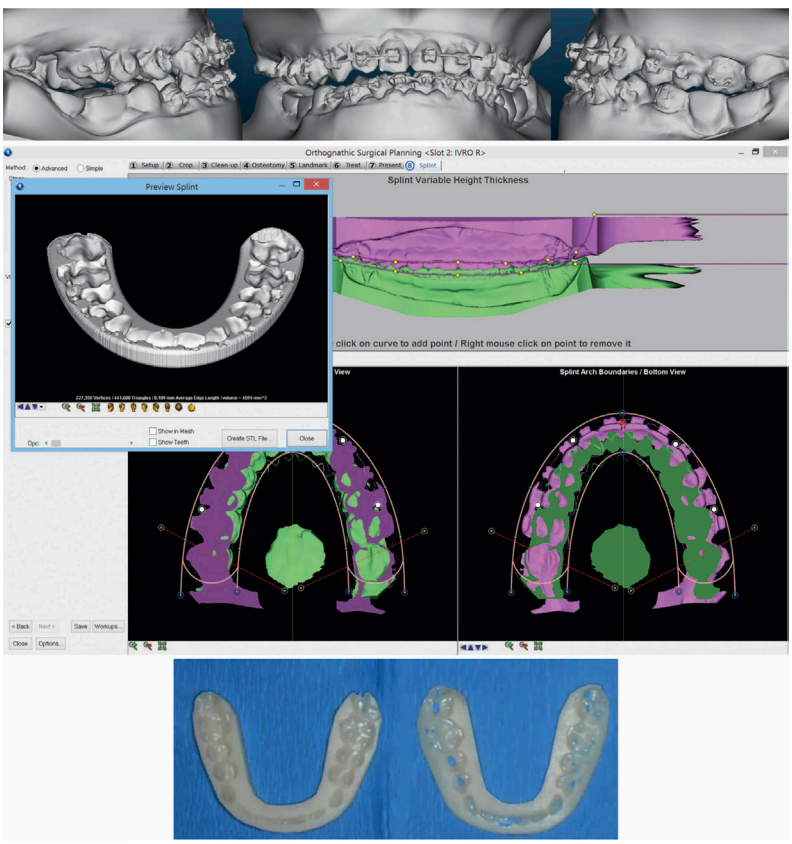

Figure 4
We must recognize the experimental nature of these procedures, but they certainly represent the future of surgical guidance in orthognathic surgery.

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