3D Printed Surgical Guides Used in Orthodontics

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With technology becoming more and more advanced, the medical system is being consistently improved. From intraoral scanners that started to replace conventionally impressions technique to printed surgical guides that directs the drilling systems of implants, dentistry is one of the beneficiars of new and advanced treatments that are ergonomic, safe and put both the medical team and the patient in a more pleasant experience. The purpose of our article is to summarize the application of acrylic and metacrylic resin in 3D printing of surgical guides used in orthodontics.

Keywords: technology, advanced treatments, intraoral scanner, printed surgical guides.

Though acrylic resin is known to produce allergic reactions, it is a common material used in dentistry as base for dentures or orthodontic removable appliances, temporary crowns and lately for 3D printing. In the additive manufacturing technique (3D printing), there is not a wide range of materials to choose and among metallic and ceramic materials, acrylic resin is the most processed.

Recent studies reveal that if printed and lightcured, the resin used in surgical guides reduces the negative impact on L929 Cell and on human gingival fibroblasts. This information is of clinical importance in producing surgical guides, since they can be either supported by bone, by the mucosa or by the teeth.

3D printing in orthodontics is used beside fabrication of study models, clear aligner models, in producing drilling templates, pilot drill guides, surgical guides for inserting miniimplants, custom-made appliances like clear aligners, lingual appliances, wires splints and occlusal guards.

Regarding surgical guides, they don’t only help the surgeon to insert the implants, but are also reliable, safe and when used, the surgery is minimally invasive, giving the patient a better after surgery recovery experience.

As stated before, present studies reveal the use of surgical guides not only for dental implant insertion, but also in orthodontic miniimplants placement. Being autoclavable and biocompatible, the resin used in 3D printed surgical guides came to help the practician and to fulfill a wide range of needs.

The template for the surgical guide be made either using a customized conventional Rx surgical method or a computer generated one. Besides the stiffness and the instability given by the template made using conventional Rx surgical method, it also has some limitations that one cannot overlook, the most important ones being the lack of information given for the bucco-lingual dimension and for the anatomical landmarks.

For achieving stability of the surgical guide during implant placement, retention criteria has to be reached. This way, they provide enough accuracy for placing the implants as previously established on the digital setup with no damage to the surrounding anatomical landmarks, this way increasing the success rate of the miniscrews.

Recently, surgical guides have been used also for piezoelectric corticotomy, having special material characteristics like higher porosity for the coolant, translucency to provide visibility and rigidity for support. In placing C-tube miniplates, printed surgical guides have shown their effectiveness, minimizing the lab work and the high awareness demanded by the conventional technique.

In order to create an implant surgery guide the practician needs computer tomography, 3D implant planning software and image guided template production technique. The CBCT is indicated due to the low radion and high resolution in all three dimensions.

Experimental part

Materials and methods

The first step in obtaining a surgical guide is providing data record from the patient. Besides intraoral and extraoral photographs and intraoral scanning, that will provide a virtual cast, a Cone Beam Computer Tomography is required. After the evaluation of the available bone areas in transverse and axial incidence, the digital setup of the future position of the miniscrews is being made. This setup can be either made by the medical doctor or by the technician and in the end sent to the medical practice for the doctors’ approval.

Careful assessment needs to be done before setting up the implants for excluding the possibility of dental complications.
After the radiographic setup of the miniscrew placement, a visualization on the 3D digital model is needed for selecting the positions of the guiding cylinders.

The flexural strength at 5% strain is of 95.8 MPa and flexural modulus of 2.5 GPa for the light-cured resin and about 1/3 of these values for the green resin [5].

Both types of resin are resistant to solvents like acetic acid 5%, bleach, ~5% NaOCl, Hydrogen peroxide 3%, isooctane, Sodium hydroxide (0.025%, pH = 10), salt water (3.5% NaCl) and water [5].

When exposed in solvents like acetone, butyl acetate, diethyl glycol monomethyl ether, isopropyl alcohol and xylene, the green resin will decrease its mechanical properties while the light cured resin will degrade just under acetone exposure.

Due to its components, the material can cause skin or respiratory irritation. Prevention measures are wearing protective gloves and avoid inhaling the vapours [5].

In the Easy Driver complete surgical kit, there are sleeves for guiding the drill and the miniimplants, a screwholder, a guiding cap, a cap remover, two drills (a red drill of 1.4 mm and a grey one of 1.8 mm), a laboratory finger screwdriver and extension of 16 mm.

The basic surgical set consists of guiding sleeves (for both the drill and the mini-screw), a screwholder, a guiding cap and a cap remover and in the and only one drill of 1.4 mm (red).

The 1.4 mm drill is for the 2 mm screw and the grey one is for the 2.3 mm screw [6].

After receiving the appliance on the printed guide, the screws are removed using the fingerscrewdriver. Once the appliance is being checked in the patients’ mouth, the surgical guide is inserted and checked too. If the surgical guide does not fit perfectly, it can be corrected using occlusal spray.

Under local anesthesia, if there is a need for drilling, this procedure will precede the miniimplant placement and will be planned during the digital setup using the drilling sleeve inserted in the surgical guide. Only one sleeve will be inserted at a time for both the drilling and for the insertion stages. Afterwards, the miniimplants are placed using the guiding cap inserted in the cap remover.
The miniimplant is attached to the guiding cap and the rubber from the cap remover is removed. The miniscrew along with the guiding cap and the screw holder are inserted in the counterangle and through the miniimplant guiding sleeve that is inserted in the surgical guide, the TAD (temporary anchorage device) is inserted. When the wider part of the screw holder reached the guiding sleeve, the miniimplant is totally inserted.

After insertion of miniimplants, the appliance is settled in place, first fixing screws on the miniimplants and afterwards light curing the cement from the bands.

Results and discussion

The material used for their fabrication of surgical guides can be either transparent for better visualization or pigmented. They are stiff enough to remain stable during the whole miniimplant placement procedure and for this reason, the clinician can remain calm and confident.

Printed surgical guides have quickly found their way into the orthodontic field, providing an safe and easy method for placement of the C-tube miniplane, American Journal of Orthodontics and Dentofacial Orthopedics, May 2014, Vol 145, Issue 5

Surgical guides remain a helpful aid in the insertion of orthodontic miniimplants with guides fabricated on models replicated with cone-beam computed tomography; 2007, American Association of Orthodontists. doi:10.1016/j.ajodo.2006.01.027

Conclusion

The materials used in fabrication of printed surgical guides can be biocompatible, autoclavable and have specific properties for bringing accuracy and reliability to the medical team.

References

5. ***Formlabs Material Properties - Dental Model: Photopolymer Resin for Form 2 3D Printers
6. ***Easy Driver Prospect: The Guiding System for TADs-Digital Skeletal Anchorage
10. SIMONE LANTEAN 1, IGNAZIO ROPPOLO 1,2 ID, MARCO SANGERMANO 1 ID, CANDIDO FABRIZIO PIRRI, ANNALISA CHIAPPONE, Development of New Hybrid Acrylic/Epoxy DLP-3D Printable Materials, Inventions 2018, 3, 29.
15. SIRBU, A., BORDEA, R., LUCACIU, O., BRAINTORU, C., Szuhanek, C., CAMPIAN, R.S., 3D Printed Splints as an Innovative Method to Treat Temporomandibular JointPathology, RevChim.Bucharest), 69, no. 11, 2018, p. 3087-3089

Manuscript received:26.06.2019