ADVANTAGES OF A PRINTED VS A CONVENTIONALLY MANUFACTURED EXPANDER USED IN ORTHODONTIC PRACTICE

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Abstract: The production of an orthodontic appliance requires great accuracy and precision, which is very time consuming. The critical moments in this process are: accuracy of the alginate impression, the time to make plaster models, lack of defects in the plaster model, dental technician expertise and skills.

The purpose of our analysis is to bring out the advantages in clinical orthodontic work using metal-printed expanders.

Material and methods. Comparison of clinical and preclinical parameters when working with a printed expander and a conventionally made expander (with soldered wire construction or plastic tooth caps McNamara modification). Our analysis is based on a survey of orthodontists in our practice and patients. Each patient had to write positives and negatives about the appliance applied to him. The orthodontist had to write positives and negatives about working with different types of expanders.

Results. Taking impressions from the patient's mouth by the classical method leads to a series of deviations (shrinkage of impression material, transport to the laboratory and defects in the plaster model) and takes human labor. The procedure often causes patients to feel nauseous and vomit. Soldering the wire structure often changes the elasticity and size of the molar and premolar bands used. Sometimes the metal grill was twisted during soldering, if the molar bands were not well adjusted to the model. When modifying the device with plastic toothed caps, the negative is the positioning of glass-ionomer cement in contact with the gingiva. At first, it is difficult for patients to get used to eating on plastic surfaces.

The digitally planned and printed expander minimizes human fingerprint error. In this case, the mouth is scanned with an intraoral scanner, which immediately generates a 3-dimensional image, such as an STL file, which can electronically reach the laboratory instantly. Patients accept the scan well and even participate with interest. Programming the position of the screw itself is done virtually, which allows you to choose the place closest to the center of resistance of the displaced tooth segment. The design of the metal grill makes it possible to cover all the teeth of the segment and distribute the expansion force on them. The process from scanning to placing the expander in the patient's mouth is only two visits. The device is light and comfortable and does not require ring adjustment.

Conclusion. 3D images and printed devices are accepted by patients more easily and pleasantly, free up clinical time in the practice and the dental laboratory and save the physical space for the orthodontic archive.

Keywords: 3D Printing expander, Intraoral scanning, STL file, alginate impression

1. INTRODUCTION

The production of an orthodontic appliance requires great accuracy and precision, which is very time consuming. The critical moments in this process are: accuracy of the alginate impression, the time to make plaster models, lack of defects in the plaster model, dental technician expertise and skills (Zimmermann et al. 2017, Goracci et al. 2016).

Intraoral scanning enters into the orthodontic practice as a routine procedure through which the teeth in the upper and lower dental arch and the occlusal relations between them are recorded. These 3-dimensional files allow to minimize the plaster cast that are removed and stored at several stages of an orthodontic treatment (Dinkova et al., 2014). On this basis many software programs have been developed that allow analysis on these 3D images, which fully cover the methods used on the plaster cats. The use of plaster cast and the dental technique work still remains only in the manufacture of the devices. In order to reduce the physical work in this direction, printed devices of different materials were developed and entered into our practice. We have a large selection of 3D printers that offer a variety of printing technologies. Through the printer, the digital files can be printed on ceramic, metal, wax and resin materials using extremely unique processes depending for which technology. Initially, in the orthodontics, the printing of resins and plastics for models and devices started to be used for the retention (Rebong et al. 2018, Aly et al. 2020). At the present stage, the printing of metal structures has greatly expanded the range of orthodontic appliances, which can be entirely digitally designed and made. The most commonly used are transpalatal arch with modifications, lingual arch, hyrax appliance (Graf et al. 2017, Graf 2017), mini-implant supported Expander (Graf et al. 2018, Lo Giudice et al. 2020). Patient-specific devices can be developed to reduce the patient's discomfort (Barone et al. 2018).

2. PURPOSE

The purpose of our analysis is to bring out the advantages in clinical orthodontic work using metal-printed expanders.

3. MATERIAL AND METHODS

Comparison of clinical and preclinical parameters when working with a printed expander (fig.1) and a conventionally made expander (with soldered wire construction (fig. 2) or plastic tooth caps (fig. 3) McNamara modification).

Fig. 1 Printing RME

Fig. 2 RME with metal grill

Fig.3 RME with plastic caps

Our analysis is based on a survey of orthodontists in our practice and patients. Each patient had to write positives and negatives about the appliance applied to him. The orthodontist had to write positives and negatives about working with different types of expanders.

The work flow consisted of intraoral scanning, digital design with incorporation of a scanned prefabricated expansion screw, direct 3-dimensional metal printing via laser melting, welding of an expansion screw, insertion, and finally activation in the patients' mouths. At the time of the intraoral scanning, a digital 3-dimensional image is generated, which can be recorded, analyzed, stored, sent to a laboratory or processed by an appropriate program (Fig. 4). The next step is to make a digital design of the future device, the most important part of which is the positioning of the expansion screw. The virtual control allows to select the position of the screw, which most accurately corresponds to the level of the center of resistance of the lateral tooth segments (Fig. 5). The position of the screw is palatal from the roots of the teeth that we will move, so it is possible that its position is almost perpendicular to the axes of the teeth. The metal construction of the device allows it to be completely individually modeled and in accordance with the dental topography. Elements that do not enter the interdental contacts and elements that fit snugly on the occlusal surfaces are used. The design of the expander can be adapted according to the preferences of the orthodontist. He chooses which lateral teeth to be supported (only punctured permanent molars and premolars can be included or stable temporary molars can be included). If the metal arms cover only the distal teeth, then the force will be concentrated mainly in them. The modifications are possible that transmit less force by designing an extension of the metal arms extending medially from the molars, without them having a direct connection to the screw itself. Thus, through the design of the metal structure, the orthodontist influences the force transmitted in the different sections. This creates individuality in the operation of the device. The ability to obtain a detailed three-dimensional shape during the construction of the expander makes it possible to design them according to real clinical needs: the shape and position of the shoulders can distribute forces in the most optimal way, according to the type of expansion required.

The connecting metal arches to the screw can completely follow the relief of the hard palate without touching it. This ensures a maximum tight position of the device to the palate, which does not irritate the position of the tongue. This is followed by direct three-dimensional metal printing by laser melting, expansion screw welding and finishing of the device. Adjustment is usually trouble-free and almost absent (Fig. 6). Bonding is done with glass-ionomer cement.

Fig. 4 Generated digital model, fully identical with the patient dental arch

Fig. 5 Position of the expander screw

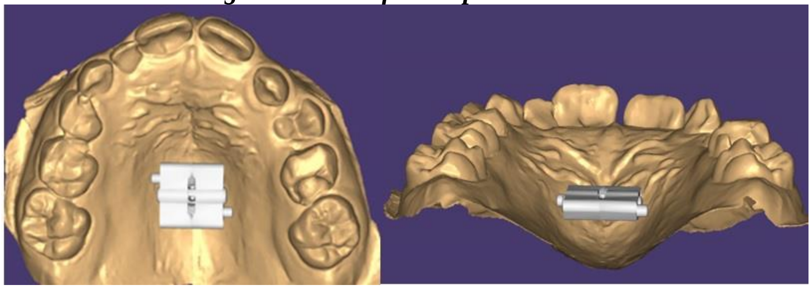

Fig. 6 Appliance design and fixation on the distal teeth

4. RESULTS

Taking impressions from the patient's mouth by the classical method leads to a series of deviations (shrinkage of impression material, transport to the laboratory and defects in the plaster model) and takes human labor. The procedure often causes patients to feel nauseous and vomit. Soldering the wire structure often changes the elasticity and size of the molar and premolar bands used. Sometimes the metal grill was twisted during soldering, if the molar bands were not well adjusted to the model. When modifying the device with plastic toothed caps, the negative is the positioning of glass-ionomer cement in contact with the gingiva. At first, it is difficult for patients to get used to eating on plastic surfaces.

The digitally planned and printed expander minimizes human fingerprint error. In this case, the mouth is scanned with an intraoral scanner, which immediately generates a 3-dimensional image, such as an STL file, which can electronically reach the laboratory instantly. Patients accept the scan well and even participate with interest. Programming the position of the screw itself is done virtually and is controlled by the orthodontist. The design of the metal grill makes it possible to cover all the teeth of the segment and distribute the expansion force on them. The process from scanning to placing the expander in the patient's mouth is only two visits. The device is light and comfortable and does not require ring adjustment.

In the survey, the patients mainly define as "negative" the moment of taking an alginate impression and the adjustment of the orthodontic rings in the interdental spaces. On the positive side, those treated with conventional techniques do not describe any process. At patients treated with the digital method, the moments of scanning and visualization of the patient's mouth directly on the TV screen are highlighted as "positive". This is very interesting and informative for them.

The orthodontists determine that the achieved clinical results with the digital type of design and manufacture of the device is effective. The design allows flexibility and individuality, according to the topography of the patient's palate. The material used for printing is biocompatible and with appropriate strength. They do not find a difference in the treatment result compared to the classic variant. For the positives, they determine the easy adjustment, the absence of a clinical stage for the placement of rings and the use of alginate material for fingerprints. Another important positive that they point out is the possibility for digital tracking of the treatment course and result.

The 3D technique has the advantage of eliminating all conventional imperfections of the casts: patient discomfort to the cast material (if the alginate material is not machine mixed, there is always dust that is not dispersed by water and it is irritating and causes nausea and vomiting). The placing of the spoon with alginate in the patient's mouth reduces the volume of air inhaled through the mouth, which makes it especially difficult for patients to breathe orally, and they are a target group of maxillary expansion. Another advantage is that it is not necessary to separate the upper first molars and place orthodontic rings. In computer modeling, half-rings are modeled in the area of the first molars, which perfectly cover the accessible surfaces of the molars without entering tightly into the interdental contacts. This eliminates the moment of ring adjustment and change in their position, using the conventional method of soldering to them a wire structure. This stage is critical for the accuracy of the device.

Using the computer design to precisely produce these elements for the attachment to the lateral teeth ensures their easy fixation in the mouth, the accuracy of adhesion and, accordingly, the transmission of the acting force. Unblocking of the occlusion with this action mechanism is quite minimal and is provided only by the thickness of the metal that lies on the occlusal surfaces of the lateral teeth. This thickness does not exceed 1-1.5 mm, which is within the physiological rest of the patient.

5. CONCLUSION

3D images and printed devices are accepted by patients more easily and pleasantly, free up clinical time in the practice and the dental laboratory and save the physical space for the orthodontic archive. With the wider penetration of metal printing, the prices for the final product - orthodontic appliance should be diminished and the technology should become widely applicable. To this end, more and more clinics should be digitally oriented, which will allow them to easily exchange data and consultations.

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