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Treatment of Partially Edentulous Patient by a Hybrid Approach Based on Both Digital and Conventional Methods

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Abstract: ***Introduction: Nowadays the digital technologies are not just the future, they are widely used in daily practice. There is no doubt that the digital approach has lots of positives, but like everything in this world they are not unlimited. At the same time some conventional techniques are proven to be very successful. For this reason choice of the best approach for every single case become harder, as the treatment approach options are not only conventional and digital but also different hybrid combination between them. For this reason the correct planning and approach selection for every single stage of the treatment plan should be wisely chosen. Aim: The aim of the current case report is to propose an approach for aesthetic rehabilitation of the maxillary dental arch using a hybrid method. Case report: A full arch maxillary restoration was done by the means of both digital and conventional techniques for planning and denture fabrication. Conclusion: The digital technologies develop incredibly fast, at same time they become integral part of each treatment plan, as they ensure faster, more predictable and reliable result to be achieved. Despite their positives they are able to accumulate errors that cannot be predicted. For this reason they should be used wisely, as the most suitable treatment approach should be chosen for every case.***

Keywords: prosthetic dentistry, digital approach, conventional approach,3Dprinting, additive manufacturing

1. Introduction

Nowadays the digital technologies are not just the future, they are widely used in daily practice [1-4, 20]. Digital denture designing (fixed or removable) become more complex and refined that's why the dentist's or dental technician's requirements become higher and higher. In this context the milling machines have limited potential, even though they are a well-know and a rich variety of materials are available for milling [7, 20].

The alternative of this production technology is the 3D printing. These methods ensure a lot more opportunities, but some of them are still experimental or not so well studied [1, 2, 7]. Before a couple of years they were specified as the future of the dentistry and just a few companies were focused in dental solutions. Today there are a huge number of 3D printers for dental use as they are more accessible than ever [1]. At the same time the offered raw materials, which were produced for 3D printed purposes, become more and more [5,6]. For this reason, 3D printing technologies like Vat Polymerization or Powder Bed Fusion become deeply integrated in daily dental practice, as some other types of the 3D manufacturing process make their first steps [10-12,15,16,17].

There is no doubt that the digital approach has lots of positives, but like everything in this world they are not unlimited [20]. At the same time some conventional techniques are proven to be very successful. For this reason,choice of the best approach for every single case become harder. Moreover, the treatment plan selection is not only between conventional and digital but the different hybrid combination between them are countless [18]. For this reason, the correct planning and approach selection for every single stage of the treatment plan is a question of present interest for daily practice [7-9,13,14,19]. There still aren't any commonly accepted algorithm for decision making, may be because of the fast development speed of the digital technologies and also the additive manufacturing.

2. Aim

The aim of the current case report is to propose an approach for aesthetic rehabilitation of the maxillary dental arc using a hybrid method. As this case is just one of many treatment options, the main goal of the report is to extend the conventional treatment approach and to be an initial point in development of innovative ones.

3. Case report

A 53-year-old female patient came to the dental office with painful and mobile tooth 16. As a result of the examination a periodontal pocket around the whole tooth was observed. The tooth served as an abutment tooth for a cantilever fixed partial denture (FPD) with the following configuration 16-x(**fig.1**). A fractional involvement of class 3 according to Ramfjord and Ash classification was also observed. The tooth was mobile and painful upon percussion. An orthopantomogram (OPG) was also prescribed. When the OPG was inspected a huge bone resorption around the whole tooth was found. As a result of the examination the tooth was specified as irrational for treatment and indicated for extraction. The situation was explained to the patient and as a result of short discussion two main treatment goals are discussed: esthetic and masticatory rehabilitation. Two treatment options were discussed with the patient. The first one suggested a removable patrial denture retained by precision attachments. and the second one – a cantilever fixed partial denture with two bridge unit at each side. The implant treatment was not an option for the patient due to financial issues. After a brief presentation and discussion of the different options, she chose the cantilever FPD treatment

plan, which would engage tooth 13, 12, 11, 21, 22 and 23 as abutment teeth and two cantilever bridge units at each side. According to this treatment plan a single fixed partial denture with the following configuration was planned be done x-x-13-12-11-21-22-23-x-x, where x is the position of the cantilevers bridge units. For the purpose of the treatment and impression of each jaw was taken and also bite and facebow registers were recorded. Finally, some photos were made, in order to allow digital smile design to be done. Then all the information was sent to the dental laboratory.

Figure 1: The initial situation, before any treatment actions were taken.

At dental laboratory two casts were poured, one for the maxillary and one for the mandibular dental arch. They were mounted in class III articulatorArtex®, AmannGrribach™ by using theSplitex®, AmannGrribach™ as bases. During the next step by using a laboratory scanner the casts were digitalized and imported in a specialized dental CAD (Computer Aided Design) software. This software allows a digital smile design to be done as it can be verified by using the digital models. By this way a digital project of the future restoration was created in correspondence with the patient's personal esthetic behavior and functional characteristics. After the teeth design was chosen a special digital model was created, which integrates the current situation and the dentition after the restoration (**fig. 2).** The digital model was 3D printed by using a DLP (Digital Light Processing) 3D printer **(fig. 3).** The object was post-processed by the prescription of the resin producer. A silicon impression was taken from the model and the information was transferred directly on the patient's teeth (a mock-up was done).

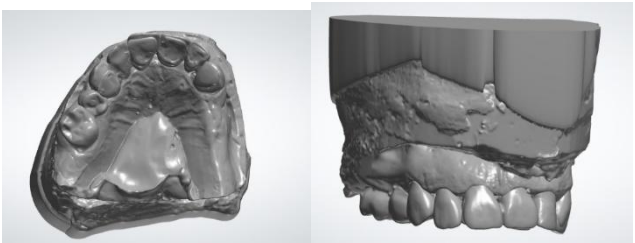

Figure 2: The digital model that contains information for the current patient dentition and the project of the future restoration at the same time. To reduce the extra calculation by the software it is advisable the digital model to be trimmed in a way that keeps only theessential information

Figure 3: The 3D printed model which was used for the mock-up procedure.

During the mock-up several modifications of teeth shape was made according to the patients taste, which were saved by an alginate impression taken form the mock up (**fig. 4**). After the denture design was approved by the patient and during the next visit the crown of tooth 16 and the cantilever at the region of 15 were removed, then tooth 16 was extracted.

Figure 4: The mock up

At dental laboratory the alginate impression was used for pouring a cast, which further was digitalized. It is imported in a specialized dental CAD software and will serve as a guide for immediate fixed partial denture fabrication. By using the software, a digital project of the immediate FPD was created and 3D printed afterward. For this purpose the same printing technology was used as for the model fabrication. Actually, this approach allows the immediate FPD to correspond completely to the approved by the patient denture design as denture is done before any teeth preparation.

During the next visit all the teeth left at the upper jaw was prepared and the immediate FPD was relined and fixed by temporary cement. After a few days and regeneration of the soft tissues the temporary FPD was removed, then the final impression was taken and also a centric relation and facebow register were recorded. Finally, the temporary FPD was fixed once again.

During the laboratory stage the impressions were poured and the casts were mounted in an articulator class III. The models were scanned by a laboratory scanner and turned in to a digital. Then by using a specialized dental CAD software the FPD framework was designed. For better result and precision, the digital model containing the approved denture design was used as reference point in the designing procedure. For this purpose the it was imported as pre-

preparation image which can be merged with the digital working model (**fig. 5**). The digital denture framework was exported as .stl file and imported in a special software for 3D printing process set up. Finally, the framework was 3D printed by DLP technology of light-curing resin-based material that burns without ash content and is suitable for high quality casting to be achieved (**fig. 6**). After 99% isopropyl alcohol rinsing and supporting structures removal the object was ready for the casting procedure. First of all, the resin denture framework was invested by using the investment matrialWiroFine, BEGO, which was prepared according to the prescription of the producer. Then the mould was burned out in to a furnace, then the casting process was compiled by alloy Wirobond 280, BEGO. Finally, the FPD metal framework was prepared for the try-in procedure.

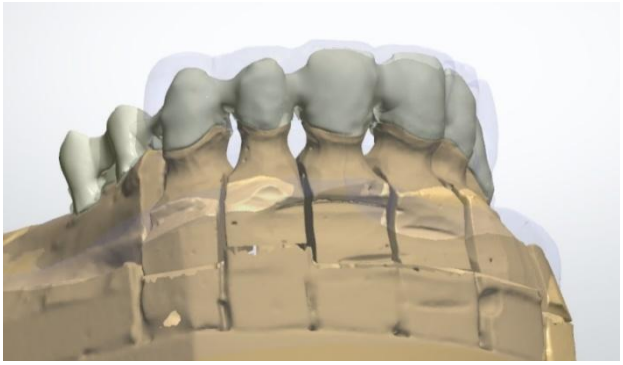

Figure 5: The digital image ofthe working model and the designed denture framework (inlight beige). It is apparent the denture design was made by using an image of the one approved by the patient which is merged with the master digital model (the light silhouette around the framework corresponds to the pre-preparation image). This was achieved by a special option of the CAD software to merge both images of the master model and another scan.

Figure 6: The 3D printed denture framework after the alcohol bath

After the clinical stage the framework was brought back to the laboratory for ceramic veneering. During this process the dental technician has been using the model 3D printed initially (**fig. 4**), which allows him to reach maximum accuracy in teeth sizes, forms and details. During the next clinical visit, the FPD was tried in once again, but now the ceramic veneering was evaluated. After some minimal corrections the denture was brought back to the laboratory for glazing and some specific correction of the veneering. Finally, the FPD was permanently fixed on the next visit (**fig. 7**).

Figure 7: The final restoration just after it was fixed permanently.

The digital approach allows fast and accurate personalization of the custom principles of dental esthetics. By this way it allows easy change and modification of teeth form, sizes, position by giving the opportunity the final result of restoration to be evaluated by the patient before any invasive and irreversible actions to be done. Another advantage that the digital approach provide is the ability an immediate “Eggshell” denture to fabricated, which allows the patient to evaluate the final result for a long period of time and to share the desired correction by his dentist. All this information should be considered when the final restoration is fabricated. The presented clinical case is pure evidence that the digital creates new opportunities for the treatment planning and accomplishment. At the same time it can make the whole treatment process more predictable and shorter and more reliable.

4. Discussion

Current case report doesn’t exhaust all the opportunity of the digital approach and the 3D printing process as well. Actually the paper presents one of many possible approaches, but the most valuable thing is that it describes a specific interaction between the real and digital based on simple and secure conversion of the patients data. The restoration started with digital smile design which ensures better ,more accurate and predictable results to be achieved. Then the data collected from the virtual planning was converted to real world and tried-in directly on the abutment teeth. This conventional approach is a good way to double check the desired teeth position, form and color, especially when maxillary frontal region is concerned. Further the information is collected from the mock up is converted to the digital world and serve as an reference point for final restoration designing. On the next step the digitally designed denture framework was converted to the real world as it was 3D printed. This stage modifies the conventional loss-wax casting process by replacing the wax and all its negatives with a new material with more reliable features. Actually, this approach combines some of the biggest positives of both conventional and digital methods of planning and fabrication as it allows them to replace most of each other negatives.

The treatment process can be even more digitalized by adding some more data to the initially collected. Some other 3D images can be used at stage of planning such as magnetic resonance imaging (MRI), cone beam computed tomography (CBCT), facial scan, intraoral scan (digital model) etc. [1,9,19]. All these methods for data collection allow the

treatment planning and process to be compiled predominantly as digital and less as conventional (in real world). This approach would be more time-saving and the result would have almost the same predictability as to the presented treatment approach. The major negative of such a predominantly digital way of planning and fabrication of restorations is the accumulation of errors. For example during the conventional techniques as the impression material shrinks, the dental stone expands and compensate partially the shrinkage. This reduces the discrepancies between the master model and the dentition. Furthermore the discrepancies may vary in a very small range as the materials are well-known and tested and exact working instruction are available.

As far as digital technologies are concerned error of the digital image doesn't differ much to the conventional materials, Actually they can be more accurate, but the 3D master cast, the need of additional data processing and alignment processes, error accumulation (correlate with the number of images used) and the sensitivity of the data collection process to many factors that cannot be controlled (as the patient and physician behavior cannot be predicted and controlled) could make the final discrepancies unpredictable and they may vary in a wider range [19]. For this reason every clinical case should be carefully planned and the most suitable approach should be chosen - the one that ensures more predictable and reliable result to be achieved.

5. Conclusion

The digital technologies develop incredibly fast, at same time they become integral part of each treatment plan, as they ensure faster, more predictable and reliable result to be achieved. Despite their positives they are able to accumulate errors that cannot be predicted. For this reason they should be used wisely, as the most suitable treatment approach should be chosen for every case.

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