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Aesthetic Anterior Restoration by Means of Digital Approach and 3D Printing Process

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Abstract: ***Introduction*** *Nowadays the digital technologies have become an integral part of every industry all over the world, including healthcare and dentistry Just before a decade the 3D printing was defined as new manufacturing approach with huge future potential. Today it becomes more and more essential part of every treatment, as it ensures much creative freedom, fast and cheap production process and last but not least more predictable result.* ***Aim.*** *The aim of the current case report is to present a contemporary approach for anterior aesthetic restoration. At the same time this report is demonstrative for the 3D printing potential today.* ***Case Report****: Anterior aesthetic restoration was planned by a conventional way (by wax up, followed by mock up). Then the abutment teeth (13, 23 and 25) were prepared and the desired denture design (chosen during the mock up procedure) was copied to the temporary bridge by means of specializeddental CAD software. The temporary construction was 3D printed by stereolithographic technology. The same design was used for final denture framework manufacturing for metal-ceramic restoration. A pattern of the framework was 3D printed and casted. Finally, the case was finished bythe ceramic veneering according to the conventional metal-ceramic technology.* ***Conclusion****. Nowadays digital technologies have become an integral part of prosthetic treatment of the patients. At the same time by adding the 3D printing process as a part of the restoration manufacturing process the potential of the digitally driven dentistry become almost infinite.*

Keywords: prosthetic dentistry, digital dentistry, 3Dprinting, aesthetic restoration, dentistry, additive manufacturing

1. Introduction

Nowadays the digital technologies have become an integral part of every industry all over the world, including healthcare and dentistry. [1,2,3,4,5] Actually, the CAD/CAM technology is not a brand-new process, as it is involved in 1970s, but the development of the information technology and the lack of materials with specific properties delay its use and progress by two or three decades. During the last 15 years the CAD/CAM technologies are develop with unusual speed. Manufacturing technologies in dentistry like CNC milling which was revolutionary before a couple of years as today are substituted by additive manufacturing. [1,2] Just before a decade the 3D printing was defined as new manufacturing approach with very big future potential. [3,4,5] Today it become more and more essential part of every treatment, as it ensures much creative freedom, fast and cheap production process and last but not least more predictable result. At the same time a numerous type of new materials with various features are involved. [6,7,8,9,10] This makes the process suitable for various range of laboratory and clinical procedures. [11, 12, 13, 15, 16, 17, 18, 19]

2. Aim

The aim of the current case report is to present a contemporary approach for anterior aesthetic restoration. At the same time this report is demonstrative for the 3D printing potential today.

3. Case Report

A43-year-old female patient who came to our practice because of problem with fixed partial denture which engages 23 and 25 as abutment teeth. During the examination it was found out that the connection between the abutment and the mesial retainer was broken down. The patient declared her interest in aesthetic restoration of the maxillary frontal area of the dental arch. **(fig. 1)**

Figure 1: Patient dentition during the initial examination. It is apparent that tooth 12 is missing, tooth 22 is rudimental tooth and tooth 21 is in mal position.

Maxillary and mandibular impressions were taken at the same visit. In addition a centric occlusion and face bow registers were taken. Finally, the fixed partial denture 23-X-25 (FPD)was temporarily cemented. At dental laboratory the two impressions were poured and the casts were mounted in articulator class three. Then a wax up was made in order to be planned the possible restoration of the maxillary frontal segment. (**fig. 2**)

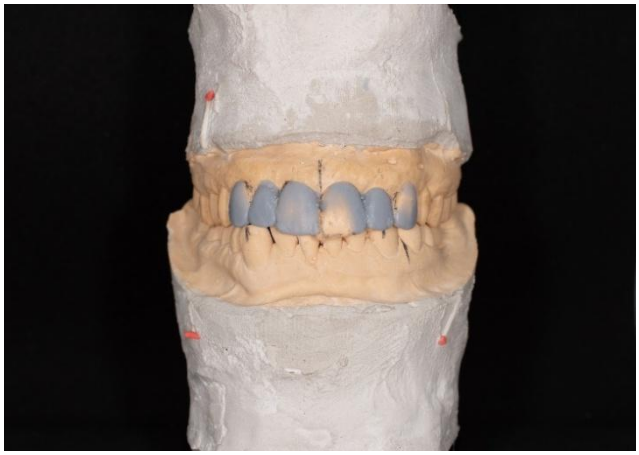

Figure 2: The project of the possible future restoration of the maxillary frontal segment made of wax

It is important to be noted that the patient was not sure about the final result of the restoration, all the procedures engaging the wax up were made without any interferences to the integrity of the cast. This would allow the mock up to be set without interfering patient's dentition. During the next visit a mock up was set and the teeth design was modified according to the patient taste. After the patient saw the result of the mock up she agreed for the aesthetic restoration to be done. For this reason an impression of the mock up was made in order to save the desired smile design. As a result of detailed analysis of the patients x-rays and clinical examination, a conclusion was made that the teeth 11, 21, 22 were indicated for extraction, because of their poor periodontal condition. At the same time this action will ensure better option for optimal aesthetic result to be achieved.

During the next visit teeth 13, 23 and 25 were prepared for full veneer metal-ceramic crowns. At the same visit three immediate temporary crowns were fabricated of acrylic resin. Then an impression was taken from both dental arches, including the prepared teeth. Then a facebow and centric occlusion register was taken. At dental laboratory both impressions were poured. The casts were mounted in class three articulator. For the purpose of the mounting procedure a Splitex® system, AmannGrribach™ was used. During the next step the casts were scanned by a laboratory scanner, which was calibrated for working with Splitex® system. This will allow the software to know where exactly the cast is located and to reproduce accurately the desired relation between the two jaws. An additional scan was done, which collects the information from the smile design which is approved by the patient. By using a specialized dental CAD software an immediate fixed partial denture (abutment teeth 13, 23 and 25) was designed. The design of the immediate FPD was planned to be an absolute copy of the approved smile design (**fig. 3**). The denture was materialized by a laser stereolithographic 3D printed (Form 2™, Formlabs™) of resin that is indicated for fixed temporary restorations (**fig. 4**). Two pairs of restorations were 3D printed at once, just in case of possible denture fractures as a result of the masticatory function or different treatment procedures. After the restoration were made, they were rinsed by 99,9% isopropyl alcohol and finally post-cured according to the producerprescription. Finally, the supporting structures were eliminated and the dentures were tried on the stone cast and polished afterward.

Figure 3: The digital pattern of the immediate fixed partial denture

Figure 4: 3D printed immediate fixed partial denture.

During the next visit the three immediate full veneer crowns were removed and the cement remnants were eliminated (**fig.5).** The teeth that were planned for extraction were removed and procedures for guided bone regeneration were made immediately after the extraction. During the same visit and just after the surgical procedures the immediate fixed partial denture was fixed to teeth 13, 23 and 25 (**fig. 6**).

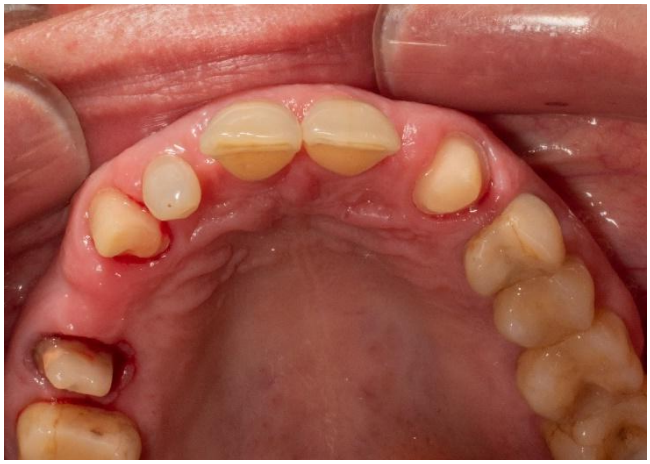

Figure 5: Prepared abutment teeth 13, 23, and 25 for full veneer crowns after removal of immediate full veneer crowns and before the extraction of the indicated teeth.

Figure 6: The immediate FPD just after the extraction of teeth 11, 21 and 22.

The patient visited our practice two months after the suture removal, because of COVID infection and the need of rehabilitation treatment after the illness. Then the temporary restoration was removed and the pontic was relined in a way that an ovoid design to be achieved. Because of the advanced tissue regeneration, the soft tissues had to be surgically modified in order to achieve the desired soft tissue configuration.

During the next visit the aesthetic result was evaluated and some more relining procedures of the pontic were done (**fig. 7).** The ovoid pontics were modified by adding or removing a little portions of acrylic resin underneath. Once the desired aesthetic result was achieved, the immediate fixed partial denture was duplicated and was used for impression of the soft tissues under the pontic (**fig. 8**). The duplicated construction was integrated in the final impression, which was made according to the conventional double layer double phase technique with an additive silicone **(fig.9).** In addition a centric occlusion and facebow register were taken in order to allow a proper orientation of the cast in the articulator.

Figure 7: A, B The contour of the soft tissues of the edentulous alveolar ridge at the region of teeth 12, 11, 21 and 22.

Figure 8: The duplicated pontic design made of acrylic resin

Figure 9: The final impression taken by the double phase double layer technique. It is important to be noted that a special clutch that contains a duplicated pontic design of the immediate FPD is fabricated, which further would be integrated in the final impression. This procedure is mandatory in order a proper impression of the soft tissue under the pontic to be achieved.

During the laboratory procedure a gypsum model with removable die and also a model of antagonist were poured. The casts were mounted in class three articulator by using Splitex® plates, AmannGrribach™. The cast were scanned by a laboratory scanner and imported in specialized CAD software for final restoration designing. The initially approved denture project was used as guide for designing process. A digital pattern of metal denture framework was designed. The digital approach allows a precise reduction of

approved design in order to achieve appropriate space for ceramic veneering. It also ensured the correspondence of the final design to the initially approved by the patient. Finally, a .stl file was created and then it was imported in generic CAD software. At this stage a digital custom-made sprue system was designed. The whole casting system (sprue system and denture patterns) was exported in .stl file, which was imported in another software for 3D printing process set up (**fig. 10**). The pattern was 3D printed by laser stereolithographic printer (Form 2™, Formlabs™) of CastableWax® (Formlabs™), which is indicated for casting. The fabricated object was rinsed by 99,9% isopropyl alcohol and the supporting structures were remove. Then the sprue system was fixed to the casting cone by slight portion of wax and invested by phosphate bonded investment material. The sprue system was eliminated and the mold was casted and is prepared for the try-in procedure.

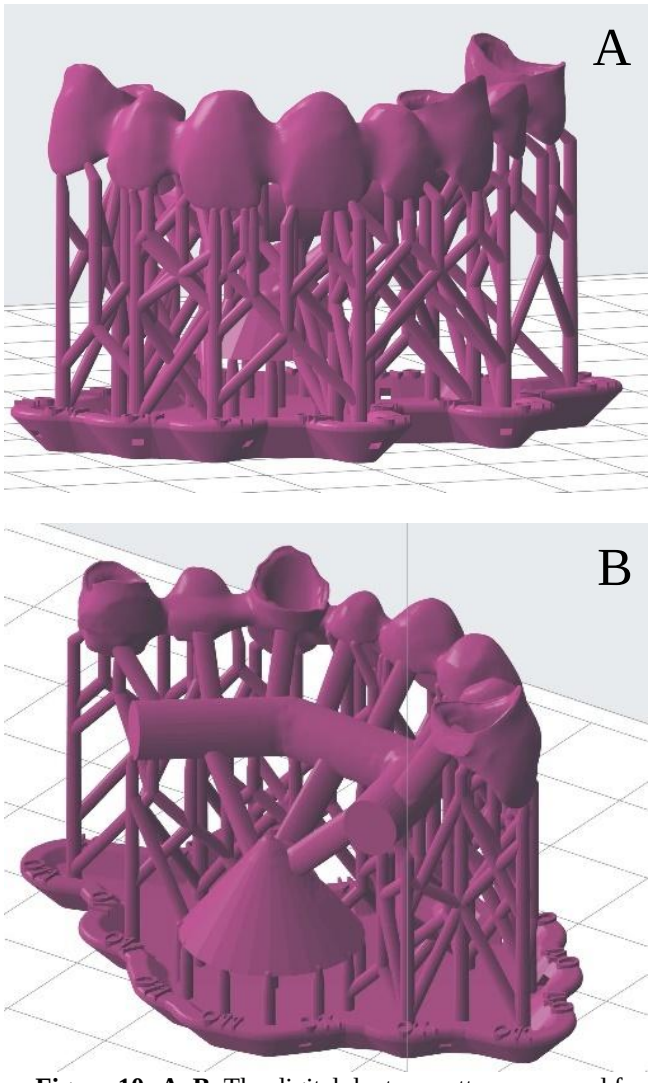

Figure 10: A, B. The digital denture pattern prepared for the 3D printing process. The process was set up to be compiled in way suitable for fabrication of CastableWax®, Formlabs™.

Once the try-in procedure was done the framework was brought back to laboratory and prepared for ceramic veneering. After the veneering process the glazed denture was tried-in and some details which concerns dental morphology were fixed according to the patient's taste. The denture was glazed again in laboratory and sent back to the dental office for a fixation (**fig. 11**).

Figure 11: The final restoration just after it is fixed permanently to the abutment teeth.

The presented case report contains a large number of conventional techniques, which were partially or completely modified by the contemporary digital approaches. This allows all the advantages of the conventional and contemporary techniques to be combined in order to achieve best condition for predictable and aesthetic result to be achieved.

4. Discussion

Before a decade many authors share their opinion that the future of dentistry is in the digital approach. Today this state is not actual as the digital technologies has become an essential part of the contemporary treatment approach. The presented case report integrates the digital technologies in just a few stages of the whole treatment process. The digital approach substitutes some conventional procedures, but this is crucial for the final result of the restoration, by making it faster and more predictable for both patient and dentist.

At the same time the digital technologies are useless without an appropriate manufacturing process. Nowadays the 3D printing technologies have an outstanding potential. They allow faster and more accurate production process that the CNC milling. It is important to be noted that the additive manufacturing also allows intricate object fabrication, as at

the same time the wide variety of materials expand its indications a lot wider than the computer aided milling process.

As it mentioned the digital technologies and 3D printing have unlimited potential, and the presented case is just a drop in the ocean. The digital technologies can substitute many other conventional processes like wax up or even the impression taking. At the same time the additive manufacturing allows a process like casting to be left in history. This new manufacturing method provides a freedom to the dentist and the technician to choose the best approach for every specific situation.

5. Conclusion

Nowadays the digital technologies have become an integral part of prosthetic treatment of the patients. At the same time by adding the 3D printing process as a part of the treatment process, the potential of the digitally driven dentistry become almost infinite. Today the dentist and the technician can choose between a countless number of options to select the best way for each treatment to be compiled.

References

[1] Kalberer N, Mehl A, Schimmel M, Müller F, Srinivasan M. CAD-CAM milled versus rapidly prototyped (3D-printed) complete dentures: an in vitro evaluation of trueness. Journal of Prosthetic Dentistry.2019; 121:637–643.
[2] Lee S, Hong SJ, Paek J, Pae A, Kwon KR, Noh K. Comparing accuracy of denture bases fabricated by injection molding, CAD/CAM milling, and rapid prototyping method. Journal of AdvancedProsthodontic.2019;11:55–64
[3] Stratasys [Internet]. Origin One: accuracy, repeatability, and isotropy. Available from:https://www.stratasys.com/explore/whitepaper/origin-one-accuracy?returnUrl=%2Fexplore%3FPage%3D1%26Phrase%3D%26ResourceTypes%3D%257B460BE7D2-8558-48CB-9AF8-C21F926E875D%257D
[4] Stratasys [Internet]. Transforming dentistry.Availablefrom:https://www.stratasys.com/explore/whitepaper/transforming-dentistry?returnUrl=%2Fexplore%3FPage%3D1%26Phrase%3D%26ResourceTypes%3D%257B460BE7D2-8558-48CB-9AF8-C21F926E875D%257D
[5] Rekow E. Digital dentistry: The new state of the artisit disruptive or destructive? Dental Material.2019
[6] Chen S, Yang J, Jia YG, Lu B, Ren L. A study of 3D-Printable reinforced composite resin: PMMA modified with silver nanoparticles loaded cellulose nanocrystal.Materials.2018;11
[7] Schweiger J, Edelhoff D, Güth JF. 3D Printing in Digital Prosthetic Dentistry: An Overview of Recent Developments in Additive Manufacturing. Journal ofClinical Medicine. 2021;10,2010
[8] Guo Y, Liu Y, Liu J, Zhao J, Zhang H, Zhang Z. Shapememory epoxy composites with high mechanical performance manufactured by multi-material direct ink writing. Composites Part A: Applied Science and Manufacturing. 2020;135
[9] Javaid M, Haleem A. Current status and applications of additive manufacturing in dentistry: A literature-based review. Journal of Oral Biology and CarniofacialResearch.2019;9:179-185
[10] Jawahar A, Maragathavalli G. Applications of 3D printing in dentistry–a review, Journal of Pharmaceutical Science and Research. 2019;11(5):1670–1675
[11] Lin WS, Harris BT, Pellerito J, Morton D. Fabrication of an interim complete removable dental prosthesis with an in-office digital light processing three-dimensional printer: a proof-of-concept technique. Journal of Prosthetic Dentistry. 2018;120:331–334
[12] ISO/ASTM 52900:2015(E)
[13] Ahmad I, Al-Harbi F. 3D Printing in Dentistry2019/2020. Quintessence Publishing; 2019
[14] Stavropoulos P, Foteinopoulos P. Modelling of additive manufacturing processes: a review and classification, Manufacturing Review.2018; 5 (2):1-26
[15] Al-Harbi N, Osman R, Wismeijer D. Effects of build direction of the mechanical properties 3D printed complete coverage interim dental restorations. Journalof Prosthetic Dentistry. 2016:115:760-767
[16] Clark WA, Duqum I, Kowalski BJ. The digitally replicated denture technique: a case report. Journal of Esthetic Restorative Dentistry.2019;31:20–25
[17] Della Bona A, Cantelli V, Britto VT, Collares KF, Stansbury JW. 3D printing restorative materials using astereolithographic technique: a systematic review. Dental Materials. 2021;37(2):336-350
[18] Kim DY, Lee GY. Evaluation of dimension stability according to UV-C ultrasonic cleaning of full arch artificial teeth made with DLP printer for photopolymerization. Journal of TechnologicDentistry.2021;43(3):84-92
[19] Hong JK, Kim SK, Heo SJ, Koak JY. Mechanical Properties and Metal-Ceramic Bond Strength of Co-CrAlloy Manufactured by Selective Laser Melting. Materials 2020;13(5745):1-15pqE86cdp3zRHhD2EuHsSN8eJw