Digital Diagnostic Wax-up as a Part of Esthetic Dental Treatment in Front Area: a case report

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Abstract

Introduction

Digital diagnostic wax up is a 3D representation of the final dental treatment result as far as esthetics (shape, size, color, position, outline), occlusion and function, marginal adaptation are concerned and it is overlaid onto a 3D digital pre-op model.

Aim

To present the role of the digital diagnostic wax up as a part of dental treatment of front teeth based on a case report

Materials and Methods

Dental treatment in the front area due to esthetic indications is reported. A young patient is seeking for a whiter and brighter smile.

Results

The clinical protocol for fabrication of digital diagnostic wax up used in this case is described.

Although the veneers provide better long term esthetic result, the patient chose bonding due to no prep approach and lower expenses. The digital diagnostic wax-up was used for printing a 3D model which is needed for fabrication of a silicone index for the composite resin injectable technique.

Conclusion

The digital diagnostic wax up helps the dentist and the patient to visualize the desired changes. The communication between dental office, lab and patient is a lot easier. Editing is done easily and fast using the software until the perfect result is achieved and accepted by the whole team. It is a precise, time and money saving method that leads to predictable final result and satisfaction of the dental treatment.

Keywords: digital diagnostic wax up, smile design, composite resin injectable technique

Introduction

The wax-up is "a waxing of intended restorative contours on dental casts for the purpose of evaluation and planning restorations; a wax replica of a proposed treatment plan" according to The Glossary of Prosthodontic Terms (1).

There are conventional, completely digital approach or a mixture of them. The conventional wax up is done by adding wax on a stone cast in order to restore the teeth contour and occlusion. The process includes altering the cast which is irreversible (2).

Abduo et al. compared the conventional and digital diagnostic wax-up (DDW) according to several criteria. As a whole the differences are not significant although the occlusal contacts are less in number and greater in surface in conventional wax up (3). More symmetrical teeth but with bigger axial tooth

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contour alterations are achieved in DDW (4, 5, 6).
Since the digital technologies are widely introduced in Dental medicine, a DDW is used in treatment planning (7, 8, 9, 10).
It is a 3D representation of the final result as far as esthetics (shape, size, color, position, and outline), occlusion and function, marginal adaptation are concerned and it is overlaid onto a 3D digital pre-op model. It is an important part of treatment planning because the communication between dentist, lab and patient is a lot better due to visualization of the final predictable result. After patient's approval the final restorations are done which leads to reduced material cost and time loss (7).
The digital diagnostic wax up is a valuable part of planning dental treatment in the front area (11) or in much more complicated cases of full mouth rehabilitation (severe abrasion, bruxism) including not only smile design but also restoring the occlusal plane, VDO, centric relation etc. (12, 13, 14).
The workflow could be completed digital or a combined approach could be used (15). The impressions could be conventional or digital, the occlusion could be evaluated in virtual articulator or models could be printed and mounted on a physical articulator (16, 17). Albera-Crum et al. described a mixed protocol- the lab done a conventional diagnostic wax up from 3D printed models (7).

Aim

To present the role of the digital diagnostic wax up as a part of dental treatment of front teeth based on a case report

Materials and Methods

Dental treatment in the front area due to esthetic indications is reported.
A young patient (aged 26) came for a regular check up. His chief complaint was dissatisfaction of his upper front teeth. He thought bigger teeth would look better on his face as well as he was concerned about the lack of symmetry of central incisors' incisal edges. The patient expected a whiter and brighter smile.
During **clinical examination** of the patient the following was observed:
General condition: no diseases or medical conditions were reported.
Extraoral status: the apparent age of the patient corresponds to the actual. The patient is in very good general physical condition. The facial form is tapering, the cranial, respiratory and masticatory part of facial height are proportional, the two halves of the face are symmetrical. A medium smile line, a parallel smile arch and a straight upper lip curve were observed (18).

Intraoral status:

- I class occlusion according to Angle
- Several teeth have carieses- #15, 16, 17, 28, 38, 46, 47, 48
- Tooth #18 is not present in the oral cavity but it is visible on the panoramic radiograph (Fig.1)



Figure 1. *Panoramic radiograph*

- There are old fillings on teeth # 25, 26, 37
- Chippings of the incisal edges of teeth# 13, 21, 23 and vestibular cusps of teeth# 14, 24
- Hard palate- U-shaped
- Dental hygiene could be improved- dental plaque and inflammation of marginal gingiva on some of the teeth
- No changes in mastication and speech

The treatment plan includes prophylaxis, treatment of the carieses and/or pulpitis of tooth#16, extractions of the wisdom teeth and a digital diagnostic wax up for considering esthetic changes.

Results:

The clinical protocol for fabrication of digital diagnostic wax up and its varieties are described by several authors (7, 16, 19).
In this case the following steps were done:

1. Extra- and intraoral photos and conventional diagnostic impressions (Fig. 2, 3, 4, 5)
2. In the dental lab the diagnostic casts are poured and scanned (Fig. 6, 7)
3. The 2D smile photo and the 3D scan file are merged in a 3D digital design software
4. A digital smile template is chosen from a library and it is overlaid over the patient's smile image. (Fig. 8, 9)



Figure 2. *Patient's smile before the treatment*



Figure 3. *Upper front teeth*



Figure 4. *Occlusion-front view*



Figure 5. *Upper jaw- occlusal view*



Figure 6. *Diagnostic casts*

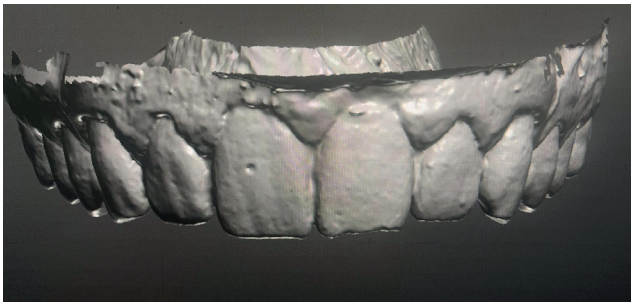


Figure 7. *Digital scan of the upper jaw*

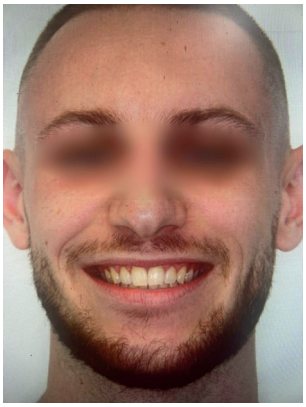


Figure 8. *Patient's smile before DD wax up*

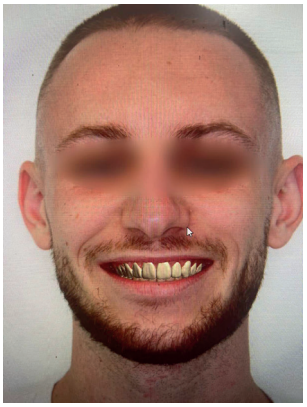


Figure 9. *Patient's smile with overlaid template*

5. The digital teeth are selected from a library and they are adjusted and individualized- shape, size, position, marginal adaptation, occlusal and proximal contacts which are verified later. This approach saves a lot of time (12).

The digital diagnostic wax up includes the front teeth as well as the premolars for better esthetics. (Fig.10, 11, 12, 13)

It is possible to see the initial and the final situation overlaid on a single image. This helps evaluating the amount of preparation or over contouring of the teeth. (Fig. 14)

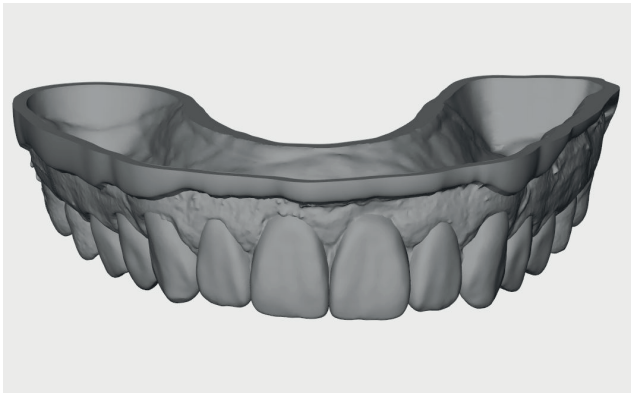


Figure 10. *DDW of the upper teeth- front view*

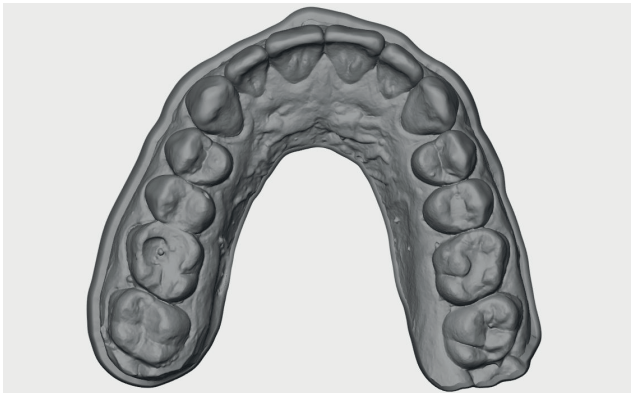


Figure 11. *DDW of the upper teeth- occlusal view*

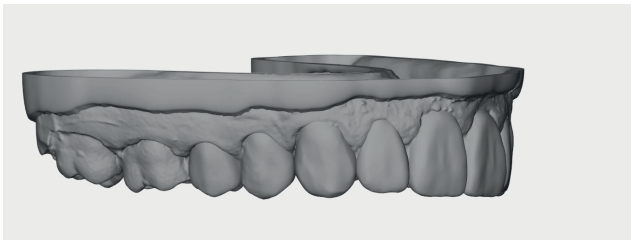


Figure 12. *DDW of the upper teeth- right side*

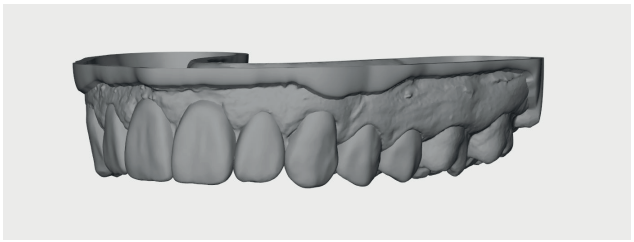


Figure 13. *DDW of the upper teeth- left side*

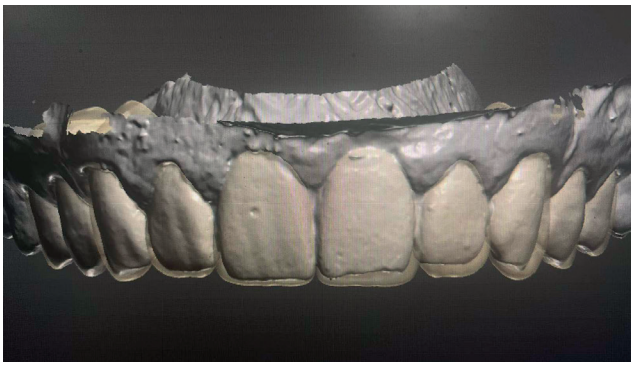


Figure 14. *The initial situation and the DDW are merged*



Figure 15. *3D printed model representing the digital diagnostic wax up*

6. The digital diagnostic wax up could be shown to the patient from various angles and point of views as well as a 3D model could be printed (Fig. 15)

In this case the esthetic changes could be achieved either by composite bonding or by ceramic veneers. All the advantages and disadvantages were discussed with the patient.

The first option could correct shape, size and color of the teeth. No preparation is necessary, only adhesive protocol could be used due to intact teeth. The composite bonding has an acceptable durability at lower cost (2).

The second option offers a long lasting esthetic result correcting shape, size and color of the teeth but at a higher cost and a little preparation of the teeth will be necessary also.

Bleaching only or doing no treatment were not even considered by the patient because he wants to improve his smile by changing the shape, size and color of his upper front teeth.

The first option was chosen. Bonding is done using composite injectable technique. A silicone impression is taken from the 3D printed model (Exaclear, GC) which was used as a mold for injecting composite (Gaenial Universal Injectable, GC) (2, 20, 21). (Fig. 16, 17, 18)

The digital diagnostic wax up helps the dentist



Figure 16. *Upper teeth at the end of the bonding procedure- front view*



Figure 17. *Occlusion after treatment- front view*

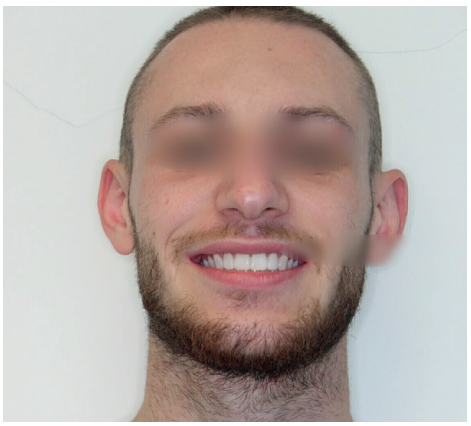


Figure 18. *Patient's new smile*

and the patient to visualize the desired changes. The communication between dental office, lab and patient is a lot easier. Editing is done easily and fast using the software until the perfect result is achieved and accepted by the whole team. It leads to predictable final result and satisfaction of the dental treatment.

In this case the esthetics was increased by changing what patient requested. There was no problems with mastication and phonetics. The control follow-up was done. (Fig. 19, 20) The prognosis is very good. The patient was informed about the importance of maintaining good hygiene as well as regular recall visits.

Discussion

The digital diagnostic wax-up is a major part in dental treatment planning. Besides better visualization and communication between the dental team and the patient, DDW could be used for fabrication of:

- A 3D printed model (22)
- A printed silicon index which could be used for mock up fabrication (22)
- Provisionals/ temporaries by using the 3d printed model and a silicone matrix from the wax up



Figure 19. *Follow up after 6 months-front view*



Figure 20. *Follow up after 6 months- occlusal view*

or by milling based on DDW (22, 23)
- A surgical guide in implant treatment (24) or a surgical template for gingivectomy (11)
- A prep guide fabrication- to evaluate the potential invasiveness of the tooth preparation (25)
- Even final restorations- a wax pattern could be printed or milled

The main advantages of DDW are:
- Higher quality, precise method, standardized steps and lower cost (26)
- Time saving (9, 12, 26, 27) and accurate. The process is faster because the digital teeth are designed using a template from a biogeneric library fitting of an average tooth or mirror imaging of an intact adjacent tooth (12).
- Less tooth morphological asymmetry because it is not free hand fabricated and the process is not so vulnerable to human interventions (3, 6).
- 3D result could be seen in real time from different point of views and easily changed if necessary trying different treatments.
- Easily edited as many times as needed because it is reversible process (the casts are not permanently altered) and could be reproduced at any time (2).
- It could be saved, sent or accessed on any electronic device such as computer, phone, tablet etc.
- Esthetic and functional try in of the future restorations (12)
- Better communication between the dentist, dental technician and the patient (9)
- Predictable final result (9, 12, 28)
- Patient's satisfaction

Espinel-Arteaga et al. describe the usage of DDW in children's cases because it is faster and better accepted by the kids (29).

The result of using DDW could get even better if additional information is acquired by using a virtual articulator, a digital face bow, CBCT or facial scanners.

The DDW is a perfect for cases in the front area but sometimes it is difficult to consider all the variables in more complicated cases. The occlusion could be checked and verified either by a virtual articulator (16) or a physical one.

The authors show the application of virtual articulator by analyzing the occlusal contacts using static intraoral scans and dynamic records with optic measuring system (30, 31).

Others prefer to print a 3D models of the DDW and to mount them on a physical articulator. Lee JH et al. use DDW for better communication with the patient but they use a conventional approach with physical casts and articulator as far as occlusion is concerned (32).

The whole digital workflow could get better and more accurate by generating "a completely virtual patient". The regular DDW is done using 2D face image and an intraoral scan or conventional impressions of the dental arches. The DDW could be improved by integrating a facial scan of soft tissues (EOS-extra oral scan) with facial skeleton (CBCT-cone beam computed tomography) and dentition (IOS-intraoral scans) in statics. This approach helps the dental team to make the DDW, implant placement and future prosthesis match perfectly the patient's facial anatomy (8). The future expectations are about improvement the virtual patient in 4D real time motion (33, 34).

Conclusion(s)

DDW is a precious tool in decision making for both the dental team and the patient when discussing options of treatment plan. The dentist and the dental technician could plan their work precisely. The patient could see and evaluate the changes in one's smile, accept them or ask for some corrections in order to meet one's requirements before the final decision is taken.

Although the veneers provide better long term esthetic result, the patient chose bonding (composite injectable technique) due to no prep approach and lower expenses in this case report. The predictable final result leads to satisfaction of the dental treatment.

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