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Review Article

Smile Design and Digital Dentistry

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Abstract

Introduction: In the past few decades, the demand for computer-aided design and manufacturing (CAD/CAM) in dentistry has dramatically increased. It has become possible with the rapid development of technology and science. Similarly, digital smile design (DSD) is a method of practical diagnosis that can assist the clinician in visualizing and measuring the dento-gingival discrepancies. By applying smile design principles, harmonic smile correction can be accurately made. The digital workflow allows the rehabilitation of teeth in both functional and aesthetic point of view. Dynamic documentation of smile is an important step in 2D/3D digital smile designing; the video recording helps in simplifying and facilitating the documentation process, facial analysis, improve smile design, treatment planning as well as serve as the best tool for patient-clinician communication and patient education. The DSD model facilitates further clinical treatment that is CAD-CAM restoration. With the improvement in dental materials, CAD-CAM assisted restoration is now possible with accuracy.

Aim of the Study: The review aims to understand the entire digital workflow from designing smile and fabricating restoration using CAD-CAM techniques.

Methodology: The review is comprehensive research of PUBMED since year 2009 to 2019.

Conclusion: The smile created should be aesthetically appealing as well as functionally sound. Thus, to achieve one such smile, proper treatment planning is essential. Properly made computerized smile designing, facial analysis, other parameters and measurements, intra-oral scanning, dental material assessment, and further method of CAD-CAM aided restoration, altogether makes digital dentistry a useful tool in creating better smiles and providing comprehensive aesthetic treatment to patients. It's one of the valuable tools for future treatment planning.

Keywords: *Digital Dentistry; Digital Smile Design; CAD-CAM Restoration; Intra-Oral Scanning*

Introduction

The recent development in prosthetics and implant-prosthetic rehabilitation in dentistry has undergone a strong development in the aesthetics and cosmetics field, improved laboratory techniques, and some anatomical criteria which are required for an aesthetic smile. The introduction of computer-aided design and computer-aided manufacturing (CAD/CAM) allows the clinician to guarantee repeatable and remarkable results from both anatomic and functional point of view. The small size of machines, relative ease to use as well as the accessible costs, make it useful even for small out-patients facilities. Among much new processing software that makes the rehabilitative workflow digital, simplifying the work and establishing good communication between patient and clinician, the Digital Smile Design (DSD) undoubtedly plays an important role [1].

The use of digital smile design allows for workflow, which simulates the rehabilitation of patients, starting with calibrated photos. The facial study is done using certain reference lines, from which the standardized parameters are developing standardized parameters for frontal and profile views of the face. The horizontal lines in the frontal view include interpupillary and inter-commissural lines, which provide an overall sense of harmony of the face and horizontal perspective, which is present in an aesthetically pleasing face. But this is limited to several anatomic features involved in rehabilitation. The treatment for aesthetic smile depends on many anatomical areas such as teeth, gingiva, lip, skin, mucosa [2].

With the advancement in dental materials like lithium disilicate ceramic, minimally invasive treatments have become possible because of these materials featuring translucent properties. Apart from dental material, another important tool in the digital workflow is an intraoral scanner, which allows quality and precise impression in less time. The computer-aided design software is available and is one essential tool since it guides the robotic devices to create the restoration according to the design set by DSD [3-5].

Figure 1: *Showing E4D system with intraoral scanner and CAD/CAM milling device, touch screen calibration system as shown by the arrows [6,7].*

Advantages of using DSD [8]

The DSD allows the following advantages:

- Esthetic diagnosis
- Communication
- Feedback
- Patient management
- Education.

Esthetic design

Many factors play an important role when a clinician first evaluates the esthetic concern of the patient. Thus, a digital analysis protocol along with digital photography and videography enables a clinician to analyze and visualize the issues which may not be apparent to patients clinically [8].

Communication

The success of restorative treatment depends on esthetics, structure, function, and biology. Among esthetics, the four main parameters, such as horizontal reference plane, facial midline, smile design according to tooth shape and arrangement, selection of the color, must be controlled to improve the predictability and thereby meeting the expectation of patients. The precise transfer of this information from the face to mouth to DSD application and further to cast and milling machine till the final restoration is made important, and the main goal of DSD is to facilitate this process [8].

Feedback

With the help of DSD, the precise evaluation of the results obtained in every phase of treatment can be obtained. The treatment sequence is organized on slides with photographs, videos, notes, graphics, and drawings. The digital ruler, drawings, and reference lines make the comparison easier between pre and post-treatment photographs. This comparison is helpful in determining if the treatment has followed the original plan successfully or if any other adjunctive procedures are required to improve the outcome of treatment. This double-checking ensures an excellent outcome and serve as a good learning tool for the entire approach [8].

Patient management and education

DSD is helpful in motivating patients and serve as an educational tool to explain better the issues related to treatment by comparing a before and after photographs. DSD can also be shared with patients and colleagues as dental presentations and lectures. The visual impact helps in understanding the concept of DSD and its application [8,9].

The DSD workflow

Prerequisites:

- Photography
- Videos.

The DSLR camera with a 100 macro lens is recommended to click pictures, and these are minimum pictures required as follow [8]:

- Full face with a wide smile and teeth apart
- Full face at rest
- Retracted view of the maxillary arch with teeth apart
- All of the above in frontal profile view.

Videography of the frontal profile view is taken pre-operatively as well as postoperatively.

Following are the software used in DSD [8]:

- Cerec
- Keynote
- Microsoft Powerpoint
- DSD by Dr. Coachman
- Planmeca romnexis
- Visagi Smile
- Photoshop C6
- Smile designer pro.

The number of photos and videos vary according to different software. According to a study in assessing the application parameters for comprehensive smile esthetics by digital smile design programs, its been inferred that score of Photoshop is 20/20 in its ability to fulfill the analysis of facial, dentogingival, and dental esthetic parameter and Keynote scoring 19/20 [10].

The following table states the total score of facial, dentogingival, and dental analysis features found in the analyzed DSD programs [10].

Software	Score out of 20
Photoshop CS6	20
Keynote	19
Aesthetic Digital Smile Design	18
Cerec 4.2 software	13
DSD App by Coachman	10
Smile Designer Pro	10
Visagi Smile	10
Planmeca Romexis Smile Design	10

Table

The first step includes patient analysis and aesthetic concern of patients, a thorough clinical and radiographic examination are done, and respective photographs are taken. Digital intraoral photographs are taken from a retracted frontal, occlusal and lateral view, as well as extraoral photos in frontal, lateral and 45º view, which is taken with DSLR camera [4].

Figure 2: *A: Shows chipped maxillary central incisors, reduced vertical dimension due to tooth wear caused by bruxism. B and C: Occlusal view of the upper and lower jaw [11].*

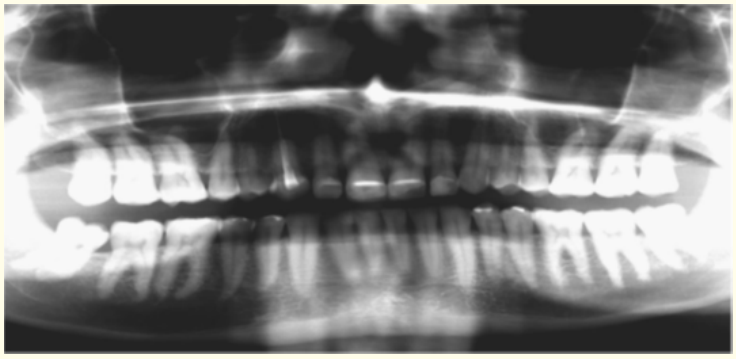

Figure 3: *Showing initial radiographic analysis using the panoramic view [11].*

The next step includes the impression making, a diagnosis impression is made of both the arches using Care-stream 3500 intraoral scanner. A maximum intercuspation position is registered intra-orally using the scanner, and a new desired vertical dimension of occlusion (VDO) is established by opening it to an appropriate amount on virtual articulator CAD/CAM software [11].

Figure 4: *Showing the impression of the upper and lower arch using an intra-oral scanner [11].*

Now the digital smile design dynamic documentation protocol is applied. Four different videos are taken in various calculated angles to achieve an ideal facially smile frame. Videos taken are [4,11]:

- Facial frontal video with or without retractor smiling.
- A profile video.
- A 12 o'clock video.
- An anterior occlusal video perpendicular to the occlusal plane without a mirror was recorded.
- The other complementary videos are also taken in a facial interview, 180º phonetics video, intraoral functional, and structural videos using a retractor for functional, facial, and structural analysis.

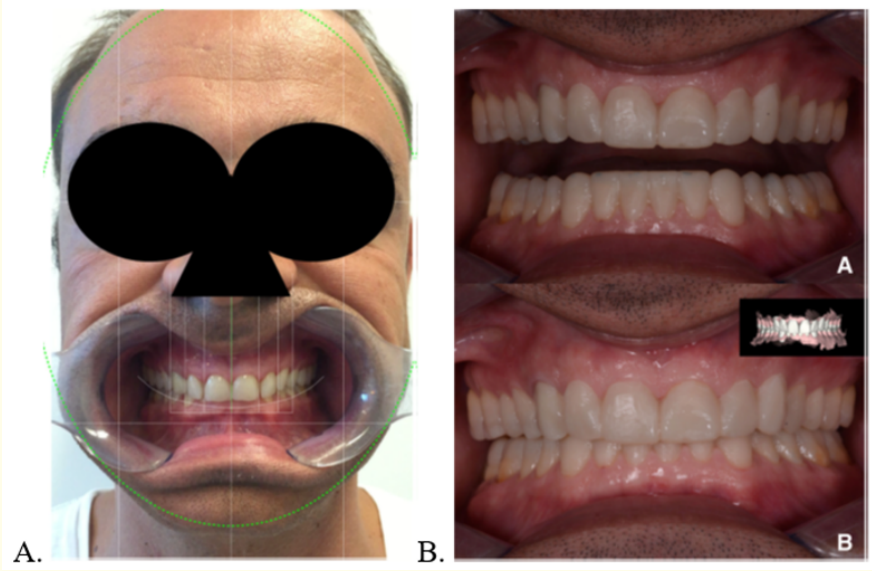

Figure 5: *Showing A: DSD protocol with r*

etractor. B: Motivational mock-up with intraoral scan [11].

The information recorded in this way is processed in the DSD lab; the DSD technique reconciles the photos of all the views with a digital ruler and creates a smile design supported by and in harmony with video analysis. The smile-frame develop as follows [11]:

- Digital facebow smile
- Smile curve shape and position
- Width determination using recurring aesthetic dental (RED) proportion
- Length proportion
- Gingival curve
- Papillae curve
- Vermillion curve and arch curve.

Figure 6: *Showing DSD software for designing a new smile model [11].*

This 2D smile model is converted into 3D digital wax-up on CAD software, the 3D file in STL format is exported to the printer to generate a new design. It is further used to fabricate matrix for motivational mock-up made with bis-acryl (structure VOCO). The new model contains augmented vertical dimensions (VD), allow patients for two weeks adaptation to the new VD. The bite is finalized when the patient is comfortable and stable, no further bite deprogramming and new centric relation is needed [4].

Later the abutment teeth and anterior teeth are minimally prepared, and a digital scan of prepared abutment teeth is made. The final definitive veneers and crowns are prepared digitally (Ceramill mind, Amann Girrbach) prosthetic software and manufactured in a milling machine (Ceramill Motion 2, Amann Girrbach) using machinable lithium disilicate ceramic blocks (VITABLOCS). In a trial insertion, marginal fit and optical properties are confirmed. The abutment teeth and ceramic crowns and veneers are prepared. The ceramic surface is prepared with 50 μm aluminum oxide, treated 5% hydrofluoric acid for 20 secs and rinsed for 20 seconds, 37% phosphoric, and 96% alcohol is used for cleaning. The crowns and veneers are adhesively luted to abutments using light polymerizing resin luting agents by the power LED cure device. The occlusal adjustment is made after removing excessive luting agents [12-14].

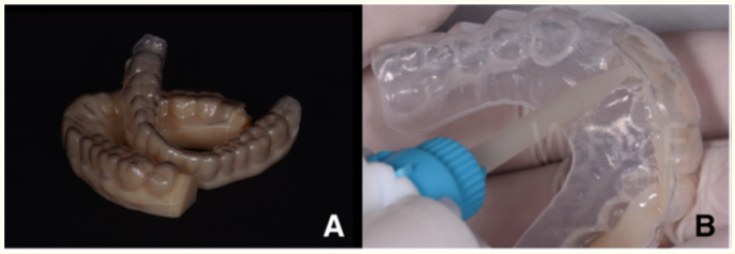

Figure 7: *Source [11]*

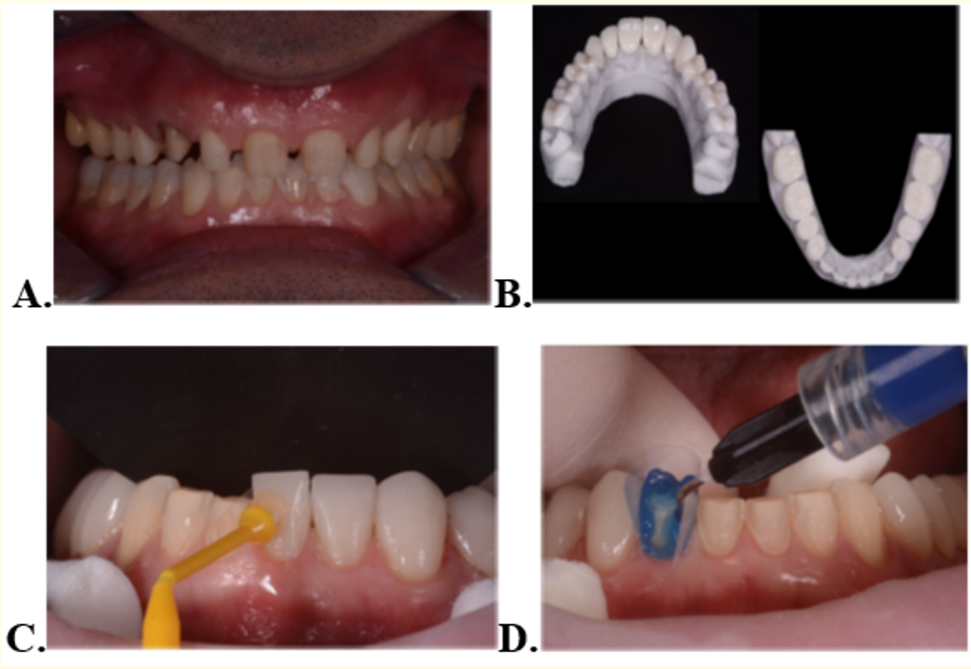

Figure 8: *Showing A: Abutment tooth preparation, B: Digitally prepared veneers, and crowns. C and D: Veneers and crowns adhesively luted using light polymerizing luting agents [11].*

Six months follow up is done after giving final restoration, and the facial harmony, structure, function, and form is evaluated.

Figure 9: *Showing A and B intraoral front view post-treatment in intercuspation and teeth apart. C and D are showing the occlusal view of upper and lower jaw post-treatment [11].*

Conclusion

With the introduction of this whole wide range of devices, machines, and software, the digital revolution is booming in the dental profession. This virtual world allows us to plan a detailed restorative to surgical procedures with the help of CAD/CAM software and 3D modeling. The digital impressions also contribute to having a precise bite registration, and elimination of possible error and distortions occur manually. By generating mock-up, the patient can see a new smile and allows any further adjustments if needed. The virtual simulation allows the clinician to have a better visualization of problems and thus helps in better decision making processes with comparatively fewer mistakes and less consumption of time.

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