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Digital Smile Design: A Literature Review

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Abstract

Dentistry has become easier, accurate and time saving after the advent of digitalization. Amongst them, the development of digital smile design (DSD) is one of the recent innovations in virtual field. It is a technical tool which is used to design and modify the smile of patients digitally and help them to visualize it beforehand by creating and presenting a digital mockup of their new smile before the treatment starts. This article reviews about the aspects of digital smile designing in aesthetic dental practice pertaining to its use, advantages, limitations and future prospects.

Keywords: digital smile design, virtual reality, aesthetic.

Introduction

Digital Smile Design is a technique that allows us to digitally design our patients' smiles by simulating and visualising the treatment outcome. A digitally developed design entails the participation of the user. A physician can utilise the Digital smile designing (DSD) tool when a patient wants to get that smile but is hesitant to undergo treatment because he or she cannot picture the treatment outcome. The DSD concept assists clinicians by improving the aesthetic visualisation of the patient's worry, providing comprehension of the potential remedy, and teaching and inspiring them about the treatment's benefits, so increasing case acceptance. On the one hand, Digital Smile Design enables the patient to be aware of the therapeutic plan from the start, allowing them to be the first interpreter in the aesthetic and

functional rehabilitation of their mouth; on the other hand, it enables the specialist to better tune in to the patient's expectations and needs, allowing them to provide better care. These protocols allow for the previsualization of the clinical situation and therapeutic outcome, as well as the clear presentation to the patient of the value of being able to design the rehabilitation and interface with other professional figures. By being able to convey case information to colleagues in a straightforward and digital method, it becomes easier to supply all of the data to the dental technician, or even to analyse the prosthetic–implant rehabilitation or orthodontic rehabilitation. Coachman and Calamita described DSD as a multi-use conceptual tool that can support diagnostic vision, improve communication, and enhance treatment predictability, by permitting careful analysis of the patient's facial and dental characteristics that may have gone unnoticed by clinical, photographic or diagnostic cast-based evaluation procedures.[1]

Development of Digital Smile Design

Christian Coachman in 2017 has proposed this evolution in generations as:[2]

Generation 1. Analogue drawings over photos and no connection to the analogue model.

Drawing with a pen on a printed copy of a photograph to visualise the treatment result was common at the time, but it couldn't be linked to the study model. By this time, digital dentistry had not been implemented.

Generation 2. Digital 2D drawings and visual connection to the analogue model.

With the appearance of advanced world, certain software like PowerPoint were acquainted which allowed computerized drawing. Albeit not explicit to dentistry and restricted to attracting two aspect it was more exact and less tedious than hand drawing. The drawing could be outwardly associated with the study model yet physical association was needed.

Generation 3. Digital 2D drawings and analogue connection to the model.

The absolute first drawing software explicit to digital dentistry was presented which connected 2D advanced smile plan to 3D wax-up. Facial analysis to smile design was additionally presented at this stage, however association with 3D world was absent.

Generation 4. Digital 2D drawings and digital connection to the 3D model.

Digital dentistry progressed from 2D to 3D analysis. 3D digital wax-up could be done involving facial analysis and predetermined dental aesthetic parameters.

Generation 5. Complete 3D workflow.

Generation 6. The 4D concept. Adding motion to the smile design process.

DSD Photography Protocol & Oro Facial Esthetics Parameters

To proceed with a correct digital planning, it is essential to follow a photographic protocol. The correct photograph position can provide important information to the aesthetic planning.[3]

The following photographic views in fixed head position are necessary:

1. Three frontal views:

• Full face with a wide smile and the teeth apart,

• Full face at rest, and

• Retracted view of the full maxillary and mandibular arch with teeth apart.

2. Two profile views:

• Side Profile at Rest

• Side Profile with a full Smile

3. A 12 O'clock view with a wide smile and incisal edge of maxillary teeth visible and resting on lower lip.
4. An intra occlusal view of maxillary arch from second premolar to second premolar.

According to Coachman, during videography best framing and zoom should be adjusted with suitable exposure and focus adjusted to mouth. For ideal development of the facially guided smile frame, four videos from specific angles should be taken[4]:

1. A facial frontal video with retractor and without retractor smiling,
2. A facial profile video with lips at rest and wide smile,
3. A 12 O'clock video above the head at the most coronal angle that still allows visualization of the incisal edge.
4. An anterior occlusal video to record maxillary teeth from second premolar to second premolar with the palatine raphe as a straight line.

Four complementary videos should also be taken for facial, phonetic, functional and structural analysis.

The parameters in consideration are the midline, height and curve of the smile, and intra- interdental proportion. A correct interincisal distance among the centrals, laterals, and canines is necessary to create an attractive incisal curvature that parallels the inner curvature of the lower lip, and it also creates the aesthetically required "dynamic negative space."[5] In an open smile the upper and the lower teeth usually maintain a slight interocclusal clearance. This space might be equal to the interocclusal space of vertical dimension of rest. Artists use the "eye unit" (the unit of facial measurement) theory to describe the topographic interrelationship of facial features. The distance between the base of the nose and the lower border of the lower lip is equal to one eye unit (length of the individual's eye). This distance remains unchanged whether at rest or during a smile, because the upper lip is stretched laterally and becomes shorter.[6] (Figure 1)

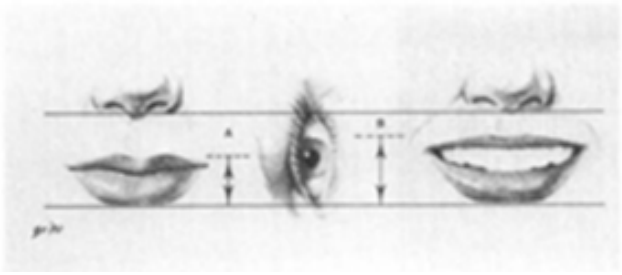

Fig.1: Dimension between base of nose and border of lower lip remain unchanged between rest and smiling.

The basic procedures of smile designing remains the same although there is variation of aesthetic parameters in different DSD software. The facial analysis is done using reference lines. uniform parameters are developed from reference lines for frontal view of the face. There are two reference lines which are the horizontal and vertical reference lines. Horizontal reference lines contains the interpupillary and inter commissural lines which deliver a complete sense of balance and a horizontal outline in the aesthetically pleasing face.[7] (Figure 2) The vertical reference line consists of the facial midline, passing the glabella, nose and chin. These two reference lines are crossed against each other in order to measure symmetry and cant of the face[8].

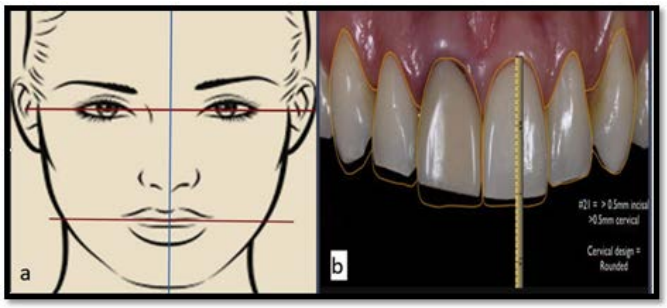

Figure 2: 2a. Facial view with horizontal and vertical reference lines. 2b- Digital ruler

Dento-gingival analysis is done following the facial analysis. At rest and smile, the length of the upper lip is

examined to determine the gingival display. Smile curve is fixed by correlating the curvature of the incisal edges of the maxillary anterior teeth. The dental contour is established according to lower lip proportions and the anteroposterior curvature of the teeth. The intraoral view is shown by cropping the facial photograph. The teeth are marked with 3 reference lines, a straight horizontal line drawn from canine tip to canine tip, another horizontal line is drawn on the incisal edges of central incisors and one more vertical line passing through the interdental papillae. Additional lines such as gingival zenith is obtained by joining lines of gingival and incisal battlement for a full dental examination (Figure 3).

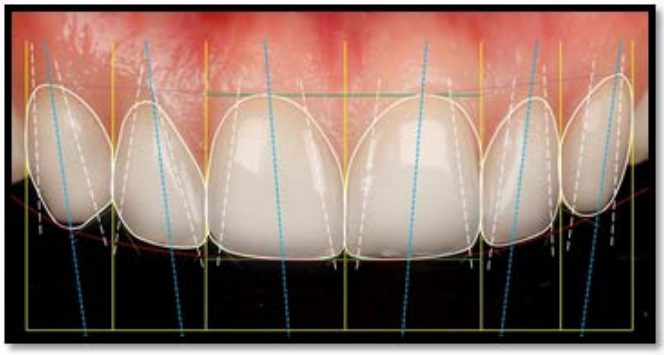

Figure 3: Dento-gingival analysis

The adequate teeth dimensions can be obtained by any one of the published theories such as Golden proportion[9], Pound's theory[10], Recurring aesthetic dental proportion, and Dentogenic theory[11](Figure 4). A digital ruler is used to carry out required changes. Changes can be edited, reduced or adapted to different situations depending upon the aesthetic requirement and individual needs[12]. After the new smile design is obtained, it can digitally be presented to the patient to look for feedback and appreciation. The physical mock up can be created after the smile design is approved and can be tested aesthetically in the patient's mouth. The mock up also allows visualization of phonetics during evaluation period.[13]

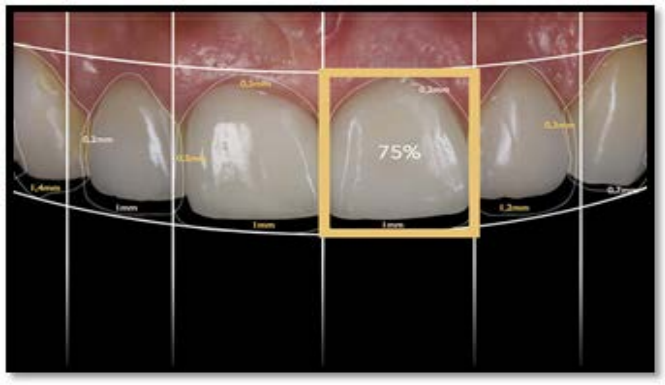

Figure 4: Teeth dimensions according to published theories

In 2015, Arias et al. carried out a further study on the approach using Digital Smile, to perform and plan a periodontal surgery in order to solve a gummy smile[14]. Perez-Davidi carried out a study on prosthetic rehabilitations in monolithic material, with CEREC CAD/CAM systems. There is the possibility, therefore, to perform an immediate mock up and then combine the data from Digital Smile Design and CEREC SW4 for manufacturing[15]. The approach to improve patient aesthetics through Digital Smile Design techniques is further confirmed by other works, such as that by Tak On et al.[16]. The authors confirm the possibility of planning the prosthetic treatment in a preventive manner. Some authors, such as Daher et al., have evaluated the possibility of using cheaper strategies to perform an analysis of Digital Smile Design, such as obtaining images with mobile phones[17]. Trushkowsky et al.[18] confirm the possibility of carrying out aesthetic evaluations for oral rehabilitations. According to Garcia et al., the use of new digital tools offers important perspectives for the daily clinic; in his study, a prosthetic rehabilitation of the anterior maxillary area is evaluated, all planned through Digital Smile Design[19].

Types of DSD software

The clinician may follow any one of the given softwares

1. Photoshop CS6 (Adobe Systems Incorporated),
2. Microsoft PowerPoint (Microsoft Office, Microsoft, Redmond, Washington, USA).
3. Smile Designer Pro (SDP) (Tasty Tech Ltd),
4. Aaesthetic Digital Smile Design (ADSD - Dr. Valerio Bini),
5. Cerec SW 4.2 (Sirona Dental Systems Inc.),
6. Planmeca Romexis Smile Design (PRSD) (Planmeca Romexis®),
7. VisagiSMile (Web Motion LTD),
8. DSD App by Coachman (DSDApp LLC),
9. Keynote (iWork, Apple, Cupertino, California, USA)
10. Guided Positioning System (GPS)
11. DSS (EGSolution)
12. NemoDSD (3D)
13. Exocad DentalCAD 2.3

Advantages of DSD

1. Customised smile design that is mad-to-measure for patient requirements.
2. A realistic simulation of the final result of the smile before the treatment.
3. A mutual acceptance from the patient and the dentist can be brought together to come to a final outcome of the treatment.
4. Easy communication with the multidisciplinary approach.
5. Digital Smile Design is easy, convenient, safe, accurate and speedy.

Limitations of DSD

1. The diagnosis and treatment plan entirely depends on photographic and video documentation therefore even a minor inadequacy may result in incorrect diagnosis and planning.
2. Expensive equipment and software.
3. Handling and training for few software are time consuming and costly. [20]

Conclusion

Digital smile design concept is a helpful tool in aesthetic visualization of patient's problem. It not only helps patients to envision their treatment outcome but also improves clinician's diagnosis and treatment planning. DSD works as a test drive procedure, and will enable us to enhance the predictability of success in Smile Designing. It improves communication between multidisciplinary team members, but also works as a new tool for complex cases and treatment planning. Also, in many cases, patients are not satisfied with their appearance but really do not understand which contributing factors are responsible. When the clinician is able to clearly illustrate the elements present that deviate from ideal esthetic principles, the patient is more likely to appreciate the treatment challenges ahead and the potential compromises that may ensue.

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