

## Digital Smile Design-An innovative tool in aesthetic dentistry

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### ABSTRACT

A fundamental objective of an aesthetic treatment is the patient's satisfaction and that the outcome of the treatment should meet the patient's expectation of enhancing his/her facial aesthetics and smile. A patient constantly doubting the end result of the treatment, which is an irreversible procedure, can be motivated and educated through Digital Smile Designing (DSD) technique. DSD 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 design before the treatment physically starts. It helps in visual communication and involvement of the patients in their own smile design process, thus ensuring predictable treatment outcome and increasing case acceptance. This article reviews the aspects of digital smile designing in aesthetic dental practice pertaining to its use, advantages, limitations and future prospects.

### 1. Introduction

A beautiful confident smile is desired by all. When a patient wishes to attain that smile but is skeptical to undertake the treatment procedure, for not being able to visualize his or her treatment outcome, is when, a clinician can use the Digital smile designing (DSD) tool. DSD concept aims to help clinician by improving the aesthetic visualization of the patient's concern, giving understanding of the possible solution therefore educating and motivating them about the benefits of the treatment and increasing the case acceptance. Digital smile design is a digital mode that help us to create and project the new smile design by attaining a simulation and pre visualization of the ultimate result of the proposed treatment. A design created digitally involves participation of the patients on the designing process of their self-smile design, leading to customization of smile design as per individual needs and desires that complements with the morpho psychological characteristics of the patient, relating patient to an emotional level, increasing their confidence in the process and better acceptance of the anticipated treatment.<sup>1</sup>

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.<sup>2</sup>

### 2. Evolution of digital smile designing

In the last two decades smile designing has progressively evolved from physical analogue to digital designing which has advanced from 2D to 3D. From the earlier times when hand drawing on printed photos of the patient were used to communicate and explain the patients of how the end result would look like, it has now progressed into complete digital drawing on DSD software on computer. This can be easily be edited and can be done and undone anytime to achieve the final design balancing patients aesthetic and functional needs.

Christian Coachman in 2017 has proposed this evolution in generations as:<sup>3</sup>

**Generation 1. Analogue drawings over photos and no connection to the analogue model.** It was the time when drawing with pen was done on printed copy of photographs to visualize the treatment result but that could not be co-related with the study model. Digital dentistry by now was not introduced.

**Generation 2. Digital 2D drawings and visual connection to the analogue model.** With the advent of digital world, certain software like PowerPoint were familiarized which permitted digital drawing. Although not specific to dentistry and limited to drawing in two dimension it was more accurate and less time consuming than hand drawing. The drawing could be visually connected to the study model but physical connection still lacked.

**Generation 3. Digital 2D drawings and analogue connection to**

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**the model.** This was the beginning of digital-analogue connection. The very first drawing software specific to digital dentistry was introduced which linked 2D digital smile design to 3D wax-up. Facial integration to smile design was also introduced at this stage, but connection to 3D digital world was missing.

**Generation 4. Digital 2D drawings and digital connection to the 3D model.** Now was the time when digital dentistry progressed from 2D to 3D analysis. 3D digital wax-up could be done involving facial integration and predetermined dental aesthetic parameters.

**Generation 5.** Complete 3D workflow.

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

### 3. Requirements for DSD

DSD technique is carried out by digital equipment already prevailing in current dental practice like a computer with one of the DSD software, a digital SLR camera or even a smart phone.<sup>4</sup> A digital intra-oral scanner<sup>5</sup> for digital impression, a 3D printer and CAD/CAM are additional tools for complete digital 3D work flow. An accurate photographic documentation is essential as complete facial and dental analysis rests on preliminary photographs on which changes and designing is formulated, a video documentation is required for dynamic analysis of teeth, gingiva, lips and face during smiling, laughing and talking in order to integrate facially guided principles to the smile design.

#### 3.1. Photography protocol

To proceed with a correct digital planning it is crucial to follow a photography protocol. Photographs taken should be of utmost quality and precision, with correct posture and standardized techniques, as facial reference lines like the commissural lines, lip line and inter-pupillary line which forms the basis of smile designing are established on them. Poor photography misrepresents the reference image and may lead to an improper diagnosis and planning.<sup>6</sup>

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.

#### 3.2. Videography protocol

According to Coachman<sup>7</sup> 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:

1. A facial frontal video with retractor and without retractor smiling,
2. A facial profile video with lips at rest and wide-E 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.

As it is, that a static photograph taken at a particular time cannot guarantee the ideal moment captured at the idealistic rest position and a real maximum full smile position, videos are helpful to allow the choice of capturing photo at the perfect moment. Videos can be paused and transformed into a photo by making a screenshot of the best recorded moment at the desired angle. A study conducted by Tjan and Miller on static photographs of a posed smile, reported that 11% of the patients presented a high smile as opposed to the 21% of patients with an anterior high smile in a study with video recording.<sup>8</sup> Tarantili et al. also studied the smile on video and observed that the average duration of a spontaneous smile was 500 ms, which emphasizes the difficulty of recording this moment in photographs.<sup>9</sup>

#### 3.3. 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. Aesthetic 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

Factors such as dentofacial aesthetic parameters, ease of use, case documentation ability, cost, time efficiency, systematic digital workflow and organization, and compatibility of the program with CAD/CAM or other digital systems may influence the user's decision.<sup>10</sup>

There are many aesthetic parameters that guide smile evaluation and design such as the midline, height, and the curve of the smile and intra- and interdental proportion.<sup>11–13</sup> A study conducted by Doya Omar et al.<sup>10</sup> compared eight DSD softwares (Photoshop CS6, Keynote, Planmeca Romexis Smile Design, Cerec SW 4.2, Aesthetic Digital Smile Design, Smile Designer Pro, DSD App and VisagiSMile in their capability to evaluate and digitally modify these aesthetic parameters i.e facial, dento-gingival and dental parameter and concluded that Photoshop, Keynote and Aesthetic Digital Smile Design included the largest number of aesthetic analysis parameters. Apart from these the other included DSD softwares were deficient in analyzing the facial aesthetic parameters although they had wide range of dentogingival and dental aesthetic features. According to the authors, “the DSD App, Planmeca Romexis Smile Design, and Cerec SW 4.2 could execute 3D analysis; moreover, Cerec SW 4.2 and PRSD worked together with CAD/CAM. The DSD App and Smile Designer Pro were offered as mobile phone applications. SDP and ADSD were marketed as specialized digital design programs. Furthermore, VisagiSMile and DSD App shared the idea of visagism” which was first introduced by Braulio Paolucci<sup>14,15</sup> that suggests temperament can be used as a factor in smile design.

More recently, Exocad DentalCAD 2.3 was introduced which does 3D analysis and could be incorporated with CAD/CAM.

### 4. Procedure of carrying DSD

Although the inclusion of aesthetic parameters in different DSD software varies, basic procedure of smile designing remains the same. All the DSD software allows for aesthetic designing through the

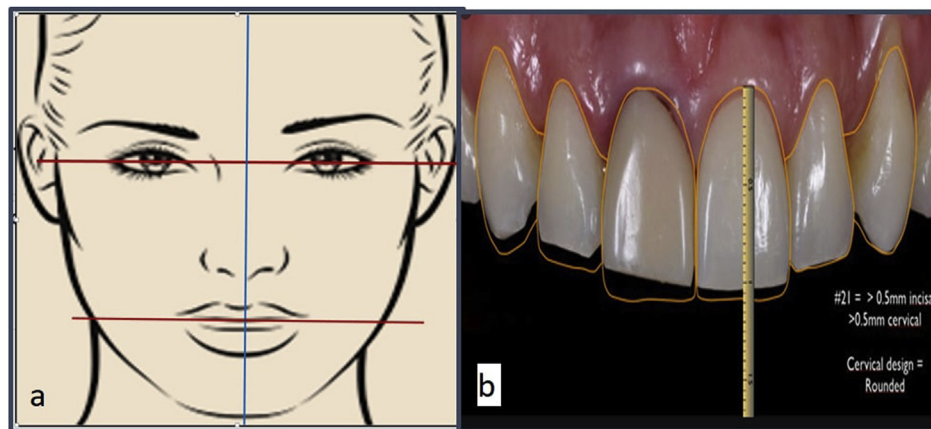


Fig. 1. 1a- Facial view with horizontal and vertical reference lines. 1b- Digital ruler.

drawing of reference lines and shapes on extra- and intraoral digital photographs. Facial analysis is done using reference lines from which uniform parameters are developed for frontal view of the face. The horizontal reference lines consist of the inter-pupillary and inter-commissural lines that deliver a complete sense of balance and horizontal over view in the aesthetically pleasing face<sup>16,17</sup> while the vertical reference line includes the facial midline, passing the glabella, nose, and the chin (Fig. 1a). The horizontal and vertical lines are crossed against each other to measure symmetry and cant of the face.<sup>18</sup> The facial photograph with a wide smile and the teeth apart is moved behind this cross to determine the ideal horizontal plane and vertical midline which permits a comparative analysis of the teeth and face.

After facial analysis, dento gingival analysis is done. The length of the upper lip at rest and in a smile is checked to determine the gingival display. Smile curve is established by correlating the curvature of the incisal edges of the maxillary anterior teeth. The dental contour is made according to the lower lip proportions and the anterior-posterior curvature of the teeth. This facial photograph is then cropped to show only the intraoral view. Three reference lines are marked on the teeth, a straight horizontal line drawn from canine tip to canine tip, one more horizontal line on the incisal edges of central incisors and another vertical line passing through the dental midline (passing through the interdental papillae). This supports in reproducing the cross, that is, the reference inter-pupillary and facial midline on the face onto the intraoral view. Few additional lines are drawn such as the gingival zenith, joining lines of the gingival and incisal battlements for complete dental analysis. For adequate teeth dimension the ideal size of dental width to length ratio can be incorporated by any one of the published theories which includes Golden proportion,<sup>19</sup> Pound's theory,<sup>20,21</sup> Recurring aesthetic dental proportion,<sup>21</sup> Dentogenic theory,<sup>22,23</sup> or Visagism.<sup>24</sup>

Required changes are carried out with the help of a digital ruler (Fig. 1b) which can be calibrated on the photograph by measuring the width of the central incisors in the study model. Changes can be modified, decreased or adapted to different situations, depending on the aesthetic requirement<sup>25</sup> and individual needs of the patient. Fig. 2 shows the procedure of digital smile designing on a DSD 3D software Exocad.<sup>26</sup>

After the new smile design is attained it can be digitally presented to the patient to seek out appreciation and feedback. This digitally approved smile design at this stage can be used to create physical mockup which can be tested aesthetically in the patient's mouth. The mock-up allows for not only visualization of the shape integrated to the gingiva, lips, face, but also to phonetics during the evaluation period.<sup>27,28</sup> As such, the patient may evaluate, provide opinion, and approve the final shape of the new smile before any irreversible procedures are performed.

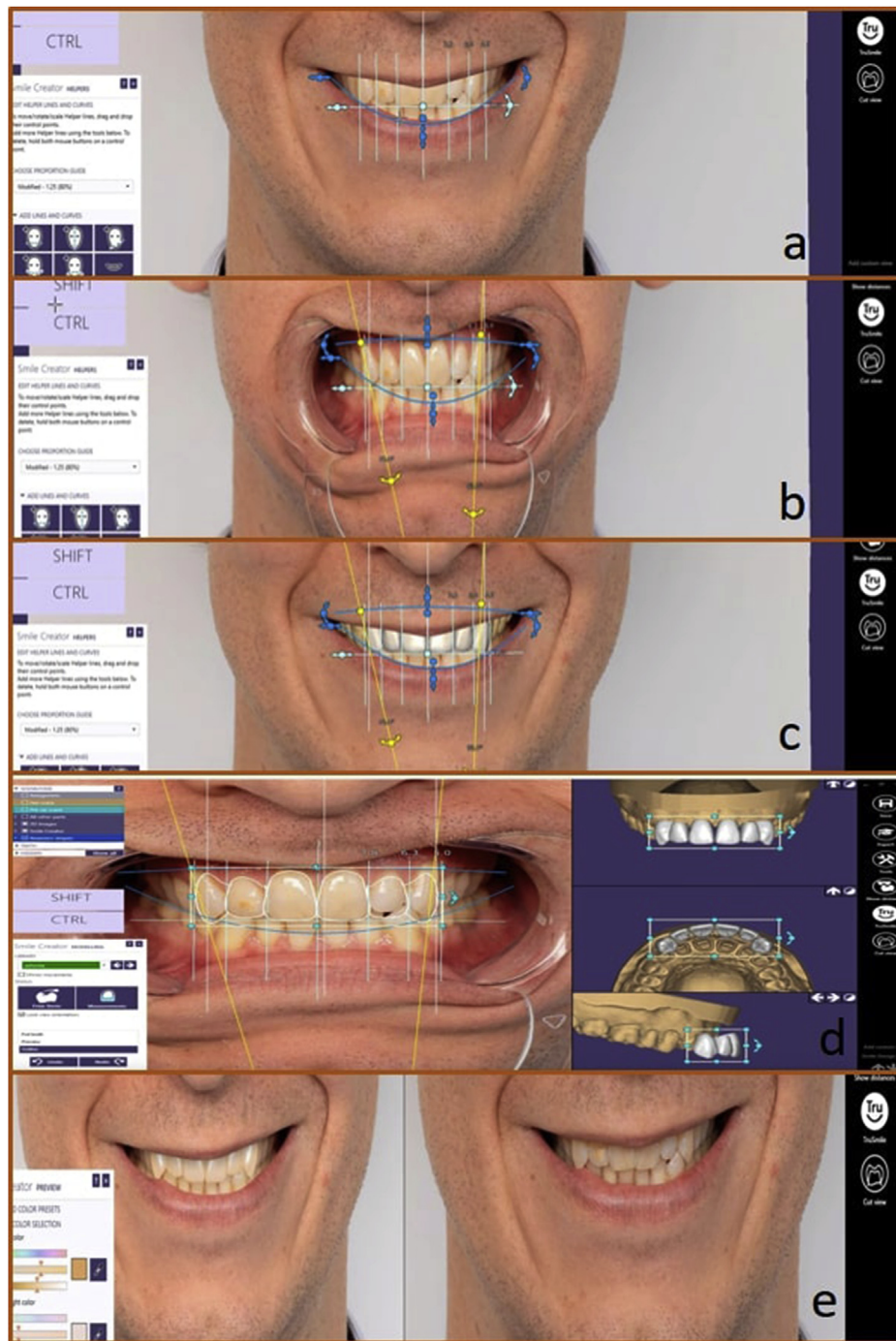
## 5. Advantages

Digital imaging and designing helps patients to visualize the expected final result before the treatment itself starts which enhances the predictability of the treatment.<sup>29,30</sup> The clinician can address patients concern by showing digitally the final outcome, motivating and educating them about the benefits of the treatment. It improves clinician diagnosis and treatment plan by aesthetic visualization of patients problem through digital analysis of facial, gingival and dental parameters that will analyze the smile and the face in an objective and standardized manner.

DSD leads to customization of smile design by increasing the participation of patient in their own smile design which result in a more aesthetically driven, humanistic, emotional and confident smile.<sup>1</sup> The patient may evaluate, provide opinion, and approve the final shape of the new smile before any treatment procedures are performed thus enhancing patients satisfaction. It leaves no scope of regret post treatment where the irreversible procedures once carried out cannot be undone. It also helps to evaluate and compare pre and post treatment changes. With the digital ruler, drawings, and reference lines, easy comparisons can be made between pre- and post-treatment photographs.

It not only improves communication between clinician and patient but also between interdisciplinary team members, between clinicians, clinician and lab technician. All team members can access this information whenever necessary to review, change, or add components during the diagnostic and treatment phases, without being available in the same place or at the same time. This enhances visual communication, improves transparency, creates a better team work, and interdisciplinary treatment planning. The lab technician also receives feedback of patients expectation related to tooth shape, arrangement, and color to enable any desired modifications. This persistent double-checking ensures the quality of the final result.

A study conducted by Gabriele Cervino et al.<sup>31</sup> reviewed as much as 24 articles on DSD published up till the year 2018 with the purpose to evaluate the effectiveness of the use of Digital Smile Design techniques and whether Digital Smile Design is bringing any improvements in the comfort of patients and in their treatments. It took into consideration, the “communicative” utility of the software, the therapeutic planning, and, of aesthetic and functional rehabilitation of the patients. The authors concluded from all of the articles present in the literature regarding Digital Smile Design, that, this tool provides important information to the clinician and patient. Patients can view their rehabilitations even before they start, and this can also have important medico-legal functions.



**Fig. 2.** Digital smile designing process on Exocad 3D software  
 2a & 2b shows drawing of facial and intraoral reference lines.  
 2c shows integration of facial with dental analysis.  
 2d represents incorporation of ideal dental contours in 3D.  
 2e shows digital designed smile compared with original smile.

## 6. Limitations

1. As the diagnosis and treatment plan depends on photographic and video documentation, inadequacy in them may distort the reference image and may result in an incorrect diagnosis and planning.<sup>6</sup>
2. For complete 3D digital work flow, 3D softwares with updates, intraoral scanner, 3D printer and CAD/CAM are required which makes it economically expensive.
3. Training and handling for certain software are necessary which

further increases time and cost.<sup>32</sup>

## 7. Future prospects

Complete 3D digital workflow is still not extensively used which in future may come into practice far and wide when more and more clinician will adopt digital scanner, 3D printers, CAD/CAM, then the need for time-consuming impressions, plaster and wax will become far less necessary. With the improvements in the software over the next few

years, it will be possible to address facial aesthetics in advanced cases where implants need to be placed by superimposing the files coming from a CT scan or a Cone Beam, along with 3D files of an oral impression or a facial scan and a photo. There also is a possibility of incorporating 4D concept in which motion can be added to the smile design concept.<sup>3,33</sup> With ever evolving fast paced technology a time, not so far, may come, when digitally designed smile can be projected to virtual reality glasses to foresee the desired smile in actual reality.

## 8. 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.

## Declaration of competing interest

NIL.

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NIL.

## References

- Coachman C, Yoshinaga L, Calamita M, Sesma N. Digital smile design concepts. *The Technologist*. 2014.
- Coachman C, Calamita M. Digital smile design: a tool for treatment planning and communication in aesthetic dentistry. *Quintessence Dent Technol*. 2012;35:103–111.
- Evolution of Smile Design. (Accessed on 15th February 2020) Available online: <https://media.digitalsmiledesign.com/christian-coachman-thoughts/smile-design-evolution>.
- Daher R, Ardu S, Vjero O, Krejci I. 3D digital smile design with a mobile phone and intraoral optical scanner. *Comp Cont Educ Dent*. 2018;39(6):e5–8.
- Aragón ML, Pontes L, Bichara L, Flores-Mir C, Normando D. Validity and reliability of intraoral scanners compared to conventional gypsum models measurements: a systematic review. *Eur J Orthod*. 2016;38:429–434.
- Zanardi PR, Zanardi RL, Stegun RC, Sesma N, Costa BN, Laganá DC. The use of the digital smile design concept as an auxiliary tool in aesthetic rehabilitation: a case report. *Open Dent J*. 2016;10:28.
- Coachman C, Calamita MA, Sesma N. Dynamic documentation of the smile and the 2D/3D digital smile design process. *Int J Periodontics Restor Dent*. 2017;37(2):183–193.
- Tjan AH, Miller GD. Some aesthetic factors in a smile. *J Prosthet Dent*. 1984;51(1):24–28.
- Tarantili VV, Halazonetis DJ, Spyropoulos MN. The spontaneous smile in dynamic motion. *Am J Orthod Dentofacial Orthop*. 2005;128(1):8–15.
- Omar D, Duarte C. The application of parameters for comprehensive smile aesthetics by digital smile design programs: a review of literature. *Saudi Dent J*. 2018;30(1):7–11.
- Fradeani M. *Ethetic Rehabilitation in Fixed Prosthodontics*. Chicago: Quintessence; 2004.
- Davis NC. Smile design. *Dent Clin North Am*. 2007;51(2):299–318.
- Dias NS, Tsingene F. SAEF—Smile's aesthetic evaluation form: a useful tool to improve communication between clinicians and patients during multidisciplinary treatment. *Eur J Esthetic Dent*. 2011;6(2):160–176.
- Paolucci B. Visagismo e odontologia. In: Hallawell P, ed. *Visagismo Integrado: Identidade, Estilo, Beleza*. São Paulo: Senac; 2009:243–250.
- Paolucci B, Calamita M, Coachman C, Gurel G, Shayder A, Hallawell P. *Visagism: The Art of Dental Composition*. Quintessence of Dental Technology; 2012:1–14.
- Chiche G, Pinault A. Diagnosis and treatment planning of aesthetic problems. *Aesthetics of Anterior Prosthodontics*. Quintessence. 2004; 2004:13–25.
- Cohen SE. *Fundamentals of Dental Aesthetics: Analysis. Atlas of Cosmetic and Reconstructive Periodontal Surgery*. third ed. PMPH; 2007:217–238.
- Naini FB, Gill DS. Facial aesthetics: 2. Clinical assessment. *Dent Update*. 2008;35(3):159–170.
- Priya K, Rahul DP, Varma S, Namitha R. Norms for crafting a beautiful smile. *Amirata J Med*. 2013;2(9):4–9.
- Vassantha Kumar M, Ahila SC, Suganya Devi S. The science of anterior teeth selection for a completely edentulous patient: a literature review. *J Indian Prosthodont Soc*. 2011;11(1):7–13.
- Ward HD. Proportional smile design using: the recurring esthetic dental proportion to correlate the widths and lengths of the maxillary anterior teeth with the size of the face. *Dent Clin North Am*. 2015;59(3):623–638.
- Farias FO, Ennes JP, Zorzatoo JR. Aesthetic value of the relationship between the shapes of the face and permanent upper central incisor. *Int J Dent*. 2010;1:1–6.
- Pedrosa VO, Franca FM, Florio MF, Basting RT. Study of the morpho-dimensional relationship between the maxillary central incisors and the face. *Braz Oral Res*. 2011;25(3):210–216.
- Sharma A, Luthra R, Kaur P. A photographic study on Visagism. *Indian J Oral Sci*. 2015;6(3):122–127.
- Ahmad N, Ahmed M, Jafri Z. Aesthetics considerations in the selection of teeth for complete denture patients: a Review. *Ann Dent Spec*. 2013;1(1):4.
- GGmbH Exocad. Viewed March 2020 <https://www.youtube.com/watch?v=3GLXEweaXeM&t=648s>; Nov 2019.
- Neto AF, Bandeira AS, de Miranda BF, Sánchez-Ayala A. The use of mock-up in dentistry: working with predictability. *Full Dent Sci*. 2015;6:256–260.
- Lin WS, Zandinejad A, Metz MJ, Harris BT, Morton D. Predictable restorative work flow for computer-aided design/computer-aided manufacture-fabricated ceramic veneers utilizing a virtual smile design principle. *Operat Dent*. 2015;40(4):357–363.
- Fan F, Li N, Huang S, Ma J. A multidisciplinary approach to the functional and aesthetic rehabilitation of dentinogenesis imperfecta type II: a clinical report. *J Prosthet Dent*. 2019;122(2):95–103.
- Ahrberg D, Lauer HC, Ahrberg M, Weigl P. Evaluation of fit and efficiency of CAD/CAM fabricated all-ceramic restorations based on direct and indirect digitalization: a double-blinded, randomized clinical trial. *Clin Oral Invest*. 2016;20(2):291–300.
- Cervino G, Fiorillo L, Arzukanyan AV, Spagnuolo G, Cicciù M. Dental restorative digital workflow: digital smile design from aesthetic to function. *Dent J (Basel)*. 2019;7(2):30.
- Meereis CT, De Souza GB, Albino LG, Ogliaeri FA, Piva E, Lima GS. Digital smile design for computer-assisted aesthetic rehabilitation: two-year follow-up. *Operat Dent*. 2016;41(1):E13–E22.
- Halley E. The future—3D planning but with the face in motion. *Br Dent J*. 2015;218:326–327.