Effectiveness Of Esthetic Rehabilitation Of Patients Using Digital Smile Designing Versus Conventional Anatomic Mock-up -An Invivo Study

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Abstract

Introduction/Background: We have been employing the diagnostic wax-up and mock-up technique for various prosthodontic treatments and many esthetic cases, but it has drawbacks of its own. Digital Smile Design has emerged as a feasible substitute tool for esthetic dentistry. Therefore, to make a sensible decision on the treatment plan for esthetic cases, this study was conducted. This study evaluates the efficacy of Conventional anatomic mock-up and Digital smile designing in the esthetic rehabilitation of patients both preoperatively and postoperatively and compares the Digital Smile Designing and Conventional anatomic mock-up in terms of the Aesthetic Numeric Analog score.

Materials and methods: Twelve participants who were reported for maxillary anterior rehabilitation were included in this observational study. Extraoral and Intraoral photos were obtained for the case's examination and treatment planning. For the Conventional mock-up, a diagnostic (Alginate) impression was created. Silicon putty index was then created from wax-up and transferred to the patient using Bis-acryl composite resin. With the aid of a mobile app (SMILEFY), digital planning was done.

Results: The data were statistically analyzed using the paired t-test. After analyzing the t-score between the two variables, a P-value that indicates statistical significance at a 95% confidence interval is obtained which shows digital aids and virtual planning meet high esthetic expectations of patients.

Conclusion: Considering the limitations of this research, it can be concluded that the Digital smile design planning technique plays a pivotal role in planning esthetically conscious patients and yields more predictable outcomes along with more patient acceptance.

Keywords: Conventional mockup, Digital smile designing, Esthetic rehabilitation, Esthetic satisfaction, Mobile app digital planning.

Introduction

Having an unattractive smile limits people from experiencing optimum social and emotional well-being.[1] Therefore, a patient's overall well-being can be boosted by a smile that is both pleasant and visually appealing.[2] The goal of esthetic treatment is to enhance the patient's smile and personality to ensure that the finished results meet the patient's expectations.[3]

Typically, Clinicians face challenging circumstances while deciding on treatment plans.[4] There are now several ways to provide an aesthetic sneak peek of the prosthodontic treatment before beginning the final procedure. This enables us to create a restoration that fulfills the patient's expectations and closely mimics their original teeth.[5]

The conventional wax-up technique aids in identifying the ideal treatment plan by displaying the planned restoration.[6,7] This tool's primary function is its ability to give important diagnostic data and offer a virtual blueprint of the completed restorations to the patient.[8] Among the multiple advantages of diagnostic wax-up is the ability to create a vacuum-formed splint or silicone matrix which can be used for fixed prosthesis and guide tooth reduction based on the contours provided by the wax-up.[9]

Diagnostic wax-up is usually done by an experienced dental technician who is familiar with the fabrication of anatomically shaped teeth. However, the diagnostic wax-up will be inaccurate if the patient's teeth in terms of their length , width, position in relation to

the lips and gingiva, as well as their inclination, are not known. [10] If clinical guidance is not given, the technicians fabricate the waxing using landmarks on the diagnostic casts. These landmarks include the remaining teeth's length and position, as well as the occlusal plane that already exists. This works in some cases, but in most situations, it can lead to serious errors. In particular, If the remaining teeth are not in the correct position with the structure of the patient's lips and face, they can act as false guides. Even after a substantial amount of time and effort, the outcome cannot match the patient's facial features.[11]

Although laboratory wax-ups are used to create aesthetic principles from a patient's dental cast, their advantages—both aesthetically and functionally remain restricted. Even if the wax does not perfectly reproduce the tooth colour from an aesthetic point of view, this concept can facilitate only visualizing the shape and position of the tooth.[12]

Additionally, not every case can be performed without preparing the teeth. As such, a severe misalignment or the buccally placed anterior teeth could not be corrected with an additional approach. The model requires to be trimmed to perform the wax

-up in order to correct this,
but this would prevent the silicone key from fitting the patient's mouth properly.

However, digital mock-ups and tools, can be done on misaligned teeth and give precise evaluation of the results with natural morphology. [13,14,15] The main role of mock-up in aesthetic dentistry is the trilateral communication between patient-dentist-dental technicians.[16]

Therefore, to identify the most functional tool for planning the esthetic cases this clinical study compares the effectiveness of esthetic improvement of the patients using the Digital smile designing technique against the conventional anatomic mock-up technique preoperatively and postoperatively by showing patients both Anatomic mock-up & digital mock-up designs and patient's satisfaction were measured using an Aesthetic numeric analogue scale (ANA-scale). After patient acceptance of the digital or conventional design of their maxillary anterior dentition, further treatment plan continues. The null hypothesis is that there would be no difference in the esthetic outcome of the patients rehabilitated using DSD and Conventional anatomic mock-up designs.

Materials And Methods

The required armamentarium used for this study includes Addition Silicone putty (Dentsply Sirona, Germany), Light-bodied material (Type III Light Bodied Consistency-Dentsply Sirona, Reprosil, U.S.A), Orthokal Dental stone (KALABHAI White Type III Dental Gypsum, Mumbai, India), Mock-up wax (2GM White, Mumbai), PKT Carvers (GDC, Hoshiarpur, India), Autopolymerizing resin (Luxatemp Fluorescence, DMG Germany), DSD app (SMILEFY Mobile App, USA), Digital Vernier Caliper (SSU Digital Vernier Caliper, India), Chromium coated Occlusal & Lateral Mirrors (Capri Intraoral Photo Mirrors, Maharashtra, India), Black Anodized Aluminium Contrastors (Capri Contrastors, Maharashtra, India), iPhone X mobile(Apple, California), LED Ring flashlight (Creative Dizayn, India).

The study sample consists of 12 adult patients (5 Males & 7 Females) between the age group of 23 years to 49 years whose chief complaint was an unsightly smile resulting from missing teeth in the upper front teeth region, and to improve the upper front teeth's

overall appearance respectively. This observational study's participants were drawn from the outpatients who visited the Prosthodontics Department at Adhiparasakthi Dental College, & Hospital in Melmaruvathur, Tamil Nadu, India from January 2021 to November 2021. During this observational period, 12 cases were reported for rehabilitation of their maxillary anteriors, and all 12 subjects were taken for this study. As per the availability of samples, Simple Random Sampling was chosen for this study.

The statistical analysis of the data was done using the paired t-test with a significance level of $\alpha = 0.05$ and $\alpha = 0.01$ respectively. After being imported into Microsoft Excel(MS Office 2019), the collected data were transferred to IBM SPSS Version 23.0 (Windows) for statistical analysis. A tabular presentation was developed after descriptive statistics were calculated with the mean and standard error.

This study obtained approval from the Institutional Ethics Review Board, Adhiparasakthi Dental College and Hospital with IRB REFERENCE VALUE 2019-MDS-Brl-PRA-02/APDCH. The patients gave their written and informed consent to be photographed and to participate in this investigation.

Inclusion criteria:

1. Patients with stains and discoloration of anteriors

2. Patients with overlapped/ crowded/ missing anterior teeth

3. Patients with anterior fractured/carious teeth

4. Patients with midline diastema (maxillary anteriors)

Exclusion criteria:

1. Subjects who are more than 50 years old

2. Subjects having major deformity of dental or skeletal origin

3. Subjects with periodontally compromised maxillary anterior teeth along with pathologic migration of anterior teeth.

The Steps followed in the Conventional Mock-up procedure include,

After a preoperative examination to record the patient's wishes expectations, and medical history, proper registration of the impression was made using properly sized stock trays and addition silicone PVS material. Then proceeded with the mock preparation of the cast and waxing the cast with mock-up wax. Basics of anterior dental anatomy are followed during the waxing of anteriors. [17] For selecting the tooth-tooth width proportions or their sizes, the RED proportion is used in this study.

For this maxillary anteriors length and width were measured from stone cast and Intercanine distance (ICW) (the curved distance around the labial surface from the distal-most point of the right canine to the distal-most point of the left canine) was measured using digital vernier caliper and measuring tape. Several RED proportions may be utilized for a given ICW of the patient, considering the patient's desires, the size of their face, and the relative length of their teeth. Table 1

Following that, the width/length ratio of each patient's central incisor is calculated to determine a suitable RED proportion. Each consecutive distal tooth becomes a smaller percentage of the width of the preceding tooth when the RED proportion decreases. Therefore, different RED proportions can be used for the given ICW such as 80% (very short tooth length), 75% (short tooth length), 70% (Normal tooth length), 66% (Tall tooth length), 62% (very tall tooth length). Table 2 can be used to calculate anterior tooth width using the RED proportions and relative tooth lengths. [18]

After fabricating the wax-up according to the RED proportion, they were duplicated with putty silicone extending a pair of teeth adjacent to each end of the wax-up. With adequate tooth preparation, the patient's prepared teeth serve the tissue surface form (TSF), and silicone index of wax mock-up preparation provides the external surface form (ESF), thus indirect-direct technique is followed for making provisional restorations.[19]

While the material is loaded, the mixing tip should be held deep inside the silicone index and always immersed in it to avoid air bubbles/voids. Vaseline was used to isolate the teeth and gingiva. Then, the silicon index was seated properly in the patient's mouth. Once the bis-acryl composite resin had hardened, the silicon putty matrix was removed

from the patient's mouth & the putty index had been separated apart, to retrieve the provisional restoration. Excess material trimmed facially & palatally.

To create a natural appearance and facilitate good hygiene, the incisal and gingival embrasures are opened, and axial contouring, finishing, and polishing are carried out. After final evaluation, mock-up / provisional restoration was luted using IRM restorative material. From a functional and aesthetic perspective, the final shape was assessed. The patient is now encouraged to interact and engage in the treatment. We can also incorporate the corrections given by the patient & check whether their esthetic expectations are met.

The Steps for Digital smile designing using the SMILEFY Software app include,

For all patient's photographs standard mode had been set, i.e., f-stop 1.8, phase detection autofocus for capturing the images with high dynamic range (HDR) mode turned on. An optimal distance of 12 inches from the patient's face is maintained. All intraoral & extraoral photographs were captured after installing the LED ring flash on the iPhone. The frontal wide smile view with teeth 1-2mm apart & the frontal photography at rest with the maximal intercuspal position taken with the head fixed in the same position. These photos are important for proper planning & transitions between retracted & full smile views.

For Intraoral retracted frontal view with teeth in occlusion, maintain a fixed head position and have photos taken. Photos of the patient's profile with the lips and teeth in contact and at rest were taken. For the occlusal view of the upper & lower arch, position the patient in a dental chair in a reclined horizontal position and the phone camera axis is kept at 45° to the surface of the mirror. Focus pointed on the occlusal surface of the first bicuspids & air blown to eliminate the fog on the mirror. Photos were taken with the intraoral occlusal mirror & cheek retractor.

After installation of the SMILEFY app, it is logged in by using Username & password. For smile designing, photos that were taken were imported into the SMILEFY software. Under the guidance of the software, the designing was completed in phases.

Subsequently, the patient's frontal view smile photograph is uploaded inside the smile frame. The smile image is aligned in reference to the horizontal line bisecting both the pupils, then the vertical midline bisecting the patient's glabella, the tip of the nose, the philtrum, and the chin. The patient's information of their age i.e., young, mid-aged, mature, and along with their facial form (Oval, Square, Triangle) entered & the smile zone was marked. Then there was a smile simulation where the smile curve, buccal corridor, midline, occlusal plane, and the number of teeth that would be featured in the frame could all be changed. As per the patient's desire and wishes further designing was followed. Finally, based on the patient's profile, the smile frame was modified to the shape, and shade of the teeth, optimal height-to-width ratio, as well as the transparency and opacity of the gingiva. The designed case was saved in PDF format for later reference.

Both the conventional mock-up & digital mock-up designs were shown to the patient, and their esthetic satisfaction & compliance were identified preoperatively & postoperatively using an aesthetic numeric analogue scale (ANA-scale) developed by Wolfgang Funk et al 2012 Figure 1 [20] and their difference score was taken to identify their esthetic satisfaction. Their verbal assessment,

1. "Insufficient" is similar to rating "0"
2. "Unsatisfied" means "1"
3. "Poor" means "2"
4. "Sufficient" means "3"
5. "Neutral" means "4"
6. "Agreed" means "5"
7. "Satisfied" means "6"
8. "As requested," means "7"
9. "Perfect" means "8"
10. "Harmonic" means "9"
11. "Highly satisfied" means "10"

After their acceptance to either conventional anatomic mock-up design or DSD, duplication of the respective mock-up design was sent lab to act as an exact guide for switching forward with the fabrication of the final restorations.

Results

Out of the 12 patients in our study, 7 patients preferred virtual mock-ups and DSD treatment planning. Four patients had the highest post-operative score of 10, while the other patients' scores were 9, 8, 7, and 6. Five patients were happy with the conventional anatomic mock-up. One patient had the greatest post-operative

score, which was 10, while the other patients' ratings were 9, 8, 7, 6, 5, 4, 3, 2. As a result, the majority of samples favoured digital smile designing, which is known to be influenced by both macroesthetics and microesthetics. Table 3

The mean difference and the standard error of pre-op scores for Digital designing and Conventional anatomic mock-up were 1.58 & 0.2289 and the mean difference and the standard error of post-op scores for Digital smile designing and Conventional anatomic mock-up were 8.42 & 0.4345 and 6.42 & 0.7633 respectively. The mean difference between the two variables was analyzed & the obtained t-test value is 12.16 for DSD and 6.65 for Conventional anatomic mock-up, which implies that a large difference exists between the two variables. Therefore, the obtained P-value for both variables (DSD & Conventional anatomic mock-up) is 0.000 which implies a highly significant P- value < 0.01 between pre-op and post-op scores. Table 4

For the ANA score of DSD, the mean difference and standard error were 6.83 and 0.5618while for the AN A score of Conventional anatomic mock-up, they were 4.83 and 0.7265. After analyzing the t-score, a value of 2.18 and a P-value of 0.0404 (P-value <0.05) were found,
indicating statistical significance at a 95% confidence interval. Table 5

Discussion

One of the basic yet invaluable form of human communication is Smile and Smiling is perceived as a key facial expression in daily interactions. [21,22] In the field of cosmetic dentistry, smile design is an increasingly popular discipline that encompasses several aspects of assessment and treatment planning. [23] An accurate assessment of the esthetic zone is essential for positive treatment outcomes, and it necessitates a facial soft and hard tissue evaluation. [24] The imbalance between the orofacial tissues, periodo ntium, and teeth is one of the fundamental motives for patients to search for a solution in esthetic dentistry. [25]

In this present study the SMILEFY DSD mobile app was utilized for 2D virtual smile planning of esthetic cases that were subjectively assessed pre-operatively and post-operatively & also compared the effectiveness and esthetic outcome of patients rehabilitated using DSD and Conventional anatomic mock-up and the results showed that DSD planning yielded more esthetic outcome along with more patient acceptance which is consistent with research conducted by Pinzan-Vercelino CRM et al (2017), Atwal H et al (2021), HM Alharkan et al (2023). [26,27,28] Thus, the hypothesis that there is no difference between the two treatment plans is rejected.

The treatment sequence was explained well to patients using hand drawings on printed images of themselves in previous decades, but this has evolved over time to include full virtual drawings on DSD software. This tissue-preserving approach can be easily altered and edited anytime to achieve a harmonious design fulfilling the patient's aesthetic as well as functional needs which is in accordance with our findings. [29,30]

Jaafar Abduo et al (2015) [31] in a study concluded that when compared to the pre-treatment model, the conventional wax-up significantly reduced the amount of tooth contour alteration than digital wax-up. Similarly, in this present research, we faced several difficulties with the digital wax-up of the patient cases than conventional wax-up. To list a few issues, i.e., we cannot alter the proportions of existing teeth and correct supra-erupted teeth to achieve a parallel incisal plane with the occlusal plane.

Magne P et al (2006) [32] presented a clinical case report of rehabilitating moderate enamel loss by integrating an additive diagnostic wax-up and a direct intraoral acrylic mock-up. The author discussed that under certain circumstances, preliminary corrections of the existing crown shape are required to allow the complete seating of the silicon index & subsequent fabrication of the mock-up. Similarly in our study, alteration of the existing teeth dimensions was needed for a patient for the direct intra-oral mock-up procedure but this leaves the patient with no idea about their final planned restorative outcome.

Lambodaran G et al (2020) [33] presented a case report in which esthetic rehabilitation did use the latest digital technique i.e., Digital Smile Design Software. The author discussed the rehabilitation of the case done using DSD planning yielded a better outcome by explaining to the patient all systematic planning & framed treatment plans. Similar findings were suggested in a study done by Cattoni F et al (2016),

CTW Meereis et al (2016), and Jaisudhaa M et al (2020).

[34,35,36] These results were consistent with our study, which showed that patients' ability to see the anticipated outcome using digital imaging increases patient acceptability, which in turn contributes to the aesthetic outcome.

According to WS Lin et al (2015) [37], CAD digital planning was recommended for definitive restorations instead of the traditional wax-up method. Similarly, a patient in our study underwent digital planning based on the desired midline and incisal edge positions. Additionally, photo-realism tools were added, such as adjusting tooth shades, texture, translucency, and characterization & opacity of gums. Compared to the traditional anatomic mock-up method, the patient gave the digital mock-up a higher ANA post score of 10/10.

According to Mamaly Reshad et al (2008) [38] and Manuel S. Thomas et al (2014) [39], patients' esthetic goals were met methodically and objectively using an intraoral mock-up approach that provided the highest degree of predictability for the treatment's final result. This report contrasts with our study, in which the ANA score of DSD, the mean difference and standard error were 6.83 and 0.5618 while for the ANA score of Conventional anatomic mock-up, they were 4.83 and 0.7265.

In a study done by ME Miranda et al (2016) [40], both DSD planning and a diagnostic wax-up were shown to the patients, which assisted the clinician in confirming the treatment plan and achieving the esthetic & functional harmony of the case. This report supports our study, which found that even with DSD planning using different smile simulations completed in a short amount of clinical time, prosthodontists must still invest in their traditional training in manual wax-up techniques to fully benefit from and take advantage of the advancements in digital dentistry.

Therefore, it can be inferred from the statistical analysis of our study that a highly statistically significant difference observed between pre-op and post-op satisfaction scores of patients designed using the mobile smile designing app than the Conventional anatomic mock-up with a P-value is 0.0000 (P-value<0.01), which could be due to implementation of all the vital elements of smile designing principles and easy handling of varied digital tools available in the software.

Conclusion

Within the limitations of this study and based on the patient's own experience of their treatment, it can be concluded that the Digital smile design planning technique plays a pivotal role in planning esthetically conscious patients and yields more predictable & highly esthetic outcomes when compared with the Conventional anatomic mock-up technique along with more patient acceptance. Further investigations can be carried out on objective assessment between Digital smile designing and Conventional anatomic mock-ups with regard to macro, micro, and mini esthetics since this study only focused on subjective assessment and with the increased number of samples.

References

1. Goldstein RE. Study of need for esthetics in dentistry. J Prosthet Dent 1969;21(6):589-98.

2. Garcia PP, da Costa RG, Calgaro M, Ritter AV, Correr GM, da Cunha LF, et al. Digital smile design and mock-up technique for esthetic treatment planning with porcelain laminate veneers. J Conserv Dent 2018;21(4):455-458.

3. Gürel G. Discovering the artist inside: a three-step approach to predictable aesthetic smile designs. Dent Today 2013;32(5):74-78.

4. Ahmad I. Risk management in clinical practice. Ethical considerations for dental enhancement procedures. Br Dent J 2010;209(5):207-14.

5. Chisnoiu AM, Staicu AC, Kui A, Chisnoiu RM, Iacob S, Flueraşu M, et al. Smile Design and Treatment Planning—Conventional versus Digital—A Pilot Study. Journal of Personalized Medicine 2023;13(7):1028.

6. The Glossary of Prosthodontic Terms: Ninth Edition. J Prosthet Dent 2017 ;117(Suppl 5):e1-e105.

7. Magne P, Belser UC. Novel porcelain laminate preparation approach driven by a diagnostic mock-up. J Esthet Restor Dent 2004;16(1):7-16

8. Kahng LS. Patient-dentist-technician communication within the dental team: Using a colored treatment plan wax-up. J Esthet Restor Dent 2006;18(4):185-93.

9. Seymour DW, Patel M and Chan MFWY. Aesthetic preview: A novel approach. DentalUpdate 2012;39: 422–426

10. Simon H, Magne P. Clinically based diagnostic wax-up for optimal esthetics: the diagnostic mock-up. J Calif Dent Assoc 2008;36(5):355-62

11. Sailer I, Fehmer V, Pjetursson B. Fixed restorations. A clinical guide to the selection of materials and fabrication technology. 1st ed. Deutschland (Germany): Quintessence Publishing; 2021.

12. Harichane Y. The mock-up: your everyday tool. International dentistry-African edition 2015;8(1):50-56

13. Segundo ARTC, Saraiva S, de Castro C, Sesma N, Bohner L, Andretti FL, et al. CAD-CAM natural restorations-Reproducing nature using a digital workflow. J Esthet Restor Dent 2023;35(7):993-1000.

14. Coachman C, Calamita M. Digital smile design: A tool for treatment planning & communication in esthetic dentistry. Quintessence of Dental Technology 2012;1-9.

15. Heinsohn JPS, Arteaga EM, Rivera GAJ, Stange VB. Mock-up An old tool renewed. Clinical research in dentistry 2018;1(1):1-5.

16. Dragusha R, Ibraimi D. Mock-up: An Aid in the different steps in aesthetic dental treatment. European Scientific Journal 2016;12(6):307-315.

17. Ness JC. Anterior anatomy and the science of a natural smile. USA: PTC Techbooks; 2012.

18. Goldstein RE, Chu SJ, Lee EA, Stappert CFJ editors. Esthetics in dentistry. New Jersey: Wiley Blackwell; 2018.

19. Rosenstiel SF, Land MF, Fujimoto J. Contemporary fixed prosthodontics. 3rd ed. Missouri: Mosby Inc; 2001.

20. Funk W, Podmelle F, Guiol C, Metelmann HR. Aesthetic satisfaction scoring - introducing an aesthetic numeric analogue scale (ANA-scale). J Craniomaxillofac Surg 2012; 40(5):439-42.

21. Singh S, Jasoria G, Kushwah A, Soni S. Macroesthetics elements of smile; A review article. TMU Journal of Dentistry 2018;5:23-26

22. Caraiane A, Antohe ME, Olteanu C, Pacurar M, Dimofte AR. Aesthetics -dental structure preservation and restoration method. Medicine and Materials 2021;1(1):43-52.

23. Morley J, Eubank J. Macroesthetic elements of smile design. J Am Dent Assoc 2001;132(1):39-45.

24. Panossian AJ, Block MS. Evaluation of the smile: Facial and dental considerations. Journal of Oral and Maxillofacial Surgery 2010;68(3):547-554.

25. Phillips C, Broder HL, Bennett ME. Dentofacial disharmony: motivations for seeking treatment. Int J Adult Orthodon Orthognath Surg 1997;12(1):7-15.

26. Pinzan-Vercelino CRM, Pereira CC, Lima LR, Gurgel JA, Bramante FS, Pereira ALP, et al. Two-Year Follow-up of Multidisciplinary Treatment Using Digital Smile Design as a Planning Tool for Esthetic Restorations on Maxillary Midline Diastema. Int J Orthod Milwaukee 2017;28(1):67-70.

27. Atwal H, Mendiratta T, Kumar D, Khattak A. Digital smile design & computer-aided design/computer-aided milling:Pivotal tools in esthetic dentistry. Journal of Dentistry Defence Section 2021;15(2):152-155.

28. Alharkan HM. Integrating digital smile design into restorative Dentistry: A narrative review of the applications and benefits. The Saudi Dental Journal 2024;36(4):561-567.

29. Coachman C, Paravina RD. Digitally enhanced esthetic dentistry - From treatment planning to quality control. J Esthet Restor Dent 2016; 28 Suppl 1:S3-4.

30. Lo Giudice A, Ortensi L, Farronato M, Lucchese A, Lo Castro E, Isola G. The step further smile virtual planning: milled versus prototyped mock-ups for the evaluation of the designed smile characteristics. BMC Oral Health 2020;20(1):165.

31. Abduo J, Bennamoun M, Tennant M. Influence of Conventional and Digital Wax-ups on Axial Tooth Contour. Int J Periodontics Restorative Dent 2015;35(4):e50-9.

32. Magne P, Magne M. Use of additive waxup and direct intraoral mock-up for enamel preservation

with porcelain laminate veneers. Eur J Esthet Dent 2006;1(1):10-9.

33. Lambodaran G, Jagadeesan N. Digital smile design -A case report. International Journal of Dental Science and Innovative Research 2020;3(3):382-386.

34. Cattoni F, Mastrangelo F, Gherlone EF, Gastaldi G. A New Total Digital Smile Planning Technique (3D-DSP) to Fabricate CAD-CAM Mockups for Esthetic Crowns and Veneers. Int J Dent 2016;2016:1-5.

35. Meereis CTW, de Souza GBF, Albino LGB, Ogliari FA, Piva E, Lima GS. Digital Smile Design for Computer-assisted Esthetic Rehabilitation: Two-year Follow-up. Oper Dent 2016;41(1):E13-22.

36. Jaisudhaa M, Lambodaran.G, Shankar MSS, Vighneshwaran S, Lakshmi S, Annapoorni H. Smile deisgning using DSD: A Case report. Medico-legal Update 2020;20(4):2222-2227.

37. 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. Oper Dent 2015;40(4):357-63.

38. Reshad M, Cascione D, Magne P. Diagnostic mock-ups as an objective tool for predictable outcomes with porcelain laminate veneers in esthetically demanding patients: a clinical report. J Prosthet Dent 2008;99(5):333-9.

39. Thomas MS, David K. Importance of anatomic mock-up for predictable esthetic smile design with ceramic veneers. Journal of Interdisciplinary Dentistry 2014;4(1):55-58.

40. Miranda ME, Olivieri KA, Rigolin FJ, de Vasconcellos AA. Esthetic Challenges in Rehabilitating the Anterior Maxilla: A Case Report. Oper Dent 2016;41(1):2-7.

TABLES:

Table 1: Calculated cast width and length(mm) from a patient; ICW = 56mm; 80% RED proportion can be used for this patient

FDI Tooth number	13	12	11	21	22	23
Width	9	Missing	10	10	8.5	9.5
Length	12	Missing	11.5	11.5	10.5	10

Table 2: Calculating Anterior Tooth Widths using Relative Tooth lengths and the RED proportion.[18]

RELATIVE TOOTH LENGTH	RED PROPORTION	CENTRAL INCISOR WIDTH (CIW)	LATERAL INCISOR WIDTH (LIW)	CANINE WIDTH (CW)
Very tall	62%	ICW/4.0	CIW*0.62	LIW*0.62
Tall	66%	ICW/4.2	CIW*0.66	LIW*0.66
Normal	70%	ICW/4.4	CIW*0.70	LIW*0.70
Short	75%	ICW/4.6	CIW*0.75	LIW*0.75
Very short	80%	ICW/4.8	CIW*0.8	LIW*0.8

Table 3: Pre-op, Post-op, ANA scores of 12 samples.

	DIGITAL SMILE DESIGNING			CONVENTIONAL ANATOMIC MOCK UP		
	PRE-OP	POST-OP	ANA SCORE	PRE-OP	POST-OP	ANA SCORE
Case 1	2	7	5	2	9	7
Case 2	3	6	3	3	7	4
Case 3	2	10	8	2	8	6
Case 4	2	6	4	2	9	7
Case 5	0	8	8	0	4	4
Case 6	1	10	9	1	5	4
Case 7	1	10	9	1	6	5
Case 8	2	9	7	2	5	3
Case 9	2	8	6	2	9	7
Case 10	1	8	7	1	10	9
Case 11	1	9	8	1	3	2
Case 12	2	10	8	2	2	0

Table 4: Paired t-test comparing mean values and standard error for pre-op and post-op scores of two variables (Digital smile designing & Conventional anatomic mock-up):

VARIABLES	Pre-op			Post-op			t - Test	P - Value	RESULT
	N	MEAN	±SE		MEAN	±SE			
Digital	12	1.58	0.2289		8.42	0.4345	12.16	0.0000	[b]
Conventional	12	1.58	0.2289		6.42	0.7633	6.65	0.0000	[b]

Note: [a]. Correlation is significant at the 0.05 level.

[b]. Correlation is significant at the 0.01 level.

Table 5: Mean values and standard error for ANA scores of two variables (Digital smile designing & Conventional anatomic mock-up):

VARIABLES	Digital			Conventional			t - Test	P - Value	RESULT
	N1	MEAN(X)	±SE(X)	N2	MEAN(Y)	±SE(Y)			
ANA Score	12	6.83	0.5618	12	4.83	0.7265	2.18	0.0404	[a]

Note: [a]. Correlation is significant at the 0.05 level.

[b]. Correlation is significant at the 0.01 level

Figures

Figure 1: Rehabilitation of an esthetic case preferring Digital smile designing (A) Pre-Op Frontal wide smile view (B) Maxillary anterior close-up view (C) Wax-up   (D) Post-Op Temporization
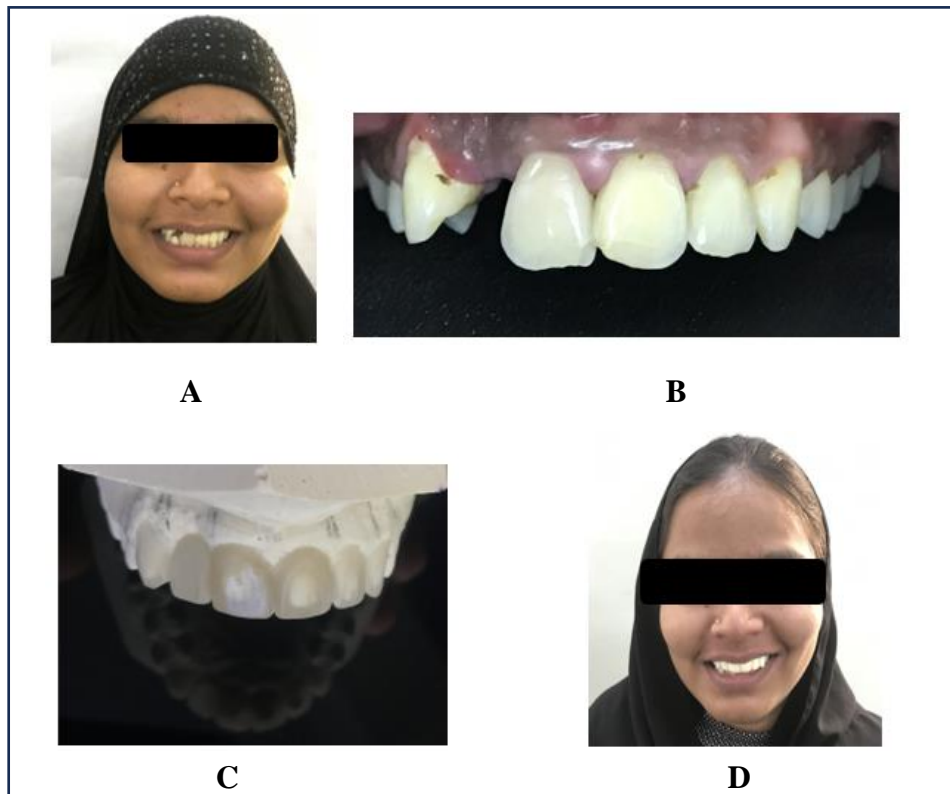

Figure 2: (A), (B), (C), (D) Digital smile designing workflow, (E) &(F)Final prosthesis design and Post-Op photo

Figure 3: Rehabilitation of an esthetic case preferring Conventional anatomic mock-up design:(A)Pre-Op Frontal wide smile view (B) Maxillary anterior close-up view (C) Wax-up (D) Post-Op Temporization
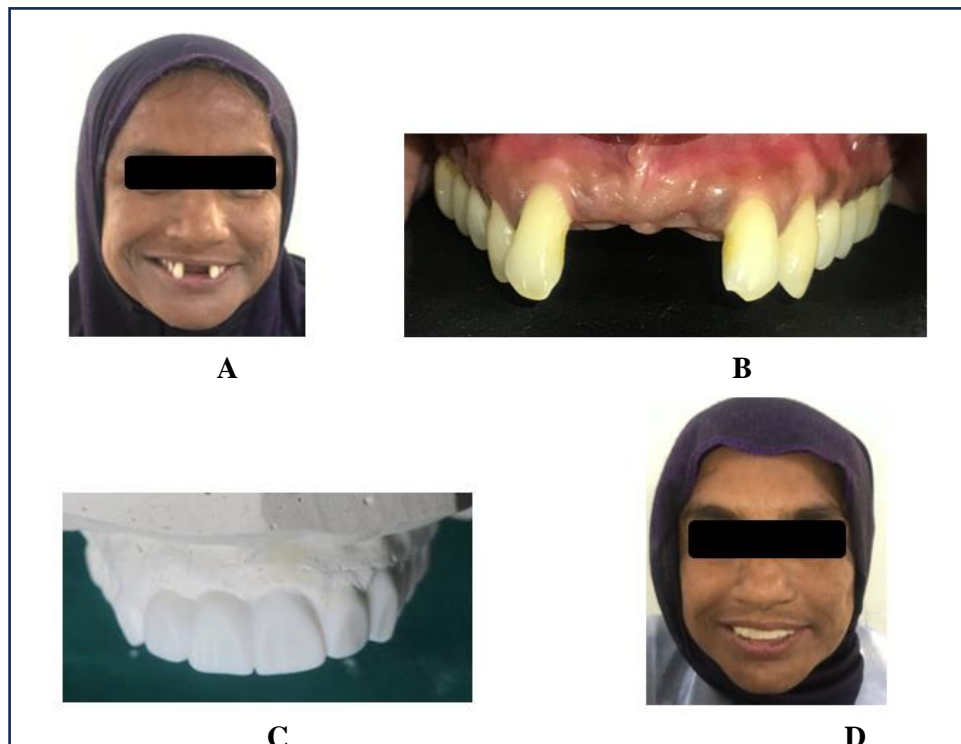

Figure 4: (A), (B), (C), (D) Digital smile designing workflow, (E) &(F)Final prosthesis design done according to Conventional smile design and Post-Op photo