

A Narrative Review of the Conventional and Contemporary Components of an Aesthetically Pleasing Smile

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ABSTRACT

The personality of a person is reflected by smile of that person. Smile designing encompasses hard tissue and soft-tissue components. The treatment plan includes facial, dental and gingival analysis to execute analysis and formulate treatment plan. The main objective of smile designing is to meet patient expectations and enhance patient's smile with improved quality. Now, smile designing has shifted to digital platform. There has been evolution in smile designing from 2-dimensional (2D) to 3-dimensional (3D) and now further to 4-dimensional (4D). The techniques include veneers and laminates, bonded restorations, modification on tooth form and various prosthetic procedures including Digital Smile Designing (DSD). The artificial intelligence can be applied only when parameters, components and various principles are known to the clinician. Smile designing comprises of aesthetic and cosmetic principles for reconstruction of smile. Certain reference lines are to be considered for designing of aesthetic appealing smile. The present narrative review emphasises on all the factors which should be considered in smile designing and also the new concepts for smile designing.

Keywords: Aesthetics, Dental analysis, Digital smile designing, Facial analysis, Gingival analysis, Smile designing

INTRODUCTION

Smile design is defined as the process of creating an aesthetic smile based on scientific and artistic guidelines established through studies, perception, and cultural and racial standards that have been recognised over time [1]. Aesthetic smile design is the process of creating a pleasing and harmonious smile that not only enhances the aesthetic appearance of the individual, but also improve their overall oral function [2]. Having a pleasing smile not only creates a better impression but also boosts the person's confidence. For a person to maintain a pleasing personality and to attain perfection in the way a person represents himself it is crucial to take every aspect into consideration especially smile. This is not just for the sole reason of aesthetics, but for better functioning and oral hygiene it is important to care of one's teeth as problems like malalignment could lead to various other issues.

Aesthetic smile design can be achieved through a combination of different dental treatments such as orthodontics, periodontics, prosthodontics, and cosmetic dentistry. One must analyse the facial, dentogingival and dental proportion to create an aesthetic appealing smile [3]. The need for aesthetics was observed by the Phoenicians and Etruscan's (800-900 BC), when animal tusks were carved in the shape of actual teeth. Pierre Fauchard (1678-1761) with other colleagues modernised the concept of dentistry and practiced aesthetic dentistry [4].

Previously, smile designing was restricted to 2-dimensional (2D) models, analogues and casts but in modern era with introduction of Digital Smile Designing (DSD) (Coachman C and Calamita M, 2012) [5] final outcome can be visualised in 3-dimension (3D) prior to any irreversible procedure and also movements can be visualised in 4-dimension (4D). In 2017, Coachman C et al., divided the software for DSD into six generations [Table/Fig-1] [6].

The components for aesthetic smile designing and parameters to decide on changes in smile will remain same for analogue smile designing and DSD as well [Table/Fig-2] [7].

Therefore, smile designing will involve evaluation and analysis of both hard and soft-tissue components and also facial components to enhance smile of a person. Davis also provided smile analysis form involving components from facial, soft and hard tissues [8].

Generation	Advancement	Description
First	Analogue drawing over images and no link to the analogue mock-up	At that time, the treatment outcome was visualised by scribbling with a hand drawing on a printed copy of a photograph, but that cannot be linked to the digital mock-up. Digital dentistry had not yet been developed at the time.
Second	Digital 2D drawing and visual link to the analogue mock-up	Some programmes, e.g., PowerPoint, became familiar with the advent of the digital era, allowing for digital drawing. Although, it was limited to 2D drawing and was not specific for dentistry, it was more appropriate and required less time than manual drawings. Although, the artwork was aesthetically related to the study model, there was no true relationship.
Third	Digital 2D drawing and analogue link to the mock-up	It was the start of digital-analogue conversion. The first dental specific digital drawing application was launched, which linked 2D-DSD to 3D models. Facial integration for smile design was also created at this time, but there was no link to the 3D digital world.
Fourth	Digital 2D drawing and digital link to the 3D mock-up	Digital dentistry has moved from 2D to 3D analysis at the time. A 3D digital model was made with facial integration and current aesthetic requirements.
Fifth	Complete 3D workflow	Now, it was the time when complete workflow is done digitally and a 3D workflow is done involving all the facial and digital analysis parameters.
Sixth	The 4D concept	Including movement in the smile design process.

[Table/Fig-1]: Six generation of Digital Smile Designing (DSD) software [6].

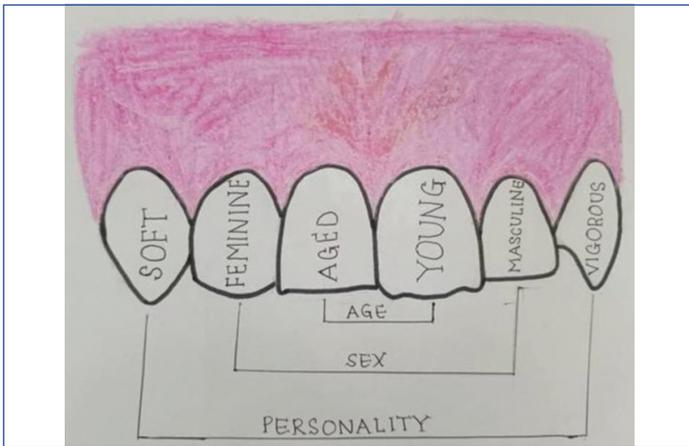
Components	Parameters
Facial aesthetics	Height of face, shape of face, facial profile, gender, age
Gingival aesthetics	Gingival health, gingival architecture, gingival symmetry
Macro-aesthetics	Lip analysis, lip morphology, lip mobility, smile line, midline, balance, length of incisors, incisor angulation, radiating symmetry, incisal embrasure form, buccal corridor
Micro-aesthetics	Specific tooth form and shade matching

[Table/Fig-2]: Components and parameters of smile designing.

Factors Considered for Smile Designing

Facial aesthetics: Facial beauty is elicited from established aesthetic principles which involve the proper symmetry, alignment, and

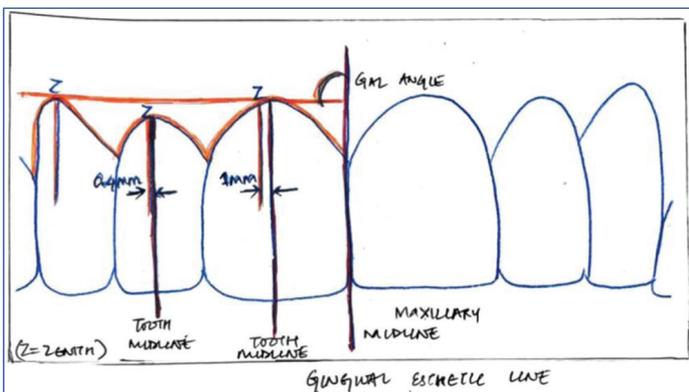
proportions of the face. Facial features in smile design entail facial height, facial shape, facial profile, gender, and age. In accordance with Trubyte denture tooth mold indicator, facial shape can be categorised as square, tapering, square tapering, and ovoid. Tooth form should mimic the facial form while performing any smile designing procedure. Facial feature having great impact on dento-facial composition is interpupillary line. The occlusal plane, commissure line and interpupillary line should be parallel to each other and also perpendicular to dental midline [9,10]. According to gender and age, facial features involve the changes in soft-tissues, contour, texture, complexion, and tissue integrity of the epithelial tissues and so are the teeth. Sex, Personality, Age (SPA) factor (Dentogenic concept), given by Frush and Fischer includes difference in tooth form, contour and texture as influenced by sex, personality and age [Table/Fig-3] [8].



[Table/Fig-3]: Difference in tooth form and contour as per sex, age and personality (Dentogenic concept).

For females, teeth should be rounded, more curved, smooth and delicate while for males teeth are more cuboidal, hard and vigorous. Aggressive, hostile angry person will have pointed long “fangy” cusp form as compared to blunt, rounded, short cusp form for soft personality [8].

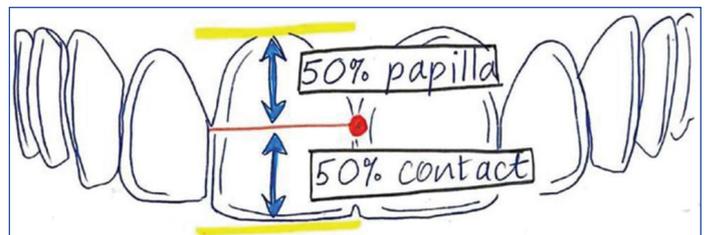
Gingival aesthetics: The gingival health colour, contour are of paramount importance and contribute to aesthetic value for any treatment. Healthy gingival is pale, pink in colour and matte in appearance extending to contact point of teeth. If the gingival doesn't extend to contact point then unaesthetic black triangles will be visible. The apical most point of gingival in relation to tooth is known as zenith point. Zenith point should be equal and distal to long axis for maxillary central incisors and canines [Table/Fig-4].



[Table/Fig-4]: Zenith point in relation to maxillary central incisor, lateral incisor and canine.

Maxillary lateral incisors zenith point should be slightly below and along the long axis as compared to central incisor and canine [11]. Crown lengthening procedure can be carried out to sculpt the position of labial gingival margin in case of discrepancy [12].

Interdental papilla must fill the interproximal spaces till the contact area. In ideal smile, papilla/contact relationship must be 1:1 [Table/Fig-5] [13].



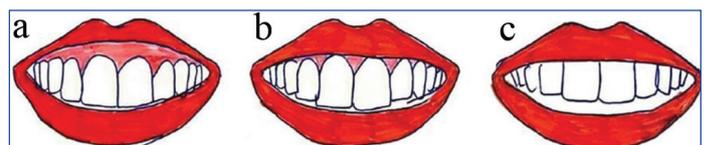
[Table/Fig-5]: 1:1 Ratio of contact area and papillary height in central incisor region.

Chu and his group has studied the papillary height and concluded that interdental papilla of upper anterior teeth is 40% of crown height [14]. Recession of interdental papilla leads to black unaesthetic triangles. Teeth reshaping can be performed to remove these black triangles.

The terms ‘pink aesthetics’ and ‘white aesthetics’ have been introduced to correlate harmony in gingival design during smiling. Gingival exposure varies during speech or smile and effected by dental and muscular structures [15]. For ideal aesthetic gingival design, canine gingival margin must coincide with central incisor but lateral incisor should be below this line [16]. During modified gingival design: 1) gingival margin of centrals and laterals coincide and below the canines. (0.5-1 mm); 2) gingival margin of centrals incisors is below canines (0.5-1 mm) and gingival margin of lateral incisor is below central incisors (0.5 mm). Gingival asymmetry >1.5-2 mm between central incisors and canines are acceptable [13].

Macro-aesthetics: Macro-aesthetics involve lip analysis, morphology, lip mobility, smile line, midline, balance, length of incisors, incisor angulation, radiating symmetry, incisal embrasure form, buccal corridor.

- **Lip analysis, morphology and mobility:** Lip line is relation of inferior border of lip with teeth and gingival when patient is smiling. Lip line is classified arbitrarily in three categories [Table/Fig-6] [8].
 - Average lip line- In this, there is exposure of maxillary teeth and inter-dental gingival.
 - Low lip line- Gingival tissues are not exposed during smiling.
 - High lip line- Maxillary teeth along with gingival tissues above gingival margins are exposed, which is also referred as ‘gummy smile’.



[Table/Fig-6]: Classification of lip line as average, low and high.

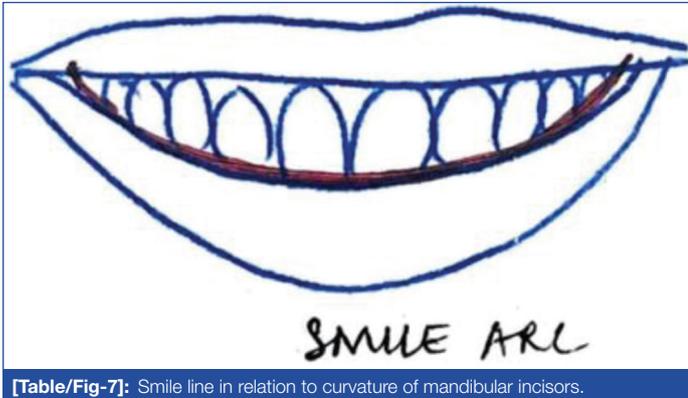
Treatment option for gummy smile include periodontal, orthodontic and orthognathic surgery. After confirmation of maxillary excess by cephalometric analysis, orthodontic and orthognathic surgery can be planned [8].

Lip morphology frames the smile and Burstone suggested that relaxed lip and closed lip posture should be evaluated for determining the position of incisors [17] instead of dynamic measures like smiling. During rest position, 2 mm of anterior incisors should be displayed while during smile 3-4 mm display is required [17]. There are three aspects which should be considered: width, fullness and symmetry. Position of the anterior teeth, mandibular and maxillary arches and their relationship influence the shape of lips. Wide lips make wide smile and a smile that is half the width of face is considered to be aesthetic. Lip fullness can be categorised as full, average and thin. Lip symmetry involves mirror image of lips when smiling. Upper and lower lip should be evaluated separately for lip fullness and symmetry [8].

Lip mobility influences teeth visibility during full smiling. It is measured by subtracting teeth display during spontaneous smile and from lip length in repose. Normal lip mobility is found to be 6-8 mm [18].

Tosun H and Kaya B evaluated the perception of smile attractiveness when maxillary incisors and lower lip are seen with the maxillary gingival display. They concluded that smile attractiveness is improved by elimination of maxillary gingival display; however the coverage of maxillary incisor edges has undesirable influence [19].

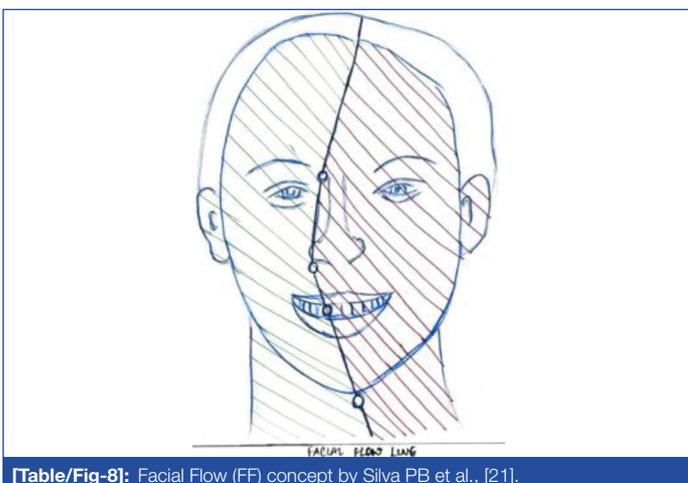
- **Smile line:** Smile line is a fictional line following the curvature of maxillary anterior teeth. It should follow lower lip curvature. In aesthetic smile, maxillary central incisors, lateral incisors and canines should be made gull wing appearance [Table/Fig-7] [8].



[Table/Fig-7]: Smile line in relation to curvature of mandibular incisors.

In a study by Tosun H and Kaya B it was found that the step between maxillary centrals and laterals in males is 0.5 to 1 mm while for females the step was found to be 1.0 to 1.5 mm [19].

- **Midline:** A dental midline over the papilla, parallel to long axis of face and perpendicular to the incisal plane provides a more aesthetic appearance to the patient. Certain anatomical landmarks are used as a guide to identify the midline like nasion, philtrum, chin but most accurate is philtrum except in cases of cleft lip and surgeries of lip. As far as dental midline is parallel with the midline of face, 3-4 mm discrepancy in maxillary and mandibular midline can be perceived as aesthetic according to classic literature [19], however more contemporary literature states that deviation of 2 mm is considered to be unaesthetic [20]. Angulation of midline has more pronounced effect on aesthetics instead of midline [20]. In 2018, Facial Flow (FF) concept was presented for smile analysis by Silva BP et al., which divides it into two components; vertical and horizontal. Facial Flow Line (FFL) is an imaginary line which can be drawn connecting the glabella, nose bridge, philtrum, and chin. This line is usually not always straight [Table/Fig-8] [21].

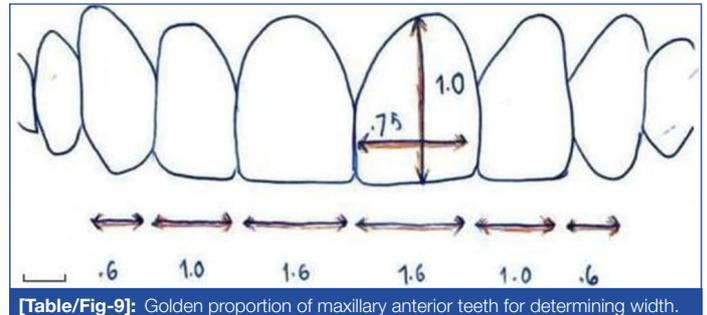


[Table/Fig-8]: Facial Flow (FF) concept by Silva PB et al., [21].

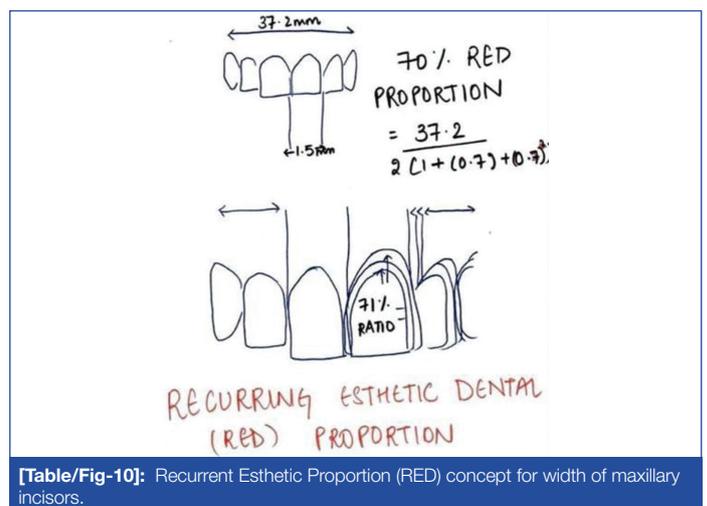
When canting or shifting of midline follows facial low, it is acceptable. Hence, smile and face should follow FFL to maintain harmony and balance.

- **Length, width and angulation of incisors:** Maxillary incisal length is determined at rest and full smile. At rest, the maxillary incisal display should be 2-3 mm in females, however for males

it is 1-2 mm [22]. More incisal display depicts more youthful smile. During 'F' sound, maxillary central incisors should touch the vermilion border of lower lip. During spontaneous smile, Pound E stated that maxillary centrals should occupy 50% to 80% of inter-labial space [23]. Some theories have been proposed for incisor length to width ratio or proportion of central incisor to lateral and canine and so on e.g., Golden proportion [Table/Fig-9], Pound's theory, Visagism, Dentogenic theory or Recurring Esthetic Dental (RED) proportion [Table/Fig-10] [24].



[Table/Fig-9]: Golden proportion of maxillary anterior teeth for determining width.



[Table/Fig-10]: Recurrent Esthetic Proportion (RED) concept for width of maxillary incisors.

Divine proportion or golden proportion which was studied by Greek sculptor, Phidias also known as phi, which is approximately 1.618034 [25]. It states that there is 62% ratio in width of central to lateral incisor and further from lateral to mesial half of canine. It was disapproved by many authors as this leads to narrow smile. Other proportions were advocated to achieve wider smile. RED was proposed by Ward DH and this encourage on range of proportion rather than any particular percentage. The range varies from 62% to 80% depending on tooth length and width [26]. Curvature of maxillary teeth should support upper lip and follow the facial form according to Williams JL Tupal theory [24]. Facial forms by Williams were entirely subjective so new method was given by Ashok V and Ganapathy D which was based on geometrical method for classification of face form by incorporating photograph along with face form indicator [27]. Ovoid tapering, tapering ovoid and tapering ovoid tapering were three new facial forms concluded from aforementioned study.

- **Incisal and interproximal embrasures:** From central incisor to canine, there is space available between proximal surfaces to contact point which meets the contact point of adjacent teeth known as incisal embrasure. Inadequate incisal embrasure depth and variation will give non uniform look and if contact points are made too long then it gives box-like appearance to the teeth [27]. Incisal embrasure increase gradually from central to canine (20% to the height of mandible to 35% to distal to canine) [1] Interproximal embrasures represents the space between adjacent teeth in entire dental arch. It constitutes the embrasure space, occlusal or incisal to the contact point. There should be no darkness of the oral cavity in the interproximal

triangle present between the gingiva and the contact area. An improperly developed cervical embrasure may be seen as a result of overextended, bulky restorations which effectuate an improper emergence profile and swollen and inflamed gingival tissues area. If the most apical point of the restoration is not much as 5 mm assessed from the crest of the bone, this will encourage the formation of a healthy, firm and pointed papilla. Failure to achieve the same results in unaesthetic blunted tissue form and ultimately black triangle [28].

- **Buccal corridor:** During smiling, dark space is present between buccal surface of teeth and labial commissure known as buccal corridor. Buccal corridor can be classified as narrow, intermediate, or wide. The significance of buccal corridor is still controversial; Prasad K et al., stated that there is no difference found by laymen person on increased buccal corridor while Nascimento DC et al., and Abu Alhajja ESJ et al., concluded that the buccal corridor played a major influence on smile aesthetics [29-31]. A wide corridor is usually requires maxillary expansion or added restoration to camouflage the space.

Micro-aesthetics: Micro-aesthetics include specific tooth geometry and shade of tooth. Line angles frame the tooth and create the boundary of tooth. Illusion can be created by alteration of line angles to make the tooth wide or slim, long or short. Height of contour is located distally from midline in gingival third [1]. Contact areas decrease distally and more apically to distal of canine. Texture like developmental groove is to be developed in younger teeth [32]. Guidelines for shade selection are value, chroma and last hue. During shade selection, light source, environment, condition of tooth and stump shade and also distance and timing of shade selection matters [33]. Although visual shade guides provide conventional way of shade selection but now-a-days colour measuring instruments like colourimeter, spectrophotometer etc., can minimise the error in decision making. High chroma and low value give aged appearance while reverse is true for young person [28]. Young teeth will have more translucent incisal edge as compared to worn out dentition. The colour of the teeth can be altered by bleaching or restorative options [8]. Introduction of new adhesive systems led to minimum adhesive procedures to be considered in restoration or rehabilitation like veneers and laminates.

New Concepts in Smile Analysis and Treatment Planning

Facially Generated Treatment Planning (FGTP): This concept was given by Egyptians who visualised the end result and then through reverse engineering treatment plan was executed. This is one of the interdisciplinary treatment planning concepts proposed by Spear Kokich FM and Mathews VG [34]. If repositioning or restoration of anterior teeth is required then teeth harmony with Temporomandibular Joint (TMJ) should be evaluated. The rationale of FGTP lies on saying of Dr. Peter Dawson that one should keep the end result in mind with attention on facial and dental aesthetics thenceforth Esthetics, Function, Structure, and Biology (EFSB system) [35]. Airway has been added recently as the first step in FGTP so they have included the sleep questionnaire as first step [36]. The goal of treatment should benefit the overall health of patient rather than merely camouflage the dentition with restoration.

Global diagnosis concept for gingival display: Global diagnosis concept was proposed by Robbins and Spouse in 2016 for gingival display. Global diagnosis approach focuses on ‘Gummy Smile’ and put forward the 4, 5, 6 rule which states that there are (4) global diagnoses for interdisciplinary treatment planning, (5) core questions to determine the diagnosis, and (6) treatment options, respectively [Table/Fig-11] [37].

The global diagnoses include upper lip length and mobility, clinical crown length, dentoalveolar extrusion and skeletal discrepancy if any. Dentist will answer five core questions for global diagnosis.

(4) global diagnosis	Upper lip	<ul style="list-style-type: none"> • Short/long • Hypermobile/hypomobile
	Clinical crowns	<ul style="list-style-type: none"> • Short, microdontia, incisal wear, APE • Long
		Dentoalveolar extrusion
	Skeletal discrepancy: VME, VMD, Class II, Class III malocclusion	
(5) Core questions	Facial proportions?	
	Length and mobility of upper lip?	
	Relation of gingival line to horizon?	
	Length of maxillary central incisors?	
	Cemento-Enamel-Junction (CEJ) location?	
(6) Treatment options	Orthognathic surgery:	<ul style="list-style-type: none"> • Diagnosis: VME, VMD, Class II and III malocclusion
	Plastic surgery:	<ul style="list-style-type: none"> • Diagnosis: Short/long upper lip, hypermobile/ hypomobile upper lip
	Orthodontics	<ul style="list-style-type: none"> • Diagnosis: Dentoalveolar extrusion • Class II or III malocclusion
	Restorations	<ul style="list-style-type: none"> • Diagnosis: Microdontia, incisal attrition
	Crown lengthening	<ul style="list-style-type: none"> • Diagnosis: Altered passive eruption, dentoalveolar extrusion
	Connective tissue grafting	<ul style="list-style-type: none"> • Diagnosis: Long clinical crown

[Table/Fig-11]: Global diagnosis concept for gingival display [8,37].
 APE: Altered passive eruption; VME: Vertical maxillary excess; VMD: Vertical maxillary deficiency

There are several variables mentioned in [Table/Fig-3] which can affect global diagnosis. Depending on global diagnosis treatment plan is fabricated along with alternative treatment plan [37].

Virtual treatment phase: Once the virtual plan has been established, two options are presented in front of the patient: 2D and 3D. The 2D plan is based on mock-up by photographic method using traditional applications such as PowerPoint or contemporary digital technology using software such as SmileFy, DSD or Exocad. The patient is involved by the clinician in every step of the procedure, including selection of teeth shape, size from library, gingival design, incisal edge display and also other variables. During 3D virtual treatment plan, a motivational wax-up and a technical wax-up should be created. The motivational wax-up may be additive or subtractive depending on clinical condition. In additive wax-up, wax is added on occlusal surface to diagnose change in occlusal plane, Occlusal Vertical Dimension (OVD) and also on the cervical aspect to determine gingival display and other variables. During subtractive mock-up, a computer-simulated plan will have to be used instead of patient. Aforementioned subtractive and additive methods are for motivation for the patient to choose the treatment. The technical wax-up is not additive and used when the actual treatment starts and is more anatomic as compared to motivational wax-up [36]. Coachman C and Calamita M developed a natural tooth library for copy-paste in DSD. This process will make the contour of tooth to be restored more life-like and natural [35].

CONCLUSION(S)

Smile designing encompasses multiple procedures from different specialities, so there is a need for multidisciplinary approach. The treatment plan includes facial, dental and gingival analysis to execute analysis and formulate treatment plan. A thorough understanding of principles and components is essential before beginning the process. Keeping in mind the case history, functionality, aesthetics and patient’s desires, various options can be considered that include use of veneers, implants etc. Frontal and profile reference lines should be taken care for designing of smile in aesthetic region. On introspection it can be said that the final aesthetics seems to be a cumulative effect of various tooth proportion guidelines, cultural and social influences, dentist artistic influences, patient’s own ideas and perception, and also effective communication with laboratory. With

introduction of digital technology, the outcome can be predicted and feedback from the patient can be taken for improved results.

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