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College of Dentistry

Digital smile design for complete denture

A Project Submitted to The College of Dentistry, University of Baghdad, Department of prosthodontics in Partial Fulfillment for the Bachelor of Dental Surgery

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PhD in prosthodontics

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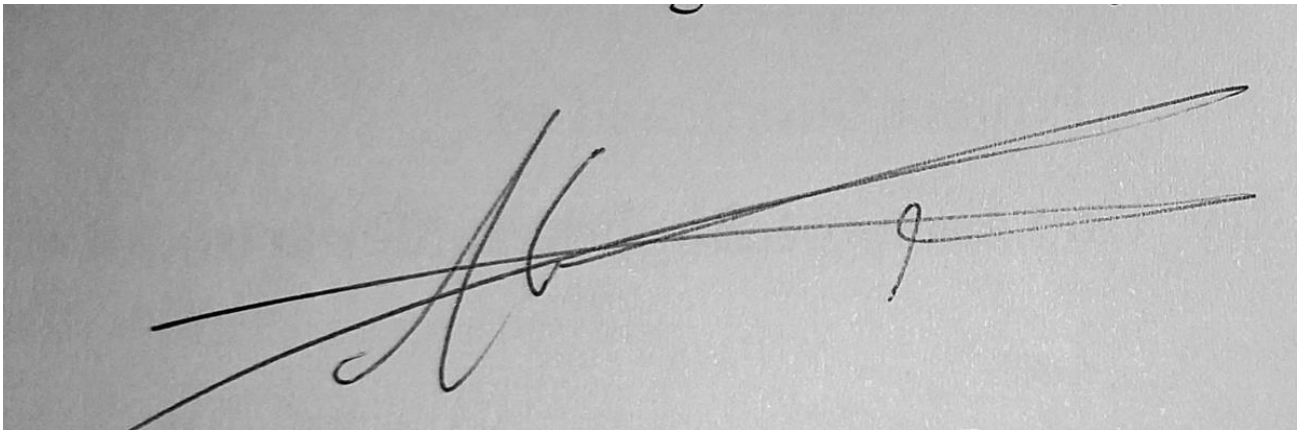
SUPERVISOR CERTIFICATION

I certify that this project entitled **" Digital smile design for complete denture "** was prepared by the fifth-year student **Fatima jabbar abd al-sada** under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.



Supervisor's name: **Dr. Ali Abdulrazzaq Mohammed**

PhD in prosthodontics

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DEDICATION

I am dedicating this work to two beloved people who have meant and continue to mean so much to me. To my mother, who has been a constant source of support and encouragement during the challenges of life.

To my father, who has never failed to give me financial and moral support.

To the person from whom I draw my strength (Imam Hussain) and his grandson (Imam AL Mahdi), The person I am still waiting for.

ACKNOWLEGEMENT

First and foremost, I must acknowledge my limitless thanks to Allah, the Ever-magnificent, the Ever-Thankful, for His help and bless by giving me the opportunity, courage and enough energy to carry out and complete the entire work.

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LIST OF ABBREVIATONS AND SYMBOLS

DSD Digital Smile Design

RED Recurring Aesthetic Dental

CAD Computer aided design-

CAM Computer aided manufacturing

PMMA Polymethyl methacrylate

GPS Guided Positioning System

SDP Smile Designer Pro

ADSD Aaesthetic Digital Smile Design

PRSD Planmeca Romexis Smile Design

INTRODUCTION

Introduction

Esthetics is becoming more important to completely edentulous patients than ever before, and more of them are asking for the smile of movie stars (**Alkhodary, 2018**). Patients' desires and higher expectations have been affected by social media as smile design and their esthetic role to general appearance have participated in personal appearance improvement. Dental esthetics has therefore been introduced by different dental protocols to accomplish higher esthetic expectations. (**EL Naggar et al., 2022**).

Esthetic dentistry has become one of the most sought-after disciplines in dentistry which focuses on the smile and pleasing appearance. Modern dentistry is not limited to just the repair of individual teeth. There has been an increase in the incidence of patients who give esthetic outcomes the main priority with the restoration of the tooth structure (**Thomas et al., 2022**).

Nowadays, dental aesthetics is becoming more and more a subject of interest in dental practice for those patients who want to improve their smile appearance. If, some time ago, the esthetic requirement was the prerogative of younger people, now, given the increased time of active life, with the increase of life expectancy, this requirement is frequently found among seniors, including the full edentulous ones or those in the imminent moment of full edentulism (**Țâncu et al., 2020**).

healthy and attractive smile represents an individual's spectrum of feelings and emotions in a positive way. This depends on the arrangement of their teeth and soft tissue structures. An attractive smile is indicative of a high societal feeling and influences their self-confidence, thereby boosting their personality (**Thomas et al., 2022**).

The smile design is the combination of aesthetic principles that make facial aesthetics compatible with the dentogingival structures. Or, more simply, it can often be described as the aesthetic treatment of anterior teeth in the visible aesthetic

region. These aesthetic concepts were created with information gathered from cases, diagnostic moulds, photographic records, scientific dimensions, and fundamental aesthetic beauty principles (**Yeşim et al., 2021**).

In recent decades, smile design has progressively shifted from analog to digital workflows, which have further evolved from 2-dimensional (2D) to 3D tools. The implementation of digital tools and online interaction has improved communication among clinicians, dental technicians, and patients. Merging 2D photographs with 3D digital files allows the transition to a full digital workflow and facilitates facially driven digital smile design (**Almalki et al., 2022**).

Newer digital smile design tools can be used to design and modify smiles of patients digitally and visualize the projected outcome before any irreversible procedures are done. Such tools also permit meticulous analysis of the patient's facial and dental characteristics to facilitate the digital design (**Almalki et al., 2022**).

Digital technologies allow accurate treatment planning and facilitate the obtaining of aesthetic, functional and predictable prosthetic structures, Digital Smile Design benefiting from the application of a digital workflow for an oral rehabilitation that can be evaluated and analysed by the patient, dentist and technician (**Beldiman et al., 2022**).

Aims of the study

The aim of this study is to enlighten dentists about digital smile design parameters and current digital smile design software also to explore digital smile design technology in complete denture.

CHAPTER ONE

REVIEW OF LITERATURE

Review of Literature

1.1 Digital smile design

Digital Smile Design is a multi-use conceptual dental treatment planning tool that is used in interdisciplinary esthetic dentistry to strengthen diagnostic vision, improve communication/education and enhance predictability throughout the course of the treatment (**Coachman et al., 2014**). digital smile design can assist the restorative team throughout treatment, improving the dental team's understanding of the esthetic issues and increasing patient acceptance of the final result (**Gupta and Mittal, 2018)**.

DSD is a method that allows us to digitally design the smile of our patients, by obtaining a simulation and pre-visualization of the therapeutic result. Patients are often found by the dentist and are immediately subjected to dental services or therapies, without the dentist himself having planned well or having shared the therapeutic project of a tailor-made smile for the patient with them (**Cervino et al., 2019**).

On the one hand, Digital Smile Design allows the patient to have awareness from the beginning of the therapeutic plan and for them be the first interpreter in the aesthetic and functional rehabilitation of their mouth, and on the other hand, it allows the specialist to tune in better to the expectations and needs of the patient, in order to pursue their shared goals. These protocols therefore allow for a previsualization of the clinical case and of the therapeutic result, and for presenting the patient, in a clear way, the usefulness of being able to program the rehabilitation and interface clearly with the help of other professional figures. Being able to provide all of the data to the dental technician, or even being able to evaluate the prosthetic–implant–orthodontic rehabilitation is made simpler, by being able to communicate information about the case in a simple and digital way to colleagues (**Cervino et al., 2019**).

1.2 Esthetics in complete denture

Steps for achieving esthetics in complete denture:

1.2.1 An accurate impression

Thickness of labial flange of both dentures, this is accomplished at the impression phase of treatment, so that the esthetics as well as retention and stability are important goals. Border thickness should vary with the needs of the patient, depending on the extent of residual ridge loss. The vestibular fornix should be filled, but not overfilled, to restore facial contour (**Abdalbasit, 2021)**.

1.2.2 jaw relation

Amount of separation between maxilla and mandible, this is establishment of the correct vertical dimension of occlusion; proper vertical dimension of occlusion helps restore normal physiological length to muscles and allows normal facial expression. Reestablishing the appropriate vertical spacing will improve the patient's appearance by decreasing the sunken and aging appearance. This vertical space must be not only esthetically pleasing but also compatible with the typical mandibular joint apparatus, including the muscles of mastication **(Abdalbasit, 2021**).

1.2.3 selection of teeth

Selection of teeth forms an important step before teeth arrangement. Objective of teeth selection-It is to create a dentofacial harmony. Teeth selection falls under two different categories (**Singh et al, 2021)**:

1. Anterior teeth selection
2. Posterior teeth selection

1.2.3.1 Methods used for selecting anterior teeth are: (Devi and Nayar, 2018).

Pre extraction records

Diagnostic casts: of patient's natural teeth or restored teeth prior to extraction of remaining teeth.

Recent photographs: They will often provide general information about the width of the teeth and possibly their outline form that is more accurate than information from any other source.

Radiograph of teeth: Radiographs made before the natural teeth were lost can supply information about the size and form of the teeth to be replaced. Radiographic images are however always enlarged and may be distorted because of divergence of the x-ray.

Post-extraction examination

Size and form of edentulous foundation, matching teeth to face forms and arch forms. If patient is already a denture wearer, mouth should be examined with the dentures in the mouth giving importance to physiological and aesthetic aspects.

Use of golden proportion: Lombardi was the first to propose the application of the golden proportion in dentistry.

The ratio can be established between the width of central and lateral incisor and

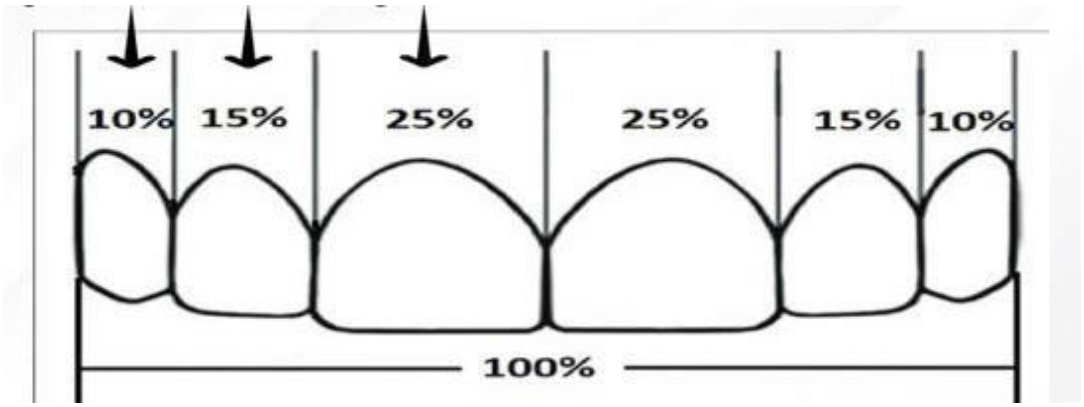
continue this ratio in the placement of the remaining teeth and spaces (figure1.1: golden proportion):

(Figure1.1: golden proportion)(Reddy et al, 2017)

Snow has supported the use of the „golden proportion" as a means of applying the golden proportion across the midline to encompass the total canine-canine width.

The golden proportion has been applied to the canine- canine width to become the "golden percentage":10%:15%:25%:25%:15%:10%.

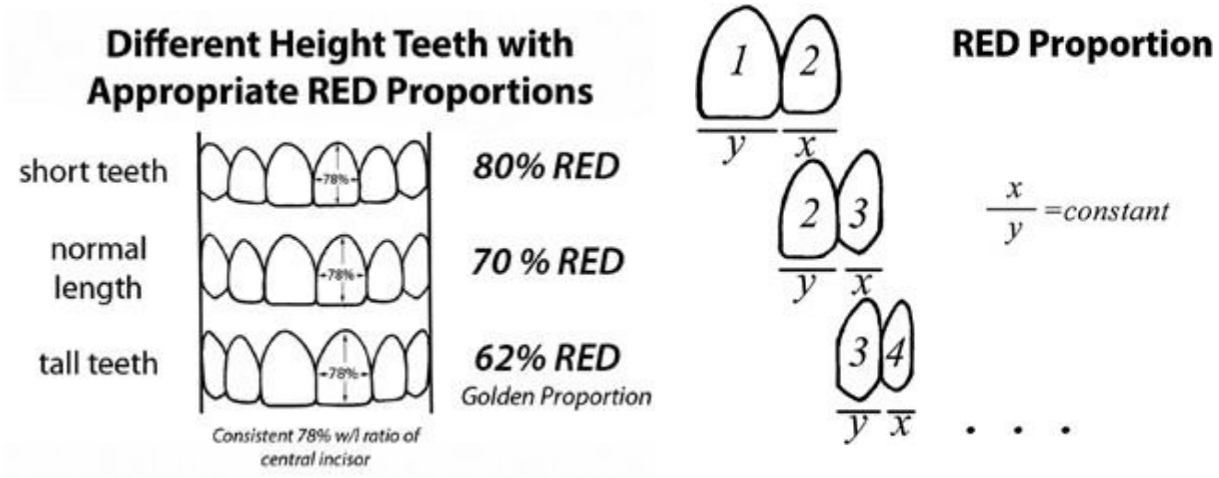
The golden percentage was calculated by dividing the width of each central incisor, lateral incisor and canine by the total width of all six maxillary anterior teeth and multiplying the resulting value by 100, in order to obtain the golden percentage for each tooth. If the values from canine to canine were 10, 15, 25, 25, 15, and 10%, it indicates that the six maxillary anterior teeth are in golden percentage (**Murthy and Ramani, 2008**) (figure1.2: golden percentage):



(Figure1.2: Golden percentage)(ward, 2007)

RED proportion: Recurrent Esthetic Dental proportion was proposed by Ward states that the proportion of the successive widths of the maxillary teeth as viewed from the front should remain constant as we move posteriorly from midline which offers great flexibility to match tooth properties with facial proportion.

Generally the values of the RED proportion used are between 60% to 50% (figure1.3: red proportion):



(Figure1.3: red proportion) (ward, 2007)

Seven anatomic entities are used as guides to select size of the anterior teeth

Size of the face:

The size of the upper central incisor tooth should be in harmony with the face size.

Large faces require large teeth, and small faces small teeth for best esthetic values. The average width of the maxillary central incisor is estimated to be one sixteenth of the width of the face measured between the zygoma. The lateral incisors vary more in size, form, & position than any other maxillary anterior tooth. The combined width of the six maxillary anteriors is slightly less than one third of the bizygomatic width of the face (**Devi and Nayar, 2018**).

Size of the Maxillary Arch:

The mould selectors are used to make measurements of the maxillary cast. Measurements are made from the crest of the incisive papilla to the hamular notches and from one hamular notch to the opposite side hamular notch. When discrepancies exist between the face size and arch size, the selection of anterior tooth should be governed more by face size than arch size, since resorbed tissue can leave one astray (**Vasantha et al, 2011**).

Incisive papilla and canine eminence:

If the eminences are discernible, a line can be placed on the cast at the distal termination of the eminence. If the eminences are not discernible, the attachments of the buccalfrenum can be used. A line placed slightly anterior to the frenum attachment will be distal to the eminence (**Devi and Nayar, 2018**).

Maxillomandibular Relations

Any disproportion in size between the maxillary and mandibular arches influences the length, width and position of the teeth. This is of importance in class II and class III maxillomandibular relations (**Vasantha et al, 2011**).

Contour of the Residual Ridge

The artificial teeth should be placed to follow the contour of the residual ridges that existed when natural tooth were present. As resorption occurs there is alteration

in the contours of the ridge (**Vasantha et al, 2011**).

Vertical distance between the ridges:

The length of the teeth is determined by the existing space between the ridges. When the space is available, it is more esthetically suitable to use a tooth long enough to remove the display of the denture base. Denture bases can be characterized, personalized, or natural appearing (**Devi and Nayar, 2018**).

Lips:

Labial surface of the maxillary anterior teeth supports the relaxed lip. Frequently incisal edges extends inferior to or slightly below the lip margin. When the teeth are in occlusion and lips closed the labial incisal third of the maxillary anterior teeth supports the superior border of the lower lip. In speech, incisal edges of maxillary anterior teeth contacts the lower lip at the junction of the moist and dry surfaces of the vermilion border (**Vasantha et al, 2011**).

Selection of tooth shape

Dentogenic and dynesthetics concept was proposed by Frush and Fisher (1955-1959) and authored a series of articles that presented a concept of esthetics based on gender, personality and age. According to them, to achieve a more natural-appearing denture, three things are necessary: the right teeth, teeth placed at proper position, and should be held in place by natural appearing denture base (**Prasad, 2013).**

Sex: Masculine: Teeth selected are strong, large and squarish; Feminine: Teeth selected are delicate, rounded, smaller.

Personality: Spectrum of personality types ranges from vigorous to medium to delicate.

Vigorous: Masculine imparts roughness; delicate imparts feminine softness whereas medium in between these two.

Age: The dignity of advancing age must be copied in the denture in terms of Translucency, shade and wear.

Selection of Tooth Colour

Colour is described using the terms 'value' (lightness), 'chroma' (saturation) and 'hue' (colour). As age progresses darker teeth should be selected for older patients **(dentulous, 2018).**

1- Colour of the teeth should blend with patient's age, skin, hair and eyes.
2- Shade selection can be done on the basis of age, sex, skin complexion and patient preference.
3- As a general rule, bright teeth for young patients with fair skin and dark teeth for aged with dark skin is suitable.
4- Some of the colour characteristics of natural teeth that can be reproduced are:

- Neck of the teeth have a more pronounced yellow colour
- Incisal edges are more translucent than the middle third
- Canines are darker than incisors
- Attrition facets and gingival recession
- Stains

1.2.3.2 POSTERIOR TEETH SELECTION:

Factors for selecting posterior teeth:

Size of The Teeth: Following factors for selecting the size of the teeth.

1. Buccolingual width of posterior teeth.

2. Mesiodistal length of posterior teeth.
3. Occlusogingival (vertical) height of the facial surfaces of posterior teeth.

Form of the occlusal surfaces (dentulous, 2018).

Form of the occlusal surfaces is selected on the basis of the occlusal surfaces desired and the type of occlusion planned.

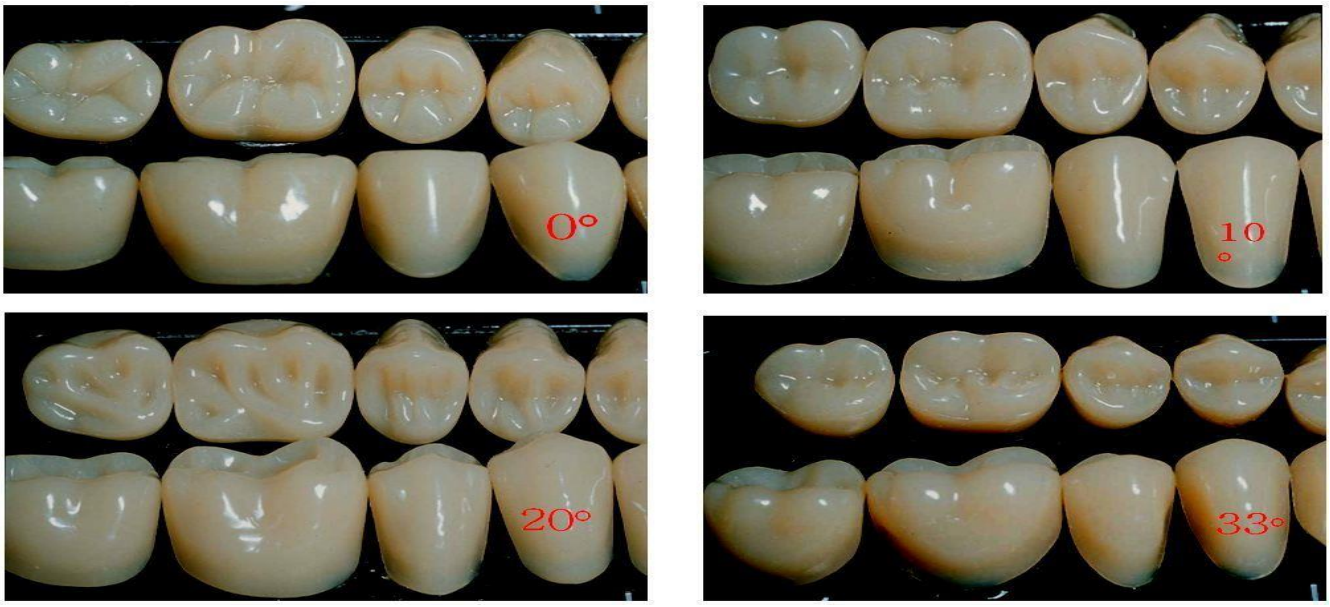
Condylar inclination, shape and height of the residual ridge, Incisal guidance, plane of occlusion, compensating curves and ridge relationship are the factors that influence the form selection.

Based on this, the forms of posterior teeth can be grouped as: (figure1.4: forms of posterior teeth):

Anatomic (Cusp angle 33º)

Semi anatomic (Cusp angle 20º)

Non anatomic (0 degree or Cusp-less teeth or Monoplane teeth)



(Figure1.4: form of posterior teeth) **(**dentulous, 2018).

Colour

Should be harmonized to the shade of anterior teeth

Maxillary first premolars are used more often for aesthetic purpose than function. So it's advisable to select premolar teeth with lighter colour than the other posterior teeth, but not lighter than anterior teeth.

Generally the shades of posterior teeth are slightly darker than anterior teeth.

1.2.4 Arrangement of teeth:

The correct alignment of teeth is essential to the production of a functionally effective and esthetically pleasing denture. Many factors enter into the arrangement of the artificial teeth arrangement. It is not simply a mechanical procedure of placing teeth to follow the form of arch or to satisfy the laws of leverage. The arrangement of teeth must be physiologically and esthetically acceptable. The prescription for teeth arrangement may be complex and provides scope for skillful limitation of nature. The factor of physiologic compatibility, denture stability, masticatory efficiency and esthetics are the major factors to be considered when arranging artificial teeth (**Al-Khuraif, 2010**).

1.2.5 Characterisation Of Complete Dentures:

"Denture characterization is alteration of the form and color of the denture base and teeth to produce a more realistic appearance." Hardy stated that, "To meet the esthetic needs of the denture patient, we should make the (denture) teeth look like (the patient‟s) natural teeth." Frush and Fisher state that "the environment of the teeth is as important as the tooth itself" (**Devi and Nayar, 2018).**

The four factors involved in fabricating real life-like dentures are:

1. Selection of anterior teeth with respect to size, form, colour, and arrangement of anterior teeth to suit the patient‟s need.
2. Characterising the denture teeth

3. Creating accurate denture base contour
4. Matching the denture base colour to the patient‟s oral tissues.

The characterisation of denture is still more critical when patient has short upper lips, single arch complete denture is given opposing a dentulous or partially dentulous arch and in implant supported prosthesis17. The method can aid in communication include – Good quality photograph, colour mapping chart, shade guides and wax characterization (**Devi and Nayar, 2018)**

1.3 Digital smile design

1.3.1 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. A digital intra-oral scanner 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 (**Jafri et al, 2020**).

1.3.1.1 Photography protocol

Dental photography has become an important adjunct to dental records, informed patient treatment planning, and communications with dental laboratories and dental insurance companies. But perhaps its most important use is in the field of esthetic dentistry **(Ban, 2019).**

The following photographic views in fixed head position are necessary: (figure1.5: dental photography in DSD):

1- **Facial frontal smile with teeth apart**. Make sure the face is centered and both sides show symetrically, also make sure that the hair is behind the ears so the whole face is visible (**DSD, 2017).**

2- **Facial frontal retracted with teeth apart**

Eyes must be open and look straight to camera.lens Glasses to be removed- if any Teeth apart- have patient say "eee" .Head straight in a fixed position Full face photo (**TDSA, 2022**).

3- **Facial profile at rest**

take the photo of the patient's profile with lips and teeth in contact (**TDSA, 2022**).

4- **Facial profile smile**

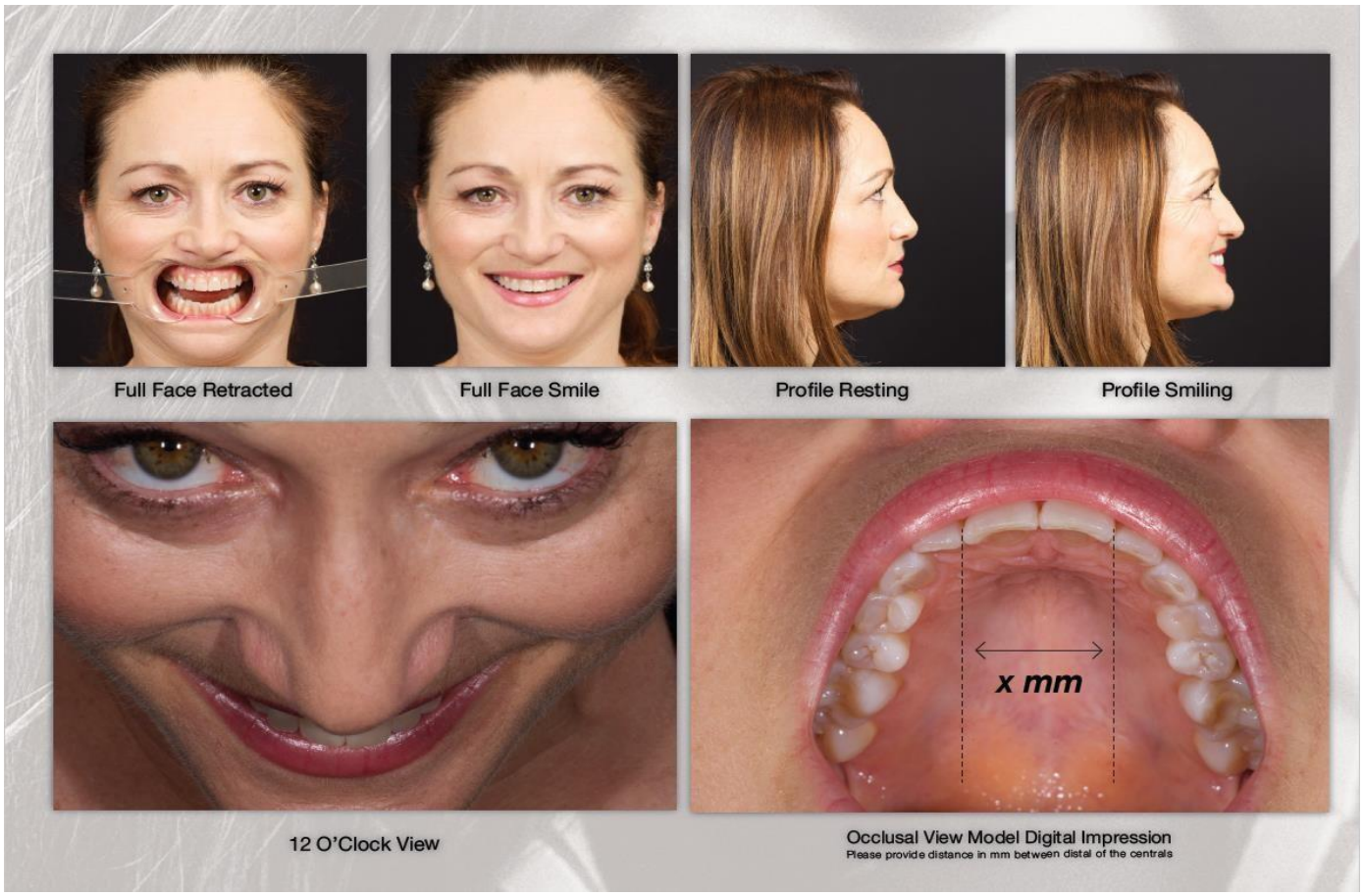
Take the photo of the patient's side profile with a full smile Making sure we have the full side profile Patient must smile (**TDSA, 2022**).

5- **Occlusal without mirror or from the model**

Oclussal view of the Patient's upper arch without using a mirror or taken directly from the stone model (**DSD, 2017**).

6- **12 o'clock view smile**

make sure the eyes, chin and angles of the jaw are shown in the photo. The patient must be looking towards the camera. The picture should be taken from the most coronal position without having the nose covering the teeth (**DSD, 2017**).



(figure1.5: dental photography in DSD) (Race Dental, 2023).

1.3.1.2 Videography protocol

According to Coachman during videography best framing and zoom should be adjusted with suitable exposure and focus adjusted to mouth (**Jafri et al, 2020**).
For ideal development of the facially guided smile frame, four videos from specific angles should be taken (**Jafri et al, 2020**). (figure1.6: dental videos in DSD):

1- **Facial frontal video:**

with retractor and without retractor smiling. The key is to keep the camera and patient's head still so one can create photos with and without retractor with similar, distances, angles and distortions so both images can be overlapped on the DSD

process linking the facial analysis into the intra oral analysis. The camera should be levelled with the eyes. That means that the camera will be slightly above the mouth creating a natural smile curve. Smartphone lenses are not macro, so a bigger distortion will happen, the closer you get to the patient the bigger the distortion of the image. To minimize this distortion, it's better to keep one meter distance and slightly zoom in digitally. Both frontal videos should have the teeth apart for better visualization of the esthetic issues, visualization of lower teeth, visualization of drawings and simulation. To keep the teeth apart similar on both photos, the patient should bite a jig on the molar area, made of silicone or the disposable flexible plastic suction.

2. **Facial profile video:** lips at rest and wide "E" smile. The key is to have a total profile view and the reference should be the filtrum.

3. **12 o'clock video:** from the top of the head with the most coronal angle possible that allows one to visualize the incisal edge of the 6 anterior upper teeth with the patient retracting the upper lip with both thumbs. This image should show the relationship between the facial midline, inter-pupilar line, comissural line, Angles of the mandibule, mentum, arch form and vermilion of the lower lip.

4. **Anterior occlusal:** film without a mirror and perpendicular to the occlusal plan. The goal is to capture from bicuspid to bicuspid having the palatine rafe as straight line.

(figure1.6: dental videos in DSD) (DSD, 2017).

Short complementary videos are also be recommended, capturing possible smile positions, including 45-degree and profile views for facial, phonetic, functional and structural analysis and better treatment outcomes.

Benefits of videos are that they can be paused and a screenshot can be taken of the best recorded moment and converted into a photo. Tarantili et al. 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 photo- graphs (**Jain and Gupta, 2021**).

1.3.2 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
14. 3Shape smile design

1.3.3 Advantages of Digital Smile Design (DSD)

• DSD assists patients in visualising the predicted outcomes prior to beginning treatment. This enhances the treatment's predictability.

• Operator can motivate and educate the patient by showing the final outcome digitally before doing any irreversible procedure this can also serve in crucial medicolegal purposes.

• Clinicians and patients can both digitally visualise and analyse gingival, dental and facial characteristics that will decide the final smile and facial aesthetics.

• DSD contributes to the personalisation of smile design by exceeding patient's involvement in their own smile designing, results in a more cosmetically motivated, emotive and confident smile.

• Before the treatment begins, comparison between before and after treatment images using a digital scale, horizontal and vertical reference lines can be done.

• DSD not only helps in better communication between patients and clinician but also helps in better communication between other team members, lab technician, etc., (**CHITLANGE et al, 2023).**

1.3.4 Limitations of Digital Smile Design (DSD)

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.

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. **(Jafri et al, 2020).**

1.3.5 DSD Workflow

three components of using CAD/CAM technology for digital dentures are:

1.3.5.1 Data acquisition
1.3.5.2 Prosthesis design
1.3.5.3 Manufacturing

1.3.5.1 DATA ACQUISITION

With the conventional complete denture process, master casts are obtained by border molding a custom tray and using an elastomeric impression material. Similarly, in the CAD/CAM process, the initial step requires the acquisition of data. Two options are available: direct intraoral scanning, or making a conventional impression that can be scanned with a desktop scanner or poured in gypsum to obtain the master casts that, in turn, are scanned (**Amit and Francois, 2020**).

1.3.5.2 PROSTHESIS DESIGN

Denture-designing software offers a powerful tool that lets clinicians select molds from a library of teeth to generate the tooth arrangement automatically — although it is still possible to customize the tooth setup. It is the authors' opinion that use of CAD technology for complete dentures can be a great teaching tool for students, as it can show them the proper positioning of the denture teeth in terms of esthetics, relationship to the residual ridge, location of the occlusal plane, and occlusal relationship (**Amit and Francois, 2020**).

1.3.5.3 MANUFACTURING TECHNOLOGIES

Since the introduction of polymethyl methacrylate by Wright in 1936, many issues of conventional complete denture materials have been associated with polymerization shrinkage, leading to issues of fit, strength, and also release of monomer. With CAD/CAM technology, two types of fabrication methods can be used to overcome these shortcomings.

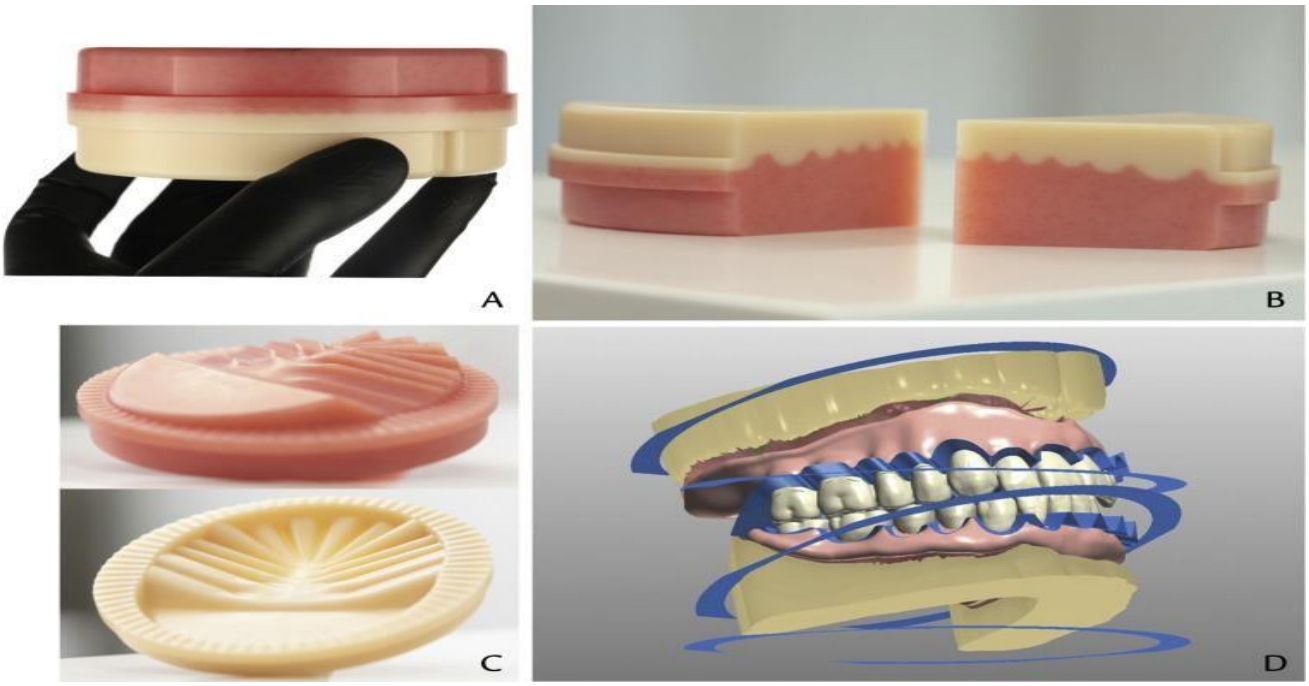
Subtractive manufacturing (milling):

subtractive manufacturing method for digital complete dentures has recently been developed. The method consists of a single disk that is milled at a single time. The milling disk combines highly cross-linked polymethyl methacrylate (PMMA) dual-shaded tooth and denture base materials, promising to provide a rapid and predictable monolithic milling solution that eliminates the manual tooth-bonding process.

The dual-shaded monolithic concept uses shell geometry technology based on data gathered from an extensive range of successful complete denture treatments. The shell geometry's 3-dimensional dental arch structure defines the transition between the tooth and base sections of the milling disk for a stress-free, high-strength, homogeneous transition. The CAD design process is integrated into a CAD software program (Dental System 2020; 3Shape A/S), allowing full patient-specific

customization of the removable complete denture to meet patient needs. The tooth library and coordinated shell geometry offer CAD design strategies for a wide range of jaw shapes and sizes and even the ability to customize and morph individual teeth (**Silva and Kukucka, 2022**).

(Figure 1.7: Subtractive manufacturing (milling)):



(Figure 1.7: Subtractive manufacturing (milling))

(Silva and Kukucka, 2022).

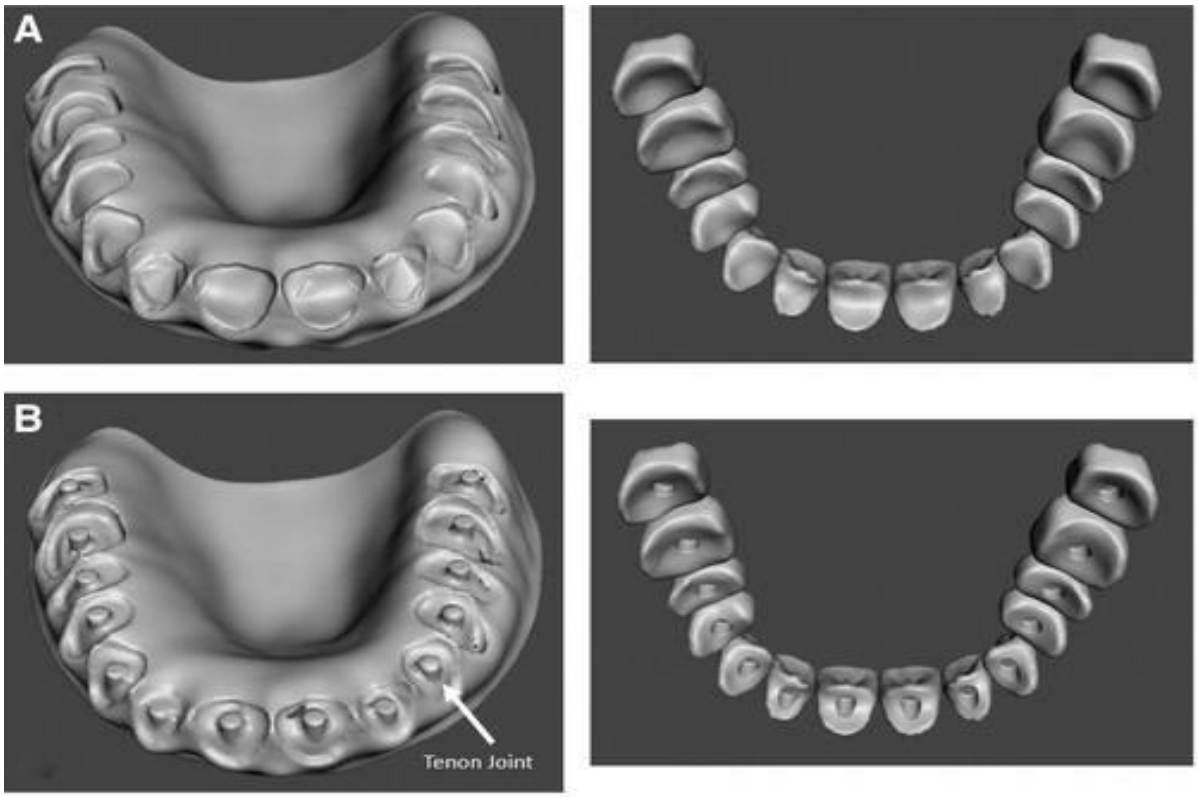
Additive manufacturing (three-dimensional printing):

In this method, material is stacked layer by layer, one over the other, to create a three-dimensional structure. Furthermore, additive manufacturing offers the ability to produce structures with complex geometries.

It also reduces material waste by 40% and allows finer detail compared to subtractive technology Compared to conventional fabrication methods, delivering complete dentures with CAD/CAM technology requires fewer appointments (two to three visits), saving chairtime.

This can be beneficial for older adults. The two-visit procedure generally skips the

try-in appointment - although the authors highly recommend this step. One advantage of a try-in prosthesis is that the patient can take it home for a few weeks to evaluate function and esthetics, which is not possible with traditional wax try-in setups (**Amit and Francois, 2020).** (Figure1.8: Additive manufacturing (three-dimensional printing)):



(Figure1.8: Additive manufacturing (three-dimensional printing))

(Yang et al., 2020)

applications of digital smile design planning technique incomplete dentures

Patient Ș.M., male, 40 years old, bimaxillary full edentulous with great aesthetic expectations (Figure 1.9). (**Țâncu et al., 2020**)

Facial features:

- Face shape: oval;
- Face size: 21 cm long, 18 cm wide;
- Skin color: light;
- Hair color: black;
- Eye color: black.

A B C D

(Figure 1.9: A: Facial features. B: Frontal facial full smile.
C,D: Frontal facial full smile and smile design)
(Țâncu et al., 2020)

Smile components:

1- Labial line of smile: it is low and reveals less than 75% of the cervico-incisal height of the maxillary frontal teeth.

2- Smile arc is a curved line almost parallel to the upper border of the lower lip.

3- Upper lip curvature - the right mouth commissure is at thesame level as the lower border of the upper lip, and the left one is located below, thus the upper lip has a downward curvature on the left side, while the right side is straight.

4- Buccal corridor – poorly visible on both sides -2 mm.

5- The patient does not have a gingival smile.

DSD working protocol with example working on the maxillarytemplate.

We roughly established the width of the maxillary center incisor at 9 mm and its length at 9.2 mm, the application setting a 90% ratio between width and length. These dimensions were going to be subsequently modified in the smile simulation process for a suitable adaptation of the teeth templates that were pre-set by the application to the elements of the facial assembly. (**Țâncu et al., 2020**).

The next step consisted of choosing the appropriate teeth template, according to the patient's facial typology and preference, generating the smile frame according to the references set in the previous steps and starting the smile simulation itself (Figures 1.9: B, C, D).

For patient Ș.M., we proposed 3 types of teeth templates: framing the templates in the smile frame, over the patient's pre-existing teeth, and altering their predefined shape, position, size and color, depending on the patient's needs and preferences, as well as on the facial, dental and gingival features. Then we proceeded by marking the upper lip contour and choosing the teeth color from a series of pre-setapplication shades and individualizing it. The last step consisted of applying the false gum and individualizing its color. (Figure 1.10: final results). (**Țâncu et al., 2020**).

(Figure 1.10: final results)
(Țâncu et al., 2020)

DSD simulation on the existing denture and definition of aesthetic elements that corresponded to the patients' aesthetic expectations were performed for the

Patient I.E., female, 80 years old, disatisfied with the existingcomplete denture, due to the colour of the artificial teeth. (Figure 1.11: Patient with the existing complete denture). (**Țâncu et al., 2020**).

(Figure 1.11: Patient with the existing complete denture)
(Țâncu et al., 2020)

Facial features:

- Face shape: oval;
- Face size: 18 cm long, 16 cm wide;
- Skin color: dark;
- Hair color: brown;
- Eye color: brown. Smile components:

1. Labial line of smile is at the level of the free gingival borderand reveals the entire cervico-incisal height of the maxillary frontal teeth and the interdental papilla.
2. Smile arc is a curved line parallel to the upper border of the lower lip.
3. Upper lip curvature - mouth commissures are at the same level as the lower border of the upper lip and thus they do not have a curve, being straight.
4. Buccal corridor - visible on both sides - 3 mm.
5. The patient does not have a gingival smile.

We uploaded the frontal extraoral photos in smile and with apertures, while the patient had the maxillary denture applied to the prosthetic field, but in the smile simulation, we only used the frontal facial photograph. Calibration of the frontal facial photograph that captures the patient's smile with the maxillary denture was applied to the prosthetic field. (**Țâncu et al., 2020**)

Then, the identification and positioning of the incision line and the lines corresponding to the distal faces of the maxillary central incisors was performed.

Afterwards, the identification and marking of the labial line of the smile, the smile arc, and the recording of the dimensions of the maxillary central incisors were performed.

We roughly established the width of the maxillary center incisor at 8 mm and its length at 10 mm and the application setting at an 84% ratio between width and length. These dimensions were going to be subsequently modified in the smile simulation process for a suitable adaptation of the teeth templates that were pre-set by the application to the elements of the facial assembly.

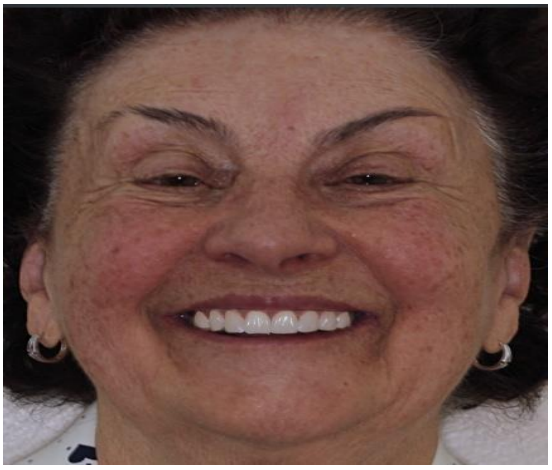
The next steps were the choice of the appropriate teeth template according to the patient's facial typology and preference, the generation of the smile frame according to the references set in the previous steps and the start of the smile simulation. (**Țâncu et al., 2020**)

For patient I.E. we proposed three types of teeth templates: framing the templates in the smile frame, over the patient's pre-existing teeth, and altering their predefined shape, position, size, and color, depending on the patient's needs and preferences, as well as on the facial, dental, and gingival features. Then, we proceeded by marking the upper lip contour and choosing the teeth color from a series of four pre-set application shades and individualizing it. The last step consisted of applying the false gum and individualizing its color.

Final result (Figure1.12: Final result patient I.E).

While smiling, the patient discovered the entire cervico- incisal height of the

maxillary frontal teeth, thus allowing the proper application of the DSD working protocol, which required such a smile for a proper simulation of the smile and the achievement of aesthetic results. It was possible to keep the initial size of the teeth without distorting it, in order to allow the teeth to fit into the smile frame. (**Țâncu et al., 2020**).



(Figure1.12: Final result patient I.E).
(Țâncu et al., 2020)

CHAPTER TWO

CONCLUSION

Chapter two

Conclusion

Introducing digital techniques to preview the final result of the prosthetic treatment in current dentistry brings important benefits regarding the success of the treatment, communication with the patient and the dental laboratory.

DSD technique is a tool used in a relatively small percentage in current practice by dental practitioners, only to the dentate patient, which requires the use of digital photographs, templates, and digital applications.

In full edentulism, the current DSD technique can be used with some limitations related to: the dynamics of the lips in smile, execution of the original photographs for which the denture should have a good retention on the prosthetic field and the proposal of a limited number of templates that do not satisfy all facial typologies.

However, the preview of the end result offers the patient the chance to have a realistic picture of his desires, regarding the shape, color, size of teeth, which are inadequate in relation to the patient's age and facial typology.

The more the natural appearance given to the complete denture, more will be the acceptability of the complete denture by the patient.

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