Article received on October 30, 2019 and accepted for publishing on May 20, 2020.

CLINICAL PRACTICE

Study on the applications of digital smile design planning technique in complete dentures

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Abstract: *One of the most obvious trends in current prosthetic dentistry is the introduction of digital techniques. Of these, the techniques that offer the possibility of aesthetic prefiguration of the final prosthetic result are of particular interest to the dentist.*

The aim of this paper was to verify the applicability of the Digital Smile Design application, which is the most commonly, used aesthetic prefiguration application, an application designed for the dentate patient, to full edentulism. Two groups of full edentulous patients were formed: the first group, complete denture carriers, dissatisfied with the aesthetic aspects, that they wanted to improve in the new denture, and, the second group, newly bimaxillary full edentulous patients with high aesthetic expectations. Thus, on the first group, the tests were performed on the existing denture, and the second one with the maxillary occlusion template. However, the view of the final result offered the patients the chance to have a realistic picture of their desires regarding the shape, color, size of the teeth, which were inadequate in relation to age and facial typology. The use of this application also improves communication with the dental laboratory. In full edentulism, the current DSD technique can be used with some limitations and the use of it in this field needs more complex studies on larger groups of patients.

Keywords: *digital techniques, smile design, complete denture*

INTRODUCTION

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 [1], including the full edentulous ones or those in the imminent moment of full edentulism.

Ageing causes a series of major aesthetic disorders, such as altering the soft parts of the face, emphasizing the perioral lines, oral commissures, nasogenian and mentolabial folds, the loss of elasticity of the tissues and the oro-facial muscles [2]. These signs of physiological aging are associated with the pathological signs following the installation of full edentulism. Oral commissures are lowered, and the mouth slit becomes a line with superior convexity. The lower part of the face is diminished, the prominent menton, thus generating a concave profile [3]. To meet patients' requirements, in order to improve the attractiveness of smiles, practitioners must perform a complex facial assessment in an objective and standardized manner. The fundamental criteria for aesthetic analysis include facial, dental, and dento-gingival parameters.

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Nowadays, digital smile simulation programs have been implemented for both research and clinical practice. These are multifunctional tools that strengthen the way of analysis and diagnosis of the facial and dental parameters, improve communication between team members, allow the education and motivation of patients by visualizing the final results of the proposed treatment solutions, and also increase the degree regarding treatment acceptance, the most commonly used technique within current practice being Digital Smile Design DSD [4-6]. Another smile design digital application for dentate but also for the edentulous patient, which takes into consideration patient's personality is Visagismile. Based on visagisme concept (Philippe Halawell), this digital application helps the dentists in their prosthetic work in order to obtain the best esthetic result reflecting patients' personality [7,8]. Designing the smile based only on mechanical parameters such as shape and size of the face will give a monotonous and stereotype appearance whereas customizing it with the person's attitudes and behavior will make it more life-like [9].

However, it addresses fixed dentures retained on teeth or implants [10]. Of course, the implant based dentures, in particular maxillary overdentures retained on implants, a solution with higher esthetic degree by compensating for the horizontal resorption of the vestibular slope through the denture base, supporting the soft parts, remains the first treatment alternative [11] especially for patients who find themselves in the imminent moment of becoming total edentulous. However, this alternative is often not possible due to extensive surgery, poor health, or high costs, the only solution remaining the conventional complete dentures.

When analyzing specialized literature, we observed that no publications tested the applicability of these systems through conventional complete dentures therapy. Thus, the purpose of our study was to check the possibilities and limitations of digital smile simulation applications regarding the total edentulous patient with conventional complete denture.

MATERIAL AND METHOD

The study was conducted between September 2017 and September 2018 on a group of 12 patients, 8 women and 4 men, aged 40 to 80 years, full bimaxillary edentulous, with and without conventional complete dentures, being treated within the Complete Denture Clinic of "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania.

The inclusion criteria of patients in the study were represented by the increased aesthetic requirements and expectations, but also the desire to preview the result before the treatment itself. The exclusion criteria were represented by patients manifesting disinterest in aesthetics and by uncooperative ones.

All 12 patients who participated in the trial have expressed and signed an informed consent regarding their participation in the study, publication of personal data and photos.

The working protocol consisted in applying and adapting the digital smile planning workflow to the full edentulous patients using the Digital Smile Design application (DSD Free App by Christian Coachman).

The group of patients was divided in 2 categories in order to compare results: patients with existing dentures, on whom simulations were performed, and patients without dentures, being at the clinical stage of determination of intermaxillary occlusion relations, for whom the upper occlusion template was used.

Patients were clinically examined and evaluated for facial features and smile elements, following these aspects:

- Facial features: Shape and Face Size: length/ width, skin, hair, and eye color.

- Smile components: Labial line of smile, smile arc, upper lip curvature – mouth commissures located at the same level (yes/no), buccal corridor – visibility in mm and gingival smile visibility.

Following extraoral clinical examination, each patient received extra and intraoral photos as indicated by the DSD specific working protocol, which we briefly described: uploading photos, calibration of the frontal facial photo, identification and positioning of the incision line and the lines corresponding to the distal faces of the maxillary central incisors, identifying and marking the labial line of the smile, the smile arc and recording the dimensions of the maxillary central incisors, 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, marking the upper lip contour, choosing the teeth color from a series of four pre-set application shades and individualizing it, applying the false gum and individualizing its color, visualization of the final result.

RESULTS AND DISCUSSIONS

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

Pacient I.E., female, 80 years old, disatisfied with the existing complete denture, due to the colour of the artificial teeth

(Figure 1).

Figure 1: Patient disatisfied with the existing complete denture due to color of artificial teeth

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 border and 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.

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.

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.

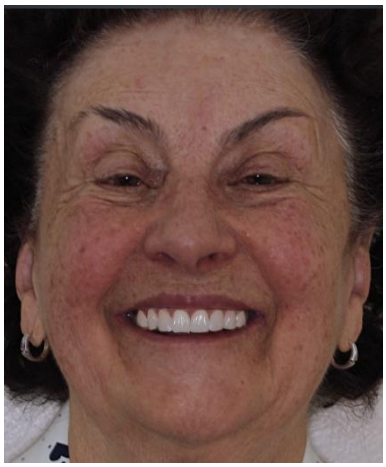
Final result

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.

The teeth templates were selected in agreement with the patient, having a similar shape as the original ones. The patient was aesthetically pleased with the old denture, showing the desire to preserve the same aspect, but we tried to suggest other colors for the teeth, more suitable for the

skin, eyes, and hair. During her first session, the patient had high aesthetic expectations and wanted a new denture with a teeth color that was much lighter than the initial one, very unaesthetic and inapropriate with her age. However, with the application, the patient being able to preview the final result, she understood the shortcomings of a lighter nuance for the teeth and finally opted for a color appropriate to her age and facial typology.

Figure3: Final result patient I.E.



Patient Ș.M., male, 40 years old, bimaxillary full edentulous with great aesthetic expectations (Figure 3).

Figure3: Facial features

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

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 the same 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.

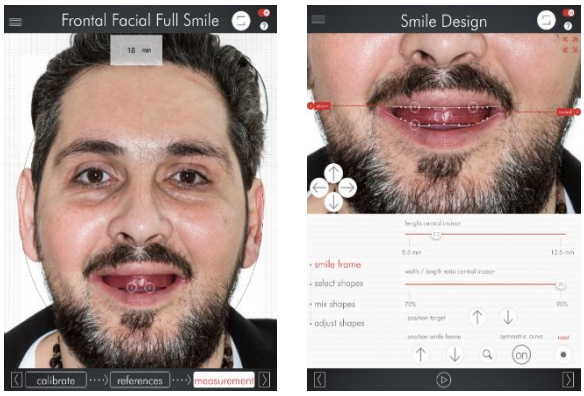
4. Buccal corridor – poorly visible on both sides – 2 mm.

5. The patient does not have a gingival smile.

DSD working protocol with example working on the maxillary template (second group).

Figure4: Frontal facial full smile

Figure5: Frontal facial full smile and smile design



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.

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 (Figures4, 5).

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-set application shades and individualizing it. The last step consisted of applying the false gum and individualizing its color.

Figure6: Final result patient Ș.M.

Taking a picture with the maxillary template allowed us to simulate a gingival smile because it had a very good hold on the prosthetic field.

The occlusion template gives total freedom in positioning the reerence points such as the incisal line, the lines corresponding to the distal faces of the maxillary central incisors, the labial line of the smile and the smile arc.

In addition, working on the template, we were able to establish several dimensions and shapes of the maxillary frontal teeth, not having to choose a certain size or shape close to the original one, which would cover the artificial teeth on the patient's old denture. In this case, the application guided us to choose rectangular teeth with well-defined angles for the new denture.

Digital Smile Design (DSD App by Christian Coachman) is a tool for digital smile planning used for total edentulous patients, facilitating the choice of shape, color, and size of the artificial teeth, and the possibility to preview the final result before the actual treatment. Moreover, it favors a faster integration of the denture by the patient through his active involvement in the whole process.

In case of full edentulous patients who cannot provide a gingival smile, either because of a poor maintenance of the maxillary denture that comes off the prosthetic field during the attempt to mimic a forced smile, or because of the patient's impossibility to expose the entire cervico-incisal height of the maxillary frontal teeth during the smile, the application has some limitations and requires a considerable reduction in the size of the teeth, in order to allow their optimal fitting within the smile frame, generating less aesthetic results.

Using a photograph with the maxillary template applied to the prosthetic field, instead of the old maxillary denture, within the smile simulation process, will provide the possibility to choose between several types of teeth templates without any limitations regarding the teeth shape close to the one on the old denture, which would generate similar results to the original design of the denture.

Another advantage of using the occlusion template instead of the denture is its good retention. This way, the patient can mimic a gingival smile without the risk of detaching the template from the field, the resulting photograph allowing the correct application of the DSD working protocol and the achievement of superior aesthetic results.

In terms of colors, the application offers a limited range of only four shades with the possibility of changing their features.

In specialized literature, there are still insufficient articles or studies illustrating the expansion regarding the use of digital smile planning applications in total edentulous patients, despite the fact that they can greatly facilitate the design concept of the complete denture, by being able to preview the final result and choose the shape, color, size and arrangement of the artificial teeth according to the facial typology and patient's wishes, thus the patient being involved in establishing the treatment plan.

CONCLUSIONS

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.

In full edentulism, the vestibular slope of the denture is an important part of its aesthetics, but the application cannot simulate it.

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.

In the future, studies that are more complex are needed on a larger group of patients, in order to make the application more efficient also in the field of full edentulism.

Acknowledgements

All authors have equal contribution as the first author.

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