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A comparative analysis of patient satisfaction with various methods of digital smile design and simulation

Mahsa Babaei, Mehrdad Kazemian, Mehrdad Barekatain

Department of Operative Dentistry, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran

ABSTRACT

Background: Digital smile design (DSD) is a technique that utilizes the scientific methods and advanced software to design patients' smiles, presenting the visualized smile map directly to the patient. However, patients may not always find the proposed smile satisfactory or feel a sense of alignment with it. To address this concern, dentists have been integrating the tooth shape with the overall facial shape and other parameters to develop a personalized smile plan for each patient.

Materials and Methods: This study employed a descriptive-analytical, cross-sectional research design conducted during the summer and fall of 2022. This research sought to evaluate patient satisfaction levels associated with three distinct DSD techniques: Visagism, Proportional, and Stepwise Comprehensive. A sample of 20 participants, evenly split between males and females, was selected, all of whom were seeking smile design treatment and did not present with skeletal, jaw, facial, or periodontal complications. Interviews were conducted to analyze personality and temperament, and smile maps were created utilizing the Visagism, Stepwise Comprehensive, and Proportional methods. Subsequently, patients evaluated the designs produced by all three methods and completed a satisfaction questionnaire. Nonparametric statistical tests, namely the Kruskal–Wallis test and *post hoc* Bonferroni tests, were used to examine the research hypotheses at a significance level of 0.05.

Results: The results indicated a high level of satisfaction with all three DSD methods, with no statistically significant differences observed among them. These results suggest that all three approaches effectively met the patients' expectations and preferences.

Conclusion: The outcomes of this study have practical implications for dental professionals engaged in DSD, potentially enhancing patient experiences and treatment outcomes. Further research in this domain may explore the additional factors that could influence patient satisfaction and refine the DSD process.

Key Words: Digital smile design, patient satisfaction, proportional smile design, Visagism

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Address for correspondence:
Dr. Mehrdad Kazemian, Department of Operative Dentistry, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran.
E-mail: m.kazemian@khuisf.ac.ir

INTRODUCTION

Digital smile design (DSD) is a cutting-edge approach that utilizes advanced software and scientific methods to design patients' smiles. Patient satisfaction is a crucial aspect of the smile design process, and various methods, such as Visagism and Proportional techniques, are employed to enhance the alignment between the proposed smile and the patient's preferences.[1,2] This introduction highlights the significance of DSD, patient satisfaction, and the

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use of different smile design methods, specifically focusing on Visagism and Proportional approaches.[2-4] Charles Darwin was the first to recognize the powerful impact of a smile and proposed the facial feedback hypothesis, suggesting that a "beautiful smile" has a positive effect on both the mind and body. The primary objective of cosmetic dentistry is to ensure patient satisfaction, which begins with effective communication.[5-7] Patients typically desire a beautiful and confident smile but often struggle to visualize the outcome of treatment, leading to doubts about the efficacy of the procedure. DSD is a versatile clinical tool that enhances visualization, motivation, and esthetics. It utilizes two-dimensional clinical images of the patient and reference planes such as facial and tooth midlines, incisal edge position, lip dynamics, and incisal plan to design a personalized smile map. DSD simulates and predicts the final treatment result, encouraging greater patient participation and acceptance of the treatment plan.[6,7]

The digital plan can be tailored to the patient's needs, wishes, personality, and psychological identity, based on the dentist's thorough analysis of the face and teeth.[4,5] The process of generating a final smile map for a patient utilizing the DSD method encompasses the various approaches, one of which involves the implementation of the Visagism concept. This approach allows dentists to design a smile that not only possesses esthetic appeal but also aligns with the patient's psychological attributes, encompassing emotions, behavior, and personality.[8-11] Visagism entails the development of a personalized image that reflects an individual's sense of identity, achieved by integrating artistic principles, visual language, psychology, neurobiology, anthropology, and sociology. By employing this approach, dentists can devise a smile that harmonizes with the patient's physical appearance and personality traits. Drawing on Hippocrates' theories, each person's temperament-based personality can be classified into four categories: choleric, sanguine, melancholic, and phlegmatic, which are now classified as strong, dynamic, peaceful, and sensitive. Visagism employs these categories to describe a patient's states and personalities, each necessitating distinct designs for maxillary teeth, lip characteristics, dental arch shape, and smile plans.[12-17] The proportional method represents one technique employed to create a digital smile map, involving smile design through proportional assessments and emphasizing factors such as the IPS factor, position of the incisal edge, embrasures, and apical form of the teeth. Balance, symmetry, and proportion are the fundamental concepts for understanding beauty and harmony in objects, including a captivating smile.[18-22] The golden ratio, introduced by Phidias in ancient Greece, embodies the concept of beauty in correlation with mathematical science. It is imprinted in the unconscious mind and perceived as beauty, satisfaction, and pleasure. The golden ratio also aids in designing an appealing smile, with evaluated ratios encompassing tooth size-to-face size ratio, width-to-length ratio of maxillary centrals, tooth width to adjacent tooth ratio, as well as facial image view evaluation and recuring esthetic dental (RED) property ratios.[10,11] The RED ratio stipulates that the ratio between the widths of successive frontal views of teeth should remain constant as they move distally. The proportional method further considers the sex, personality and age (SPA) factor, which refers to sex, personality, and age. The incisal edge form of maxillary centrals is somewhat congruent with the patient's age, while the final shape of the upper jaws evokes the reverse view of the patient's face, with square jaws for individuals with square faces and tapered jaws for those with contracted jaws.

The appearance of the lateral teeth in a patient's smile can be influenced by their gender, with women typically having rounder line angles and men having sharper line angles. The appearance of the canine tooth, on the other hand, can correspond to the patient's personality, with more aggressive personalities having a more prominent canine and calmer personalities trending towards a more subtle cusp.[10] Stepwise Comprehensive Design Evaluation is an innovative smile design method that involves a step-by-step process of integrating patients' information and wishes into the analysis of smile elements. The design of the smile involves the evaluation of certain beauty elements in different stages, including facial analysis, dental-facial analysis, dental-labial analysis, dental-gum analysis, phonetic analysis, and dental analysis. All these steps and elements are interrelated and affect each other.[12] The smile evaluation process begins with observing the facial elements, with the evaluation of the harmony of the facial components being done by reference lines such as the interpupillary line (IPL), facial midline, and lip corner line (CL). The most attractive smile is achieved when IPL, CL, and the occlusal plane

are parallel to each other. The dental-facial analysis involves checking the amount of central incisors in resting state, with the incisal edges of the central incisors being 3–4 mm in women and 1–2 mm in men if the lip length is normal. Prominent incisal edges in the center indicate a younger and more attractive smile.[14-17] The assessment of buccal corridors, the dark spaces between the upper buccal teeth, and the corners of the lips during smiling, represents another crucial stage in smile evaluation. Smiles lacking buccal corridors can appear artificial, with the middle type being widely regarded as the most aesthetically pleasing.[18-20] In addition, other important aspects evaluated during this stage encompass the distance from the upper central incisal edge to the lower lip, the width and extent of tooth display, gum display, examination of the midline alignment of the teeth and lips, and evaluation of the smile arc. Phonetic analysis plays a pivotal role in determining the length of teeth, with patients pronouncing specific sounds while maintaining an upright position to assess the position of the incisal edge of the central maxilla, extent of tooth display at rest, and the alignment of the upper and lower central incisors in relation to each other.[21-24] During the tooth analysis stage, each tooth undergoes scrutiny regarding color, anatomy, line angles, height of contour, zenith points, interdental contacts, incisal edges, embrasures, textures, and shape. When considering the dimensions and proportions between teeth, the central incisors are regarded as the focal point of a beautiful smile, with numerous studies suggesting a length of 10.5–12 mm for central incisors and a length of 11 mm serving as an appropriate starting point for smile design. The lateral incisor is typically 1 mm to a maximum of 2.5 mm shorter than the central incisor, while the canine tooth is generally 0.5 to 1 mm shorter than the central incisor.[25-28]

The upper anterior teeth are generally designed with a width-to-length ratio of 75%–85%, resulting in highly attractive smiles.[29-34] To design a more suitable smile plan, dentists can evaluate the patient's personal taste and information such as their age, occupation, place of residence, and social status using an interview form.[35-37] The design of the smile should consider the patient's sociology and professional occupation, as well as their priorities and desires for the smile design, such as the level of naturalness and teeth whiteness.[38-42] Patient satisfaction with the final smile plan is the best guarantee of successful treatment. This research suggests that implementing the three smile design methods mentioned and comparing patient satisfaction levels can lead to the best way and DSD system, providing a much higher probability of achieving patient satisfaction and successful treatment. This study presents a comparative analysis of patient satisfaction with three different DSD methods: Visagism, Proportional, and Stepwise Comprehensive. By integrating tooth shape with overall facial shape and other parameters, dental practitioners aim to create personalized smile plans for each patient. The novelty lies in evaluating the effectiveness of these methods in meeting patients' expectations and preferences, providing valuable insights for dental professionals involved in DSD. The aim of this study is to assess patient satisfaction levels with three DSD methods by conducting personality and temperament analysis interviews, as well as generating smile maps. The results will enrich the current understanding of DSD techniques, enabling dental practitioners to make informed decisions tailored to individual patients, thereby potentially improving patient experiences and treatment outcomes.

MATERIALS AND METHODS

This study employed a descriptive-analytical, cross-sectional research design conducted during the summer and fall of 2022 at Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan. The participants consisted of patients seeking smile design treatments, who were specifically referred to a private restorative and esthetic dental office in Isfahan city. Professional photographs were taken of the patients both in a resting state and while smiling. In addition, the patients were administered a personality analysis questionnaire and an interview form to identify their primary desires regarding smile design. Subsequently, a professional observer classified the patients based on the Visagism Concept, taking into account the results of the questionnaire and interview form. The research outcomes reveal a statistically significant association between smile design and personality characteristics, with a 71.1% level of concordance. Therefore, dental practitioners should not solely concentrate on the esthetic aspects of smile design in dentistry, but also consider psychological factors to create esthetically pleasing smiles that align with the patients' individual personality characteristics. The sample size was calculated based on a comparison of patient satisfaction levels across three methods of DSD and simulation. Two-sided and Chi-square

tests were conducted at a significance level of 5% ($\alpha = 0.05$) and a power of 80% ($\beta = 0$), following the methodology outlined in a study by Lemborgia and Kochman (2014). This approach aimed to detect differences corresponding to 95% of the standard deviation ($\sigma = 0.95$) using the specified formula.

$$n = \frac{2\left(z_{1-\alpha/2} + z_{1-\beta}\right)^2 \sigma^2}{\delta^2} = \frac{2\,(1.96+0.84)^2\sigma^2}{(0.95)^2\sigma^2} = 17.3$$

By taking into account the dropout rate of at least 19%, 20 people were included in this study, half of them were men and half were women.

n = sample size

Z = Z value equal to standard normal distribution function

α = equal to the value of the first type error and equal to 0.05

β = equal to the value of the second type error and equal to 0.2

σ = standard deviation

δ = differential detection

This study focused on patients between the ages of 18 and 50 years who were seeking smile design treatment and had skeletal and dental relationships of class 1. Patients with severe orthodontic problems such as severe crowding, severe spacing, and severe gummy smile that required orthodontic intervention before starting smile design treatment, as well as those with periodontal problems such as gingival recession and other problems requiring intervention before beginning smile design treatment, were excluded. Data collection involved taking photographs of patients' smiles based on smile analysis protocols, completing an online "personality and temperament analysis interview form" available at www. rebel. dental. com with the patients' cooperation, and filling out a "smile design interview form" for step-by-step smile design (Stepwise Comprehensive). The patients' smile maps were used to prepare 60 two-dimensional smile designs (three designs for each patient with the three methods of Stepwise Comprehensive, Proportional, and Visagism), and the satisfaction questionnaire was completed by the patient.

PREPARATION OF PHOTOGRAPHY

For this research, a series of photographs were captured from a sample of 20 individuals who sought smile design treatment. A standardized and specific protocol of DSD was followed during the photography process. To ensure precise measurements and consistent outcomes, it was imperative to maintain the patients' head position without any forward, backward, or sideways deviation, while also ensuring that the line connecting their pupils remained parallel to the horizon. To achieve this, a glove box was positioned between the patient's head and the wall, serving as a stabilizing support. Furthermore, the patient was instructed to maintain steadiness and avoid any movement. The photographer, likewise, adopted a motionless and stable approach during the photography session, either by remaining steady or utilizing a tripod to prevent any unintended camera movement. The study utilized a Nikon D7100 camera equipped with a 105 mm Nikon lens for capturing the photographs.

Examination of personality type and temperament

Each patient completed the "Personality and Temperament Analysis Interview Form" as part of the study. This form, which is identical to the online DSD interview available at www.rebel. dental. com, includes psychological questions designed to evaluate personality and temperament. Following the principles of visageism, the goal was to identify the patient's facial expressions and smile, categorizing them into four temperament types: Choleric, Sanguine, Melancholic, and Phlegmatic. The original form was in English, and a backward-forward translation method was utilized, with guidance from psychological experts, to produce an equivalent version in Farsi.

Online evaluation of face and smile by rebel dental website

Rebel simplicity is a DSD software that offers efficient smile designing and rapid production of dental replicas. This software employs a personalized approach to smile design, taking into account individuals' personality traits and utilizing the concept of visageism. The software shows two-dimensional (2D) designs and 3D printable mockups to facilitate the process. In the initial stage of smile design using this online software, the patient's photographs are uploaded. Subsequently, in the second stage, the patient's previously obtained interview form is completed on the website. The software analyzes the data, incorporating psychological assessments based on the interviews, to evaluate the patient's face and smile. The software then classifies the

patient's smile into relative categories, such as Strong, Sensitive, Dynamic, and Peaceful. Finally, in the last step, an initial online smile design is generated for the patient, presented in two dimensions based on the principles of visageism as shown in Figure 1a-c as various view.

Visagism, a technique commonly employed in dentistry and aesthetics, is utilized to create a personalized and harmonious smile design that complements the individual's facial features. Figure 2a and b likely represents a visual illustration of this process, specifically for patient number 19. The template creation involves developing a mock-up of the desired smile using temporary materials such as dental wax or composite resin. The dentist shapes and adjusts the material to achieve the desired tooth size, shape, and positioning. This template serves as a guide for the final restoration process.

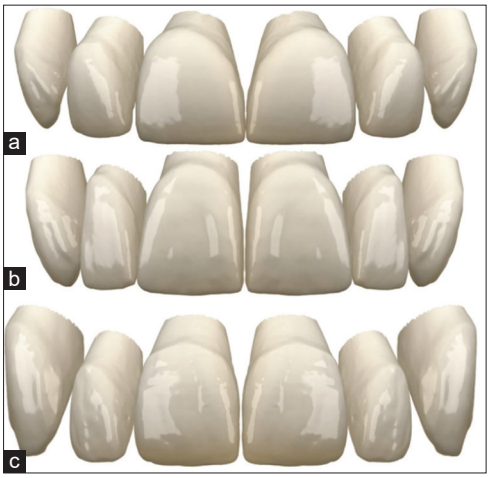

Figure 1: Examples of raw design done by rebel.dental site, overview of the smile design process: patient photo upload, and the creation of a two-dimensional design using Visagism principles from (a) front view, (b) side view, and (c) side view.

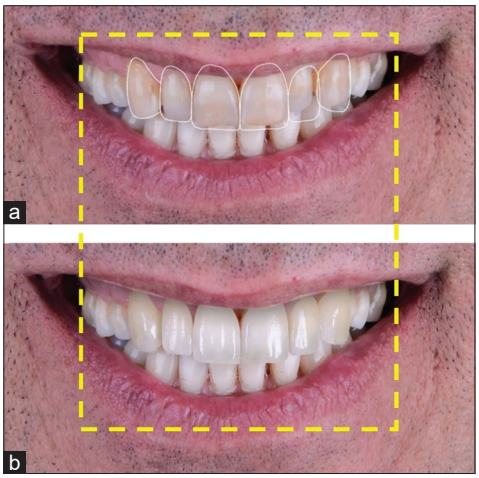

Figure 2: Preparation of the template and the final map of the smile with the Visagism method for patient number 19, (a) front view and (b) side view.

A smile map based on the concept of Visageism

Using the dental system's DSD software, the initial unprocessed smile design was transformed into a template, preserving its dimensions and distinctive characteristics. Subsequently, the template was superimposed onto the patient's smile image, resulting in the creation of the initial two-dimensional smile map. The smile map was generated based on the Visagism concept, and the corresponding pattern was obtained from the website rebel. dental.

Preparation of smile map by proportional method

The creation of the two-dimensional smile map was accomplished using the Dental system DSD software. This process involved uploading the photographs taken from the patient and conducting an analysis based on the specific principles employed by this particular method. Figure 3a and b shows the template and final map of the smile for patient number 19, utilizing the proportional method.

The template serves as a preliminary guide for smile design, outlining the desired proportions and dimensions of the teeth and their relationship to the surrounding structures. It acts as a visual framework, allowing the dentist to evaluate and make necessary adjustments before finalizing the smile design. The final map, on the other hand, represents the outcome of applying the proportional method to patient number 19's smile. It showcases the precise positioning and shape of the teeth, taking into account factors such as the IPS factor, incisal edge position, embrasures, and overall tooth form. The final map serves as a comprehensive representation of the desired smile outcome, providing a clear visual reference for both the dentist and the patient. Figure 4 illustrates the interface and working environment of the dental system software, presenting a visual depiction of the various functionalities and features offered by the software.

The interface serves as the user's gateway to interact with the software, providing a clear and intuitive layout that facilitates ease of use and navigation.

Preparation of smile map by stepwise comprehensive method

The creation of the two-dimensional smile map was achieved using the Dental system DSD software. This process involved uploading the patient's photographs

and conducting an analysis based on the specific principles of this method. The software also relied on the "Smile Design Interview Form" for additional information, as depicted in Figure 5a and b.

Smile design interview form

The ultimate success of a cosmetic treatment hinges upon the acceptance of the outcome by the patient, underscoring the significance of comprehending individual opinions and preferences in the development of an effective treatment plan. To facilitate this objective, a step-by-step (Stepwise Comprehensive) interview form was devised to systematically identify the specific characteristics that patients desire in their smile. The form collects the data pertaining to the desired level of naturalness, tooth whiteness, modifications in the final smile map, primary concerns, motivation for smile correction, resemblance to Hollywood smiles, and the extent to which the corrected smile stands out in the patient's surroundings. By utilizing this form, dentists are guided in the creation of a smile map that aligns with the patient's preferences and aspirations. In addition, the form includes demographic information such as the patient's age, occupation, place of residence, and social status, enabling dentists to conduct a more comprehensive review.

Checking patients' satisfaction with different digital smile design methods

Once the three two-dimensional smile designs were completed, the resulting smile maps were presented to the patients in image format. Subsequently, the patients were given a satisfaction questionnaire, which had undergone prior evaluation to ensure its quality, validity, and reliability [Figure 5a and b].

The purpose of Figure 6 is to show the average level of satisfaction among all participants in the study. This visual representation helps in identifying potential patterns and trends within the data, as well as providing a summary of the overall satisfaction level.

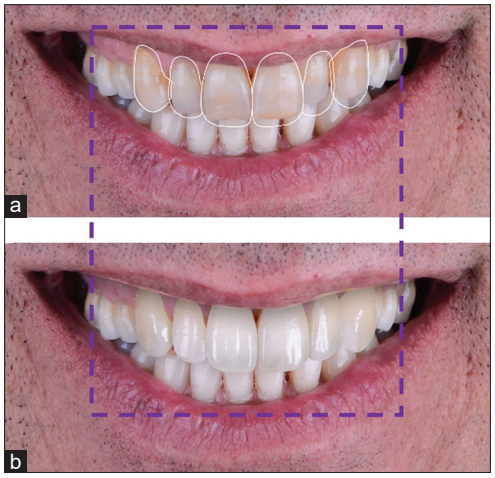

Figure 3: Template and final map of the smile of patient number 19 by proportional method, (a) front view and (b) side view.

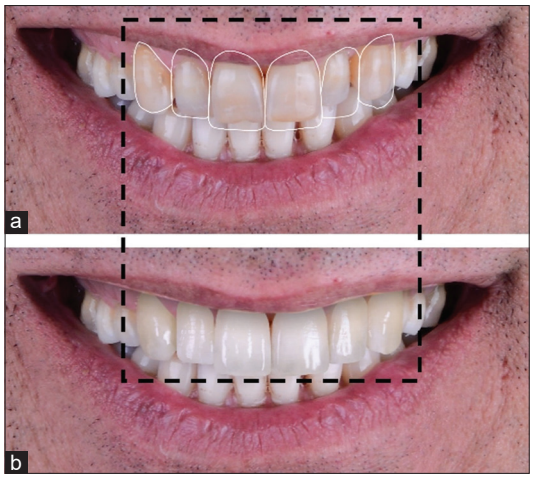

Figure 5: Template and final map of the smile of patient number 19 by stepwise comprehensive method, (a) front view and (b) side view.

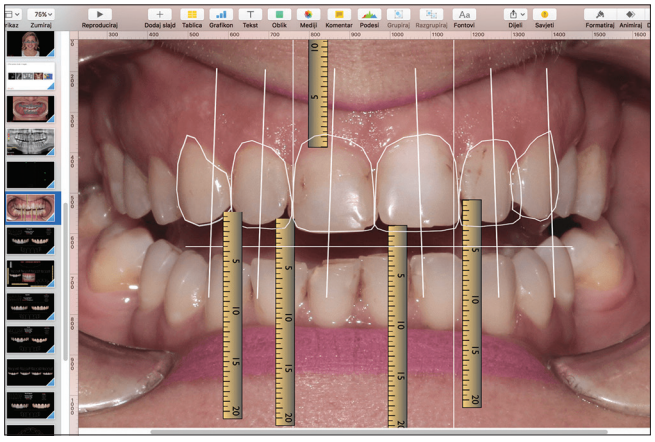

Figure 4: Dental system software working environment.

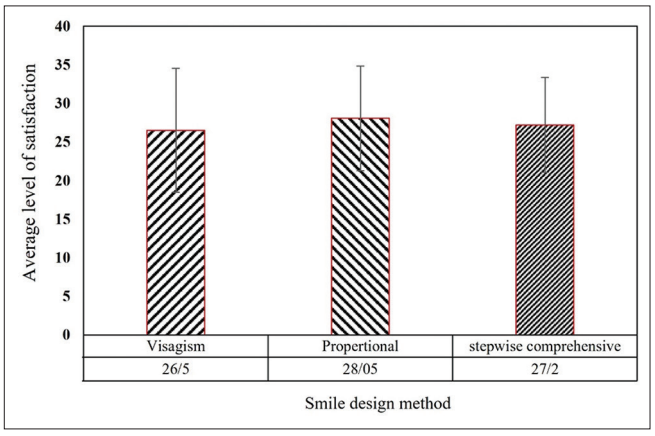

Figure 6: Average level of satisfaction.

Depending on the design of the study, Figure 6 may also offer insights into the variability of satisfaction levels among participants and any factors that may be associated with higher or lower levels of satisfaction.

Satisfaction questionnaire

The questionnaire consists of seven questions that aim to evaluate patients' satisfaction with different aspects of their smile, such as tooth visibility, alignment with the lower lip curve, gum display, smile width, tooth shape, and overall smile map. Each patient completed the questionnaire for each designed smile map they were presented with. To accommodate patients who could not visit the clinic in person, an online version of the questionnaire was made available in addition to the in-person completion option.

Questionnaire validity

Ensuring validity is crucial for a questionnaire to effectively measure its intended purpose. Content validity index (CVI) is a significant aspect of validity, focusing on the alignment of questions with the desired standards or goals. In this study, content validity was assessed by consulting 10 experts in cosmetic and restorative dentistry in Isfahan. The CVI and content validity ratio (CVR) were calculated to determine the level of alignment. Questions with a CVI lower than 0.79 were revised or eliminated, while questions with a CVR lower than 0.62 were removed from the questionnaire [Table 1]. The overall content validity of the questionnaire was found to be 90, indicating a high level of validity.

Reliability of the questionnaire

Reliability is a crucial aspect that measures the internal consistency and correlation between test questions. The Cronbach's alpha method, a widely used statistical approach, was employed to evaluate the internal consistency in this study. A Cronbach's alpha coefficient of 0.6 or higher is generally considered indicative of high reliability. The results of the reliability analysis are presented in Table 2.

Scoring method

The final questionnaire consists of 7 questions. The questions were scored in such a way that in case of choosing any of the options mentioned below, points were given to that question. The satisfaction scale ranged from completely dissatisfied (1) to dissatisfied, (2) somewhat satisfied, (3) satisfied (4), and fully satisfied (5). For each person, the total score of design satisfaction was calculated from the sum of the scores of 7 questions, for each design method separately. The range of scores that can be obtained for each person is from 7 to 35. The range of scores that can be obtained for each design method is from 140 to 700. The average total score of each design method was obtained from the total score of all participants divided by the number of people.

Table 1: Content validity index and content validity index for all questionnaire questions

Question	CVI	CVR
q1	1	0.8
q2	1	1
q3	1	1
q4	0.9	0.8
q5	1	1
q6	1	1
q7	1	1

CVR: Content validity ratio; CVI: Content validity index

Table 2: Calculation of Cronbach's alpha coefficient for each method

Method	Average	Maximum	Minimum	*n*	SD
Visagism	26.50	35	7	20	8.04
Proportional	28.05	35	14	20	6.77
Stepwise comprehensive	27.20	35	14	20	6.14

SD: Standard deviation

Method of data analysis

The study employed a combination of descriptive and inferential statistical methods to analyze the data. Descriptive analysis involved calculating basic statistics such as frequency, mean, standard deviation, and utilizing graphical representations of the data. For inferential analysis, variables with quantitative scales underwent normality tests, specifically the Shapiro–Wilk or Kolmogorov–Smirnov tests. If the assumption of normality was met, parametric tests such as analysis of variance and paired t-tests were conducted. In cases where the normality assumption was not met, non-parametric tests like the Mann–Whitney and Kruskal–Wallis tests were utilized. All statistical analyses were performed using SPSS software version 26, developed by IBM Corporation in Armonk, New York, United States, was utilized for statistical analysis at a significance level of 0.05.

RESULTS

Patient satisfaction with DSD and simulation methods is crucial for enhancing dental esthetics and treatment outcomes. Various techniques, including

Visagism, Proportional, and Stepwise Comprehensive approaches, have been developed to tailor smile designs to individual preferences. Research indicates that patients often favor methods that incorporate personalized features and realistic simulations. Positive experiences with these technologies not only improve esthetic results but also foster patient trust and engagement, ultimately leading to better compliance and satisfaction with dental treatments. Kukich's research demonstrated that the general public cannot perceive a deviation of up to 4 mm in the midline dental position relative to the facial midline. Consequently, such a degree of deviation may not necessitate correction in the smile map, while the angle of the midline significantly influences the esthetic appeal of the smile. In contrast, previous studies indicate that a 2-mm deviation in the midline is perceptible and can lead to an unattractive smile. Furthermore, it was found that in 75% of cases, the midlines of the upper and lower jaws do not align, rendering the mandibular midline an unsuitable reference for determining the maxillary midline. However, this misalignment does not affect the appearance of the smile since the mandibular teeth are typically not visible during a smile. The Frankfort Horizontal, Ala-tragus Angle, Nasolabial, and Ricketts E-plane lines are used to evaluate the harmony and balance of the profile, while the Alatragus line is useful in determining the spatial position of the occlusal plane. The nasolabial angle ranges from 90º–95º in men and from 95°–115° in women.[36-39] Numerous dental studies have explored various aspects of dental treatments and materials. In their *in vitro* study, Jasim and Khalaf[8] compared the microleakage of composite and glass ionomer restorations in primary molars that were pretreated with silver diamine fluoride at two different time intervals. Similarly, Zaidan *et al*.[9] conducted an *in vitro* study to assess the shear bond strength of three luting materials used in the cementation of band and loop space maintainers. Mirmohammadi *et al*.[10] performed a bibliometric analysis of dental preprints published in 2022. Rajaei *et al*.[11] investigated the mechanical stability of lithium disilicate ceramic reinforced with titanium nanoparticles. Iranmanesh *et al*.[12] evaluated the perceived confidence of undergraduate dental students in performing endodontic treatment. Khandan *et al*.[13] focused on the fabrication and characterization of a porous bioceramic-magnetite biocomposite for the application in maxillofacial fractures. Finally, Khandan *et al*.[14] conducted a mechanochemical synthesis evaluation of nanocrystalline bone-derived bioceramic powder for bone tissue engineering. These studies significantly contribute to the understanding of various dental procedures, materials, and the training of dental students, providing valuable insights to the dental field.

The study suggests that patients demonstrate a high level of satisfaction with the DSD and simulation when utilizing the Visagism, Proportional, and Stepwise Comprehensive methods. Furthermore, the results indicate that there is no significant difference in patients' satisfaction levels among these three methods. Within this study, the collected research data are subjected to analysis, employing non-parametric statistical tests, namely the Kruskal–Wallis test and *post-hoc* Bonferroni tests, to examine the research hypotheses. Analyzing data collected with reliable tools is one of the main foundations of any study and research. At this stage, the researcher tries to examine the data by using different methods in order to test the hypotheses and evaluate them. In this chapter, the analysis of the research data is done, and the nonparametric Kruskal–Wallis test and the Bonferroni *post hoc* tests are used to check the hypotheses. The primary objective of this study was to assess and compare patients' satisfaction levels with three different methods of DSD and simulation. In this section, the descriptive statistics of the research data will be examined, as presented in Table 3 and Figure 6.

According to the results in Table 3, the average satisfaction score for the Visagism method is 26.5, with a standard deviation of 8.04. For the proportional method, the average satisfaction score is 28.05, with a standard deviation of 6.77. Finally, for the Stepwise Comprehensive method, the average satisfaction score is 27.20, with a standard deviation of 6.14. Across all questions, the highest percentage of satisfaction was observed in the "completely satisfied" and "satisfied" options, while the lowest percentage was associated with the "completely dissatisfied" option. Specifically, for the "completely satisfied" section, the highest percentage of satisfaction was found for questions 4 and 6. By examining a wide range of research studies, this article shows a thorough exploration of emerging trends and innovations in healthcare.[43-47] The topics covered include medical device innovation in Asia, user behavior in mobile app usage, sentiment analysis of social media data, advancements in nanotechnology-based therapeutics,

text classification techniques, nursing education, and leadership in nursing.[48-52] The insights obtained from these studies have significant implications for policy-making, healthcare practice improvement, and ultimately, the enhancement of patient outcomes.[53-55] Table 4 shows the analysis conducted to assess the normality of the level of satisfaction pertaining to the question "I am satisfied with the shape of my teeth in the design." This analysis aimed to determine whether the distribution of satisfaction levels followed a normal or Gaussian distribution. Normality is a crucial assumption in many statistical tests and analyses. The normality test was performed using a suitable statistical test, such as the Shapiro–Wilk test or the Kolmogorov–Smirnov test. The results of this analysis provide insights into the distribution of satisfaction levels and help ensure the appropriateness of subsequent statistical analyses and interpretations based on the satisfaction data.

DISCUSSION

The satisfaction survey results indicated that most respondents reported either complete satisfaction or general satisfaction with all aspects of their smile, while the option for complete dissatisfaction received the lowest percentage of responses. Question 6, which evaluated patient satisfaction levels with three different DSD and simulation methods, garnered the highest percentage of completely satisfied responses. Before conducting the satisfaction test, the normal distribution of data was assessed. The Shapiro–Wilk test indicated that only the stepwise comprehensive method demonstrated normal distribution in satisfaction levels. On the other hand, the Visagism and proportional methods exhibited nonnormal distribution in satisfaction levels. To compare the satisfaction levels among the three methods, Friedman's nonparametric test was applied, yielding a nonsignificant result ($P = 0.094$), indicating no significant difference in satisfaction levels across the three methods. Furthermore, the satisfaction levels pertaining to the shape of teeth in the design and the overall smile plan were also compared using Friedman's test. The analysis revealed no significant differences in satisfaction levels across the three methods for both the shape of teeth ($P = 0.859$) and the general plan of the smile ($P = 0.309$). Many reviews indicate a broad spectrum of studies focusing on advancements in nanotechnology and its applications in biomedicine, materials science, and dental research.[56-59] Several studies investigate the potential of nanoparticle biosensors, emphasizing their properties and strategies for performance enhancement.[60-63] Other research examines the role of gold nanoparticles in cancer therapy, highlighting recent progress in drug delivery and diagnostics. In addition, some studies evaluate the mechanical and biological properties of bredigite-magnetite nanocomposite scaffolds and analyze the effects of zinc content on cobalt ferrite for magnetic hyperthermia applications.[64-68] Contributions also detail the fabrication of novel porous calcium silicate scaffolds and assess advancements in osseointegration for orthopedic applications.[69-71] This collection includes studies on composite materials and scaffolds aimed at improving mechanical properties

Table 3: Descriptive statistics

Question	Completely satisfied	Satisfied	Satisfied to some extent	Unhappy	Totally unhappy
I am satisfied with the design done on my smile	35.0	30.0	20.0	10.0	5.0
I am satisfied with the amount of teeth displayed in my smile	30.0	40.0	10.0	15.0	5.0
I am satisfied with the curve of my smile compared to my lower lip	20.0	50.0	10.0	15.0	5.0
I am satisfied with the amount of gum showing in my smile	45.0	20.0	15.0	15.0	5.0
I am satisfied with the width of my smile (the number of teeth displayed)	35.0	30.0	15.0	15.0	5.0
I am satisfied with the shape of my teeth in the design	45.0	15.0	25.0	10.0	5.0
I am satisfied with the general plan of the smile	40.0	20.0	30.0	5.0	5.0

Table 4: Checking the normality of the level of satisfaction in the question "I am satisfied with the shape of my teeth in the design"

Smile design method	Friedman	Average rank	Deviation from the norm	Average	*P*
Visagism	0.305	2.08	1.26	3.85	0.859
Proportional		2.00	1.40	3.75	-
Stepwise comprehensive		1.93	1.16	3.75	-

and biocompatibility, reflecting ongoing innovations in ceramics and tissue engineering.[21,72-74] The study was limited by a relatively small sample size of 20 participants, all of whom were seeking smile design treatment at a specific dental clinic in Isfahan, Iran, potentially limiting the demographic representativeness of the findings. Additionally, while the DSDs were created by experienced dental professionals, the influence of clinician expertise on the final outcomes was not explicitly evaluated, and assessing the impact of clinician experience and training on patient satisfaction could offer valuable insights. Furthermore, the current study focused on the immediate patient satisfaction with the DSDs, and evaluating the long-term stability and durability of the designed smiles over time would be beneficial to understand the sustainability of the treatment outcomes.

CONCLUSION

In recent years, advancements in esthetic and restorative treatments have allowed for minimally invasive procedures in achieving desired dental form and function. DSD has emerged as a promising approach, providing patients with various scientific methods to design their smiles using advanced software and photography. However, patient satisfaction with the designed smile may sometimes be lacking. To address this, dentists have sought to integrate the shape and form of teeth with additional parameters like personality, gender, and age to better meet patient expectations. This study aimed to assess patient satisfaction with smile maps created using three different two-dimensional DSD software approaches. Patient opinions, dentist input, digital facial and oral-dental analyses, facial proportions, oral-dental ratios, and software analyses were utilized in designing the smiles using the three methods. The results revealed generally high levels of satisfaction across all three DSD methods (Visagism, Proportional, and Stepwise Comprehensive), with no statistically significant differences in satisfaction levels observed between the methods. Visagism and Proportional methods exhibited a slight advantage over the Stepwise Comprehensive method. Moreover, patient satisfaction with tooth shape and final smile map quality did not significantly differ among the three methods.

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Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or nonfinancial in this article.

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