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Studying the relationship between the outlines of the face, maxillary central incisor and maxillary arch in Indian population by Fourier analysis along with spectrophotometric shade analysis of the teeth in different age groups

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Abstract
Purpose: To investigate the quantitative relationships between the outlines of the face, the maxillary central incisor, and the maxillary arch by using Fourier analysis as well as spectrophotometric shade selection in different age groups.
Material and methods: Frontal facial photographs and irreversible hydrocolloid impressions of the maxilla were obtained from 100 dentate individuals (50 men, 50 women) from different age groups 20-30 yrs, 30-40yrs, 40-50yrs. On the resultant casts, standardized photographs were made for the dental arch and the maxillary central incisor. The outlines of the face, dental arch, and tooth were digitally traced and the digitized curved outlines were converted into X-Y coordinates with special software, which, in turn, were imported into Fourier Shape Descriptor software for harmonic analysis. The quantitative outputs of Fourier analysis were analyzed and tested with statistical software to investigate the differences across the shapes of the 3 outlines under study. Shade selection was done with Vita Easy Shade of the central incisor for each patient for analysis.
Results: Facial and tooth outlines were similar for each sex, although the similarity was stronger among the men. By contrast, no relationship was found between tooth and maxillary arch outlines or between face and maxillary arch outlines.A1 is the most common shade in both the sexes.
Conclusions: Face and tooth forms were quantitatively related. Accurate shade selection along with face form as a reliable guide can help to attain an esthetically pleasing prosthesis for edentulous patients.

Keywords: Fourier analysis, maxillary central incisor, spectrophotometric

Introduction

Esthetics, as applied to complete denture prosthesis, may be defined as a combination of science and art. Art is in itself a science - the appreciation of the beautiful in both form and color.

By skillful application of this science, it is possible to produce beautiful restorations that are almost completely natural in appearance [37]. If some teeth remain, it is a relatively straightforward procedure to select artificial teeth that blend with the natural dentition. However, for edentulous patients with no available pre-extraction records, the choice of tooth mold and arrangement becomes far more difficult, resulting in disappointment if the selection and expectations of the patient do not match those of the dentist [6].

The size and form of the maxillary anterior teeth are important to not only dental, but also facial esthetics. The most influential factors contributing to a harmonious anterior dentition are the size, shape, and arrangement of the maxillary anterior teeth, particularly the maxillary central incisors as viewed from the front [17].

The correct tooth color selection is also essential for the successful esthetic outcome of a restoration. The use of commercially available visual shade guides is the standard for tooth color matching of prosthetic restorations. However, visual color assessment is subjective and relies on a series of visual evaluations that are communicated between 2 or more professionals using shade guides that do not always represent the entire gamut of natural teeth [41].

Spectrophotometers are amongst the most accurate, useful, and flexible instruments for color matching in general and for shade matching for dental applications. A spectrophotometer is equipped with a source of optical radiation, a means of dispersing light, an optical measurement system, a detector, and a means of converting the light obtained to a signal that can be analyzed [39].

In patients whose anterior teeth are missing and for whom no records are available, choosing the form of anterior prosthetic teeth becomes more difficult. The best artificial teeth are the ones that reflect the patient's sex and age, which render the prostheses more natural [12, 42].

Several criteria were presented to aid artificial tooth selection, and several methods were introduced to assess the best esthetic outcome of the definitive prosthesis after anterior tooth loss. Among the most well-established criteria is the form of the face or maxillary arch for predicting the form of maxillary incisors [42].

Qualitative classification by Williams, first proposed in 1914, remains the most commonly accepted method for determining anterior tooth form and has been supported by studies that link the form of the face or the maxillary arch with that of the maxillary incisors [11, 16, 34].

Nevertheless, other studies did not agree with classification by Williams [2, 3, 6, 15].

For an accurate description of the forms of the face, maxillary arch, and maxillary central incisor, mathematical analysis may provide more objective information than subjective visual assessment.

Facial soft tissues and profiles studied previously by linear measurements of cephalometric radiographs and skeletal parameters have been limited by the inability of such measurements to represent the face as a whole. The face is a complex structure which cannot be described comprehensively by angles, planes and linear measurements and problems in the location and identification of anatomical landmarks are acknowledged [8].

Moreover, in mathematical analysis, errors are readily calculated to assess their potential effect on the accuracy of the definitive outcome. Among many mathematical approaches to shape quantification, Fourier shape analysis relies on decomposing contours or curvatures into harmonic functions liable to quantification by Fourier descriptors.

It is a mathematical method based on converting a curved outline into infinite successive sine and cosine functions capable of quantitatively describing, analyzing, and comparing the details of form [42].

Fourier analysis has been used to quantify biologic forms in different fields of dentistry. Therefore the aim of this study was to investigate the relationships of the forms of the face, the maxillary arch, and the maxillary central incisor by using Fourier analysis in a sample of Indians population along with spectrophotometric shade analysis.

Objective of the Study

To evaluate the quantitative relationship between outlines of face, the maxillary central incisor and the maxillary arch by Fourier analysis along with the shade using spectrophotometer in different age groups which will guide anterior teeth selection to provide a definitive prosthesis in patients in whom it is missing and relevant data is available.

Material and Methods

This study was approved by the institutional research board at HKESS. Nijalingappa Institute of Dental Science & Research (approval no.1606/2015-2016).

Hundred dentate participants (50 men and 50 women) aged between 20 and 50 years provided signed consent and took part in the study.

The participants were recruited from the dental predoctoral students, postgraduate students, and the dental staff at the Faculty of HKESS. Nijalingappa Institute of Dental Science & Research, and from the outpatients who had been regularly treated at the Dental Teaching Clinics, at HKES S. Nijalingappa Institute of Dental Science & Research.

All participants were healthy, young, dentate adults with normal development.

Individuals with any condition that affects the outline shape of the maxillary central incisors, the maxillary arch, or the face were excluded.

The participants were divided into three groups, those are

- Group 1- Participants ranging from age group 20-30 yrs.
- Group 2- Participants ranging from age group 30-40 yrs.
- Group 3- Participants ranging from age group 40-50 yrs.

Each group consisted of minimum of 30 participants equally divided into males and females

Consent forms were provided to the patients before carrying out the further procedures which was of the given format.

A tripod-mounted 16-mega pixels digital camera (Canon power shot SX530 HS) was used to make frontal facial photographs of the participants against a green wall. The photographs were made under constant and reproducible conditions, with the position of the head adjusted in the sagittal, coronal, and transverse planes and with the jaws at rest position, and the lips completely sealed.(Fig.1).

Fig 1: Frontal photograph of the patient

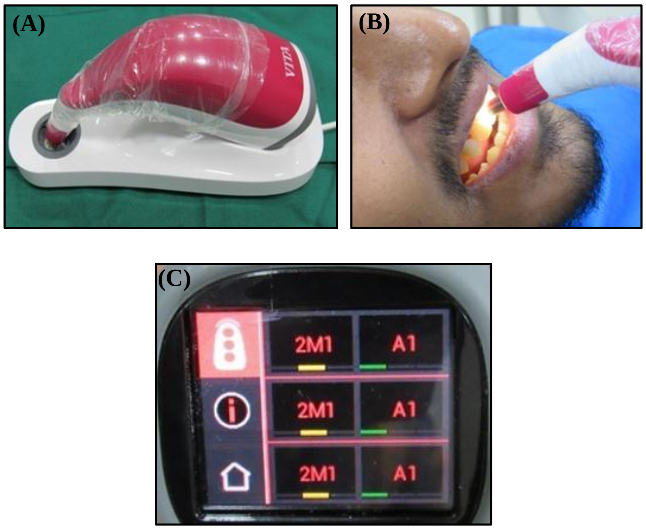

Fig 2(A): Vita Easy Shade Spectrophotometer (5th generation) **(B).** Shade selection of central incisor of the patient with spectrophotometer. **(C).** Display of shade on the Vita Easy Shade Screen.

For each participant, irreversible hydrocolloid impressions were made of the maxillary arch and poured with dental stone. The resulting casts were trimmed so that the base of the cast was parallel to the occlusal plane, and areas distal to the second molar were removed, which allows the cast to stand on a flat surface with the occlusal plane vertical. (Fig.3)

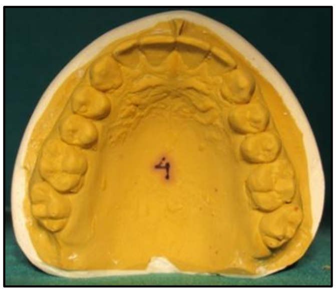

Fig 3: Irreversible hydrocolloid impression of maxillary arch Photographs of the right maxillary central incisor and of the maxillary dental arch were made with the same camera with standardized settings. The focus was set at the mid palatine suture in maxillary arch photography. (Fig.4)

Fig 4: Image of maxillary right central incisor The 3 images assigned to each participant (a frontal facial image, the maxillary dental arch image, and the maxillary central incisor image) were imported separately for outlining and tracing with computer graphic software (Adobe Illustrator CS4 ME; Adobe Systems Inc).

To give a symmetric labial tooth outline, only the mesial half was traced and then mirror imaged (Fig.5).

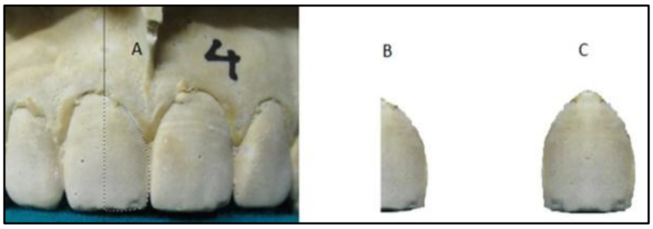

Fig 5: A-Mesial half of central incisor oulined, B- Mesial half of the central incisor cropped, C- Mirror image of the mesial half

This was done to ensure that the results related to the differences between the outlines of the tooth, face, and arch were not due to the asymmetric outline of the tooth compared with the more symmetric outlines of the face and the arch.
The traced outline of the central incisor was used as a guide to define the part of the facial image to be included for tracing. (Fig.6).

Fig 6: Tracing the outline of the of the maxillary central incisor The traced outline of the tooth was inverted and superimposed on the image of the face by using 3 points of coincidence. First, the maximum cervical outline curvature of the tooth corresponded exactly to the menton of the chin.

The size of the traced outline of the tooth then was rescaled to match the size of the facial image by bringing the height of contours on either side into coincidence with the outlines of the face and head close to the temple areas.
On superimposition, the region of the face that corresponds to the upper part of the forehead was cropped above the superimposed incisal edge line of the tooth (Fig.7).

Fig 7: Superimposition of outline of maxillary central incisor on the face the outline of the image of the maxillary arch was traced along the incisal edges of the anterior teeth and through the cusp tip of the canine and the apices of the buccal cusps of the posterior teeth to the second molars.

The base of the curve was determined by the distal end of the second molar of both sides of the cast. To ensure the uniformity of the curved outline of the maxillary arch, any irregularities in the alignment of teeth is bypassed (Fig.8).

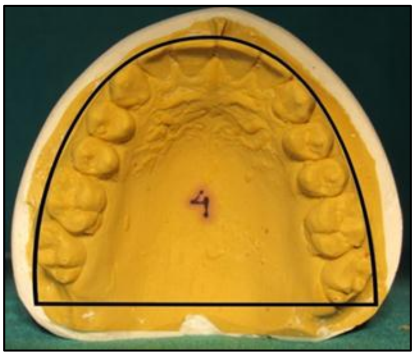

Fig 8: Outlining the maxillary arch till the second molars The 3 outlines of the face, tooth, and arch were resized to a common width (300 pixels) and each saved in Joint Photographic Experts Group (JPEG) format.

Computer software (written by Pioneers Training Academy) was used to convert the outline of each face, tooth, and arch into an X-Y function curve, which was saved as a comma -separated- value (.csv) file to be used for Fourier shape analysis.
Fourier analysis is a periodic function based on the transformation of shape into a mathematical series with an infinite number of sine and cosine wave harmonics.
These harmonics, also referred to as Fourier coefficients, are periodic waves of successive and different frequencies.
By increasing the number of harmonics, finer details are recorded for the shape. Thus, the main function of Fourier analysis is to quantify qualitatively described curvatures and explain them objectively by means of coefficients that represent the peaks of the sine and cosine waves at different harmonic levels.
Each harmonic level designates 4 coefficients: 2 for the top and bottom peaks of the cosine wave (coefficients A and C) and 2 for those of the sine wave (coefficients B and D).
Fourier shape descriptor software was used to import each of the 3 outlines for each participant separately to be decomposed into 32 harmonic levels. The outline curves were normalized for both orientation and size to restrict analysis to shape.

Therefore, the first 2 harmonics that represented size and orientation were excluded from analysis in the study.
Results of previous studies recommended that 30 harmonics or fewer be used in the analysis.
Because the first 2 harmonics are not descriptive of shape, the truncation at 32 harmonics was used in the analysis of this study to achieve 30 shape-specific harmonics.
The quantitative outputs of Fourier analysis take the form of coefficients that describe different levels (details) of shape. Each of the Fourier output spreadsheets has 32 harmonics, each of which includes the 4 coefficients: A, B, C, and D.30
Fourier analysis is accomplished at 2 projections for each outline, the peak projection (X projection; projection on the X axis of the outline), which designates A and B coefficients; and the side projection (Y projection; projection on the Y axis of the outline), which designates C and D coefficients. (Fig.9)

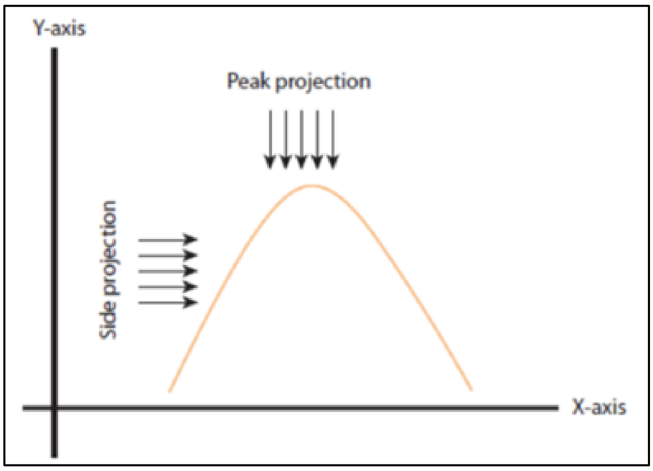

Fig 9: Harmonics projections in Fourier analysis of curvatures.

The process of mirroring to establish a closed contour produces 2 curvatures of even functions, and, as a result, all sine coefficients (B and D) become exactly zero.31
Thus, only the coefficients A and C were used for statistical analysis. A scatter plot that presents an example of a tooth outline for one of the participants decomposed into A and C coefficient cosine series is shown in Figure. (Fig.10)

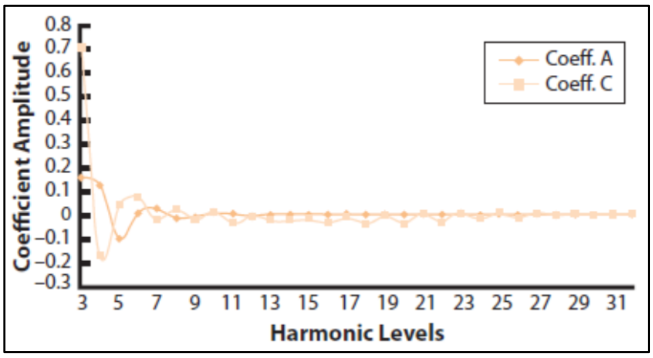

Fig 10: Scatter plot, presenting tooth outline decomposed into a cosine series with 30 shape harmonic levels (harmonics 3 to 32).

The first shape harmonic (H3) describes the general and the grossest detail of shape
(The primary curvature of the outline in the present study). By proceeding higher in the harmonic level (from H6 toward H32), finer details are described.
Because the comparisons in the present study are limited to the shape of the general or primary curvature, only lower harmonic levels that describe the gross or the primary curvatures of an outline (H3-H6) were considered in the analysis of the results.
Statistical software (Statistical Package for Social Sciences, v16; SPSS Inc) was used for data analysis. For each of the 3 outlines, the intersex similarity or difference across the coefficient values was tested by using the independent sample t test at each harmonic level and per projection.
In addition, the differences between the coefficient values within all possible outline pairs (face-tooth, face-arch, and arch-tooth) per projection was tested with ANOVA to determine whether the differences were statistically significant for each harmonic level at a time. The post hoc Tukey test was used to allow comparisons within all possible pairs of outlines.
Descriptive analysis was done for correlation of shade evaluation in different age groups and between different sexes.

Result

Table 1: Shade selection of the participants ranging from 20-30yrs

Male Participant	Shade	Female participants	Shade
1	A1	1	A1
2	B4	2	C4
3	A1	3	B4
4	B1	4	A1
5	B3	5	B4
6	A1	6	C4
7	B1	7	B3
8	B4	8	B4
9	A1	9	A1
10	B1	10	B1
11	D3	11	B4
12	A1	12	D3
13	B3	13	B1
14	B4	14	A1
15	A1	15	A1
16	A1	16	A1
17	B1	17	A1

Total participants-34 in number, Shade A1-41%, Shade B4 and B1- 14.7%, Shade B4-17.6%, Shade B3 and D3- 5.8%

Table 2: Shade selection of the participants ranging from 30-40yrs

Male Participants	Shade	Female participants	Shade
1	B1	1	B1
2	A3.5	2	A3.5
3	B3	3	C3
4	B1	4	B3
5	A3.5	5	A3.5
6	C3	6	C3
7	B1	7	B3
8	C3	8	A3.5
9	A3.5	9	B3
10	B3	10	C3
11	A1	11	B3
12	C3	12	C3
13	B1	13	A1
14	A3.5	14	A3.5
15	B3	15	B3
16	C3	16	B4

Total participants-32 in number Shade A3.5 and B3-25%, Shade C3-21%, Shade B1-15%, Shade A1 and B4-2%

Table 3: Shade selection of the participants ranging from 40-50 yrs

Male Participants	Shade	Female participants	Shade
1	B3	1	B4
2	A1	2	B3
3	B1	3	C3
4	B3	4	D4
5	A1	5	B4
6	C4	6	A3.5
7	A3.5	7	A1
8	D4	8	C3
9	B3	9	B1
10	B1	10	D4
11	A1	11	A1
12	C3	12	A3.5
13	B1	13	B1
14	A3.5	14	C3
15	C4	15	B3
16	B3	16	D4
17	C3	17	C4

Total number of participants- 34 in number Shade B3-17.6%, Shade A1,B1,C3-14.7%, Shade A3.5,D4-11.7%, Shade C4-8.8%, Shade B4-5.8

Table 4: Overall shade matching

Sr no.	Shade	Number of participants accurately matching the shade	Percentage
1	A1	22	22%
2	A3.5	13	13%
3	B1	15	15%
4	B3	17	17%
5	B4	11	11%
6	C3	13	13%
7	C4	5	5%
8	D3	3	3%
9	D4	3	3%

Table 5: Overall shade matching by male participants (50)

Sr no.	Shade	Number of participants accurately matching the shade	Percentage
1	A1	11	22%
2	A3.5	6	12%
3	B1	11	22%
4	B3	9	18%
5	B4	3	6%
6	C3	6	12%
7	C4	1	2%
8	D3	2	4%
9	D4	1	2%

Table 6: Overall shade matching by female participants (50)

Sr no.	Shade	Number of participants accurately matching the shade	Percentage
1	A1	10	20%
2	A3.5	6	12%
3	B1	5	10%
4	B3	7	14%
5	B4	7	14%
6	C3	7	14%
7	C4	3	6%
8	D3	2	4%
9	D4	3	6%

At both projections and at all studied harmonic levels (H3- H6), no statistically significant differences were found for arch and tooth outlines between men and women (P>.05) (Table 7).

Table 7: Statistical differences in mean harmonic coefficients for each of arch, face, and tooth outlines between men and women for each age group

Harmonic	Projection	Arch	Face	Tooth
3	Peak	.685	.681	.701
	Side	.927	*	.614
4	Peak	.738	**	.820
	Side	.755	.462	.279
5	Peak	.456	.809	.379
	Side	.340	.167	.942
6	Peak	940	.180	.926
	Side	.595	.395	.288

Significance levels: ≤.05 (*), ≤.01 (**).

Statistically significant differences were found between male and female faces at H4 on peak projection (P<.01) and H3 on side projection (P<.05) (Table 7). Therefore, the face differed between the sexes in its gross outline shape.

The ANOVA results for men (Table 8) revealed no statistically significant differences between face and tooth outlines at any of the 4 shape harmonic levels (H3-H6) or at both projections (P>.05).

Table 8: Significant differences in mean harmonic coefficients within all outline pairs (face-tooth, face-arch, and arch-tooth) for men of all age group

Harmonic	Projection	Arch	Face	Tooth
3	Peak	*	.666	*
	Side	*	.159	*
4	Peak	*	.331	*
	Side	*	.254	*
5	Peak	*	.473	*
	Side	*	.260	*
6	Peak	*	.515	*
	Side	**	.287	.234

Significance levels: ≤.001 (*) and ≤.01 (**).

However, all the differences between face and arch outlines were statistically significant at all studied harmonic levels and at both projections (P<.01).

Similarly, between arch and tooth outlines, almost all differences at all studied levels were statistically significant (P<.001), H6 at side projection was the only exception and would not be of great concern in the current study because the lower harmonic levels that describe the gross details of curvatures are of more interest.

Similar to the finding in the men's group, all the differences between face and arch outlines, and between arch and tooth outlines for women were statistically significant at all studied harmonic levels and at both projections (P<.05) (Table 9).

Table 9: Significant differences in mean harmonic coefficients within all outline pairs (face-tooth, face-arch, and arch-tooth) for women for all age group

Harmonic	Projection	Arch	Face	Tooth
3	Peak	*	.882	*
	Side	*	**	*
4	Peak	*	**	*
	Side	*	.553	*
5	Peak	*	.874	*
	Side	*	**	*
6	Peak	*	**	*
	Side	***	.467	**

Significance levels: ≤.001 (*), ≤.01 (**), and ≤.05 (***).

However, the results for the 2 sexes regarding the differences between face and tooth outlines were not quite the same.

For the women, as shown in Table 9, the differences between face and tooth outlines were not significant only at H3 and H5 for peak projection and at H4 and H6 for side projection (P>.05), which indicates a less powerful similarity between face and tooth outlines for women than for men.

Discussion

The Indian population is polygenetic and is a mixed amalgamation of various races, cultures and ethnic groups. In a developing country like India, problems such as non-availability of pre-extraction records often hinder fabrication of dentures.

Several esthetic guides have been proposed as aids for artificial tooth selection. There are also numerous methods and techniques for establishing the relationship between face form and tooth form when determining the form of artificial teeth. To date, no reliable method has been found, but William's method is that most widely and universally accepted [37].

Gender variations in the dimensions of the anterior teeth have been noted for most racial groups, with men exhibiting wider anterior teeth than women [17].

Mathematical methods, for example, Fourier analysis, may facilitate the study and conversion of the qualitative form of the curved outline into a quantitative form amenable to numerical description and analyses [42].

Because the outputs of Fourier decomposition, are a series of numbers that represent the amplitudes of sine and cosine functions, those numbers can be assessed by statistical tests to give objective outcomes.

In the current study, studying the difference among face, tooth, and arch outlines was based only on shape, which allowed the H3 to be the first shape harmonic and the most important because it describes the most general and the grossest detail of shape (the primary curvature of the outline). Because many previous studies recommended that 30 or fewer harmonics be used in the analysis, it was decided that the Fourier series be cut at the H32 (30th shape harmonic).

Because higher harmonic levels refer to finer details and because first to fourth Fourier shape harmonics reproduce accurately the maxillary dental arch form, we chose to analyze the 4 shape harmonics (H3-H6) that describe the gross or primary curvatures of the outline.

In fact, taking higher harmonics into consideration would have been misleading because the differences between outlines would only be the results of secondary curvatures caused by the vibration of the mouse cursor while the outlines were being traced interactively on the computer screen.

The results of sex differences found that, generally, all arch outlines were similar between men and women. All tooth outlines also were similar between the sexes.

Therefore, the insignificant sexual dimorphism for tooth shape does not support the dentogenic theory that states that female tooth form is ovoid whereas male tooth form is square. However, the findings in the present study agree with those reported by previous studies, [3, 14, 42] in that no association between sex and tooth shape was found.

In the current study, sex similarity was not consistent through all harmonics levels of face outlines. Although most harmonic levels had sex similarity, some difference was found at low harmonic levels (the second shape harmonic on peak projection and the first shape harmonic of side projection), which indicates much less sex similarity for gross facial outlines than for gross arch and tooth outlines, and signifies that some sexual dimorphism exists in gross face outline shape.

Analysis of the results indicated a similarity between facial and maxillary central incisor tooth outlines, although the similarity in women was not as powerful as that detected in men.

The less powerful similarity between face and maxillary central incisor tooth shapes in women compared with men may be attributed to sexual dimorphism in facial outlines.

Nevertheless, the similarity between the face and the maxillary central incisor tooth outlines reported in the current study supports the theory of the association by Williams between the central incisor shape and the upside down shape of the face. Our results also are in agreement with similar findings reported by other more recent studies [16, 34, 42].

In contrast, the finding in the present study is that face and maxillary central incisor outlines are similar is not in agreement with earlier studies [1, 3, 6, 12, 15, 37].

The use of different analytical approaches in those studies, including qualitative ones, may partly explain such disagreement.

The less powerful similarity between face and maxillary central incisor outlines for women compared with men is in agreement with Koralakunte and Budihal [37], although that study stated that face form is not reliable for tooth selection because no strong association between face and tooth forms was detected.

The present investigation found no relationship between maxillary central incisor outline and maxillary arch outline, which agrees with results reported by Sellen *et al*. [6]

However, in a single study, a correlation between face and arch forms, and no correlation between arch and tooth forms were reported [11].

Visual shade matching is characterized by several innate difficulties (metamerism, conditions that are less than ideal for shade matching, tools, and methods, as well as the examiner's age/level of fatigue).

Digital measurement devices for dental shades, such as spectrophotometers, have proven to be a reliable improvement over conventional visual shade selection using shade tabs [33].

Vita Easyshade is a portable system for tooth shade determination in the mouth. It has been available on the dental market since 2004 and consists of three main components: a light source, a device that receives the light reflected from the object, and a spectrometer.

The spectrometer measures the intensity of the light received in the form of a wavelength in the range of 400–700 nm. The L*a*b* and C*h* color space coordinates of the shade are calculated using a D65 illuminant and at an observer angle of 2° [39].

Shade evaluation by descriptive analysis of different age groups with Vita Easy Shade showed that overall A1 was the most common shade found in all age groups irrespective of the sex which was about 22% followed by B3(17%), B1(15%), A3.5 & C3 (13%), B4(11%), C4 (5%) and least being D3 and D4(3%).

A1 and B1shade were the most common shade found in male participants each accounting for 22% and A1 being the most in female participants about 20%.

In male participants the next most common shade was B3 (19%) and in female participants the next most common being the B3, B4, C3 (14%).

C4 and D4 were the least obtained shade for the male participants both about 2%, while in female participants the least was D3 of about 4%.
In the age group between 20-30yrs A1 (41%) is the most common shade, least being D3 (5.8%).
In the age group between 30-40yrs A3.5 and B3 (25%) being the most common, B4 and A1were the least (2%).
In the age group between 40-50yrs B3 (17.6%) was the most common, B4 was the lowest (5.8%).

Conclusion

Analysis of the results found that tooth and face forms were quantitatively related. Therefore, face form may act as a reliable guide for the selection of the appropriate anterior teeth form for complete denture prostheses for completely edentulous patients or complex anterior restorations.
Nevertheless, before such results become useful for the manufacturers in producing artificial tooth forms that esthetically match face forms, further investigations may be needed to see how exactly different tooth forms correlate to different face forms.

Summary

Fabrication of functionally and esthetically acceptable denture is one of the prime aim of Prosthodontist.
While selecting anterior teeth, three factors should be considered namely size, form and color.
The best artificial teeth is the one that reflects the patients sex and age, which render the prosthesis more natural.
In patients whose anterior teeth are missing and for whom no records are available choosing the form of anterior prosthetic teeth becomes more difficult.
This study aims to investigate the quantitative relationship between the outlines of the face, the maxillary arch form by Fourier analysis (mathematical analysis) and shade by spectrophotometer in different age groups to aid artificial teeth selection as to get the best esthetic outcome of definitive prosthesis after anterior teeth loss.
Frontal facial photographs and irreversible hydrocolloid impressions of the maxilla were obtained from 100 dentate individuals (50 men, 50 women) from different age groups 20-30 yrs,30-40yrs,40-50yrs.
On the resultant casts, standardized photographs were made for the dental arch and the maxillary central incisor.
The outlines of the face, dental arch, and tooth were digitally traced and the digitized curved outlines were converted into X-Y coordinates with special software, which, in turn, were imported into Fourier Shape Descriptor software for harmonic analysis.
The quantitative outputs of Fourier analyses were analyzed and tested with statistical software to investigate the differences across the shapes of the 3 outlines under study.
Shade selection was done with Vita Easy Shade of the central incisor for each patient for analysis.
It was found that facial and tooth outlines were similar for each sex, although the similarity was stronger among the men.
By contrast, no relationship was found between tooth and maxillary arch outlines or between face and maxillary arch outlines.A1 is the most common shade in both the sexes.
It was concluded that face and tooth forms were quantitatively related. Accurate shade selection along with face form as a reliable guide can help to attain a esthetically pleasing prosthesis for edentulous patients.

Reference

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