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MANUSCRIPT

Evaluation of the validity of Leon Williams' Geometric Proportion in Maxillary Anterior Teeth Selection: A Study on Kanpur Population

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Abstract

Background: Selection of maxillary anterior teeth for complete dentures is crucial in clinical practice and controversy about the validity of even best method to employ still exists. Leon Williams formulated and publicized a method called the "Geometric theory" which is still widely used. Williams believed that the anterior teeth selection process should involve the criteria of an existing relationship between the face-form and the form of the maxillary central incisor in most people. In spite of the SPA theory introduced later, geometric theory remains till date a popular method of selection of anterior artificial teeth. For this reason, it was decided to assess the validity and specificity of William's geometric proportion by comparing tooth shape and form with apparent facial form as well as actual facial form in Kanpur, Uttar Pradesh population for the age group 18-30 years and integrate it with teeth selection procedure.

Introduction: The selection of maxillary anterior teeth for complete dentures is a critical aspect of dental practice, with ongoing debate surrounding the most effective methods. Leon Williams proposed the "Geometric theory," suggesting a relationship between facial form and the shape of the maxillary central incisor, which remains widely utilized. Despite the introduction of alternative theories such as the SPA theory, the Geometric theory persists as a popular method for tooth selection. This study aims to assess the validity and specificity of Williams' Geometric theory by comparing tooth shape and form with apparent and actual facial forms in the Kanpur population aged 18-30 years.[4,5]

Methodology: A cross-sectional observational study was conducted on 200 subjects (100 males and 100 females) comprising dental students and patients from the Rama Dental College,

Kanpur, U.P., within the age range of 18-30 years. The sample selection was based on a predetermined formula.

Keywords: Geometric theory, Leon Williams, face-tooth form, maxillary anterior teeth, tooth selection, complete dentures, Kanpur population.

Introduction

Aesthetic replacement of missing teeth is one of the major concerns of the dentist and patients. The maxillary central incisor is the most relevant teeth of the human dentition and is often used as a guide for the selection of the artificial anterior teeth.[1] For complete dentures, the restoration of facial harmony lies in the art of selecting artificial teeth; plays a very crucial role as it also enhances beauty and brings psychological comfort to the patients. Selecting maxillary anterior teeth for complete dentures remains a contentious issue in clinical practice, with ongoing debate about the best method to use.

Leon Williams formulated and publicized a method called the "Geometric theory" which is still widely used. Williams believed that "the contour lines of your upper incisors must be, in a general way, the reverse of what they are in the face. This was the accepted theory for about 50 years. Then Frush and Fisher introduced the SPA theory, in which selection of teeth was determined on the basis of sex, personality, and age of the individual. However, despite the widespread acceptance of the SPA concept, the Geometric theory is still used by many dentists for selection of the shape and size of the artificial anterior teeth in complete denture patients.[4] Thus, a study was planned to assess the validity of the Geometric theory in a sample Kanpur (Uttar Pradesh, India) dentate population.[5]

Methodology:

- The study employed a cross-sectional observational design involving 200 subjects, evenly distributed between genders (100 males and 100 females). The participants

consisted of dental students and patients from the Rama Dental College-Hospital and Research Centre, Kanpur, aged between 18 and 30 years. The sample size was determined using the following formula:

- ***Z* =1.96/d**

- where *Z* represents the standard normal variate (at 5% type one error), *SD* denotes the standard deviation based on previous studies, and *d* signifies the absolute error or precision (set at 0.05). Each group was required to contain at least 70 subjects, resulting in a selected sample size of 100 subjects for both males and females.
- Front profile photographs were taken to analyse facial form, while intraoral photographs were captured using cheek retractors to examine the form of the maxillary central incisors. Digital comparison of both forms was conducted using Adobe Photoshop software (CS3) and Image Analyzer software (version 1.38).

To estimate the sample size, we'll use the given formula:

$$(Z^2 \times [p] \times [I-p])/C^2$$

Where**,**

- *Z* = Z value for the chosen confidence level
- *p* = Percentage of individuals meeting the inclusion criteria (expressed as a decimal)
- *C* = Confidence interval (expressed as a decimal)

Given that:

- Confidence level: 95% (corresponding Z value: 1.96)
- Expected percentage of individuals meeting the inclusion criteria (p): We'll assume 50% for simplicity, but this value can be adjusted based on the prevalence of the desired characteristics in the population.
- Confidence interval: 0.05 (corresponding to 95% confidence level)

Calculating the sample size using these values:

Sample size = $(1.962 \times 0.5 \times (1-0.5))0.052$

Sample size = $0.052(1.962 \times 0.5 \times (1-0.5))$

Sample size = (3.8416×0.5×0.5)0.0025

Sample size = 0.0025(3.8416×0.5×0.5)

Sample size = 0.0025 x 9604

Sample size ≈184.16

Rounding up, we would need approximately 185 subjects for the study.

Inclusion criteria:

- Patient belonging to the Kanpur region for at least four previous generations.
- Age group: 18-30 years.
- Full complement of permanent natural teeth (excluding third molars).

Exclusion criteria:

- Obvious facial asymmetry or craniofacial anomaly, congenital or acquired.
- Previous history of maxillofacial trauma, surgery, or excessive body weight.
- Congenitally missing or extracted maxillary central incisor teeth.
- Gingival recession, enlargement, or advanced periodontal diseases.
- Restoration or prosthesis involving the maxillary central incisor.
- History of aesthetic treatment in anterior teeth.
- Anterior teeth showing regressive alterations.

Each subject was informed about the study objective, and written informed consent was obtained from all participants. The study protocols were approved by the Institutional Ethical Committee at Rama Dental College-Hospital and Research Centre, Kanpur, ensuring compliance with the Helsinki declaration.

Frontal facial profilometric photographs were captured using a Canon DSLR camera model No. 1200D equipped with 25-55x & 55-250x optical zoom lenses. The high-resolution images (20 Mega pixels) were transferred to a computer for analysis. The camera's in-built zoom lens with a focus range to infinity ensured high-quality images. A standard adjustable tripod stand was utilized to position the camera parallel to the horizontal plane. Subjects were positioned upright, with predetermined distances between the subject's sagittal plane and the photographic film (50 cm for facial photographs and 20 cm for intraoral photographs).

To stabilize the head and minimize errors due to lateral head rotation during photography, a grid was employed. Intraoral photographs were taken using a cheek retractor.

The obtained images were transferred to a computer (HP EliteBook 2560p) for analysis. Facial and maxillary central incisor forms were traced digitally using image analyser (version 1.38) software, with standard points 1 cm apart. Outlines were digitally marked using Adobe Photoshop software (CS3) and analysed according to predetermined standards:

- Facial forms were classified as triangular, square, or ovoid.
- Maxillary central incisor forms were classified similarly.

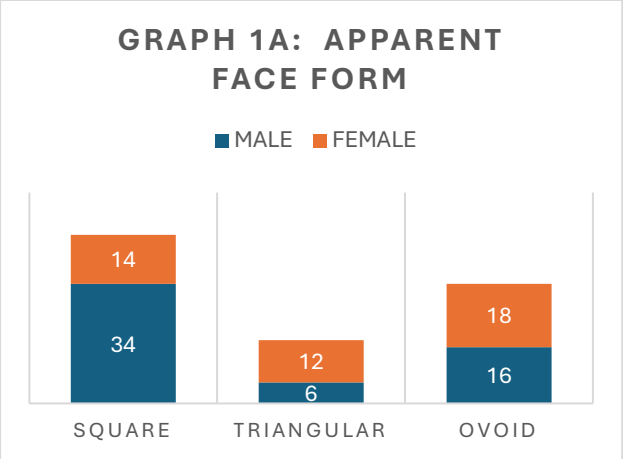
The acquired facial form was digitally superimposed on the maxillary central incisor outlines, and the tracings were analyzed for accuracy or differences.

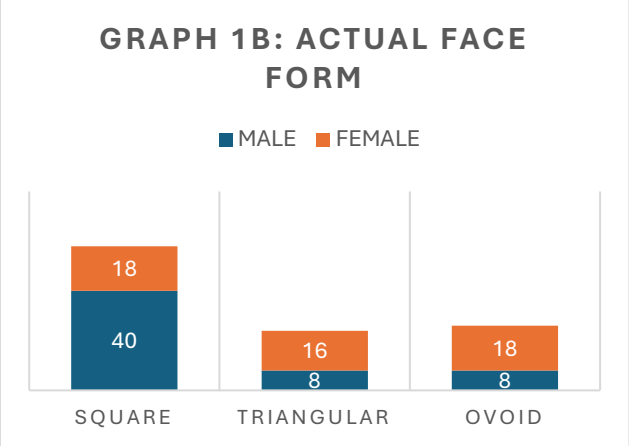
Statistical Analysis: Using statC software, statistical analysis calculated mean, standard deviation, Chi-square values, and P values. Facial and maxillary central incisor forms were classified by gender at a significance level of $p = 0.05$. The comparison of facial and tooth forms used the Chi-square test, also with a significance level of $p = 0.05$.

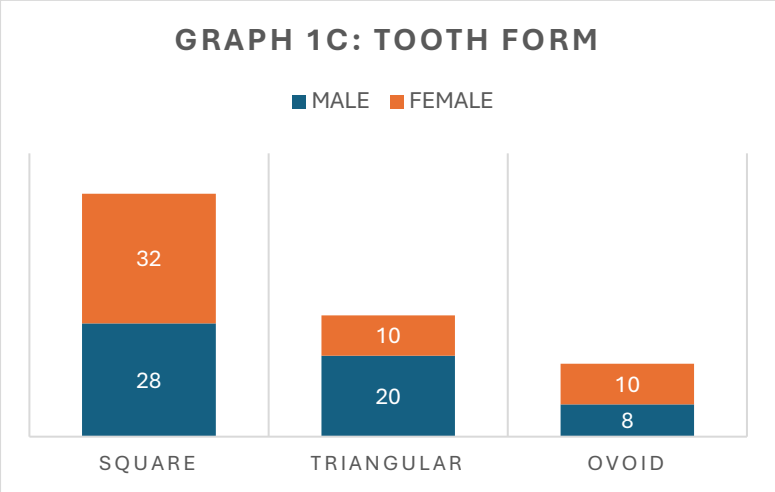
Results:

Table 1: Frequency of types of apparent facial form, actual facial form, and tooth form

FACEFORM	GENDER	SQUARE		TRIANGULAR		OVOID		CHI SQ Value	p Value
		N	%	N	%	N	%		
APPARENT FACE FORM	M	34	60.7	6	10.7	16	28.6	9.14	<0.01
	F	14	31.8	12	27.3	18	40.9		
ACTUAL FACE FORM	M	40	71.4	8	14.3	8	14.3	9.94	<0.01
	F	18	40.9	16	36.4	10	22.7		
TOOTH FORM	M	28	50.0	20	35.7	8	14.3	5.94	<0.05
	F	32	72.7	10	22.7	2	4.5		







The results obtained in present study revealed:

- A highly significant statistical relationship between apparent face form and gender with p-value <0.01
- A highly significant statistical relationship between actual face form and gender with p-value <0.01
- A significant statistical relationship between tooth form and gender with p-value <0.05

However, it was found that there was no statistically significant relationship between Apparent face form and tooth form with Chi-sq value 2.82 and p-value > 0.05

There was no statistically significant relationship between Actual face form and tooth form with Chi-sq value 5.03 and P-value > 0.05

Table 2: Comparison of Apparent face form**,** Actual face form withTooth form

FACEFORM	GENDER	SQUARE		TRIANGULAR		OVOID		CHI SQ Value	P Value
		N	%	N	%	N	%		
APPARENT FACE FORM	M	0	0.0	24	42.9	32	57.1	2.82	<0.05
	F	2	4.5	16	36.4	26	59.1		
ACTUAL FACE FORM	M	1	1.8	19	33.9	36	64.3	5.03	<0.05
	F	4	9.1	20	45.5	20	45.5		

Discussion:

The earlier studies that have analyzed face and tooth forms in different geographical populations include Sellen *et al.*, 1998; Brodbelt *et al.*, 1988; Lindemann *et al.*, 2004; and Wolfart *et al.*, 2004. The methodology involved varied, and most analyses relied on visual assessments by laypeople or dentists. This method was dependent on many variables related to experience, background, social agreement, and personnel preference and was thereby biased. The current study utilized standardized digital images; an image analyzing software (Image Analyzer 1.38) and Adobe Photoshop CS3 were used to capture the face, analyse the maxillary central incisor form, and face form in order to limit the variability in recording and evaluation (Table 1) (Graph 1A, 1 B, 1C). This method seems to be more practical, easy to perform and offers acceptable precision and reliability.

Mavroskoufis F *et al* and Sellen PN *et al* found no link between face shape and the inverted shape of the maxillary central incisor.[2] In contrast, Wright WH *et al* and DeSouza *et al* observed similar shapes in 64% and 70.2% of individuals respectively.[5]

The facial form consideration, the result of this study (Table 2) was not consistent with those reported by Wright WH (1936), in which the square shape was observed in 7% of the sample, ovoid in 11%, and triangular in 82%.[5]

DeSouza *et al* also found different results the triangular shape was the most frequent one (56.7%), followed by the square (35.1%), and the ovoid shape (8.1%).

Miraglia et al. concluded that no tooth selection system can accurately guide the selection of teeth without the artistic and scientific inputs from the operator.[6] Therefore, despite its widespread use, the theory proposed by Williams may not be completely reliable.

Conclusion

This study concludes that there is a much greater percentage of dissimilarity between incisor and face-form, in sample Kanpur population. The “Williams’ law of harmony” to select artificial teeth stands inconclusive in sample Kanpur population both in males and females.

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