

A study on visible iris diameters as a surrogate measure for width and length of maxillary central incisors

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Abstract

Maxillary central incisor is the most prominent teeth when viewed from frontal aspect. Various methods have been suggested for teeth selection for complete dentures but till date there is no single reliable method available. In this study, anatomical landmark chosen to correlate with maxillary central incisor is iris, since, it is a unique and stable internal organ which is formed by 10th month and remains unaltered throughout life. A total of 150 subjects (75 Males and 75 Females) between the age group of 18-30 years were included in this study. Iris diameters were measured using reticle loupe with the measurement scale built in it. Maxillary central incisors are measured using dividers and digital calipers. A positive Pearson correlation was found between the mesiodistal widths of the maxillary central incisor and Horizontal Visible Iris Diameter (HVID) and the length of maxillary central incisor and Vertical Visible Iris Diameter (VVID). This correlation was higher in males

than in females. ‘Regression equation’ was also formulated for the determination of cervical, middle and incisal thirds of the maxillary central incisor using HVID and the clinical length using VVID. The formulated equation in the study, would help in teeth selection for complete denture patients with no pre-extraction records.

Keywords: Complete denture, Maxillary Central Incisor, Mesiodistal width, Clinical length, Horizontal Visible Iris Diameter, Vertical Visible Iris Diameter.

Introduction

As face is the most expressive part of the human body it determines the individual’s social acceptance. Teeth loss affects facial appearance and also creates psychological trauma to the person. Hence, esthetically pleasing and functionally comfortable replacement of the missing teeth is essential.

In today’s world, where people are conscious about their health and esthetics, smile is viewed as an

important component that adds a segment to the person's appearance and well-being. In fact, esthetics is often the reason that motivates patient to seek dental care.² Patients receiving their first dentures often expect them to appear similar to when they had their natural teeth. Therefore, the correct selection of artificial teeth is essential for achieving a pleasant esthetic outcome. The selection of artificial teeth for complete and removable partial dentures is a widely neglected phase of prosthodontics. Many dentists inappropriately surrender this critical phase of restorative dentistry to a dental laboratory technician. Over the years, teeth selection and arrangement norms, criteria and guidelines have been suggested by the artisans of the dental profession. Success in this can often be related to the appearance of teeth within the framework of face.³

A complete denture should restore function, esthetics and phonetics, with esthetics being the primary concern for the patient visiting a prosthodontist.^{4,5} For the current generation, dental esthetic and facial appearance has become very important and this has led in an increased interest in achieving optimal treatment outcomes.⁶

One of the most confusing and difficult aspect of complete denture prosthodontics is the selection of appropriately sized artificial maxillary anterior teeth. This is a problem when fabricating new dentures and for old dentures with poor esthetics.⁷

Pre-extraction records are a reliable guide for selection of teeth.⁸ Diagnostic casts and photographs are the best guides when they are available. Roentgenograms made when natural teeth are present give some clues.⁹ The selection and arrangement become difficult when pre-extraction records are not available. Errors at selection

stage can often result in patient rejection of well-constructed, comfortable and efficient dentures.^{10,11}

Several literatures regarding the selection of the anterior tooth size exist but till date there is no single reliable method available. Methods like Cephalic Index, Berry's Index, Sears Index, Bizygomatic Width Index, Ala of the Nose, Inter Canthal Distance, Inter Commissural Width, Anthropometric Measurements, Distance between Pterygomandibular Notches, Facial Width, Corner of the Mouth, Interpupillary Distance have been reported to be not clinically significant and may vary with sex and ethnicity.^{4,5} So, there is a need for development of a method which can aid in correct estimation of size of the tooth in edentulous patients.

Amidst different studies done till date to correlate anatomical landmarks to the size of the anterior teeth, measurement of eye is one corner which has not been explored much. Though studies have been done on intercanthal and interpupillary distance of the eye but they are still under research as significant correlation has not been established.⁴ Iris is a unique and stable internal organ used for person's identification. It is formed by the 10th month and remains unaltered throughout the life.^{5,12}

If an equation is derived for the calculation of widths and length of Maxillary Central Incisors using the Visible Iris Diameters, it can help the clinician in selecting the size of the tooth which can fulfil the patients' esthetic expectation. With this equation accurate size of maxillary central incisors can be estimated in edentulous patients who do not have pre-extraction records like standard photographs, radiographs, extracted teeth, pre-extraction diagnostic casts or measurements of the natural teeth and are willing for a denture.

Studies done on correlation of Vertical Visible Iris Diameter (VVID) and Horizontal Visible Iris Diameter (HVID) to length and width of maxillary central incisors respectively have demonstrated a positive correlation between them. But there were few major constraints in those studies, like photography was used for measurement of the iris and tooth, instead of objective devices like reticle loupe, corneal topographer and slit lamp which can provide accurate measurement of the iris and digital caliper for tooth evaluation.^{4,5}

Thus, this study is an attempt to derive an equation with the variables measured with devices like reticle loupe and digital caliper which can provide explicit measurements.

Materials and Method

Dentulous subjects required for the study was selected from the Bapuji Dental College and Hospital, Davangere and other institutes in Davangere, after being fully informed about the nature of the investigation. Subjects of both genders (males and females) belonging to the age group of 18-30 years, having completely erupted permanent, well aligned, natural maxillary central incisors were included for the study. Any subject having these were excluded, gingival alteration involving gingival overgrowth, hyperplasia, attachment loss or history of periodontal surgery with respect to maxillary central incisors, any evidence or history of alteration to the incisor edge or proximal surfaces of the maxillary central incisor by restorative intervention, caries, trauma or incisal wear, crowding in the anterior maxillary teeth that prevent accurate measurement of the width of the teeth, ongoing orthodontic treatment, evidence or history of any congenital dental or facial anomalies or obvious facial asymmetry, evidence or history of tumors of the

eye, aberrations of cornea (microcornea, macrocornea), evidence or history of any congenital anomalies or trauma or scars or surgery of eye or subjects using contact or intraocular lenses.

Materials

Dividers (Maped, France).

Digital caliper (Zoom, India) - with resolution of 0.01mm.

Reticle loupe (Gaopin, China) - with minimum scale division of 0.1mm and 10x magnification.

Measurements recorded

Teeth – Right and Left Maxillary Central Incisors

Mesiodistal width at Cervical third.

Mesiodistal width at Middle third.

Mesiodistal width at Incisal third.

IRIS – Right and Left eyes

Horizontal Visible Iris Diameter (HVID).

Vertical Visible Iris Diameter (VVID).

The mesiodistal widths and length of each maxillary central incisor were recorded intraorally. These measurements were done with a pair of dividers and a digital caliper. Widths were determined at the cervical, middle and incisal thirds of the crown with the help of dividers that has fine pointed ends to fit interdentially. Measurements were done in a straight line, with the pointed members of the dividers held parallel to the incisal edges. After this, the pointed members of the dividers were placed on a piece of white paper mounted on a board, so that the pointed members perforate the paper when gentle pressure is applied. The perforations were joined by a straight line and measured with a digital caliper. Similarly, clinical crown length measurement of maxillary central incisors was done intraorally from zenith point to the centre of incisal edge with the dividers and transferred to a white sheet and measured with the digital caliper.¹³

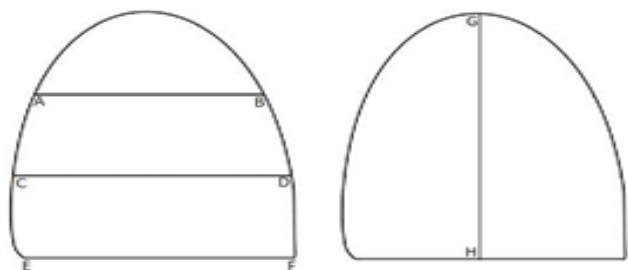


Fig. 1: Schematic diagram showing the measurements recorded in maxillary central incisors.

Measurement of Horizontal and Vertical Iris diameters were done with a Reticule Loupe. Subjects were made to sit upright on a chair. The examiner looked into the subject's eye through the reticle loupe and used the measurement scale built in it to measure the Visible Iris Diameters. The Horizontal Visible Iris Diameter (HVID) was measured as distance between the nasal and temporal imaginary tangents to the corneal circumference, along the center of pupil. The distance between the superior and inferior imaginary tangents to the corneal circumference, along the center of pupil was recorded as the Vertical Visible Iris Diameter (VVID). In measuring VVID, it is occasionally necessary to lift the eyelids with minimal pressure being applied to the globe.¹⁴

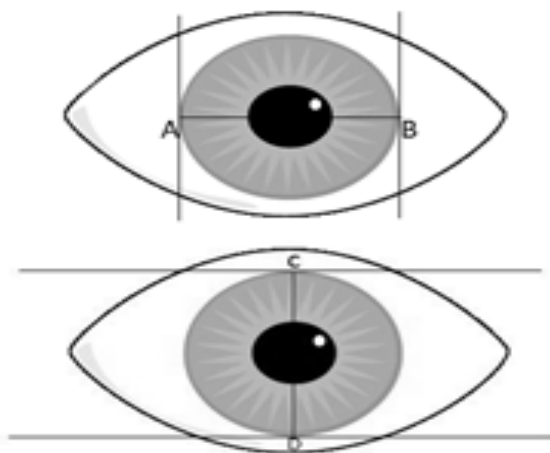


Fig. 2: Schematic diagram showing the measurements of iris



Fig. 3: A. Digital Calipers (Zoom). B. Dividers (Maped). C. Measuring Iris Diameter using Reticule Loupe (Gaopin). D. Scale in the Reticule loupe - visible when looked through it. E. Measuring clinical length of the maxillary central incisor. F. Measuring cervical third width of the maxillary central incisor G. Measuring Middle third width of the maxillary central incisor H. Measuring incisal third width of the maxillary central incisor

Results

The widths of the maxillary central incisor were correlated to the HVID and the clinical length was correlated to the VVID. The correlations of right & left eyes and right & left maxillary central incisors were done separately. The data was also subjected to analysis to formulate a 'regression equation' for the determination of cervical, middle and incisal thirds of the maxillary central incisor using HVID and the clinical length of the maxillary central incisor using VVID.

The correlations obtained for right and left sides were tabulated. Scatter diagrams were also plotted showing the correlation between Maxillary Central Incisor Widths at Cervical (MCIWC), middle (MCIWM) and incisal thirds (MCIWI) with HVID after calculating the mean of right and left sides. Similarly, scatter diagram was also plotted for Maxillary Central Incisor Length (MCIWL) with VVID.

Maxillary Central Incisor		HVID Right	HVID Left	VVID Right	VVID Left
Cervical 3 rd width	correlation	0.519	0.502	--	--
	p	< 0.001	< 0.001	--	--
Middle 3 rd width	correlation	0.631	0.631	--	--
	p	< 0.001	< 0.001	--	--
Incisal 3 rd width	correlation	0.597	0.643	--	--
	p	< 0.001	< 0.001	--	--
Length	correlation	--	--	0.503	0.494
	p	--	--	< 0.001	< 0.001

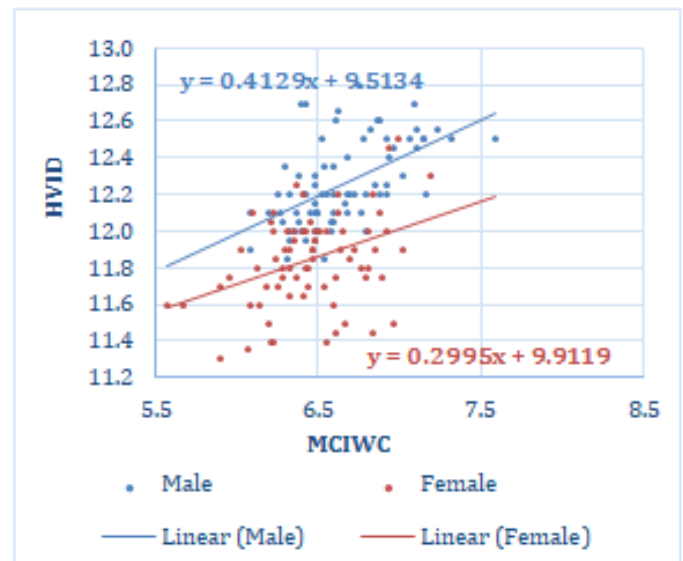
Table 1: Showing correlation between variables (left and right sides) for 150 subjects.

Maxillary Central Incisor		HVID Right	HVID Left	VVID Right	VVID Left
Cervical 3 rd width	correlation	0.546	0.512	--	--
	p	< 0.001	< 0.001	--	--
Middle 3 rd width	correlation	0.606	0.604	--	--
	p	< 0.001	< 0.001	--	--
Incisal 3 rd width	correlation	0.745	0.779	--	--
	p	< 0.001	< 0.001	--	--
Length	correlation	--	--	0.55	0.51
	p	--	--	< 0.001	< 0.001

Table 2: Showing correlation between variables (left and right sides) for 75 male subjects.

Maxillary Central Incisor		HVID Right	HVID Left	VVID Right	VVID Left
Cervical 3 rd width	correlation	0.355	0.367	--	--
	p	< 0.01	< 0.01	--	--
Middle 3 rd width	correlation	0.379	0.359	--	--
	p	< 0.01	< 0.01	--	--
Incisal 3 rd width	correlation	0.345	0.373	--	--
	p	< 0.01	< 0.01	--	--
Length	correlation	--	--	0.355	0.331
	p	--	--	< 0.01	< 0.01

Table 3: Showing correlation between variables (left and right sides) for 75 female subjects.



Graph 1: Scatter diagram showing the correlation between Maxillary Central Incisor Width at Cervical third (MCIWC) with Horizontal Visible Iris Diameter (HVID)

The scatter plot shows a positive correlation between MCIWC with HVID for both males (blue) and females (orange).

The relationship between them:

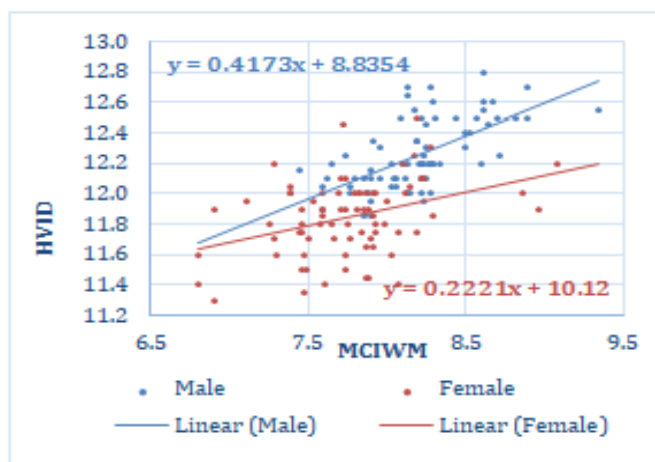
For males:

$$y = 0.4129x + 9.5134$$

For females:

$$y = 0.2995x + 9.9119$$

Where, 'x' is Maxillary Central Incisor Width at Cervical third (MCIWC) and 'y' is Horizontal Visible Iris Diameter (HVID).



Graph 2: Scatter diagram showing the correlation between Maxillary Central Incisor Width at Middle third (MCIWM) with Horizontal Visible Iris Diameter (HVID)

The scatter plot shows a positive correlation MCIWM with HVID for both males (blue) and females (orange).

The relationship between them:

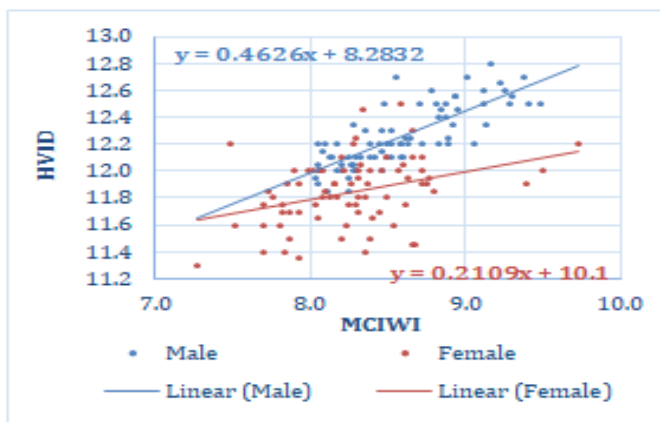
For males:

$$y = 0.4173x + 8.8354$$

For females:

$$y = 0.2221x + 10.12$$

Where, 'x' is Maxillary Central Incisor Width at Middle third (MCIWM) and 'y' is Horizontal Visible Iris Diameter (HVID).



Graph 3: Scatter diagram showing the correlation between Maxillary Central Incisor Width at Incisal third (MCIWI) with Horizontal Visible Iris Diameter (HVID)

The scatter plot shows a positive correlation MCIWI with HVID for both males (blue) and females (orange).

The relationship between them:

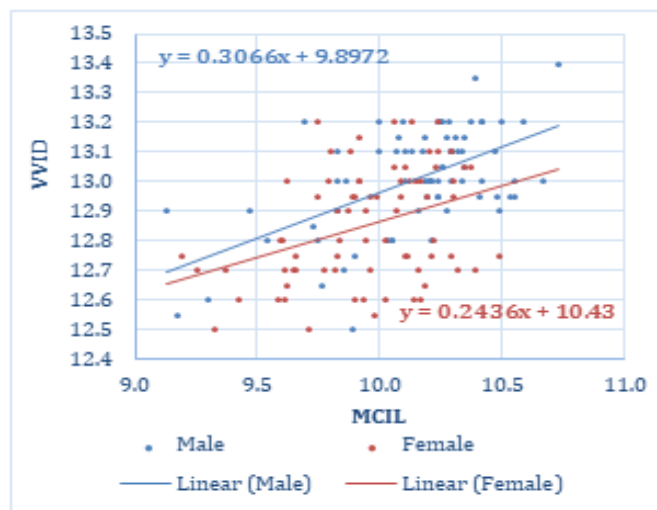
For males:

$$y = 0.4626x + 8.2832$$

For females:

$$y = 0.2109x + 10.1$$

Where, 'x' is Maxillary Central Incisor Width at Incisal third (MCIWI) and 'y' is Horizontal Visible Iris Diameter (HVID).



Graph 4: Scatter diagram showing the correlation between Maxillary Central Incisor Length (MCIL) with Vertical Visible Iris Diameter (HVID).

The scatter plot shows a positive correlation MCIL with VVID for both males (blue) and females (orange).

The relationship between them:

For males:

$$y = 0.3066x + 9.8972$$

For females:

$$y = 0.2436x + 10.43$$

Where, 'x' is Maxillary Central Incisor Length (MCIL) and 'y' is Vertical Visible Iris Diameter (VVID).

Discussion

Edentulism is not a disease entity by itself, but rather a consequence of pathology. The need to replacing teeth that defy detection has been specifically emphasized by

the patients. Robert G Vig, had stated the discrepancies between the size of natural and the artificial teeth were responsible for the “denture look”.^{15,16} A complete denture not only replaces the visible and functional elements of the face but also plays a vital role in replacing the lost facial esthetics to acceptable limits and upper anterior teeth have a vital role to play in restoring the facial esthetics of a patient.

One of the primary concerns in denture esthetics is the selection of maxillary anterior teeth, especially the width of central incisors.¹⁷ The size, form and color of the teeth should be in harmony with the surrounding oral and facial structures. The width of the teeth is considered to be more crucial than the length of maxillary central incisor as this determines the size of anterior teeth and the esthetics of the entire denture. Maxillary central incisor is the most visible teeth during unstrained facial activity. Many methods and techniques for tooth selection have been described in the literature but have not been proven as conclusive evidence.¹⁸ This research was attempted to determine if a correlation existed between dimensions of iris and length and width of maxillary central incisor.

Iris is an internal organ which is protected by the cornea. It is a stable internal organ that does not change its biometric temper over the years. It controls the amount of light entering the eyes. Diameter of the pupil constricts or dilates depending upon the amount of light entering the eyes without altering the dimensions of the iris.⁵

The objective of the present study was planned with the purpose of establishing a relationship and formulating a regressive equation for determination of width and length of maxillary central incisor. 150 subjects of both genders (males and females) belonging to the age group of 18-30 years, having completely erupted permanent,

well aligned, natural maxillary central incisors were included in the study.

A younger group (18- 30 years) was selected in this study, as the incidence of factors such as mesiodistal attrition, incisal wear, extensive periodontal disease and extensive gingival recession are comparatively lower in younger population and active growth would have ceased with complete maturation of gingival tissue in selected population.¹⁹

A digital caliper with resolution of 0.01mm was used instead of other manual counterpart for recording maxillary incisor dimensions because of the ease of recording the readings and to minimize the introduction of error by operator fatigue. Inter observer error was avoided as only one examiner performed all the measurements and recorded all the data.¹³

Earlier studies such as by Magne et al in 2003, found that recordings of the measurements of the teeth increased by approximately 1 mm on extracted teeth.²⁰ In this study, tooth height was recorded as the distance from the incisal edge which is unworn and unrestored to the gingival crest or the zenith point of the maxillary central incisor.

For measurement of the horizontal and vertical visible iris diameter, the device used was reticle loupe (reticle = graticule; loupe = magnifying glass) with minimum scale division of 0.1mm and 10x magnification. This device is used in this research as it can provide explicit measurement of the iris and is often used in optometric practice. It is a non-invasive and cost-effective option for iris measurement.^{4,5}

The association between anthropometric values and maxillary anterior teeth in dentate individuals was evaluated in the present study. Establishing the relationships between the mesiodistal widths of the maxillary central incisor and HVID and length of

maxillary central incisor and VVID was the objective of this study. The hypothesis of a relation between the HVID and the width of the maxillary central incisor and VVID and length of maxillary central incisor was accepted, as a positive correlation was found between them.

Enormous research has been done to establish a relation between anthropometric values and maxillary anterior teeth in dentulous patients to aid in selection of artificial denture teeth in completely edentulous patients. The results of this study were consistent with the results of previous studies which found a positive correlation between the anthropometric measurements and dimensions of the maxillary anterior teeth. Gomes et al in the year 2006, concluded in their study that all the facial measurements correlated to mesiodistal width of maxillary teeth, and intercanthal distance, inter pupillary distance and inter commissural distance showed highest probability.²¹ Hasanreisoglu et al in the year 2005 demonstrated that the bizygomatic width and interalar width may help in calculating the ideal width of the maxillary anterior teeth.²² Isa et al in the year 2010, noted that by using a combination of the facial dimensions the widths of the anterior teeth may be predicted.²³ Kini and Angadi in the year 2013 found that extraoral anthropometric measurements of the interpupillary distances and the intercommissural distances can help in determining the combined widths of the anterior teeth.²⁴ Tandale et al in the year 2007, and Abdullah in the year 2002, demonstrated that the intercanthal distance can be used as a method for determining the width of the maxillary anterior teeth during the selection of teeth for a patient with edentulism.^{13,25}

In the present study the results obtained were also in agreement with the results obtained by Hemalatha et al

and Rohini et al, in which they used photoimaging software for measurement of iris diameters and the maxillary central incisors dimensions. Hemantha et al in the year 2018 demonstrated that a positive correlation between the HVID and the mesiodistal widths of the maxillary central incisor exists. Similar to the results obtained in this study, they had found that the correlation in men was more than in women. The r values for 150 subjects obtained in this study are 0.519, 0.631 and 0.597 for the cervical third, middle third, and incisal edge for right side and 0.502, 0.631 and 0.643 for left side whereas Hemantha et al got r values of 0.592, 0.737 and 0.756 for the cervical third, middle third, and incisal edge for right side and 0.594, 0.740 and 0.751 for left side.⁴ Rohini et al in the year 2017, did a pilot study on 20 individuals and noted that a minimal correlation existed between the VVID and the length on the maxillary central incisor.⁵

The results of this study demonstrated a positive correlation between the HVID and the widths of the maxillary central incisor. The correlation between the mesiodistal widths of the maxillary central incisor and HVID of male participants was higher than that of female participants. This study also demonstrated a positive correlation between the VVID and length of maxillary central incisor.

Data collected in the study was subjected to analysis to formulate a 'regression equation'. The relationship between the maxillary central incisor width at cervical, middle and incisal third with HVID and the relationship between the maxillary central incisor length and VVID was formed using regression analysis. The regression equation established in this study was done separately for male and female subjects as the data collected in the study showed variation in males and females subjects. This is also in agreement with the

studies of Garn et al in the year 1967 and Lavelle in the year 1975, where they showed variation in tooth size based on sex.^{26,27} Iyamu and Osuobeni in the year 2012, also found that males had significantly wider iris diameters than their female counterparts in 130 healthy Nigerians.²⁸

This study discovered that the HVID produced a positive correlation with the mesiodistal width of the maxillary central incisor and VVID with the length. The regression equation formed in this study can be a valuable aid in the absence of pre-extraction records. Iris being unaltered throughout the life can be beneficial in estimating the tooth size, in patients who don't have pre-extraction records.

Conclusion

1. A positive 'Pearson correlation' was found between the HVID and the mesiodistal widths of the Maxillary Central Incisor at cervical, middle and incisal thirds being 0.519, 0.631 and 0.597 for right side and 0.502, 0.631 and 0.643 for the left side respectively. The 'Pearson correlation' for VVID and the length of the Maxillary Central Incisor obtained was 0.503 and 0.494 for right and left side respectively.
2. The correlation was higher in male subjects than female subjects.
3. The 'regression equation' established in this study are:
 - i. For cervical third:
 $y = 0.4129x + 9.5134$ and $y = 0.2995x + 9.9119$ for males and females respectively.
 - ii. For middle third:
 $y = 0.4173x + 8.8354$ and $y = 0.2221x + 10.12$ for males and females respectively.
 - iii. For incisal third:

$y = 0.4626x + 8.2832$ and $y = 0.2109x + 10.1$ for males and females respectively.

Where, 'x' is the width at respective cervical, middle and incisal thirds and 'y' is HVID.

- iv. For Length of Maxillary Central Incisor
 $y = 0.3066x + 9.8972$ and $y = 0.2436x + 10.43$ for males and females respectively.

where, 'x' is Maxillary Central Incisor Length and 'y' is VVID.

Clinical Relevance: The 'regression equation' established in this study can be used for estimating the width and length of maxillary central incisor in edentulous complete denture patients with no pre-extraction records.

Limitations of this study and Future research prospective

- i. This study included participants irrespective of their ethnic group. Further study can be done in different region including specific regional population and racial groups.
- ii. The present study was conducted on a young age group (18- 30 years) as the incidence of factors such as mesiodistal attrition, incisal wear, extensive periodontal disease and extensive gingival recession are comparatively lower in younger population. Further studies can also be done on different age groups to find association between the variables.

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