Original Article

Translucency characteristics of permanent maxillary central incisor in Indian population: An analytical cross-sectional study

Siddharth Mishra, Pranav Murthy, Dhruv Ahuja[1], Manuel S. Thomas, Srikant Natarajan[2], Umesh Pai[3]

Departments of Conservative Dentistry and Endodontics, [1]Orthodontics and Dentofacial Orthopaedics, [2]Oral Pathology and [3]Prosthodontics, Manipal College of Dental Sciences, Mangalore, Manipal Academy of Higher Education, Manipal, Karnataka, India

Abstract

Background: Understanding the optical characteristics, especially the translucency patterns (TPs) in teeth can assist clinicians in creating biomimetic restorations.

Aim: This study assessed the differences in enamel TPs and the area of translucency (AOT) in the most dominant teeth of an individual's smile according to their age and gender.

Materials and Methods: This cross-sectional study was conducted on 140 consented individuals. Based on the age, there were four groups with 35 subjects in each. The digital imaging method is used to classify and differentiate different TPs. The AOT was measured with the assistance of ImageJ 1.51j8 software.

Statistical Analysis Used: One-way ANOVA with a *post hoc* test was used to test the statistical significance difference among the various age groups, and an independent *t*-test was used to test the variations between genders.

Results: The outcome of this study showed that the AOT was the highest for the 50 and above age group as compared to other age groups ($P = 0.003$). Although there were variations in the TPs between the two genders, the AOT showed no significant difference.

Conclusion: The area of incisal third translucency in the upper central incisors varied between different age groups. However, gender had no influence in the area of incisal translucency. Wide variations in the TPs were seen based on age and gender.

Keywords: Age; enamel; esthetics; gender; translucency

INTRODUCTION

Understanding the interaction of light on a tooth is important for dental professionals to create biomimetic restorations.[1] Apart from the three primary components of color (hue, value, and chroma), a factor commonly overlooked in esthetic dentistry is the translucent characteristics of a tooth.[2] Translucency can be described as the relative amount of light transmitted or diffused from a substrate's surface through a turbid medium.[3,4] The incisal third of the teeth is shown to have the highest translucency because of the reduced thickness of dentin toward the incisal edges.

As the most prominent and visible of the incisor teeth, the maxillary central incisors form the foundation of an attractive smile.[5] Thus, the dominance of a smile is predominantly characterized by the esthetic attributes of the maxillary central incisors.[6,7] Therefore, an insight into

Address for correspondence:
Dr. Manuel S. Thomas,
Department of Conservative Dentistry and Endodontics, Manipal College of Dental Sciences, Mangalore, Manipal Academy of Higher Education, Manipal, 576104, Karnataka, India.
E-mail: manuel.st@manipal.edu

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the optical features of the upper central incisor, especially at the incisal aspect, will assist clinicians in recreating a naturally pleasing smile.

Clinical studies have demonstrated varied patterns of incisal translucency. Variations in these patterns were seen based on the age, gender, and race of the subjects studied.[8] There is no known literature assessing the enamel translucency characteristics in an Indian population. Therefore, the current research aims to analyze the translucency characteristics of the incisal one-third of upper central incisors among Indians based on type and area covered among various age and gender groups.

MATERIALS AND METHODS

Study setting and design

This cross-sectional study was conducted among consented patients reporting to a dental hospital. Institutional ethics committee approval was obtained before the study's commencement (IEC No. 19058).

Sample size calculation

Based on the values of derived from the article by Bayindir *et al.*,[8] the sample size arrived in total was 138. The two proportions selected from the above study for calculating the sample size were 8% and 1%. The alpha error and power were set at 5% and 80%, respectively.

Study population and grouping

The primary dataset of intraoral images of 140 subjects was obtained from four groups which were divided based on age:

1. Group I: 8–19 years
2. Group II: 20–29 years
3. Group III: 30–49 years
4. Group IV: 50 and above.

Inclusion criteria and exclusion criteria

Consented subjects with vital permanent maxillary central incisors without caries or restorations were included in the study. Those with missing, decayed, or nonvital maxillary central incisors were excluded from the study. The screening and imaging process certified that participants fulfilled the exclusion and inclusion standards of this study.

Digital image acquisition

All images were intraoral clinical patient images in frontal esthetic view using D7000 SLR digital camera (Nikon Corp) and a wireless close-up Speedlight flash (4804 R1 wireless close-up Speedlight system [Nikon Corp]), equipped with 85-mm lens (AF-S VR Micro-NIKKOR [Nikon Corp]), film speed (200), exposure (1/200 s, f25), flash (ETTL), focusing (1:1), and distance (80 cm).[9]

Subjects were directed to hold their heads up and with the plane of occlusion for their maxillary jaw to be aligned with the floor. Retractors were used for the lips and black contrastors were placed palatally to accentuate the translucent incisal edges.[10]

Assessment of the translucency pattern

The captured images were assessed using ImageJ 1.51j8 software (Wayne Rasband, National Institute of Health, Bethesda, MD, USA), and the pattern of enamel translucency was traced by two calibrated examiners. They were then asked to come to a common consensus and to classify the translucency pattern (TP) according to the classification suggested by Yamato[11] and Bayindir *et al.*[8] [Figure 1]. This classification explains TPs based on three main types, Type A, B, and C.[11] Type A pattern is a tooth having no TP. Type B pattern is a tooth having translucency limited to the incisal portion of the facial aspect of the tooth, which is further divided into seven subdivisions. Type C is divided into eight subdivisions. The Type C pattern is a tooth having translucency involving more than just the incisal portion of the facial aspect of the tooth and involving mesial and distal aspects of the facial side in some subdivisions.

Estimation of the area of translucency

The area percentage was also calculated with ImageJ software.[12] The area of incisal translucency was calculated from the digital photographs captured by the camera using the ImageJ software. The image selected was opened through ImageJ software. Then using the polygon tablet in ImageJ software, the total area of the tooth was measured. Then, the total area of the incisal TP is carved out as shown in Figure 2. Both the marked areas were calculated using the measure command in the analyze tablet. Further calculations regarding the ratio and percentage of translucency were assessed with Microsoft Excel (version 2212, build 15928.20216).

Statistical analysis

The data obtained were tabulated and subjected to statistical analysis using the SPSS 17.0 software program (SPSS Inc., Chicago, IL, USA). ANOVA with a *post hoc*

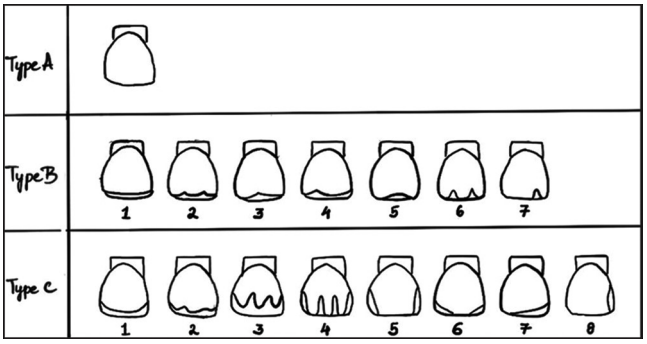

Figure 1: Classification of translucency patterns suggested by Yamato[11]

test and independent *t*-test was used to test the statistical significance difference among the various groups. $P < 0.05$ was considered statistically significant.

RESULTS

Out of the 140 participants, 71 were male and 69 were female. A statistically significant difference did not exist ($P = 0.914$) between males (10.66 ± 9.29) and females (10.8 ± 6.43) on the percentage area of translucency (AOT).

Among the various age groups, the area percentage of teeth translucency was the highest in Group IV (16.07 ± 12.28) followed by Group I (10.01 ± 4.36), Group III (8.99 ± 5.28), and the lowest in Group II (7.84 ± 4.59b). One-way ANOVA test showed a significant difference in the AOT among the groups studied [$P < 0.003$, Table 1]. On *post hoc* analysis using the Tukey test, the difference in the AOT between Group I (8–19 years), Group II (20–29 years) as well as Group III (30–49 years) with Group IV was statistically significant [Table 2].

The most common TP seen was Type C (72.9%), following which was Type B (18.5%) and Type A (7.1%). For subjects ages 8–19 years, Type B1 (34.3%) was the most common TP. The individuals with an age of 50 and above had Type C1 as the most common TP (22.9%), followed by Type A (8.6%). With individuals aged 8–19 years, Type B1 was observed in greater percentage in comparison with the groups studied. Types C6 and C8 were linked with a mean age of >50 years [Figure 3]. The interrelation between gender and incisal translucency was significant for females having Type B1 (20.3%), whereas Type C3 and C4 are significantly seen in males. However, the Type C1 and C2 showed a similar pattern for both males and females [Figure 4].

DISCUSSION

For a restoration to be biomimetic, not only the shape and color should match, but also the natural dentition ancillary characteristics such as translucency, opacity, and fluorescence of natural teeth should be replicated.[2] An idea about the various optical characteristics will provide clinically relevant information for clinicians while considering smile designing.[13] Since maxillary central incisors are known to be the most dominant teeth when individuals smile, and also, since they are convenient for carrying out various measurements, these teeth were considered for the present study.[7,14]

The translucency characteristics of teeth are said to vary based on age, gender as well as ethnicity.[15] Previous

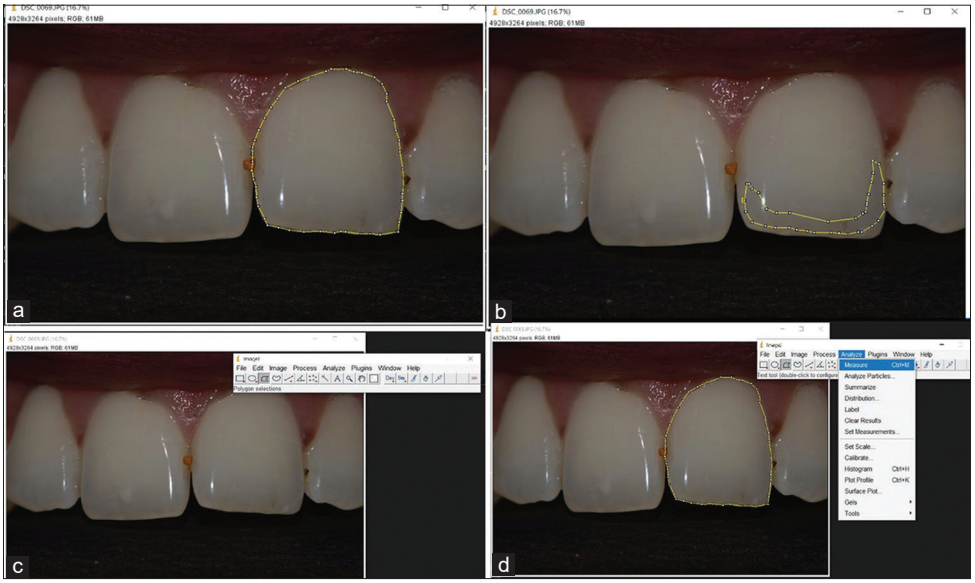

Figure 2: Steps to mark and measure the area of the tooth using ImageJ software (a) Total area of tooth marked; (b) Translucent part of the tooth marked; (c) Tools tab opened in ImageJ software; (d) Total area percentage measured

Table 1: Comparison of the percentage area of translucency in the central incisor among various age groups

Group	Age group	*n*	Mean±SD	Statistics/mean squares	Df2 (welch)/*F* (ANOVA)	*P*
I	8–19	35	10.01±4.36	4.98	73.51	0.003
II	20–29	35	7.84±4.59			
III	30–49	35	8.10±5.28			
IV	≤50	35	16.07±12.28			
Total		140	10.73±7.98			

SD: Standard deviation

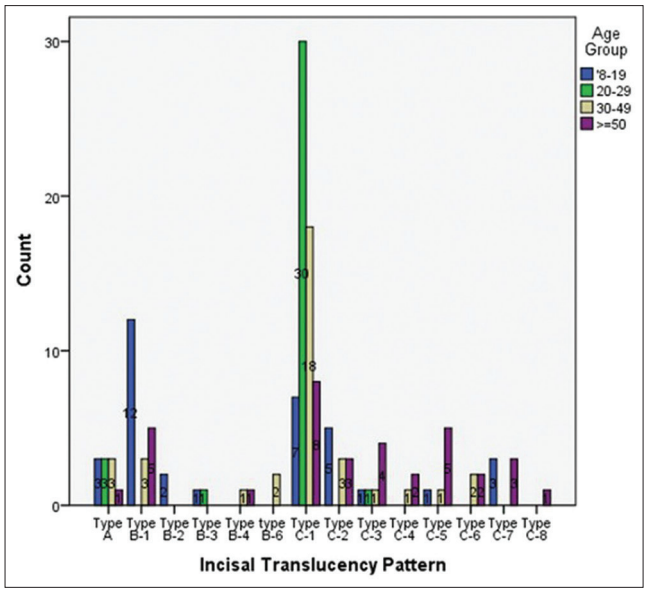

Figure 3: Incisal translucency patterns seen among various age groups (For subjects aged 8–19, Type B1 [34.3%] was the most common translucency pattern. The individuals with age of 50 and above, Type C1 [22.9%] was the common translucency pattern, followed by Type A [8.6%])

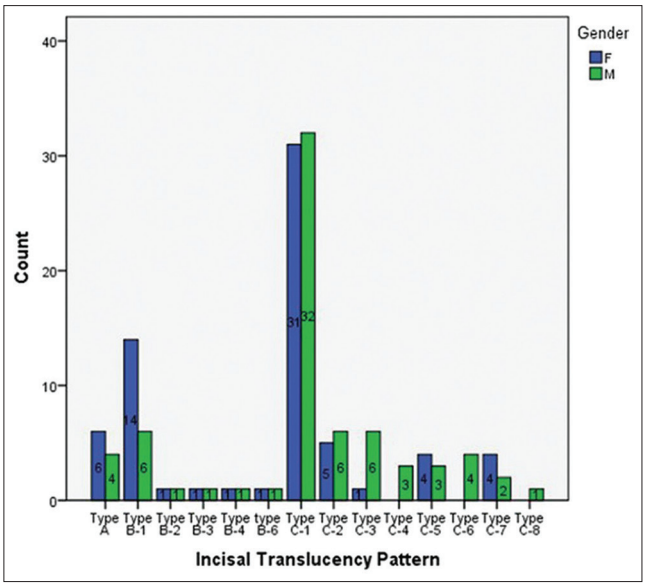

Figure 4: Translucency patterns observed in males and females (The most prevalent pattern was Type C1. Females had more of Type B1 [20.3%], whereas Type C3 was seen more in males)

Table 2: Intergroup comparison of the percentage area of translucency

Dependent variable	Comparison group	Compared with	Mean difference	*P*
Percentage AOT	8–19	20–29	2.17	0.611
		30–49	1.02	0.939
		≥50	−6.06	0.004*
	20–29	30–49	−1.15	0.915
		≥50	−8.23	<0.001*
	30–49	≥50	−7.08	0.001*

*Statistically significant. AOT: Area of translucency

studies on enamel translucency parameters were checked in white, Black, and Asians and not specific to the Indian population.[3,8,15] Hence, to comprehend the differences and similarities in the TPs between other ethnicities and the Indian population, this study was started, making it the first in the Indian population.

It is possible to measure the degree of translucency of the teeth visually and digitally using color-matching procedures. Digital color analyzers, spectrophotometers, and colorimeters are all examples of digital methods.[3,16,17] The visual method is easier and does not require expensive equipment or expertise to interpret, but this method can be marred by intra- and inter-observer bias.[3,17] In the current study, to reduce the bias, the digital camera settings and lighting parameters were kept uniform for all patients. Two calibrated examiners were asked to trace the translucency in the digital images of the teeth independently. They were then asked to reach a common consensus at the end of each image. The TPs were categorized in this study based on the literature by Yamato[11] and Bayindir *et al*.[8] Apart from the pattern of translucency, the present study also studied the AOT using Image J software. ImageJ software was used as it allows us to zoom in and precisely mark exact areas of translucency. Using its tools, the contrast of the images was adjusted to identify the type of TP and calculate the AOT.

In the present study, the area of incisal translucency was shown to be the highest in the older age group (>50 years). This is contrary to the previous studies by Wee *et al*.[15] and Bayindir *et al*.[8] The probable reason could be the variation in the study methodology as well as the characteristics of the population studied.[3] The reason suggested by the above studies for the decrease in translucency with an increase in age is the changes in enamel calcification and the increased visibility of underlying opaque dentin, with age.[3,15] Interestingly, the study by Xia and Xiong[14] demonstrated an increase in translucency in the elderly population. This was attributed to the reduction in incisal edge dentin thickness due to occlusal wear as well as the tendency of dentin to increase in translucency with age.[18]

Apart from the percentage AOT, the various patterns of incisal edge translucency were also studied in the current study. The TPs of the natural dentition showed variations based on age, gender as well as race.[8] These changes in patterns can be attributed to variations in the thickness of enamel and dentin, differences in hydroxyapatite crystallization, staining, and variable refractive indices.[8] The TP classification used for the present study was the one suggested by Yamato.[11] As per this classification, in the

Type A pattern tooth has no translucency, and this is said to be seen when enamel at the incisal edge is completely attritted. The Type B pattern is seen when the translucency is seen only at the incisal edge. This could be due to the reduced thickness of the tooth structure in this region. Type C is when translucency extends to the proximal surface. This can be associated with tooth wear and is seen more frequently as one age. Increasing translucency in the proximal region can be attributed to the thinning of the tooth structure palatally.[8,18]

In this study, Type C1, which involves the incisal third and the mesial and distal aspect of the labial portion, was the most common pattern seen across the different age groups. The greatest tendency for this pattern was seen in 20–29 years of age group. This was followed by Type B1 which involves only the incisal one-third and it was most prevalent in the 8–19 years of age group; whereas Type C8 which involves only the distal aspect of the labial portion was the least observed in the studied population. Type A and Type B were inconsequentially detected, and these findings are similar to the study by Bayindir *et al*.[8] The above-mentioned study was conducted on different ethnicities and also demonstrated a higher prevalence of Type C in the age group of 18–29 years and also for the population group with age more than 50 years, as in the present study. In addition, the above study also showed that Type C1 is the most common pattern among the Southeast Asian population.[8] The TP is evident for the age group of 8–19 years and above 50 years, as the younger population showed smooth surfaces with light reflecting through glossy surfaces through thinner anatomical structures. On the other hand, in the geriatric population, tooth wear is noted with an increase in age which is an influential factor for higher incidence of translucency.[14] Furthermore, in older people, the dentin is characterized by the continuous constriction of the lumen of the dentinal tubule, increase in the calcification, decreased sensitivity and thus making dentin more transparent.[19,20]

Type C1 TP was common for both genders and Types C2 and C3 were more prevalent in males whereas Type B1 was commonly found in females. While in the study of Bayindir *et al.*,[8] the most frequent TPs for females were Type C2 (30%), followed by Type C5 (14.5%), and Type C6 (13.4%). In males, the common TP was Type C2 (22.2%), followed by Types C6 and C8 (13.3%), and Type C5 (11.6%). Another point to be noted was that gender had no influence on the AOT in the current study. This is contrary to the results by Xia and Xiong[14] where gender had a significant effect on the translucency of maxillary central incisors. According to the above study, females had higher mean translucency than males. These variations could be attributed to the difference in the population studied and the method employed to determine the TP.

This study is the first to evaluate the various patterns and amount of translucency in an Indian population. Although the subjects acquired are not sufficient to draw a generalized conclusion, this study could be a precursor for further studies. This could assist dental ceramists and esthetic dentists in creating life-like restorations depending on the patient's age and gender. Apart from the visual method of determination of translucency, the use of digital devices would have given more insight into the translucency parameters of the teeth. Therefore, further investigations using digital devices can be considered for better understanding of the factors influencing tooth translucency.

CONCLUSION

Based on the findings of this clinical study, the following interpretations were observed:

- Contrary to expectations, the AOT was seen more in older individuals
- There was no difference in the AOT between males and females
- The most common TP was Type C1 in all age groups
- Patients aged 8–19 years and females were more likely to have type B1 TP.

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Conflicts of interest

There are no conflicts of interest.

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