Nepalese Esthetic Dental (NED) Proportion in Nepalese Population

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ABSTRACT

Background

Lots of studies on maxillary anterior teeth proportions have been studied in different populations in various countries, but no studies have been conducted in Nepal on the esthetic maxillary anterior teeth proportions.

Objective

The study was done to investigate the maxillary anterior teeth proportions in a Nepalese population. Teeth proportions in the total population were compared with golden proportion (GP) and golden standard (GS).

Method

A total of 150 Nepalese subjects were divided in three facial types; broad, average and narrow group. Maxillary anterior teeth were measured from dental casts using digital calipers. The perceived width ratios of lateral to central incisor (LI/CI) and canine to lateral incisor (CN/LI), ratios of mean central incisor length to 2 central incisor widths (CIL/2CIW), and actual width to length ratios (WLRs) (%) were calculated in each facial type and compared. Mean LI/CI, CN/LI and CIL/2CIW in total population were calculated and compared with GP (0.618), and mean WLRs in the total population were compared with GS (80%). All teeth proportions were compared among three facial types. One-sample t-test and one-way ANOVA were performed to analyze the data ($\alpha = 0.05$).

Result

The LI/CI, CN/LI, CIL/2CIW and WLRs in three facial types showed no significant difference. The LI/CI, CN/LI and CIL/2CIW in the total population were 66%, 70% and 55% respectively, and were significantly different from GP. The WLRs for CI, LI and CN in the total population were 90%, 86% and 89% respectively and significantly differed from GS. These values were considered to constitute the Nepalese Esthetic Dental (NED) proportion.

Conclusion

No significant difference of maxillary anterior teeth proportions were observed among three facial types. Teeth proportions in the total population significantly differed from GP and GS. We propose the NED proportion as a guideline for dental treatment in the maxillary anterior region in Nepalese populations.

KEY WORDS

Anterior tooth, esthetics, golden proportion, golden standard, Nepalese population, teeth proportion.

INTRODUCTION

Prosthetic and restorative treatment in anterior teeth should be performed to maximize the esthetic outcome. The maxillary anterior teeth size, shape and proportion play an essential role in accomplishing pleasing dental, facial esthetics and satisfaction.[1,2] Various methods for teeth size determination for restoring and replacing maxillary anterior teeth includes previous photographs, facial measurements, facial types, and ideal teeth proportions including golden proportion (GP) and golden standard (GS) of teeth.[2-11]

Human faces can be classified as broad, average and narrow according to the facial index, which is the ratio of naso-menton length (NML) and bizygomatic width (BZW).[12,13] Facial type of each patient plays an important role in prosthetic dentistry in artificial teeth selection. Ward and Berry mentioned that facial types may help in teeth selection.[14,15] Hence, the shape of face may be used as a guide for teeth selection in maxillary anterior region.

Another method for teeth size determination is using GP. The term GP was given by Euclid of Alexandria and it is equal to 1.618 (the ratio of larger to smaller).[16] GP can be seen in nature and human body.[17] In dentistry, it is used in the anterior teeth esthetics.[6,7,10,18] Lombardi first proposed the application of the GP in dentistry in 1973.[18] According to Leven,[6,7] GP can be found in the perceived width ratios of LI/CI, CN/LI and the ratio of mean central incisor length to 2 central incisor widths (CIL/2CIW). However, GP was not seen in the maxillary anterior teeth by many authors.[1,10,19-31] In addition, Wolfart et al. mentioned that a golden standard (GS) of 80% was ideal for the width to length ratio (WLR) of maxillary central incisor.[8] In many studies, GS of 80% in WLRs of maxillary anterior teeth was not found, instead, the WLRs of maxillary anterior teeth were found to be 66-85%.[19-21]

METHODS

A total of 150 Nepalese medical students (52 males and 98 females) participated in this cross-sectional study using the criteria: (1) subject is Nepalese by birth, (2) age of the participants: 16-35 years, both male and female, (3) no gross asymmetry of the face, (4) no gingival or periodontal disease, (5) less than 0.5 mm spacing between anterior teeth, (6) minimal crowding as defined by the Little Irregularity Index (LII)32 (1 to 3 mm of the linear displacement of the anterior tooth at five anterior contact points), (7) no intruded or extruded anterior teeth, (8) no anterior open bite, (9) no apparent loss of tooth structure due to attrition, fracture, or caries and (10) no anterior restoration. Study protocol and ethics were approved by the Institutional Review Committee of Kathmandu University School of Medical Science. All participants were requested to sign an informed consent document before participating.

Figure 1. Measurement of naso-menton length (NML) of the face.

Figure 2. Measurement of bizygomatic width (BZW) of the face width.

For each participant, NML and BZW were measured using digital calipers (Model CD-6", Mitutoyo Co., Kanagawa, Japan) as shown in Fig. 1, Fig. 2. Then facial index (NMH/BZW) was calculated in percentage and facial type was classified as broad, average or narrow. Impressions of the maxillary arch were taken from each participant with irreversible hydrocolloid (Jeltrate, Dentsply, PA, USA) using stock tray (Impression Trays, Dentaurum, Germany) and dental cast was made with dental stone type IV (Vel-Mix stone, Kerr Co., CA, USA) manipulated according to the manufacturer instructions. The perceived width of each anterior tooth was measured according to the method described by Al-Marzok et al. Each maxillary cast was placed on a plain paper,[20] mesial and distal border lines were marked and lines were drawn on the paper (Fig. 3a). Then perceived width was measured as the distances between these lines using digital calipers (Fig. 3b). The mean LI/CI, CN/LI and CIL/2CIW in each facial type were calculated and compared among three types. The mean LI/CI, CN/LI and CIL/2CIW in total studied population were compared with GP (0.618). Actual width of each anterior tooth was measured as the maximum mesio-distal distance and actual length was measured as the longest distance from the cervical margin to the incisal edge on the dental cast (Fig. 3c, Fig. 3d). Mean WLRs of each anterior tooth
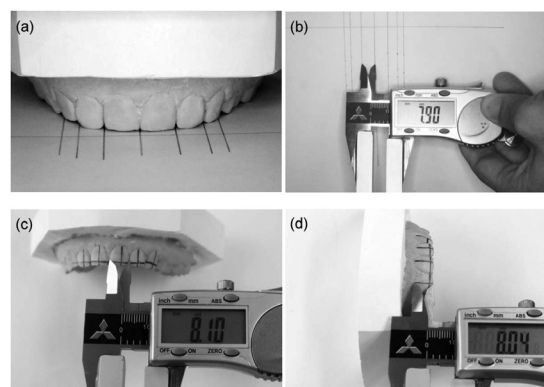

Figure 3. Measurement of the perceived widths and actual lengths of the maxillary anterior teeth. Measuring perceived teeth widths (a): drawing the mesial and distal lines of each anterior tooth after placing the cast on a plain paper, and (b) measuring the perceived widths. Measuring actual teeth measurements (c): measuring the actual widths, and (d): measuring the actual length.

was calculated and compared among three facial types. Mean WLRs in the total studied population were compared with GS (80%).

All measurements were made by one investigator. Each measurement was measured three times and the mean value was calculated. Statistical analyses were conducted using Statistical PASW® Statistics 18.0 (SPSS, Chicago, IL, USA) with the level of significance (α) = 0.05. One-way ANOVA (post-hoc: Gabriel) was used to compare the teeth proportions among three facial types and one-sample t-test was used to compare the teeth proportions of the total studied population with GP and GS. To test the validity of the present study, one week after the completion of study, 10% of the total participants (15 participants) were selected according to their availability. All measurements were repeated and measurement errors were calculated using Dalhberg's Formula. Power test was used to calculate the power of our study. Power test above 80% was considered to be an appropriate power.

RESULTS

Different facial types obtained from the participants comprised 11 broad faces, 35 average faces and 104 narrow faces. The narrow facial type was predominant in this study.

Table 1. Mean LI/CI, CN/LI, CIL/2CIW and WLRs of maxillary anterior teeth, and their multiple comparisons with GP and GS in the total studied Nepalese population

Teeth proportions	Min	Max	Mean ± SD	p-value	
				Comparison with GP	Comparison with GS
LI/CI	0.54	0.81	0.66 ± 0.60	<.001	-
CN/LI	0.53	0.85	0.70 ± 0.06	<.001	-
CIL/2CIW	0.47	0.54	0.55 ± 0.4	<.001	-
CI WLRs (%)	77.30	99.33	90.36 ± 5.27	-	<.001
LI WLRs (%)	68.15	102.37	86.01 ± 7.71	-	<.001
CN WLRs (%)	70.45	103.83	88.61 ± 7.35	-	<.001

p-values <0.05, indicates statistically significant differences. Min: Minimum; Max: Maximum; SD: standard deviation; GP: Golden proportion (0.618); GS: Golden Standard (80%); LI/CI: perceived width ratios of lateral incisor to central incisor; CN/LI: perceived width ratios of canine to lateral incisor; CIL/2CIW: ratios of mean central incisor length to 2 central incisor widths; CI: central incisor; LI: lateral incisor; CN: canine; WLRs: width to length ratios.

Table 1 shows the mean LI/CI, CN/LI, CIL/2CIW and WLRs of maxillary anterior teeth in the total studied Nepalese population. The mean width ratios were 0.66 for LI/CI and 0.70 for CN/LI. One-sample t-test showed that LI/CI and CN/LI significantly differed from GP (0.618) (p < 0.001). The mean CIL/2CIW ratio was 0.55. It showed that CIL/2CIW significantly differed from GP (p < 0.001).The mean WLRs

were found to be 90.36% for central incisors, 86.01% for lateral incisors and 88.61% for canines. The mean WLRs of all teeth significantly differed from GS (80%) (p < 0.001).

Table 2. Mean LI/CI, CN/LI, CIL/2CIW, WLRs and their multiple comparisons among three facial types

Teeth proportions	Broad (n=11)	Average (n=35)	Narrow (n=104)	p-value		
	Mean ± SD	Mean ± SD	Mean ± SD	Broad vs. Average	Average vs. Narrow	Broad vs. Narrow
LI/CI	0.66 ± 0.06	0.66 ± 0.05	0.67 ± 0.06	1.00	0.93	0.98
CN/LI	0.70 ± 0.05	0.71 ± 0.05	0.69 ± 0.06	0.88	0.37	0.99
CIL/2CIW	0.55 ± 0.03	0.55 ± 0.04	0.55 ± 0.04	0.98	0.97	0.99
CI WLRs (%)	90.36 ± 5.76	89.36 ± 5.23	90.29 ± 5.26	0.92	0.72	1.00
LI WLRs (%)	86.01 ± 8.96	85.41 ± 6.65	87.24 ± 7.92	0.99	0.50	0.92
CN WLRs (%)	88.61 ± 8.16	88.28 ± 8.12	89.14 ± 7.05	0.99	0.90	0.99

N: population in each group; SD: standard deviation; LI/CI: perceived width ratios of lateral incisor to central incisor; CN/LI: perceived width ratios of canine to lateral incisor; CIL/2CIW: ratios of mean central incisor length to 2 central incisor widths; CI: central incisor; LI: lateral incisor; CN: canine; WLRs: width to length ratios.

Table 2 shows the mean LI/CI, CN/LI, CIL/2CIW and WLRs of three facial types and their multiple comparisons among three groups. The mean LI/CI in broad, average and narrow types were 0.66, 0.66 and 0.67, respectively and the mean CN/LI in broad, average and narrow types were 0.70, 0.71 and 0.69, respectively. The mean CIL/2CIW was 0.55 in each group. The mean WLRs in broad, average and narrow facial types were 90.36%, 89.36% and 90.29% for central incisors; 86.01%, 85.41% and 87.24% for lateral incisors and 88.61%, 88.28% and 89.14% for canines, respectively. No significant difference was revealed for LI/CI, CN/LI, CIL/2CIW and WLRs among the three facial types. In this study, Dalhberg's formula showed the error ranged from 0.12 to 0.67, within an acceptable range. The power of the test was 98%, implying that the sample size of 150 was adequate for this study.

DISCUSSION

The facial measurements used for the selection of maxillary anterior teeth include bizygomatic width, interpupillary distance, intercanthal distance, mouth width and nose width.[2-5] However, Zlatarić et al. suggested that the use of facial measurements for artificial denture teeth selection was generally inaccurate and suggested that the teeth should be selected according to the patient's appearance maintaining both dental and overall facial esthetics.[11] Facial types also play an important role in the selection of artificial teeth as suggested by some authors.[14,15] They expected that size and shape of anterior teeth in each facial type might differ. Hence, we aimed to compare the

teeth proportions among three facial types. We believe that the Nepalese students who participated in this study represented the Nepalese population as they were from different parts of the country. For the classification of facial types, the facial index was used as in other studies where direct facial measurement of the face were made.[12,13,33,34] The predominant facial type in this study was narrow followed by average and broad face. This finding was in agreement with a study conducted among an Iraqi population (among 100 undergraduate students) showing that 80% had narrow faces, 16% had average faces and 4% had broad faces.[33] A study conducted in a Bangladeshi population (140 undergraduate dental students) showed that narrow faces comprised the most common face in their population (56%) followed by average faces (44%).[34] However, in their study, broad face was not found. This all may indicate that narrow face might be the most common facial type in the Asian population. In this present study, teeth proportions (LI/CI, CN/LI, CIL/2CIW and WLRs) among three facial types showed no significant differences (p > 0.3). Therefore, it showed that facial type might not be an important factor for the selection of artificial teeth in the Nepalese population. Maxillary anterior teeth of one size may be used in any facial type.

Lombardi defined the idea of a repeated ratio,[18] implying that in an optimized dentofacial composition from the frontal aspect. In addition, he commented that GP has been proved too strong for dental use. Leven presented that a relationship exists between the beauty in nature and mathematics,[6,7] and implemented GP in dentistry for the perceived width ratios of maxillary anterior teeth (LI/CI and CN/LI). In other words, according to Leven,[6,7] the perceived width of the lateral incisor is 62% of the central incisor and perceived width of the canine is 62% of the lateral incisor. However, the results from our study showed that neither GP was seen for the LI/CI, CN/LI, CIL/2CIW nor GS was observed for the WLRs of maxillary anterior teeth in the total population. These results are in accordance with the other studies in different populations: Turkish, German, North American, Croatian, Jordanian, Iranian, Indian, Brazilian, Malaysian, Hungarian, Londoners, Portuguese, Irish and Korean.[8-10,14,18-31] Hence, GP and GS may not be a proper guideline for anterior teeth selection in esthetic treatment.

Chu studied the tooth width of the maxillary anterior teeth among North Americans and suggested the ideal WLRs of the six maxillary anterior teeth to be 78%.[25] Brisman proposed that the optimal WLRs for maxillary anterior teeth should be 75%.[26] Petricevic et al. studied the WLRs of maxillary anterior teeth in a Croatian population and found that WLRs for central incisors,[9] lateral incisors and canines were 90%, 82%, and 84%, respectively. They reported that these ratios significantly differed from 75% and GS. Another study by Tsukiyama et al. compared the WLRs ratios of maxillary anterior teeth among 157 Asians and 142 Caucasians.[35] The WLRs ratios of all maxillary anterior

teeth significantly differed between Asians and Caucasians. They concluded that ethnicity influences WLRs for all maxillary anterior teeth. Maxillary anterior teeth among Asians appear to be more slender compared with those among Caucasians. Hence, no universal WLRs for maxillary anterior teeth was found and WLRs for different population were found to differ.

Table 3. Formula proposed by Preston[10] to calculate maxillary anterior teeth width and application in Nepalese population

Anterior teeth width	Formula given by Preston[10]	Maxillary anterior teeth width calculation	
		In North Americans (Using Preston proportion[10])	In Nepalese (Using NED proportion)
CIW	$\dfrac{ICW}{2[1+ LI/CI + (LI/CI \times CN/LI)]}$	$\dfrac{ICW}{2[1+ 0.66 + (0.66 \times 0.84)]}$	$\dfrac{ICW}{2[1+ 0.66 + (0.66 \times 0.70)]}$
LIW	CIW × LI/CI	CIW × 0.66	CIW × 0.66
CNW	LIW × CN/LI	LIW × 0.84	LIW × 0.70

NED: Nepalese Esthetic Dental; CIW: central incisor width; LIW: lateral incisor width; CNW: canine width; ICW: intercanine width of six maxillary teeth; CIL: central incisor length; LIL: lateral incisor length; CNL: canine length; CI: central incisor; LI: lateral incisor; CN: canine.

Among North Americans, various teeth proportions have been proposed for the restoration of anterior teeth.[10,14] A study by Preston of 58 computer generated images of dental casts of a North American population found that only 17% of the lateral incisors were in GP with the central incisors.[10] He suggested that the optimal LI/CI should be 66% instead of 62% and CN/LI should be 84%. Thus, he proposed these values as the Preston Proportion. Ward suggested that the ratio between two adjacent teeth should remain constant as progressing distally when observed in a frontal view.[14] He found that when the 62% was used, the lateral incisor appeared too narrow and the resulting canine was not prevalent enough. Therefore, he proposed the Recurrent Esthetic Dental (RED) proportion ranging from 60% to 80%. He preferred using the 70% proportion for LI/CI and CN/LI. In addition, Preston proposed the formula for maxillary anterior teeth width calculation in North Americans using the Preston proportion (Table 3).[10] Similarly, Ward also proposed the formula for maxillary anterior teeth length calculation in North Americans using the RED proportion (Table 4).[14] Another study by Calcada et al. in a Portuguese population (50 dental patients) found that the proportions between the widths of the maxillary anterior teeth exhibited the Preston proportion of 66% rather than the GP and the RED proportions.[30] A study by Murthy and Ramani in an Indian population evaluated the existence of GP and RED proportion in natural dentition discovering that GP and RED proportions were not seen in natural dentition.[24]

Regarding teeth proportion in the total Nepalese population, a combination of the Preston and RED proportions was found in our study. The mean LI/CI in the total population was 66%, similar to the Preston proportion, while the mean CN/LI was 70%, similar to the 70% RED proportion.[10,14] The CIL/2CIW in total studied population

Table 4. Formula proposed by Ward[14] to calculate maxillary anterior teeth length and application in Nepalese population

Anterior teeth length	Formula given by Ward[14]	Maxillary anterior teeth length calculation		
		In North Americans (Using RED proportion[14])	In Nepalese (Using NED proportion)
CIL	$\frac{CIW}{CI\ WLRs}$	$\frac{CIW}{0.70}$	$\frac{CIW}{0.90}$
LIL	$\frac{LIW}{LI\ WLRs}$	$\frac{LIW}{0.70}$	$\frac{LIW}{0.86}$
CNL	$\frac{CNW}{CN\ WLRs}$	$\frac{CNW}{0.70}$	$\frac{CNW}{0.89}$

NED: Nepalese Esthetic Dental; CIW: central incisor width; LIW: lateral incisor width; CNW: canine width; ICW: intercanine width of six maxillary teeth; CIL: central incisor length; LIL: lateral incisor length; CNL: canine length; CI: central incisor; LI: lateral incisor; CN: canine; WLRs: width to length ratios.
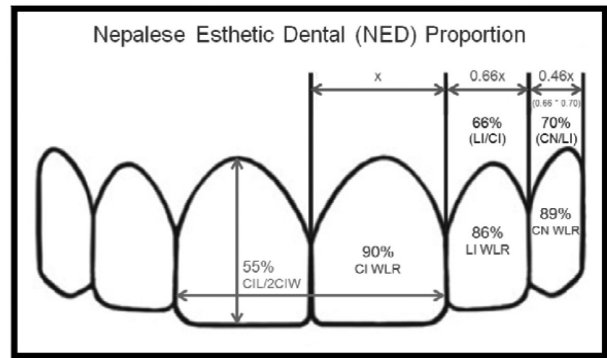

Figure 4. Teeth proportions in total population and the Nepalese Esthetic Dental (NED) proportion. LI/CI, perceived width ratios of lateral incisor to central incisor; CN/LI, perceived width ratios of canine to lateral incisor; CIL/2CIW, ratios of mean central incisor length to 2 central incisor widths; CI, central incisor; LI, lateral incisor; CN, canine; WLR, width to length ratio.

was 55%.The WLRs in total studied population were found about 90% for central incisors, 86% for lateral incisors and 89% for canines. Therefore, we propose these values as the Nepalese Esthetic Dental (NED) proportion and it might be used for maxillary anterior teeth size estimation in Nepalese. For teeth width calculation, if the width of the CI is x, then the width of the LI should be 66% of x, which is 0.66x, and the width of CN should be 70% of 0.66x, which is 0.46x (Fig. 4). Furthermore, teeth width and length in Nepalese patients can be calculated by the formulae given by Preston10 and Ward14 using NED proportion obtained from this study (Tables 3, 4). This can be used in edentulous, partial edentulous and dentulous patients with loss of tooth structure (attrition, abrasion, erosion or trauma) in maxillary anterior region. In addition, teeth size calculation using the NED proportion might be helpful not only in clinical practice but also in the manufacture of artificial teeth moulds.

CONCLUSION

No significant differences were found in teeth proportions of maxillary anterior teeth among three facial types. Teeth proportions in the total studied population significantly differed from GP and GS. Hence, GP and GS may not be applicable for maxillary anterior teeth proportions in the Nepalese population. In the total studied population, the mean LI/CI was 66%, the mean CN/LI was 70% and the mean CIL/2CIW was 0.55. The WLRs were found to be 90% for central incisors, 86% for lateral incisors and 89% for canines. We propose these values as the Nepalese Esthetic Dental (NED) proportion which may serve as a guideline for treatment planning, restorative dental treatment and esthetic smile design in the maxillary anterior region in the Nepalese population.

ACKNOWLEDGEMENT

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