Original Research Article

Correlation between cephalic index and facial index in skeletal malocclusions – An analytical cross-sectional study

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ABSTRACT

Aim: The study aimed to assess the correlation between Cephalic Index and Facial Index in patients with skeletal malocclusions reporting to the Department of Orthodontics and Dentofacial Orthopedics in a private Dental College in Kerala.

Materials and Methods: A study was conducted using analytical cross-sectional study design, on patients numbering 120 (40 Class I, 40 Class II & 40 Class III) between ages 18 to 30 years. Statistical analysis was carried out with SPSS version 22.0 (SPSS Inc., Chicago, IL). The data was assessed using the Shapiro-Wilk test for normality. Inferential statistics to find the difference between the Cephalic and Facial Indices was done using the independent t-test and Chi-square test for proportion analysis. Correlation coefficient between the Facial and Cephalic indices was assessed using Pearson Correlation Coefficient.

Results: A weak negative correlation existed between the Cephalic Index and Facial Index in different skeletal malocclusions - (-0.28) in Class I, (-0.15) in Class II and (-0.08) in Class III malocclusion.

Conclusion: The present study observed that cranial morphology exerted a weak morphologic influence on the facial type as indicated by the weak negative correlation between the Cephalic Index and Facial Index in the different antero-posterior malocclusions.

1. Introduction

The assessment of facial form and cranial morphology are very important in planning orthodontic treatment and its prognosis. Retzius G[1] in 1840 gave the first classification based on cranial morphology. When used in living individuals, these craniofacial measures are referred to as Cephalic Index, whereas Cranial Index is used when referring to dry skulls. Ricketts[2] in 1964 introduced the terms dolichofacial, brachyfacial and mesofacial. According to Ricketts,[2] mesofacial describes patients with Class I malocclusion having a pleasant soft tissue profile, an average facial pattern and a normal maxillo-mandibular relationship. A horizontal growth pattern usually associated with Class II Division 2 malocclusion is referred to as brachyfacial type. Dolichofacial type which is associated with Class II Division 1 malocclusion, usually presents with a vertical growth pattern. The term Facial Index is used to represent facial proportions[3] The Facial Index was determined by dividing the Nasion-Menton length by the interzygomatic width.

The null hypothesis stated that there was no correlation between cephalic and facial indices in the different skeletal antero-posterior malocclusions. The following article investigated the possible influence of the cranial morphology on the facial type in patients with skeletal

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malocclusions.

2. Materials and Methods

This analytical cross-sectional study was approved by the Institutional Ethical Committee (IEC/MES/66/2019 dated 20/11/19) and followed the criteria in the 2013 Declaration of Helsinki. The study sample was selected after fulfilling the requirements for inclusion and exclusion criteria. A written informed consent was obtained before the photographs of the patients were taken as a part of the study.
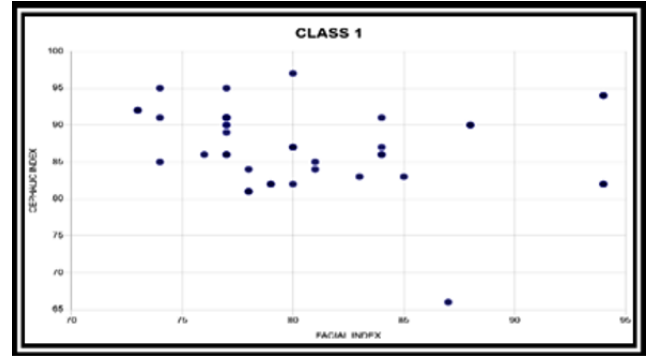
Patients between ages 18 – 30 years, with intact molar and canine relationship in the maxillary and mandibular dentition and having different antero-posterior skeletal malocclusions, and their corresponding dental malocclusion were included in the study (Figure 1). Patients with any cranial and dental anomalies, prior orthodontic therapy, history of trauma in the cephalic and facial region were excluded from the study.

Figure 1: Measurement of headform (A) and face form (B) with standard spreading caliper

Figure 2: Categorization of antero - posterior malocclusion

Graph 1: Correlation between the cephalic index and facial index in Class I patients (-0.28).
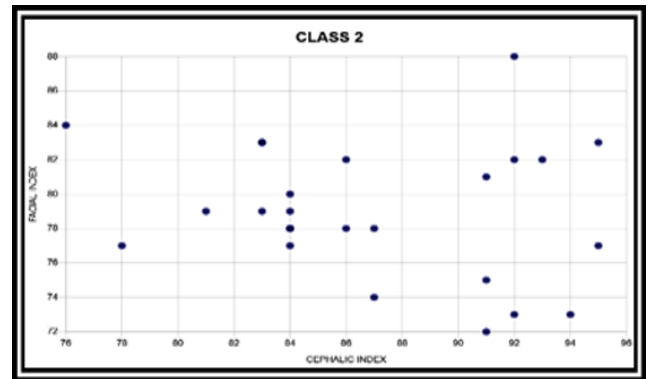
Graph 2: Correlation between the cephalic index and facial index in Class II patients (-0.15).

Graph 3: Correlation between cephalic index and facial index in Class III patients (-0.08).

Table 1: Martin and Saller's classification for Cephalic index and Facial index
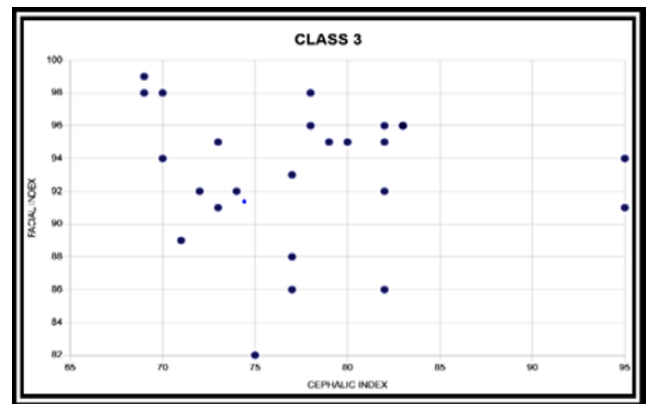
Head type	Cephalic Index	Calculation
Hyperdolichocephalic	65.0-69.9	The Cephalic Index (CI) was calculated with the formula:[4]
Dolichocephalic	70.0 – 74.9	
Mesocephalic	75.0 – 79.9	
Brachycephalic	80.0 – 84.9	CI = Maximum head width (Eu') – (Eu')x 100/ Maximum head length (G -Op)
Hyperbrachycephalic	85.0 – 89.9	
Ultrabrachycephalic	≥ 90.0	
Face type	Facial index	Calculation
Hypereuryprosopic	≤ 79.9	The Facial Index (FI) was calculated by the formula:[4]
Euryprosopic	80.0 – 84.9	
Mesoprosopic	85.0 – 89.9	
Leptoprosopic	90.0 – 94.9	$FI = \dfrac{Facial\ height\ N - Me \times 100}{Bizygomatic\ face\ width}$
Hyperleptoprosopic	≥ 95.0	

Table 2: Distribution of cephalic index and facial index in different antero-posterior malocclusion

Parameter	Class I		Class II		Class III	
	(%)		(%)		(%)	
Cephalic index		Number		Number		Number
Hyperdolichocephalic	7.5	3	2.5	1	5	2
Dolichocephalic	12.5	5	5	2	32.5	13
Mesocephalic	55	22	57.5	23	42.5	17
Brachycephalic	20	8	32.5	13	17.5	7
Ultrabrachycephalic	5	2	2.5	1	2.5	1
Facial Index						
Hypereuryprosopic	0	0	0	0	0	0
Euryprosopic	7.5	3	5	2	7.5	3
Mesoprosopic	50	20	57	23	7.5	3
Leptoprosopic	22.5	9	27.5	11	27.5	11
Hyperleptoprosopic	20	8	10	4	57.5	23

Table 3: Comparison between different antero-posterior malocclusion

Groups	Class I	Class II	Class III
Cephalic Index	80.77 ± 5.91	79 ± 3.89	77.84 ± 5.57
Facial Index	87.17 ± 5.57	87.04 ± 5.27	93.08 ± 4.26
T Value	5.01	7.85	13.92
P value	0.0001*	0.0001*	0.0001*

*P<0.05 is statistically significant (Independent t-test)

Table 4: Correlation between the cephalic index and facial index in different antero-posterior malocclusions

Groups	Class 1	Class II	Class III
Cephalic Index Facial Index	-0.28(P=0.08)	-0.15(P=0.35)	-0.08(P=0.62)

*P<0.05 is statistically significant (Pearson Correlation Coefficient)

2.1. Study sample

The sample size was calculated in the present study using a two-sided test to detect correlation r (Estimated correlation coefficient r= 0.637), α= 0.05, β= 0.1, the calculated sample size was n > 22; the sample size taken was 40 in each group.

120 patients were selected for the study who were split into three groups, each group containing 40 patients. Each group had patients with their corresponding sagittal skeletal and dental malocclusion. All the participants were examined in the dental chair with head kept oriented to the Frankfort-horizontal plane. The patients were classified into different sagittal malocclusions based on Clinical and Cephalometric assessment as shown in Figure 2.

3. Evaluation of Cephalic and Facial Index

1. *Cephalic index:* The Cephalic Index refers to a ratio between the width of head and length of head.[4] In the present study, a standard spreading caliper was used for taking the measurements of head width and length (Figure 1) for the estimation of Cephalic Index. The Cephalic Index was measured using the landmarks[4] Eurion (Eu′), Opisthocranion (Op), Glabella (G′).

2. *Facial index:* The ratio between the facial height to the bizygomatic facial width describes the facial index.[4] In this study, a standard spreading caliper (Figure 1) was used to measure facial height and facial width. The different landmarks used for the measurement of the Facial Index were Nasion (N′), Menton (Me′), Zygion (Zy′).

The participants in this study were categorized according to Martin and Saller's classification for Cephalic and Facial index (Table 1). All linear measurements were recorded in millimeters to 0.10" accuracy. To control any measurement error, all measurements were taken twice and if there was a discrepancy, a third reading was taken.

4. Results

The study consisted of 120 participants, with 57 male patients and 63 female participants. Males contributed to 47.5% and females contributed to 52.5% of the total study population. The statistical analyses were done by using the SPSS (Version 22-SPSS Statistics for Windows, IBM Corp., Armonk, NY, USA). The level of significance was set at p<0.05. The Shapiro-Wilk test was used to test the normality of the data. The independent t-test was used to calculate any difference between the 2 groups and Chi-square test was used for proportion analysis. Correlation coefficient between the Facial index and Cephalic index was calculated using Pearson Correlation Coefficient. The confidence interval of 95%, the Power of the study at 80%, and the probability of α-Error at 5 % were selected.

While analysing the Cephalic indices of the study subjects in different antero-posterior malocclusions (Table 2), it was found that Mesocephalic head form was the predominant head form in Class I (55%), Class II (57.5%) and Class III (42.5%) malocclusions. The least prevalent was Ultrabrachycephalic - 5% in Class I and 2.5% in both Class II and Class III malocclusions respectively. While evaluating Facial indices for the different antero-posterior malocclusions (Table 2), it was found that Mesoprosopic was most predominant in Class I and Class II with an incidence of 50 % in Class I, 57 % in Class II, and 7.5 % in Class III malocclusion.

After analyses and comparison of the mean values for Cephalic Index and Facial Index using independent t-test, a difference which was statistically significant was observed between the two indices in all the study groups (p<0.05) as seen in Table 3.

5. Discussion

The present study employed anthropometric/craniofacial measures which are widely used to describe and classify the face and head form according to Martin and Saller. Cephalic index and Facial index of 120 adult patients were evaluated.

Head form prevalence: The results indicated a prevalence of Mesocephalic head form (45.1%) in the Malabar region of Kerala. Concordant results with predominance of mesocephalic head form were observed in the studies of Njemirovskij V *et al.*,[5] Alves HA *et al*,[6] Nair SK *et al*,[7] Patro S *et al*,[8] Mishra M *et al*,[9] Akinbami BO,[10] Lakshmi KK *et al*,[11] Shah T *et al*,[12] Setiya M *et al*,[13] Ahmed SKN and Sreenivasan M,[14] Ranga MKS and Mallika MCV,[15] Doshi MA and Jadhav SD,[16] Mangeshkar A *et al*.[17] and Thomas MW and Rajan SK.[18] The present study results showed Brachycephalic head form as the second most prevalent group with an incidence of 21% among the study subjects. Dolichocephalic head form was the third most (7.1%) common in the study population. The prevalence of the Hyperdolichocephalic type was 4%. The rarest head type in this study was found to be the Ultrabrachycephalic head type (3%).

Face form prevalence: While evaluating the Facial index, the Mesoprosopic face form was the prevalent group with an incidence of 38.3%, thus indicating a predominance of Mesoprosopic face form in the Malabar region of Kerala. The predominance of Mesoprosopic face form was also seen in the studies done by Njemirovskij V *et al*,[5] Kumar M and Lone MM,[19] Prasanna PL *et al*.[20] Hyperleptoprosopic face form was the second most prevalent in our study population with an incidence of 31.8%. Unlike our study, the Hyperleptoprosopic face form were found to be the most predominant face type as reported by Kamble NB and Kamble D,[21] Maina MB *et al*.[22] and Kataria DS *et al*.[23] Leptoprosopic face form was the third most prevalent in the study population with an incidence of 25.8%. In the present study incidence of Euryprosopic face form was 10.8%.

Cephalic index in different antero-posterior malocclusions: While evaluating the prevalence of Cephalic index in different skeletal malocclusions, it was observed that the Mesocephalic head form predominated in all three sagittal malocclusions, with an incidence of 55% in Class I, 57.5% in Class II, 42.5% in Class III malocclusion. Similar to the present study, Rao NR *et al*.[24] also observed a predominance of Mesocephalic head form in Class I subjects in their study. The current study gave an incidence of Brachycephalic head form of 20% in Class I, 32.5% in Class II, 17.5 % in Class III malocclusion. Dolichocephalic -12.5 % in Class I, 5% in Class II, 32.5 % in Class III malocclusion. Hyperdolichocephalic head

form showed an incidence of 7.5% in Class I, 2.5% in Class II, 5% in Class III malocclusion. The least prevalent was Ultrabrachycephalic - 5% in Class I, 2.5% in Class II, 2.5% in Class III malocclusion. Rao NR *et al.*[24] had observed that Brachycephalic head were more prevalent in skeletal and dental Class III or Class I occlusion patterns and Dolichocephalic head corresponded with skeletal and dental Class II occlusion pattern.

Facial index in different antero-posterior malocclusions: Mesoprosopic face form predominated in Class I and Class II malocclusion with an incidence of 50 % in Class I, 57% in Class II, and 7.5 % in Class III malocclusion. Class III malocclusion showed a higher prevalence of Hyperleptoprosopic face (57.5%) than Class II (10%) and Class I (20%) malocclusion. The incidence of Leptoprosopic was 22.5 % in Class I, 27.5 % in Class II and Class III malocclusion. The least prevalent was Euryprosopic with an incidence of 7.5% in Class I, 5% in Class II, 7.5% in Class III malocclusion. The study done by Rao NR *et al.*[24] observed that Mesoprosopic face was more associated with skeletal and dental Class I pattern which was in concordance with our findings however, they also reported that Leptoprosopic face showed more skeletal and dental Class II occlusion pattern and that Euryprosopic face had skeletal and dental Class III or Class I occlusion pattern which was not evident in our study.

Correlation between head form and face form: The strength of the linear relationship between two variables is quantified as the correlation coefficient. The concordance between Facial Index and Cephalic Index was analysed to observe the correlation between them if present. Results of the present study demonstrated a weak negative correlation between the Cephalic Index and Facial Index in different antero-posterior malocclusions - (-0.28) in Class I malocclusion, (-0.15) in Class II malocclusion and (-0.08) in Class III malocclusion (Table 4 and Graphs 1, 2 and 3). Catharino F et al. Observed that of the study subjects who were classified as brachycephalic, 52.6% were leptoprosopic, whereas only 10.5% were euryprosopic. Catharino F et al.[25] had observed that of the study subjects who were classified as brachycephalic, 52.6% were leptoprosopic, whereas only 10.5% were euryprosopic. Menapace *et al.*[26] in their study also observed weak association between face form and head form and found frequent association between the euryprosopic facial type and the dolichocephalic head shape. Raghavendra *et al.*[27] in 2021 also observed no significant correlation between the cranial and facial parametersin the study subjects, which is in consensus with our study results.

However, there have been studies in the previous literature which support the consensus between cranial and facial morphology. That would support the paradigm that the head and face type would be similar; that is, individuals with a leptoprosopic face form would have a corresponding dolichocephalic head type. According to Bhat M and Enlow

DH[28] *in 1985, the cranial base serves as a model for the face. Rao NR et al.*[24] also observed a positive correlation between the Cephalic and Facial indices.

The present research was limited by a few factors like the sample size. The selection of larger number and more representative sample with different skeletal malocclusion would provide more reliable results. The results are in concordance with our null hypothesis that there is no correlation between facial and cephalic indices in the different antero-posterior malocclusions.

6. Conclusion

The present study investigated the correlation between head and face forms in patients with different skeletal antero-posterior malocclusions. The study concluded that:

1. There was a predominance of Mesocephalic head form in the different antero-posterior malocclusions (Class I, Class II and Class III malocclusion).
2. Among the face form, Mesoprosopic predominated in Class I and Class II malocclusion, Hyperleptoprosopic face was the most common in Class III malocclusion.
3. A weak negative correlation existed between head form and face form in Class I, Class II and Class III malocclusion. The results indicate that cranial morphology and facial morphology exerts a weak influence on each other.
4. The study results possibly suggest the prevalence of Mesocephalic head form and Mesoprosopic and Hyperleptoprosopic face form in the Malappuram district of Kerala.

7. Financial Support and Sponsorship

None.

8. Conflicts of Interest

There are no conflicts of interest

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