Content available at: https://www.ipinnovative.com/open-access-journals

Journal of Contemporary Orthodontics

Journal homepage: https://www.jco-ios.org/

Original Research Article

Evaluation of the correlation of mandibular ramus to base ratio with mandibular incisor angulation: A cephalometric study

Vivek Kumar Thakur[1], Dinesh Chander Chaudhary[1]*

[1] *Dept. of Orthodontics & Dentofacial Orthopedics, Army Dental Centre (R&R), Delhi, India*

ARTICLE INFO

Article history:
Received 17-01-2024
Accepted 12-02-2024
Available online 15-05-2024

Keywords:
Mandibular ramus-base ratio
Incisor mandibular plane angle
Cephalometrics

ABSTRACT

Background: The cephalometric evaluation of an individual case using floating norms is the contemporary approach in orthodontic diagnosis. This study aimed to evaluate the correlation of mandibular ramus to the mandibular base ratio with mandibular incisor proclination in a mixed Indian population.

Materials and Methods : A total of 100 cephalograms were selected from the archives of the department of orthodontics fulfilling inclusion and exclusion criteria. The mean age of cases studied was 17.09 ± 2.61 years, with an age range of 13–26 years. The sample comprised 47 males and 53 females.

Results: The results of this study showed that the higher incisor mandibular plane angle (IMPA) has statistically and clinically significant association with a higher ramus to mandibular base ratio in both male and female groups. The unit increase in IMPA is significantly associated with a 0.004 unit increase in the ratio of ramus to mandibular base.

Conclusions/Implications: This study concludes that the IMPA and ratio of ramus to mandibular base are the closest counterparts of each other and explains the variations in the IMPA even in the population group with similar skeletal characteristics. These two components interacts with each other to give a balanced occlusion and function.

1. Introduction

Lateral cephalogram and cephalometric measurements form an integral part of orthodontic diagnosis and treatment planning. The cephalometric evaluation is based on composite norms available through various studies on different populations and varied sample sizes.[1–3] The judicious contemporary method is to use floating norms as suggested by Athenosiou.[4] However, specific racial and ethnic differences need to be taken into account while considering the normal values of a specific cephalometric parameter.[5] Normal skeletal and dental cephalometric parameters along with associated compensations are also counterparts.[6,7] The knowledge of these existing compensations as regional normative standards may enable the orthodontist to formulate a more population-specific treatment plan. Various studies have given Indian norms for Incisor Mandibular Plane Angle (IMPA) that are significantly more than Caucasian norms.[8–10] However, there is a vacuum in literature, correlating the mandibular incisors anteroposterior position with mandibular proportions and whether the change in their position has any correlation with mandibular ramus to base proportion. To find answers to these questions, this study was designed with a null hypothesis that there is no correlation of mandibular ramus (Co-Go) to the base (Go-Pog) ratio with incisor proclination in a mixed Indian population.

* *Corresponding author*.
E-mail address: thakurvivek13@gmail.com (D. C. Chaudhary).

https://doi.org/10.18231/j.jco.2024.032
2582-0478/© 2024 Author(s), Published by Innovative Publication.

1.1. Inclusion criteria

1. Pretreatment records of subjects with skeletal Class I malocclusion (ANB: 1-3 degrees and Witts +1to -1)
2. Availability of diagnostic quality lateral cephalograms
3. No spacing in the upper or lower anterior teeth
4. Saddle angle (N-S-Ar in the normal range (123±5)°
5. Average growth pattern

1.2. Exclusion criteria

1. Previous orthodontic treatment
2. Patients with cleft lip and palate or syndromic conditions
3. Patients in mixed dentition

2. Materials and Methods

The study was carried out in a tertiary care dental hospital with orthodontic facility and available data bank of a mixed Indian population.[11] Sample size calculation was based on previous studies, using a two-sided test, a 5% significance level test (α=0.05) with power 80% (β=0.2) and the required sample size was approximately 60 (n=60). However, A total of 100 cephalograms were selected from the archives of the department of orthodontics fulfilling inclusion & exclusion criteria. [Figures 1 and 2] The mean age of cases studied was 17.09 ± 2.61 years with an age range of 13 – 26 years. The selected cephalograms were traced manually by the first author. The parameters used for comparisons are shown in the representative image. [Figure 3]

The statistical evaluation of means of normally distributed continuous variables with the reference standard is done using a one-sample t-test. Correlation analysis was done using Pearson's correlation method. Linear regression analysis was performed to predict the value of the dependent variable based on the independent variable on obtaining a statistically significant correlation. The underlying normality assumption was tested before subjecting the study variables to Pearson's correlation analysis and regression analysis. The statistical analysis was carried out using Statistical Package for Social Sciences (SPSS ver 24.0, IBM Corporation, USA) for MS Windows.

3. Results

3.1. Comparison of IMPA and the ratio of ramus to the mandibular base with the reference standards. [Table 1]

The mean IMPA in the study population was significantly higher 102 ± 6.71 degrees, compared to the reference standard value of 90 degrees (P-value<0.05).[1] The mean ratio of ramus to mandibular base in the study population is significantly higher 0.8 compared to the reference standard value[12] of 0.7 (P-value<0.05).

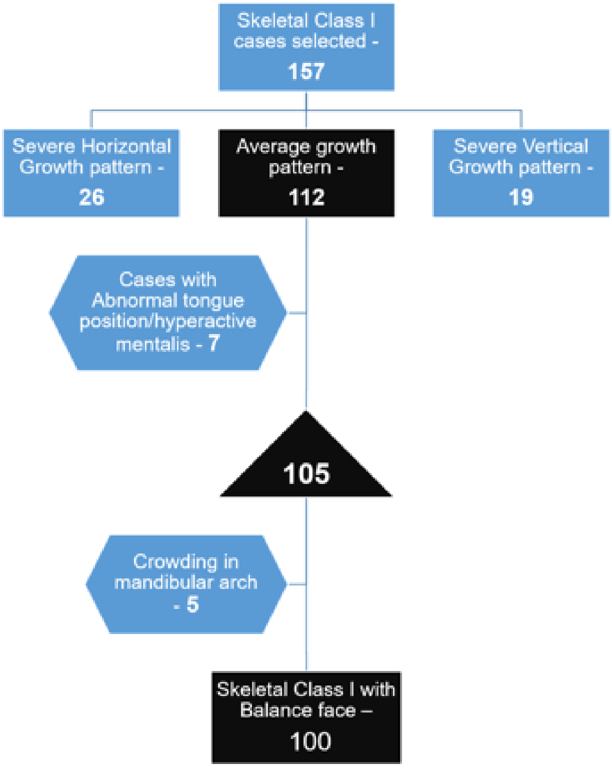

Figure 1: Sample selection

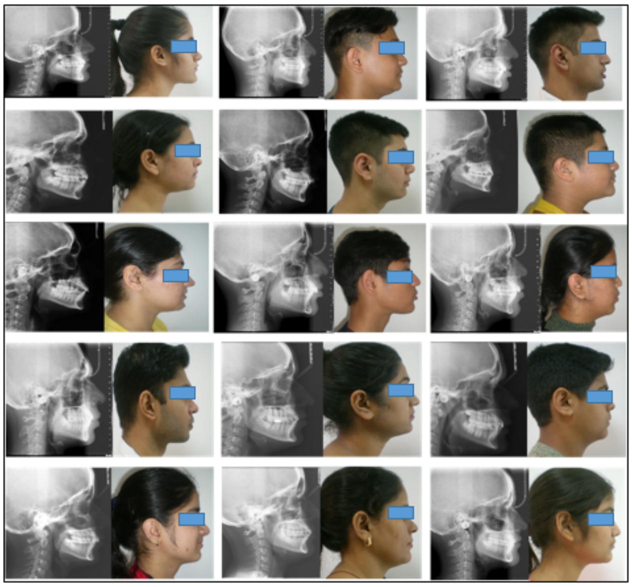

Figure 2: Representative sample

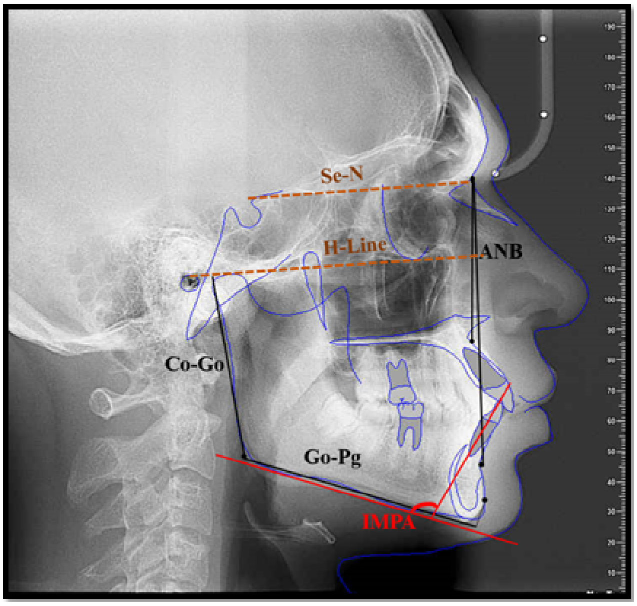

Figure 3: Cephalometric parameters

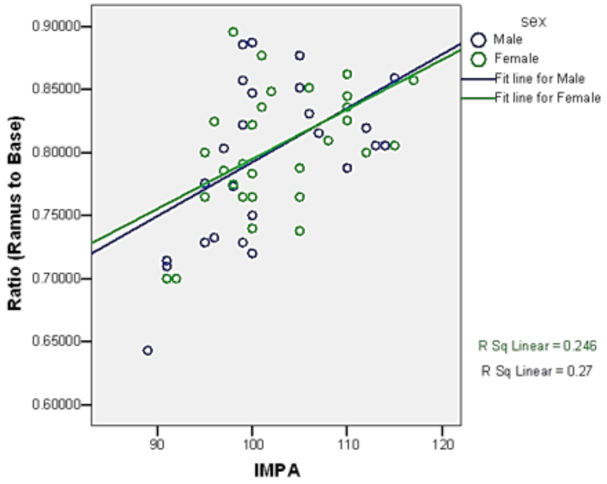

Figure 4: Scatter diagram showing correlation analysis

Table 1: Comparison of incisor mandibular plane angle (IMPA) and Ratio of Ramus to Mandibular Base with the reference standards

Variables	Mean	SD	Reference value	P-value
Incisor mandibular plane angle (IMPA)	101.59	6.71	90.00	0.001***
Ratio of Ramus to Mandibular Base	0.80008	0.0543	0.71428 (1/1.4)	0.001***

P-value by one-sample t test. P-value<0.05 is considered to be statistically significant. ***P-value<0.001.

Table 2: Correlation analysis of incisor mandibular plane angle (IMPA) with ratio of ramus to mandibular base

		Correlate between IMPA with Ratio of Ramus to Mandibular Base	
Group	**No. of subjects**	**r-value**	**P-value**
Male	47	0.519	0.001***
Female	53	0.496	0.001***
All	100	0.508	0.001***

Correlation analysis by Pearson's method. P-value<0.05 is considered to be statistically significant. ***P-value<0.001.

Table 3: The sex-specific linear regression analysis for the prediction of ratio of ramus to mandibular base using incisor mandibular plane angle (IMPA).

		Regression analysis for the prediction of Ratio of Ramus to Mandibular Base using IMPA		
Group	**No. of subjects**	**Regression Equation**	**P-value**	**$\%R^2$**
Male	47	Ratio = 0.364 + 0.004 x IMPA	0.001***	27.0%
Female	53	Ratio = 0.400 + 0.004 x IMPA	0.001***	24.6%
All	100	Ratio = 0.382 + 0.004 x IMPA	0.001***	25.8%

Dependent Variable: Ratio, Independent Variable : IMPA, ***P-value<0.001.

3.2. Correlation analysis of IMPA with the ratio of ramus to the mandibular base. [Table 2]

On Pearson's correlation analysis, the IMPA showed a statistically significant positive correlation with the ratio of ramus to mandibular base in the study group (p value<0.05). The higher IMPA was significantly associated with a higher ratio of ramus to mandibular base in both male and female groups.

3.3. The gender-specific linear regression analysis for the prediction of the ratio of ramus to the mandibular base using IMPA. [Table 3] [Figure 4]

Simple linear regression analysis was used to test if IMPA significantly predicted the ratio of ramus to mandibular base. Based on regression analysis it was concluded that the unit increase in IMPA is significantly associated with 0.004 units increase in the ratio of ramus to mandibular base in both the genders.

4. Discussion

Achieving balanced facial proportions and stable orthodontic treatment results always remain one of the important treatment objectives during the orthodontic diagnosis and treatment planning phase. The importance of mandibular ramus and mandibular body size in determining the proportionate facial dimensions along with compensatory cephalometric angles such as saddle angle, articular angle, gonial angle, and the basal plane angle is historically well known and documented in cephalometric literature.[4,12,13] Incisor mandibular plane angle is often associated with treatment stability.[14–17] However, the correlation between these two cephalometric parameters (mandibular body length & IMPA) has not been studied in detail.

It is a known fact that racial differences lead to specific normative standards for a specific population, studies confirm the variability and also increased IMPA values for the Indian population.[8,9] Also reduced mandibular body size when compared with mandibular ramus length in the Indian population, resulting in an increased value of mandibular ramus to body ratio. In our study, the mean IMPA of the population was 102 ± 6.71 degrees and this corroborates with the study of Garg and co-worker[9] on the north Indian population with well balanced faces and Class I occlusion. Their study found IMPA for males as 102 ± 7° and for females as 99 ± 7°. But, a similar study by Singh SP and co-workers found IMPA in the north Indian population to be 92.21°± 10.31 in males and 97.41°± 10.61 in females. The standard deviation was significantly higher in the study by Singh & co-workers.[8] Thus, there is a significant variation in average IMPA values, especially in males, in the findings of the two studies. This may be attributed to the different age groups of populations evaluated; being 18-25 years in one and 14-24 years in the second group respectively. The study by Tripti et al[18] in another north Indian population sample of 100 patients in the age group 18-25 years with a mean age of 21±2.62 years found that IMPA values for females were higher; 101.49°±7.94° compared to males 99.99°±7.30°. Sahoo et al.[19] in a similar study on the East Indian population in the age group 18-30 years found IMPA in males to be 98.8°±14.9° and 102.3°±9.1°. All these studies have been carried out in similar population groups with similar age and gender subgroups. All these studies prove that IMPA values in the Indian population are significantly increased compared to established norms and considering the high standard deviation there is a significant individual variation in the angulation of mandibular incisors. Though the subjects in these studies have a well-balanced facial proportion and Class I occlusion the reason for these large variations remains unexplained.

Various other studies made attempts to correlate mandibular incisor angulation with gonial angle, mandibular symphysis characteristics and skeletal patterns. Guterman et al.[20] in a sample from Zurich Craniofacial longitudinal growth study in 6-18 years old, studied the correlations between the angulation of the lower incisors with age, symphyseal measurements (height, width, and depth), symphyseal ratios (height-width, height-depth), and skeletal angles (divergence of the jaws and gonial angle) for all ages separately and both genders independently. They found that inclination of lower incisors changed over age; 8 years: girls 93.9° (92.3°–95.7°), boys 93.3° (91.8°–94.9°) to 16 years: girls 96.1° (94.1°–98.2°), boys 97.1° (95.6°–98.6°). They concluded that symphyseal dimensions have a limited effect on lower incisor angulation but are linked to the subject's gender, age and skeletal vertical pattern.

Rakosi[12] found that angulation of lower incisors with mandibular plane changes with age. He concluded that this angle increased from 88° to 94° from the 6th to 12th year of age with the mean value of 90°± 3°. They have compiled the comparative linear measurements of the mandiblular body and ramus but have not correlated any of these with the angulation of lower incisors.

Nazir & Mushtaq[21] studied the correlation of incisor mandibular plane angle (IMPA), Frankfort mandibular plane angle (FMA) and lower incisor to A-Pog distance and their relation in different skeletal classes. They concluded that there appears to exist a demonstrable relationship between the axial inclination of the mandibular incisors and the incisor mandibular plane angle and a relationship between the incisor mandibular plane angle and the contour of the lower third of the face; the lower incisors being more upright in subgroups with prognathic mandible than subgroups with the normal or retrognathic mandible. But, in their study, the mean IMPA in Class I, II and III subjects with similar Frankfurt-Mandibular plane angle (FMA) was 91.35° (SD-6.49°), 93.75° (SD-6.62°) and 81.60° (SD-10.05°) respectively. Although this study proposes the role of the contour of the lower third of the face in IMPA, but considering similar FMA angles the influence seems limited as the average difference in IMPA is only 2.45° in patients of Class I & Class II. The study would have been more informative if different FMA subgroups would have been considered in Class I, II & III malocclusions and then correlated with IMPA.

It's been a common observation that skeletal Class II cases present with increased IMPA and Class III cases with decreased IMPA as an attempt to compensate for the decreased and increased mandibular length respectively to maintain function, but the degree of variation is always variable. There is no available literature quantifying the increase or decrease in IMPA with the change in the unit length of the mandible. Besides, the lip and tongue musculature may have a profound and variable effect on the mandibular incisor angulation, depending on their activity. Lip trap in Class II div 1 malocclusion may prevent the increase in mandibular incisor angulation or altered tongue pressure due to reduced space as seen in the retrognathic mandible may significantly increase their angulation. Thus, to study the adaptation of mandibular incisor angulation to mandibular base, the sample of Class I malocclusion cases with balanced facial proportions was the apt choice.

Thus, to find the unanswered questions this study took into consideration the ratio of mandibular ramus to body and its correlation with the angulation of mandibular incisors. Although age dependent norms are available for different populations yet considering the diversity, not many people will have similar facial dimensions even in well balanced faces and this variability finds its expression in the angulation of mandibular incisors as well. In our study, the IMPA showed a positive correlation with the ratio of ramus to mandibular base. The higher incisor mandibular plane angle was significantly associated with a higher ratio of ramus to mandibular base in both male and female groups. The statistical finding shows that the unit increase in IMPA is associated with a 0.004 unit increase in the ratio of ramus to mandibular base. On extrapolating these findings to the clinical relevance, every 10 degrees increase of IMPA might be related to approximately 4 mm deficiency in the mandibular body length compared with the ramus length of that particular case or vice-versa every 5mm mandibular deficiency will increase IMPA by 2°. In our study, the ramus to mandibular base ratio was found to be 0.8 against the norm of 0.7. Now let us consider one example; if the ramus length is 55 mm then the corresponding body length should be 78 mm for a ratio of 0.7. For a ratio of 0.8, the corresponding body length is only 65 mm. Thus, for a change in the ratio of 0.1, the change in mandibular body length is approximately 13 mm. Thus, even a slight change in the ratio of ramus to body can have a significant impact on the anteroposterior positioning of the dentition. Thus, in an average grower, this change can produce an average change of about 12 degrees of IMPA, as reflected in our study results with mean IMPA 102° ± 6.85°.

The only limitation of this study was the limited sample size. The strength of this study is that the results of this study show a strong correlation between a ratio value of two mandibular dimensions (ramal length and basal length) with IMPA, a correlation that has not been explored. Hence, within the limitation of the exclusion factors, the results of this study may apply to any individual case irrespective of his/her ethnic or racial background. Further, such studies on populations of different ethnicities will throw more light on the subject matter to substantiate or negate the findings of our study. This will broaden the diagnostic criteria for evaluation of IMPA and improve clinical application in achieving patient specific results.

5. Conclusion

There is wide variation in the IMPA across the populations of different ethnicities and within as well but there is no satisfactory explanation for this variable finding. Even in a well matched samples, the variation ranges from 8-10 degrees from the average. No study has studied the correlation of IMPA with the mandibular ramus to base ratio and this study provides insight into this correlation. This finding of the study indicate that this is one of the most important parameters that explain the major and minor variations in IMPA. The unit increase in IMPA is significantly associated with a 0.004 unit increase in the ratio of ramus to mandibular base i.e. every 10 degrees increase in IMPA might be related to approximately 4 mm deficiency in the mandibular body length compared with the ramus length. Thus, the ratio of mandibular ramus to base hold great significance in planning the final position of lower inciosrs.

6. Declarations

6.1. Ethics approval and consent to participate

Consent taken from all the participant for including their photograph.

7. Authors' Contributions

First author – Conduct of study, literature review and data collection.

Second author – Original idea, Scientific writing and revision.

8. Source of Funding

None.

9. Conflict of Interest

None.

References

1. Tweed CH. The Frankfort-mandibular incisor angle (FMIA) in orthodontic diagnosis, treatment planning and prognosis. *Angle Orthod*. 1954;24:121–69.
2. Ricketts RM. Planning treatment on the basis of the facial pattern and an estimate of its growth. *Angle Orthod*. 1957;27(1):14–37.
3. Mcnamara JA. A method of cephalometric evaluation. *Am J Orthod*. 1984;86:449–69.
4. Athanasiou AO, Cephalometry. 1995.
5. Atit MB, Deshmukh SV, Rahalkar J, Subramanian V, Naik C, Darda M. Mean values of Steiner, Tweed, Ricketts and McNamara analysis in Maratha ethnic population: A cephalometric study. *APOS Trends Orthod*. 2013;3(5):137–51.
6. Enlow DH, Hans MG. Essential of Facial Growth. 2nd ed. Philadelphia, PA, USA: Saunders; 1996. p. 512.
7. Enlow DH, Kuroda T, Lewis AB. The morphogenetic basis for craniofacial form and pattern. *Angle Orthod*. 1971;41(3):161–88.
8. Singh SP, Utreja AK, Jena AK. Cephalometric norms for orthognathic surgery for North Indian population. *Contemp Clin Dent*. 2013;4:460–6.
9. Garg R, Alexander M. Are we similar to Caucasians": Orthognathic surgery for North Indians. *J Maxillofac Oral Surg*. 2015;14(2):271–8.
10. Grewal H, Sidhu SS, Kharbanda OP. A cephalometric appraisal of dento-facial and soft tissue pattern in Indo-Aryans. *J Pierre Fauchard Acad*. 1994;8(3):87–96.
11. Moorjani P. Genetic Evidence for Recent Population Mixture in India. *Am J Hum Genet*. 2013;93(3):422–38.

12. Rakosi T. An Atlas and Manual of Cephalometric Radiography. Munich: Wolfe Medical Publications; 1982. p. 71–5.
13. Jacobson A. Radiographic Cephalometry: From Basics to Video-imaging. Chicago: ; 1995. Available from: https://go.planmeca.com/see-the-difference2?utm_source=paid-search&utm_medium=googleps&utm_campaign=see-the-difference&gclid=Cj0KCQjw_-GxBhC1ARIsADGgDjt7F67YREgMnsOuo9yR6Qpij90mKjKf4glksbmx8xX7kd4tIN7cbQaArmYEALw_wcB.
14. Margolis H. Axial Inclination of Mandibular Incisors. *Am J Orthod*. 1943;28:571–594.
15. Tweed CH. Frankfort Mandibular Incisor Angle (FMIA) in Orthodontic Diagnosis, Treatment Planning and Prognosis. *Angle Orthod*. 1954;24:121–69.
16. Tweed CH. The diagnostic facial triangle in the control of treatment objectives. *Am J Orthod*. 1969;55:651–70.
17. ain S, Tondon R, Singh K, Kulshrestha R, Umale V. Tweed's Philosophy-A Review. *Indian J of Orthod Dentofac Res*. 2017;3(4):198–206.
18. Tikku T, Khanna R, Maurya RP, Verma SL, Srivastava K, Kadu M. Cephalometric norms for orthognathic surgery in North Indian population using Nemoceph software. *J Oral Biol Craniofac Res*. 2014;4(2):94–103.
19. Sahoo N, Mohanty R, Mohanty P, Nayak T, Nanda SB, Garabadu A. Cephalometric norms for East Indian population using burstone legan analysis. *J Int Oral Health*. 2016;8(12):1076–81.
20. Gutermann C, Peltomaki T, Markic G, Hanggi M, Schatzle M, Signorelli L, et al. The inclination of mandibular incisors revisited. *Angle Orthod*. 2014;84(1):109–28.
21. Nazir S, Mushtaq M. Frankfort Mandibular Plane Angle (FMA) and Lower Incisor to A-pog distance, and their relation in Different Skeletal Classes. *Int J Appl Res*. 2020;6(12):309–14.

Author biography

Vivek Kumar Thakur, Assistant Professor https://orcid.org/0000-0003-3040-3698

Dinesh Chander Chaudhary, Associate Professor https://orcid.org/0000-0003-2507-675X

Cite this article: Thakur VK, Chaudhary DC. Evaluation of the correlation of mandibular ramus to base ratio with mandibular incisor angulation: A cephalometric study. *J Contemp Orthod* 2024;8(2):222-227.