ORIGINAL RESEARCH

Mixed Dentition Analysis in and around Kanpur City: An Existential and Illustrative Study

Shashank Gaur[1], Neha Singh[2], Reshu Singh[3], Anuve H Phukan[4], Manoj Mittal[5], Anil Kohli[6]

Abstract

Context: Mixed dentition space analysis helps in determining the discrepancy between the available and required space in each dental arch during the mixed dentition period; further, it helps to diagnose and plan the treatment of developing malocclusion.

Aim: The aim of this study is to evaluate the applicability of Tanaka and Johnston's and Moyer's methods of predicting the size of permanent canines and premolars and compare the tooth size between the right and left sides between males and females, and also to compare the predicted values of mesiodistal widths of permanent canines and premolars from Tanaka and Johnston and Moyer's method with the measured values.

Materials and methods: The sample consisted of 58 sets of study models, of which 20 were girls and 38 were boys, that were collected from the children of the 12–15 year age-group. A digital vernier gauge, whose beaks were sharpened, was used to measure the mesiodistal widths of the individual teeth in order to increase accuracy.

Statistical analysis: The two-tailed paired *t*-tests were used to assess the bilateral symmetry of the mesiodistal diameter of all measured individual teeth.

Results and conclusion: It was concluded that Tanaka and Johnston's method could not accurately predict the mesiodistal widths of unerupted canines and premolars of children of Kanpur city due to the high variability in estimation, whereas the least statistically significant difference was obtained only at 65% level of Moyer's probability chart for male, female, and combined sample.

Keywords: Mixed dentition, Moyers analysis, Nonradiographic, Space analysis, Tanaka and Johnston analysis.

International Journal of Clinical Pediatric Dentistry (2022): 10.5005/jp-journals-10005-2470

Introduction

Improving dental health and facial esthetics is the main reason patients seek orthodontic treatment. Misaligned teeth are one of the most common patient complaints, which leads to plaque buildup, which in turn leads to tooth decay, and gum diseases. This is primarily due to the inability of patients to maintain proper oral hygiene due to misaligned teeth.[1]

The greatest malocclusion and orthodontic problems occur during the transition in the mixed dentition phase. This is considered mainly due to the space discrepancies (reduction) due to premature loss of deciduous teeth. Therefore, performing space assessment during this period before subsequent permanent teeth erupt could potentially be used to minimize and prevent the occurrence of malocclusion.

Mixed dentition analysis helps to estimate the difference in each dental arch's available and needed space during the mixed dentition stage. It also helps in diagnosing and planning treatment for evolving malocclusions that require various prophylactic and preventive orthodontic measures, such as serial tooth extractions. It includes guidance on permanent tooth eruption, space maintenance, and space acquisition through observation and periodic assessment.

One of the following principles serves as the foundation for traditional mixed dentition analysis methodologies[2]:

- Estimation of the size of non-erupted teeth by X-ray measurements, for example, Nance.[3] Prediction based on the correlation between different types of tooth sizes within the dentition, for example, Tanaka and Johnston,[4] Moyers.[5–7] Combining the two approaches, as demonstrated by Hixon and Oldfather[8] and Staley and Kerber.[9]

[1,2]Department of Pediatric and Preventive Dentistry, Bhabha College of Dental Sciences, Bhabha University, Bhopal, Madhya Pradesh, India

[3]Department of Prosthodontics and Crown & Bridge, Government Dental College, Srimanta Sankaradeva University of Health Sciences, Guwahati, Assam, India

[4]Department of Pediatric and Preventive Dentistry, Government Dental College, Srimanta Sankaradeva University of Health Sciences, Guwahati, Assam, India

[5]Department of Periodontics, Bhabha College of Dental Sciences, Bhabha University, Bhopal, Madhya Pradesh, India

[6]Department of Pediatric and Preventive Dentistry, Rama Dental College Hospital & Research Centre, Rama University, Kanpur, Uttar Pradesh, India

Corresponding Author: Shashank Gaur, Department of Pediatric and Preventive Dentistry, Bhabha College of Dental Sciences, Bhabha University, Bhopal, Madhya Pradesh, India, Phone: +91 9752104547, e-mail: shash.gaur@gmail.com

How to cite this article: Gaur S, Singh N, Singh R, *et al.* Mixed Dentition Analysis in and around Kanpur City: An Existential and Illustrative Study. Int J Clin Pediatr Dent 2022;15(5):603–609.

Source of support: Nil

Conflict of interest: None

There have been numerous investigations into the applicability of two nonradiographic modalities, including Moyer and Tanaka and Johnston space analysis, have been published in the literature, resulting in both methods, which underestimated tooth dimensions in noncaucasian samples.[2,10,11] Both Tanaka and Johnston space analysis in the year 1974 and Moyer in the year 1988 found an overestimation of tooth size in Caucasian specimens.[12–14] A positive

correlation was found between Tanaka and Johnston's space analysis and Moyer's studies. But the probabilities seen for the sample of the North Indian population are different.[15] Given racial and geographic differences in the Kanpur population, which lacks such a prediction table formulation, this study is similar to that of Tanaka and Johnston's space analysis and Moyer. It was developed to assess the applicability of these methods in the sizes of extremely durable canines and premolars of Kanpur youngsters.

Aim

This study focused on predicting the size of permanent canines and premolars in Kanpur children using Tanaka and Johnston's space analysis and Moyer's methods.

Objectives

- To compare the tooth size between the right and left sides.
- To compare the tooth size between males and females.
- Moyer's method was used to contrast the measured values with the predicted values of mesiodistal widths for permanent canines and premolars from Tanaka and Johnston space analysis.

Materials and Methods

A total of 58 sets of dental casts of high quality, that are free of distortions were obtained during the outpatient department hours of the pedodontics and preventive department from children aged 12–15 years, out of which 20 were girls and 38 were boys. All the children had fully erupted permanent incisors, canines, and premolars in the mandible and maxilla, free from any fractures, proximal wear, restorations, proximal caries, hypoplasia, or any dental anomalies.

The Mesiodistal Tooth Width Measurement

A vernier gauge calibrated with a digital micrometer was used to measure the mesiodistal widths of the individual teeth from the study casts.[16]

All the teeth from the left second premolar through to the right second premolar of each set of dental casts were measured to the nearest 0.01 mm and entered in a Microsoft Excel spreadsheet. The sum total of four mandibular incisors, mandibular canines, and premolars per quadrant, maxillary canines and premolars per quadrant were measured together for each sex and whole sample.

Data Analysis

Data collected was then used to evaluate the applicability of regression equations that can be used for the prediction of tooth sizes.

Tanaka and Johnston space analysis regression equation used for the analysis are as follows:

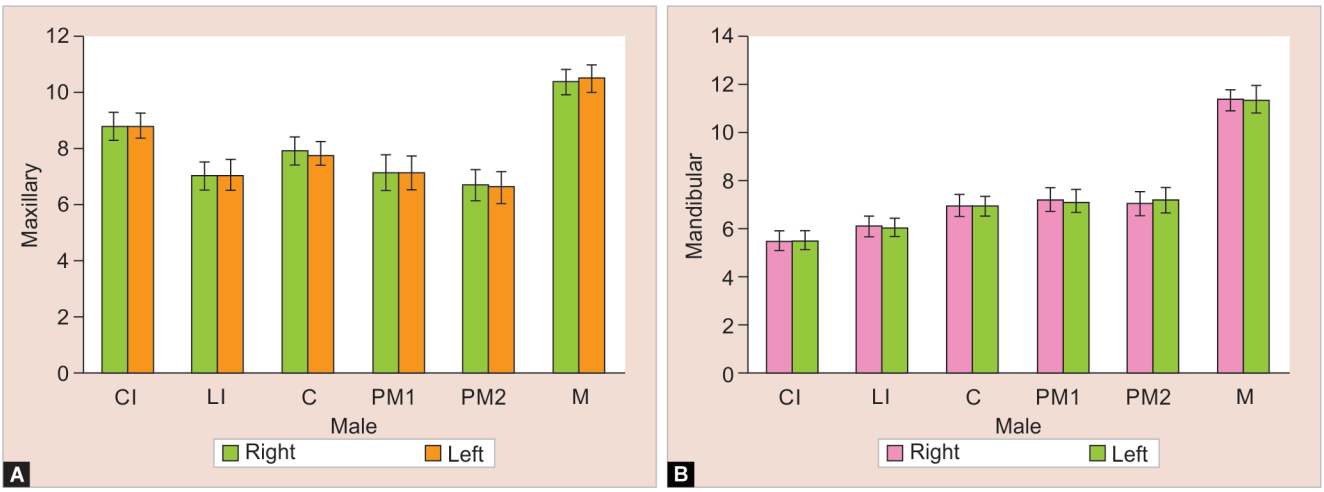
- Maxillary cuspid and both the premolar (3, 4, and 5) in one quadrant = (sum total of four mandibular incisors)/2 + 11.00 mm.
- Mandibular cuspid and both the premolar (3, 4, and 5) in one quadrant = (sum total of four mandibular incisors)/2 + 10.5 mm.
- The individual data of maxillary and mandibular were then compared with Moyer's predictability chart.
- The two-tailed paired *t*-tests were used to assess the bilateral symmetry of the mesiodistal diameter of every single tooth measured. Independent *t*-tests were utilized to look at the male and female subjects' estimated values. The significance of the difference between the predicted and measured mesiodistal diameters for each method was evaluated using the paired *t*-test. The measurable programing, specifically Statistical Package for the Social Sciences 15.0, Stata 8.0, MedCalc 9.0.1, and Systat 11.0 were utilized for the investigation of the information, and Microsoft Word and Succeed have been utilized to produce diagrams, tables, and so on.

Results

The purpose of this study is to see if Tanaka and Johnston's space analysis and the Moyer's approaches to predicting the size of permanent canines and premolars in Kanpur children are applicable. To improve precision, the mesiodistal widths of each tooth were measured using a digital vernier gauge with sharpened beaks. Every tooth in each dental cast, from the left first molar to the right first molar, was measured to the nearest 0.01 mm.

The values obtained by measuring the 58 sets of dental casts were tabulated, and from this study, the following conclusions were derived:

Figure 1A shows a right and left comparison of individual teeth of the maxillary jaw in male subjects by using paired *t*-test.



Figs 1A and B: (A) Right and left comparison of individual teeth of the maxillary jaw in male; (B) Right and left comparison of individual teeth of the mandibular jaw in male

Figure 1B shows a right and left comparison of individual teeth of the mandibular jaw in male subjects. There were significant bilateral differences ($p < 0.05$) found with the maxillary first molar and maxillary premolar, and no statistical difference ($p > 0.05$) was found with other teeth.

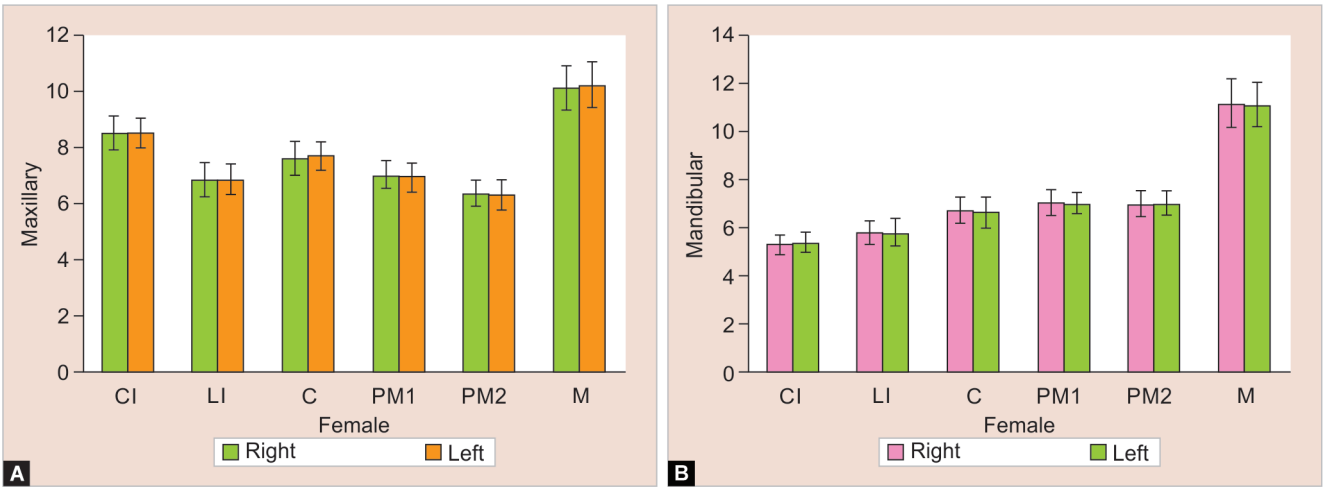
Figure 2A shows the right and left comparison of individual teeth in the maxillary jaw in female subjects by using paired *t*-test. Figure 2B shows a right and left comparison of individual teeth of the mandibular jaw in female subjects.

There were no statistically significant bilateral differences ($p > 0.05$) found with the right and left teeth of female subjects.

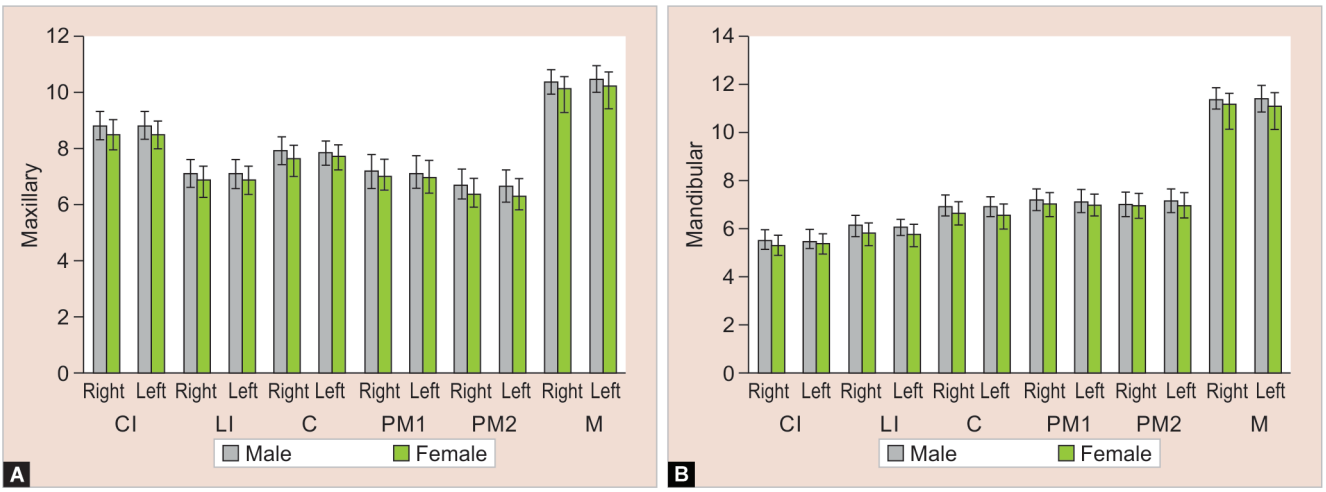
Figure 3A shows a comparison of the size of male and female teeth of both the right and left sides of the maxillary jaw. Figure 3B shows a comparison of the size of male and female teeth of both the right and left sides of the mandibular jaw. There were significant bilateral differences ($p < 0.05$) found with maxillary first molars, and no statistically significant difference ($p > 0.05$) was found with other teeth.

Figure 4A shows a comparison of the size of male and female teeth of the maxillary jaw, taking an average of the right and left sides. Figure 4B shows a comparison of the size of male and female teeth of the mandibular jaw, taking an average of the right and left sides. Results show that the female teeth are comparatively smaller than the male teeth. Statistically significant differences were found with maxillary central incisors, canines and second premolars, and mandibular central incisors, lateral incisors, and canines.

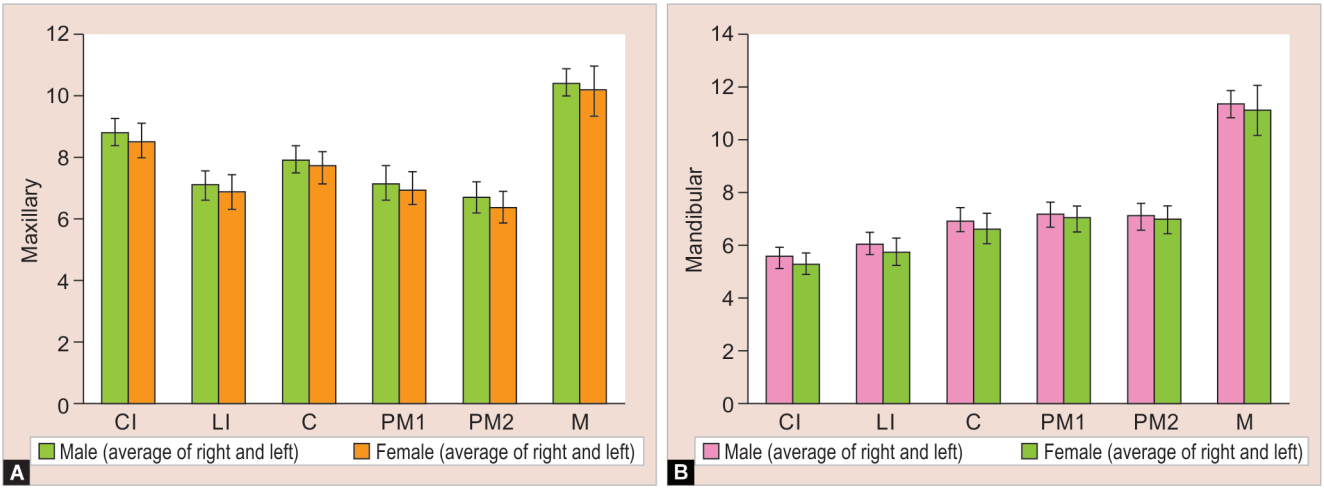
Figure 5A shows the sum total of incisors, the measured sum total of maxillary cuspids and bicuspids (actual tooth width), and the predicted sum total of maxillary cuspids and bicuspids by Tanaka and Johnston space analysis prediction method in males and females. Figure 5B shows the sum total of mandibular incisors, the measured sum total of maxillary cuspids and bicuspids (actual tooth width), and the predicted sum total of maxillary cuspids and bicuspids by Moyer's method at different probability levels in males and females. The bar diagram also shows the results of the paired *t*-test for the comparison between the measured sum total of mesiodistal width of canines and premolars and the predicted values derived from Tanaka and Johnston space analysis and Moyer's method at different levels for maxillary arch. Results of paired *t*-test show that the difference between the measured sum total of mesiodistal width of maxillary canines and premolars and the predicted values derived from the Tanaka and Johnston space analysis method is statistically significant for the male, female, and combined samples. The difference between the measured sum



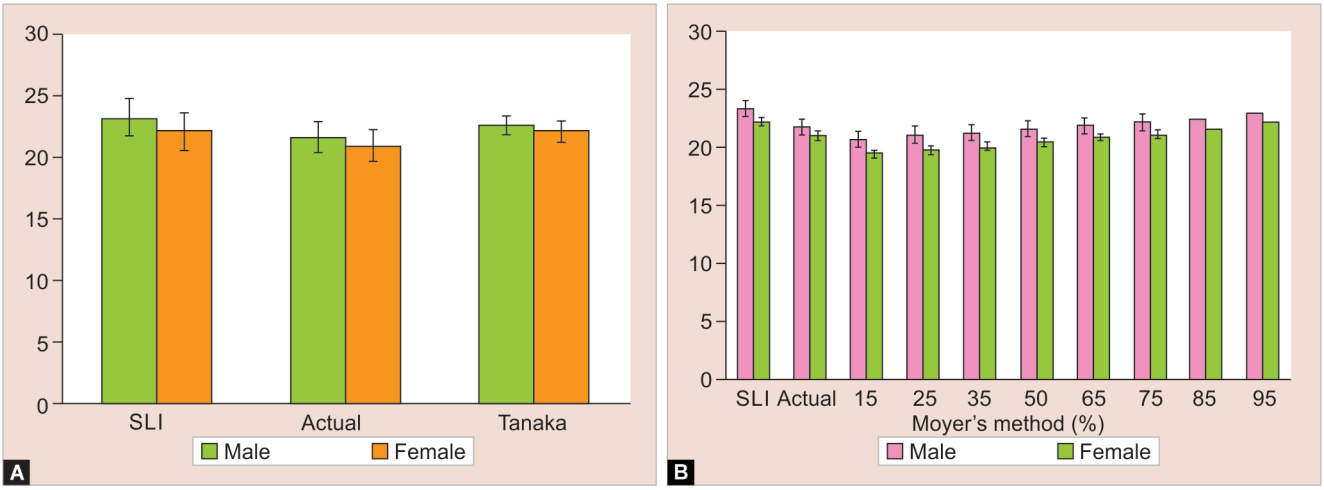
Figs 2A and B: (A) Right and left comparison of individual teeth in the maxillary jaw in female; (B) Right and left comparison of individual teeth of the mandibular jaw in female



Figs 3A and B: (A) Comparison of size of male and female teeth of both right and left sides of the maxillary jaw; (B) Comparison of size of male and female teeth of both right and left sides of mandibular jaw



Figs 4A and B: (A) Comparison of size of male and female teeth of maxillary jaw taking an average of right and left sides; (B) Comparison of size of male and female teeth of mandibular jaw taking an average of right and left sides



Figs 5A and B: (A) Mandibular incisors, the measured sum total of maxillary cuspids and bicuspids (actual tooth width), and predicted sum total of maxillary cuspids and bicuspids by Tanaka and Johnston space analysis; (B) Sum total of mandibular incisors, the measured sum total of maxillary cuspids and bicuspids (actual tooth width), and predicted sum total of maxillary cuspids and bicuspids by Moyer's method

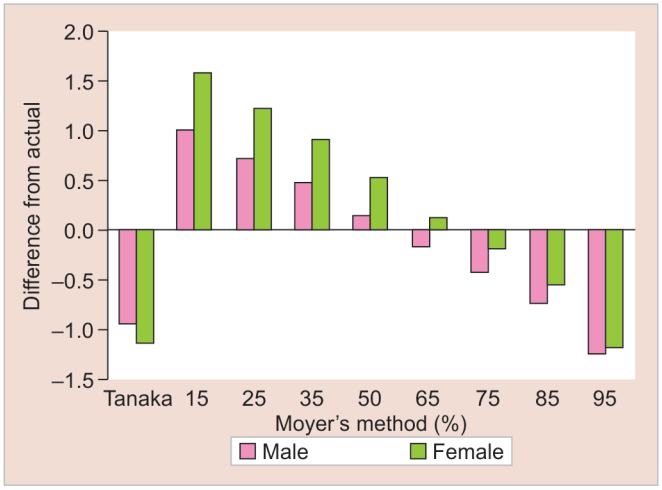
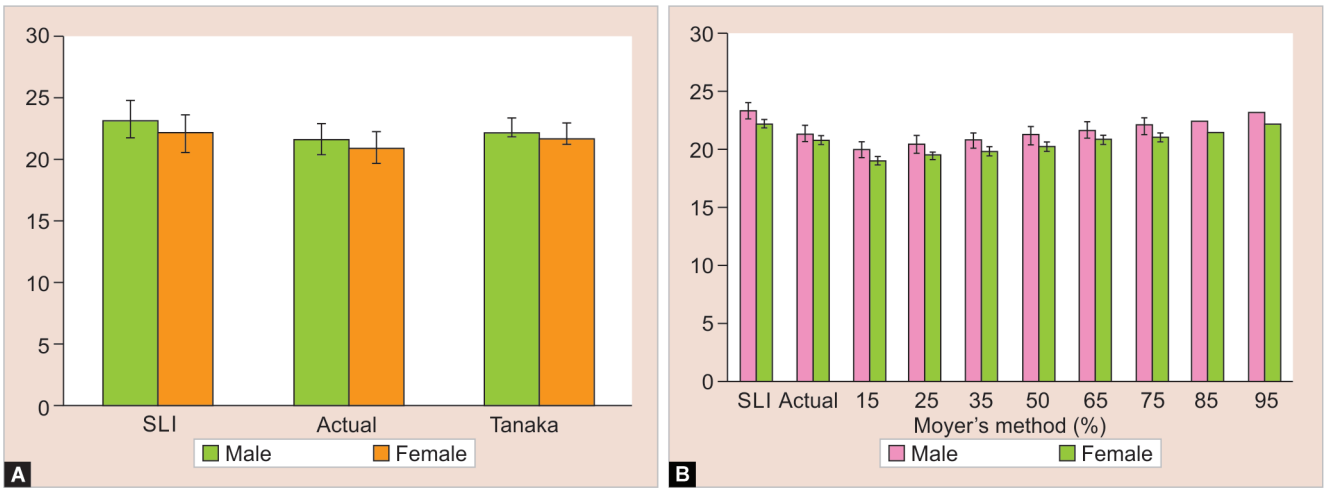


Fig. 6: Difference between the measured sum total of mesiodistal width of canines and premolars and the predicted values derived from Tanaka and Johnston space analysis and Moyer's method

total of mesiodistal width of maxillary canines and premolars and the predicted values derived from Moyer's method is statistically significant at 15, 25, 35, 75, 85, and 95% levels for the male sample, at 15, 25, 35, 50, 85, and 95% levels for the female sample, and at 15, 25, 35, 50, 75, 85, and 95% levels for the combined sample. The difference between the measured sum total of mesiodistal width of maxillary canines and premolars and the predicted values derived from Moyer's method is statistically not significant at 50 and 65% levels for the male sample, at 65 and 75% for the female sample, and at 65% for the combined sample.

Figure 6 shows the difference between the measured sum total of mesiodistal width of canines and premolars and the predicted values derived from Tanaka and Johnston space analysis and Moyer's method at different levels for the maxillary arch in males and females.

Figure 7A shows the sum total of mandibular incisors, the measured sum total of mandibular cuspids and bicuspids (actual tooth width), and the predicted sum total of mandibular cuspids and bicuspids by Tanaka and Johnston space analysis prediction method in males and females. Figure 7B shows the sum total of



Figs 7A and B: (A) Sum total of mandibular incisors, the measured sum total of mandibular cuspids and bicuspids (actual tooth width), and predicted sum total of mandibular cuspids and bicuspids by Tanaka and Johnston space analysis; (B) Sum total of mandibular incisors, the measured sum total of mandibular cuspids and bicuspids (actual tooth width), and predicted sum total of mandibular cuspids and bicuspids by Moyer's method

mandibular incisors, the measured sum total of mandibular cuspids and bicuspids (actual tooth width), and the predicted sum total of mandibular cuspids and bicuspids by Moyer's method at different probability levels in male and female. This also shows the results of the paired *t*-test for the comparison between the measured sum total of mesiodistal width of canines and premolars and the predicted values derived from Tanaka and Johnston space analysis and Moyer's method at different levels for mandibular arch. Results of paired *t*-test show that the difference between the measured sum total of mesiodistal width of mandibular canines and premolars and the predicted values derived from the Tanaka and Johnston space analysis method is statistically significant for the male, female, and combined sample. The difference between the measured sum total of mesiodistal width of mandibular canines and premolars and the predicted values derived from Moyer's method is statistically significant at 15, 25, 35, 65, 75, 85, and 95% levels for the male sample, at 15, 25, 35, 50, 85, and 95% levels for the female sample, and at 15, 25, 35, 50, 75, 85, and 95% levels for the combined sample. The difference between the measured sum total of mesiodistal width of mandibular canines and premolars and the predicted values derived from Moyer's method is statistically not significant at 50% level for the male sample, at 65 and 75% for the female sample, and at 65% for the combined sample.

Figure 8 shows the difference between the measured sum total of mesiodistal width of canines and premolars and the predicted values derived from Tanaka and Johnston space analysis and Moyer's method at different levels for the mandibular arch in males and females.

Results show that the corelation of the sum total of mandibular incisors (specific language impairment) and the sum total of predicted mesiodistal width of mandibular canines and premolars by Tanaka and Johnston method and Moyer's method at different levels with the sum total of actual mesiodistal tooth widths of mandibular canines and premolars for male, female, and the combined sample is statistically significant. Though the measured values of the sum total of the mesiodistal diameter of canines and premolars in both the arches fall between 50 and 65% for the male sample, between 65 and 75% for the female sample, and at 65% for the combined sample, 65% value is taken into consideration because most of the values are falling nearer to the 65% probability

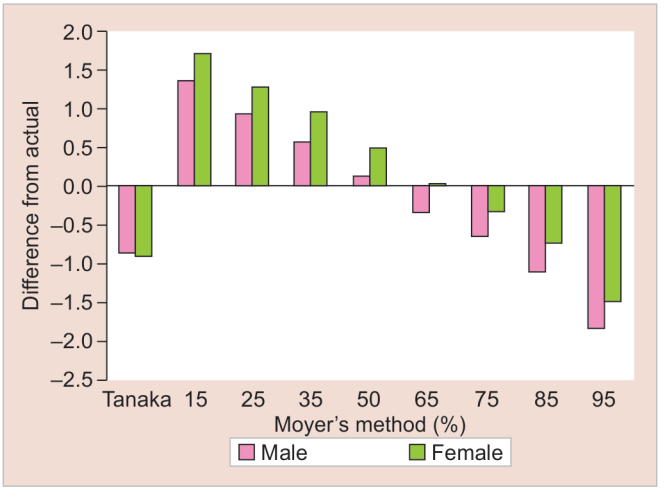


Fig. 8: Difference between the measured sum total of mesiodistal width of canines and premolars and the predicted values derived from Tanaka and Johnston space analysis and Moyer's method

range. The least statistically significant difference was obtained only at the 65% level of Moyer's probability chart for male, female, and combined samples.

Discussion

Early diagnosis and treatment planning in the mixed molar stage rely heavily on predicting the size of pre-erupted canines, premolars, and the available space to accommodate them.[17] By analyzing the mixed dentition, the dentist has the first opportunity to determine the risk of misalignment and space loss. One of the most crucial aspects of orthodontic research is measurement reliability, or the capacity to consistently obtain the same measurement across multiple measurements.

For the entire sample (n = 58), the paired *t*-test was used to compare individual differences in left and right mean diameters. Statistically, there was no difference between the right and left teeth ($p > 0.05$). This is due to the fact that the same factors that affect a tooth will also affect its life span.

The present results were found to be consistent with another investigator Melgaço et al.[18] Independent *t*-test results show that the mean tooth width of male subjects is always larger than that of female subjects in the upper and mandibular arches. This is consistent with the studies of Dahlberg,[19] Moorrees and Reed,[20] Bishara and Jakobsen,[21] Hattab et al.,[22] and Yeun et al.[23] Therefore, the results indicate the presence of sexual dimorphism. This, therefore, requires separate prediction formulas and probability tables for men and women. In this study, the predicted values of the mesiodistal diameters of the canines and premolars obtained by the spatial analysis technique of Tanaka and Johnston space analysis showed an overestimation when applying the prediction equation to guess the total number of mandibular incisors plus 11 for the upper arch and the sum total of the mandibular incisors plus 10.5 for the mandibular arch. This difference can be explained by the difference in racial origin of this study sample and that of Tanaka and Johnston space analysis. This finding is consistent with other researchers (Bishara and Jakobsen[21] and Vijayashree and Vijay[24]), who in their study, found that Tanaka and Johnston's space analysis prediction equation overestimated the width dimension of canines and premolars in the study sample.

This study found that Moyer's tables can be used at probabilities of 50 and 65% for the upper function, 50% for the imperative function, and other probabilities of 65 and 75% for the maxilla and mandible in girls, respectively, and 65% probabilities for the maxilla and mandible in the combined sample. It can be observed throughout the bar graph that the 50% Moyer probability level shows maximum agreement with the actual measured values of the sum total of the mean canine and premolar diameters for the given canine and premolars, the corresponding mean sum total of the mesiodistal diameters of the mandibular incisors for the maxillary and mandibular arches in the male sample, and at the 65% probability level for the maxillary and mandibular arches in the female sample.

Thus, the measured values of the total mesiodistal diameter of the canines and premolars in both arches range from 50 to 75%, the probability level in men and women. This result is consistent with the study carried out in Chennai (South India) by Kommineni et al.[25]

In the present study, the statistical evaluation showed a positive corelation between the total width of the mandibular permanent incisors and the total mesiodistal diameters of canines and premolars of the maxillary and mandibular arches in boys, girls, as well as samples.

Although predictions were maintained by taking precautions, this study was based solely on children's fully erupted teeth. If retrospective data with long-term follow-up are available, we can accurately assess the mean width of unerupted canines and premolars and provide a formula to apply to predict values for a particular population group. The current data can be retained as a basis for future studies to provide a new regression equation to increase the prediction accuracy for unerupted canine and premolar.

Conclusion

The study shows these conclusions.

Significant gender dimorphism in tooth size is observed among children in Kanpur city. Both boys and girls had significant bilateral symmetry. The sum total of the mesiodistal diameters of the mandibular permanent incisors can be used to accurately predict the sum total of the mesiodistal diameters of the premolars and canines before they begin to erupt. Tanaka and Johnston's space analysis technique couldn't precisely foresee the mesiodistal widths of canines and premolars before their emissions in Kanpur city youngsters because of the high changeability in gauges. Moyer's table can be used, according to this study, at the 50 and 65% probability levels for the upper jaw, and the 50% probability level for the imperative function for male subjects. It can also be used at the 65% probability level and 75% probability levels for the upper and mandibular jaws in female subjects, and at the 65% probability level for the upper and mandibular jaws in the combined sample.

References

1. Shaw WC, O'Brian KD, Richmond S, et al. Quality control in orthodontics: risk/benefit considerations. Br Dent J 1991;170(1):33–37. DOI: 10.1038/sj.bdj.4807399
2. Irwin RD, Herold JS, Richardson A. Mixed dentition analysis: a review of methods and their accuracy. Int J Paediatr Dent 1995;5(3):137–142. DOI: 10.1111/j.1365-263x.1995.tb00296.x
3. Nance HN. The limitations of orthodontic treatment: I. Mixed dentition diagnosis and treatment. Am J Orthod Oral Surg 1947;33(4):177–223. DOI: 10.1016/0096-6347(47)90051-3
4. Tanaka MM, Johnston LE. The prediction of the size of unerupted canines and premolars in a contemporary orthodontic population. J Am Dent Assoc 1974;88(4):798–801. DOI: 10.14219/jada.archive.1974.0158
5. Moyer RE. Handbook of orthodontics for the student and general practitioner. 3rd Ed. Chicago: Yearbook Medical Publishers, pp. 370–371.
6. Moyer RE. Hand book of Orthodontics. 4th Ed. Chicago: Yearbook Medical Publishers, pp. 235–240.
7. Moyer RE, Van der Linden P. G. M., Riolo M. L., McNamara, (Jr), J. A.: Standards of Human Occlusal development. Monograph 5, Craniofacial Growth Series. Ann Arbor, Michigan, Centre for Human Growth and Development, University of Michigan, pp. 43-48.
8. Hixon EH, Oldfather RE. Estimation of the sizes of unerupted cuspid and bicuspid teeth. Angle Orthod 1958;28(4):236–240. DOI: 10.1043/0003-3219(1958)028<0236:EOTSOU>2.0.CO;2
9. Staley RN, Kerber PE. A revision of the Hixon and Oldfather mixed-dentition prediction method. Am J Orthod 1980;78(3):296–302. DOI: 10.1016/0002-9416(80)90274-2
10. Rani MS, Goel S. Evaluation of Moyers mixed dentition analysis for south Indian population. J Indian Dent Assoc 1989;60:253–255.
11. Diagne F, Diop-Ba K, Ngom PI, et al. Mixed dentition analysis in a Senegalese population: elaboration of prediction tables. Am J Orthod Dentofac Orthop 2003;124(2):178–183. DOI: 10.1016/s0889-5406(03)00390-1
12. Bishara SE, Fernandez Garcia A, Jakobsen JR, et al. Mesiodistal crown dimensions in Mexico and the United States. Angle Orthod 1986;56(4):315–323. DOI: 10.1043/0003-3219(1986)056<0315:MCDIMA>2.0.CO;2
13. Wangpichit K, Huntington NL, Kapala JT. Comparison of three nonradiographic methods of mixed dentition analysis in cleft lip and palate patients. Pediatr Dent 2001;23(6):476–480.
14. Bernabé E, Flores-Mir C. Appraising number and clinical significance of regression equations to predict unerupted canines and premolars. Am J Orthod Dentofacial Orthop 2002;126(2):228–230. DOI: 10.1016/j.ajodo.2004.03.021
15. Priya S, Munshi AK. Formulation of a prediction chart for mixed dentition analysis. J Indian Soc Pedod Prev Dent 1994;12(1):7–11.
16. Zilberman O, Huggare JA, Parikakis KA. Evaluation of the validity of tooth size and arch width measurements using conventional and three-dimensional virtual orthodontic models. Angle Orthod 2003;73(3):301–306. DOI: 10.1043/0003-3219(2003)073<0301:EOTVOT>2.0.CO;2

17. Ingervall B, Lennartsson B. Prediction of breadths of permanent canines and premolars in mixed dentition. Angle Orthod 1978;48(1):62–69. DOI: 10.1043/0003-3219(1978)048<0062:POBOPC>2.0.CO;2
18. Melgaço CA, Araújo MT, Ruellas AC. Applicability of three tooth prediction methods for white Brazilians. Angle Orthod 2006;76(4):644–649. DOI: 10.1043/0003-3219(2006)076[0644:AOTTSP]2.0.CO;2
19. Dahlberg A.A. Papers on the physical anthropology of the American Indian. Edwards Brothers Inc, Ann Arbor, Michigan. 1951.
20. Moorrees CF, Reed RB. Correlations among crown diameters of human teeth. Archs Oral Biol 1964;9:685–697. DOI: 10.1016/0003-9969(64)90080-9
21. Bishara SE, Jakobsen JR. Comparison of two non-radiographic methods of predicting permanent tooth size in the mixed dentition. Am J Orthod Dentofac Orthop 1998;114(5):573–576. DOI: 10.1016/s0889-5406(98)70019-8
22. Hattab FN, Al-Khateeb S, Sultan I. Mesiodistal crown diameters of permanent teeth in Jordanians. Archs Oral Biol 1996;41(7):641–645. DOI: 10.1016/S0003-9969(96)00066-0
23. Yuen KK, Tang EL, So LL. Relations between the mesiodistal crown diameters of the primary and permanent teeth of Hong Kong Chinese. Archs Oral Biol 1996;41(1):1–7. DOI: 10.1016/0003-9969(95)00107-7
24. Vijayashree UH, Vijay RN. Reliability of Moyers and Tanaka Johnston mixed dentition analysis in school children of Belgaum. Indian J Orthod Dent Res 2016;2(4):166–171.
25. Kommineni NV, Reddy CV, Chandra NS, et al. Mixed dentition analysis- applicability of two non-radiographic methods for Chennai school children. J Int Soc Prevent Communit Dent 2014;4(2):133–138. DOI: 10.4103/2231-0762.139847