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A Novel Ratio to Determine Normal Maxillary Transverse Dimension by Using Intercanine width and Interpalatal First Molar Width

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ABSTRACT

Background: Malocclusion in the vertical and sagittal planes is easy to observe, whereas it is difficult to diagnose malocclusion in the transverse plane. There are few criteria defining a normal transverse occlusion. `

Materials and Methods: A total sample of 50 maxillary dental models in the age range of 12–16 years were randomly selected. Intercanine width (ICW) and inter-palatal molar width (IPMW) were measured for all the models. Banker's hypothesis, McNamara's criteria and Pont's analysis were applied. The models were bifurcated in two groups; deficient and normal arch, according to each analysis. The data were statistically analyzed using SPSS software version 23.0. Shapiro-Wilks test was performed to test the statistically significant difference between the groups.

Results: The number of deficient arches identified by Pont's, McNamara, and Banker's hypothesis was 47 (95.9%),11 (20%), and 17 (34%), respectively. Similarly, the number of well-formed arches identified by Pont's, McNamara, and Banker's hypothesis was 3 (4.1%), 39 (79.6%), 33 (65.3%), and respectively. There is no statistically significant difference. Nearly 98.60% of normal arches were found to have an IPMW to ICW ratio of 1:1 ± 0.05. On further analysis, it was found that when IPMW ≥34.83 mm, then the case may be considered to have normal arches, and if the ratio between IPMW to ICW is 1.11:1 ± 0.05 or more and IPMW is <34.83 mm, then the case may be identified as the deficient arch.

Conclusion: The IPMW-to-ICW ratio (Banker's hypothesis) can be used to differentiate deficient and normal arches. This hypothesis is an easy and non-invasive method, using only two parameters- IPMW & ICW. It has been developed to help clinicians in identifying the adequacy of the transverse dimension.

Keywords: Maxillary Transverse Dimension, Intercanine width, Interpalatal First Molar Width.

INTRODUCTION

A balanced transverse relationship between maxillary and mandibular dentition is a prerequisite for the establishment of normal occlusion regardless of patient's age. In particular, considering the high prevalence among adults, maxillary transverse deficiency does not appear to be diagnosed or treated properly, possibly due to the lack of diagnostic measures. The dental arch forms are of considerable importance to orthodontists as they aid in treatment planning, esthetics, and teeth stability.[1] Deficiency in the maxillary arch width leads to constriction of the maxilla, and it is considered to be one of the most common skeletal problems in the craniofacial region.[2] Diagnosing a case of transverse deficiency is subjected to debate among orthodontists, as there is no one agreed on a set of diagnostic criteria available. Traditional diagnostic techniques such as

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transpalatal tooth-to-tooth measurement, posteroanterior film measurement, and posterior crossbite visual assessment have been applied to identify transverse deficiency cases.

The transverse dimension of the maxilla is determined by anterior arch width measured through interchained distance and posterior arch width through intermolar distance. Some authors[3,4] have also used interpersonal distance to assess the transverse dimension of the maxilla. Arch width is one of the parameters in deciding the arch form, which plays a key role in creating the optimum esthetics, functional occlusion, stability, and well-finished results from an orthodontist's point of view. Broad arches are implicated in having stable, well-balanced, functional occlusion. Hence, there is a need for a delineation of broad or normal arches from narrow or deficient arches based on arch width. Several methods have been proposed to evaluate the transverse dimension: McNamara's hypothesis[2], Pont' formula,[5] Schwarz's analysis (Schwarz et al., 1966), Korkhausanalysis, Hayes's finger palpation technique,[6]Rickett's method[7] using cephalometric analysis, Howe's Index,[8] Moyer's Index (Profitt, 2000), and trans palatal width measurement index by Howe et al.[9] However, each method has its own drawbacks.

In the majority of the normal maxillary arches, the cusp tip of the canine was usually in line with the palatal surface of the first molar [Figure 1]. According to Banker's hypothesis[10], the interpalatal molar width (IPMW), the intercanine width (ICW), and its ratio can ascertain the transverse dimension. In this study, we intended to utilise the maxillary arch to predict the arch form only by using the ICW and IPMW as parameters. The authors wanted to test Banker's hypothesis that if the ratio between IPMW to ICW is equal to 1:1 ± 0.05, the case may be considered to have normal arches. With the advent of advanced diagnostic technology such as cone beam computed tomography, a more precise diagnosis of maxillary transverse deficiency (MTD) is possible nowadays, though it is highly expensive and technique sensitive. A normal sagittal dimension can be defined through Angle's classification as Class I, and a normal vertical dimension can be defined as a 2 mm overbite; however, there is no definite parameter to define the normal transverse dimension. Through this study, we made an attempt to identify those parameters which can define the normal transverse dimension using limited parameters and tools.

MATERIALS AND METHODS

Fig 1: Tangential line from the canine cusp tip in line with the palatal surface of the first molar.

The aim, objectives, and possible outcomes of the study were explained to orthodontists from where samples were collected. A total sample of 50 maxillary dental models in the age range of 12–16 years was selected. Pretreatment maxillary dental models of 50 patients in the age group of 12–16 years were obtained from an orthodontic clinic. None of the patients had a cleft lip, cleft palate, or any other craniofacial syndrome nor had undergone previous orthodontic treatment or prosthodontic treatment. All the arch dimensions measurements were made on the models using an electronic digital vernier calliper (Forbes 2004, Model number 111-302).

The following linear parameters were considered in the measurement.

Intercanine width (mm)

The ICW is measured from tips of the right and left canines. In case where the canines are out of arch, measurements were taken from the center of the alveolar arch in the canine region.

Interpalatal molar width (mm)

The interpalatal molar distance is measured from where the palatal groove ends on the palatal aspect of the first right and left molars.

Sum of incisors (mm)

The mesiodistal widths of all the four upper incisors were calculated and summed up. The linear distance between canines and interpalatal molars was measured. Then, the ratio between IPMW and ICW was calculated. Based on the hypothesis of the authors, all the dental models were divided into two categories such as narrow or deficient arches (B deficient) and normal arches (B normal).

Banker's hypothesis = If ratio between IPMW: ICW = 1:1 ± 0.05, it is a normal arch

To compare our hypotheses with other commonly used methods, all the dental models were also subjected to Pont's analysis5and categorized into p-deficient (narrow according to Pont's analysis) and p-normal (broad according to Pont's analysis).

Pont's analysis = if the inter premolar width ≤ SI×100/80, it is a deficient arch if molar width ≤ SI × 100/64, it is a deficient arch

Where, SI = Sum of incisor. Similarly, McNamara's criteria2were also taken into consideration and the models were categorized into M-deficient (narrow according to McNamara) and M-normal (broad according to McNamara).

McNamara's criteria = maxillary arches with IPMW ≤32 mm = deficient arches

=maxillary arches withIPMW between 33 to 36mm = normal arches

IPMW and ICW were measured on blinded models and the ratio between IPMW and ICW

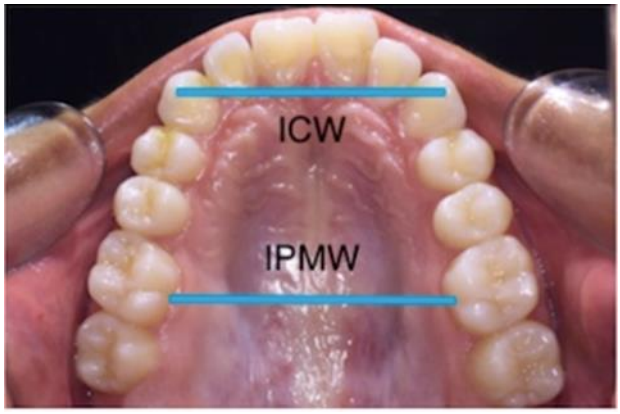

Fig 2: Landmarks used for measuring intercanine width, interpalatal molar width was calculated. After that, Banker's hypothesis,

Pont's analysis and McNamara's criteria were applied. The models were bifurcated into two groups; deficient and normal arch, according to each analysis. Then, blinding from the models was removed, and the result of the analysis was compared with the study models in the actual situation.

Statistical Analysis

Descriptive statistics (mean and standard deviation) and hypothesis tests were performed using SPSS software version 23.0. All the parameters of arch dimension were repeated three times with a time interval of 1 week by the same examiner to eliminate possible error in the measurements. Then, the mean of the repeated measurements was taken. To assess intraexaminer reliability, the operator measured fifty randomly selected casts at two different times. Interclass coefficient of correlation was performed to test the reliability of data. The nonparametric test (Cochran's Q test) was applied to test the distribution of data in BH, McNamara and Pont's analysis. The null hypothesis defines that the distribution pattern in all the above three analysis is the same. However, the test result revealed that there is a highly significant difference in the distribution. Cross tabulations were made for the diagnosis of MTD for each of the above-mentioned groups, and they were compared with the actual situation. A Chi-square test was performed to test the statistical significance difference between the diagnosis of Pont's, McNamara, and our study, at $p \leq 0.05$.

RESULTS

Interclass coefficient correlation results mentioned in Table 1 show that data are reliable to perform further statistical analysis. The mean ICW and IPMW in the study and control group are mentioned in Table 2. From Table 3, it can be observed that out of the 50 study models, the number of deficient arches identified by Pont's, McNamara, and Banker's hypothesis was 47 (95.9%),11 (20%), and 17 (34%) respectively. Similarly, the number of well-formed arches identified by Pont's, McNamara, and Banker's hypothesis was 3 (4.1%), 39 (79.6%), 33 (65.3%), and respectively. There is no statistically significant difference between McNamara, and Banker's hypothesis in the

assessment of transverse dimension as compared with the actual situation. This suggests that the assessment of transverse maxillary dimension is possible by all these methods, and furthermore, McNamara (79.6%) and Banker's analyses (65.3%) are more accurate in the diagnosis of normal arches.

Table 1: Intraclass coefficient of correlation.

Parameters(mm)	R^2
Intercanine width(ICW)	0.099
Interpalatal molar width (IPMW)	0.099
Sum of incisors (SI)	0.096

Table 2: Mean±SD values of ICW and IPMW for study group.

Inter Canine Width (ICW) (mm)	Inter Palatal Molar Width (IPMW) (mm)	ICW:IPMW
31.43 ± 2.39	34.83 ± 3.10	1.11± 0.09

Table 3: Table 3: Cross-tabulation for Pont's, McNamara and our study in an assessment of maxillary transverse dimension.

Pont's		McNamara's		Banker's		Total
P Deficient	P Normal	M Deficient	M Normal	B Deficient	B Normal	50
47 (95.9%)	3 (4.1%)	11 (20%)	39 (79.6%)	17 (34%)	33 (65.3%)	

DISCUSSION

The contraction or expansion of the maxillary arch, especially at the canine or molar regions, requires thorough pretreatment analysis and planning. Unplanned management produces instability in those regions posttreatment.[11]A good, well-balanced occlusion is often dependent on treating all the three components of malocclusion, i.e. vertical, sagittal, and the transverse dimensions. Even with all the various proposed methods, there is no single criterion on which every clinician can rely on. The assessment of MTD is very subjective. Hence, this study was undertaken to find a simple and preliminary diagnostic method to assess the dimension of the maxilla in the transverse plane. Smyth and Young[12] found that the relationship between tooth size and arch width was below an 'r' value of +0.4, which was statistically insignificant; they did not agree with Pont's Index. Greeve[13] critically analyzed the validity of the Pont's Index. In 102 dentitions with perfect occlusion, he found that only a low coefficient of correlation existed between the Sum of the mesiodistal crown diameters of the incisors and arch widths. They were statistically insignificant. Howe et al. [9] have shown that dental crowding, at least in individuals of European ancestry, appears to be related more to a deficiency in arch perimeter than to teeth that are too large. A primary factor in dental crowding often is a maxillary transverse or sagittal deficiency. If the position of the maxillary dentition reflects the skeletal discrepancy, crossbite results; on the other hand, if maxillary constriction is camouflaged by the dentition, and both dental arches are constricted, crowding in the absence of crossbite is observed. Banker et al. [10] took a total sample of 151 maxillary dental models (M = 55, F = 96) in the age range of 12–16 years were randomly selected, with 73 models in the control group and 78 in the study group. All the models were mixed up and given to an operator for the measurement of interchained width (ICW) and inter-palatal molar width (IPMW). Among all the three groups, Banker's hypothesis and McNamara's criteria were efficient in the diagnosis of the control group consisting of normal arches whereas Pont's analysis was more efficient in the diagnosis of the study group consisting of deficient arches. We used only two parameters in our study, i.e. ICW and the IPMW, which can be measured easily by the clinicians as a chairside technique and help them to plan out their treatment regimen for the patients. The primary findings of this study are that though all the three methods could identify deficient and normal arches, Banker's hypothesis and McNamara's criteria are more accurate in identifying well-formed arches as compared to Pont's analysis.

According to Banker's hypothesis, normal arches will have an IPMW: ICW ratio of 1.1 ± 0.05 ($P \leq 0.05$). Banker's hypothesis could identify 33 out of 50 models from the study group consisting of normal arches. On analyzing further, it was also found that if the ratio between IPMW: ICW ≥1.11:1, the models can be identified as having deficient arches.

Out of the 50 models in the study group, Pont' analysis could identify 47 cases as having deficient arches. Hence, Pont's analysis was not efficient in identifying the normal arch since it could identify

only 3 out of the 50 models. These findings are in agreement with those reported by another investigator.[14] Results of McNamara's criteria are similar to that of our study. The average trans palatal molar width in Banker's hypothesis is 34.83 ± 3.10 mm in the study group. McNamara9stated that a maxillary arch with a transpalatal width of 36–39 mm is considered to be adequate for dentition of average size without crowding or spacing, whereas maxillary arches <31 mm in width may be crowded and need orthopaedic or surgically assisted expansion. In our study, if IPMW < 34.83 ± 3.10 mm was seen in the study group consisting of the narrow arches. This was 3.83 mm more than that suggested by McNamara. When these results were statistically analyzed, it was found that both the studies, i.e., McNamara and Banker's hypothesis are efficient in the diagnosis of the Normal arch group. In this study, the average IPMW was < 34.83 ± 3.10 mm in the cases of the narrow arch and >34.83 ± 3.10 mm in the cases of the normal arch, which was in accordance with the study done by Howe et al.[9] In their study, the IPMW of the maxillary arch in males averaged 37.4 mm in the noncrowded group and 30.8 mm in the crowded group. Banker et al. have used a method that is a very simple, easy, and chairside technique. It can be used by clinicians on a preliminary basis to plan their treatment regimen. This method will help identify cases having normal arches and rule out the cases requiring expansion as a part of their comprehensive treatment plan. It is advised that the final diagnosis should always be confirmed by using radiographs.

Clinical Significance

It helps in identifying cases requiring maxillary expansion by differentiating normal and deficient maxillary arches provides a benchmark for achieving proportionate arch widths after treatment.

CONCLUSION

Among all the three groups, Banker's hypothesis and McNamara's criteria were efficient in the diagnosis of normal arches, whereas Pont's analysis was not efficient in the diagnosis of the normal as well as deficient arches. This study suggested Banker's hypothesis is as reliable as McNamara's criteria.

On further analysis, it was found that if the ratio between IPMW width to ICW is equal to 1:1 ± 0.05 and IPMW is more than 34.83 mm, the case may be considered to have normal arches, and if the ratio between IPMW to ICW is 1.15:1 ± 0.05 or more and IPMW is <34.83 mm, the case may be identified as a deficient arch.

A 1:1 ratio of IPMW to ICW is a simple, easy to measure, chairside diagnostic aid. Clinicians can aim to achieve this ratio at the end of treatment for achieving well-proportioned normal arches

This technique does not require any expensive equipment or exposure to extra radiation.

There is the scope of future research in this area on larger sample size and gender-specific ratio.

Limitations of the study

One of the limitations of this study was this ratio cannot be applied to cases that are constricted simultaneously in both anterior and posterior regions. However, in such cases, the posterior teeth would be in crossbite, and this feature itself is one of the criteria for MTD.

When the canine is in the ectopic position, it is necessary to assume its correct position in the arch.

There was no discrimination done based on gender in our study.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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