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Assessment of accuracy and reliability of Pont's index in different classes of dental malocclusion

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Abstract

Introduction: Proper interdigitated dentition, ideal arch form and widths are the key for occlusion, function and stability. Different indices are used by the clinicians to assess the amount of expansion required to obtain ideal arch width and to relieve crowding. Pont's Index introduced by Pont, can be easily applied and it could provide the valuable information to help treatment planning. The rationale of this study was to assess the accuracy and reliability of Pont's index in calculating the dental arch width in different classes of dental malocclusions.

Material and methods: A total of 50 scanned models of patients were included in the study. The digital measurements were taken from scanned models via CS Model+ software and manual measurements were taken using digital vernier caliper from the same dental casts. Mesiodistal widths of maxillary incisors, Inter-premolar widths (IPW) and Intermolar widths (IMW) were measured both digitally and manually. Predicted arch widths were calculated using Pont's prediction formula.

Results: Statistically significant differences between actual and predicted values for IPW and IMW were found. Excellent correlation was observed between all digital and manual measurements. Maxillary central incisors, IPW and IMW were larger in males compared to females for both digital and manual measurements. IPW was significantly greater in class-III than in other classes of dental malocclusions.

Conclusions: Pont's index is not a reliable method for predicting dental arch width in orthodontic patients. Maxillary central incisors, IPW and IMW were larger in males compared to females for both digital and manual measurements. IPW was significantly greater in class-III than in class I and II.

Keywords: Malocclusion; maxillary central incisors; software; index

Introduction

Dental casts play a key role in prediction of dental arch growth and help in diagnosis and treatment planning of orthodontic cases.[1] Analysis of dental cast provides information about maxillary and mandibular teeth and their inter-cuspal relation in three dimensions. Arch form, arch length and arch width are among the important parameters which describe arch dimensions.[2]

Many crowded cases can be treated efficiently with either an extraction or non-extraction therapy. Crowding is due to discrepancy between total tooth material and arch perimeter. Because of the comparatively shorter treatment period non-extraction treatment can be more efficient while extraction approaches take longer time, however, are probably more stable.[1] Different approaches to relieve crowding apart from extraction include interproximal tooth

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reduction, distalization, proclination of incisors and arch expansion.[2]

Different indices are used by the clinicians to assess the amount of expansion required to obtain ideal arch width and to relieve crowding. In 1909 Pont presented a method for estimating the ideal dental arch width known as "Pont's index". According to this method there is a constant relationship between the width of four maxillary incisors and inter premolar and intermolar arch width in the maxilla.[3 4]

Pont's Index can be easily applied and it could provide the valuable information to help treatment planning.[5] However, using this index remains highly debatable with some studies are in favor of its use to predict arch widths[6,7]while others concluding that Pont's Index is not reliable and should not be used for purposes.[1-3,8]A study conducted by Rathi et al found a weak correlation between actual values and values calculated by Pont's prediction formula. They proposed that Pont's index is not clinically useful to predict arch width.[9] Another study reported low correlations between measured and Pont's predicted values for arch width in sample of Peshawar population.[10]

Since manual analysis takes time and careful handling is needed, chances of cast damage and losing models are more. Nowadays new techniques using digital models are in use, which takes less time, data saving, and retrieval is easy, no storage space is needed and minimal chances of data loss.

Previous studies have shown mixed results regarding the reliability and accuracy of Pont's index, it was required to obtain a thorough understanding of its potential usefulness. Previous studies were conducted using a digital caliper. To our knowledge, no study has been conducted using digital software. There is a need to check the correlation of digitally measured values to the manually measured values

The objective of present study was to evaluate the accuracy and reliability of Pont's index in calculating the dental arch width in different classes of dental malocclusion in patients presenting to orthodontics department of Rehman College of dentistry using CS Model+ software.

Material and Methods

This cross-sectional analytical study was conducted at the department of orthodontics, Rehman College of dentistry (RCD) in August-Nov 2020. Approval of ethical committee of RCD was obtained for the study in the Ref No:2021-06-071. A total of 50 scanned models of patients (age range 13-35years) irrespective of gender was selected for participation in study.

Inclusion criteria were Angle class I, II, III occlusion, complete permanent dentition and reasonably aligned upper arch. While patients having transverse skeletal deformity, history of orthodontic treatment, extraction or congenitally missing teeth and Carious teeth were excluded.

The measurements were directly taken from scanned models, according to method used by Alam et al,[11] using software CS Model+ version. The measurements were taken from the same dental casts manually via digital vernier caliper. Following measurement was recorded for each dental cast on occlusal view:

1.Mesio distal widths of maxillary incisors was measured from anatomical contact point of one tooth to other, Sum of incisor width (SIW).

- Maxillary Inter premolar width was measured from the distal pits of one maxillary first premolar to other (IPW).
- Maxillary Inter Molar width was measured from the central fossa of one maxillary first molar to the other (IMW).

Predicted arch widths were calculated using Pont's prediction formula as

$$\text{Inter premolar arch width (IPW)} = \frac{sum\ of\ incisal\ widths(SIW)}{80} \times 100$$

Inter molar arch width (IMW)= $\frac{sum\ of\ incisal\ widths(SIW)}{64}$ ×100

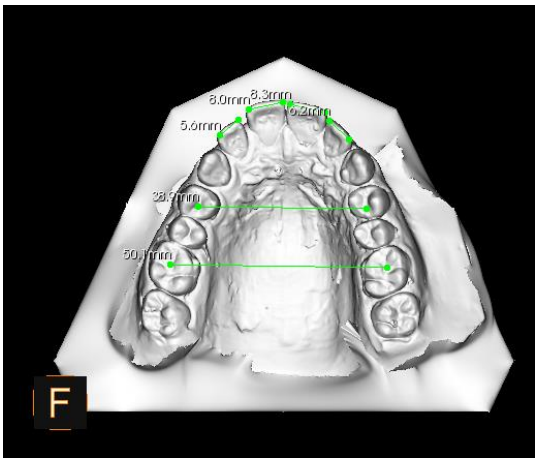

Figure 1: Occlusal view of dental cast.

Data was statistically analyzed by using SPSS software version 22.0. Normality of the data was evaluated with Shapiro-Wilk test. For comparison between the actual and predicted inter premolar and inter molar widths, paired t-test was used. To assess the relationship between digital and manual measurements interclass correlation coefficients were calculated. An r-value of 0.80 or more was considered excellent correlation. Independent sample t-test was used for gender comparisons while one-way ANOVA test was used for comparison among different classes of dental malocclusion. P value of ≤ 0.05 was considered significant. Clinical significance was set at a difference of 1mm or more between measurements.

Results

Scanned models of 50 patients (27 females, 23 males) with a mean age of 18 years (range 13-35) were included in this study. Class I included 16 patients (12 females,4 males); class II included 22 patients (12 females, 10 males) while class III included 12 patients (9 females, 3 males).

Statistically significant differences between actual and predicted values for IPW and IMW were found except for digital measurements of IPW. Highest mean difference was found for manual IPW (-2.48±3.8) measurements while lowest mean difference was found for digital IPW values (0.94±3.5).

Table I: Differences between IPW and IMW.

	Actual IPW (mm)	Predicted IPW (mm)	Difference (mm)	P value	Actual IMW (mm)	Predicted IMW (mm)	Difference (mm)	P value
DIGITAL	35.34±3.4	34.44±2.1	0.94±3.5	.143	45.2±3.2	43.05±2.6	2.1±3.4	.001
MANUAL	35.2±3.4	37.6±2.3	-2.48±3.8	0.000	45.2±3.5	47.05±2.9	-1.9±3.9	0.007

Table II: Correlation between digital and manual measurements.

	Actual IPWd	Actual IPWm	Actual IMWd	Actual IMWm	Predicted IPWd	Predicted IPWm	Predicted IMWd	Predicted IMWm
Mean ±SD	35.3±3.4	35.1±3.4	45.2±3.2	45.1±3.5	34.4±2.1	37.6±2.3	43.05±2.6	47.05±2.9
Correlation	0.9		0.9		0.9		0.9	
(p-value)	0.000		0.000		0.000		0.000	

Excellent correlation was observed between all digital and manual measurements. (Table II)

Table III: Gender based descriptive statistics.

GENDER		MALE	FEMALE
DIGITAL	**IPW**	38.0±4.2	34.7±3.5
	IMW	46.8±2.6	44.0±3.4
	UR2	5.9±0.5	5.8±0.4
	UR1	8.0±0.4	7.7±0.6
	UL1	8.1±0.4	7.7±0.5
	UL2	5.9±0.5	5.7±0.4
MANUAL	**IPW**	36.7±2.8	34.7±3.5
	IMW	47.4±2.8	44.0±4.0
	UR2	6.6±0.6	6.3±0.5
	UR1	8.8±0.5	8.2±0.5
	UL1	8.8±0.5	8.2±0.6
	UL2	6.6±0.6	6.3±0.4

Actual IPW and IMW were significantly different between genders with a maximum difference of 3.6±0.7mm and 2.6±0.7mm respectively (P value .005). Mean digital

values of actual IPW and IMW were larger for males (38.0 ± 4.2 and 46.8±2.6) as compared to females (34.7± 3.5 and 44.0± 3.4). similarly, manually measured values for IPW and IMW were larger for males (36.7 ±2.8 and 47.4 ±2.8) as compared to females (34.7 ±3.5 and 44.0 ±4.0) (table III). Individual tooth sizes were also compared in genders. Both central incisors were significantly larger in males as compared to females (p value 0.001).

Table IV: Difference in manual and digital values in relation to dental malocclusion classes

MALOCCLUSION		CLASS I	CLASS II	CLASS III
DIGITAL	IPW	36.1±3.0	34.3±3.2	40±4.7
	IMW	45.3±2.9	44.8±3.3	46.2±4.1
	UR2	5.7±0.4	5.9±0.5	5.7±0.4
	UR1	7.8±0.5	7.9±0.6	7.8±0.6
	UL1	7.8±0.4	7.9±0.6	7.8±0.6
	UL2	5.7±0.4	6.0±0.5	5.6±0.5
MANUAL	IPW	35.6±3.1	34.5±3.6	37.7±2.6
	IMW	45.2±3.7	45.1±3.7	47.8±3.9
	UR2	6.5±0.5	6.5±0.6	6.4±0.5
	UR1	8.4±0.6	8.6±0.6	8.3±0.5
	UL1	8.4±0.5	8.6±0.6	8.3±0.6
	UL2	6.3±0.4	6.5±0.6	6.4±0.6

Individual tooth sizes were compared in classes. IPW was significantly higher in class-III than in class I and II (p value 0.000). However, no significant differences were observed for other variables (table IV).

Discussion

This study aimed to assess the accuracy and reliability of Pont's index in calculating the dental arch width in different classes of dental malocclusion. Maxillary premolar and molar width differences in different dental malocclusions were also assessed, both manually and digitally. Our results show that Pont's index is not an accurate measure of inter-premolar and inter-molar widths.

Many researchers have assessed the clinical applicability of Pont's index using different selection criteria. Studies have been done on different populations and ethical groups to check applicability of this.[1,3,5] To our knowledge, no other study evaluated Pont's index on local population using both manual method and digital software in Pakistan.

Statistically significant differences were found between the actual and predicted IPW and IMW for both manually and digitally measured values. Interestingly, the manual method overestimated the arch widths while the values were underestimated when calculated digitally. This can be because of more precise measurements which are possible with digital measurements. A study conducted by Alam et al on Malay population using CBCT (Cone Beam Computer Tomography) showed the same results of overestimation of the widths.[11] Our results show that Pont's formula cannot be used clinically to estimate the arch widths in our population. These results are in agreement with the previous studies of Dalidjan, Al-Omari on Jordanian population and Faizan et al who conducted a similar study on Peshawar population. All these studies showed that the correlation between actual and predicted values was weak and thus they proposed that the Pont's index formula should not be used for determination of arch widths.[1,5,12]

Excellent correlations were found between manually and digitally measured actual and predicted IPW and IMW (Table II). According to this, digital software can be used as an alternative to manual calculations of arch widths on dental casts. Digital models can be easily and reliably used for measurements which takes less time for calculations.[13 14]

Actual inter-premolar and inter molar width were significantly greater for males compared to females in both manually and digitally measured values. These results were in accordance with the previous studies [12,15,16] whereas the study of Azeem which was conducted in Faisalabad and Lahore found

greater arch widths in females than in males.[17] According to this study individual tooth sizes were larger in males compared to females and major difference was in central incisors. Same results were found in the study of karaman.[18] This disagrees with the findings of Al-Omari and Ahmet Arif conducted on Turkish population who showed no significant difference in individual tooth sized in both genders.[5,19] (Table III)

In the present study individual tooth sizes and arch widths were also compared in different sagittal dental malocclusions, where no significant difference was found except for IPW which was significantly greater in Class-III than in Class-I and Class-II. To our knowledge no other study compared these variables in various classes of malocclusions.

In future studies can be conducted considering extraoral features, soft tissue profile, growth status, skeletal jaw relationships as perimeters while assessing the arch width and teeth sizes.[11]

The limitations of the study were

- Sample size can be increased in further studies to strengthen the bases for comparison.
- Skeletal classes of malocclusion can be included to assess the application of Pont's index to various classes.
- Post treatment records can be evaluated to assess if predicted widths are achieved after treatment.

Conclusions

- Pont's index is not a reliable method for predicting dental arch width in orthodontic patients.
- Manual method overestimated the arch widths while digital underestimated the values.
- Maxillary central incisors, IPW and IMW were larger in males compared to females for both digital and manual measurements.
- IPW was significantly greater in class-III than in class I and II.

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