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EVALUATION OF VALIDITY OF PONT'S INDEX AND ITS CORRELATION TO THE FACIAL FRAMEWORK IN INDIANS

Dental Science

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ABSTRACT

Objective: Assessing applicability of Pont's index in Indians and determining whether a correlation existed between it and other facial framework landmarks in this group.

Methodology: 100 Indian subjects between 18-25 years were selected and combined incisal width and arch widths were measured from maxillary study models. Facial framework measurements were taken directly on the subjects from specified craniofacial landmarks. Values obtained were compared with predicted values according to Pont's index and correlations between different dental and facial framework measurements were studied.

Results: Moderate correlation existed between combined incisal width and the arch widths in the premolar and molar region. The measured arch widths were smaller than the predicted arch width. A significant correlation of facial width, mouth width, mandibular width, maxillary depth, mandibular depth with arch width in the premolar and molar region was reported.

Conclusion: Pont's index tends to overestimate the premolar and molar arch widths by 2.46 mm and 2.08 mm respectively in Indian population and a moderate to strong correlation exists between facial framework and the above arch widths.

KEYWORDS

INTRODUCTION

In clinical practice, arch size and shape are of particular interest to orthodontist. The wealth of information obtained from dental cast plays a significant role in diagnosis, treatment planning and evaluation.[1]

In1909, Pont reported that in the ideal dental arch, the ratio of combined maxillary incisor width to transverse arch width was .80 in the premolar area and .64 in the molar area. He concluded that his work should be applied to different ethnic groups for verification or correction.[2]

Pont's Index is easy to apply and provides valuable information to aid treatment planning. However, the use of Pont's Index in predicting ideal arch shape in orthodontics has been controversial.[3] Some investigators have supported its use as a guide in expanding the dental arch[4-5] and as a determinant of arch development.[6-9] Others have found very low correlations between observed and predicted arch widths and have concluded that Pont's Index is not a reliable diagnostic procedure for planning orthodontic treatment.[10-12]

One of the objections raised against the Pont's Index is that it ignores the patient's craniofacial framework. However, Pont did feel that there were certain relationships between the form of the skull..[11] Hence, there is also a need to validate the usefulness of Pont's Index against the patient's craniofacial pattern.

Population from different geographical locations and the two genders differ with respect to the facial form, [17,18] tooth size and ratios[19,20] and the arch widths.[21-22] Tthis study was conducted to assess the applicability of Pont's index in Indian population and to determine whether a correlation existed between it and other landmarks of the facial framework in this ethnic group.

METHODOLOGY

100 subjects in the age group of 18-25 years (having both parents as Indian) were selected from 5 different dental colleges of India and written consent was obtained after explaining the procedure.

INCLUSION CRITERIA:

1. Healthy gingivae and periodontium.
2. Angle's class I occlusal relationship with overbite < 4 mm, overjet < 3 mm.
3. Well-aligned upper and lower dental arches.
4. Full complement of teeth from second molar to second molar in both arches.
5. No supernumerary teeth.
6. No or minimal spacing /crowding.
7. Minimal rotations.
8. Minimal attrition.
9. No prior orthodontic or prosthodontic treatment.

EXCLUSION CRITERIA:

1. Obvious diastema.
2. Abnormal buccal or lingual tipping of teeth.
3. Rotated teeth.
4. Crossbite
5. Reverse curve of Spee.
6. Fractured or carious teeth.
7. Missing teeth (excluding third molars).
8. Malformed teeth like peg laterals.
9. Presence of cleft palate.

10. Proximal restorations.

After Alginate impression of maxillary arch and cast models, facial framework measurements using a digital Vernier Caliper with 0.01 mm accuracy were taken directly on the subjects from specified craniofacial landmarks.

Measurements from cast models:

1. Sum of incisal width – Measurement of mesiodistal incisor width was performed as described by Hunter and Priest.23The combined measured width of 4 maxillary incisors was obtained by the sum of their diameters.
2. Premolar arch width - Distance between the distal end of the occlusal groove of the maxillary left and right first premolars.
3. Molar arch width - Distance between the mesial pits on the occlusal surfaces of the maxillary left and right permanent molars.

Calculations from cast model's measurements:

The predicted arch widths were estimated with the formula proposed by Pont.

$$\text{Predicted premolar arch width} = \frac{\text{Sum of incisal widths}}{80} \text{ X } 100$$

$$\text{Predicted molar arch width} = \frac{\text{Sum of incisal widths}}{64} \text{ X}100$$

The premolar and molar indices were then calculated using the following formulae:

1. Pont's premolar index

$$\text{Premolar Index} = \frac{\text{Sum of incisal widths}}{\text{Premolar arch width}} \text{ X } 100$$

2. Pont's molar index

$$\text{Molar Index} = \frac{\text{Sum of incisal widths}}{\text{Molar arch width}} \text{ X } 100$$

Measurement of Craniofacial Dimensions:

Soft tissue landmarks:

1. Zygion (zy)
2. Gonion (go)
3. Nasion (n)
4. Gnathion (gn)
5. Subnasale (sn)
6. Tragion (tr)
7. Cheilion (ch)
8. Stomion (sto)

Measurements from soft tissue landmarks:

1. Face width (zy-zy)
2. Mandibular width (go-go)
3. Face height (n-gn)
4. Upper face height (n-sto)
5. Mandibular height (sto-gn)
6. Left maxillary depth (t-sn) (Left)
7. Left mandibular depth (t-gn) (Left)
8. Mouth width (ch-ch).

To take the measurements, the caliper was placed from the facial aspect and the jaw beaks were closed until they touched the appropriate facial landmarks.

Error of the method:

Twenty subjects and dental cast models were selected randomly and the measurements were carried out on two separate occasions with a 2-week interval. The error was estimated using Dahlberg's formula.[24]

Statistical Analysis:

The data was analysed using IBM SPSS (Statistical Package for Social Sciences) software version 20.0 A t -test for independent samples was used to determine any significant difference in facial framework, upper incisor size and/or arch width values for males and females.Correlations were calculated between the measured and predicted arch width values and between the measured facial framework parameters, combined incisal widths and arch widths.Regression analyses were carried out to estimate premolar and molar arch width based on facial dimensions. Relationship and variability between arch widths and facial dimensions were obtained with the help of Scatter plot diagrams.

RESULTS

Out of the 100 samples recorded 58 were females and 42 were males.

Table I shows descriptive parameters of mean, standard deviation and 95% confidence limit of the facial and dental dimensions.

There was a highly significant difference between males and females in all facial and dental dimensions ($p<0.001$) with males having a greater value for all parameters (Table II). Also, p value of .027 for premolar width and .003 for mandibular width respectively showed significant difference between the two sexes..

The mean measured premolar and molar widths were smaller than the mean premolar and molar widths by 2.46 mm and 2.08 mm respectively ($p<0.001$, HS)(Table III).

Table IV presents the results of regression analysis done to estimate premolar arch width based on facial dimensions. The final model showed significant result for mouth width, upper face height and left maxillary depth for calculating the dependent variable – the premolar arch width.

Table V shows the results of regression analysis done to estimate molar arch width based on facial framework measurements. The final model showed statistically significant result for face width and mouth width as constants.

	N	Mean	Std. Deviation	95% Confidence Interval for Mean		Minimum	Maximum
				Lower Bound	Upper Bound		
Face Width (zy-zy)	100	121.65	6.33	120.39.	122.90	106.41	138.64
Mand. Width (Go-Go)	100	107.17	7.61	105.66	108.68	93.06	132.70
Mouth width (Ch-Ch)	100	51.48	3.35	50.82	52.15	44.12	60.19
Face Height (n-gn)	100	106.42	6.45	105.14	107.70	94.51	124.39
Upper Face Ht (n-sto)	100	68.14	3.97	67.36	68.93	60.19	79.64
Mand. Height (sto-gn)	100	38.28	3.52	37.58	38.98	29.75	45.76
Left Max Depth (t-sn)	100	123.01	5.60	121.90	124.12	111.02	135.53
Left Man Depth (t-gn)	100	134.79	7.33	133.33	136.24	117.86	149.94
Tooth dimension	100	31.00	1.83	30.63	31.36	26.02	36.22
PM width	100	36.28	2.22	35.84	36.72	31.27	42.47
Molar width	100	46.35	2.50	45.86	46.85	40.50	55.95

Table I – Descriptive statistics of facial framework and dental parameters

		N	Mean	Std. Deviation	95% Confidence Interval for Mean		t value	p value
					Lower Bound	Upper Bound		
Face Width (zy-zy)	F	58	119.31	5.55	117.85	120.77	4.79	p<0.001
	M	42	124.87	5.97	123.01	126.73		HS
	Total	100	121.65	6.33	120.39	122.90		
Mand. Width (Go-Go)	F	58	105.26	6.05	103.67	106.85	3.07	.003
	M	42	109.81	8.76	107.08	112.54		HS
	Total	100	107.17	7.61	105.66	108.68		
Mouth width (Ch-Ch)	F	58	50.24	2.89	49.48	51.00	4.84	p<0.001
	M	42	53.20	3.20	52.21	54.20		HS
	Total	100	51.48	3.35	50.82	52.15		
Face Height (n-gn)	F	58	104.21	5.28	102.82	105.59	4.39	p<0.001
	M	42	109.47	6.72	107.38	111.57		HS
	Total	100	106.42	6.45	105.14	107.70		
Upper Face Ht (n-sto)	F	58	66.91	3.29	66.04	67.77	3.92	p<0.001
	M	42	69.86	4.22	68.54	71.17		HS
	Total	100	68.14	3.97	67.36	68.93		
Mand Height (sto-gn)	F	58	37.30	3.26	36.45	38.16	3.42	p<0.001
	M	42	39.62	3.47	38.54	40.70		HS
	Total	100	38.28	3.52	37.58	38.98		
Left Max Depth (t-sn)	F	58	120.17	4.44	119.00	121.33	7.40	p<0.001
	M	42	126.93	4.61	125.49	128.37		HS
	Total	100	123.01	5.60	121.90	124.12		
Left Man Depth (t-gn)	F	58	131.07	5.68	129.58	132.56	7.41	p<0.001
	M	42	139.92	6.18	137.99	141.85		HS
	Total	100	134.79	7.33	133.33	136.24		
Tooth dimension	F	58	30.44	1.51	30.05	30.84	3.79	p<0.001
	M	42	31.76	1.97	31.15	32.38		HS
	Total	100	31.00	1.83	30.63	31.36		
PM width	F	58	35.87	2.08	35.32	36.41	2.25	.027
	M	42	36.86	2.31	36.14	37.58		sig
	Total	100	36.28	2.22	35.84	36.72		
Molar width	F	58	45.52	2.05	44.98	46.06	4.25	p<0.001
	M	42	47.51	2.62	46.69	48.32		HS
	Total	100	46.35	2.50	45.86	46.85		

Table II – Gender differences between the facial and dental parameters

	Mean	Std. Deviation	Difference	t test p value
Measured Premolar Width	36.28	2.22	-2.46	p<0.001, HS
Predicted Premolar Width	38.75	2.29		
Measured Molar Width	46.35	2.50	-2.08	p<0.001, HS
Predicted Molar Width	48.43	2.86		

Table III–Difference between measured and predicted arch width

Model	Unstandardized Coefficients	Standardized Coefficients	t	p-value	
	B	Std. Error	Beta		
1	(Constant)	14.78	4.40	3.35	0.001*
	Face Width	0.03	0.04	0.09	0.83	0.40(NS)
	Mand. Width	0.03	0.03	0.10	0.99	0.32(NS)
	Mouth width	0.30	0.06	0.46	4.50	<0.001*
	Upper Face Ht	-0.14	0.05	-0.25	-2.68	0.009*
	Mand Height	0.005	0.06	0.008	0.07	0.93(NS)
	Left Max Depth	0.15	0.06	0.38	2.24	0.03*
	Left Man Depth	-0.08	0.04	-0.26	-1.68	0.09(NS)
2	(Constant)	14.80	4.37	3.38	0.001*
	Face Width	0.03	0.04	0.09	0.83	0.40(NS)
	Mand. Width	0.03	0.03	0.10	0.99	0.32(NS)
	Mouth width	0.30	0.06	0.46	4.61	<0.001*
	Upper Face Ht	-0.14	0.04	-0.25	-2.87	0.005*
	Left Max Depth	0.15	0.06	0.38	2.30	0.02*
	Left Man Depth	-0.08	0.04	-0.26	-1.70	0.09(NS)
3	(Constant)	15.84	4.18	3.78	<0.001*
	Mand. Width	0.04	0.02	0.14	1.49	0.13(NS)
	Mouth width	0.30	0.06	0.46	4.60	<0.001*
	Upper Face Ht	-0.14	0.04	-0.25	-2.93	0.004*
	Left Max Depth	0.16	0.06	0.41	2.58	0.01*
	Left Man Depth	-0.07	0.05	-0.25	-1.64	0.10(NS)
4	(Constant)	16.36	4.19	3.90	<0.001*
	Mouth width	0.31	0.07	0.47	4.74	<0.001*
	Upper Face Ht	-0.14	0.05	-0.25	-2.89	0.005*
	Left Max Depth	0.18	0.06	0.45	2.84	0.005*
	Left Man Depth	-0.06	0.05	-0.21	-1.41	0.16(NS)
5	(Constant)	16.76	4.21	3.98	<0.001*
	Mouth width	0.30	0.07	0.45	4.55	<0.001*
	Upper Face Ht	-0.14	0.05	-0.26	-2.95	0.004*
	Left Max Depth	0.11	0.04	0.28	2.68	0.008*

Table IV – Linear regression to estimate premolar arch width based on facial framework measurements

Dependent Variable :- Premolar width
Model Fit ANOVA for step 1 to 5 = P<0.001*
R2 = 0.42 for step 1, Δ R2 = 0 for step 2, Δ R2 = -0.004 for step 3, Δ R2 = -0.014 for step 4, Δ R2 = -0.013 for step 5
*P<0.05 statistically significant

Model	Unstandardized Coefficients	Standardized Coefficients	t	p-value	
	B	Std. Error	Beta		
1	(Constant)	16.00	5.05	3.17	0.002*
	Face Width	0.13	0.04	0.35	2.97	0.004*
	Mand. Width	0.01	0.03	0.03	0.32	0.74(NS)
	Mouth width	0.28	0.07	0.38	3.66	<0.001*
	Upper Face Ht	-0.02	0.06	-0.04	-0.41	0.68(NS)
	Mand Height	-0.03	0.07	-0.05	-0.56	0.57(NS)
	Left Max Depth	0.04	0.07	0.10	0.61	0.53(NS)
	Left Man Depth	-0.03	0.05	-0.11	-0.70	0.48(NS)
2	(Constant)	15.93	5.02	3.17	0.002*
	Face Width	0.14	0.04	0.36	3.42	0.001*
	Mouth width	0.29	0.07	0.38	3.72	<0.001*
	Upper Face Ht	-0.02	0.06	-0.03	-0.39	0.69(NS)
	Mand Height	-0.04	0.06	-0.06	-0.59	0.55(NS)
	Left Max Depth	0.04	0.07	0.11	0.63	0.52(NS)
	Left Man Depth	-0.03	0.05	-0.10	-0.67	0.50(NS)
3	(Constant)	15.32	4.74	3.22	0.002*
	Face Width	0.14	0.04	0.36	3.43	0.001*
	Mouth width	0.28	0.07	0.38	3.72	<0.001*
	Mand Height	-0.05	0.06	-0.07	-.80	0.42(NS)
	Left Max Depth	0.04	0.07	0.10	0.59	0.55(NS)
	Left Man Depth	-0.03	0.05	-0.11	-0.68	0.49(NS)
4	(Constant)	16.17	4.51	3.58	0.001*
	Face Width	0.15	0.04	0.38	3.81	<0.001*
	Mouth width	0.30	0.07	0.40	4.04	<0.001*
	Mand Height	-0.04	0.06	-0.06	-0.68	0.49(NS)
	Left Man Depth	-0.02	0.04	-0.05	-0.39	0.69(NS)
5	(Constant)	15.97	40.46	3.58	0.001*
	Face Width	0.14	0.03	0.36	4.16	<0.001*
	Mouth width	0.28	0.06	0.38	4.41	<0.001*
	Mand Height	-0.05	0.05	-0.07	-0.91	0.36(NS)
6	(Constant)	14.52	4.16	3.48	0.001*
	Face Width	0.14	0.03	0.35	4.08	<0.001*
	Mouth width	0.28	0.06	0.38	4.40	<0.001*

Table V – Linear regression to estimate molar arch width based on facial framework measurements

Dependent Variable :- Molar width
Model Fit ANOVA for step 1 to 6 = P<0.001*
R2 = 0.40 for step 1, Δ R2 = -0.001 for step 2, Δ R2 = -.001 for step 3, Δ R2 = -.002 for step 4, Δ R2 = -.001 for step 5, Δ R2 = -.005 for step 6, *P<0.05 statistically significant

DISCUSSION

Tooth morphology and facial forms are known to be influenced by cultural, environmental and racial factors.[17-21] Thus, the applicability and clinical value of Pont's Index has been assessed in many investigations using different selection criteria. The present study aimed to assess the validity of Pont's Index in Indians and also to find out its correlation with the facial framework.

In present study, the combined maxillary incisal width was significantly larger for males than females similar to the finding of Hattab et al.[25], and Hashim et al.[28]but dissimilar with the results of Al-Omari et al.[13]and Bishara et al.[29]Significant difference between genders for interpremolarwidth, and a highly significant difference for intermolar arch width is in agreement with previous studies done on Colombian,[15] Saudi Arabian,[28] and Malay[18] but is in disagreement with the findings for the Egyptian population.[30] This suggests that the maxillary arch in Indian males is significantly wider compared with the maxillary arch in females. This specific gender difference was also reported by Jyotirmayet al.[31] The difference may be related to the wider male face compared to female as observed in the current craniofacial anthropometric data.

Highly significant gender differences were found between all facial framework parameters in the present study with males having a significantly larger facial framework than females. This is in accordance with the study by Zhuang et al.[32] on four ethnic groups (African-Americans, Caucasians, Hispanic, Asians).

The facial height (n-gn) and face width (zy-zy)of both male and female subjects in the present study was in general smaller than the international anthropometric measurements described by Farkas et al. However, the mandibular width (go-go) of both male and female subjects in the present study was greater than most of populations. The mouth width (ch-ch) of Indian males was in accordance with most of the populations measured by Farkaset al.[17] in his study while the females had a smaller mouth width. The mean values of face height, upper face height, mouth width, left maxillary depth and left mandibular depth of the present study were also smaller than the result of study done by Fourieet al.[33] in Netherlands.

The results of this study showed only moderate correlation between combined incisal width and the arch widths in the premolar and molar region indicating that combined maxillary incisal tooth width cannot be used as a reliable predictor for estimation of premolar and molar arch widths in Indian population.

The correlations between measured arch widths and those calculated according to Pont's formula were only fair. This is in accordance with

the studies done by Joondephet al.[11], and Celebi et al.16. The average difference of -2.46 mm in the premolar region and -2.08 mm in the molar region depicts that arch width of Indians is narrower by around 2.5 mm in premolar region and 2 mm in the molar region compared to the French sample taken by Pont. Moreover these differences show that Pont's index tends to overestimate the arch width in Indian subjects.

However, the results of the present study are dissimilar to the findings of . Gupta et al.[5], Agnihotri et al.[26] and Jyotirmay et al.[31] who found a significant and definite correlation between the combined maxillary incisal width and both premolar and molar arch widths.

Beside the ethnic and racial variations, this difference between the studies could be due to variations in the selection parameters. It could be possible that a type of occlusion considered unacceptable in one study could be considered as acceptable in another study.

There was a moderate correlation between facial width (zy-zy) and premolar arch width contradictory to that reported by Thu et al.[18]and Purmal et al.[3] There is a strong correlation between the molar arch width and the facial width which was in accordance with the study done by Serglet al.[36] in German population. A strong correlation was also observed between mouth width (ch-ch) and premolar and molar arch widths. This study confirms the suggestions that a correlation existed between the maxillary arch and facial (zygomatic) width.[15,36] This may be explained by the facial framework of the Indian population who has longer lateral and smaller anteroposterior dimensions (brachycephalic feature/ broad short head).

A moderate correlation between mandibular width (go-go) and the premolar and molar arch widths respectively shown in the present study was in accordance with the work of Alvaran et al.[15] who reported that mandibular width (bigonial breadth) was the most important predictor of interpremolar width. Significant correlations were also observed in this study between the maxillary depth, mandibular depth and arch width in the premolar and molar regions.

Regression analyses were performed to quantitatively estimate premolar and molar arch width based on facial framework measurements. It was found that the premolar arch width increased by 0.3 mm for every 1 mm increase in mouth width, decreased by 0.14mm for every 1 mm increase in upper face height and increased by 0.11 mm for every 1 mm increase in left maxillary depth respectively. For molar width, face width and mouth width were the two main parameters which were able to better predict molar arch width. Molar arch width was found to increase by 0.14 mm for every 1 mm increase in face width and 0.28 mm for every 1 mm increase in mouth width respectively.

From a clinical point of view, Pont's index does not provide reliable predictions for individual orthodontic treatment planning in Indian population. Treatment plans should not be based on simplistic mathematical concepts but formulated with regard to sound biological rationale.[26] An assessment of the facial profile and soft tissues, future growth status, determination of the Angle's classification, relationship of upper and lower jaws to one another, and the midline etc. are possible other parameters which need to be taken into consideration.

CONCLUSION

It can be concluded from the present study that in Indian population:

1. Combined maxillary incisal tooth width cannot be used as a reliable predictor for estimation of premolar and molar arch widths.
2. Pont's index tends to overestimate the premolar and molar arch widths by 2.46 mm and 2.08 mm respectively. Arch form of Indian subjects is narrower than the Pont's sample.
3. A moderate correlation exists between facial width (zy-zy) and premolar arch width and between mandibular width (go-go), maxillary depth (t-sn), mandibular depth (t-gn) and arch width in the premolar and molar regions.
4. A strong correlation exists between facial width (zy-zy) and molar arch width and between mouth width (ch-ch) and premolar and molar arch widths.

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