European Journal of Orthodontics 29 (2007) 627–631
doi:10.1093/ejo/cjm067
Advance Access publication 30 October 2007

Application of Pont's Index to a Jordanian population

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SUMMARY The aim of this study was to assess the applicability of Pont's Index to a Jordanian population and to compare the results with those obtained from studies of different ethnic subjects. Dental casts of 144 Jordanians (71 males and 73 females; mean age, 15.5 years) with 'normal' occlusions were selected from the records of a random stratified sample of 383 Jordanian schoolchildren in the 10th grade. The mesiodistal widths of the maxillary permanent incisors, as well as intercanine, interpremolar, and intermolar arch widths, were measured directly on the selected dental casts using a digital calliper. An independent sample *t*-test was used to determine significant differences in tooth and/or arch width values for males and females.

Correlation coefficients determined between the measured arch width values and those calculated according to Pont's Index were low in all cases, with *r* values ranging from 0.25 to 0.39. It was concluded that Pont's Index should not be used to pre-determine ideal arch width values in Jordanian individuals.

Introduction

Many subjects with a Class I occlusion with crowding may be treated satisfactorily with an extraction or non-extraction approach. In borderline cases, non-extraction treatment can be more efficient (Proffit, 1994) because of the relatively shorter treatment duration (Vig *et al.*, 1990). Extraction approaches, however, are probably more stable (Proffit, 1994), although studies of long-term stability show that relapse may still occur despite premolar extractions (Little *et al.*, 1981, 1990).

Non-extraction treatment commonly involves arch expansion, a procedure whose stability has always been controversial (Kahl-Nieke *et al.*, 1996). Because of this, many indices and methods have been suggested to guide clinicians in predicting the ideal arch width (hence the expansion) required to alleviate dental crowding (Howes, 1947; Rees, 1953; McNamara and Brudon, 1993), to produce more stable final results. One of these was described by Pont (1909) who found that the ideal arch width necessary to accommodate the dentition and relieve crowding can be determined by assuming a constant relationship between the sum of the mesiodistal widths of the permanent maxillary incisors (SI) and the interpremolar or intermolar arch widths. This is expressed by the following formulae:

$$\text{Interpremolar arch width} = \frac{\text{SI}}{0.80} \text{ and}$$

$$\text{Intermolar arch width} = \frac{\text{SI}}{0.64}.$$

The advantage of Pont's Index lies in ease of application and the valuable information it could provide to aid treatment planning. Nevertheless, using this index remains highly controversial with some investigators supporting its use to predict arch widths (Stifter, 1958; Gupta *et al.*, 1979), and others believing that Pont's Index is not reliable and should not be used for clinical purposes (Joondeph *et al.*, 1970; Worms *et al.*, 1972; Dalidjan *et al.*, 1995; Nimkarn *et al.*, 1995).

Although Pont (1909) stated that his study was performed on a French population, the sample size and selection criteria were not described. He concluded that his work should be applied to different ethnic groups for verification or correction.

Gupta *et al.* (1979) applied the index on an Indian population and found a significant relationship between the sum of the incisor widths and arch widths. Worms *et al.* (1972) studied Navajo-Indians and American dental students. Low correlations were found between the actual arch widths and those calculated using Pont's formulae, and in most cases the actual values were less than the predicted values. Their conclusions were that use of Pont's Index for clinical purposes could not be recommended. The findings of Nimkarn *et al.* (1995) were also in agreement with those of Worms *et al.* (1972). They found that Pont's Index overestimates the arch expansion required to alleviate dental crowding. Dalidjan *et al.* (1995) applied the index on three different populations: Australian Aborigines, Indonesians, and white Australians, and the results again discouraged the clinical use of Pont's Index.

Most of the previously mentioned studies concluded that Pont's Index was unlikely to be a useful clinical predictor of dental arch width, but these investigations had their drawbacks in terms of adequacy of sample size and randomization. Furthermore, no study has been undertaken to assess Pont's Index on Jordanian or any other Arab population. Therefore, the aim of this study was to assess the applicability of this index on a Jordanian population and to compare the results with those obtained from studies of other ethnic populations. Special consideration was given

to the adequacy of the chosen sample in terms of size, selection criteria, and representation of the Jordanian population.

Subjects and methods

Collection of data

A total of 1439 Jordanian students in the 10th grade (mean age, 15.5 years) were screened in 12 schools from the six regional directories in Amman, which is the largest city and capital of Jordan. Both parents of each subject had to be Jordanian in order for the subject to be included in the screening process.

The schools were randomly selected from a list of all schools in Amman. For each directory, the total number of selected subjects was approximately equal to 1 per cent of the total population living in the same directory.

Ethical approval for the study was obtained from the Ministry of Health of Jordan and the Deanship of Scientific Research of the University of Jordan. Written consent was obtained from the parents of all subjects who underwent examination and/or impression taking.

Alginate impressions were taken for individuals who had: all permanent teeth erupted (except third molars), no interproximal caries and/or restorations, no missing or supernumerary teeth, no abnormally sized or shaped teeth, minimal or no tooth wear, and no previous orthodontic treatment. The impressions were poured on the same day with hard dental stone, taking into consideration correct storage of impressions until they were poured. The dental casts were not soaped or waxed.

Dental casts of 395 subjects were obtained. A small number of them were discarded because they were of inadequate quality, leaving 383 study models that were screened again to select the individuals appropriate for the present study.

Sample size

A power calculation was undertaken to determine the sample size. The minimum number of subjects to be included in the study was found to be 128, assuming that the sample has an 80 per cent power to detect a relationship between the independent (mesiodistal tooth size) and dependent (arch width) variables at a two-sided 5 per cent significance level, if the true change in the arch width is 1 mm per unit change in the tooth width. The standard deviations of tooth and arch width were estimated to be 0.5 and 2.0, respectively, based on the values determined by Dalidjan *et al.* (1995).

Dental casts of 144 subjects (71 males and 73 females) were selected from the previously described sample to be included in this study because they fulfilled the selection criteria.

Selection criteria

For every subject selected, both parents were Jordanian and fulfilled the criteria of normal occlusion, i.e. angle Class I molar relationship; overjet less than 3 mm; normal overbite; minimal spacing or crowding (less than 3 mm); minor tooth rotations, and no crossbites.

Measurements

The measurements were carried out using a digital calliper (Orteam, Lotto 56, Milano, Italy) with an accuracy of 0.01 mm. The mesiodistal widths of the incisors were previously taken in another study by two examiners (IKA-O and ZBA-B) according to the method described by Hunter and Priest (1960).

Arch width measurements were under taken by a single examiner (RBD). The landmarks used for measurements were as follows: maxillary and mandibular intercanine widths: cusp tips of the canines; maxillary interpremolar width: distal pits of the maxillary first premolars; maxillary intermolar width: central fossae of the maxillary first molars; mandibular interpremolar width: distal fossae of the mandibular first premolars; and mandibular intermolar width: cusp tips of the distobuccal cusps of the mandibular first molars.

When there was minimal wear of the tooth structure, the midpoints of the wear facets were taken as the points of measurements.

Error of the method

Twenty study models were selected randomly and tooth width measurements were under taken twice by each observer (IKA-O and ZBA-B) on two separate occasions with an interval of 2 weeks. For arch width measurements, 40 study models were selected randomly and the measurements were carried out twice by the same observer (RBD) on two separate occasions with a 2-week interval between measurements. Inter- and intra-observer error for tooth width measurements and intra-observer error for arch width measurements were assessed as recommended by Dahlberg (1940) and Houston (1983). The mean errors calculated using Dahlberg's formula ranged from 0.08 to 0.28 mm for tooth size measurements and from 0.23 to 0.35 mm for arch width measurements. The coefficients of reliability calculated as recommended by Houston (1983) ranged from 92 to 99 per cent for tooth width measurements and from 96 to 98 per cent for arch width measurements. These findings indicate that the errors were minimal and unlikely to bias the results.

Statistical analysis

Incisor and arch widths were recorded for each subject to the nearest 0.01 mm and described in terms of average values, standard deviations, and coefficients of variation for males and females separately.

Arch widths were calculated for each subject according to Pont's formulae, and the correlation coefficients were

Table 1 Upper incisor and arch width values (in mm) for males and females described in terms of arithmetic means (AVG), standard deviations (SD), and coefficients of variation (CV).

Variables	Males ($n=71$)			Females ($n=73$)		
	AVG	SD	CV	AVG	SD	CV
Tooth widths						
12	6.87	0.48	6.99	6.75	0.52	7.70
11	8.83	0.61	6.91	8.69	0.51	5.87
21	8.87	0.60	6.76	8.70	0.50	5.75
22	6.82	0.49	7.18	6.74	0.53	7.86
Arch widths						
Maxilla						
3–3	35.28*	1.76	4.99	33.92*	1.71	5.04
4–4	37.87*	2.13	5.62	36.34*	1.84	5.06
6–6	48.18*	2.52	5.23	45.96*	2.17	4.72
Mandible						
3–3	26.90*	1.78	6.62	25.82*	1.37	5.31
4–4	32.17*	2.05	6.37	31.06*	1.80	5.80
6–6	49.11*	2.75	5.60	46.86*	2.18	4.65

*Significant differences between males and females at $P < 0.05$.

Table 2 Correlation coefficients (r) and coefficients of determination (r^2) between measured and calculated arch width values according to Pont's formulae.

Arch widths		Males ($n=71$)	Females ($n=73$)
Interpremolar	r	0.25*	0.39**
	r^2	0.06	0.15
Intermolar	r	0.36**	0.26*
	r^2	0.13	0.07

*r values differ significantly from zero at $P < 0.05$.
**r values differ significantly from zero at $P < 0.01$.

calculated between the measured and the calculated arch width values. Correlations were also determined between individual and combined incisor widths and measured arch widths.

A *t*-test for independent samples was used to determine whether there was a significant difference in tooth and/or arch width values for males and females.

All statistical tests were carried out using the Statistical Package for Social Sciences (Version 14.0, SPSS Inc., Chicago, Illinois, USA).

Results

There was no significant difference between males and females in incisor widths. Females, however, had significantly smaller values for maxillary and mandibular arch widths (Table 1).

Correlation coefficients determined between the measured arch width values and the corresponding values calculated according to Pont's Index were low in all cases for males and females, with r values ranging from 0.25 to 0.39 (Table 2).

The correlations between individual and combined mesiodistal widths of the maxillary incisors and arch widths were also found to be low for males and females with r values ranging from 0.11 to 0.39 (Table 3).

The differences between measured and calculated arch width values were calculated for each individual subject and are presented in Tables 4 and 5 and in Figure 1.

Discussion

The applicability and clinical value of Pont's Index has been assessed in many investigations using different selection criteria. These studies were applied to populations of different ethnic origins to determine whether the index could be applied to different populations. This is the first study that aimed to assess Pont's Index on an Arab population.

In the previous investigations, the subjects in most cases were chosen from university or hospital records. Therefore, they cannot be considered truly representative of their corresponding populations. The subjects in the present study were of a single age group selected from a random stratified sample that was collected from randomly selected schools from all regional directories in Amman. According to the last census undertaken in Jordan in 2005, Amman's population, which is a mixture of Jordanians who come from all regions of Jordan, surpasses 1.9 million (37 per cent of Jordan's population). Therefore, this sample was believed to be truly representative of the Jordanian population.

Special attention was also given to the sample size. This is the largest sample of a single population compared with all similar previous studies. The power calculation ensured that the sample size was adequate since the total number of subjects included in the study surpassed the minimum sample size determined by the calculation.

The mesiodistal widths of the teeth were measured by two examiners in a previously conducted study. In the present investigation, only one examiner measured arch width. This was not expected to affect the accuracy of measurements especially as error calculations were undertaken and the results showed that the measurements were highly reliable.

Statistical analysis showed that the maxillary incisor widths did not differ significantly between males and females (Table 1). This disagrees with the findings of Hattab *et al.* (1996) who found that Jordanian males have significantly larger incisors than females but is consistent with the results of Al-Khateeb and Abu Alhaija (2006) who found no significant differences in maxillary incisor widths between Jordanian males and females with a Class I occlusion. In another study, Bishara *et al.* (1989) compared the dimensions of teeth in three populations from Egypt, Mexico, and the United States and found no significant differences in maxillary incisor widths among the genders.

Table 3 Correlations between measured arch widths and individual and combined maxillary incisor widths (SI) for males and females.

	Interpremolar arch widths with					Intermolar arch widths with				
	12	11	21	22	SI	12	11	21	22	SI
Males (n=71)	0.17	0.20	0.19	0.23	0.25*	0.22	0.31**	0.34**	0.25*	0.39**
Females (n=73)	0.39**	0.29*	0.29*	0.34**	0.36**	0.30**	0.11	0.15	0.30**	0.26*

*r values differ significantly from zero at $P < 0.05$.
**r values differ significantly from zero at $P < 0.01$.

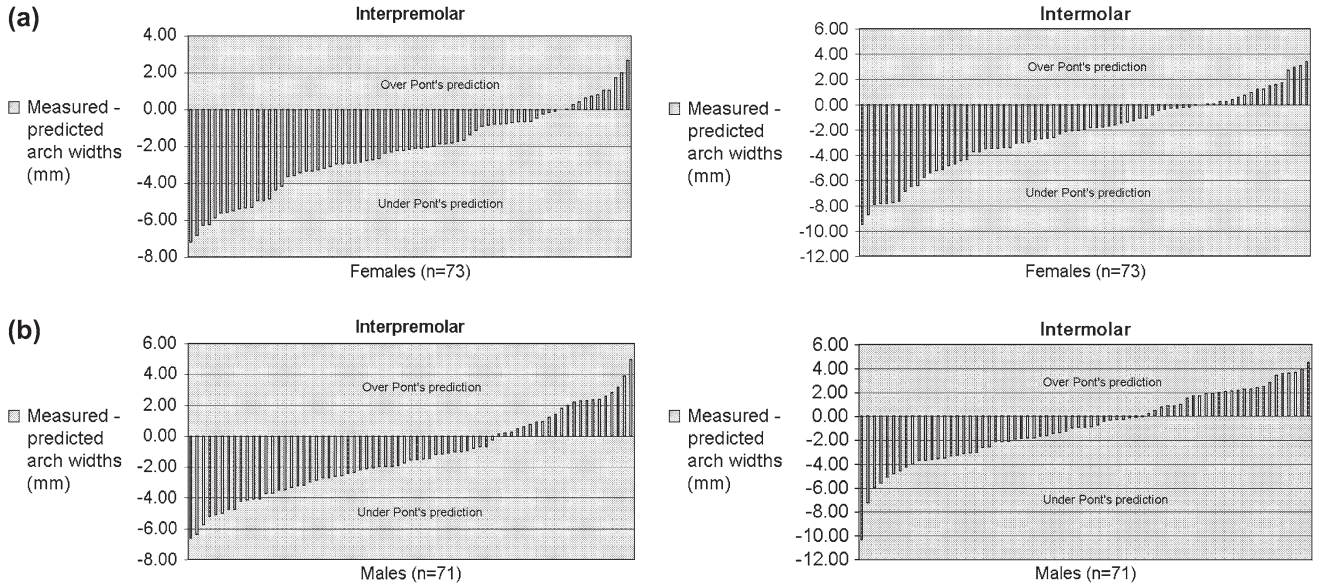

Figure 1 Differences between measured and predicted arch width values for females (a) and males (b) in millimetres.

Table 4 Percentage of individuals having an observed arch width values under, over, and ±1 mm around Pont's prediction.

	Under Pont's prediction	Over Pont's prediction	Pont's prediction ±1 mm
Interpremolar			
Males (n=71)	69	31	18.3
Females (n=73)	85	15	27.4
Intermolar			
Males (n=71)	63	37	25.4
Females (n=73)	77	33	23.3

Table 5 Largest differences under and over Pont's prediction for males and females in millimetres.

	Largest difference under Pont's prediction	Largest difference over Pont's prediction
Intepremolar		
Males (n=71)	−6.63	4.95
Females (n=73)	−7.20	2.67
Intermolar		
Males (n=71)	−10.32	4.49
Females (n=73)	−9.49	3.41

The correlations between measured arch widths and those calculated according to Pont's formulae were low (Table 2), indicating that Pont's Index should not be used clinically to pre-determine arch widths for Jordanian individuals. Dalidjan *et al.* (1995) came to the same conclusion after applying Pont's Index in their study on three different populations.

The differences between the actual and predicted arch width values for each subject were large, especially for the intermolar widths which ranged from −10.3 to +4.5 mm for males and from −9.5 to +3.4 mm for females (Table 5). This shows the wide range of possible error if the index were to be applied clinically. Moreover, these differences show that Pont's Index tends to overestimate the arch width required to relieve crowding (Figure 1). Worms *et al.* (1972) and Nimkarn *et al.* (1995) came to the same conclusion after assessing the index on Navajo and

Caucasian populations, respectively. This was particularly true for the females group in this study in which 85 per cent of subjects (for interpremolar widths) and 77 per cent of cases (for intermolar widths) demonstrated actual values that were less than those predicted according to Pont's Index. This indicates that Jordanians have arches that are narrower than those of Pont's sample.

The percentage of individuals having observed arch width values around the predicted values (with a ±1 mm difference) were generally low, ranging from 18.3 to 27.4 per cent (Table 4). Dalidjan *et al.* (1995) found these values to be similarly low for the populations in which they applied the index.

When considering the results of this research and other similar studies, it may be postulated that Pont's Index represents mean values for groups that should not be extrapolated to individuals of different ethnic origins as it does not give accurate estimates of ideal arch widths for a given individual in the majority of cases.

Conclusion

Pont's Index should not be used to pre-determine ideal arch width values for Jordanian individuals and consequently it should not be applied clinically to individual patients undergoing assessment for orthodontic treatment.

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