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The Relationships of the Maxillary Central Incisors and Canines to the Incisive Papilla in Jordanians

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Abstract

Aim: The validity of the relationship between the maxillary anterior teeth and the incisive papilla and the pertinence of this relationship to Jordanians was examined.

Methods and Materials: A computerized digital caliper (CDC) tool was developed and used in the measurements which were made on scanned images of dental casts of 298 Jordanians. The distances from a tangent to the labial surface of the central incisors to the midpoint and the posterior border of the incisive papilla were measured. The tool was also used in marking the exact point on the incisive papilla of the intersection with the line that connected the tips of the maxillary canines. The data sets were analyzed statistically and comparisons among various sets were drawn at a 95% confidence level.

Results: Gender had no significant effect on the relationship of the incisive papilla to the maxillary anterior teeth, whereas this relationship was significantly influenced by the incisal classifications of the examined subjects.

Conclusion: Differences between the Jordanian scores and the Caucasian norms were insignificant.

Clinical Significance: Therefore, the guidelines recommended for Caucasians could be used as starting points in the preliminary location of maxillary incisors and canine teeth during construction of dentures for Jordanians.

Keywords: Incisive papilla, intercanine line, gender, incisal classification

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Introduction

Setting anterior teeth in dentures often depends on the operator's perception of esthetics. Ideally, subjectivity on the part of the clinician should not prevail but denture appearance must adhere to the general convention which requires denture teeth be placed in or as close to the position of their natural predecessors.[1-6] In order to achieve this goal reference is often made to certain oral and facial anatomic landmarks. The incisive papilla has been suggested as a useful landmark on the basis of Caucasian norms which place the maxillary central incisors 8 to10 mm anterior to the center of the papilla.[7-12] Other reports have suggested the labial surface of the maxillary incisors should be 12 to 13 mm from the posterior border of the incisive papilla.[13] Maxillary canines were used by some investigators, and the relationship of these teeth to the incisive papilla was utilized as an aid in the placement of denture teeth.[14,15] Anatomic landmarks outside the mouth such as the nasal width and the intercanthal dimension and their relationship to the widths of the maxillary anterior teeth have also been suggested as guides to the selection and placement of denture teeth.[16-18]

Most of the reported investigations were conducted on Caucasian samples, and their findings were extrapolated to other ethnic groups. Only a few studies were carried out on samples other than Caucasians, such as Chinese,[19] Thai,[20] and French.[21]

All past studies used direct linear measurement between two objects in a three- dimensional relationship. Such a measurement imposes problems since the objects are not aligned on the same plane in three dimensions.[10] This fact casts doubts on the accuracy of such a measurement.

Distances measured on photocopies of dental casts were considered inaccurate as the photographic camera produced images of variable axial (x, y) ratios which resulted from the variable focal length of their different lenses.[15] In other words, in order to produce an image with a camera the photons reflected from a dental cast should meet at the focal point of the camera's lens where a photo sensor is positioned. This means the distances between the different areas of the three-dimensional dental cast and the lens' focal point are variable, therefore, the resulting image will have variable scale ratios on different parts of the image.

The present study, which is the first part of an ongoing investigation into the application of common guidelines to the various ethnic communities of the cosmopolitan Jordan, was conducted to examine the validity of the relationships claimed for the incisive papilla in a sample of Jordanian Arabs. To date, no similar study has been conducted.

Methods and Materials

The Sample

The sample for this study was randomly chosen from clinic attendees at the Jordan University Hospital. The following criteria were adopted for patient selection:

- No history of previous orthodontic treatment
- Erupted permanent teeth including maxillary incisors, canines, and second molars
- Normal position of the maxillary canines with no missing or supernumerary teeth in the anterior maxillary segment

A total of 298 subjects (39% males, 61% females) were included in the study. The gender of subjects was noted and their incisal classification determined by conventional methods. The surveyed subjects were categorized according to the incisal classification into Class I (Figure 1) which comprised 47%; Class II Division 1 (Figure 2) 20%; Class II Division 2 (Figure 3) 15%, and Class III (Figure 4) that comprised 18% of the sample.

Impressions and Cast Production

Impressions were made with fast setting Tropicalgn alginate (Zhermack Badia Polesine, Rovigo, Italy)

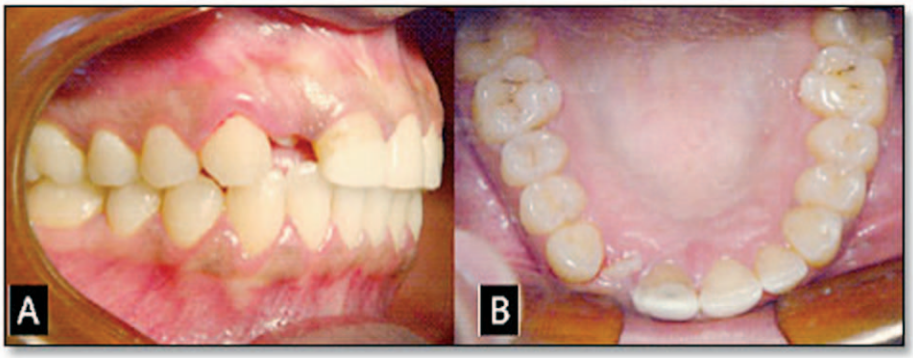

Figure 1. A patient with Class I incisal relationship. **A.** Profile; **B.** Occlusal view.

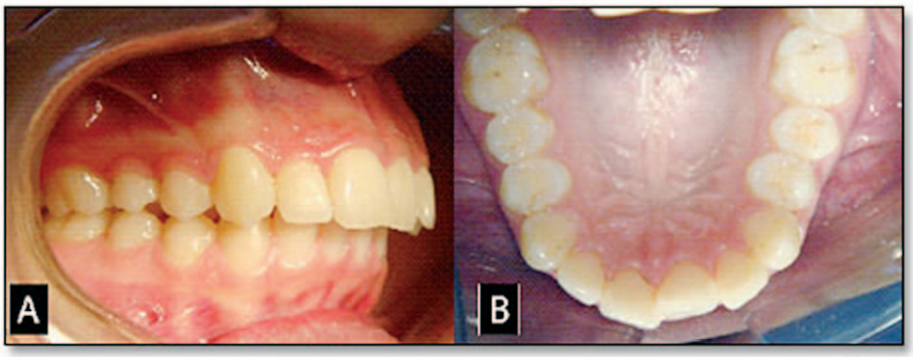

Figure 2. A patient with Class II Division 1 incisal relationship. **A.** Profile; **B.** Occlusal view.

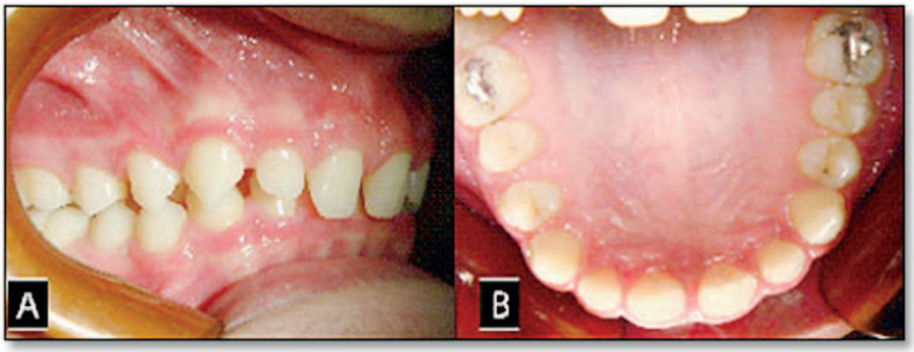

Figure 3. A patient with Class II Division 2 incisal relationship. **A.** Profile; **B.** Occlusal view.

Figure 4. A patient with Class III incisal relationship. **A.** Profile; **B.** Occlusal view.

and disposable stock trays. The impressions were made by two clinicians and were cast by a well-trained technician in Type IV stone (Micromod/ Zeus, Zahn Quayle Dental Manufacturing Co. Ltd. Worthing, W. Sussex, U.K.). The casts were separated after two hours, and the defective casts (damaged by air bubbles or voids on important landmarks) were excluded. The remaining casts were coded.

Location of Landmarks

Two anatomical landmarks were high-lighted on the maxillary arch models using a sharp 0.5 gauge HB pencil. These were the tips of the maxillary canines and the incisive papilla. If the incisal tip was worn, the tip was identified by a point of cross-wire drawn on the incisal facet (Figure 5).

Figure 5. Occlusal view of a stone cast demonstrating marking the position of the tip of faceted maxillary canines.

Method of Measurement

In the present investigation a two-dimensional computer scanner imaging technique was employed in conducting all dental cast measurements. The use of a computer scanner for dental measurements was based on its reliability as a procedure that produces images which have a scale ratio of 1:1.

Computer images are composed of very small dots (pixels) arranged in rows and columns. If, for instance, the scale ratio of the image was variable, there wouldn't be a fixed number of pixels to represent the scanned object in different parts of the image. In other words, on an image captured with a camera, the number of pixels represent an inch on the upper left corner of the image differ from those in the middle of the image. On the other hand, images generated by a computer scanner have a fixed overall scale ratio, i.e., the number of pixels representing an inch on the scanned object is the same all over the image which is referred to as the scanning resolution of the image. Resolution is usually measured in either dots per inch (dpi) or ppi pixels per inch (ppi). While dpi is generally used to describe the resolution of printed images, it is essentially equal to ppi in a computer image. For example, if an object was scanned at a resolution of 300 dpi, it means that every inch on the computer image of the scanned object would be represented by 300 pixels. Therefore, to measure the distance between two points on an object one has to count the pixels between these two points on the computer image and divide them by the scanning resolution.

A computer program was specially developed in the present investigation and was designed in a way that utilized pixels and its relation to the scanning resolution. For a measurement of a distance between any two given points on a dental cast, the program counted the pixels between the two points on the scanned image of the dental cast and calculated the distance in millimeters.

The computerized digital caliper (CDC) developed in this study comprised of three lines (Figure 6). The first line was the tangent (T) of the labial surfaces of the maxillary central incisors. The second line (C) was the inter-canine line that joined the tips of the right and left maxillary canines. The third line (M) was the midline that passed through the centre of the incisive papilla. In addition to the three lines, the CDC designated two points that marked the most anterior and the most posterior borders of the incisive papilla.

A high-resolution image of the three lines and the two points was super-imposed on the scanned image of each dental cast. By adjusting the lines and points to fit the exact position of their corresponding anatomic positions on the cast image, it was possible to carry out the following measurements:

1. The distance between the anterior point of the incisive papilla and the incisal tangent.
2. The distance between the midpoint of the incisive papilla and the incisal tangent.

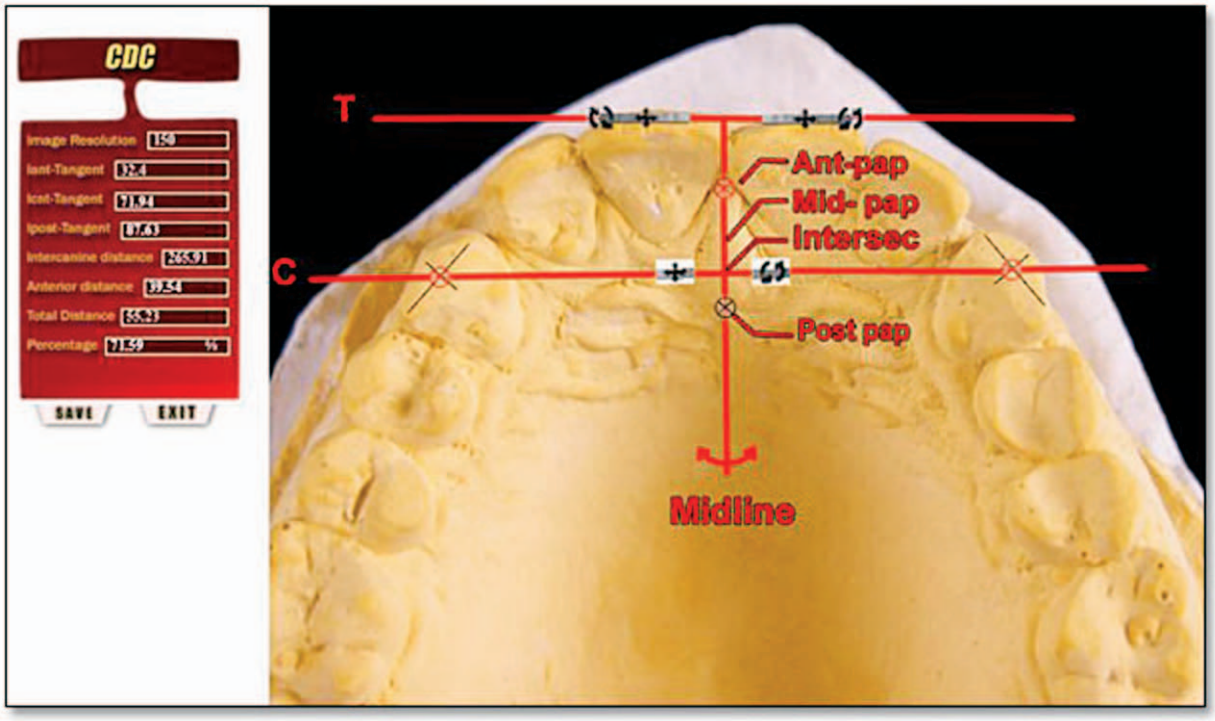

Figure 6. The CDC superimposed on a scanned image of a maxillary cast. **T:** Incisor's tangent; **C:** Intercanine line. **Incisive Papilla:** The anterior, middle, and posterior points of the incisive papilla (ant-pap, mid-pap, post-pap, respectively). **Intersect:** the intersection point of the incisive papilla and the intercanine line.

3. The distance between the posterior point of the incisive papilla and the incisal tangent.
4. The distance from the intersection of the midline and the intercanine line to the incisal tangent.
5. The total length of the incisal papilla.
6. The inter-canine distance.

After calculating the length of the incisive papilla, the measuring tool divided this structure into three thirds and calculated at which third the inter-canine line crossed the incisive papilla of each dental cast.

Measurement of Accuracy and Reproducibility of the Method

Prior to conducting measurements, two examiners were calibrated by a third investigator in relation to the use and efficient handling of the CDC. Each examiner was unaware of the other examiner's measurement results.

To test the sensitivity of the CDC and to examine the accuracy of its measurements replicas of 19 randomly selected dental casts were made with alginate impressions and cast in Type IV dental stone. Impressions that were accepted contained the marks that were drawn on the original casts using an indelible pencil, thus, transferring the anatomical landmarks to the replica dental casts. Scanning and measurements were preformed on all of the original casts and their replicas.

Statistical Analysis

Statistical Package for Social Sciences software (SPSS, version 12.0, Inc., Chicago, IL, USA) was employed in the analysis of the various data sets collected in the study and included the following:

1. Accuracy and reproducibility of the results were tested using the paired-sample t-test.
2. Measures of central tendency were calculated for all data.
3. Gender effect on the distance between the incisal tangent and the midpoint of the incisive papilla was tested using the Independent-sample t-test.
4. Influence of the incisal class on the incisors-midpapilla distance was also tested using both one-way analysis of variance (ANOVA) and Scheffe' test. These tests were also used in examining the influence of gender and the incisal classification on the relationship of the

incisal tangent to the posterior border of the incisive papilla.

5. The possible effect of gender on the relationship of the intercanine line to the incisive papilla was tested with the use of Chi-Square test. The effect of incisal class on this relationship was tested using one-way ANOVA.

All statistical tests were performed at 0.05 level of confidence.

Results

The rigorous statistical treatment carried out on various sets of the computer-generated measurements made on the dental casts helped establish important facts and derive vital comparisons. These facts and comparisons were essential to demonstrate how well the studied Jordanian sample would conform to the commonly used guidelines, which were based on Caucasian norms that govern the relationship of the maxillary anterior teeth to the incisive papilla.

Measurement of Accuracy and Reproducibility of the Method

Measurements of the distance from the tangent (T) of the incisors to the posterior point of the incisive papilla made on 19 original casts were compared with the distance between the same landmarks made on 19 duplicate casts. Similar comparisons of the intercanine distance were also made between original casts and duplicate casts. The results of these comparisons showed the differences were not statistically significant as indicated by the paired *t*-test (Table 1).

Relationship of Central Incisors to the Incisive Papilla

When the midpoint of the incisive papilla was considered as a reference point, the measured distances to this reference point from the incisors' tangent (T) ranged, for the entire sample, from 6.1 mm to 14.41 mm with a mean of 9.28 mm and standard deviation of 1.49 mm (Figure 7).

The mean distance from the incisors' tangent (T) to the midpoint of the incisive papilla was 9.42 mm in male subjects and 9.2 mm in the females. This difference was not statistically significant (P>0.05) (Table 2).

The distances from the incisal tangent (T) to the posterior point of the incisive papilla, when this landmark was considered as a reference point, ranged for the entire sample from 8.29 mm to 17.49 mm with a mean of 12.93 mm and standard deviation of 1.66 mm (Figure 8).

The difference between the mean distances for males (12.97 mm) and for females (12.90 mm) was not significant (Table 3 and Figure 9).

Measurements carried out on samples of the various incisal classifications revealed the mean distances from the midpoint of the incisive papilla to the incisal tangent (T) in subjects with Class I, Class II Division 1, Class II Division 2, and Class III incisal relationships were 8.96 mm, 10.13 mm, 8.43 mm, and 9.95 mm, respectively. One-way ANOVA showed the differences among the four classes were significant (P<0.05) (Table 4 and Figure 10).

However, Scheffe' test, which computed the limits of the confidence interval *(I)* for each difference between means, showed the computed *(I)* value of 0.593 was smaller than the mean difference between Class I and Class II Division 1and also smaller than the difference between Class I and Class III means indicating these differences were significant.

A statistically significant mean difference was also found between Class II Division 1 and Class II Division 2 and between Class II Division 2 and Class III (Table 5).

The mean distances from the incisal tangent (T) to the posterior point of the incisive papilla in subjects with Class I, Class II Division 1, Class II Division 2, and Class III incisal relationships were 12.71 mm, 13.61 mm, 11.72 mm, and 13.79 mm, respectively. One way ANOVA showed the differences among the four classes were significant (P<0.05) (Table 6 and Figure 10).

The Scheffe' test revealed the computed *(I)* value of 0.491 which was smaller than the group mean differences between Class I and Class II Division 1, Class I and Class II Division 2, Class I and Class III, Class II Division 1 and Class II Division 2, and Class II Division 2 and Class III (Table 7).

Table 1. Distances from incisor tangent (T) to the posterior point of the incisive papilla and distances between canines measured from original and duplicate casts as shown by paired *t*-test.

Landmarks	Cast	No. in Sample	Paired *t*-test			
			Mean	SD	*t*-value	P value
Distance from incisor tangent to posterior point of incisive papilla.	Original	19	12.3	1.33	40.19	0.68
	Duplicate	19	12.24	1.21	44.15	
Intercanine distance.	Original	19	34.44	3.14	47.81	0.26
	Duplicate	19	33.69	3.36	43.72	

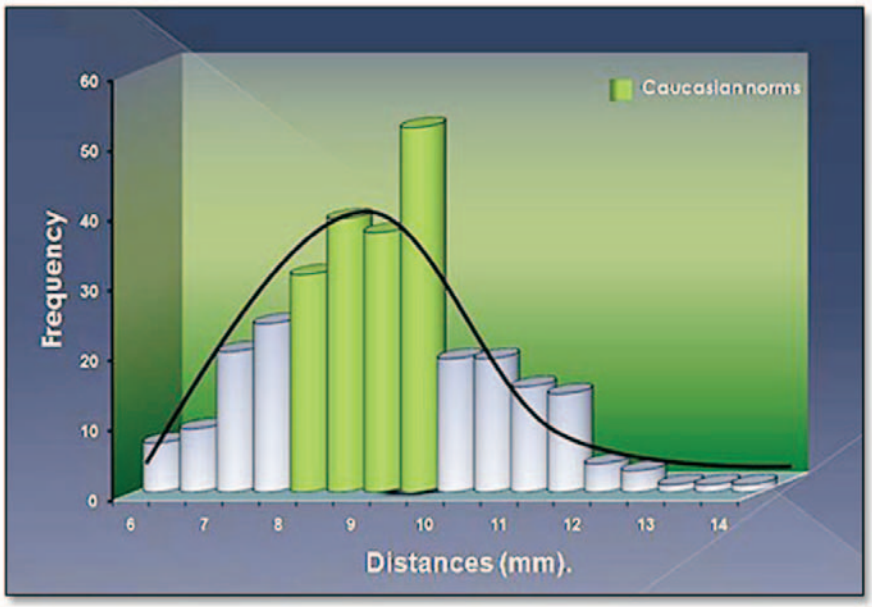

Figure 7. The distances measured from the incisor tangent to the midpoint of the incisive papilla for the entire sample.

Table 2. Mean distances from the midpoint of the incisive papilla to the incisor tangent (T) in males and females as shown by *t*-test.

Sample	No. (η)	Mean (mm)	Std. Deviation	*t*-test	
				t-value	P value
Whole sample	298	9.28	1.49	1.235	>0.218
Males	116	9.42	1.55		
Females	182	9.2	1.46		

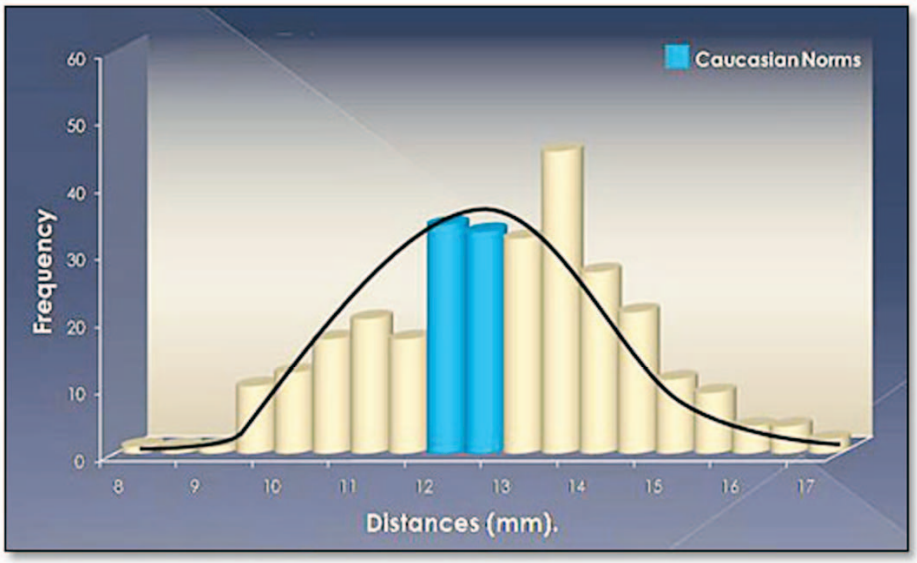

Figure 8. The distances measured from the incisor tangent to the posterior point of the incisive papilla for the entire sample.

Table 3. Mean distances from the posterior point of the incisive papilla to the incisor tangent (T) in males and females as shown by *t*-test.

Sample	No. (η)	Mean (mm)	Std. Deviation	*t*-test	
				t-value	P value
Whole sample	298	12.93	1.66	0.370	0.712
Males	116	12.97	1.74		
Females	182	12.90	1.61		

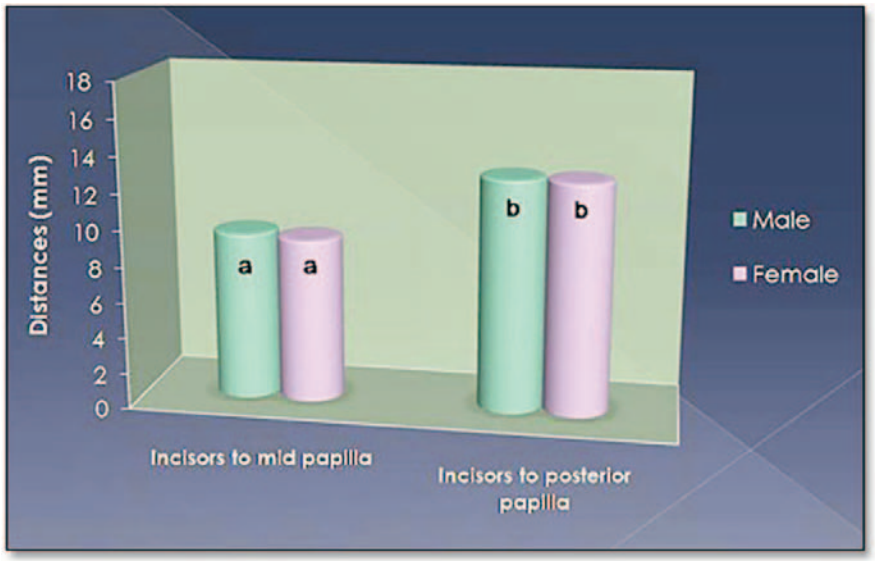

Figure 9. The mean distances from the incisor tangent to the midpoint and the posterior point of the incisive papilla for male and female subjects. Different alphabets denote a statistical difference at 95% confidence level.

Table 4. Mean distances from the midpoint of the incisive papilla to the incisor tangent (T) among subjects with different incisal classifications as shown by ANOVA.

Incisal Class	No. (η)	Mean (mm)	Std. Deviation	ANOVA	
				F ratio	F probability
I	140	8.96	1.38	20.425	0.00
II Division 1	58	10.13	1.49		
II Division 2	46	8.43	1.16		
III	54	9.95	1.34		

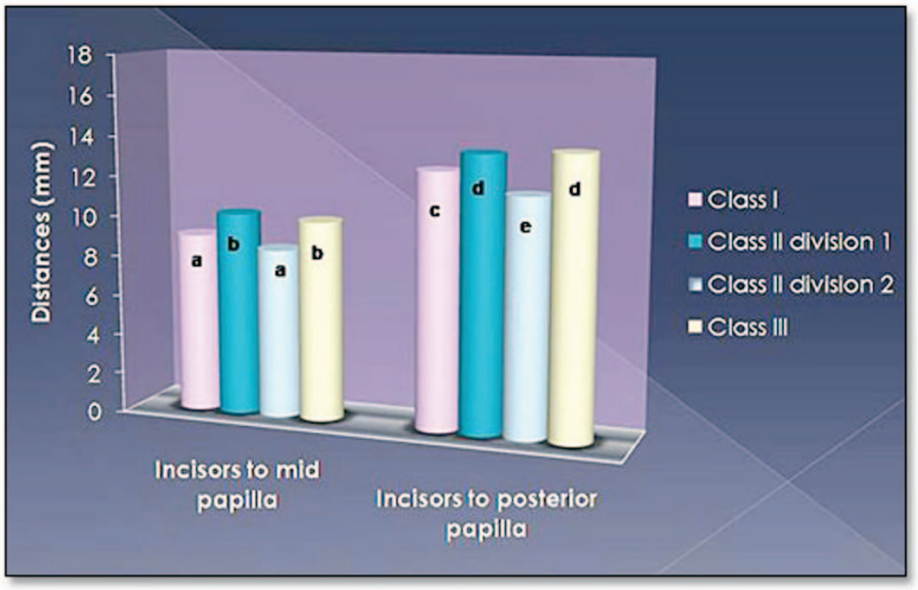

Figure 10. The mean distances from the incisor tangent to the midpoint and the posterior point of the incisive papilla for subjects of different incisal classifications. Different alphabets denote a statistical difference at 95% confidence level.

Table 5. Differences in mean distances from the incisor tangent (T) to the midpoint of the incisive papilla among subjects with different incisal classifications as shown by Scheffe' test statistics.

Incisal classification	M1 Mean (mm)	M2	M3	M4	Scheffe' test	
					$I_{0.05}$	P value
Class I	8.96	M1-M2=-1.17*	M1-M3=0.53	M1-M4=-0.99*	0.593	<0.05*
Class II Division 1	10.13		M2-M3=1.70*	M2-M4=0.18		
Class II Division 2	8.43			M3-M4=-1.52*		
Class III	9.95					

* Statistically significant difference at $p<0.05$.

Table 6. Mean distances from the posterior point of the incisive papilla to the incisor tangent (T) among subjects with different incisal classifications as shown by ANOVA.

Incisal class	No. (η)	Mean (mm)	Std. Deviation	ANOVA	
				F ratio	F probability
I	140	12.71	1.57	20.335	0.00
II Division 1	58	13.61	1.4		
II Division 2	46	11.72	1.45		
III	54	13.79	1.57		

Table 7. Differences in mean distances from the incisal tangent (T) to the posterior point of the incisive papilla among subjects with different incisor classifications as shown by Scheffe' test statistics.

Incisal Classification	M1 Mean (mm)	M2	M3	M4	Scheffe' test	
					$I_{0.05}$	P value
Class I	12.71	M1-M2=-0.90*	M1-M3=0.99*	M1-M4=-1.08*	0.491	<0.05*
Class II Division 1	13.61		M2-M3=1.89*	M2-M4=0.18		
Class II Division 2	11.72			M3-M4=-2.07*		
Class III	13.79					

* Statistically significant difference at $p<0.05$.

Relationship of Canines to the Incisive Papilla

When the body of the incisive papilla was divided into three parts, the anterior, middle, and posterior thirds, it was possible to monitor the canine-papilla relationship in terms of the intersection of the canine line with the body of the papilla. Of the entire sample, the intercanine line passed through the middle third of the papilla in 49.3% of the cases, whereas the line passed through the posterior third in 28.9% of the cases and crossed the anterior third of the papilla in 16.4% of the studied cases (Figure 11).

The intercanine line passed across the palate but anterior to the incisive papilla in about 2.7% of the cases and passed across but posterior to the papilla in about the same number of cases, i.e., 2.7% of the subjects.

In males the intersection of the intercanine line was through the middle third of the papilla in 48.3% of the cases, whereas, the line passed through the posterior third in 31% of the cases and through the anterior third in 13.8% of the cases. The intercanine line crossed the palate but behind the papilla in 3.4% of the cases and in front of the papilla in 3.4% of the male cases.

In females the intercanine line passed in 50% of cases through the middle third, in 27.5% passed through the posterior third, and in 18.1% passed through the anterior third. The intercanine line passed across the palate anterior to the papilla in about 2.2% of cases and across the palate but posterior to the incisive papilla in about 2.2% of cases (Figure 12).

The differences in the relationship of the canine to the incisive papilla between males and females were not statistically significant ($P>0.05$) as shown by Chi-square test (Table 8).

The results of the intersection position of the incisive papilla by the intercanine line in subjects of different incisal classifications showed variations among different classes. The intercanine line passed through the posterior third of the incisive papilla in 53.5% of Class I subjects, 24.4% of Class II Division 1 subjects, 8.1% of Class II Division 2 cases, and 14.0% of Class III subjects (Figure 13).

Subjects whose incisive papillae were intersected through the middle third by the intercanine line were 51% Class I subjects, 17.7% Class II Division 1 subjects, 14.3% Class II Division 2 subjects, and 17% Class III subjects, whereas the intercanine lines passed through the anterior third of the papilla in 32.7% of Class I subjects, 14.3% of Class II Division 1 subjects, 30.6% of Class II Division 2 subjects, and 22.4% of Class III subjects (Figure 13).

In very few cases, there was no intersection between the papilla and the intercanine lines as the latter crossed the palate through a location posterior or anterior to the body of the incisive papilla.

Results of the ANOVA showed the differences in incisal classifications significantly influenced ($P<0.05$) the relationship between the intercanine line and the incisive papilla (Table 9).

Discussion

The validity of the computerized digital caliper (CDC) method of measurements developed in this investigation demonstrated accuracy, precision, and reproducibility.

In the present study the occlusal plane of the dental casts was oriented in a standardized way which maintained a close contact of the occlusal plane and the screen of the computer scanner. This is identical to arranging denture teeth in wax bases whereby the occlusal plane is defined by the most incisal points of the central incisors and the most occlusal points of the right and left first molars. This resemblance to the clinical situation added reliability to the method used in this study. There has been a general consensus for considering the incisive papilla as a useful guide for the proper location of the anterior teeth.[3,7,8,16] The anterior part of the papilla was believed more susceptible than the rest of the papilla to damage during extraction of maxillary anterior teeth or because of the resorption that takes place following loss of teeth. The middle and posterior parts of the incisive papilla were considered more likely to remain constant and, therefore, more reliable for use as reference points.[16]

In this study the results obtained for the mean distance from the central incisors to the midpoint of the incisive papilla, when this point was considered as a reference, was 9.28 mm; when the posterior

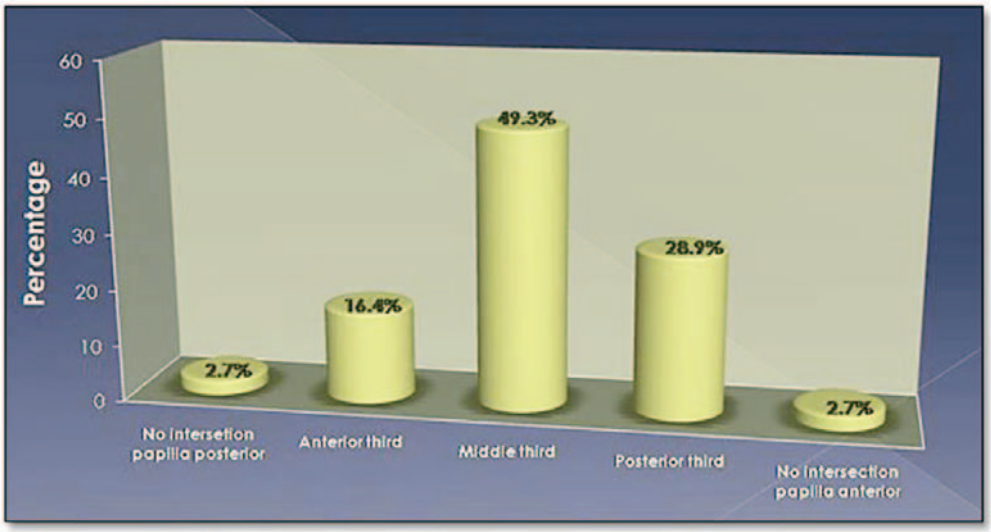

Figure 11. The position on the incisive papilla of the intersection with the intercanine line for the entire sample.

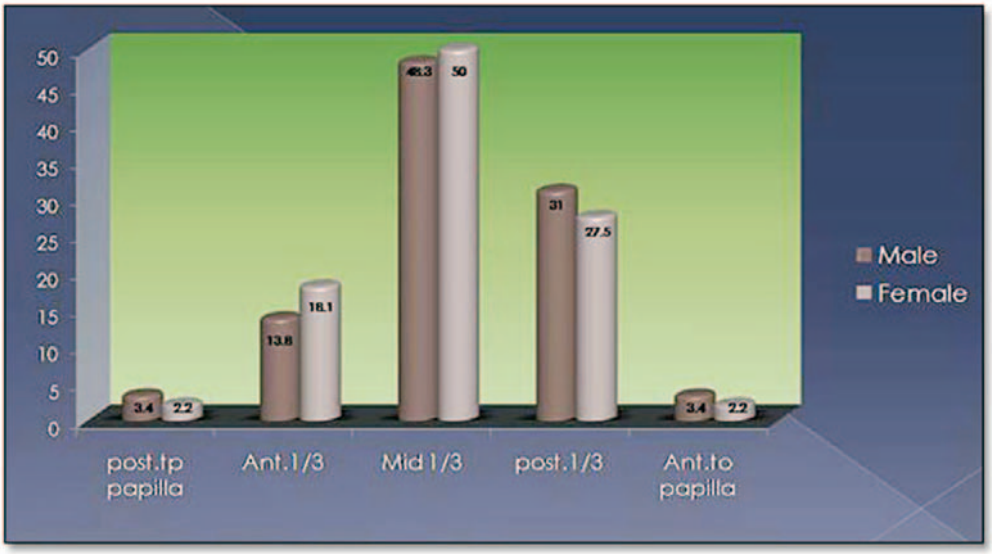

Figure 12. The position on the incisive papilla of the intersection with the intercanine line for male and female subjects.

Table 8. The position of the intersection of the intercanine line to incisive papilla in men and women shown by Chi-square test.

Position of intersection	No. of men	No. of women	Chi-square test	
			X^2	P value
Anterior third	16	33	1.99	0.74
Middle third	56	91		
Posterior third	36	50		

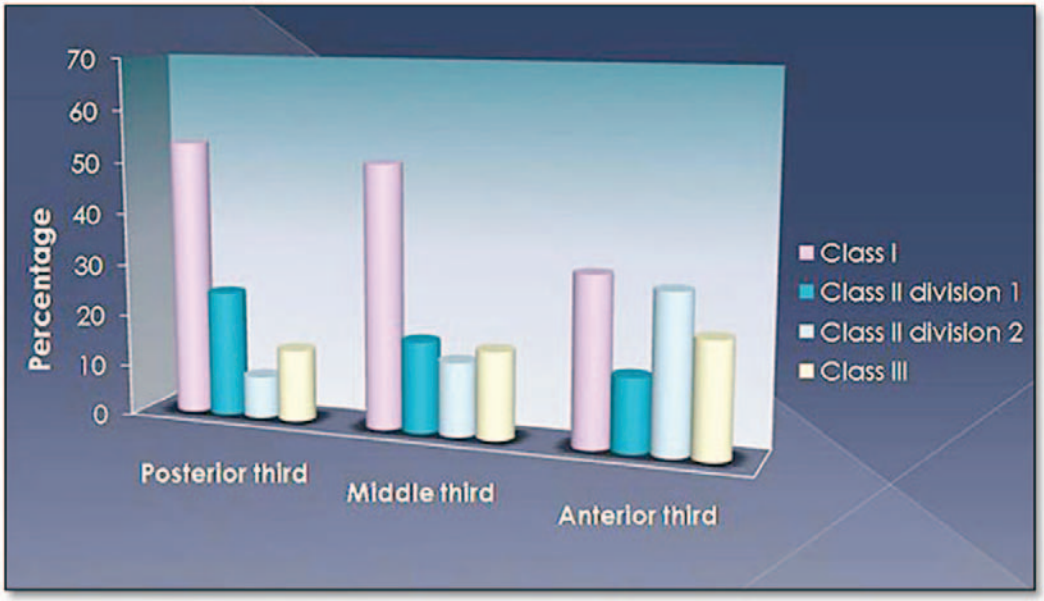

Figure 13. The position on the incisive papilla of the intersection with the intercanine line for subjects of different incisal classifications.

Table 9. Variations in the relationship between intercanine lines and the incisive papilla in subjects with different incisal classifications, shown by ANOVA.

Location of intersection	Class I (n)	Class II div 1 (n)	Class II div 2 (n)	Class III (n)	ANOVA	
					F ratio	P value
Anterior third	16	7	15	11	5.9	0.001
Middle third	75	26	21	25		
Posterior third	46	21	7	12		
Intercanine line crossed anterior to papilla	1	4	2	1		
Intercanine line crossed posterior to papilla	2	0	1	5		
Total	140	58	46	54		

border of the papilla was considered a reference, the mean distance between this point and the central incisors was 12.93 mm. The two figures fall within the recommended range of 8-10 mm,[2,7-12] for the former reference distance and 12-13 mm[13] for the latter. This indicates the study sample of Jordanians does conform to the recommended norms and guidelines that use the incisive papilla as a reference for the setting of artificial teeth in denture construction recommended for Caucasians can be applied to Jordanians. These results were in agreement with the findings of previous studies which reported compatible values for the two reference distances as follows: 8.50 mm,[22] 10.2 mm,[17] 9.17 mm,[15] 12.31 mm,[16] 12.45 mm,[10] and 13.17 mm.[13]

Comparisons made among the different groups that constituted the investigated sample revealed gender had no significant effect on the measured distances. Both male and female subjects demonstrated very similar results, and the minor differences between the two groups wouldn't have any clinical significance. Similar findings were reported by other investigators[15] who did not find any influence of gender on the relationship between the anterior teeth and the incisive papilla.

On the other hand, comparisons among subjects of different incisal classifications showed a significant influence of the incisal class on the distance between the central incisors and the reference points on the incisive papilla. Incisal Class II Division 2 demonstrated the shortest distances to the midpoint or the posterior point of the incisive papilla compared to the other classes. This is attributed to the retroclined position of the central incisors in Class II Division 2 which made the incisal tangent fall at a close distance from the incisive papilla. Longer distances to the incisive papilla were portrayed by subjects of Class II Division 1 and Class III groups. This was attributed in the former case to the effect of the lower lip which often gets trapped behind the maxillary anterior teeth, proclining them and, hence, increasing the distance between the central incisors and the incisive papilla.

In case of the incisal Class III subjects the increased incisors-to-papilla distance may be attributed to proclination of the maxillary incisors in a compensation mechanism in order to minimize the effect of the negative overjet which is mostly associated with this type of malocclusion. Comparable results were reported by other researchers[15] regarding the mean distances between central incisors and the incisive papilla. However, those researchers reported the incisal classification had no significant influence on the relationship of central incisors to the midpoint or posterior point of the incisive papilla. The disagreement of the findings between the two studies may be due to the difference in the size of the investigated sample. In the present study, the sample size was 3.5 times larger which made a rigorous statistical analysis possible to conduct and consequently yielded reliable results.

The transversal line that connected the cusp tips of the maxillary canines passed within 1.2 mm anterior and posterior to the midpoint of the incisive papilla in about 50% of subjects. The intercanine line passed across the posterior third of the papilla in about 30% of subjects, whereas it crossed the anterior third of the papilla in 16.4% of subjects. In very few cases, less than 6%, the intercanine line crossed the anterior palate outside the body of the papilla, either anterior or posterior to the papilla. It is believed this was due to malocclusion at the canine area.[9] These findings were comparable to the results of many previous studies which reported intersection between intercanine line and center of the papilla in 57%,[15] 57.6%,[16] and 64%[22] of the studied cases. Another study,[23] which reported the results of 71 examined dentate casts, concluded a coronal

plane through the middle of the papilla generally passed through the canine crowns. In one study[9] a relatively high percentage, 92% of the studied cases, were found to have an intercanine line within an area 1 mm anterior and posterior to the centre of the incisive papilla. The results of this investigation showed gender did not have a significant influence on the relationship of the canines to the incisive papilla.

Comparison of the results of intersection of the incisive papilla by the intercanine line among subjects of different incisal classification revealed significant differences among the different classes. It was shown in each third of the papilla's body there were significantly more occurrences of intersection by the intercanine line of subjects of incisal Class I than the intersection portrayed by subjects of the other incisal classes. The results demonstrated subjects of different incisal classifications were distributed in the same descending order of prevalence in both the middle and the posterior thirds of the incisive papilla with the subjects of incisal Class I of the highest prevalence, followed by subjects of Class II Division 1, Class III, and Class II Division 2. The distribution of subjects of the different incisal classifications in the anterior third of the incisive papilla did not follow the same order of prevalence. This could be attributed to the structural instability of the anterior part of the papilla and its vulnerability to resorption. This finding confirmed a previous report[16] which stated "the anterior part of the papilla may be affected or damaged during extraction of maxillary anterior teeth." These findings emphasized the likelihood of the middle and the posterior parts of the papilla to remain constant and stressed their use as reference points.

Conclusion

The computer-aided tool developed in this study for measurement of distances between landmarks of three-dimensional objects measured on a two-dimensional scanning image of the objects was accurate and reliable.

The data obtained for a representative sample of 298 young Jordanians from measurements made on dental stone casts of the distances from the labial surface of the central incisors to the midpoint and the posterior border of the incisive papilla and that of the area on the incisive papilla where the intercanine line crossed indicated the difference between the scores of the Jordanian sample and the Caucasian norms was insignificant. Thus, the guidelines that use the relationship of the incisive papilla to the maxillary central incisors and canine teeth as a reference for the setting of the artificial teeth in denture construction recommended for Caucasians can be applied to Jordanian patients.

The results showed gender had no significant effect on the relationship of the incisive papilla to the maxillary anterior teeth, whereas the relationship to the papilla of subjects of different incisal classifications differed significantly. This was attributed to the proclination of the maxillary incisors influenced by the lower lip in Class II Division 1 subjects or in response to a compensation mechanism to reduce the effect of the reversed overjet in Class III subjects.

Clinical Significance

Clinicians and laboratory technicians are advised to implement the guidelines that use the incisive papilla as a reference for placement of anterior teeth based upon the normal alignment of the natural dentitions. However, an allowance must be considered for the possible changes in the characteristic features of the lips and the other investing soft tissues affected by the aging factors. Such structural changes in the denture's soft tissue envelop may preclude the strict application of the guidelines for the location of denture teeth.

Clinicians must base their judgments on a combination of their knowledge of the guidelines to reproduce the relationships between natural teeth and the surrounding soft tissues as well as their understanding of the biometric guides and the application of phonetic tests to achieve a most functionally and esthetically effective scheme for placement of artificial teeth.

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