INCISIVE PAPILLA AND HAMULAR NOTCHES AS GUIDES TO MAXILLARY ANTERIOR TEETH SIZE IN EDENTULOUS PATIENTS

(PAPILA INSISIVUS DAN HAMULAR NOTCHES SEBAGAI PETUNJUK UNTUK UKURAN GIGI DEPAN RAHANG ATAS PADA PASIEN TIDAK BERGIGI)

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Abstract

This study aimed to use the incisive papilla and hamular notches as guides to selecting maxillary anterior teeth in complete dentures. One hundred and twenty maxillary casts of dentate adults were used in this study. Standardised digital photographs from the occlusal view of the casts were made. Using image analyser software (Leica Qwin Lite Vers. 2, Leica Microsystems Imaging Solutions, Cambridge, U.K.) the images were used to determine: relationship of the incisive papilla to positions of maxillary central incisors and canines; relationship of incisive papilla to the hamular notches and interhamular distance; correlation between these distances to width of the six anterior teeth. The results showed that the mean incisor distance to mid-point of the incisive papilla (MIP) was 9.59 ± 1.01 mm. Mean incisor distance to intercanine distance (IC) was 8.94 ± 1.21 mm. IC passed through MIP in 13.33% of the subjects. In 55% of the subjects, IC was 1.33 ± 0.77 mm anterior to MIP. In the remaining subjects IC was 1.01 ± 0.52mm posterior to MIP. The combined width of the six anterior teeth was found to be similar to the relationship between the incisive papilla and interhamular notch distances divided by 3.7 (p>0.05). As conclusion, the incisive papilla and hamular notches are useful in the selection of anterior maxillary teeth, enabling verification of choice of teeth to be made at the jaw relationship stage. This avoids the problem of using teeth of inappropriate sizes prior to full set up of teeth.

Key words: complete denture, maxillary anterior tooth, dental aesthetics, incisive papilla, hamular notch

INTRODUCTION

Aesthetics is a primary concern for patients seeking prosthodontic treatment. In complete denture patients the suitability of artificial teeth depends on the dentist being able to provide adequate support to the upper lip by maintaining an undistorted philtrum and nasolabial grooves, and proper contact of the upper and lower lips at the vermilion border. The aim is to have the maxillary anterior teeth restore optimal dentolabial relations in harmony with the overall facial appearance, and to restore the lost tissues in approximately the same amounts and in the same positions from which they were lost.

Selecting suitable artificial teeth for complete dentures may be a challenging process in the absence of preextraction records, especially for relatively inexperienced clinicians. Many methods are used to aid in the selection of artificial teeth in complete dentures, biometric guides being one of them. Biometric guides are various anatomical features (intraoral and extraoral) that remain relatively stable even though the process of alveolar bone resorption is continuing. These features can be used as starting points from which measurements could be made to aid in the design of complete dentures.

Facial anatomical landmarks that may be used as guides to tooth selection include the bizygomatic width, intercommissural width, interpupillary width, interalar width and inner canthus distance. The width between the tips of the left and the right canines is similar to the width of the alae of the nose. Further it is necessary to add about 3-4 mm to the width of the alar of the nose to obtain the required width of the six maxillary anterior teeth to compensate for the curvature of the anterior maxillary ridge. The mid points of the upper canine teeth could be also be determined by a line extending
from the inner canthus of the eye, via the lateral border of the alar cartilage onto the incisal edge of maxillary occlusal rim.\textsuperscript{1}

Intra-orally, the incisive papilla is generally used as a guide to the position of the labial surface of the maxillary central incisors. The incisive papilla can be divided into 3 parts; anterior, centre and posterior. With gross resorption of the buccal plate after tooth extraction, the papilla may appear to be on the crest of the alveolar ridge, and in more severe resorption it would appear to be in front of the ridge.\textsuperscript{8} However, the posterior part was found to undergo the least changes after teeth have been extracted.\textsuperscript{9}

The relationship between the maxillary central incisors and the location of the incisive papilla was found to be relatively constant. The conventional biometric guideline is 10 mm from the midpoint of the incisive papilla.\textsuperscript{8} The value may range from 12-13 mm and rarely less than 8 mm.\textsuperscript{10,11} A line connecting the tips of the maxillary canines is reported to fall within an area of 1-3 mm anterior or posterior to the centre of the incisive papilla.\textsuperscript{8,13,14}

The intercanine distance is a useful measurement as it may also help in estimating the total width of the upper six anterior teeth.\textsuperscript{15} When the intercanine distance and the distance from the labial surface of the maxillary anterior teeth to the midpoint of the incisive papilla are known, the curved distance of the six maxillary anterior teeth could be calculated using the Pythagoras theorem. If this curved distance is called $A$, then $A$ could be calculated by the formula: $A = a + 7\text{mm}$, where $a$ is the intercanine distance.\textsuperscript{16}

Another anatomical landmark that appears to be least affected by residual ridge resorption and remained visible are the hamular notches.\textsuperscript{17} The hamular distance, i.e. distance between the left and right hamular notches remains the same throughout life, because it is not determined by teeth position but by anatomical structures. It was found that there was no statistically significant difference between the hamular distance and the sum of the widths of all the maxillary anterior teeth.\textsuperscript{18}

The left and right hamular notches and the incisive papilla lie on the same plane. Hence, the name hamular-incisive-papilla (HIP) plane was derived. The plane was also shown to be almost parallel to the occlusal plane and therefore it is a viable reference plane in complete denture prosthodontics.\textsuperscript{12,19}

Traditional complete denture techniques require five to six appointments. However, only in the trial denture clinical appointments are the artificial teeth evaluated in the patient’s mouth for aesthetics and occlusion. At this time, there may be disagreement on the patient’s part on the selection of teeth made by the dentist. Patient satisfaction is an important parameter related to the outcome of prosthetic rehabilitation. A number of attempts have been made to investigate supposed links between patient personality and satisfaction with complete dentures. There is no practical method in the clinic whereby patient satisfaction by physical examination or observation can be validly and reliably measured. A patient’s judgement is usually based on his/her own subjective perceptions, and apart from patients with neurotic personalities being shown to be considerably less satisfied with their complete dentures, the patient’s personality traits may not be an influence in his satisfaction with complete dentures.\textsuperscript{20} If artificial tooth selection could be made in the early stages of complete denture construction, then six anterior teeth can be placed on the trial base or the occlusion rim for patient consent to the aesthetics and phonetics, even at the jaw-relationship appointment.\textsuperscript{21}

The purpose of this study was therefore to find reliable guides for the selection of the six anterior teeth so that these teeth could be inserted on the maxillary occlusal rim at the final stages of the jaw relationship stage. This would enable assessment of the anterior denture teeth to be made by the dentist and patient prior to the completion of the teeth set up in the laboratory. Any requests from the patient for changes to the teeth size and shape could then be made easily without damage to the set of teeth that is being verified at that visit.

**MATERIALS AND METHODS**

A total of 120 casts of maxillary arches from a sample of 49 Malays, 34 Chinese and 37 Indians were measured. All subjects in the study were between 19 and 40 years of age. They had intact permanent dentition (third molars were excluded) and regular dental arches with no history of orthodontic treatment.

To ensure that the incisive papilla and the hamular notches were on the same plane, the casts were trimmed so that the bases were parallel to the occlusal plane, i.e. the HIP plane. The mesiolabial incisal edge of the upper right centrals was used as the anterior reference point, while the mesiobuccal cusp tips of the maxillary first molars were used as the posterior reference points. The casts were then placed on a flat surface with the reference points touching the surface in the most stable position. A line was then scribed along the sides of the cast using a pencil attached to one arm of a geometric compass fixed on the reference plate. The line drawn was parallel to the occlusal plane. The excess base material was then trimmed following the line.
scribed around the cast (Figure 1).

Figure 1. Method used to make the base of the stone cast parallel to the occlusal plane

Standardised digital photographs from the occlusal surface of the casts were made. Metal rulers set at 90°c to each other were used to standardize and calibrate the casts when taking the photographs. The metal rulers were placed alongside the casts by using a retort stand and clamp and were on the same plane as the occlusal plane. A straight line was drawn on the casts from the midline (between the central incisors) and made perpendicular to a line joining the hamular notches. The line joining the hamular notches was then made parallel to the horizontal. All casts were photographed with the line joining the hamular notches parallel to the horizontal plane.

The images were then transferred to the computer for measurements using image analyzer software (Leica Qwin Lite Vers.2, Leica Microsystems Imaging Solutions, Cambridge, UK).

The following measurements were made on the casts (Figure 2): 1) distance between the line joining the mesial incisal edges of the central incisors to the midpoint of the incisive papilla (I-MIP); 2) distance between the canine tips (C-C); 3) distance between the line joining the mesial incisal edges of the central incisors to the intercanine line (I-IC); 4) The inter-hamular notch distance, HN-HN (x); 5) distance between the midpoint of the incisive papilla to the left hamular notch, IP-LHN (y); and 6) distance between the midpoint of the incisive papilla to the right hamular notch, IP-RHN (2).

All measurements were made by two investigators and each measurement was made three times. The average of the three values was used as the final measure.

To verify that the measurements made from the images were valid, direct measurements of distances between canine tips were made using a pair of digimatic vernier callipers (Mitutoyo Corporation, Japan) on 10 casts which were randomly selected.

All measurements were made to the nearest 0.05 mm. The results were compared to measurements of C-C distances made using the image analyzer. The differences were insignificant and therefore the use of the image analyzer throughout the study was justified.

Figure 2. Measurements made from the computer images: distances between midpoint of incisive papilla and labial surface of central incisors, intercanine line and hamular notches, and inter-hamular notch distance

Data collected were coded and keyed into a computer. Statistical analysis of the data was carried out using SPSS 12.0 for Windows (SPSS Inc., Chicago, IL, USA). The means and standard deviations were calculated for the variables measured. Data were compared by Student’s t-test and ANOVA. For each analysis the significance level was set at p < 0.05.

RESULTS

Figure 3 shows the mean distances of MIP to the labial surface of the central incisors according to gender and ethnic group of the subjects. The mean distance for the subjects as a group in the study was 9.59 ± 1.00 mm. There was no significant difference found in the mean values of subjects in relation to sex or ethnic group (p > 0.05).

Figure 4 shows the mean values for the distance of the labial surface of the central incisors to the intercanine line according to gender and ethnic group of the subjects. The mean value for subjects as a group in the study was 8.94 ± 1.21 mm. There was no significant difference found in the mean values of subjects in relation to sex or ethnic group (p>0.05).

Figure 5 shows the mean values of the distances of the labial surface of the central incisors to MIP and IC. The values were significantly different (p < 0.05).
Figure 3. The mean distance of the labial surface of the central incisors to the MIP in dentate sample was 9.59 ± 1.00 mm. There was no significant difference found among the values in relation to sex or ethnic group (p > 0.05).

Figure 4. The mean distance of the labial surface of the central incisors to the intercanine line in the study sample was 8.94 ± 1.21 mm. There was no significant difference found between either the sex or ethnic group of the subjects (p > 0.05).

Figure 5. The mean values for I-IMP and I-IC distances were significantly different (p < 0.05).

Table 1. The relationship of the intercanine line to MIP

<table>
<thead>
<tr>
<th>Posterior to MIP</th>
<th>At MIP</th>
<th>Anterior to MIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-3 mm</td>
<td>&lt; 1 mm</td>
<td>&lt; 1 mm</td>
</tr>
<tr>
<td>1-2 mm</td>
<td>0 mm</td>
<td>1-2 mm</td>
</tr>
<tr>
<td>&lt; 1 mm</td>
<td>0 mm</td>
<td>2-3 mm</td>
</tr>
<tr>
<td>Mean distance:</td>
<td>1.01 ±0.52 mm</td>
<td>1.33 ±0.77 mm</td>
</tr>
<tr>
<td>1.67 %</td>
<td>12.5 %</td>
<td>17.5 %</td>
</tr>
<tr>
<td>13.33 %</td>
<td>20.0 %</td>
<td>27.5 %</td>
</tr>
<tr>
<td></td>
<td>6.67 %</td>
<td>0.83 %</td>
</tr>
</tbody>
</table>

Table 2. Values of the calculated curved widths of the six anterior teeth (A), the summation of LHN-IP-RHN (x+y+z), ratio of A/(x+y+z) and the calculated value of x+y+z/3.70.

<table>
<thead>
<tr>
<th>Variables measured</th>
<th>A = a + 7</th>
<th>x + y + z</th>
<th>A / (x+y+z)</th>
<th>(x+y+z) / 3.70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>41.94</td>
<td>155.10</td>
<td>3.70</td>
<td>41.92</td>
</tr>
<tr>
<td>S.D.</td>
<td>1.88</td>
<td>7.60</td>
<td>0.18</td>
<td>2.06</td>
</tr>
</tbody>
</table>

Students t-test between the calculated curved widths of the six anterior teeth (A = a + 7 mm) and the calculated formula of [(x+y+z)/3.7] shows a p-value of 0.895 (> 0.05). Hence, there was no significant difference between the two values.

DISCUSSION

When using photographs or computer images to measure distances between intra oral landmarks, it is important to orient the casts in a standardised manner when taking the photographs and to verify that the landmarks to be measured were in the same plane. This is to ensure that the results achieved are valid and can be applied when artificial teeth are set on complete denture bases.

The present study used the HIP plane which had been shown to be parallel to the natural occlusal plane that was defined anteriorly by the mesiolabial incisal edge of the upper right central incisor and posteriorly by the mesio-buccal cusp tips of the maxillary first molars.12

In previous studies relating the incisive papilla to
the labial surface of the central incisors, either the midpoint of the incisive papilla or the posterior border was used as reference points for measurements. The posterior border was used as it seemed to be relatively stable even after bone resorption. However, as the present study used the HIP plane as a reference plane, the midpoint of the incisive papilla was used when making measurements as the pterygomandibular–notch-incisive papilla occlusal plane also uses the centre of incisive papilla as the anterior reference point.

The mean distance between the labial surface of the central incisors to the midpoint of the incisive papilla recorded in the present study was 9.59 ± 1.00 mm (Figure 3). This finding is within the range that has been quoted by earlier studies. In similarity with the other studies that have been quoted earlier, there was no significant difference found between the mean values for males and females, and among the different ethnic groups studied.

Besides the distance of the anterior teeth to the incisive papilla, the intercanine tip distance and the relationship of the intercanine line (IC) to the midpoint of the incisive papilla was also studied as the size of the anterior teeth would depend on the size of the anterior maxillary arch. In the present study IC distance was 34.94 ± 1.88 mm (data not shown). The value is close to the values given by Mavrosukofis and Ritchie, where the average length of the intercanine distance was reported as 35.3 mm.

The intercanine line was shown to pass predominantly through the centre of the incisive papilla, or 1 to 3 mm posterior to the centre of the papilla in the ovoid and tapering arch. In square arches, it was found to pass either through the centre of the incisive papilla, or 1 to 2 mm anterior to the centre of the papilla. In contrast to the study by Watt, whereby a line joining the tips of the canines was found to pass through the midpoint of the incisive papilla, the results in the present study showed that only in 13% of the casts did this situation occur (Table 1). In 55% of the casts, IC was 1.33 ± 0.77 mm anterior to the MIP and in 32% of the casts studied, IC was 1.01 ± 0.9 mm posterior to the MIP.

This implies that in the sample of the population studied, a line through the midpoint of the incisive papilla may not necessarily be a useful guide to indicate the position of the canine tips. When the relationship between IC and MIP was considered, the data showed that the relationship was not sufficient to be of value. The midpoint of the incisive papilla cannot be used as a guide in positioning the canines, because in 87% of the subjects studied, it did not pass through the MIP. The utilization of the centre of the papilla to determine the position of the canine tips would lead to the selection of wider or narrower artificial teeth.

Although the incisive papilla may indicate the positions of the central incisors and possibly the tips of the canines, it may not necessarily be useful in determining the size of the anterior teeth. A guide that would help to determine the size of the six anterior teeth using the incisive papilla and its relationship to other relatively stable anatomical structures in the edentulous arch would therefore be useful.

It was suggested that for the skeletal Class 1 edentulous patient, a harmonious length of arc for the anterior teeth (A) could be obtained by adding 7 mm to the measurement of the individual’s nasal width (A=N+7mm). As it was found the intercanine distance (a) equals the nasal width (N), it was recommended that the curved widths of the six anterior teeth (from the tip of one canine to the other) could be estimated by the formula: (A=a+7mm), whereby 7 mm is added to compensate for the curvature of the anterior part of the maxillary arch and the difference between the tip of the canine to the distal surface of the canines on both sides of the arch. In the present study the mean value of A was found to be 41.94 ± 1.88 mm (Table 2). Using the relationship of the interhamular notch distances and the interhamular notch-incisive papilla distance, i.e. (x+y+z)/3.70, the value calculated was 41.92 ± 2.06 mm. This value was not significantly different from the calculated value of A (P = 0.90), and therefore implies that the width of the six maxillary anterior teeth from the distal of the canine to the distal of the opposite canine, could be predicted by the distances (HN-HN+LHN-IP+RHN-IP) divided by 3.7.

Although dentists can select teeth appropriate for complete denture patients based on their knowledge of oral anatomy, aesthetics and physiology of speech and mastication, the anterior teeth selection also depends on the patient’s demands. Thus, it is suggested that an aesthetic try-in precedes the try-in of the full set of denture teeth, preferably at the end of the jaw relationship stage, so that the teeth would be a set that would be agreeable to both patient and dentist. Thus two trial denture visits are recommended, the aesthetic try-in for the anterior teeth only, and the second try in, whereby the occlusion, phonetics and final aesthetics are assessed.

Within the limitations of this study, the following conclusions were drawn: the incisive papilla and hamular notches could be used as guides to the selection of the size and position of the six artificial anterior teeth in edentulous patients, the method of the centre of the incisive papilla to determine the position of the canines is not accurate, but it may aid in
the initial artificial teeth selection for the ethnic groups studied, the width of the six anterior teeth was found to be similar to the relationship between the incisive papilla and interhamular notch distances divided by 3.7, leading to the formula: \( A = \frac{x+y+z}{3.7} \). This formula may be a reliable predictor of the curved width, and hence the size of the six maxillary anterior teeth.

References