Appropriate proportions as guidelines in selection of anterior denture teeth

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ABSTRACT

**Aim** To examine width-to-length and tooth-to-tooth width ratios of maxillary anterior teeth and to compare the obtained proportions with the width-to-length ratio of the hard palate, the Golden Proportion and the 75 % Proportion.

**Methods** The widths and the lengths of the clinical crowns of the maxillary anterior teeth were measured. Hard palate width and length were measured. Width-to-length ratio of the hard palate was calculated, as well as width-to-length ratios of the maxillary anterior teeth. Further, tooth-to-tooth width ratios were calculated for all maxillary anterior teeth.

**Results** Comparison between width-to-length ratios of the maxillary anterior teeth and the 75 % Proportion, the Golden Proportion and the proportion of hard palate revealed statistically significant differences (p < 0.05). Tooth-to-tooth width ratio of maxillary anterior teeth were significantly different (p < 0.05) from the Golden Proportion.

**Conclusion** The ratios obtained in this study could be helpful in clinical practice and in artificial teeth mould manufacture: width-to-length ratio for maxillary lateral incisor 82 % and for maxillary central incisor 91%, the tooth-to-tooth width ratios ranged from 78 % (between lateral and central incisor) to 91% (between canine and central incisor). The Golden Proportion and the 75 % Proportion should not be used in clinical practice for the selection of maxillary anterior teeth.

**Key words:** maxillary anterior teeth, tooth crown proportion, Golden proportion, hard palate proportion, 75% proportion
INTRODUCTION

Esthetically acceptable dentures should not differ from natural teeth (1, 2). Therefore, the selection of artificial teeth is an important concern in complete denture construction (3, 4). Several factors have been proposed as aids for artificial tooth selection and numerous methods have been devised for evaluation of reliable esthetic factors in determining artificial tooth form and dimensions (5).

The first theory ever introduced for artificial anterior teeth selection was the temperamental theory (6). Afterwards, Williams suggested that a correlation existed between the upside-down facial shape and the shape of the upper central incisors (7, 8). Frush and Fisher (9-11) introduced the dentogenic theory on the basis of sex, personality, and age (SPA) of each individual. Lowery and Nelson (12, 13) proposed that a close relationship existed between face, tooth and tooth arch form (hard palate form). However, recent studies were able to confirm the relationship neither between the face form and the shape of upper central incisor (14-16) nor between palatal shape and the form of upper central incisor (17).

Width-to-length ratio and tooth-to-tooth width ratio of the maxillary anterior teeth have been considered as important factors for dental esthetics and harmonic teeth arrangement. Unfortunately, only few guidelines describe maxillary anterior teeth proportions (18, 19). The Golden Proportion was described by Levin who proposed that dental esthetics could be achieved when central-to-lateral and lateral-to-canine width ratios were in the Golden Proportion (62%) (20). However, Preston and Rosenstiel were not able to confirm the existence of the Golden Proportion in natural dentition. (21, 22). Brisman proposed that the optimal width-to-length ratio for the maxillary central incisor should be 75%, while Wolfart, Sterret and Magne suggested the ratio up to 85% (4, 23-25).

Currently, there is no universally accepted single esthetic factor that can be used reliably to aid artificial tooth selection (17) and a need exists for improved training and guidance on artificial tooth selection and arrangement (26, 27). Therefore, further studies seem to be necessary either to confirm or disapprove some contradictory results from other studies.

The aim of this study was to examine width-to-length and tooth-to-tooth width ratios of maxillary anterior teeth and to compare the obtained proportions with the width-to-length ratio of the hard palate, the Golden Proportion and the 75% Proportion.

MATERIAL AND METHODS

A total of 80 individuals (26 men and 56 women, Angle class I occlusion and 18-30 years old) participated in the study. Exclusion criteria were: one or more teeth missing (except third molars), anterior teeth dental restorations, prosthetic appliance or tooth wear. Patients who had undergone orthodontic treatment or patients with asymmetries and abnormalities in tooth size or shape were also excluded from this study, as well as the patients with marginal periodontitis and gingival recession.

All subjects were well-informed, and gave a written consent to participate in the trial. The study was approved by the institutional ethic’s committee.

Irreversible hydrocolloid impressions of the maxillary jaw were obtained from each individual (Alginoplast fast set, Heraeus Kulzer, Hanau, Germany) and casts were poured in the hard stone (ISO Type I, Vel-Mix Stone, Kerr Italia S. p. A., Salerno, Italy). Since the hamular notch is a soft tissue area, round end filling instrument was used to precise its location and indelible pencil was used for demarcation prior to impression.

Measurements were made on the casts using a precise calliper (0.1 mm precision) (DKSH Switzerland, Ltd., GPM Anthropological Instruments, Zurich, Switzerland). All the measurements were obtained by one person.

The widths and the lengths of the clinical crowns of the maxillary anterior teeth were measured. Mesiodistal width was measured at
the level of contact points. Length of incisors was measured between incisal edge and the most apical point of marginal gingival. Length of canines was measured between the tip of the cusp and the most apical point of marginal gingiva.

Hard palate width (hamular width) was measured between the left and the right hamular notch (the most mesial demarcation point). Hard palate length (palatine foveas- papilla incisiva) was measured between the palatine foveas (midline between left and right palatine foveas) and the centre of incisive papilla.

Width-to-length ratio of the hard palate was calculated, as well as width-to-length ratios of the maxillary anterior teeth. Furthermore, tooth-to-tooth width ratios were calculated for all maxillary anterior teeth.

To test the reliability of the measurements, the measurements were repeated for 10 randomly selected casts. First survey was done by 5 dental practitioners. After 2 weeks the same measurements were repeated by the same dental practitioners. Statistical analysis was performed to verify the reliability of the results between the first and the second survey (paired t test) and between subjects (ANOVA). No significant difference was revealed (p>0.05).

Statistical analysis was made by SPSS 12 for Windows. Normality of the distribution was tested by the Kolmogorov-Smirnov test. Descriptive statistics was calculated for the dimensions of hard palate, widths and lengths of the maxillary anterior teeth, as well as for their ratios (x, SD, minimum, maximum). Descriptive statistics of the width-to-width ratios of maxillary anterior teeth was also obtained. One sample t test was used to test the significance of the differences between the obtained values and the Golden Proportions (62% proportion) and the 75 % Proportion. Dependent t test was used to compare width-to-length ratios of maxillary anterior teeth with the proportion of the hard palate. A level of significance was set at 95%.

RESULTS

The distribution of the data was normal as revealed by Kolmogorov-Smirnov (p>0.05).

There was no statistically significant difference between men and women (independent t test, p>0.05). There was also no significant difference between tooth dimensions on the left and the right side of the dental arch (paired t test, p>0.05). Therefore, mean values for the maxillary anterior teeth dimensions and for the hard palate dimensions were calculated. Mean values of the anterior maxillary teeth dimensions are presented in Figure 1 and mean values of the hard palate width and length are presented in Figure 2.

The width-to-length ratios of the hard palate and of the maxillary anterior teeth, as well as tooth-to-tooth ratios of the maxillary anterior teeth are presented in Table 1.

<table>
<thead>
<tr>
<th>Figure 1. Means and standard deviations for the maxillary anterior teeth width and length*</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1, width of the maxillary central incisor; W2, width of the maxillary lateral incisor; W3, width of the maxillary canine; L1, length of the maxillary central incisor; L2, length of the maxillary lateral incisor; L3, length of the maxillary canine</td>
</tr>
<tr>
<td>Means (mm)</td>
</tr>
<tr>
<td>SD</td>
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<table>
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<tr>
<th>Figure 2. Means and standard deviations of the hard palate width (hamular width) and length (palatine foveas- papilla incisiva)</th>
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<tr>
<td>Mean (mm)</td>
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</table>
The significance of the differences between the width-to-length ratio of the hard palate and of the maxillary anterior teeth is presented in Table 2.

The significance of the difference between the width-to-length ratio of the maxillary anterior teeth and the 75% Proportion and the Golden Proportion, as well as between tooth-to-tooth ratios of maxillary anterior teeth and the Golden Proportion and the 75% proportion are presented in the Table 3.

DISCUSSION

Decision on the selection of appropriate artificial teeth has to be based on proper dimensions and proportions. Since the position of maxillary anterior teeth has the strongest influence on esthetics (19) and only few guidelines describe their proportions (16, 17), it seemed reasonable to perform the study to define the ‘average proportions’ in intact dentition, and to compare them with the Golden Proportion and the 75 % Proportion, since those proportions have been proposed in the literature as guidelines for artificial teeth selection (23).

Number of subjects is relatively small due to the fact that this study is actually a pilot study and may be an introduction to a greater investigation in this field of dentistry.

All subjects were 18-30 years old since the inclusion criteria were finished craniofacial development and no tooth wear, no fillings and no proshodontic appliances on frontal teeth. In older population the first signs of tooth wear exist on the frontal teeth. The greater number of female examinees in this study is a result of more frequent exclusion of males due to the tooth wear or fillings on the frontal teeth.

Since the clinical crown reflects “natural” aesthetics, width to length ratios of the clinical crowns were calculated (Table 1). Obtained ratios are similar to the results of other authors: Sterret reported 85 % width-to-length ratio of the maxillary central incisor (24), Magne 87% (25), while Brisman proposed the optimal ratio of 75 % (3).

Wolfart suggested other proportions according to the attractiveness judged by dental professionals and patients (23). He proposed that central incisor’s width-to-length ratio should be between 75 and 85% and for the gingiva compromised teeth the range should be extended from 70 to 91%. The results obtained in this study are higher than the ratios suggested by other authors.

Magne (28) suggested tooth-to-tooth ratio between the maxillary lateral and central incisors of 78%, which is in accordance with the results of this study (Table 1). Wolfart (18) suggested ratio between 43 and 81%, based on the dentists and patients preferences. The tooth-to-tooth width ratios obtained in this study are higher than the ratios suggested by Wolfart.

According to Lowery and Nelson (12, 13) a close relationship exists between the tooth and the palate form. It has also been reported that the sum of the widths of maxillary anterior teeth equals to the hamular notch distance (29). Therefore, it seemed reasonable to compare width-to-length ratios of the maxillary anterior teeth.

### Table 1 Width-to-length (W/L) ratio of the hard palate and of the maxillary anterior teeth, and tooth-to-tooth width ratios (W/W) of the maxillary anterior teeth*

<table>
<thead>
<tr>
<th></th>
<th>x</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>W/L of hard palate</td>
<td>1.052</td>
<td>0.107</td>
<td>0.818</td>
<td>1.341</td>
</tr>
<tr>
<td>W/L of maxillary central incisor</td>
<td>0.908</td>
<td>0.084</td>
<td>0.677</td>
<td>1.123</td>
</tr>
<tr>
<td>W/L of maxillary lateral incisor</td>
<td>0.821</td>
<td>0.102</td>
<td>0.572</td>
<td>1.126</td>
</tr>
<tr>
<td>W/L of maxillary canine</td>
<td>0.841</td>
<td>0.092</td>
<td>0.692</td>
<td>1.199</td>
</tr>
<tr>
<td>W/W of maxillary lateral incisor and central incisor</td>
<td>0.782</td>
<td>0.064</td>
<td>0.657</td>
<td>1.138</td>
</tr>
<tr>
<td>W/W of maxillary canine and central incisor</td>
<td>0.912</td>
<td>0.057</td>
<td>0.768</td>
<td>1.138</td>
</tr>
</tbody>
</table>

*X, mean; SD, standard deviation; t, = t-value; df, degree of freedom; p, level of significance; W/L, width-to-length ratio; † p<0.01
teeth and width-to-length ratio of the hard palate. To calculate the hard palate proportion it was necessary to define the hard palate dimensions that are not subjected to resorptive changes after the extraction of the remaining teeth. Therefore, hamular notches, papilla incisiva and palatine foveas have been considered to be reliable landmarks since their position has been determined by anatomical structures and they have not been submitted to resorptive changes after teeth extraction (30). Therefore the interhamular distance and the distance between the centre of papilla incisiva and palatine foveas have been chosen as reference dimensions to calculate the width-to-length hard palate dimension. It has also been reported that papilla incisiva may be used as a guide for setting anterior maxillary teeth in a proper position in the arch during complete denture set-up procedure (31).

Comparison between width-to-length ratio of the hard palate and width-to-length ratio of the maxillary anterior teeth revealed statistically significant differences (Table 2) \( (p < 0.05) \). Therefore, hard palate proportion should not be used in clinical practice for the selection of any of the maxillary anterior teeth.

Comparison between width-to-length ratios of the maxillary anterior teeth and the 75% Proportion and the Golden Proportion revealed statistically significant differences (Table 3, \( p < 0.05 \)). Therefore, the 75% Proportion and the Golden Proportion should not be used in clinical practice for the selection of any of maxillary anterior teeth.

Comparison of the tooth-to-tooth width ratio and the Golden Proportion also revealed statistically significant difference (Table 3, \( p < 0.05 \)), which also discredits the use of the Golden Proportion in clinical practice for obtaining ideal denture aesthetics.

Furthermore, the proportions obtained in this study could be helpful in clinical practice, as well as in the dental artificial teeth mould industry.

Based on the results obtained and the limitation of this study (small sample) the following conclusions could be made: width-to-length ratios obtained in this study were significantly different from the Golden Proportion, the 75 % Proportion and the width-to-length ratio of the hard palate. Tooth-to-tooth width ratio of maxillary anterior teeth were significantly different \( (p < 0.05) \) from the Golden Proportion. The ratios obtained in this study could be helpful in clinical practice and in artificial teeth mould manufacture. However, more studies will be necessary in older population with intact dentition to define frontal teeth dimensions and proportions appropriate for a certain age group.

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REFERENCES: