Coll. Antropol. **30** (2006) 3: 573–577
Original scientific paper

Selection of Appropriate Artificial Frontal Teeth Size Using Dimensions of Hard Palate

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A B S T R A C T

Eighty dentate students participated as a study group and another 74 as a control group. The aim was to determine a possibility to reconstruct maxillary frontal teeth dimensions by use of certain hard palate dimensions. The height (IH) and the incisal (IW), contact point (CtW) and cervical width (CW) of maxillary central incisors (MCI), hamular width (HW) and the distance between the incisive papilla and the palatine foveas (IP-FP) were measured on the maxillary casts. CtW of maxillary lateral incisors and canines were measured too. In the study group the ratios were computed: HW/IW (5.71), HW/CtW (5.69), HW/CW (5.51) and IP-FP/IH (4.76). These ratios were multiplied by incisor's dimensions (obtained from the control group) to calculate the hard palate dimensions. No significant differences were obtained between the calculated and the measured (study group) hard palate dimensions. Furthermore, there was no significant difference between the HW and the Sum of contact-point widths of all maxillary frontal teeth ($p>0.05$) in the both groups. The results revealed: 1. MCI width and height might be calculated by dividing dimensions of a patient's hard palate and appropriate ratio; 2. hamular width dimension can be used as a selection guide for the sum of contact-point widths of six maxillary frontal teeth.

Key words: *angle class II, selection of artificial frontal teeth, hard palate*

Introduction

Esthetics is an important issue for both, dentists and their patients[1]. Esthetically acceptable dentures should not be different from the natural teeth[2–4]. Therefore, the selection of artificial teeth is an important concern in complete denture construction. Dimension, shape and color of artificial teeth are the most important factors in their selection[5–7].

Attempts have been made to find a method for selection of acceptable anterior teeth. Almost 90 years ago, Williams suggested that a correlation between the upside-down facial shape and the shape of the upper central incisors existed[8,9]. The dental outlines of the upper incisors were classified into three categories: tapered, ovoid and square-shaped. William's theory was the most accepted one throughout the literature, although data regarding the size of the teeth were lacking. Frush and Fisher introduced the dentogenic (SPA) theory[10]. Selection of artificial teeth was determined according to the sex, personality, and age (SPA) of each individual[11]. Lowery and Nelson proposed that a close relationship between face, tooth and tooth arch form (hard palate form) existed[12,13]. However, recent studies were neither able to confirm the relationship between the face form and the shape of the maxillary first incisor, nor between palatal shape and the shape of maxillary first incisor[14–17].

Appearance of artificial frontal teeth in dentures has often been unsatisfactory. It had been reported that artificial teeth were frequently too narrow and/or too long due to too narrow prosthetic moulds[18]. Therefore, attempts have been made to establish methods for selection of appropriate size of maxillary anterior teeth. Many investigators studied the relationship of dimensions between various landmarks on a subjects' face and a size of maxillary anterior teeth[19–21]. However, few attempts in

Received for publication June 21, 2006

order to correlate the dimensions of the hard palate and the maxillary incisors have been made.

The aim of this study was to assess a possibility to reconstruct maxillary first incisors and other frontal teeth dimensions using dimensions of various landmarks of the hard palate.

Materials and Methods

Study population

A total of 80 individuals (24 men and 56 women, 18–30 years old) participated as a study group, and another 74 individuals (23 men and 51 women) participated as a control group. All individuals had intact frontal teeth, Angle Class I occlussal relationship (minimal tooth rotations or compressions were allowed). Exclusion criteria were: one or more teeth missing (except the third molars), any restorations or visible tooth attrition on frontal teeth. Patients who had undergone orthodontic treatment or patients with any tooth size or shape abnormalities were also excluded from this study, as well as patients with marginal periodontitis and gingival recession.

Irreversible hydrocolloid impressions of the maxillary jaw were made (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). The round end filling instrument was used for precise location of the hamular notch and indelible pencil (0.1 mm point) was used for demarcation prior to impressions.

All subjects were well-informed about the aim and the methods, and gave a written consent. The study was approved by the institutional ethic's committee.

Measurements

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

Clinical crown height (IH) of the right and the left maxillary central incisor (MCI) are measured between incisal edge and the most apical point of marginal gingiva. The widths of the right and the left MCIs are measured at the incisal edge (IW), at the level of interdental contact points (CtW) and between the tips of interdental papillas (cervical width-CW). Contact point width of maxillary lateral incisors and canines were measured as well.

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

The ratios between the hard palate width (HW) and MCI widths (IW, CtW, CW) and ratio between the hard palate length (IP-FP) and the MCI height (IH) were calculated for the study group. The sum of contact-point widths of all maxillary frontal teeth (incisort and canines) was also calculated (SCtPW) for the both groups.

The dimensions of the maxillary first incisors were measured in the control group and the results were multiplied by the ratios (hard palate dimension / frontal tooth dimension) obtained from the study group. Then the calculated and the measured hard palate dimensions of the control group were compared.

Reliability

In order to test the reliability of measurement, 10 randomly selected casts were measured by five dental practitioners within a two-week period. Statistical analysis (ANOVA) revealed no significant differences between different subjects and between the first and the second survey ($p>0.05$).

Data analysis

Statistical analysis was made by SPSS 12 for Windows. Normality of the distribution was tested by the Kolmogorov-Smirnov test. Means and standard deviations were calculated. The significance of the differences were tested by the Student's t test.

Results

The distribution of the data was normal ($p>0.05$), as assessed by the one-sample Kolmogorov-Smirnov test.

Descriptive statistics for the study group (mean values, standard deviations, minimum and maximum values) is presented in Table 1.

There was no significant difference between men and women ($p>0.05$).

There was no significant difference between the dimensions of the left and the right MCI ($p>0.05$). Therefore, mean values between the left and the right MCI dimensions were calculated.

Descriptive statistics of the mean height and width of MCI, as well as SCtPW in the study group is presented in Table 2.

The ratios between palate dimensions and MCI dimensions were calculated in the study group and the results are presented in the Table 3.

Descriptive statistics and the significance of the difference between the measured hard palate dimensions and the calculated hard palate dimensions in the control group are presented in Table 4. The hard palate dimensions of the control group were computed by multiplying the MCI dimensions of the control group by the ratios obtained from the study group (Table 3). There was no significant difference between the measured and the calculated dimensions of the hard palate ($p>0.05$).

Furthermore, there was no significant difference between HW and the SCtPW in the both groups (study group: $t=1.69$, $df=79$, $p>0.05$; control group: $t=1.32$, $df=73$, $p>0.05$).

TABLE 1
MEASURED DIMENSIONS OF THE STUDY GROUP

	Min.	Max.	X	SD
Hamular width	36.0	55.0	47.1	4.71
Distance between incisive papila and palatine foveas	37.3	55.1	44.79	3.48
Height of left maxillary first incisor	7.0	11.4	9.58	0.89
Height of right maxillary first incisor	7.4	11.5	9.38	0.88
Cervical width of left maxillary first incisor	7.1	9.9	8.25	0.52
Cervical width of right maxillary first incisor	7.4	9.8	8.27	0.49
Contact points width of left maxillary first incisor	6.5	1..3	8.57	0.53
Contact points width of right maxillary first incisor	6.5	10.0	8.54	0.51
Incisal width of left maxillary first incisor	6.7	9.8	8.33	0.56
Incisal width of right maxillary first incisor	6.1	9.8	8.24	0.61
Contact points width of left maxillary second incisor	5.5	8.2	6.68	0.52
Contact points width of right maxillary second incisor	5.6	8.3	6.68	0.52
Contact points width of left maxillary canine	6.7	8.7	7.78	0.43
Contact points width of right maxillary canine	6.9	8.8	7.79	0.41

TABLE 2
CALCULATED VARIABLES FOR THE STUDY GROUP

	Min.	Max.	X	SD
Height of maxillary first incisor	7.30	11.45	9.48	0.857
Cervical width of maxillary first incisor	7.35	9.85	8.26	0.497
Contact points width of maxillary first incisor	6.50	10.15	8.55	0.514
Incisal width of maxillary first incisor	6.65	9.70	8.29	0.558
Contact points width of maxillary second incisor	5.65	8.25	6.68	0.508
Contact points width of maxillary canine	6.80	8.75	7.79	0.405
Sum of contact-point widths of all maxillary frontal teeth	36.9	53.8	46.04	0.223

TABLE 3
RATIOS BETWEEN THE HAMULAR AND THE MAXILLARY FIRST INCISOR DIMENSIONS

Ratios	Min.	Max.	X	SD
Hamular width / cervical width of maxillary first incisor	4.25	7.50	5.71	0.64
Hamular width / incisal width of maxillary first incisor	4.13	7.34	5.70	0.70
Hamular width / contact point width of maxillary first incisor	4.02	7.51	5.51	0.65
Distance between incisive papila and palatine foveoas / height of maxillary first incisor	3.63	6.90	4.76	0.58

Discussion

Proper selection of artificial teeth is very important in removable prosthodontics. When the maxillary anterior teeth have to be restored, clues gained from the natural dentition can be helpful in achieving an individual restoration[1,22,23]. However, when all teeth are missing and no photographs or cast documents of the original dentition are available, the choice of artificial teeth is more complex and other criteria have to be used.

Selection of artificial teeth has to be based on the proper shape and exact dimensions. Anterior position of the maxillary frontal teeth has the strongest influence to patients' esthetics[24–27]. The relationship of a shape and dimensions of various soft tissue landmarks on someone's face and a size and a shape of maxillary anterior teeth showed no significant correlation in previous studies[19–21]. Data correlating some dimensions of a hard palate and maxillary incisors are scarce in the literature.

The purpose of this research was to study a possibility to reconstruct maxillary frontal teeth dimensions using certain dimensions of a hard palate.

Measurements were made on the casts of maxillary jaws poured in a hard stone (ISO Type I). Although, hard stone expansion during setting might influence the precision of the results, possibility of such error is very small and of no clinical importance, as reported by Mack[28].

No significant differences between men and women for the height and the widths of the maxillary first incisors ($p>0.05$) were found. Lindemann found out that

TABLE 4
SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE MEASURED AND CALCULATED HARD PALATE DIMENSIONS

	X	SD	t	df	p
Distance between incisive papillas and palatine foveas (study group)	44.79	3.48	–0.53	73	0.43 ns
Calculated hard palate length by multiplying the height of maxillary first incisor (control group) by the ratio (4.76)	45.07	4.08			
Hamular width (study group)	47.1	4.71	0.24	73	0.81 ns
Calculated hamular width by multiplying the cervical width of maxillary first incisor (control group) by the ratio (5.71)	47.14	2.84			
Hamular width (study group)	47.1	4.71	0.23	73	0.82 ns
Calculated hamular width by multiplying the contact points width of maxillary first incisor (control group) by the ratio (5.51)	47.13	2.84			
Hamular width (study group)	47.1	4.71	1.31	73	0.19 ns
Calculated hamular width by multiplying the incisal width of maxillary first incisor (control group) by the ratio (5.70)	46.98	4.41			

central maxillary incisors had the same width in both gender, but women had shorter incisors[16].

No significant differences were found between the dimensions of the left and the right maxillary first incisors ($p>0.05$). Therefore mean values for the height and the width of the maxillary first incisor were calculated (Table 2).

According to Brand and Isselhard and Berkovitz et al., maxillary first incisor was 8.5 mm wide, which is in agreement with the results of the present study[29,30]. Mavroskoufis reported only 0.03 mm difference between the dimensions of MCI on the left and the right side of dental arch[31].

When all teeth are missing, it is difficult to reconstruct the exact position of the maxillary frontal teeth, since the rate of alveolar bone resorption is individual in each subject. On the other hand, hamular notches, incisive papilla and foveae palatine have been considered to be reliable landmarks because they are not submitted to resorptive changes after teeth extraction[32]. Their position is determined by anatomical structures. Incisive papilla has been used as a guide for setting frontal maxillary teeth in the proper arch position during complete denture set-up procedure[33]. Therefore HW and IP-FP have been chosen as distance references in order to calculate MCI dimensions.

Ratio between the hard palate length (IP-FP) and the MCI height was calculated, as well as the ratios between the hard palate width (HW) and the MCI widths (Table 4). Appropriate ratios obtained from the measurements of the casts in the study group were then multiplied by the MCI height or appropriate width obtained from the control group in order to calculate the hard palate height and width of the control group. There was no significant difference between the measured and the calculated hard palate dimensions in the control group ($p>0.05$) (Table 4). Therefore the ratios calculated in this study seem to be relevant for a proper choice of the maxillary first incisor's dimensions.

Furthermore, there was no significant difference between HW and SCtPW ($p>0.05$). This suggests that the hamular width is an appropriate landmark for the choice of the widths of the six frontal maxillary teeth.

Conclusions

Hamular width (distance between the left and the right hamular notch), and the distance between the centre of incisive papilla and palatine fovea could be helpful landmarks in order to determine the maxillary first incisor's dimensions. Central maxillary incisor's height (IH) might be calculated by dividing IP-FP by 4.76. Central maxillary incisor's cervical (CW), contact-points (CtW) and incisal width (IW) might be calculated by dividing hamular width (HW) by 5.51, 5.69 or 5.71.

Hamular width could be used for selection of the sum of widths of the six frontal maxillary teeth.

Acknowledgements

The authors whish to acknowledge the support of the Ministry of Science, Education and Sports of the Republic of Croatia, Project No. 0065014.

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IZBOR PRIKLADNOG UMJETNOG PREDNJEG ZUBA POMOĆU DIMENZIJA TVRDOG NEPCA

S A Ž E T A K

U istraživanju je sudjelovalo 80 studenata kao studijska grupa te dodatnih 74 studenta kao kontrolna skupina. Cilj istraživanja je odrediti mogućnost rekonstrukcije dimenzija gornjih prednjih zuba pomoću određenih dimenzija tvrdog nepca. Na modelu gornje čeljusti je izmjerena visina (IH) gornjeg središnjeg sjekutića (MCI) te njegova incizalna širina (IW), širina u razini kontaktnih točaka (CtW) i cervikalna širina (CW). Izmjerena je i CtW bočnih sjekutića i očnjaka. Također je izmjerena i hamularna širina (HW) i udaljenost između papille incisive i fovea palatine (IP-FP). U studijskoj grupi izračunati su omjeri: HW/IW (5.71), HW/CtW (5.69), HW/CW (5.51) and IP-FP/IH (4.76). Omjeri su pomnoženi sa dimenzijama sjekutića kontrolne skupine da bi se izračunale dimenzije tvrdog nepca. Nije uočena statistički značajna razlika između izračunatih i izmjerenih dimenzija tvrdog nepca. Također nije uočena statistički značajna razlika između HW i Zbroja širina u razini kontaktnih točaka svih gornjih prednjih zuba ($p>0.05$) u obje skupine. Zaključci ovog istraživanja su: 1.širina i visina MCI se može izračunati dijeljenjem dimenzija pacijentovog tvrdog nepca i određenog omjera; 2. hamularna širina se može upotrijebiti za izbor Zbroja širina u razini kontaktnih točaka svih gornjih prednjih zuba.