# TEETH SIZE DETERMINATION COMPUTER PROGRAM FOR MEAW ORTHODONTICS

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***Abstract:*** *a mesiodistal sizes of all teeth were measured on 151 dental casts of adolescents and young adults considering the individual arch form follow by statistical analysis on MS Excell to determine the mean tooth width for further MEAW orthodontic uses. Determination of tooth sizes allowed to create a computer program for individual teeth size defining using only incisors sizes of a patient. The program for teeth size defining is now a comprehensive tool in routine orthodontic practice which aids to more easy use of MEAW because counts all teeth sizes and determine the position of each L-loop for every orthodontic patient individually.*
***Keywords:*** *anthropometry, arch form, MEAW, computer program.*

# КОМПЬЮТЕРНАЯ ПРОГРАММА ОПРЕДЕЛЕНИЯ РАЗМЕРОВ ЗУБОВ ДЛЯ МПД ОРТОДОНТИИ

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***Аннотация:*** *проведено измерение 151 модели зубов подростков и взрослых, с учетом индивидуальной формы зубного ряда с последующим статистическим анализом в MS Excell для определения средней ширины зубов, для дальнейшего применения в МПД ортодонтии. Определение размеров зубов позволило создать компьютерную программу для определения индивидуального размера всех зубов пациента, имея размеры только резцов. Компьютерная программа для определения размеров зубов стала полноценным инструментом в рутинной практике, благодаря которой применение МПД стало проще, так как считает размеры всех зубов и положение L-петель для каждого ортодонтического пациента индивидуально.*
***Ключевые слова:*** *антропометрия, форма зубной дуги, МПД, компьютерная программа.*

**Introduction.** Many anthropometric proportional based on frontal teeth sizes are used today in clinical orthodontics. Also, various diagrams are in use. For instance, Pont designed his formula of dental arch width based on sum of upper four frontal teeth. Same was made by Linder and Harth [1]. Both authors created a table of norms as a result of their methods. The tables are a very convenient tools to use for daily orthodontic practice.

In addition to dental arch width determination, many arch forms identifying suggestion were established during over past one hundred and more years. Considering an orthognathic occlusion, functional stable occlusion, stable occlusion after orthodontic treatment and re-treatment there are many methods of arch form identifying ideas. Some of them are computer based [2].

A significant role in arch form construction plays Hawley chart [3]. The method is based on the combined sum of six frontal teeth and serves as a tool to construct a symmetrical aligned dental arch. However, it should be taken into account the fact, that the jaws and dental arches have a tendency to widen during the growth [8].

Multiloop edgewise arch wire method primary designed by Dr. Kim YH. The arch fabrication starts with countering the frontal area using turret. Lateral incisor inset is given at this stage. L-loops need to be located in the middle of mesiodistal points of teeth starting from lateral incisor-canine contact point. MEAW delivery requires a new study model [4, 11]. This means an extra visit, chair time, plaster cast and laboratory work required.

**Objectives.** Create teeth size determination computer program for MEAW orthodontics based on frontal teeth sizes.

**Materials and methods.** Mesiodistal sizes of all teeth were measured on 151 dental casts of adolescents and young adults. Anthropometric studies by Pont for arch width, Bolton's anterior and overall ratio were measured to determine whether there was discrepancy in upper and lower teeth sizes, ALD and arch from definition were made in our study. Microsoft Excel 2016 software was used for statistical analysis.

Some dental casts from the entire sample had missing teeth. So, we needed to define the size of missing teeth also. In order to detect the proportion of frontal teeth to the all others mesiodistal sizes had been counted in various ways:

1) Considering the size of same remaining teeth on opposite side;
2) Defining the width by Gerlach:

z13=1,22*z43; z23=1,22*z33

(where z-width of tooth; 13,23,43,33 tooth numbers);

3) Defining a one missing premolar or molar width using the Gerlach method:

z13+z14+z15+z16=z23+z24+z25+z26=z43+z44+z45+z46=z33+z34+z35+z36

For the further analysis 114 dental casts were selected from entire 151 study number. Furthermore, by using a formula d(i-j) = (zi+zj)/2 empiric width of upper and lower teeth for planning dental arch were defined and by using variational statistic, correlation and regressive analytical analysis describing adequate mathematical models d(i-j) via combination of four frontal teeth width Szr ($S_t$zr are upper teeth and $S_b$zr are lower teeth described in the text further).

Mathematical model was accepted as adequate if $R^2 \geq 0,75$ ($\underline{R}^2$ – coefficient of reliability approximation, meaning that the value is proportional to a percent of model and empiric coincidence of data).

**Results and discussion.** Correlational relationship of d(i-j) и $S_t$zr for all analyzed upper teeth was straight and statistically significant, excluding R(d(24-25), $S_t$zr), however only R(d(12-13),$S_t$zr) and R(d(22-23),$S_t$zr) had high and middle coincidence (0,707 и 0,636). All other coefficients of correlation were weak or very weak (table №1).

*Table 1. Couple correlation coefficient of dental arch segments and combined width of four upper frontal teeth*

| Dental arch fragments | d(12-13) | d(13-14) | d(14-15) | d(15-16) | d(16-17) |
|---|---|---|---|---|---|
| R(d(i-j),$S_t$zr) | 0,707 | 0,382 | 0,229 | 0,255 | 0,268 |
| Dental arch fragments | d(22-23) | d(23-24) | d(24-25) | d(25-26) | d(26-27) |
| R(d(i-j),$S_t$zr) | 0,636 | 0,236 | 0,038* | 0,295 | 0,321 |

Note*: correlational connection is statistically not significant (p≥0,05).

Scatter diagram and two types of trend mathematic models were built (in the form of polynomial in sixth degree $y = a_0 + a_1 \cdot x + a_2 \cdot x^2 + a_3 \cdot x^3 + a_4 \cdot x^4 + a_5 \cdot x^5 + a_6 \cdot x^6$ and linear equalization $y = a_0 + a_1 \cdot x$) for describe the relationship d(12-13) (Picture 1) and d(22-23) from $S_t$zr (Picture 2).

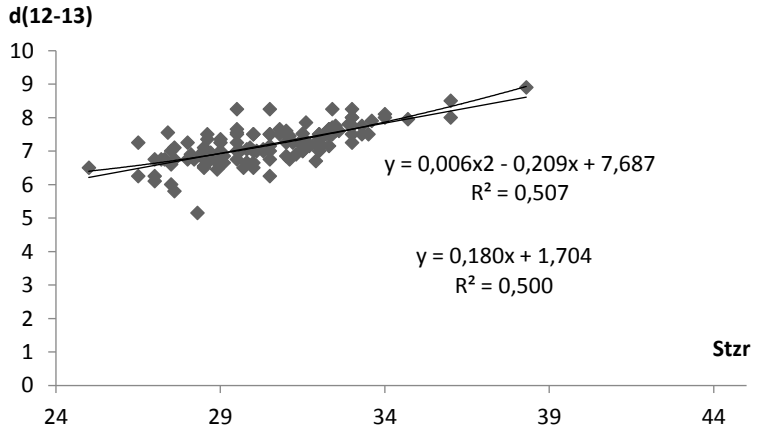


*Fig. 1. Fragment size of dental arch between upper right lateral incisor and canine depending on the sum of incisors*

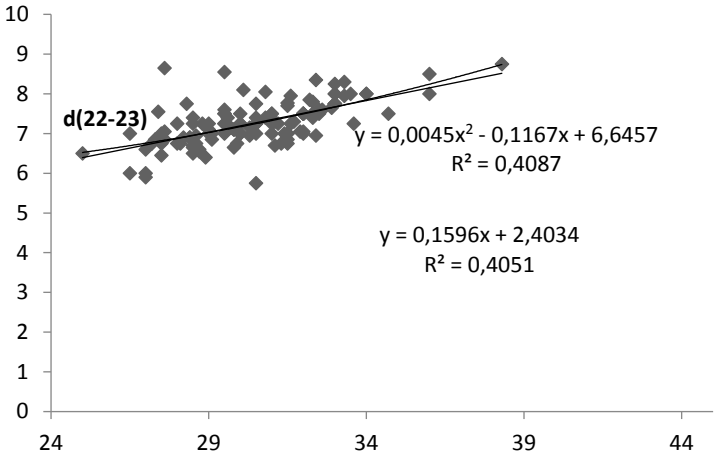


*Fig. 2. Fragment size of dental arch between upper left lateral incisor and canine depending on the sum of incisors*

Location of scattering points shown in figures 1 and 2, and also the $R^2<0,75$ value describes the non-adequateness of built mathematical models for the upper dental arch and for impossibility to find out the adequate model in combined approach.

Correlational connection of d(i-j) and $S_b$zr for all analyzed lower teeth was straight and statistically significant (Table № 2).

*Table 2. Couple correlation coefficient of dental arch segments and combined width of four lower frontal teeth*

| **Dental arch fragments** | **d(42-43)** | **d(43-44)** | **d(44-45)** | **d(45-46)** | **d(46-47)** |
|---|---|---|---|---|---|
| R(d(i-j),$S_b$zr) | 0,741 | 0,503 | 0,426 | 0,34 | 0,225 |
| Dental arch fragments | d(32-33) | d(33-34) | d(34-35) | d(35-36) | d(36-37) |
| R(d(i-j),$S_b$zr) | 0,791 | 0,512 | 0,414 | 0,337 | 0,212 |

Note*: correlational connection is statistically not significant ($p\geq0,05$); however only R(d(42-43),$S_b$zr) and R(d(32-33),$S_b$zr) have a high correlation (0,741 и 0,791).

Same as upper dental arch analysis parameters, scattering diagram with trend models for lower dental arch had been built, which describes relationship between d(42-43) and d(32-33) с $S_b$zr, and had not showed required adequateness.

The result was not satisfactory what led to the interval option in order to solve the study objectives. According to intervals of frontal teeth sizes $S_t$zr upper teeth data were put to groups and is shown in table №3.

*Table 3. Interval groups $S_t$zr for upper frontal teeth*

| **Group name** | **Intervals $S_t$zr (sum of 4 incisors, mm)** | **Number of patients** |
|---|---|---|
| g1 | [26-28) | 11 |
| g2 | [28-30) | 37 |
| g3 | [30-32) | 37 |
| g4 | [32-34) | 29 |
| **Total** | | **114** |

The average numbers of results in study group of 114 which were counted based on parameters of upper and lower dental arches allowed to construct regression mathematic models using scattering diagrams:

for upper dental arch fragments on one side (right or left):

$\underline{d}(12\text{-}13) = 0,174\cdot \underline{S_t}zr+1,885 \quad R^2 = 0,986$

$\underline{d}(13\text{-}14) = 0,106\cdot \underline{S_t}zr+4,023 \quad R^2 = 0,967$

$\underline{d}(14\text{-}15) = 0,065\cdot \underline{S_t}zr+4,934 \quad R^2 = 0,823$

$\underline{d}(15\text{-}16) = 0,056\cdot \underline{S_t}zr+6,718 \quad R^2 = 0,758$

$\underline{d}(16\text{-}17) = 0,062\cdot \underline{S_t}zr+7,867 \quad R^2 = 0,766,$

где $\underline{S_t}zr = z11+ z12+ z21+ z22;$

for upper dental arch fragments on one side (right or left):

$\underline{d}(42\text{-}43) = 0{,}233 \cdot \underline{S_b}zr + 1{,}029 \qquad R^2 = 0{,}986$
$\underline{d}(43\text{-}44) = 0{,}215 \cdot \underline{S_b}zr + 1{,}911 \qquad R^2 = 0{,}902$
$\underline{d}(44\text{-}45) = 0{,}199 \cdot \underline{S_b}zr + 2{,}487 \qquad R^2 = 0{,}884$
$\underline{d}(45\text{-}46) = 0{,}108 \cdot \underline{S_b}zr + 6{,}320 \qquad R^2 = 0{,}893$
$\underline{d}(46\text{-}47) = 0{,}063 \cdot \underline{S_b}zr + 8{,}84 \qquad R^2 = 0{,}786,$

где $\underline{S_b}zr = z41 + z42 + z31 + z32$.

Thereby, considering the symmetry of dental arches in normal occlusion and after orthodontic treatment, these mathematic models are reliably adequate for defining the upper and lower dental arch fragments. Therefore, it became possible to design a computer program for automatic defining mesiodistal sizes of teeth on upper and lower jaws using the size of four frontal teeth. It improves the process of multi loop arch wire preparation by excluding a stage of extra visit, chair time, taking expression, model preparation. Taking all these to account we believe it improves the expenses for the treatment and makes orthodontic treatment more accessible for wide population. The computer program for automatic defining mesiodistal sizes of teeth on upper and lower jaws using the size of four frontal teeth shown in the figure № 3 below.


*Fig. 3. Program appearance on the computer screen*

After opening the program orthodontist should put the upper and lower incisors width and the TSD (Teeth size definer) counts size of the rest of teeth automatically after pressing the “Рассчитать” button as shown in figures 4 and 5.


*Fig. 4. The sizes of four upper and four lower incisors are entered into the program*


*Fig. 5. The Teeth size determination program counted the individual sizes for the patient automatically after pressing the "Рассчитать" button*

In the figure №5 also "Распечатать" button appeared which means that the table with results can be printed out on paper.

In our study we were planning to simplify MEAW arch wire preparation thru the arch form determination and found that the 78,7% of patients in our study group had the oval shape as in Chuck study; also called "Normal" in Ricketts pentamorphic arch forms; and tapered, ovoid and square in McLaughlin and Bennet [3, 9, 10, 11].

Hawley chart which is one of the popular in defining the shape of the arch form is used in our department of Orthodontics. However, even if the method is taking into account a frontal teeth size it does not shows the size of the rest teeth and so cannot be used in multiloop arch wire technique to bend the wire individually.

Some authors found a mean width, length and width/length ratios, the width of tooth, width relationship and the "Golden proportion", some investigated range and mean distribution frequency of teeth width, [8, 11, 13, 14].

**Conclusions.** The computerized method of teeth size defining is comprehensive tool in everyday orthodontic practice. It leads to more easy use of MEAW because aids to count all teeth sizes and determine the position of each L-loop for every orthodontic patient individually.

As long as the program counts the teeth size automatically, it does not take any extra time for the doctor or any extra visit to the patient for taking an extra impression. It also takes less chair time during the insertion of the MEAW during the appointment and makes the orthodontic treatment more comprehensive and precise.

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