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Evaluation of Craniometric Methods for Determination of Vertical Dimension of Occlusion

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A B S T R A C T

In clinical practice, fully precise method for exact determination of vertical relation of occlusion still does not exist. This study examines the relationship between different craniofacial distances and the distance subnasale– gnathion (Sn–Gn), which represents the lower third of the face in vertical relation determination. The highest coefficient of correlation was ($r = 0.8678$, $p < 0.05$) between the distance eye–ear (E–E = lateral border of the ocular orbit–medial opening of the meatus of the external auditory canal) and Sn–Gn. The prediction of the distance Sn–Gn could be determined through the formula: Sn–Gn = E–E / 1.08 or through the regression analysis: Sn–Gn = 1.9197 + 0.6449 x E–E. None of the calculated coefficients of correlation was 1, but was < 1, so that the prediction of the distance Sn–Gn by craniometric distances is not absolutely reliable, although it is considerably helpful. Our results point at the variations of craniofacial distances in the Croatian population. Yet, craniometry could still be recommended in everyday clinical practice for prediction of vertical relation of occlusion, as it is a simple, economic and non-invasive method, however in combination with some other methods, which have proved to be helpful.

Introduction

A precise determination of the jaw relationships is one of the most important steps in diagnosis and therapy of stomatognathic system, as well as in pros-

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thodontic rehabilitation. One of the most difficult tasks is a correct determination of vertical dimension of occlusion during construction of full dentures. Vertical dimension is defined as the distance between any two selected points, one on the upper and another on the lower jaw, the most often selected points being subnasal point and gnathion, or apex of the nose and gnathion. Vertical dimension between the two selected points could be determined in the position of teeth maximum intercuspation, or in the rest position of the mandible[1]. Although rest vertical dimension is supposed to be constant throughout life, some authors recorded its instability [2–5].

Many methods have been described and used for the determination of vertical dimension in dentistry in cases when natural teeth are missing, but none of them is fully accepted or considered completely correct [6–10]. Anthropometric methods for the determination of vertical dimension are based on the measurements on the soft tissues of the cranium and face[11,12], on the plaster casts[13], on the old photographs[14], or on radiographs (cephalometric methods[15,16] or photocephalometric methods[17]). Image analysis, radiostereometrics, CT, MR, laser scans, holograms have also been described [18,19].

The aim of this study was to assess the reliability of craniometric methods for the determination of vertical dimension of occlusion by direct measurement on soft tissues, with special attention to the correlation between the distance ear-eye and subnasale-gnathion, which had not yet been measured in our population.

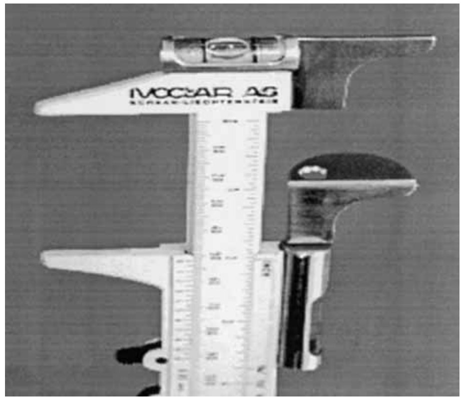

Fig. 1. Modified precise calliper (precision of 0.1 mm) for craniometric measurements.

Materials and Methods

A total of 103 subjects, aged between 20 and 30 years, of both sexes participated in this study. All of the participants were healthy, without symptoms and signs of craniomandibular dysfunction, had eugnathic jaw relationship and at least 28 teeth in both jaws. The measurements were performed by the standard cephalometer and craniometer, described by Salib[20], which was modified for this purpose (Figure 1) to allow a precise position in horizontal and vertical plane. The following distances were measured: eurion-eurion (Eu–Eu), zygion-zygion (Zy–Zy), gonion-gonion (Go–Go), nasion-gnathion (N–Gn), glabella-opistocranion (Gl–Op), nasion-prosthion (N–Pr), pupilla-rima oris (P–Ro), rima oris-gnathion (Ro–Gn), eye-ear (E–E; lateral border of the ocular orbit- medial side of the meatus of the external auditory canal), width of ales of the nose (WAN) and subnasale-gnathion (Sn–Gn) in maximal intercuspal position. All the measurements were performed by three trained therapists and mean values for each distance was used for statistical analysis. Descriptive statistics: mean values (x) and standard deviations (s), and craniofacial indices were calculated. Coefficients of correlation (r) between all the measured distances and Sn–Gn were also calculated and the regression analysis was performed to predict Sn–Gn distance.

Results and Discussion

Means, standard deviations and minimum and maximum values for all measured variables are presented in Table 1. The highest standard deviation is observed for the craniofacial indices.

The coefficients of correlation (r) between all measured variables and the distance Sn–Gn, at the probability level of 95% are presented in Table 2. All measured variables were significantly correlated with Sn–Gn, except for craniofacial indices (ILU/Gn–Sn, ILI/Gn–Sn). The biggest correspondence was registered for the variables N–Pr/ Sn–Gn (1:1.01) and P–Ro/ Sn–Gn (1:0.99). All coefficients of correlation were positive, except for the cranial index- ILU/Sn–Gn. The highest factor of correlation was registered for O–U/ Sn–Gn (r = 0.8676). A significant correlation also existed between N–Gn and Sn–Gn (r = 0,7472) and between Zy–Zy and Sn–Gn (r = 0.71194) (Table 2). Regression analysis was performed for prediction of the distance Sn–Gn by formula: y=ax+b and calculated a and b values are presented in Table 2. For example, the approximation of the distance Sn–Gn by the variable with the highest correlation (E–E) through the regression analysis is: Sn–Gn = 1,9197 + 0,64494 x O–U (Table 2).

The results of this study show that the most reliable craniometric variable for the determination of the distance Sn–Gn in the position of maximum intercuspation is the variable E–E (eye-ear), however through the calculated a and b values by a regression analysis or through the formula: Sn–Gn = O–U / 1.08. Our results resemble to those of Chou at al.[14] for Caucasians, while for the Chinese population the coefficients of correlation between Sn–Gn and O–U were smaller than in this study (r = 0.64 for men and r = 0.60 for women).

None of the measured variables had r = 1, for all measured distances r was < 1, which means that none of the craniometric measurements is fully reliable for the determination of vertical dimension of occlusion, which is due to individual variations within our population. Vertical dimension prediction through E-E measurement is a simple, economic and uninvasive method and although not fully ac-

TABLE 1
MEANS (X), STANDARD DEVIATIONS (S) AND MINIMUM AND MAXIMUM VALUES FOR THE MEASURED VARIABLES

Variable	N	$\overline{X}$	Min	Max	S
EU–EU	103	15.1912	13.8000	16.8000	0.6670
ZY–ZY	103	12.8573	11.2000	14.8000	0.7795
GO–GO	103	10.2447	8.5000	11.5000	0.6653
N–GN	103	11.1961	9.8000	13.0000	0.7005
GL–OP	103	18.4417	16.4000	20.3000	0.7891
N–PR	103	6.3544	5.3000	7.4000	0.5143
P–RO	103	6.1864	5.0000	7.2000	0.5339
RO–GN	103	3.9903	2.4000	6.8000	0.6009
E–E	103	6.7601	5.2000	8.1000	0.6378
WAN	103	2.9631	2.2000	3.5000	0.3424
ILU	103	82.4252	77.1000	87.6000	2.1702
ILI	103	87.1029	83.0000	91.4000	2.1177
SN–GN	103	6.2796	5.2	7.1	0.4741

TABLE 2
COEFFICIENTS OF CORRELATION BETWEEN ANY OF THE MEASURED VARIABLES AND SN–GN, AS WELL AS REGRESSION ANALYSIS

Variable X/ variable Y	Mean (x)	$\overline{X} : \overline{Y}$	r	P	a	b
EU–EU SN–GN	15.19 6.28	2.42	0.60334	<<0.05	–0.2350	0.4288
ZY–ZY SN–GN	12.86 6.28	2.05	0.71194	<<0.05	0.7128	0.4330
GO–GO SN–GN	10.24 6.28	1.63	0.4545	0.0000014172	2.9618	0.3239
GL–OP SN–GN	18.44 6.28	2.93	0.6116	<<0.05	–0.4790	0.3675
N–PR SN–GN	6.35 6.28	1.01	0.4722	0.0000004752	3.5131	0.4354
P–RO SN–GN	6.19 6.28	0.99	0.4357	0.00000421714	3.8861	0.3869
RO–GN SN–GN	3.99 6.28	0.64	0.4838	0.0000002249	4.7564	0.3817
E–E SN–GN	6.76 6.28	1.08	0.8676	<<0.05	1.9197	0.6449
WAN SN–GN	2.96 6.28	0.47	0.4350	0.0000044075	4.4951	0.6022
N–GN SN–GN	11.20 6.28	1.78	0.7472	<<0.05	0.6183	0.5057
ILU SN–GN	82.43 6.28	13.13	–0.002	0.9804149	6.3237	0.0005
ILI SN–GN	87.10 6.28	13.89	0.1349	0.17424736	3.6489	0.0302

curate it could be recommended for everyday practice, however, in combination with some other commonly used methods. Our modification of the craniometer described by Salib[20] also proved to be suitable and simple for everyday practice.

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PROCJENA KRANIOMETRIJSKE METODE ZA ODREĐIVANJE VERTIKALNE DIMENZIJE OKLUZIJE

S A Ž E T A K

Još uvijek ne postoji potpuno precizna metoda za egzaktno određivanje vertikalne dimenzije okluzije. Ova studija proučava odnose između različitih kraniometrijskih udaljenosti i udaljenosti subnasale–gnathion (Sn–Gn) koja predstavlja visinu donje trećine lica pri određivanju vertikalne dimenzije okluzije. Dobiven je najveći stupanj korelacije ($r = 0,8678$, $p < 0,05$) između udaljenosti oko–uho (E-E = lateralni rub orbite–mezijalni zid vanjskog slušnog hodnika) i Sn-Gn, a izračunavanje udaljenosti Sn–Gn se može izvesti formulom: Sn–Gn = O–U / 1,08 ili formulom pravca regresije: Sn–Gn = 1,9197 + 0,6449 x E–E. Niti jedna od ispitivanih korelacija nije potpuna ($r < 1$) pa se metoda određivanja udaljenosti Sn–Gn na osnovi kefalometrijskih parametara ne može smatrati apsolutno pouzdanom, ali je svakako doprinos u znanstvenom i kliničkom postizanju toga cilja. Ovakav nalaz govori o individualnim varijacijama mjerenih kraniometrijskih parametara unutar naše populacijske skupine. Ipak, ova se metoda zbog svoje neinvazivnosti, jednostavnosti, ekonomičnosti i zadovoljavajuće pouzdanosti može preporučiti za svakodnevnu stomatološku praksu u kombinaciji sa drugim metodama.