ACTA FAC MED NAISS

UDC 616.314-073.7

Original article

ACTA FAC MED NAISS 2009; 26 (4): 187-194

Dragan Mladenović[1], Lidija Popović[2], Branko Mihailović[3], Aleksandar Janković[4], Milan Stoiljković[1], Dušan Živković[3], Milan Miladinović[3]

[1]Faculty of Medicine in Niš, Clinic of Dentistry in Niš, Niš, Serbia
[2] Institute for Psychophysical Diorders and Speech Pathology Belgrade, Belgrade, Serbia
[3]Faculty of Medicine in Priština, Clinic of Dentistry in Priština, Priština, Serbia
[4] Faculty of Medicine in Niš, Dermatology Clinic, Niš, Serbia

COMPARISON OF MEASUREMENTS MADE ON DIGITAL 2D MODELS AND STUDY CASTS

SUMMARY

The caliper and Korkhaus grid may be used to make direct measurements on upper and lower study casts. The limitations of these direct measurements are: tool must be perfectly positioned on the cast, measuring is time-consuming, any accidental move of grid gives incorrect results. It is also hard to see through Korkhaus grid, as it tires one's eyes. Digital models solve all the aforesaid problems. The aim of the study was to compare the accuracy of measurements between the upper teeth and medial line of the palate, and lower teeth and medial line of the mandible on digital models (2D) and plaster study casts. The sample consisted of 17 randomly selected pairs of the study cast (34 objects for measuring, 242 individual teeth) from the model base of the Clinic of Dentistry in Niš. Dentitions of all models were permanent or mixed. Only permanent teeth were measured. The occlusal sides of the study casts were digitized into 2D. XPA3 Ortho software was used for taking measurements on digital objects (indirect measurements). Afterwards, the same measurements were performed directly on the study casts by means of Korkhaus hand measurement ruler and by digital calliper - "gold standard". The obtained results show ANOVA significance of 0.570 and F=0.563 between groups. Duncan test does not identify any group, and Spearman rank test shows certain correlation in the general sense ($p < 0.0001$ and rho=0.947), which is more than sufficient. The measurements show statistical discrepancy. Further improvement of the software and the method of digitisation are necessary to overcome the existing problems, and finally substitute the current hand measurement by calliper or ruler by software measurements in two dimensions.

Keywords: **computerized dentistry, digital models, accuracy, plaster study casts, XPA3 Ortho**

INTRODUCTION

The precise measuring is an essential part of orthodontic treatment planning. Direct measurements may be made with callipers (1), rule or the Korkhaus grid, or indirectly on photocopies (2) of the casts or on 2D digital models (3) or 3D digital models (4). Performing 2D software digitizing and measuring are enormously cheaper than 3D one, and could be done by almost all physicians. The caliper and Korkhaus grid may be used to make direct measurements on upper and lower study casts. The limitations of these direct measurements are: tool must be perfectly positioned on the cast, measuring is time-consuming, any accidental move of grid gives incorrect results. It is also hard to see through Korkhaus grid as it tires one's eyes. On the other hand, there is a possibility of digitisation of the study

Corresponding author. Milan Miladinovic • Phone: 064 44 521 44 • E-mail: milanbetter@gmail.com

casts, allowing not only measuring and analysis but also the visualization which was before impossible without damaging the study cast (5). The aim of this study was to compare direct distance measurements made on 2D digital models with identical measurements made on plaster study casts.

MATERIAL AND METHODS

An experimental random study was conducted at the Clinic of Dentistry in Niš, Serbia, in the period between April and June 2008. The sample consisted of 17 pairs of the study cast, i.e. 34 objects for measuring or 242 individual teeth. The samples were randomly chosen from the model base of the Clinic of Dentistry in Niš, and they represent the solved orthodontic cases. Criteria for selection were as follows: majority of permanent teeth, also including the first molars in both the maxillary and mandible arches had to be present. Criteria included only fully erupted permanent teeth (from 3 to 7), and that there was no obvious loss of tooth material as a result of caries, fractures, congenital defects or impression flaws. There were no damages and untrimmed 'heels' on the models. The midline of upper models was estimated with rafe palatine: first point created as the intersection of the rafe line and second plica transversa; second point was the end of spina nasalis posterior. The midline of lower models estimated in the following way: upper and lower models were brought in occlusion. Rafe midline resumed on the lower incisive and set first point; the second point created by projecting rafe line from the upper model to lower model using transparent orthometer. The occlusal sides of all the casts (upper and lower models) were digitised in two-dimensions (2D). Digitisation was performed by placing the occlusal side of each model down and scanning the models by HP Scan Jet 2400 (manufacturer: Hewlett-Packard; country of origin: United Stated) and by software Prolom S-3 ver. 3.0.3 (manufacturer: Author of this article (M.M), Serbia) (6) in the following way: the study cast was laid on the scan surface with its occlusal side. From the software we started scanning and got digitised 2D casts. The analysis and the measurements of the distance between teeth and the medial line of digitalized casts were performed by XPA3 Ortho ver.1.0.1 (7) (software created by M.M.). After this, the measuring of the study casts was performed by the circular net framed millimetre ruler, taken from orthodontic gadget of Korkhaus, in the following way: the study casts were laid on the table with their occlusal side turned upwards. The Korkhaus ruler was placed on the occlusal side, that is to say teeth, so that the medial line of the ruler could match the previously drawn medial line of the model. Finally, the measuring of the study casts was performed by digital calliper (Mitutoyo CD-15DC): the study casts were in same position as for the Korkhaus ruler. All the data were collected by one operator (M.S.). All of the measurements were performed on the permanent teeth, from eyetooth to second molar, and their distance from the medial line was measured in accordance with orthodontics principles. The measurements were repeated for three times.

Statistical analysis

The data collected from measuring of 34 casts were inserted in the table of software Microsoft Office Excel ver. 2007 and then transferred to statistical software for SPSS ver. 14 which was used for ANOVA, Duncan and Paired T Test, and Spearman rank correlation (8). The results of these 34 casts were compared both individually and in sum. The one-way ANOVA test was used to compare three groups (Korkhaus ruler, software and caliper). Then, Duncan's new multiple range test was used to identify the groups that are different. The Paired-Samples T test was used to determine the accuracy of the methods in duplicate measurements. (Tables from 1 to 8).

RESULTS

The collected data show statistically important difference in almost every measurement. Manual direct (Korkhaus orthometer and calliper) and indirect digital measurements performed on 17 upper casts show: for tooth 13 (erupted: 16/17) - difference more than 1mm in 11 cases, more than 1.5mm in 6 cases, and more than 2mm in one case; for tooth 15 (erupted: 15/17) – more than 1mm in 14 cases, more than 2mm in 8 cases; more than 3mm in 4 cases; for tooth 24 (erupted: 14/17) – more than 1mm in 7 cases, more than 1.5mm in 4 cases; for tooth 27 (erupted: 8/17) – more than 1mm in 5 cases, more than 1.5 in 3 cases. Manual and digital measurements performed on 17 lower casts show: for tooth 43 (erupted: 16/17) - difference more than 1mm in 4 cases, more then 2 mm in 2 cases; for tooth 45 (erupted: 13/17) – more than 1mm in 8 cases, more than 1.5mm in 6 cases, more than 2mm in 2 cases; for tooth 34 (erupted: 14/17) – more than 1mm in 6 cases, more than 1.5mm in 2 cases, more than 3mm in one case; for tooth 36 (erupted: 16/17) – more than 1mm in 9 cases, more than 2mm in 8 cases, more than 3mm in 5 cases and more than 9mm in one case.

Repeated measurements between the same kinds of measuring show the following correlations: 1.000 for software measuring, 0.998-0.999 for caliper and 0.987 – 0.994 for Korkhaus orthometer.

Statistical analyses are shown in tables 1-8.

Table 1 – ANOVA statistics

Value					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	30.182	2	15.091	.563	.570
Within Groups	21004.412	783	26.826		
Total	21034.594	785			

Table 2. Duncan statistics

Type	N	Subset for alpha = 0.05
		1
A	262	20.2710
C	262	20.4005
B	262	20.7360
Sig.		.336

Means for groups in homogeneous subsets are displayed.

A Korkhaus orthometer, B Software, C Caliper

Table 3. Paired Samples Correlations

	N	Correlation	Sig.
O1 & O2	262	.994	.000
O1 & O3	262	.992	.000
O2 & O3	262	.987	.000
S1 & S2	262	1.000	.000
S1 & S3	262	1.000	.000
S2 & S3	262	1.000	.000
C1 & C2	262	.999	.000
C1 & C3	262	.999	.000
C2 & C3	262	.998	.000

O1 Korkhaus orthometer Times 1, *O2* Korkhaus orthometer Times 2, *O1* Korkhaus orthometer Times 2, *S1* Software Times 1, *S21* Software Times 2, *S3* Software Times 3, *C1* Caliper Times 1, *C2* Caliper Times 2, *C3* Caliper Times 3. *I*

Table 4. Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	O1	20.2710	262	5.04245	.31152
	O2	20.3817	262	5.08692	.31427
Pair 2	O1	20.2710	262	5.04245	.31152
	O3	20.3092	262	5.09224	.31460
Pair 3	O2	20.3817	262	5.08692	.31427
	O3	20.3092	262	5.09224	.31460
Pair 4	S1	20.7360	262	5.30961	.32803
	S2	20.7399	262	5.31083	.32810
Pair 5	S1	20.7360	262	5.30961	.32803
	S3	20.7356	262	5.31359	.32827
Pair 6	S2	20.7399	262	5.31083	.32810
	S3	20.7356	262	5.31359	.32827
Pair 7	C1	20.4005	262	5.18251	.32018
	C2	20.3958	262	5.18366	.32025
Pair 8	C1	20.4005	262	5.18251	.32018
	C3	20.4115	262	5.19001	.32064
Pair 9	C2	20.3958	262	5.18366	.32025
	C3	20.4115	262	5.19001	.32064

O1 Korkhaus orthometer Times 1, *O2* Korkhaus orthometer Times 2, *O1* Korkhaus orthometer Times 2, *S1* Software Times 1, *S21* Software Times 2, *S3* Software Times 3, *C1* Caliper Times 1, *C2* Caliper Times 2, *C3* Caliper Times 3.

Table 5. Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
O1 - O2	-.11069	.57165	.03532	-.18023	-.04115	-3.134	261	.002
O1 - O3	-.03817	.64362	.03976	-.11646	.04013	-.960	261	.338
O2 - O3	.07252	.81090	.05010	-.02613	.17117	1.448	261	.149
S1 - S2	-.00389	.04807	.00297	-.00974	.00195	-1.311	261	.191
S1 - S3	.00038	.04708	.00291	-.00535	.00611	.131	261	.896
S2 - S3	.00427	.06535	.00404	-.00368	.01222	1.059	261	.291
C1 - C2	.00473	.20852	.01288	-.02063	.03010	.367	261	.714
C1 - C3	-.01099	.23542	.01454	-.03963	.01765	-.756	261	.450
C2 - C3	-.01573	.30254	.01869	-.05253	.02108	-.841	261	.401

O1 Korkhaus orthometer Times 1, O2 Korkhaus orthometer Times 2, O1 Korkhaus orthometer Times 2, S1 Software Times 1, S21 Software Times 2, S3 Software Times 3, C1 Caliper Times 1, C2 Caliper Times 2, C3 Caliper Times 3.

Table 6. Spearman Rank Colleration – Korkhaus Orthometer and Software

Tooth	rho	P	95% Confidence Interval for rho
All teeth	0.947	P<0.0001	0.933 to 0.958
13	0.764	P=0.0031	0.432 to 0.914
23	0.791	P=0.0022	0.486 to 0.924
14	0.866	P=0.0061	0.555 to 0.965
24	0.769	P=0.0077	0.378 to 0.927
15	0.494	P=0.0647	-0.025 to 0.803
25	0.918	P=0.0006	0.766 to 0.973
16	0.847	P=0.0007	0.617 to 0.943
26	0.715	P=0.0042	0.357 to 0.890
17	0.491	P=0.2291	-0.416 to 0.908
27	0.704	P=0.0845	-0.104 to 0.952
47	0.019	P=0.9635	-0.745 to 0.761
37	0.765	P=0.0608	0.029 to 0.963
46	-0.233	P=0.3664	-0.653 to 0.297
36	0.703	P=0.0064	0.319 to 0.889
45	0.675	P=0.0194	0.197 to 0.894
35	0.405	P=0.1609	-0.188 to 0.781
44	0.516	P=0.0737	-0.048 to 0.831
34	0.573	P=0.0473	0.032 to 0.854
43	0.763	P=0.0043	0.412 to 0.917
33	0.713	P=0.0076	0.316 to 0.897

Table 7. Spearman Rank Colleration – Korkhaus Orthometer and Caliper

Tooth	rho	P	95% Confidence Interval for rho
All teeth	0.948	P<0.0001	0.934 to 0.959
13	0.932	P=0.0003	0.812 to 0.977
23	0.954	P=0.0002	0.871 to 0.984
14	0.603	P=0.0567	0.004 to 0.883
24	0.939	P=0.0011	0.804 to 0.982
15	0.929	P=0.0005	0.794 to 0.976
25	0.878	P=0.0016	0.649 to 0.961
16	0.980	P=0.0001	0.945 to 0.993
26	0.983	P=0.0001	0.951 to 0.994
17	0.818	P=0.0450	0.170 to 0.972
27	0.976	P=0.0098	0.868 to 0.996
47	0.889	P=0.0293	0.413 to 0.984
37	0.941	P=0.0353	0.548 to 0.994
46	0.967	P=0.0002	.904 to 0.989
36	0.874	P=0.0007	0.667 to 0.956
45	0.905	P=0.0017	0.705 to 0.971
35	0.724	P=0.0091	0.314 to 0.906
44	0.916	P=0.0015	0.736 to 0.975
34	0.908	P=0.0017	0.714 to 0.972
43	0.931	P=0.0005	0.800 to 0.977
33	0.980	P=0.0002	0.940 to 0.994

Table 8. Spearman Rank Colleration – Caliper and Software

Tooth	rho	P	95% Confidence Interval for rho
All teeth	0.948	P<0.0001	0.934 to 0.959
13	0.680	P=0.0085	0.277 to 0.879
23	0.711	P=0.0059	0.333 to 0.892
14	0.473	P=0.1349	-0.177 to 0.836
24	0.715	P=0.0132	0.271 to 0.908
15	0.572	P=0.0324	0.084 to 0.839
25	0.675	P=0.0150	0.225 to 0.888
16	0.794	P=0.0015	0.507 to 0.923
26	0.880	P=0.0004	0.692 to 0.956
17	0.607	P=0.1370	-0.269 to 0.933
27	0.405	P=0.2842	-0.420 to 0.863
47	-0.090	P=0.8253	-0.790 to 0.711
37	0.943	P=0.0350	0.559 to 0.994
46	0.217	P=0.4007	-0.312 to 0.643
36	0.318	P=0.2186	-0.211 to 0.703
45	0.786	P=0.0065	0.414 to 0.933
35	0.338	P=0.2228	-0.235 to 0.737
44	0.465	P=0.1073	-0.116 to 0.809
34	0.687	P=0.0174	0.219 to 0.898
43	0.717	P=0.0073	0.324 to 0.899
33	0.703	P=0.0085	0.298 to 0.894

DISCUSSION

The results show that there was not a significant difference between the measurements of models on different occasions (ANOVA significance of 0.570 and F=0.563 between groups and Duncan test does not identify any group). The correlation coefficients between occasions for grid, calliper and software and between averaged (Time1, Time2, Time3) measurements from grid, calliper and software are all very high (p<0.05, correlation from 0.994(Korkhaus) to 1.000 (software)) .These are not affected by systematic differences revealed by t tests (9). We found that the overall measurement results, obtained by the computer, show a certain correlation with the results obtained by the ruler and caliper; however, there is a great difference.(For Korkhaus Orthometer and Software: rho=0.947, P<0.0001, 95% Confidence Interval for rho = 0.933 to 0.958; For Caliper and Software: rho=0.948; P<0.0001; 95% Confidence Interval for rho = 0.934 to 0.959) The difference is very significant when we make statistical analysis of correlation with single tooth measurements. After careful examination of the results of single teeth, we noticed that the front teeth show the greatest correlation, whereas the back teeth have the least. This can be accounted for by their distance from the medial line. That is to say, the front teeth are nearest to the medial line, so the difference we get is less than with back teeth. The smallest correlation is obtained for tooth 46: rho=-0.233, P=0.3664; 95% Confidence Interval for rho=-0.653 to 0.297 achieved for Korkhaus orthometer and software; and rho=0.217, P=0.4007;, 95% Confidence Interval for rho=-0.312 to 0.643 achieved for caliper and software. The highest correlation is obtained for tooth 33: rho=0.980, P=0.0002; **95%** Confidence Interval for rho=-0.940 to 0.994 achieved for Korkhaus orthometer and caliper.

The reasons for non-existing statistical correlation can be various, but still, they represent mistakes and discrepancies. The terminology employed is taken principally from Beers (10) , who defines the terms used in this area as follows (11):

Error. This word is used correctly with two different meanings:

To denote the difference between a measured value and the "true" value. Except in a few trivial cases, the "true" value is unknown and the magnitude of the error is hypothetical.

When a number such as (±.087) is given or implied, "error" refers to the estimated uncertainty in an experiment and is expressed in terms of such quantities as standard deviation, average deviation, probable error, or precision index.

Discrepancy. This is the difference between two measured values of quantity, such as the difference between two measured values of the same quantity obtained by two investigators. The word "error" is often used incorrectly to refer to such differences.

The samples can be different. Examining the available literature, we could see that even before us the authors had encountered similar problems when trying to measure the width of a tooth on a 2D study cast. As a possible cause, the process of digitalization (photocopying) is taken, that is to say the impossibility of precise three-dimensional measurement of the study model which is then transferred into two-dimensional; then the convex structure of teeth, curve of Spee, differences in tooth inclinations, deviations of teeth axes from the perpendicular axis, and crowded tooth positions (2).

In order to achieve precision, the authors tried to conduct the calibration of the digital 2D measurement by means of the ruler (2), or graphic millimeter paper placed underneath the scanned model (3).

The problem highlighted by the authors is the necessity for certain resolutions of the 2D casts in order for measuring to be successful. If we know the resolution of the picture (resolution is a number of pixels on the surface and is usually expressed as a number of pixels per inch (objection of the author) it is possible to convert the distance from pixels (dots) into millimetres, however, if the resolution is unknown this will not function (3). Nevertheless, other authors search for the perfect positioning of the study model in longitudinal direction during the process of digitization (12). In this study, those problems are overcome by using XPA3 Ortho which not only recognizes and adjusts to the resolution of the 2D model picture, but it also has installed a system for rotation, so the ideal positioning of the study cast is not necessary. The calibration was checked both by graphic millimeter paper and the ruler, and it was completely correct and in accordance with the description of the software used.

We noticed that the problem usually arises from the correct position of the ruler during measuring and appropriate position of the study cast in the process of scanning (6). When we say the correct position, we mean the position which is parallel to the ruler level that is to say with the scanning surface of the 2D scan. In everyday practice, not much attention is paid to the parallel position of the study model with the ruler during measuring. The same goes for digitization of the model. None of the authors, including us, have paid special attention to the ideal position of the study cast; they were placed 'ad hoc', so that they occupied a position determined by the height of teeth in them. *Figure 1* shows Korkhaus orthometer in the process of measuring. As one can see, its position is determined by the teeth on which it stands and the hands of orthodontist, where the parallelism with the study model lies. The same problem appears in digitization.

Figure 1.

Figure 2 shows the surface of the model (red line), and both the left (green) and the right side (blue) of teeth in the upper jaw. One can see that the angles, which cover the tooth surface, with the vertical line on the model's surface, do not form the right angle. It means that the distance obtained by this kind of measurement of a certain ruler position or by 2D scan is not 'authentic'. The measured distance is just one of the sides of a right-angle triangle, which is constituted from the surface of the model, vertical line on the model's surface, and the surface of measured teeth.

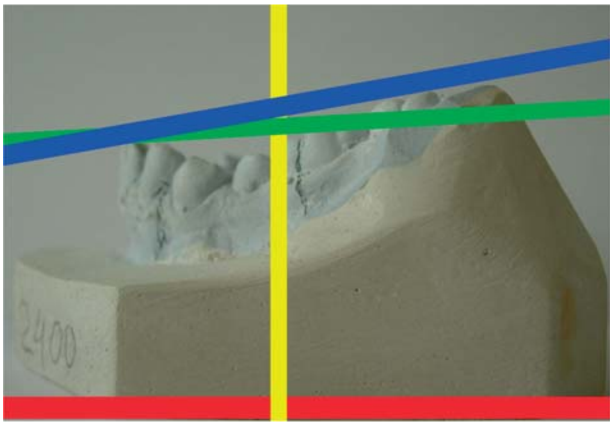

Figure 2.

As can be seen in *Figure 3*, the medial line placed by XPA3 Ortho software and the medial line manually drawn by one of the examiners do not match, so the considerable difference between the results can be expected. The non-existing parity between the model and the scan can be one of the reasons. It leads to false projection of the model in the moment of scanning; therefore, the measuring of such 2D model gives different results.

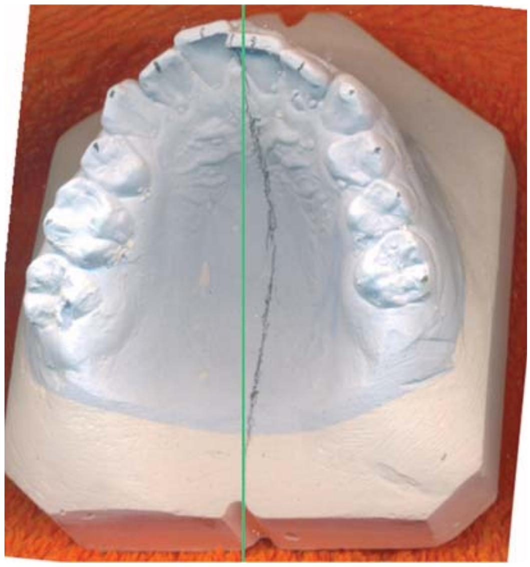

Figure 3.

However, *Figure 4* shows matching of medial lines. This matching is accidental and is not the result of our work on parity with the scan.

Figure 4.

All this means that 2D digital measuring can not substitute manual measuring. Despite the obtained results and all the earlier studies on the topic of measuring 2D casts, as well as the latest researches of measuring the 3D casts (8) which clearly shows that hand measuring in Orthodontics can not be substituted with the computer, it is our duty to continue developing the procedure and the software. Clinical implications of digital orthodontics increase year by year (13), and the results obtained justify any effort invested in the research of this field.

CONCLUSION

When trying to compare the manual measuring of the distance between teeth by means of calliper and Korkhaus orthometer of the study casts, and digitalized measuring of the two dimensional objects of the same cast, we obtained statistically significant differences. Various factors may cause such a difference. We think that the most important reason for this discrepancy is the precise positioning of Korkhaus ruler in the process of hand measuring and parity of 2D scan with plaster cast in 2D digitization of the model. The non-existing parity leads to false projection and different results.

Further perfection of the software and the method of digitization are necessary in order to overcome the current problems, and finally substitute the hand measuring with the caliper.

Acknowledgement

In the name of the Lord Jesus Christ, we have created and published this article.

REFERENCES

1. Stevens DR, Flores-Mir C, Nebbe B, Raboud DW, Heo G, Major PW. Validity, reliability, and reproducibility of plaster vs digital study models: comparison of peer assessment rating and Bolton analysis and their constituent measurements. Am J Orthod Dentofacial Orthop. 2006 ;129(6):794-803.

2. Schirmer UR, Wiltshire WA. Manual and computer-aided space analysis: a comparative study. Am J Orthod Dentofacial Orthop. 1997;112(6):676-80.

3. Paredes V, Gandia JL, Cibrian R. New, fast, and accurate procedure to calibrate a 2-dimensional digital measurement method. Am J Orthod Dentofacial Orthop. 2005;127(4):518-9.

4. Mullen SR, Martin CA, Ngan P, Gladwin M. Accuracy of space analysis with emodels and plaster models. Am J Orthod Dentofacial Orthop. 2007;132(3):346-52.

5. Zilberman O, Huggare JA, Parikakis KA. Evaluation of the validity of tooth size and arch width measurements using conventional and three-dimensional virtual orthodontic models. Angle Orthod. 2003;73(3):301-6.

6. Miladinović M, Mladenović D, Vujičić B. Applying Prolom S-3 software in evidence, billing and statistical reports for prosthetics restorations. XLVII Congress of the anthropological society of Serbia with international participation, Kruševac 2008.

7. M. Miladinović, D. Mladenović, Stojiljković M et al. Digital measurement of transversal anomalies in study models. XLVII Congress of the anthropological society of Serbia with international participation, Kruševac 2008.

8. Hildebrand JC, Palomo JM, Palomo L, Sivik M, Hans M. Evaluation of a software program for applying the American Board of Orthodontics objective grading system to digital casts. Am J Orthod Dentofacial Orthop. 2008;133(2):283-9.

9. Houston WJ. The analysis of errors in orthodontic measurements. Am J Orthod. 1983 ;83(5):382-90.

10. Yardley B. Introduction to the Theory of Error. Cambridge, Mass.: Addison-Wesley Publishing Co., Inc 1953;

11. Hunter WS, Priest WR. Errors and discrepancy in measurement of tooth sizes. J Dent Res 1960;39:405–14.

12. Tran AM, Rugh JD, Chacon JA, Hatch JP. Reliability and validity of a computer-based Little irregularity index. Am J Orthod Dentofacial Orthop. 2003;123(3):349-51.

13. Redmond WR, Redmond WJ, Redmond MJ. Clinical implications of digital orthodontics. Am J Orthod Dentofacial Orthop. 2000;117(2):240-1.

UPOREĐIVANJE MERA DOBIJENIH NA DIGITALNIM 2D MODELIMA I GIPSANIM STUDIJSKIM MODELIMA

Dragan Mladenović[1], Lidija Popović[2], Branko Mihailović[3], Aleksandar Janković[4], Milan Stoiljković[1], Dušan Živković[3], Milan Miladinović[3]

[1] Medicinski fakultet u Nišu, Stomatološka klinika u Nišu, Niš, Serbia
[2] Institut za psihofizičke poremećaje i patologiju govora Beograd, Beograd, Serbia
[3] Medicinski fakultet u Prištini, Stomatološka klinika u Prištini, Priština, Serbia
[4] Medicinski fakultet u Nišu, Dermatološka klinika, Niš, Serbia

SAŽETAK

Za direktno merenje na gornjim i donjim studijskim modelima uobičajeno se koristi šubler i lenjir po Korkhausu. Kod ovih načina direktnih merenja postoje ograničavajući faktori kao što su: lenjir mora biti idealno postavljen na model, samo merenje iziskuje dosta vremena, a bilo koji slučajni pokret rukom rezultira greškom u rezultatima. Čak i samo gledanje kroz mrežasti lenjir po Korkhausu je naporno, pa zamara oči terapeuta. Digitalni modeli razrešavaju sve pomenute probleme. Cilj rada bio je uporediti tačnost merenja između gornjih zuba i medijalne linije palatuma i donjih zuba i medijalne linije mandibule na digitalnim 2D modelima i gipsanim studijskim modelima. Uzorak se sastojao od 17 parova studijskih modela (34 modela za merenje, tj. individualnih 242 zuba) koji su slučajno izabrani iz baze modela Klinike za stomatologiju u Nišu. Denticije svih modela bile su ili stalne ili mešovite. Samo stalni zubi su mereni. Okluzalne strane studijskih modela su digitalizovane u 2D. Za indirektna merenja na digitalnim modelima korišćen je softver XPA3 Ortho. Potom su urađena direktna merenja na gipsanim studijskim modelima pomoću lenjira po Korkhausu i digitalnog šublera kao zlatnog standarda. Dobijeni rezultati pokazuju ANOVA značajnost od 0.570 i F=0.563 između grupa. Dankanov test ne identifikuje nijednu grupu, a Spearmanov rank test pokazuje izvesnu korelaciju u opštem smislu (*p* < 0.0001 i rho=0.947), koja je više nego dovoljna. Merenja pokazuju statističku diskrepancu. Dalje usavršavanje softvera i metoda digitalizacije je neophodno da se prevaziđu tekući problemi i konačno zameni ručno merenje lenjirima, softverskim merenjima u dve dimenzije.

Ključne reči: **kompjuterizovana stomatologija, digitalni modeli, preciznost merenja, gipsani modeli, XPA3 Ortho**