

COMPARATIVE ANALYSIS OF TMJ TOMOGRAPHIC IMAGES IN PATIENTS WITH DYSFUNCTIONAL SYNDROME OF TMJ

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Abstract: The radiographic imaging brings valuable information on the TMJ morphology, statics and dynamics and there are several methods described in the literature to determine condylar position. 20 patients, 10 men and 10 women, with ages between 20 and 42 years, were evaluated. The patients came for treatment to the Dental Medicine Training Centre of the Faculty of Dental Medicine at “Grigore T. Popa” University of Medicine and Pharmacy of Iasi. All the patients included in the study group were affected by the TMJ dysfunctional syndrome intercepted at various stages of evolution. The patients were clinically and radiographically evaluated, after which they were supposed to receive medical care according to the standard treatment algorithm of the clinic. In five out of ten analysed cases of the group, asymmetries of condyle position were present on the right rather than on the left, either through anterior positions of the condyle to the centre of the glenoid fossa in four cases or a posterior position in one case. Only in 5 cases for group 1 and 2 cases for group 2, equal right-left starting positions of the condyles were found. In the other cases, either anterior or posterior displacements of the C condylar centre appear in relation to the morphological elements of the joint.

Key words: *TMJ morphology, dysfunctional syndrome of TMJ, tomographic examination*

INTRODUCERE Through the variability of the components due to either the morphologic polymorphism through genetic inheritance, through function exercise [1, 2] or through joint pathology [3, 4, 17], temporomandibular joints decisively influence the dynamic behaviour of the mandible and, as a consequence, the overall functioning of the stomatognathic system. Due to its anatomical nature, TMJ eludes the examiner's senses, therefore the diagnostic of morphologic modifications that usually occur when the dysfunctional syndrome has installed cannot be carried out directly, but through a multitude of complementary examinations. The radiographic imaging brings valuable information on the TMJ morphology, statics and dynamics and there

are several methods described in the literature to determine condylar position [5, 6, 7, 8]. Robert Ricketts was the first one to introduce the TMJ evaluation in laminographies, making possible the radiographic quantification of joint space and condyle position [5].

The radiographic imaging requires the compliance with several rules: examination must be bilateral, in 2 positions of diagnostic, with the mouth closed and opened; the opened position of the mouth shall be checked with a graded scale between the patient's teeth in order to accurately obtain the maximum opening of the mouth.

This study wishes to emphasise the importance of the tomographic examination

and the direct and exact connection with the instituted treatment and the results obtained [14,16, 18,19]

MATERIAL AND METHOD

20 patients, 10 men and 10 women, with ages between 20 and 42 years, were evaluated. The patients came for treatment to the Dental Medicine Training Centre of the Faculty of Dental Medicine at “Grigore T. Popa” University of Medicine and Pharmacy of Iasi. All the patients included in the study group were affected by the TMJ dysfunctional syndrome intercepted at various stages of evolution. The patients were clinically and radiographically evaluated, after which they were supposed to receive medical care according to the standard treatment algorithm of the clinic.

Even though the joint space assessment on 2D radiographic examination of the TMJ have proven lower accuracy than 3D radiographic methods [9], the application of certain digital processing techniques offers the possibility of extra accuracy in the interpretation of these images [10].

The TMJ tomographic images with the mouth closed and opened were analysed by using a method combining two other, one proposed by Ricketts and the other one proposed by Zhang Zenkang [11]. The two methods were adapted and modified and the following data were recorded on the resulted images (Fig. 1):

- Frankfurt plane
- perpendicular line to the Frankfurt plane on the Po point (porion)
- tangent line to the articular eminence and the alpha angle value
- finding point C, the centre of the mandibular condyle, as the intersection of the diagonals of a square obtained by drawing the two perpendiculars on the Frankfurt plane tangent to the condyle anterior and posterior faces and the tangent to the superior limit of the condyle parallel with the Frankfurt plane [12, 13, 15].
- marking point A, the deepest point of the glenoid fossa and drawing through point A a parallel to the Frankfurt plane
- marking point B, the most inferior point of the articular eminence and drawing through B a line parallel to the Frankfurt plane
- measurement of AB, analogue to h_1+h_2 but still different as there are frequent situations when the Frankfurt plane is positioned above the glenoid fossa and h_1 and h_2 cannot be individually measured, then erroneous data can be obtained. This inconvenience is removed by the direct measuring of the distance between the two parallels to the Frankfurt plane.
- distance from C to the perpendicular line through P_o , in the two positions of the condyles, D_1 and respectively D_2 ; the displacement of the condyle seems to us much more accurate to be recorded starting from the centre of the mandibular condyle.
- drawing axis X in the middle of the distance between A and the Frankfurt plane and placing G (centre of the glenoid fossa) through which the axis Y was drawn
- measuring the articular space in points a, b and c, in the three anterior, superior

and respectively, posterior positions of the joint space.

- size of B-P₀ relevant for the real distance which should normally be covered in the sagittal direction by the condyle when referring to D₁ measured with the mouth closed and the incomplete trajectory when referring to D₂ measured with the mouth opened.

- depending on the position of C in relation to G on the Y axis, three indices are established on the condyle positioning: condyle in position 1, when C and G are both found on axis Y; condyle in position 2, when C is anterior to G and the condyle in position 3 when C is posterior to G. The indices easily expose the potential eccentric condylar position.

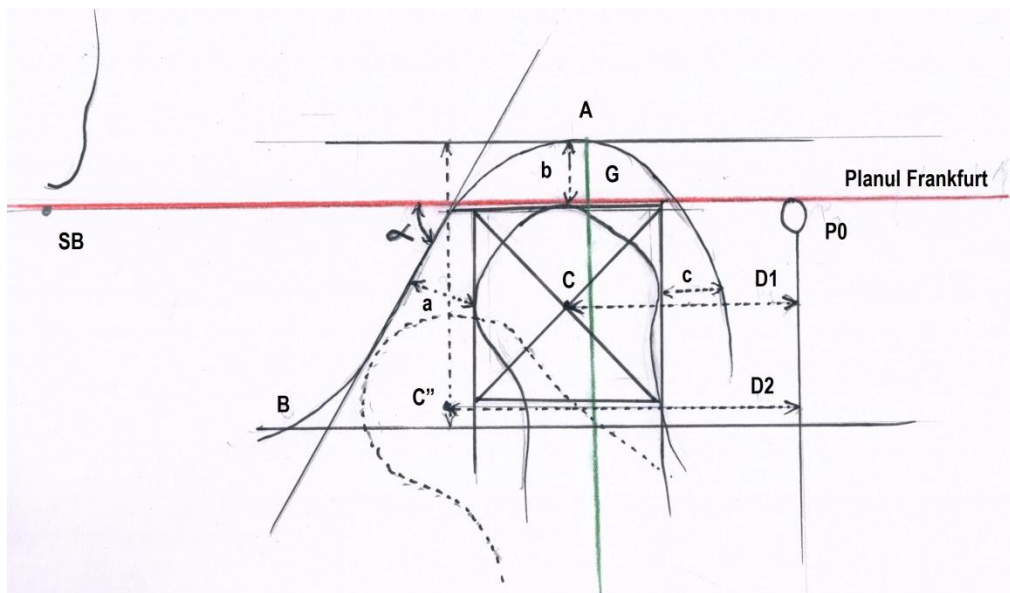


Fig. 1. TMJ tomography analysis

RESULTS AND DISCUSSIONS

Group 1 comprised of 10 men present for treatment in the clinic and who presented signs of a dysfunctional syndrome of the stomatognathic system. The patients'

ages ranged between 20 and 42 years, with a calculated mean value of 31.1 years.

On the tomography images of group 1, the above presented analysis was performed. The values in Table 1 were obtained.

Table 1 - Tomographic analysis following the method proposed for group 1.

Lot 1	Age	Condyle position		AB	Dif.	D ₁	D ₂	Dif.	B-P ₀	Alpha	Articular space											
		D.	S.								D.	S.	Dif.	D.	S.	D.	S.	D.	S.			
A.C.	35	2	1	8.5	11	2.5	15	10	20	23	-7	-1	27	24	58	70	2.0	3.0	5.0	2.0	3.0	2.0
M.M.	41	2	1	9	9	0	21	18	31	32	+5	+1	26	31	46	50	0.0	0.0	5.0	3.0	2.0	4.0
V.M.	34	1	1	9	7	2	11	11	23	27	0	+3	23	24	51	48	1.0	0.5	0.5	0.5	0.5	0.0

B.C.	40	1 1	10 8	2	13 14	29 28	+7 +6	22 22	45 58	1.5 3.0 2.0	1.5 3.0 2.0
P.I.	32	1 1	6 9	3	13 12	15 25	-8 +4	23 21	48 54	2.0 2.0 2.0	1.0 1.0 2.0
A.V.	42	2 2	7 11	4	16 16	31 31	+6 +6	25 25	50 46	2.0 5.0 4.0	1.5 3.0 3.0
C.C.	25	1 1	10 9	1	12 11	25 23	+2 0	23 23	50 49	2.0 5.0 3.0	1.5 3.0 1.5
Z.A.	21	2 1	12 10	2	13 14	23 26	-2 +3	25 23	47 47	1.0 0.0 0.0	2.0 1.5 1.0
P.G.	20	2 1	11 12	1	12 14	30 26	+2 -1	28 27	50 63	1.0 1.5 1.5	2.0 3.5 2.0
B.C.	21	3 1	11 12	1	11 13	24 26.5	+4 +4.5	20 22	62 50	2.0 3.0 3.0	1.0 4.0 2.5
Mean value	31.1	1.7 1.1	9.35 9.8	1.85	13.8 13.3	25.1 26.7	- -	24.2 24.2	50.7 53.5	1.4 2.3 2.5	2.0 2.4 2.3

In five out of ten analysed cases of the group, asymmetries of condyle position were present on the right rather than on the left, either through anterior positions of the condyle to the centre of the glenoid fossa in four cases or a posterior position in one case.

All the cases of condylar asymmetry were accompanied by specific modifications of the joint space. Thus, enlargements of the joint space measured at level c appear in the case of the displacement of point C towards the anterior (condyle position 2) and analogously, narrowing and collapse of the joint space in the displacements towards the posterior of the condyle. The results as presented in the Table 1. The mean value of the condylar positions is 1.7 mm on the right and 1.1 mm on the left, which materializes the sensitivity of the TMJ which reacts like a real seismograph determining changes of the C centres of the mandibular condyles.

The measurement of the alpha angle, made by the tangency on the slope of the articular eminence with the Frankfurt plane, has revealed the data in the Table 1 which are in compliance with the data in the literature.

The AB distance, measured as the distance between the two lines parallel with the Frankfurt plane, through point A considered to be the deepest of the glenoid fossa and point B, the most inferior of the articular tubercle, thus, the value of the vertical obstacle which must be outran in the movement of opening by the mandibular condyle, indicates that:

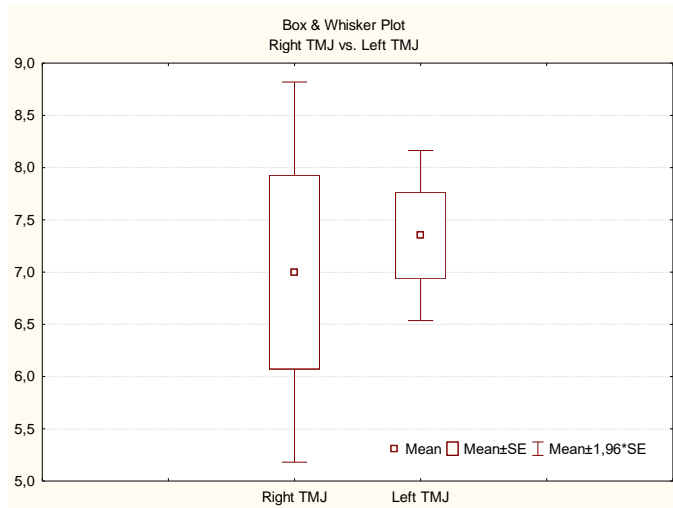
- There is a mean value of 9.35 mm and respectively 9.8 mm at the level of the entire group.
- The value decreases along with age probably through the abrasion of the articular eminence.
- The vertical obstacle which emerges in the sagittal condylar displacement upon the opening movement could be more accurately calculated, by subtracting the values of the joint space at level b from the AB distance.

By carrying out these calculations we have obtained the results from Table 2:

The mean value 7.17 mm can be observed for both TMJs for the group examined, as though the mean value would level individual differences.

Table 2 – Difference between AB and joint space in position b

Clinical cases	Right TMJ (mm)	Left TMJ (mm)
A.C.	5.5	8
M.M.	9	7
V.M.	8	5
B.C.	7	5
P.I.	4	8
A.V.	2	8
C.C.	5	7.5
Z.A.	12	8.5
P.G.	9.5	8.5
B.C.	8	8
Mean value	7.00	7.35
Mean value R-L	7.17	



	Mean - Group 1	Mean - Group 2	t-value	df	p	Valid N - Group 1	Valid N - Group 2	Std.Dev. - Group 1	Std.Dev. - Group 2	F-ratio - Variances	p - Variances
Right TMJ vs. Left TMJ	7,00	7,35	-0,34	18	0,73	10	10	2,93	1,31	4,99	0,03

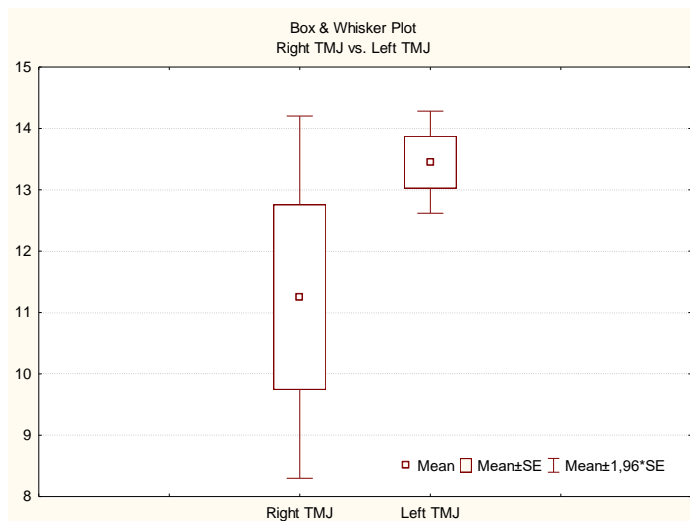
Distances D_1 and D_2 which give the amplitude of the movement have revealed the following results: the mean value for distances D_1 for the right and left side is of 13.8 mm and respectively 13.3 mm. In the case of distance D_2 , the mean value is of 25.1 mm and 26.7 mm, thus, the mean value

of the amplitude of the movement for group no. 1 (Table 3):

- at the level of right TMJ: $25.1 - 13.8 = 11.3$ mm
- at the level of left TMJ: $26.7 - 13.3 = 13.4$ mm.

Table 3 – Difference between D_2 and D_1 ($D_2 - D_1$)

Clinical cases	Right TMJ (mm)	Left TMJ (mm)
A.C.	5	13
M.M.	10	14
V.M.	12	16
B.C.	15.5	14
P.I.	2	13
A.V.	15	15
C.C.	13	12
Z.A.	10	12
P.G.	17.5	12
B.C.	12.5	13.5
Mean value	11.11	13.45
Mean value R-L	12.28	



	Mean - Group 1	Mean - Group 2	t-value	df	p	Valid N - Group 1	Valid N - Group 2	Std.Dev. - Group 1	Std.Dev. - Group 2	F-ratio - Variances	p - Variances

Right TMJ vs. Left TMJ	11,25	13,45	-1,41	18	0,177	10	10	4,762	1,343	12,58	0,001
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For the entire group 1, the differences right-left become insignificant (2.1 mm) due to the clearing through the calculation of the mean value of the high individual differences recorded. Individually speaking, the right-left asymmetries are relatively high.

It can be noticed that in only one case, the movement appears to be synchronous (A.V. 15 – 15 mm) and in three cases the amplitudes are slightly different of 1 mm (15 – 14 / 13 – 12 / 12.5 – 13.5), which could be without a pathological value. In the rest of the cases examined, high asymmetries appear in the condylar movement.

The difference between D₂ and B-P₀, which describe the distance of the condyle from the physiologic final position in opening, reveals the following values:

- A.C. Position 1, Table 1, D₂ for right TMJ = 20 mm; B-P₀ = 27 mm. There is therefore a condyle excursion of 7 mm less than the physiological position that should have been up to B.
- It is noticed that in six cases, the right TMJ displacement was bigger, with values between 2 and 6 mm, with a mean value of 4.33 mm and reduced in three cases, with values between -7, -8, -2 mm (mean value of -5.66 mm). For all the right TMJs the mean value of displacement is 0.9 mm.
- In only one case the value was 0.

For the left TMJ in 7 cases, ampler displacements with a mean value of 4.00

mm were noticed and in two cases less ample with values of 1 mm. Taking into consideration the physiological need for a perfectly symmetrical movement at the level of the two TMJs, the values obtained highlight exactly the movement asymmetries, pathognomonic signs for the dysfunctional syndrome.

The correlation of these values also becomes important through the individual analysis of the cases. It can be noticed how the symmetrical positions of the condyles at the beginning of the movement are accompanied by movements with an equal right-left amplitude and the asymmetrical condylar positions at the beginning of the movement are accompanied by large, modifications of the movement amplitude.

The analysis of group 2 comprising of 10 women affected by the dysfunctional syndrome, with ages between 20 and 39 years, the mean value being of 27.8, has indicated that in 8 cases out of 10, they presented condylar asymmetry (position 1-2 in 3 cases, or positions 1-3 in 5 cases), thus the displacement towards the posterior of the condyles. Only in 2 cases the condyles were symmetrically centred. The mean value for the right-left condylar positions is of 1.4 mm in relation to 1.9 mm (Table 4).

The measured AB distance proves that the obtained mean values of 9.2 or 9.3 are similar to the ones obtained in the examination of group no. 1.

Table 4 - Tomographic analysis following the method proposed for group 2.

Lot 2	Age	Condyle position		AB D. S.	Dif.	D ₁		D ₂		Dif.		B-P _o		Alpha		Articular space					
		D.	S.			D.	S.	D.	S.	D.	S.	D.	S.	D.	S.	D a. b. c.		S a. b. c.			
M.M.	24	1	3	8 7.5	0.5	15	13	32	24	-7	-1	26	25	46	45	1.0	2.5	1.0	2.0	3.0	2.0
C.A.	30	1	1	12 11	1	13	10	25	24	+5	+1	21	21	60	57	2.0	3.0	2.0	2.0	3.0	1.0
M.D.	21	1	3	7 8	1	11	15	25	20	0	+3	21	25	56	35	0.5	2.0	2.0	2.0	3.0	1.0
B.C.	39	1	2	12 7	5	14	13.5	17.5	5	+7	+6	24	24	58	46	2.0	2.5	1.0	2.0	3.5	3.0
M.R.	29	2	1	7 10	3	14	14	16	26	-8	+4	25	25	58	39	0.0	5.0	8.0	1.5	2.5	2.0
K.R.	25	1	3	8 1	3	13	11	24	31	+6	+6	24	24	48	60	2.0	3.0	2.5	0.5	4.0	2.0
P.I.	25	3	1	11 11	0	11	13	18	14	+2	0	25	25	60	57	3.0	3.0	1.0	3.0	3.0	1.0
G.G.	27	2	1	4 8	4	15	15	27	31	-2	+3	29	27	40	35	5.0	0.5	1.0	0.0	1.5	1.0
M.N.	25	1	1	12 10	2	10	12	24	24	+2	-1	20	20	53	65	2.0	2.0	2.0	2.0	3.0	2.0
C.I.	33	1	3	11 10	1	15	14	19	14	+4	+4.5	24	24	53	64	2.0	3.0	3.0	2.0	2.0	2.0
Mean value	27.8	1.4	1.9	9.2 9.3	2.05	13.1 13.05	22.7 22.3	- -	23.9 24.0	53.2 50.3	1.5 2.6 2.4	1.7 2.8 1.7									

The difference between AB and the value of the joint space (Table 5) shows that in 7 cases, there are unilateral abrasions of the articular tubercle, the differences being of 1 to 6 mm. The mean values of 6.55 or 6.50 certify a value lower than in group 1, normal data obtained taking into consideration the delicacy of the female jawbones.

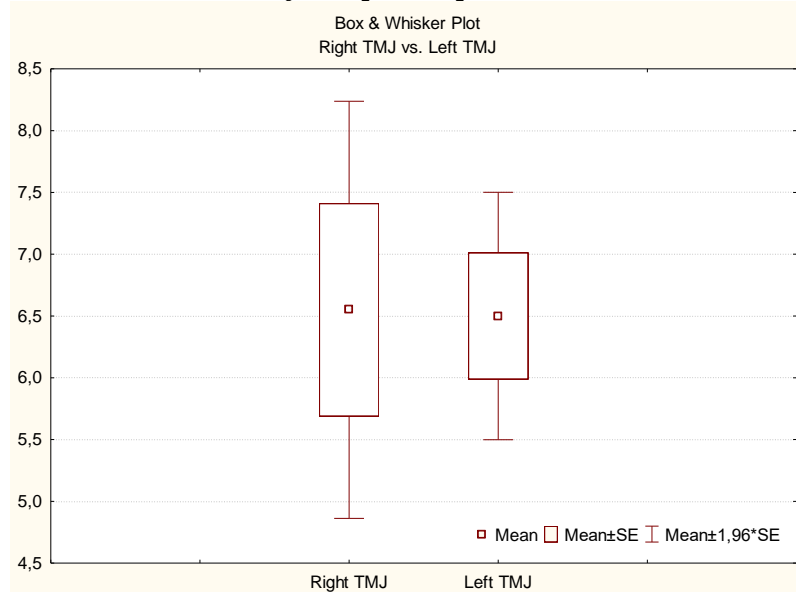
For D₁ and D₂ mean values of the condylar displacements for the opening of the mouth were recorded as follows:

- D₁ right = 13.1 mm and D₁ left = 13.5 mm
- D₂ right = 22.75 mm and D₂ left = 22.3 mm

Thus, the mean value of the movement amplitude for right TMJ is of 9.65 mm and for the left one is 9.25 mm, which marks statistic uniformity.

Table 5 – Difference between AB and joint space in position b

Clinical cases	Right TMJ (mm)	Left TMJ (mm)
M.M.	5.5	4.5
C.A.	9	8
M.D.	5	5
B.C.	9.5	3.5
M.R.	2	7.5
K.R.	5	7
P.I.	8	8
G.G.	3.5	6.5
M.N.	10	7
C.I.	8	8
Mean value	6.55	6.50
Mean value R-L	6,63	



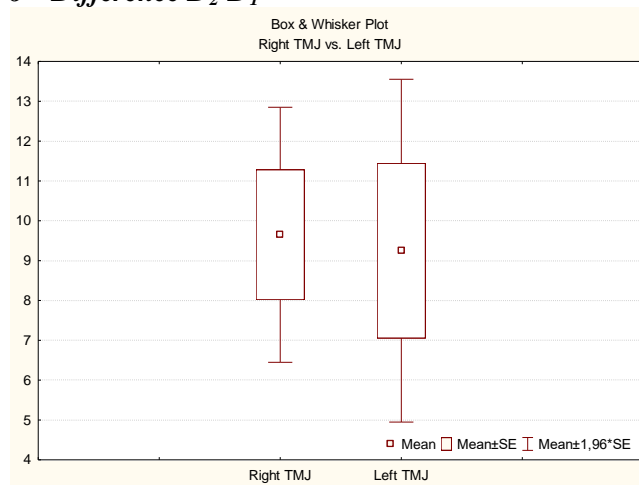
	Mean - Group 1	Mean - Group 2	t-value	df	p	Valid N - Group 1	Valid N - Group 2	Std.Dev. - Group 1	Std.Dev. - Group 2	F-ratio - Variances	p - Variances
Right TMJ vs. Left TMJ	6,550	6,500	0,050	18	0,961	10	10	2,723	1,616	2,839	0,136

The differences D_2-D_1 individually taken are high, as it can be noticed from Table 6, but the mean value cancels the

individual differences. For instance, 17 mm in relation to 11 mm, 2 mm in relation to 12 mm, 11 mm in relation to 20 mm.

Table 6 – Difference D_2-D_1

Clinical cases	Right TMJ	Left TMJ	Difference
M.M.	17	11	6
C.A.	12	14	2
M.D.	14	5	9
B.C.	3.5	1.5	2
M.R.	2	12	10
K.R.	11	20	9
P.I.	7	1	6
G.G.	12	16	4
M.N.	14	12	2
C.I.	4	0	4
Mean value			5.4 mm



	Mean - Group 1	Mean - Group 2	t-value	df	p	Valid N - Group 1	Valid N - Group 2	Std.Dev. - Group 1	Std.Dev. - Group 2	F-ratio - Variances	p - Variances
Right TMJ vs. Left TMJ	9,650	9,250	0,146	18	0,885	10	10	5,164	6,941	1,807	0,391

By subtracting the D_2 dimension from the $B-P_o$ dimension, additional variations from the normality were obtained, with maximum variations of -11 mm up to 7 mm. It can be noticed that the dynamics of modified amplitude associates with

asymmetrical positions of the mandibular condyles, narrowing of the articular space and large differences D_2-D_1 .

The comparison between group 1 and 2 does not reveal significant modifications between sexes (Table 5).

Table 7

	<i>Poziție C</i>		<i>AB</i>		<i>D₁</i>		<i>D₂</i>		<i>B-P_o</i>		<i>Alfa</i>	
	<i>D.</i>	<i>S.</i>	<i>D.</i>	<i>S.</i>	<i>D.</i>	<i>S.</i>	<i>D.</i>	<i>S.</i>	<i>D.</i>	<i>S.</i>	<i>D.</i>	<i>S.</i>
Group 1	1.7	1.1	9.3	9.8	13.8	13.3	25.1	26.7	24.2	24.2	50.7	53.5
Group 2	1.4	1.9	9.2	9.3	13.1	13.0	22.7	22.3	23.9	24.0	53.2	50.3
Mean	1.5	1.5	9.2	9.5	13.4	13.2	23.9	24.5	24.0	24.1	51.9	51.9

CONCLUSIONS

1. The Rickettz analysis cannot be performed in certain clinical situations, when the Frankfurt plane goes much above the highest point of the glenoid fossa. In such situations our suggested modification completes the Zhang Zhenkang method, proving its utility.

2. In all the cases examined, right-left morphological asymmetries were noticed, creating from the beginning the conditions for an asymmetric functionality of TMJ.

3. Only in 5 cases for group 1 and 2 cases for group 2, equal right-left starting positions of the condyles were found. In the other cases, either anterior or posterior displacements of the C condylar centre appear in relation to the morphological elements of the joint.

4. The mean value of the alpha angle was approximately 50° (53.2° and 50.3°) with variations on a broad spectrum: 35° minimum and 64° maximum. High right-left differences were also recorded for the same patient: $56^\circ - 35^\circ$ or $53^\circ - 65^\circ$, modifications

induced by asymmetric functional morphology.

5. The vertical distance between the highest point of the glenoid fossa and the inferior pole of the articular eminence (measure AB) shows a difference between 4 mm and 0 mm between the measurements performed for right and left TMJ, with a mean value of only 1.85 mm, materializing the joint modifications which occur in the dysfunctional syndrome.

6. The movement amplitude shows differences which ranged between -11 and +7 mm, thus, up to 18 mm difference, which means a lot for TMJ where even one mm has a great impact on the movement.

7. At the level of the articular space, the modification mean value is 2 – 2.3 mm.

8. We consider the TMJ tomographic images evaluation to be indispensable as it allows a precise and relatively easy diagnostic of the modifications specific to the dysfunctional syndrome and the suggested evaluation method to be advantageous and useful to be applied in all cases.

The precise measurement of the joint parameters must precede any attempt of rectifying the TMJ function.

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