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Three-dimensional evaluation of TMJ parameters in Class II and Class III patients

Zane Krisjane, Ilga Urtane, Gaida Krumina, Katrina Zepa

SUMMARY

The aim of our study was to assess condylar parameters and condyle position within glenoid fossa of TMJ in volumetric 3D imaging in patients with Class II and Class III malocclusions.

Materials and methods. The study group included 15 patients with severe skeletal Class II (mean age 18.0 yrs) and 14 patients with severe skeletal Class III (mean age 19,2 yrs) with an indication for combined orthodontic and orthognathic treatment. CT examination was performed, pictures were reconstructed in three – dimensional (3D) rendering and measured in two dimension projection (2D) pictures using *IAC review* and *Transparent bone* programs to quantify following condylar and glenoid fossa parameters – glenoid fossa width and height; tuberculum articulare angle; anterior, superior and posterior joint space; height and width of condyle, height of procesus condylaris. Mean values were calculated separately for left and right side. Differences of the mean values were tested using paired *t*-test.

Results. There were statistically significant differences (p<0,05) between two study groups for all spatial measurements on both sides with larger spatial measurements in patients with Class II malocclusions. Also the height of procesus condylaris varied between groups with statistical difference. Unilateral differences were detected for width of fossa glenoidale and height of condyle.

Conclusion. Results show that there are a tendency for smaller condyle and wider spaces between condyle and walls of glenoid fossa comparing TMJ of Class II with Class III patients.

Key words: condyle, glenoid fossa, temporomandibular joint, multi-slice computed tomography.

INTRODUCTION

In literature it has been hypotized that the condyle and the fossa might differ in shape and their interrelations among people with various malocclusions while the mandible and the temporomandibular joint can be loaded differently in persons with diverse dentofacial morphologies [1] .

Several studies with conventional tomography methods have been done to find the relations between skeletal malocclusions – Class II and Class III- and some features of temporomandibular joint (TMJ) but the results are not homogeneous. The influence of occlusion on joint morphology is still not completely understood, authors like Mongini [2], Pullinger [3], O'Byrn [4] found positive correlations but Cohlmia [5] failed to find any correlations.

It is not also clear, what is the condyle position within the fossa in various malocclusions, are there any differences and if yes- are they a cause or a result of the occlusion, since TMJ parts do not grow in unison – some follow a cranial and others a facial growth plane [6].

Difficulties in visualization of the TMJ to its complex anatomy and superimposition of adjacent structures might be a factor, responsible for the discrepancies in the results of different studies concerning TMJ, where conventional tomography as a method of investigation was used.

Nowadays other methods are used for evaluating 3-dimensional morphology of the skeletal structures of TMJ-cone beam computed tomography (CBCT) and

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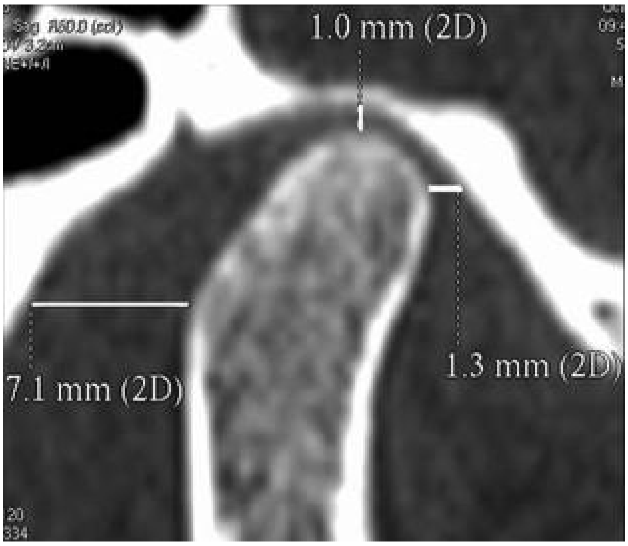

Fig. 1. Anterior, superior and posterior joint space

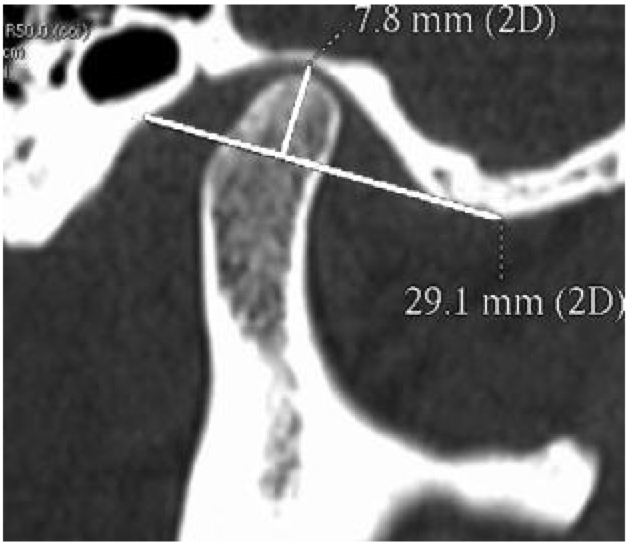

Fig. 2. Glenoid fossa width and height

multi slice computed tomography (MSCT). Both of them provide an optimal imaging of the osseous components of the TMJ [7] and gives a full size truly volumetric 3D description in real anatomical (1:1) size [8;9].

Aim

The aim of our study was to assess condylar parameters and condyle position within glenoid fossa of TMJ in volumetric 3D imaging in patients with Class II and Class III malocclusions before orthodontic and orthognatic treatment.

MATERIALS AND METHODS

Our study included 15 patients with skeletal Class II (mean age 18.0 years) and 14 patients with skeletal Class III (mean age 19.2 years) . The inclusion criteria for Class II patients were: overjet more than 6 mm, increased ANB angle; for Class III patients – overjet less than 0 mm, ANB angle ≤0 degrees. All patients had the indication for combined orthodontic treatment and orthognathic surgery. They had no evident facial asymmetry, no functional mandibular deviations nor rheumatoid or traumatic symptoms. Symptoms of temporomandibular disorders were not considered in selecting these subjects and they had not undergone previous orthodontic treatment. Conventional clinical and radiological examination of occlusion and of TMJ was used

Before starting preorthognathic orthodontic treatment, 3D CT investigation was performed using GE Medical Systems Light Speed Pro 16CT99_Oc0 system. The position of the patient was lying on the back, head positioned in the middle of orbitomeatal plane, closed mouth position – direct touch of molar teeth in habitual occlusion. Axial scanning was done from soft tissue point *Glabella* down to upper margin of C6. CT scan protocol – helical full 1.0 s, slice thickness 0.625 mm, pitch 0.625 mm, reconstruction – bone and soft tissue using *IAC Review* and *Transparent bone* programs.

Following measurements were done: anterior, superior and posterior joint space – the shortest distance between most prominent point of condyle in each di-

Table 1. Mean values of condylar and glenoid fossa measurements between Class II and Class III left and right side

Measurements	Class II				Class III			
	Rigth side		Left side		Right side		Left side	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Height of fossa glenoidale	7.9	1.25	7.6	1.09	8.07	1.09	7.7	1.39
Width of fossa glenoidale	21.9	2.67	20.6	2.21	23	2.22	22.4*	1.65
Tuberculum articulare angle	26.8	6.91	26.5	7.09	26.5	9.05	27.7	8.66
Anterior joint space	2.1*	0.43	2.2*	0.72	1.6	0.42	1.6	0.34
Superior joint space	2.8*	1.54	2.4*	0.93	1.7	0.7	1.6	0.55
Posterior joint space	3.8*	2.1	3.5*	1.67	2.1	1	1.9	0.87
Width of tub. Articulare	18.2	3	17	2.77	18.9	3.54	18.7	2.73
Height of condyle	4*	0.87	3.7	0.52	3.2	0.85	3.2	0.98
Width of condyle	8.1	1.21	8.5	1.37	7.8	1.69	7.7	1.12
Height of proc. Condylaris	19.4	3.82	18	4.6	23.7*	3.13	23.2*	2.59

* – statistically significant in comparison between groups.

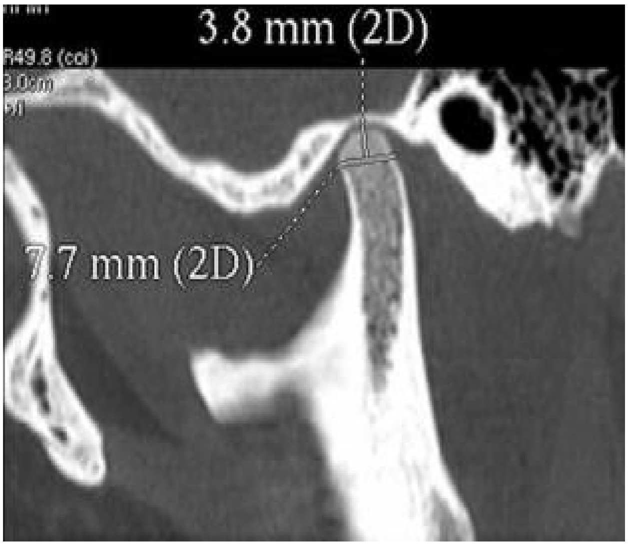

Fig. 3. Width and height of condyle

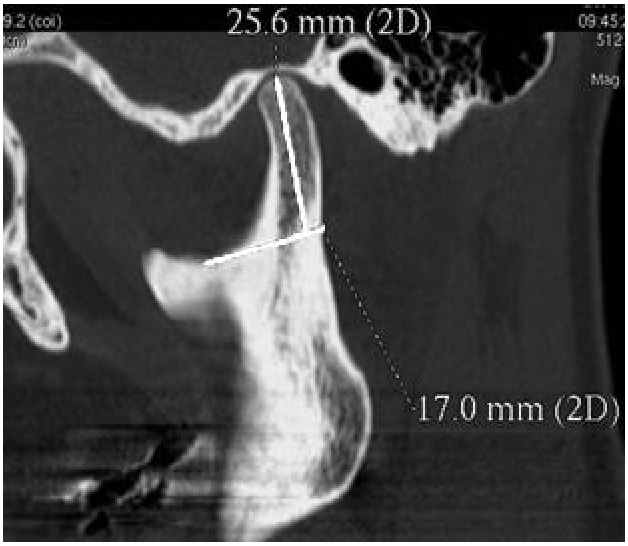

Fig. 4. Height of processus condylaris

rection and accordingly anterior, superior or posterior point in walls of glenoid fossa (Fig. 1); glenoid fossa width – the distance from the most superior point of the fossa to the plane formed by the most inferior point of the articular tubercle to the most inferior point of auditory meatus (Fig. 2), glenoid fossa height – the distance between the top of tuberculum articulare and procesus postglenoidalis (Fig.2); *Tuberculum articulare* angle – angle between the plane of the posterior wall of the articular tubercle and the plane obtained from the most inferior point of the articular tubercle to the most inferior point of the auditory meatus; height of condyle – linear distance between top of the condyle and crossectional line (Fig. 3); width of condyle – linear distance between most anterior and posterior point of condyle (see Fig. 3); height of processus condylaris – linear distance between the highest point of condyle and line that goes through mandibular incisura (Fig. 4).

According to Pullinger et al. [10], position of mandibular condyle was described as anterior, concentric or posterior, what was calculated by means of following equation:

Linear ratio = (P-A)/ (P+A) x 100

P – The closest posterior measurement
A – The closest anterior measurement
LR<-12 – posterior position
-12< LR<12 – concentric position
LR>12 – anterior position

Study was approved by Riga Stradins University Ethical committee.

Statistical analysis

All the measurements were done by one operator two times with a time interval two weeks. Intraobserver measurement error was 0.8. The mean values of those measurements were used for the statistical analysis.

Mean values of condyle and glenoid fossa measurements were calculated separately for left and right side. Differences of mean values were tested using t-test.

RESULTS

The average values of condylar and glenoid fossa measurements are given in Table 1.

As showed results in Table 2, no statistically significant differences were observed between both groups in condyle width, but height of the condyle on right side was bigger in Class II group (p=0.0231). Also the measurements for glenoid fossa and articular tubercle did not show any differences, except the width of glenoid fossa on left side – it seems to be wider in Class III cases (p=0.0219). Statistically significant differences of length of processus condylaris (p=0.0027; p=0.0004) on both sides were detected between groups, showing this anatomical structure to be longer in Class III cases.

Table 2. Comparison between Class II and Class III for right and left side (p≤0.05)

	Differences in mean values between Class II and Class III	
	Right side (p)	Left side (p)
Height of fossa glenoidale	NS	NS
Width of fossa glenoidale	NS	**0.0219**
Tuberculum articulare angle	NS	NS
Width of tub. Articulare	NS	NS
Height of condyle	**0.0231**	NS
Width of condyle	NS	NS
Height of proc. Condylaris	**0.0027**	**0.0004**

NS – the difference is not statistically significant.

All the spatial measurements showed statistically significant differences, when comparing Class II with Class III (Table 3.).

Our results were calculated for each TMJ side separately (Class II – 30 joints and Class III – 28 joints together) and they showed that condyles are more anteriorly positioned in both groups, followed by concentric position. Posterior position was observed only in few joints in both groups (Table 4.).

DISCUSSION

In orthodontics it is widely accepted that function affects form and it can be also referred to the occlusion and temporomandibular joint morphology. Our results do not show great differences in skeletal morphology of joint between two study groups.

According to Arnett [11], large condyles provide stable support for occlusal changes; they are associated with many Class III malocclusions and also some Class II. Condyles are considered to be more resistant to displacement because of the tight fit of the fossa and condyle. Inversely small condyles provide unreliable support for occlusal changes, are frequently associated with Class II malocclusion and are easily displaced because condyle, fossa and capsule fit are loose. In morphometric tomographic study where they compared condyle and fossa shape between various skeletal patterns, no condyle size differences were observed between Class II/1 and Class II/2 cases, in Class III group condyle was more elongated [1]. Our findings indicate that the height of condyle was asymmetrically higher in Class II cases, respectively, on the right side, with statistical significance (p=0.0231). There was no statistically significant difference observed condyle width in both groups. Statistically significant difference of length of procesus condylaris was observed between groups – in Class III cases the procesus condylaris of mandible is longer, what probably indicates to excessive vertical development of mandibular ramus what has happened during growth.

Table 3. Comparison of glenoid fossa and condyle distance measurements between Class II and Class III (p≤0. 05)

Measurement	Right side (p)	Left side (p)
Anterior joint space	0.0033	0.0048
Superior joint space	0.0204	0.0118
Posterior joint space	0.0155	0.0038

Table 4. Condylar position in Class II and Class III cases

Position	Class II		Class III	
	No. of joints	%	No. of joints	%
Anterior	14	**46.7**	13	**46.4**
Concentric	11	**36.7**	11	**39.3**
Posterior	5	**16.6**	4	**14.3**
Total No. of examined joints	**30**		**28**	

Also the measurements for glenoid fossa do not show remarkable differences between both groups, except width of fossa glenoidale on the left side- it seems to be wider in Class III cases.

In literature where the height of fossa glenoidale has been compared between various occlusions – respectively Class II and Class I, no statistically significant differences were observed [12]. Katsavrias et al. found that Class III group has a wider but more flattened glenoid fossa when comparing with Class II [1], what partly goes in line with our findings.

All the spatial measurements were larger in Class II group with statistically significant difference, what supports Arnett [11] and can be a reason for increased joint laxity in mandibular deficiency cases [13].

The position of the mandibular condyle was described as anterior, concentric or posterior. Results show, that condyles are more anteriourly positioned in both groups. Pullinger et al found that Class II malocclusion was associated with more nonconcentric condylar positions than Class I, with the position in Class II/1 being more frequently anterior [3]. Gianelly *et. al* [14] found that the condyles of click-free persons with Class II molar relationships, deep bites and no overjets were positioned concentricaly in the fossae. In literature condyle position has been analyzed more in connection with different TMJ and articular disc problems rather than with different malocclusions. Nonconcentric condyle-fossa relationships are associated with abnormal TMJ function and conversely asymptomatic subjects have been characterized by more concentric positions [3]. Pullinger, 1987 investigated 74 asymptomatic joints, which represent "normal" population and the results were 43% concentric, 27% posterior and 30% anterior. Evidently there is no clear statement in the literature how condyle position is affected by different skeletal malocclusions. Also our findings show only a tendency for condyles being more anteriorourly positioned in both groups while the number of examined joints is too small to find stronger proofs.

CONCLUSIONS

Due to some limitations this study must be considered preliminary and may be subjected to further progressing. Nevertheless, the advantages of 3D CT imaging analysis relative to conventional CT for determine TMJ morphology give for our study high validity. Following conclusions can be done:

1. Methods of investigation of TMJ used in our study are accepted for further imposition
2. Even in patients without clinically evident asymmetries, asymmetries in joint structures can be detected
3. No remarkable differences in condyle size were observed between patients with skeletal Class II and Class III
4. TMJ laxity is increased in cases of Class II malocclusions
5. In both groups condyles are more anteriourly positioned, what indicate to different malocclusion role in non-concentric condyle placement.

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