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Determination the Condyle Position and Measurement of Joint Space by CBCT in Patients with Disk Displacement Compared with Healthy Control Group

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ABSTRACT

Introduction: *Disc displacement is characterized by a change in the articular disc position (abnormal position) which is located between the mandibular fossa and the head of the condyle. Disc displacement can be classified as 8 positions (abnormal disc position); however, the most common types are anterior and anterolateral displacements. When the displacement of the disc occurs, the bilaminar zone is moved against the articular surfaces, gradually replacing the function of the disc itself. It has mechanical properties modifications in vascular diminishment and nerve supply which induces the condition.* ***Aim of the Study:*** *To study the radiographical assessment of temporomandibular joint in patients with disk displacement by using cone beam computed tomography and determination of condyle position anterior, centric or posterior depending on the joint space measurements (anterior, superior and posterior joint space).* ***Materials and methods:*** *The study sample consisted of 78 patients with disk displacement and 31 as control subjects. Patients with intra articular joint disorders were divided into 4 groups according to the diagnostic criteria for temporomandibular disorders (Group 1-disk displacement with reduction, Group 2-disk displacement with reduction with intermittent locking, Group 3-disk displacement without reduction with a limited opening, Group 4-disk displacement without reduction without limited opening).* ***Results:*** *The results show the position of the condyle in right and left side more anteriorly in control than in patients with disc displacement, while the position of the condyle in patients was more posterior and superior. There was a highly significant difference in condyle position between the control group and Group 2, Group 3 and Group 4.* ***Conclusions:*** *Disc displacement is one of the causes that change the condyle position in the glenoid fossa.*

Keywords: Disc displacement, Condyle position, Joint space, CBCT

INTRODUCTION

Temporomandibular joint (TMJ) is created by inserting the condyle into the glenoid fossa which is a part of the temporal bone. The movement of TMJ is primarily done by muscles. The main characteristic of Temporomandibular joint disorders (TMDs) is cranio-facial pain in the TMJ, muscles of mastication, or innervations of muscles of head and neck [1]. Temporomandibular joint disorders involve abnormalities of the intra articular disc position and, or structural dysfunction of associated musculature [2].

Okeson, classify TMDs into 2 categories as intra-articular within the joint or extra-articular involving the surrounding musculature [3]. Musculoskeletal conditions are the most common cause of TMDs, accounting for at least 50% of cases, displacement of the articular disc including the relationship between condyle and disc consider the common causes of intra articular joint disorders [4-6].

Cone beam computed tomography (CBCT) is a newer technique that produces reconstructed images of high quality in diagnosis with low doses of radiation and higher resolution than normal CT. The images obtained by CBCT have planes perpendicular or parallel to long axis of the condyle that is sagittal and coronal plane. The results showed images of the high quality of the bony structure in all planes [7].

The measurement of the joint space dimension can lead to determine the optimal position of head of the condyle in the glenoid fossa. Space surrounded joint is totally radiographical term that is used for describing the radiolucent area that is located between condylar parts and temporal parts [8].

PATIENTS AND METHODS

The study sample consisted of 78 patients with intra articular joint disorders (current TMJ noises) during jaw movement) and 31 as control subjects with age range from 21-45 years. Patients with intra articular joint disorders were divided into 4 groups according to the Diagnostic Criteria for Temporomandibular Disorders [9].

- Group 1: 33 patients with disk displacement with reduction
- Group 2: 15 patients with disk displacement with reduction, with intermittent locking
- Group 3: 15 patients with disk displacement without reduction, with limited opening
- Group 4: 15 patients with disk displacement without reduction, without limited opening

The control group was the one who attended the dental center for taking CBCT scanning for different diagnostic purposes who do not have TMD by clinical examination and patients were clinically diagnosed to have intra articular joint disorder, and had CBCT scan image using CBCT scanner (NewTom VGi)™.

Cone beam computed tomography scanner (CBCT): Image was acquired by a CBCT scanner (NewTom VGi)™. Scanning parameter was 110 VP, 24 second, 5.7 mA, avoxel size of 0.5 mm, and a field of view of 16 cm × 14 cm or 24 cm × 19 cm CBCT images.

When taking the images of CBCT, the position of control and patients was standing in an upright position. The instruction was given to look into a front mirror by their eyes to maintain a natural head position. The bite block of CBCT was removed, also control and patients scan were taken in the maximum intercuspation.

The present study involved the radiographical study of TMJ in control and patients by using CBCT and determination of the position of the condyle in glenoid fossa by measuring the joint space. The following dimension was measured according to a study conducted by Ikeda and Kawamura: Anterior joint space (Ajs), superior joint space (Sjs), and posterior joint space (Pjs) [10]. This could be accomplished by 2 true central sagittal images selected. Then, the anterior, posterior and superior spaces were measured on these made sagittal images, horizontal line on the uppermost point of mandibular fossa was drawn and the intersection of the horizontal line with mandibular fossa was chosen as superior reference point S. Then, from this point a line was drawn that was attached to the most anterior prominent points of condyle termed as A and the other line was attached to the most posterior prominent points of condyle termed as P. At last, the perpendicular distance from point A and point P tangent points to mandibular fossa as anterior joint spaces (Ajs) and posterior joint spaces (Pjs) was measured. Therefore, the liner distance from point S to the superior prominent point of the condylar head was termed as superior joint space (Sjs) as shown in Figure 1.

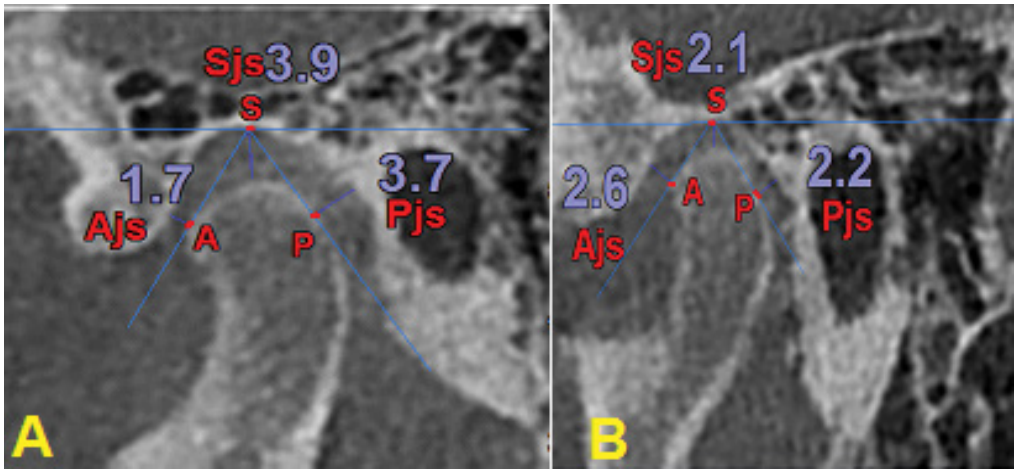

Figure 1 Measurement of joint space (Ajs, Sjs, and Pjs) on CBCT in sagittal section; A: healthy individual B: a patient with disc displacement

The position of condyle was expressed by the formula regarding the method of Pullinger and Hollender: [11,12].

$$\text{Condyle position (CP)} = \frac{\text{posterior - anterior}}{\text{posterior + anterior}} \times 100\%$$

The result was assessed according to the recommendations by Ren, et al., [13]:

- 0: The absolute centric position of the condyle
- -12% to 12%: The centric position of the condyle
- <-12%: The posterior position of the condyle
- 12%: The anterior position of the condyle

The selection of the patients based on exclusion criteria was described by the following conditions:

- Edentulous patients, patients with class I-II Kennedy classification
- Patients with parathyroid gland disease
- Patients with neoplastic disease
- Patients with developmental disorders of the TMJ such as condylar aplasia, hypoplasia or hyperplasia were not included in this study

RESULTS

The results show Ajs in right and left side, Group 2 has recorded higher mean value (right 2.47 mm, left 2.73 mm), then was followed by Group 3 (right 2.40 mm, left 2.23 mm), then followed by Group 4 (right 2.01 mm, left 2.19 mm), and finally Group 1 (right 1.93 mm, left 1.76 mm) and control (right 1.90 mm, left 1.94 mm) recorded lower mean value as shown in Table 1.

While Pjs in right and left side, control group has recorded higher mean value (right 2.86 mm, left 2.88 mm), then followed by Group 2 (right 2.77 mm, left 2.53 mm), then followed by Group 1 (right 2.74 mm, left 2.45 mm), and finally Group 3 (right 2.06 mm, left 1.73 mm) and Group 4 (right 2.29 mm, left 1.96 mm) recorded lower mean value as shown in Table 1.

Table 1 Summary statistics, and matched paired t-test for test differences of Ajs and Pjs regarding right-left in different disordered and controlled groups

Groups	Site	No.	Ajs						Pjs					
			Mean	SD	SE	MP (t-test)	df	C.S. (*)	Mean	SD	SE	MP (t-test)	df	C.S. (*)
Group 1	Right	33	1.93	0.87	0.15	1.056	32	0.299	2.74	0.89	0.16	1.864	32	0.071
	Left	33	1.76	0.63	0.11			NS	2.45	0.92	0.16			NS
Group 2	Right	15	2.47	0.63	0.16	-1.300	14	0.215	2.77	1.09	0.28	0.952	14	0.357
	Left	15	2.73	0.98	0.25			NS	2.53	0.67	0.17			NS
Group 3	Right	15	2.40	0.70	0.18	0.863	14	0.403	2.06	0.62	0.16	2.047	14	0.06
	Left	15	2.23	0.67	0.17			NS	1.73	0.34	0.09			NS
Group 4	Right	15	2.01	0.88	0.23	-0.867	14	0.401	2.29	0.90	0.23	1.386	14	0.188
	Left	15	2.19	1.05	0.27			NS	1.96	0.87	0.22			NS
Control	Right	31	1.90	0.69	0.12	-0.352	30	0.727	2.86	0.86	0.16	-0.163	30	0.872
	Left	31	1.94	0.48	0.09			NS	2.88	0.73	0.13			NS
C.S. (*)	Right		L=1.049; p=0.386 (NS); F=2.402; p=0.055 (NS)						L=0.777; p=0.543 (NS); F=2.838; p=0.000 (HS)					
	Left		L=6.512; p=0.000 (HS); F=5.121; p=0.001 (HS)						L=3.723; p=0.007 (NS); F=7.206; p=0.000 (HS)					

(*) HS: Highly Sig. at p<0.01; S: Sig. at p<0.05; NS: Non Sig. at p>0.05

Regarding to Sjs in right and left side, mean value of control group (right 3.57 mm, left 3.84 mm) and Group 1 (right 3.39 mm, left 3.35 mm) has recorded more than Group 2 (right 2.66 mm, left 2.73 mm), Group 3 (right 2.47 mm, left 2.30 mm) and Group 4 (right 3.11 mm, left 2.43 mm) as shown in Table 2.

Table 2 Summary statistics, and matched paired t-test for test differences of Sjs regarding right-left in different disordered and controlled groups

Groups	Site	No.	Mean	SD	SE	MP (t-test)	Df	C.S. (*)
Group 1	Right	33	3.39	0.93	0.16	0.312	32	0.757
	Left	33	3.35	0.91	0.16			NS
Group 2	Right	15	2.66	0.8	0.21	-0.486	14	0.635
	Left	15	2.73	0.8	0.21			NS
Group 3	Right	15	2.47	0.88	0.23	1.079	14	0.299
	Left	15	2.3	0.91	0.24			NS
Group 4	Right	15	3.11	0.82	0.21	1.702	14	0.111
	Left	15	2.43	0.99	0.26			NS
Control	Right	31	3.57	0.77	0.14	-2.583	30	0.015
	Left	31	3.84	0.82	0.15			S
C.S. (*)	Right	L=0.334; p=0.854 (NS); F=6.246; p=0.000 (HS)						
	Left	L=0.366; p=0.832 (NS); F=12.034; p=0.000 (HS)						
(*)HS: Highly Sig. at p<0.01; S: Sig. at p<0.05; NS: Non Sig. at p>0.05								

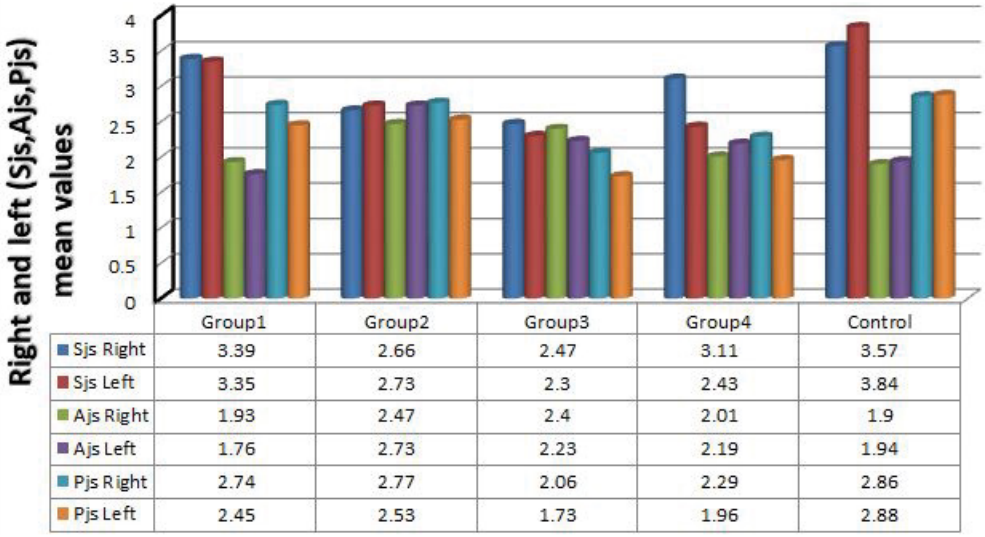

Figure 2 Cluster bar chart of Sjs, Ajs and Pjs parameters regarding right-left in different disordered and controlled groups

The results showed the position of the condyle in right and left side more anteriorly in control than in patients with disc displacement, while the position of the condyle in patients was more posterior and superior. There was a highly significant difference in condyle position between the control group and Group 2, Group 3 and Group 4 (Figure 2).

Regarding right side, Group 1, and the control group has recorded high significance among different positions at $p<0.01$, while left over groups has no significant differences at $p>0.05$. On reference to the subject of the left side, Group 1, and control group has recorded significance among different positions at $p>0.05$, and $p<0.01$ respectively, while left side over groups has no significant differences at $p>0.05$. By using the spearman correlation coefficient the p-value was <0.05 (Table 3). In addition to that, both sides have recorded a similar distribution of positions, in each group, and that interpreted the strong relationship (Figure 3).

Table 3 Distribution of studied groups according to condyle position distributed by side, and studied groups with comparisons significant

Groups	Site	Right			Left			C.S. (*) p-value	
	Position	No.	%	C.S. (*)	No.	%	C.S. (*)	Right X Left	
Group1	Anterior	20	60.6	p=0.003 HS	18	54.5	p=0.029 S	KS2=0.061 p>0.05 NS	Spearman coefficient (r=0.563) p=0.029 S
	Posterior	5	15.2		6	18.2			
	Centric	8	24.2		9	27.3			
Group2	Anterior	3	20.0	p=0.091 NS	7	46.7	p=0.247 NS	KS2=0.467 p>0.05 NS	
	Posterior	3	20.0		6	40.0			
	Centric	9	60.0		2	13.3			
Group3	Anterior	4	26.7	p=0.819 NS	3	20.0	p=0.091 NS	KS2=0.133 p>0.05 NS	
	Posterior	6	40.0		9	60.0			
	Centric	5	33.3		3	20.0			
Group4	Anterior	8	53.3	p=0.074 NS	6	40.0	p=0.549 NS	KS2=0.133 p>0.05 NS	
	Posterior	6	40.0		6	40.0			
	Centric	1	6.7		3	20.0			
Control	Anterior	23	74.2	p=0.000 HS	21	67.7	p=0.000 HS	KS2=0.065 p>0.05 NS	
	Posterior	1	3.2		2	6.5			
	Centric	7	22.6		8	25.8			

(*) HS: Highly Sig. at p<0.01; S: Sig. at p<0.05; NS: Non Sig. at p>0.05; Testing based on one sample Chi-Square, Contingency Coefficient, and Kolmogorov-Smirnov of two independent samples tests, as well as the spearman coefficient's test

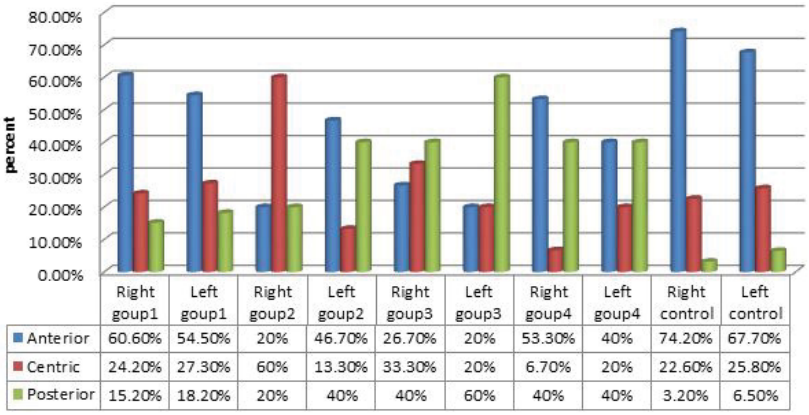

Figure 3 Cluster bar charts of different condyle positions distributed among both sites and studied group

DISCUSSION

The ideal position of the condylar head in the mandibular fossa of TMJ is one of the important topics present in dentistry with high fundamental questions [14]. Many authors stated that there has been a relation between the position of the condyle and displacement of the disc [15], as well as other authors found an association between the displacement of disc and changes in space dimensions of joint [16-18].

In normal physiologic temporomandibular joint, the disc is placed between the condylar head inferiorly and the articular eminence superiorly and anteriorly when the jaw is closed, while during the opening of the jaw, the disc slides are placed into position between the head of the condyle and temporal articular eminence. The disc attachments prevent luxation when open [19].

In our study the mean value of Sjs in control group (right 3.57, left 3.84) was greater than Sjs in patients with disk displacements this means the position of condyle was more superior in patients with disk displacement than control group, also the position of condyle is more posteriorly in patients than the control group, this results agree with the results of Gateno, et al., they stated that the head of the condyle of patients with anterior disk displacement was located more posterior and superior in the mandibular fossa when compared with the control group [20]. This could be

explained by the fact that the location of the thick posterior part of the disc in 12 o'clock position, the thin biconcave intermediate part is physiologically located in the anterior and the bilaminar zone present in the posterior joint space. In case of an anterior disk displacement, the thick posterior part is located in the anterior joint space, and anterior joint space increases the thin bilaminar zone found in the superior joint space, all of the above mention facts leads to decrease of the superior joint space [21].

The suggestion of Cohlmia, demonstrate that the position of the condyle is asymmetric in a normal population, [22]. Blaschke and Blaschke found that there was a variation in condyle position in normal joints, this agrees with our study, the results showed a variation of condyle position in glenoid fossa in both control and patients with disk displacement [23].

In an assessment of the gender involving, the present study was stated more in the females population as many authors have indicated a female predilection of signs and symptoms associated with TMDs. Troeltzsch, et al., reported a significant difference in TMJ clicking in females compared to males in a series of 1031 patients [24]. This may be explained by the presence of endogenous reproductive hormones especially estrogen and/or exogenous reproductive hormones such as oral contraceptives, therapy replacing postmenopausal hormone which may play a pathophysiological role in TMDs in women.

The present study agrees with the results reported by Kinniburgh, et al., and Ikeda and Kawamura [10,25]. In the study conducted by Ikeda and Kawamura to assess the optimal position of the head of the condyle in the asymptomatic group with no disc displacement, reported that Sjs distance was greatest, followed by Pjs and Ajs respectively [10].

The position of the condyle in temporal fossa remains controversial [26]. Many studies have reported non-concentric condylar position in association with disk displacement [27,28]. The non-centric position of condyle was conducted in one third to one half of the asymptomatic group [29]. On the other hand, studies concluded that concentric position of the condyle in patients with TMDs has a high prevalence, as well as, many studies found a significant difference between asymptomatic group and patients have TMDs in the position of condyle [30-32]. Cho and Jung stated the centric position of condyle was more in the asymptomatic group and posterior position of condyle was more common in the symptomatic group [26].

This study agrees with the study done by Paknahad and Shahidi, who reported posteriorly seated condyles in patients with severe TMDs and anteriorly and concentric seated condyles in patients with mild to moderate TMDs while disagreed with the study done by Lelis, et al., [33]. They conducted that there is no relationship between the position of condyle and TMDs if present or not [34].

CONCLUSIONS

The following conclusions can be made from the above study:

- Disc displacement is one of the causes that change the condyle position in the glenoid fossa
- The position of the condyle in the control group was more anterior than patients with disc displacement
- The position of the condyle in patients more was posterior and superior than the control group

DECLARATIONS

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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