Int J Clin Exp Med 2015;8(9):16057-16063
www.ijcem.com /ISSN:1940-5901/IJCEM0012870

Original Article

Characteristics of temporomandibular joint in patients with temporomandibular joint complaint

Yanfeng Li[1*], Xiaoqian Guo[2*], Xiaoxue Sun[3], Ning Wang[1], Min Xie[1], Jianqiang Zhang[1], Yuan Lv[1], Weili Han[1], Min Hu[1], Hongchen Liu[1]

[1]Department of Stomatology, The First Affiliated Hospital of Chinese PLA General Hospital, No. 51 Fucheng Road, Haidian District, Beijing 100048, China; [2]Department of Stomatology, General Hospital of Ningxia Medical University, No. 804 Shengli South Street, Yinchuan 750004, China; [3]Department of Brain, Liaoning Armed Police Force Hospital, No. 3 Heishan Road, Huanggu District, Shenyang 110034, China. [*]Equal contributors.

Received June 14, 2015; Accepted September 1, 2015; Epub September 15, 2015; Published September 30, 2015

Abstract: Introduction: This study was to investigate whether there was statistical difference between the bilateral temporomandibular joint (TMJ) in patients with unilateral TMJ pain or joint sounds, using cone beam computed tomography (CBCT). Methods: TMJ CBCT images of 123 cases were used to preliminarily determine the indicators suitable for the measuring method. TMJ CBCT image reconstruction was performed and 19 indicators were measured. Thirty-six cases without TMJ complaint served as controls. The comparison of bilateral TMJs was analyzed by paired t-test to find out the indicators without statistical significance. Twenty-nine patients with unilateral TMJ pain or joint sounds who underwent CBCT at the hospital were enrolled for the comparative study. The measured values were analyzed by paired t-test to determine the indicators with statistical difference. Results: In the control group, only radius value of bilateral TMJ was different statistically ($P < 0.05$). In the TMJ complaint group, the vertical 60° joint space of the bilateral TMJ was statistically different ($P < 0.05$) and the rest of the measured values showed no statistical difference. Conclusions: In the patients with unilateral TMJ pain or joint sounds, the vertical 60° joint space of the symptomatic side was significantly increased comparing with the asymptomatic side.

Keywords: Temporomandibular joint, unilateral TMJ pain, TMJ sounds, cone beam computed tomography

Introduction

Temporomandibular joint (TMJ) disorders include joint pain, disc disorders and degenerative joint disease [1]. The patients with TMJ disorders usually suffer joint pain, muscle pain, mouth-opening limitation, abnormal joint sounds, asymmetric mandibular movement, etc. [2]. Several researchers have shown the correct diagnosis of early abnormalities of TMJ is paramount to prevent temporomandibular disorders (TMDs) occurring [3]. The diagnosis of TMJ disorders is based on the presenting symptoms, medical history, the clinical examination, etc. according to the Diagnostic Criteria for TMDs (DC/TMD) [1]. There is still controversy over the value of TMJ condylar position in the fossa. But a good knowledge of the condylar morphology and the condyle-fossa relationship may provide reference for diagnosis and treatment for TMJ disorders [4, 5].

The TMJ CBCT is able to evaluate the bony structures, confirm their integrity and assess the extent and progression of TMJ changes, which also plays an important role in influencing the clinician's treatment plan [6, 7]. In clinical practice we found that the patients with TMJ complaint usually have obvious symptoms, but without obvious TMJ imaging changes by conventional radiography. Actually there are various methods for TMJ imaging and measurements. At present there is no recognized method which can provide a clear and panoramic TMJ imaging [3]. Different measuring methods and different reference marks often result in the values of joint with great differences [5]. It is reported that anteroposterior joint space and the centric position of the condyle are usually used to assess TMJ, however which is not precise enough and insufficient for clinical guidance [8, 9]. And there are a few literatures about comparative analysis between the

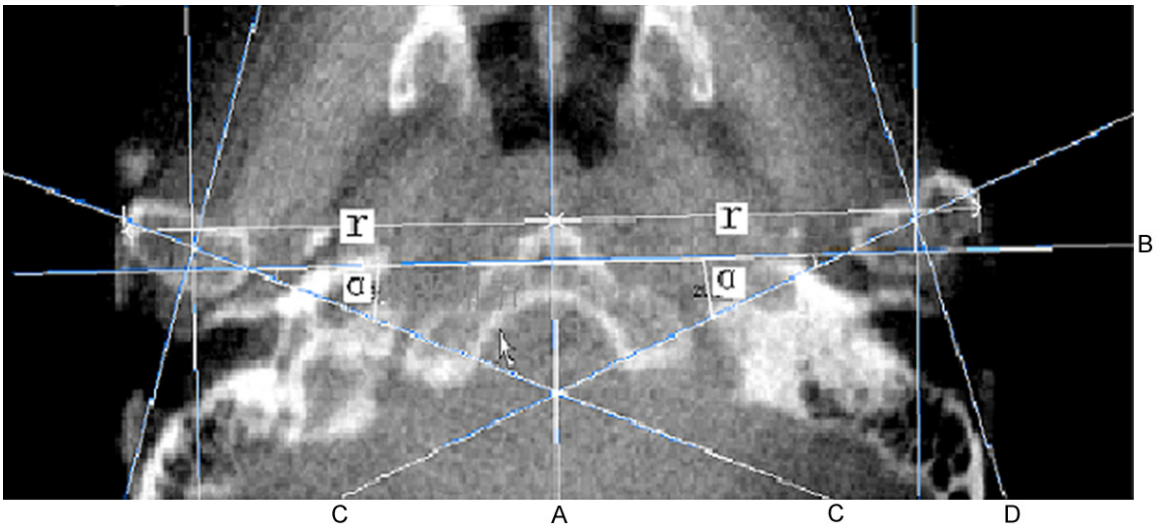

Figure 1. Image reconstruction and measurement. A. Midsagittal reference line; B. line vertical to the midsagittal line a; C. The line parallel to the long axis of condyle; D. Line vertical to the long axis of condyle; α, Horizontal condylar angle; r, The line segment between lateral condyle and line a.

two sides of TMJ and most of the results showed that there were not statistical difference in healthy individuals [10, 11]. But Rodrigues found significant discrepancy in posterior joint space in Class I malocclusion patients who had no TMD, using MRI [12]. Tecco also found obvious difference in TMJ of Caucasian through measuring the volume and superficial area of condyle [13]. Those different conclusions possibly were due to the different imaging and measuring methods and inclusion criteria.

It is uncertain whether there are statistical differences between the bilateral TMJs in patients with unilateral TMJ pain or joint sounds. Therefore, this retrospective study was performed. The bilateral TMJs of 123 who had undergone CBCT were measured to preliminarily determine the indicators suitable for the measuring method. And then 36 patients without TMJ complaints who had undergone CBCT served as controls. The bilateral TMJ images of the controls were analyzed by paired t-test. Thus, the indicators without statistical difference were determined. The bilateral TMJ indicators without statistical significance were used as the indicators in the comparative study of patients with unilateral TMJ complaints.

Methods and patients

Patients

The study was approved by the ethic committee of the hospital and all the written informed consents were obtained. To preliminarily determine the indicators suitable for the measuring method, 123 cases (61 males, 62 females; average age of 43 with the range of 15-108) that had undergone CBCT scanning between January 2007 and December 2012 were enrolled in the study. The exclusion criteria were the cases whose images didn't satisfy the scanning and measuring method. To determine the bilateral TMJ indicators without statistical significance, 36 people (19 males, 17 females; average age of 41 with the range of 16-108) without any TMJ complaints who had undergone CBCT for other reasons between January 2007 and December 2012 served as controls. The inclusion criteria were cases without any TMJ complaint (including TMJ pain; joint noise during jaw movement within 30 days; limitation of mouth opening within 30 days; difficulty of jaw movement). The exclusion criteria were the cases that had medical history of TMJ complaint, rheumatism, rheumatoid or TMJ trauma, and the cases whose images didn't satisfy the scanning and measuring method. To determine the bilateral TMJ indicators with statistical significance, 29 patients (12 males, 17 females; average age of 43, range of 15-81) with unilateral TMJ complaint who consulted the hospital between January 2007 and December 2012 were enrolled in the study. The inclusion criterion was that the patient suffered TMJ pain or abnormal joint sounds unilaterally for above 30 days without any TMJ complaint on the other side. The patients with two or more TMJ com-

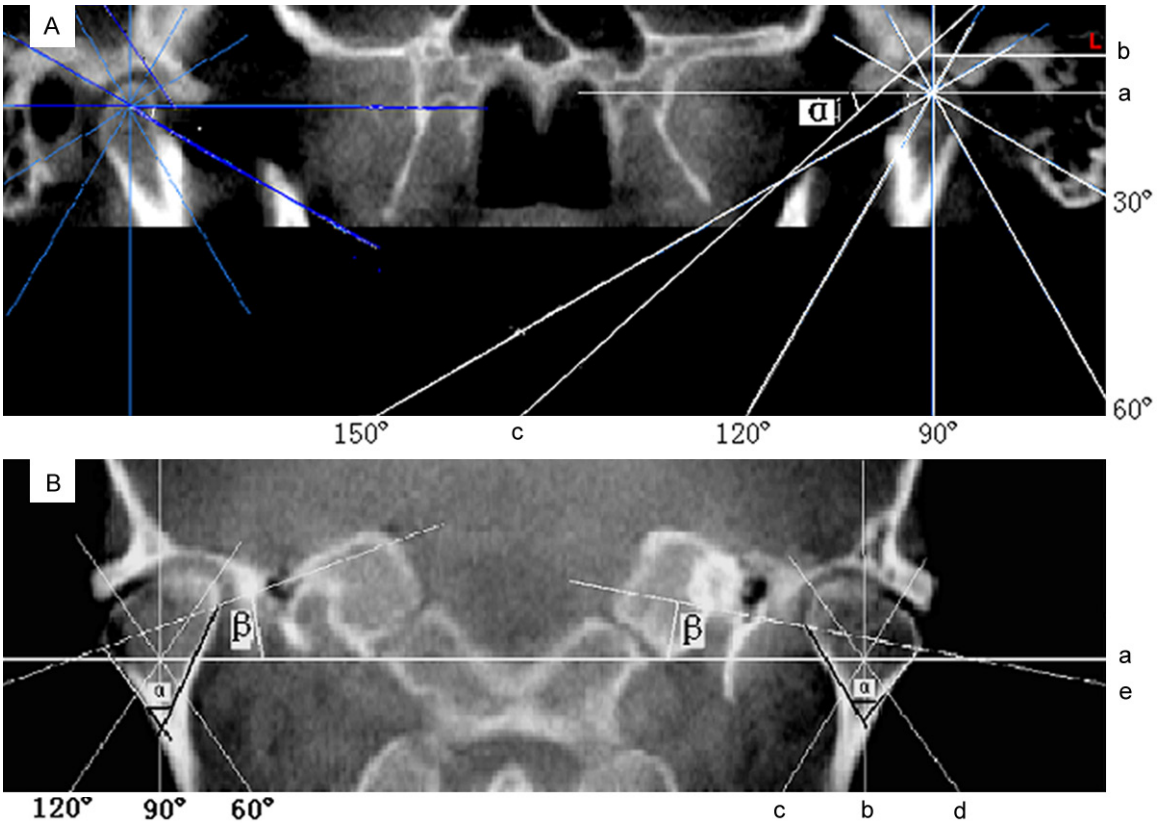

Figure 2. A. The plane vertical to the long axis of condyle. B. The plane parallel to the long axis of condyle. a. Horizontal reference line; b. The line perpendicular to line a and across the center of condyle; o, The intersection point of line a and line b; c. The line placed at 60° the line a; d. The line placed at 120° the line a; e. The line connecting the interior and exterior eminence of condyle; β, vertical condylar angle.

plaints unilaterally, TMJ complaints on the other side or with a history of general arthritis or other connective tissue diseases, rheumatism, organ diseases, general infection and TMJ trauma were excluded.

CBCT scanning of the 123 cases

To preliminarily determine the indicators suitable for the measuring method and the comparative study, the TMJ CBCT images of the 123 people was analyzed as the following.

CBCT scanning, reconstruction and measurements

The people was in supine position and the bilateral TMJs were scanned by cone-beam computed tomography (CBCT-NewTom QR-DVT 9000, Italy), which operated at 110 kVp and 8.1 mAs. Bilateral condylar image was in center of the exposure field. CBCT images of all the TMJs were obtained. Zoom the original lateral image and locate condyle in the center of the reconstruction image. Adjust the reconstruction level marker parallelly overlap to sigmoid notch. Determine the interest area suitable for observing TMJ and then performed the reconstruction. Choose transverse section, oblique plane parallel to the long axis of the condyle and oblique plane perpendicular to the long axis of the condyle to conduct the reconstruction of bilateral joint and measurement. 0.625 mm-thickness image was used for reconstruction.

The reconstruction image was restricted to the TMJ area. After the transverse plane reconstruction with the clearest and largest area, a line was traced through nasal apex, nasal septum and foramen magnum, and named as midsagittal reference line a (**Figure 1**). Coronal reference line b, perpendicular to midsagittal line a, was traced across the center of the two condyles. Line c was traced overlapping the long axis of condyle. Line b intersected line c and produced horizontal condylar angle. The distance between lateral condyle and midsagittal

Table 1. Measurements of bilateral TMJ in control group (n = 36)

Measurements	Values		*P* value
	Right	Left	
Horizontal condylar angle (°)	17.96±7.65	17.89±9.37	0.93
Radius (mm)	51.97±2.61	52.96±3.25	0.02*
Perpendicular angle (°)	3.52±5.58	3.01±6.27	0.53
Medial-lateral diameter of condylar process (mm)	19.87±1.99	20.16±1.96	0.18
Horizontal 60° joint space (mm)	2.91±0.83	3.13±0.93	0.08
Horizontal 90° joint space (mm)	3.14±0.68	3.16±0.75	0.84
Horizontal 120° joint space (mm)	2.52±0.62	2.69±0.67	0.06
Sagittal 60° joint space (mm)	2.91±0.84	3.06±0.77	0.30
Sagittal 90° joint space (mm)	3.12±0.68	3.35±1.94	0.49
Sagittal 120° joint space (mm)	1.94±0.63	2.47±0.63	0.39
Sagittal incline of articular tubercle (°)	50.91±9.67	49.50±8.41	0.17
Perpendicular 60° joint space (mm)	3.27±0.89	3.08±0.79	0.12
Perpendicular 90° joint space (mm)	3.10±0.73	3.03±0.62	0.65
Perpendicular 120° joint space (mm)	1.94±0.69	2.64±0.79	0.08
Perpendicular incline of articular tubercle (°)	55.91±11.09	53.64±9.93	0.13

*P < 0.05 statistically significant changes.

line a was the radius r. The measured values were recorded duly. Each measurement in the research was performed by the same in the department of oral radiology and was repeated three times; the investigator was blind to the group.

The condylar transverse plane with maximum transverse diameter was used for imaging reconstruction. The image parallel to the long axis of condyle was reformed (**Figure 2**). A horizontal line, tangent to the highest point of glenoid fossa, was drawn and moved down 15 mm inferiorly to produce the reference line a. The reference line b, which was perpendicular to line a, was traced across the center of condyle. Line a intersected line b at the reference point o. Across point o, three lines were placed at 60°, 90°, 120° respectively to the line a. The segments between the condyle and glenoid fossa were measured and recorded. The line e connecting the interior and exterior eminence of condyle intersected line a and formed vertical condylar angle β. The line segment between the ends of long axis of condyle was the long axis diameter.

After reconstruction and measurement, the indicators that could be measured in all the 123 people were used for the following comparative study. The images of the 36 controls and the 29 patients with unilateral TMJ complaints were reconstructed and all the suitable indicators were measured, recorded and analyzed.

Statistical analysis

Paired t-tests were conducted using the SPSS v.13.0 program and all the data were given in the form of the mean and standard deviation. P < 0.05 was considered as statistical significance. All the measurements were performed by the same investigator, who was blind to the two groups, in the department of oral radiology.

Results

All the indicators except sagittal 30° joint space, sagittal 150° joint space and perpendicular 150° joint space could be measured in all the 123 people. Sagittal 30° joint space could not be measured in 4 cases (4/123, 3.25%). Perpendicular 150° joint space and sagittal 150° joint space could not be measured in 20 cases (20/123, 16.26%) (**Figure 2A**). Therefore, all the indicators except sagittal 30° joint space, sagittal 150° joint space and perpendicular 150° joint space were measured and used in the control group and the TMJ complaint group.

In the control group of 36 cases, only radius value of bilateral TMJ was different statistically (P < 0.05); the rest of the measurements showed no statistical difference (**Table 1**). Therefore, all the chosen indicators except for sagittal 30° joint space, sagittal 150° joint space, perpendicular 150° joint space and radius value of bilateral TMJ were measured and used in the unilateral TMJ complaint group.

In the TMJ complaint group, the value of vertical 60° joint space showed statistical difference (P < 0.05) and the rest of the indicators had no statistical difference (**Table 2**).

Table 2. Values of bilateral TMJ in unilateral TMD group (n = 29)

Measurements	Values		*P* value
	Symptomatic side	Asymptomatic side	
Horizontal condylar angle (°)	21.71±18.78	19.43±15.83	0.19
Perpendicular angle (°)	8.51±8.49	7.63±9.45	0.46
Medial-lateral diameter of condylar process (mm)	19.87±2.75	21.95±12.81	0.42
Horizontal 60° joint space (mm)	3.49±2.04	3.31±1.36	0.54
Horizontal 90° joint space (mm)	2.78±1.34	2.67±1.26	0.43
Horizontal 120° joint space (mm)	2.64±1.43	2.58±1.17	0.76
Sagittal 60° joint space (mm)	2.81±0.90	2.61±1.14	0.17
Sagittal 90° joint space (mm)	2.59±1.20	2.55±1.10	0.60
Sagittal 120° joint space (mm)	2.03±1.17	2.11±0.91	0.83
Sagittal incline of articular tubercle (°)	53.56±16.05	49.71±11.78	0.17
Perpendicular 60° joint space (mm)	3.02±0.95	2.59±1.07	0.01*
Perpendicular 90° joint space (mm)	2.50±1.20	2.54±1.03	0.97
Perpendicular 120° joint space (mm)	2.13±1.13	2.00±0.95	0.50
Perpendicular incline of articular tubercle (°)	56.90±13.47	51.3±16.32	0.08

*$P < 0.05$ statistically significant changes.

Discussion

There are few reports about the comparison of characteristics of articular fossa and condyle between the bilateral TMJ in patient with one kind TMJ complaint unilaterally. In the present study, by using CBCT, a statistical comparison was performed between the findings obtained from the patients with unilateral TMJ pain or joint sounds and the controls without TMJ complaint. And the result showed that vertical 60° joint space was different statistically ($P = 0.01$) between the symptomatic side and the healthy side (**Table 2**).

In this study, we used CBCT for radiography, which is widely used in dento-facial imaging. It allows examination of TMJ anatomy without superimposition and distortion to facilitate analysis of bone morphology, joint space and dynamic function in all three dimensions [3, 4, 14, 15]. Condylar morphology and its relationship with fossa may provide some reference for diagnosis and treatment of TMJ disorders in some degree [16, 17]. The different research methods result in diverse measurements. Many scholars assess TMJ through comparing changes of anterior and posterior joint space and observing whether condyle is in a neutral position [6, 18]. In this study, the images parallel and perpendicular to the long axis of the condyle were reconstructed instead of the true anatomic coronal and sagittal planes, which allowed for easier TMJ visualization and better assessment of the condyle position. And bilateral condylar image was reconstructed in one picture for easier comparative study.

In the present study, we focused on TMJs and tried to determine the indicators with statistical difference between symptomatic side and asymptomatic side in patients with unilateral TMJ complaint. Some previous studies suggested that there were not discrepancies with statistical difference between the two sides of TMJ in the healthy individual [10, 11]. In our study, the results showed that only radius value of bilateral TMJ was different statistically in the control group, while the rest of the measurements were not statistically different. This was likely due to the linkage nature of TMJ and chewing habits which affects condylar morphology and joint disc. In the study group, vertical 60° joint space was different statistically ($P < 0.05$) and there was no significant differences in other values (**Table 2**). As single symptom may be the initiator of a series of TMJ changes, it may provide some reference for the clinical guidance to stop the continued development to serious TMJ problems.

However, it should be noted that there may be symptoms of TMJ disorders with normal TMJ and vice versa, which is possibly due to measure method, age, gender, chewing habits and so on. Both the condyle and the mandibular fossa may differ in shape in subjects with various TMJ complaints, since shape and function

are closely related [5]. This comparative study was base on both left and right sides of patients with unilateral TMJ complaint and healthy controls, which may overcome the above problems. Using that method we found that in the patients with unilateral TMJ pain or joint sounds, the vertical 60° joint space of the symptomatic side was significantly increased comparing with the asymptomatic side.

There were some limitations in the study. To preliminarily determine the indicators suitable for the measuring method, 123 cases were used. The sample was not big enough. Maybe some other indicators wouldn't be obtained if a bigger sample was used. In the study group of 29 cases, 18 cases of pain symptom had a relative dominance in the research. Different TMJ dysfunction symptoms that we recorded may have different effects on the structures of TMJ. And even the same symptom can cause different changes in TMJ morphology and joint space with the course of TMJ dysfunction. A study of a large sample and with the consideration of single factor is needed.

Conclusion

As far as we know, this is the first research about comparative analysis in patients with unilateral TMJ pain or abnormal joint sounds. In the patients with unilateral TMJ pain or joint sounds, the vertical 60° joint space of the symptomatic side is significantly increased comparing with the asymptomatic side.

Acknowledgements

This study was supported by fund from the project of 2014 special research (14BJZ03), 2014 clinical research of Chinese PLA General Hospital (2014FC-SXYY-1003), and the 2014 special research of health development of capital (2014-4-5022).

Disclosure of conflict of interest

None.

Abbreviations

TMJ, Temporomandibular joint; TMDs, temporomandibular disorders; DC/TMD, Diagnostic Criteria for TMDs.

Address correspondence to: Dr. Yanfeng Li, Department of Stomatology, The First Affiliated Hospital of Chinese PLA General Hospital, No. 51 Fucheng Road, Beijing 100037, China. Fax: +861066867491; E-mail: m.god@yeah.net

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