Int. J. Morphol.,
33(1):43-47, 2015.

Evaluation of the Prevalence of Bifid Mandibular Condyle Detected on Cone Beam Computed Tomography Images in a Turkish Population

Evaluación de la Prevalencia de Cóndilo Mandibular Bífido Detectado en Tomografía Computadorizada Cone-Beam en una Población Turca

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GUNDUZ, K.; BUYUK, C. & EGRIOGLU, E. Evaluation of the prevalence of bifid mandibular condyle detected on cone beam computed tomography images in a Turkish population. ***Int. J. Morphol., 33(1)***:43-47, 2015.

SUMMARY: The aim of this study was to assess the frequency of the BMC phenomenon in a Turkish patient population. Cone beam computed tomography (CBCT) images of 2634 consecutive patients were retrospectively reviewed. The Chi-squared test was used to determine potential differences in the distribution of BMCs when stratified by sex and side. Among the 2634 patients, 42 (1.7%) patients were found to have BMC. Of these 42 patients, 22 were female (0.8%) and 20 were male (0.7%) with age ranging from 29 to 68 years (mean age 47.47). Among the 42 patients, 39 (92.8%) of the BMCs were unilateral and three (7.1%) were bilateral. Approximately 24 cases (53.3%) were on the right side, and 21 cases (46.6%) were on the left side. All of the BMCs showed a mediolateral orientation. The mean depth of the BMC was 2.55 mm in males and 2.68 mm in females. 2 patients have symptoms whereas the other patients were atraumatic and asymptomatic. BMC is a rare condition that might be more prevalent in the Turkish population. Greater detailed information regarding BMC could be obtained by the widespread use of CBCT in epidemiological studies.

KEY WORDS: Bifid condyle; Cone beam computed tomography; CBCT images; Temporomandibular joint.

INTRODUCTION

Bifid mandibular condyle (BMC) is an uncommon anomaly that was first reported by Hrdlicka (1941). BMC, also known as a double-headed condyle, is characterized by a separation of the mandibular condylar head (Hersek *et al*., 2004). The condylar division ranges from a superficial groove to two different condyles with separate necks (Miloglu *et al*., 2010).

BMC occurs unilaterally more often than bilaterally in a ratio of approximately 4.4:1, and there is no significant difference between age and sex. BMC is diagnosed predominantly as an incidental finding on imaging studies. Although the precise etiology of BMC has not yet been fully elucidated, developmental anomalies, trauma, nutritional disorders, infection, exposure to radiation, genetic factors, teratogenic embryopathy, and surgical condylectomy have been considered as possible causal factors (Neves *et al*., 2013).

The orientation of the bifid condyle has been classified as anterior-posterior and mediolateral. Szentpétery *et al*. (1990), suggested that trauma is the cause in cases in which 2 condylar parts are in the sagittal plane, and the persistence of the fibrous septa at the condylar cartilage is the most likely cause in cases in which the parts are in the coronal plane. This description might be accurate for the majority of cases; however, some mediolateral bifid condyles have been reported to follow sagittal fractures through the condylar head (Loh & Yeo, 1990; Wu *et al*., 1994). According to Blackwood (1957), the two articulating surfaces of BMC were divided by a groove and could be oriented mediolaterally or anteroposteriorly, characterizing a specific entity.

A review of the literature supports the conclusion that bifid condyles are typically discovered as incidental findings on panoramic radiographs. The sudden increase in the number of cases reported could be attributed to the

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widespread use of radiographs (Rehman *et al*., 2009). The prevalence of BMC has been reported to range from 0.018% to 1.82%. Although initial screening for the presence of bifid mandibular condyle could be performed using panoramic radiographs, cone beam computed tomography (CBCT) images reveal morphological changes and the exact orientation of the condyle heads. The condition might occur more frequently than is suspected. To assess the frequency of the BMC phenomenon, a study was conducted using CBCT images from 2634 patients.

MATERIAL AND METHOD

A retrospective study was performed using CBCT imaging of 2634 patients. The sample consisted of 1714 implant patients, 215 TMJ disorder patients, and 705 patients with other disorders (including orthodontic patients, cyst) (Table I). The CBCT images were obtained from the GALILEOS (Sirona Dental Systems, Bensheim, Germany), operating at 98 kVp, 15-30 mA with a field of view of 15 mm X 15 mm. Real-time reconstruction was performed using an SIRONA Sidexis XG image viewer, and the acquired image data consisted of 12-bit gray scale images with a 0.25 mm^3 voxel size.

The CBCT images were evaluated by three dentomaxillofacial radiologists, and all of the images were displayed on a 27-in. flat-panel color active matrix TFT medical display (Nio Color 3 MP, Barco, Kortrijk, Belgium) under dim lighting conditions. Any conflicts in the reviews were resolved according to the suggestions of the more experienced investigator. The CBCT scans were assessed in all three planes. The mediolateral bifidity was assessed using coronal images parallel to the long axis of the condyle, and the anteroposterior bifidity was assessed using lateral images perpendicular to the long axis of the condyle. The BMC depth was measured by the shortest distance from the line connecting the two highest points of the condyles to the lowest point of the condyles (Fig. 1).

Table I. Summary of patients and their indications for cone beam CT (CBCT) referral.

Sex	Male	1455	45.41
	Female	1179	49.54
Total		2634	47.47 (mean age)
Indication for CBCT	Implant	1714	53.81
	Temporomandibular joint disorders	215	47.35
	Others	705	41.25
Total		2634	47.47 (mean age)

Finally, 45 cases of BMC were found in the 2634 patients. The BMC patients were recalled, and clinical examinations were performed to assess the history of trauma and the presence of TMJ pain and noise. The asymptomatic group consisted of the patients with no TMJ signs and symptoms. The patients who had any conditions that could affect TMJ components such as skeletal abnormalities, TMJ tumors, or other infectious diseases were excluded.

The observed results were analyzed with SPSS 16.0 (Statistical Package for Social Science Inc., Chicago, Illinois, USA). The Chi-squared test was used to determine potential differences in the distribution of BMCs when stratified by gender and side. A p value of < 0.05 was considered statistically significant.

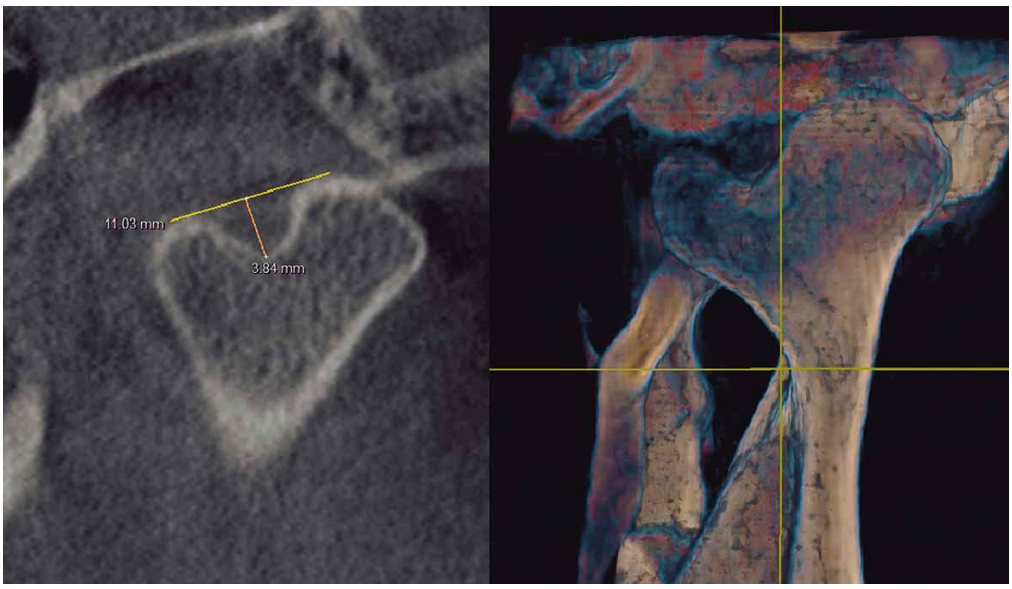

Fig. 1. Measurement of the mediolateral BMC depth on the left and the coronal image of the 3D reconstructed condyle on the right, in the same patient.

RESULTS

Among the 2634 patients, 42 (1.7%) patients were found to have BMC. Of these 42 patients, 22 were female (0.8%) and 20 were male (0.7%); there was no significant sex difference (p>0.05). The ages of the patients ranged from 29 to 68 years (mean age 47.47). Among the 42 patients, 39 (92.8%) of the BMCs were unilateral and three (7.1%) were bilateral (Fig. 2). In total, 45 BMCs and 39 normal condyles were found in 42 patients. Approximately 24 cases (53.3%) were on the right side, and 21 cases (46.6%) were on the left side; there was no significant difference found (p>0.05). All of the BMCs showed a mediolateral orientation (Fig. 3). The mean depth of the BMC was 2.55 mm in males and 2.68 mm in females (p>0.05) (Table II). In the 42 patients with BMCs, two symptomatic patients with a history of traffic accident-caused head trauma and complained only of clicking on mouth opening, whereas the other patients were atraumatic and asymptomatic.

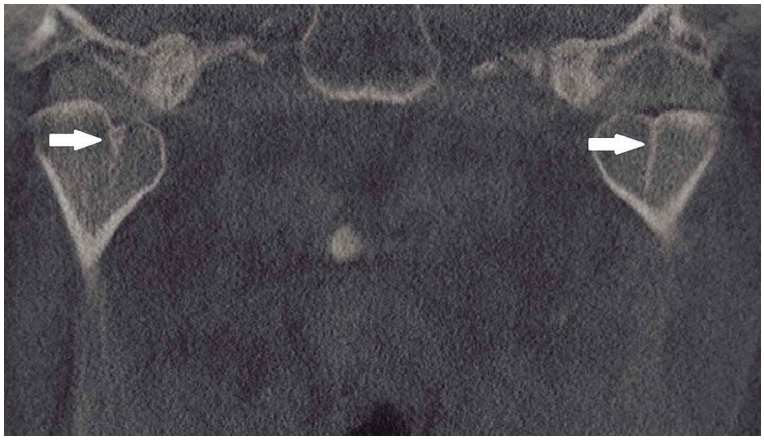

Fig. 2. A coronal CBCT slice shows the bilateral bifid mandibular condyle (arrows).

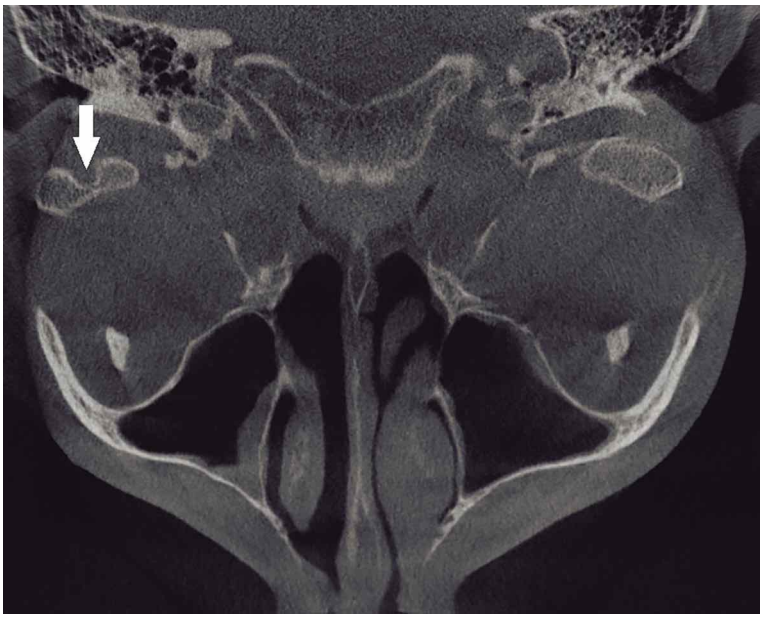

Fig. 3. An axial CBCT slice revealing the duplication of the left mandibular condyle mediolaterally (arrow).

DISCUSSION

BMC is a rare condition that is typically discovered as an incidental finding on routine radiographic examinations (Rehman *et al.*). Although panoramic radiographs and other conventional techniques are adequate in most cases, CBCT allows for the detailed visualization of condylar morphology by preventing osseous superimposition (Menezes *et al*., 2008; Sahman *et al*., 2012). A lower exposure dose is a significant advantage of CBCT in comparison with multislice computed tomography and conventional tomography (Neves *et al*.). To impede misinterpretation of BMC prevalence, CBCT was used as the imaging technique in this study.

Many epidemiological studies regarding BMC have been conducted. Menezes *et al*., found nine (0.018%) cases of BMC from 50,080 panoramic radiographs in a Brazilian population, whereas Miloglu *et al*. (2010), found 32 (0.3%) cases of BMC from 10,200 panoramic radiographs, and Sahman *et al*., found 98 (0.52%) cases of BMC from 18,798 radiographs in a Turkish population. According to these distinctive results, Sahman *et al*. (2011), hypothesized that BMC might be more frequent

Table II. Characteristics of BMC patients according to sed and variety, and the number of condyles according to the side

Patients	Uni- or bilateral		BMC side		Depth of BMC	Orientation of the bifid mandibular condyle	
	Unilateral	Bilateral	Right	Left	(mm)	Mediolateral	Anteroposterior
Male	19	1	11	10	2.55	21	---
Female	20	2	13	11	2.68	24	---

in the Turkish population. In 2013, Cho & Jung, found 37 (0.50%) cases from 7,424 CBCT images and a total of 44 BMCs (0.30%) from 14,848 condyles. In the same year, Neves *et al*., performed a retrospective study using CBCT records and panoramic radiographs of 350 patients and found BMCs in 4 cases (1.1%). Sahman *et al*. (2011), found 10 (1.82%) patients with 13 BMCs in 550 computed tomography images. Caglayan & Tozoglu (2012), found that 2.9% of patients had a bifid condyle as an incidental TMJ finding on CBCT scans. The prevalence of BMCs in this study was similar with the prevalence reported in previous studies that utilized panoramic radiographs and CBCT in the Turkish population; the prevalence was higher than that in other populations. The discrepancies could reflect the diversity of imaging modalities, race, and sample size.

According to the literature, the occurrence of BMC does not show a predilection for sex or any particular age group (Miloglu *et al*.; Menezes *et al*.; Sahman *et al*., 2011, 2012; Cho & Jung). According to Loh and Yeo, the majority of patients were over 20 years old, which is in agreement with our findings. Although Cho & Jung and Menezes *et al*., found a female-male ratio of 3.1:1 and 3.5:1, respectively, Antoniades *et al*. (2004), found a male-female ratio of approximately 1.5:1, and Miloglu *et al*., and Sahman *et al*. (2012), found a closer BMC prevalence between women and men. With the ratio of female-male patients examined in this study, there was no statistically significant difference between female and male prevalence ($p>0.05$).

To obtain precise information regarding the orientation of BMCs, 2D conventional radiographs were insufficient and 3D imaging techniques were useful (Sahman *et al*., 2011). Although Dennison *et al*. (2008), expressed that only the anteroposterior division of a condyle is a "true" bifid condyle, BMC has been generally considered in cases in which a condyle arises to be duplicated anteroposteriorly or mediolaterally (Cho & Jung). In our study, all of the BMCs showed a mediolateral orientation. In this study, no condyle showed anteroposterior bifidity, and it was hypothesized that anteroposterior bifidity presented concomitant to mediolateral orientation and that this classification is not sufficient for all cases; a BMC could be oriented in an oblique position that is not anteroposterior or mediolateral. A certain diagnosis regarding the exact pattern of a BMC is not possible with conventional radiographic techniques, and clinicians could misdiagnose the orientation of condyles in panoramic radiographs. Shriki *et al*. (2005) proposed the hypothesis that a bifid condyle with mediolateral heads was a developmental phenomenon rather than a result of trauma, and our results supported this claim. Many studies have reported that the majority of patients showing mediolateral bifidity had no traumatic history (Shriki *et al*.; Plevnia *et al*., 2009; Ramos *et al*., 2006; Acikgöz, 2006; Melo *et al*., 2012), although Melo *et al*., reported a very rare case of a nontraumatic anteroposterior bifid condyle. In connection with BMC orientation, it has been suggested that a sagittal split with an anteroposterior orientation was associated with a traumatic event (Szentpétery *et al*.; Shriki *et al*.; Plevnia *et al*.; Forman & Smith, 1984; Gunduz*et al*., 2010). Other authors have demonstrated that fractures of the mandibular condyle could result in mediolateral and anteroposterior BMCs.

In the literature review, the majority of the BMC cases were unilateral, and a bilateral pattern was rare (Miloglu *et al*.; Neves *et al*.; Menezes *et al*.; Sahman *et al*., 2011, 2012; Cho & Jung). In our study, 39 (92.8%) of the BMCs were unilateral, and three (7.1%) were bilateral, which is consistent with previous study findings. Although most studies reported that BMCs involved the left side more often than the right side (Menezes *et al*.; Sahman *et al*., 2011, 2012; Cho & Jung). Miloglu *et al*., showed a predilection for the right side. In our study, 24 cases (53.3%) were on the right side, and 21 cases (46.6%) were on the left side, and the difference was not statistically significant ($p>0.05$).

Although the exact etiology of BMC is not yet well defined, the most likely cause is a history of trauma (Sahman *et al*., 2012; Antoniades *et al*., 1993). In a study by Neves *et al*., all of the individuals with bifid mandibular condyle had a history of childhood trauma. Many studies have shown that the majority of the patients had no history of trauma or TMJ symptoms (Miloglu *et al*.; Loh & Yeo; Antoniades *et al*., 2004). According to Cho & Jung, there was no significant difference in the distribution of clinical symptoms in patients with normally shaped condyles and patients with BMCs, which supported the hypothesis that BMC does not stimulate TMJ symptoms. In this study, the two patients who had a history of trauma and clicking on mouth opening and the atraumatic and asymptomatic patients showed no significant differences in the distribution of clinical symptoms between the BMC sides ($p>0.05$), which suggested that BMC does not provoke TMJ symptoms.

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RESUMEN: El objetivo de este estudio fue evaluar la frecuencia del fenómeno CMB en una población de pacientes de Turquía. Se revisaron imágenes consecutivas de tomografía computarizada (CBCT) de 2.634 pacientes retrospectivamente. Se utilizó la prueba de Chi-cuadrado para determinar las posibles diferencias en la distribución de CMB estratificado por sexo y lado. Entre los 2.634 pacientes, se encontró que 42 (1,7%) pacientes tenían CMB. De estos 42 pacientes, 22 eran mujeres (0,8%) y 20 eran varones (0,7%), con edades entre 29 a 68 años (prome-

dio edad 47,47). Entre los 42 pacientes, 39 (92,8%) del CMB fueron unilaterales y tres (7,1%) fueron bilaterales. Aproximadamente 24 casos (53,3%) estaban en el lado derecho, y 21 casos (46,6%) estaban en el lado izquierdo. Todas las CMB mostraron una orientación mediolateral. La profundidad media de la CMB era 2,55 mm en los hombres y 2,68 mm en las mujeres. Dos de los pacientes presentaron síntomas, mientras que en el resto de los pacientes no presentó trauma ni síntomas. CMB es una afección poco común que podría ser más frecuente en la población turca. Mayor información y detalle sobre CMB se podría obtener en estudios epidemiológicos con el uso generalizado de CBCT.

PALABRAS CLAVE: Cóndilo bífido; Tomografía computadorizada de haz cónico; Imágenes CBCT; Articulación temporomandibular.

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Received: 12-05-2014
Accepted: 05-11-2014