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Assessment of radiographic morphology of mandibular condyles: a radiographic study

Running title: Morphological evaluation of condyle

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Abstract

Background: Panoramic radiographs are the most common radiographic tool used by the dental clinicians to evaluate teeth, mandible and other related structures of the jaws. Mandibular condyle is an important anatomical landmark for facial growth, expressed in an upward and backward direction. The presentation of mandibular condyle differs widely among different group of ages and individuals.

Materials and methods: The retrospective cross-sectional study was conducted from Nov 2018 to March 2019 at Dow International Dental College (DIDC) Karachi that includes radiographic evaluation of 500 mandibular condyles. All retrievable OPGs were obtained and data were extracted regarding age, gender and condylar morphology.

Results: The morphological appearances of mandibular condyle have great variation among different age groups and subjects. Normally we recognize five basic shapes i.e. Oval, Bird beak, crooked finger, diamond and mixed. Out of 250 pair of condylar heads that were evaluated, 50% were oval, 40% bird beak, 4.8% crooked finger and diamond 4.8%.

Conclusions: All four morphological types of mandibular condyles were observed and the oval shape condyles were most prevalent among both genders and all age groups. In future studies, the inclusion of other parameters and large sample size may provide unique information.

Key words: mandibular condyle, orthopantomogram, TMJ morphology

INTRODUCTION

Panoramic radiographs (OPG) are the most routinely and widely used diagnostic tool used by the dental clinicians to get valuable information about teeth, mandible and other related structures of the jaw [1]. It gives us valuable knowledge about the anatomical variation of maxilla and mandible and also osseous changes or flattening happening with time [2]. Routine Panoramic view has also been recommended by the American Academy of Oral and Maxillofacial Radiology for assessing the structural components of the temporomandibular joint (TMJ) because of the cost and risk of the relatively low radiation exposure associated with computed tomography [3].

Mandibular condyle is an important anatomical landmark for facial growth, expressed in an upward and backward direction [4]. The presentation of mandibular condyle differs widely among different group of ages and individuals. Morphological variations depend upon developmental variation along with condylar remodelling to accommodate malocclusion, trauma and other pathological and developmental abnormalities [5]. Variability in the shapes and sizes of condyles helps to diagnose the TMJ disorders associated with malocclusions such as crossbite, deep bite, and open bite [6].

The mandibular condyle varies considerably both in size and shape. The typical condylar head has a convex arrangement throughout, and symmetry should exist between contralateral sides within the same individual [4, 7]. Several studies have endeavoured to assess the

morphology of human condyle. Past researchers evaluated a variety within the mandibular condyle shapes [7, 8]. Yale SH first classifies the shapes of the mandibular condyle as convex, flat and concave when having a superior view by examining the skulls of Terry collection. However, later Yale simplified classification into four categories flattened, convex, angled, rounded [9] .

Upon surgical exposure, four different types of condyles shapes were noted which include excavated form, oblique form, and the small round shape and flattened [10]. On the other hand, flat, convex, concave, round and angled type of condylar morphology were noted when computed tomography images were observed [11].

In Pakistan, limited data is available regarding the morphological appearance of the condyle. The thorough understanding of the morphological variations in the shape of the mandibular condyle is essential so that a standard variant can be distinguished from the abnormal condition. Therefore, this study aims to record different types of normal morphological variations of the condyle through an OPG. The objective of this study is to assess the frequency of different condylar morphological variations in both genders and age groups.

MATERIALS AND METHODS

Study design and patients

The retrospective cross-sectional study was conducted from Nov 2018 to March 2019 at Dow International Dental College (DIDC) Karachi that includes radiographic evaluation of 500 mandibular condyles. All retrievable OPGs were obtained, and necessary data was extracted regarding age, gender and condylar morphology. Ethical approval for this study was obtained from the Institutional Review Board, Dow University of Health Sciences.

Digital Orthopantomograms (OPG) taken on Villa Rotograph EVO 3D, (exposure parameters being: 10 mA, 82 Kv) free of any projection errors, that showed a complete view of condyle on either side with optimum density and contrast were selected. The radiographs of the individuals with a history of TMJ dysfunction, Occlusal discrepancy, pathological and developmental abnormalities were excluded.

Sum of 250 OPGs was visualized for a routine investigation. The OPGs were evaluated by two Maxillofacial Surgeon to determine the morphology of condyle. The statistical analysis

was conducted using SPSS version 17. The participants were divided into three groups according to the age a) young Adults (18-35 years), b) middle age (36-55 years), c) older adults (56 or above). Descriptive statistics were conducted to estimate the frequency of normal morphological variations of condyles. Chisquare test was conducted to assess the difference in frequency of normal condylar morphological variations about age and gender.

RESULTS

Total of 500 condyles from 250 OPGs was examined. Out of 250 radiographs, half of them belongs to females, and half were belong to males, as shown in table 1. In terms of age, the majority of radiographs were of participants belongs to middle age groups, as shown in table 1.

The shapes of the condyles that have been identified in this study are a) Bird beak b) Oval, c) Diamond and d) Crooked Finger as shown in Fig 1, Fig 2, Fig 3, and Fig 4.. The commonest form of condylar morphology was oval (50%) followed by the bird beak (40%), diamond (4.8%) and crooked finger (4.8%). The frequency of oval condylar morphology was (57.6%) among males and (42.4%) among female participant, as shown in table 2. In all age groups, the most dominant form of condylar morphology was oval, followed by the bird beak diamond and crooked finger. The frequency of oval condylar morphology was 36% in age group 1, 44% in age group 2 and 20% in group 3, as shown in table 2.

When the frequency of condylar morphological types was compared with the gender, it was observed that among male study participants, the oval condylar morphology was significantly higher ($p=.016$). On the other hand, among females study participants, the diamond condylar morphology was significantly higher ($p=.018$) as shown in table 3.

The frequency of condylar morphological types was compared with the age groups in table 3. Among participants of age group 1, the frequency of diamond condyles was significantly lower as compared to other age groups. In the case of age group 2, the frequency of crooked finger condyles was significantly higher ($p=.002$) as compared to other age groups. Among participants of age group 3 the frequency of bird beak condyles were significantly lower ($p=.001$) as compared to other age groups and diamond condylar morphology was significantly higher ($p=.0001$) as compared to other age groups.



Figure 1. Type I — Bird beak



Figure 2. Type II — Oval



Figure 3. Type III — Diamond

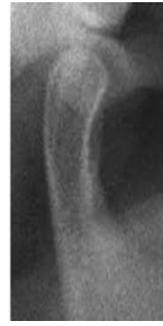


Figure 4. Type IV — Crooked finger

Table 1. Demographic distribution of the participants according to the gender and age

Variable	Age N (%)			Total
	Young Adults 18-35 years	Middle age 36-55	Older adults 56 or above	
Male	50 (40)	54 (43.2)	21 (16.8)	125 (100)
Female	38 (30.4)	69 (55.2)	18 (14.4)	125 (100)

Table 2. Distribution of the condylar morphology according to the gender and age

Gender	Bird beak	Diamond	Crooked finger	Oval
	N (%)	N (%)	N (%)	N (%)
Male	48 (47.5)	2 (16.7)	3 (25)	72 (57.6)
Female	53 (52.5)	10 (83.3)	9 (75)	53 (42.4)
Total	101 (100)	12 (100)	12 (100)	125 (100)

Age Groups	Bird beak	Diamond	Crooked finger	Oval
	N (%)	N (%)	N (%)	N (%)
Group 1	42 (41.6)	0 (0)	1 (8.3)	45 (36)
Group 2	53 (52.5)	4 (33.3)	11 (91.7)	55 (44)
Group 3	6 (5.9)	8 (66.7)	0 (0)	25 (20)
Total	101 (100)	12 (100)	12 (100)	125 (100)

Group 1: 18-35 years old, Group 2: 36-55 years old, Group 3: 56 or above

Table 3. Comparing the frequency of condylar morphology between both genders

Variable	Bird beak			Diamond			Crooked finger			Oval		
	N (%)		P	N (%)		P	N (%)		P	N (%)		P
Gender	Yes	No	P	Yes	No	P	Yes	No	P	Yes	No	P
Male	48	77		2	123		3	122		72	53	
	(38.4)	(61.6)		(1.6)	(98.4)		(2.4)	(97.6)		(57.6)	(42.4)	
			0.51			0.018			0.076			0.016
Female	53	72		10	115		9	116		53	72	
	(57.6)	(42.4)		(8)	(92)		(7.2)	(92.8)		(42.4)	(57.6)	

Chi-square test

Table 4. Comparing the frequency of condylar morphology between age groups

Variable	Bird beak	Diamond	Crooked finger	Oval
	N (%)	N (%)	N (%)	N (%)

Age Group	Yes	No	P	Yes	No	P	Yes	No	P	Yes	No	P
Group 1	42 (47.7)	46 (52.3)	0.105	0 (0)	88 (100)	0.010	1 (1.1)	87 (98.9)	0.061	45 (51.1)	43 (48.9)	0.895
Group 2 & 3	59 (36.4)	103 (63.6)		12 (7.4)	150 (92.6)		11 (6.8)	151 (93.2)		80 (49.4)	82 (50.6)	
Group 2	53 (43.1)	70 (56.9)	0.440	4 (3.3)	119 (96.7)	0.377	11 (8.9)	112 (91.1)	0.002	55 (44.7)	68 (55.3)	0.129
Group 1 & 3	48 (37.8)	79 (62.2)		8 (6.3)	119 (93.7)		1 (0.8)	126 (99.2)		70 (55.1)	57 (44.9)	
Group 3	6 (15.4)	33 (84.6)	0.001	8 (20.5)	31 (79.5)	0.001	0 (0)	39 (100)	0.223	25 (64.1)	14 (35.9)	0.080
Group 1 & 2	95 (45)	116 (55)		4 (1.9)	207 (98.1)		12 (5.7)	199 (94.3)		100 (47.4)	111 (52.6)	

Group 1: 18-35 years old, Group 2: 36-55 years old, Group 3: 56 or above; Chi-square test

DISCUSSION

The morphological appearances of mandibular condyle have great variation among different age groups and subjects [12, 13]. Normally we recognize five basic shapes i.e. Oval, Bird beak, crooked finger, diamond and mixed. In Pakistan, limited data is available regarding the morphological appearance of the condyle. Therefore present study highlights the prevalent radiographic shapes of the condylar head-on OPG. Out of 250 pair of condylar heads that were evaluated, 50% were oval, 40% bird beak, 4.8% crooked finger and diamond 4.8%. In our study, the oval condylar morphology was most common and significantly higher among male individuals (see table 3). The studies reported by Choudhary et al [14] and Ribeiro et al.[15] pertaining to the Brazilian and East Indian population respectively had shown that round/oval shape to be common in both the sexes which goes in accordance with our study.

The morphological knowledge of the temporomandibular joint (TMJ) is an important tool for evaluation of normal growth and development. This may also be helpful in the near future for the development of forensic odontology [4, 11, 14]. The growth of mandibular condyle is

indicated in an upward and backward direction. It is considered as major areas of facial growth. The appearance and the shape of mandibular condyle vary enormously among individuals and different age groups which is in accordance to present study [1, 7, 10].

In present study on the radiological examination using OPG reveals flat, pointed, angled and round condylar morphology. Similarly several other studies also showed the Bird beak, Oval, Diamond, and Crooked finger type condylar morphology [16, 17,18]. In our study the second most common condylar morphology observed was bird beak. The frequency of bird beak condylar morphology was higher among females as compared to males. However, no statistically significant difference was observed when both genders were compared (see table 3). Similarly, the Sonal 2016 also reported the bird beak as a second most common condylar morphology among females [19]. On the other hand, the diamond and crooked finger morphology were a rarity [17, 20].

We compare the participant age with the condylar morphology. However, to our knowledge, no such data is reported in previous studies thus a comparison is not possible. The diamond shape condyles were significantly higher among participants of age group 3 as compared to other age groups (see table 4). The frequency of crooked finger condyles was significantly higher among participants of age group 2 (See table 4). The frequency of bird beak condyles was significantly higher among group 1 and 2 as compared to group 3 (see table 4).

In comparison of our results, several other studies investigated that it is very important to evaluate condyle morphology with changes in condyle surface shapes, radiological dimensional measurements with malocclusion. A study reported that there was a significant relation between open bite and erosion of the head of the condyle. Ari-Demirkaya et al. [21] found that there was no difference between open, deep or normal bite groups in subjects with different condylar morphology.

Currently, various advanced radiographic modalities are available such as CT scan, cone beam volumetric imaging, which can give detailed information of the condyle. However, oral health practitioners usually prefer Orthopantomograph (OPG) to screen temporomandibular joints. The possible explanation due to which oral health practitioners still prefers OPG include favourable cost-benefit relationship, low doses of radiation exposure, ease of prescription and lack of image superimposition [12, 15, 20]. The use of Orthopantomograph (OPG) has its

limitations such as a 2-dimensional view. In addition to that, the limitations of this study include small sample size and lack of examiner reliability.

CONCLUSIONS

In conclusion, all four morphological types of mandibular condyles were observed and the oval shape condyles were most prevalent among both genders and all age groups. In future studies, the inclusion of other parameters and large sample size may provide unique information.

Conflict of interest

The authors declare that there is no conflict of interest.

Ethical approval

All procedures performed in studies were by the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments.

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