



Age-related mandibular condyle morphological variations: a panoramic radiography study at RSGMP Universitas Airlangga

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ABSTRACT

Objectives: This research aims to find out the variations of the mandibular condyle shape based on age on panoramic radiography.

Materials and Methods: This study uses secondary data from 200 digital panoramic radiographs of patients at the dental hospital (RSGM) of Universitas Airlangga aged 20-65 years in 2019, 2020, and 2021, which have met the inclusion and exclusion criteria. Data is presented in the form of tables and graphs with simple statistical calculations, and reliability tests were carried out with intraclass correlation (ICC) methods using SPSS.

Results: There are variations of the condyle shape in five age groups, the age I (20-25 Years), age II (26-35 years), age III (36-45 years), age IV (46-55 years), age V (56-65 years).

Conclusion: There are condyle shape variabilities in several age groups. In age I (20-25 years), age II (26-35 years), age III (36-45 years), and age IV (46-55 years) the most variation of the condyle shape is rounded, at age V (56-65 years) the most variation of the condyle shape is rounded and pointed. Furthermore, the morphology of the condylar structures may exhibit variances and are not consistently uniform.

Keywords: Mandibular condyle shape, panoramic radiography, age

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INTRODUCTION

Temporomandibular Joint (TMJ) has unique and complex anatomical and functional features among the joints of the human body.¹ TMJ is a ginglymoid-diarthrodial joint consisting of the glenoid fossa, condyle, and articular disk enclosed in a fibrous capsule. These joints are stabilized by the temporomandibular and sphenomandibular ligaments.² TMJ plays a role in providing smooth and efficient movement of mandible during chewing, swallowing, and speech as well as providing stability to the mandible position as well as preventing dislocation of outside forces.³ The condyle is a special part of the TMJ because it expressed the picture of mandible growth.⁴

There are several opinions in categorizing the shape of mandibular condyle, condyle can be categorized into five basic shapes: Flattened, convex, angled, rounded, and concave.⁵ Meanwhile, condyle shape is divided into four categorized: flattened, pointed, angled, rounded.⁴ Condyle morphology varies greatly among different age groups and individuals, there may even be significant differences between the left and right sides in the same individual.⁶ Normal variations of condyle morphology occur due to age, gender, facial type, occlusal force, functional load, and

malocclusion.³ Morphological shape alterations can occur based on simple developmental variability, and remodeling of the condyle head to accommodate developmental variations, malocclusion, trauma, as well as other developmental and disease disorders.³

Age is one of the factors which plays an important role in condyle variation. The condyle undergoes a remodeling process in response to continuous stimulation from childhood to adulthood that can affect its shape and volume. As we grow, the condyle also increases in size, the anteversion angle decreases, and the shape changes from round to oval. According to Ishibashi et al.⁷ Mandibular condyle growth ceases around the age of 20. But although the condyle size ceases after age 20, the specific size tends to show a gradual decrease, especially after the fifth decade. The statement was also supported by Nurfaidah,⁸ who stated changes in the prevalence of the condyle head morphology assessed by panoramic radiograph images were found to be relatively lower in subjects between the ages of 20-40 compared to those over 40 years of age. In adulthood, the condyle will more often undergo the remodeling process due to functional load.

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Panoramic radiography is a commonly utilized radiographic technique in the study of condyle morphology due to its low radiation dose and affordability. Panoramic imaging techniques provide an overview of the entire structure of the teeth and jaw support tissue, including the condyle. Panoramic radiography has also been used in several studies to determine condyle asymmetry.⁹

Research on the condyle head in the TMJ needs to be done because condyle shape variability can cause difficulties in dentists in interpreting the radiographs images.¹⁰ A comprehensive understanding of the TMJ anatomy and morphology especially condyle is essential, therefore variations of normal conditions can be distinguished from abnormal conditions.³ Based on the above description, the authors are encouraged to research variations of the condyle shape in the age range of 20-65 years, based on data on age grouping according to the Indonesian Ministry of Health/Depkes RI (2009) age groups divided into five categories, namely late adolescence (20-25 years), early adults (26-35 years), late adulthood (36-45 years), early elderly (46-55 years), and late elderly (56-65 years), This research was conducted using panoramic radiography and took place at RSGMP Universitas Airlangga because until now there is still no research that discusses the variation of condyle shape based on age at the dental hospital (RSGMP) Universitas Airlangga.

This study aimed to find out the variation of the condyle shape based on age with panoramic radiography in patients at Universitas Airlangga dental hospital (RSGMP). With the presentation of the results of this study, it is expected that the authors can provide a percentage of the variation in the shape of condyle based on age.

MATERIALS AND METHODS

This is descriptive observational research using secondary data of 200 panoramic digital radiographs images of patients at dental hospital (RSKGM-P) Universitas Airlangga in 2019-2021. This research was done by visual means that observation of panoramic radiographs focused on the condyle shape in the right and the left side. All radiographic images were taken with Instrumentarium OC 200 (Instrumentarium Dental PaloDex Group Oy, Finland) Xray unit which then exported in BMP or JPG format for evaluation. The sampling technique used is the purposive sampling method with inclusion and exclusion criteria. Inclusion criteria consist of male or female patients aged 20-65 years, panoramic radiography images meet quality evaluation. The exclusion criteria consist of a panoramic radiographs picture of a patient with a condyle fracture, panoramic radiographs of a patient with a history of TMJ surgery, panoramic radiographs of a patient with posterior tooth loss. This study uses descriptive data analysis whose results are presented in the form of tables and graphs with simple statistical calculations, in the form of modes or data that have the most frequency and often appear in each age group. Reliability tests use inter-observer measurements analyzed using intraclass correlation (ICC) in IBM SPSS version 23 (IBM Corporation, USA) to determine the consistency level of measurements.

Observations were carried out by 1 undergraduate researcher and 2 oral and maxillofacial radiologists for all radiographs and carried out directly without aids. The condyle is observed and then categorized according to the shape. Observers classified the condyle shapes into (A) rounded, (B) angled, (C) pointed, and (D) flattened as shown in Figure 1.

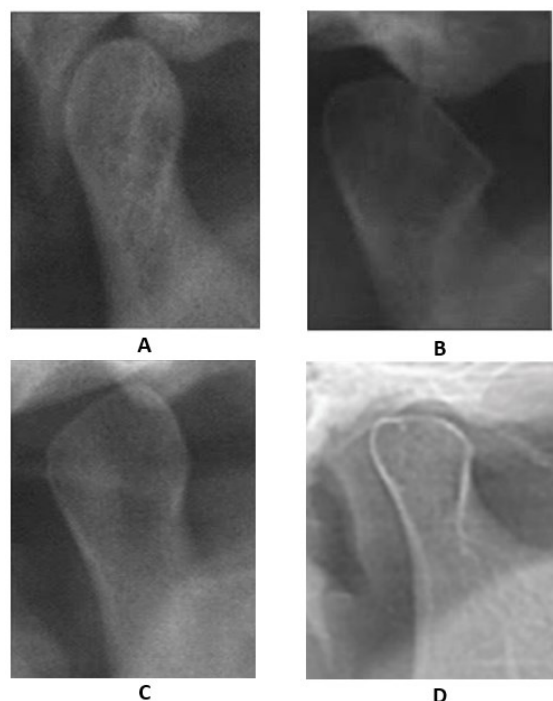


Figure 1. Variations of the condyle shape, (A) rounded, (B) angled, (C) pointed, and (D) flattened

RESULTS

From the measurements that have been done, the ICC value of the right condyle is 0.916, and for the left condyle is 0.899 which means that reliability is close to perfect (excellent reliability) as shown in Table 1.¹¹

In this study, the age group was divided into 5 categories based on the Depkes RI (2019), consisting of late adolescents (20- 25 years), early adults (26 - 35 years), late adults (36 - 45 years), early elders (46 - 55 years), and late elders (56-65 years). The number of used panoramic images is 200 images consisting of 98 male subjects and 102 female subjects.

The age group I with a total of 69 the sample consisted of 33% male and 36% female. From age group II, 33% of the sample was male and 29% of the sample was female. Of the age group III, 16% of the sample was male and 20% of the sample was female. Age group IV consisted of 10% of the male

sample and 12% female. Meanwhile, from the age group V, 8% of the sample was male and 3% of the sample was female (Table 2).

The distribution of condyle shape variations in the age group obtained a total of 400 conclusions from all the right and left sides of 200 subjects as shown in Table 3 and Figure 2. In the age group I (20-25 years), the most condyle variation found is rounded on the right side as much as 28%, while on the left side as much as 37%. The second most found form is the pointed on the left side as much as 15%, followed by the right side pointed as much as 14.5%. The third and fourth most numerous shapes in a row are angled by 7% each on both sides and flattened by 1% on each side. The most common distribution in age group II (26 - 35 years) is rounded on the left side at 27% and the right side at 25%. This followed by pointed 14.5% on each side and angled by 8% on both sides. The flattened shape was found to be more on the left side at 3% and the right side at 1%. Most

Table 1. Reliability test results

Condyle Shape	Intraclass Correlation (ICC)
Right Condyle	0,916
Left Condyle	0,899

Table 2. Data distribution by gender in each age group

Age	Man	Woman	Total
20-25 Years (I)	32 (33%)	37(36%)	69 (34,5%)
26-35 Years (II)	32 (33%)	30 (29%)	62 (31%)
36-45 Years (II)	16 (16%)	20 (20%)	36 (18%)
46-55 Years (IV)	10 (10%)	12 (12%)	22 (11%)
56-65 Years (V)	8 (8%)	3 (3%)	11 (5,5%)
Total	98 (100%)	102 (100%)	200 (100%)

Table 3. Distribution of variations of the mandibular condyle based on the age group

Age	Shape								Total
	Rounded		Pointed		Angled		Flattened		
	Right	Left	Right	Left	Right	Left	Right	Left	
20-25 Years (I)	38 (28%)	37 (27%)	20 (14%)	21 (15%)	10 (7%)	10 (7%)	1 (1%)	1 (1%)	138 (100%)
26-35 Years (II)	31 (25%)	33 (27%)	18 (14,5%)	18 (14,5%)	10 (8%)	10 (8%)	3 (2%)	1 (1%)	124 (100%)
36-45 Years (II)	21 (29%)	19 (26%)	8 (11%)	10 (14%)	6 (8%)	7 (10%)	1 (2%)	0 (0%)	72 (100%)
46-55 Years (IV)	11 (25%)	13 (30%)	5 (11%)	6 (14%)	4 (9%)	2 (4,5%)	2 (4,5%)	1 (2%)	44 (100%)
56-65 Years (V)	6 (27%)	3 (14%)	4 (18%)	5 (23%)	1 (4%)	3 (14%)	0 (0%)	0 (0%)	22 (100%)

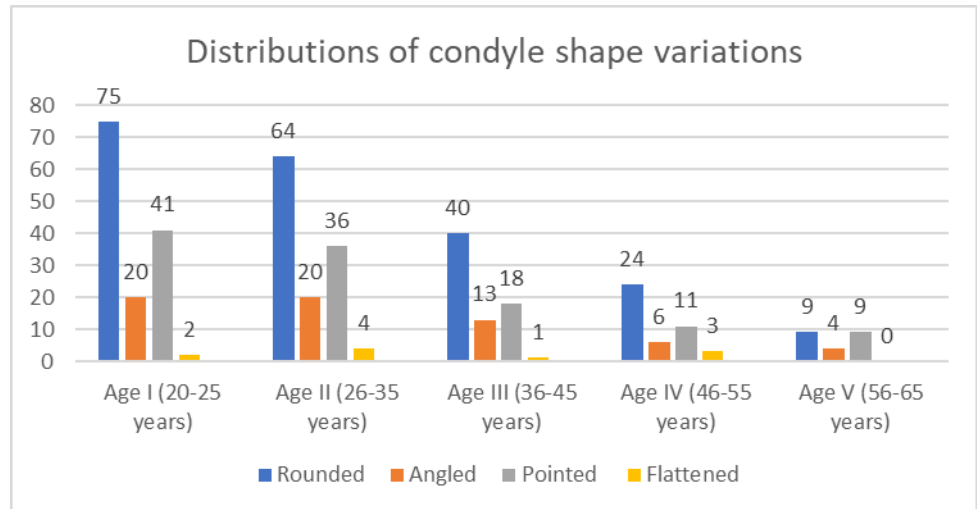


Figure 2. Distribution of the condyle shape variations

Table 4. The shape of both sides of the condyle

Condyle Shape	I (20-25 years)	II (26-35 years)	III (36-45 years)	IV (46-55 years)	V (56-65 years)	Total
Same	54 (78%)	42 (68%)	29 (81%)	14 (64%)	7 (67%)	146 (73%)
Different	15 (22%)	20 (32%)	7 (19%)	8 (36%)	4 (36%)	54 (27%)
Total	69(100%)	62(100%)	36(100%)	22(100%)	11(100%)	200(100%)

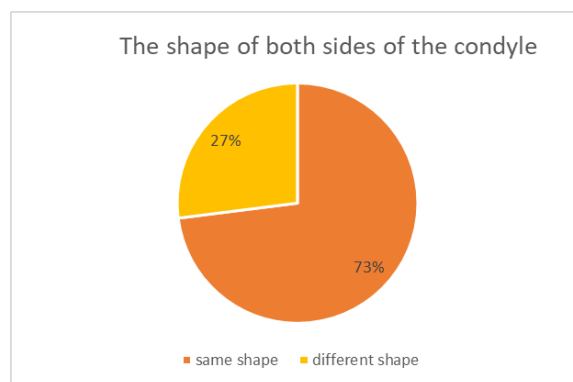


Figure 3. Diagram of the shapes on both sides of the condyle

found forms of the age group III (36 - 45 years) are rounded on the right side as much as 29% and the left side 26%; pointed on the left side as much as 14% and the right side 11%; angled on the left side 10% and the right side 8%; as well as flattened on the right side as much as 2% and on the left side no flattened shape is found. In the age group IV (46 - 55 years) sequentially the most condyle shape found is rounded on the left side as much as 30%, rounded in the right side is 25%; pointed in the left side is 14%, in the right side 11 %; angled in the right side is 9% and in the left side is 4.5%; and flattened in the right side is 4.5% and in the left side is 2%. The distribution of shapes in the last age groups (56 - 65 years) the most

widely found is rounded in the right side 27% and pointed in the left side 23%, pointed in the right side is 18%, rounded and angled in the left side is 14%, angled in the right side is 4%, and no flattened shape found on either side.

In this observation, was also found that the mandibular condyle has different shapes on both sides (Table 4 and Figure 3). In the age group I (20-25 years), condyle with the same shape on both sides found as many as 54 subjects (78%) and different shapes as many as 15 subjects (22%). Condyle shapes on both sides of the same mandible in age group II (26 - 35 years) were found as many as 42 subjects (68%) and different shapes 20 subjects (32%). In the age group III (36 - 45

years), found the same of the condyle shapes as many as 29 subjects (81%) and the different shapes as many as 7 (19%). Furthermore, in the age group IV (46 - 55 years), the same condyle in one mandible was as many as 14 subjects (64%) and a different condyle as many as 8 subjects (36%). Lastly, in the age group V (55 - 65 years) found as many as 7 subjects (67%) had the same shape and 4 subjects (36%) had different condyle shapes.

DISCUSSION

This study was conducted using secondary data in the form of 200 panoramic digital radiographs images in 2019, 2020, 2021 at the UPF Radiology of Airlangga University by observing the shape of mandibular condyle by three observers, the goal is to equalize perception and find out the variation of the condyle head shape in several age groups. The observed data has been tested reliability and showed excellent results or showed consistent measurement results even though it was done by 3 different observers.

Based on the results of this condyle head variations observation, it was obtained the results that the condyle head shape is varied in each age group. Mathew et al.¹ stated that condyle shape variations can occur because the adaptive or degenerative changes in TMJ occur for a long time and continuously. TMJ, especially the condyle will continue to receive functional loads during life. Differences in the mandibular condyle morphology are observed as a consequence of occlusal force intensity. Patients with lower occlusal force have lower pressure on the mandibular condyle surface during the mastication process, therefore, the significant difference from patients with higher occlusal force appears primarily in the lateral and posterior directions, a person who has high occlusal pressure has a larger or more rounded condyle shape on the lateral and posterior sides than others with lower occlusal force.⁸

The results of observations in the Age I group (20-25 years) and age group II (26-35 years) are most rounded, this is in line with Oliveira et al.¹² which states that the rounded shape is also the most common shape found at a young age around 20-40 years. This can be because at a young age still do not too often receive the heavy functional load of mastication so rarely experience the condyle alignment or eroded bone. Studies of condyle development also stated that the initial condyle shape was convex along the surface that received force, was wider in the mediolateral dimension, and had an oval shape in the anteroposterior, the statement refers to the rounded shape. It is also evident from the results of research obtained that flattened forms are only found as many as 2 condyles out of 138 condyles in the age group I (20-25 years) and 4 condyles of 124 condyles in age group II (26-35 years). There is an increase in the number of flattened shapes in these two age groups following the results of Nurfaidah⁸ which shows

that flattened shapes tend to be found with age, flattened shapes in patients without symptoms can be used as suspected pathological or abnormal symptoms.

Observations in age group III (36-45 years) and age group IV (46-55 years) also still show that rounded shapes are the most found shape variation followed by pointed and angled, but in age group IV (46-55 years) the number of variations in flattened shapes increases when compared to the number in age group III (36-45 years). This is in line with the opinion of Mathew et al.¹ who said that TMJ is expected to maintain its capacity for remodeling after growth ceases and continues to change its structure and morphology. This results in the erosion of the convex joint surface, this alignment is effective for distributing force over larger surface areas.¹¹ The statement is also supported by Rozylo-Kalinowska and Orhan.¹³ As we age, the condyle becomes flatter, the capsule becomes thicker, the structure of the disc changes, and sometimes osteoporosis is also seen in the bones below.

The distribution of variations in the condyle shape in age group V (56-65 years) shows the same number between variations in rounded and pointed shapes, followed by angled shapes. Variations in rounded shape are still found in the age group V this can be because the subject can maintain the condition of his teeth well so that the teeth are still intact and nothing is lost. However, in this age group, no flattened shape was found. This leads to a lack of appropriate previous statements which say that as you age, the flatter the condyle will tend to be flattened. The possibility of teeth loss at this age should also be accompanied by an increase in physiological activity that continues to occur. This condition can be due to the limited number of panoramic radiographs images of patients in the age group V that authors get.

The study also observed condyle shape variations on both sides of the right and left patient's jaws. From the results obtained as many as 146 patients have the same condyle shape in both jaws, while the remaining 54 patients have different shapes on the right and left sides of the condyle. This is in a statement by Song et al.⁶ which says that in the same individual there may be a difference in the condyle shape between the left and right sides. The right condyles show a higher volume than the left condyle, the male condyle shows a higher volume when compared to women.¹⁴

This is commonly called condyle asymmetry. Condyle asymmetry is a common condition that does not necessarily describe a pathological state, but the asymmetry of the condyle can be one of the risk factors that cause and indicate the presence of TMD. This condition is more commonly found in individuals with unilateral chewing preferences than individuals with bilateral chewing preferences. Condyle asymmetry is also associated with the absence of teeth, tooth abrasion, premature contact of occlusal, functional deviation of mandibles, unilateral posterior

crossbites, and dentoskeletal asymmetry. Further panoramic radiographs observations are necessary as a preliminary examination to detect whether there are changes in the bone structure around the conclusion or not.¹⁵

The results of the study described above have similarities with the results of the study Singh et al.⁴ which in his research observed condyle shape variations of 350 subjects. His research found the most condyle shape variation is rounded as much as 57%, then followed by pointed 29%, angled 10%, and the least is flattened 4%. Sahithi et al.,(2016) also explained that the most widely appeared condyle shape variations are rounded as much as (39.25%), but there is a difference from the second most angled form variation of (35.5%). Based on the research of Singh et al.,(2020) also found the conformity of results regarding the condyle form that is not always the same on both sides, which is as much as 18.6%, while the same shape on both sides remains more at 81.4%.

During this study, there are several limitations in this study, including the limited number of studies that discuss condyle head variations. In addition, panoramic radiograph images may occur biases that can make condyle shape observations result ambiguous, and condyle shape observations visually directly with the eye without the use of tools susceptible to subjectivity because the perception of each person when interpreting the condyle shape may be different.

CONCLUSION

There are variations in the form of the condyle in some age groups. The most significant variation in the form of the I age (20-25 years), age II (26-35 years), age III (36-45 years), age IV (46-55 years) is rounded. The most variation in the form of the conclusion in the age group V (56-65 years) is rounded and pointed. Furthermore, the symmetry of condylar morphology between the right and left sides may exhibit variances.

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FOOTNOTES

All authors have no potential conflict of interest to declare for this article. All procedures conducted were in accordance with the ethical standards.

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