



THE THICKNESS AND DENSITY OF PAWON MAN MANDIBLE BODY CORTICAL BONE AND ALVEOLAR USING CONE BEAM COMPUTED TOMOGRAPHY (CBCT)

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ABSTRACT

Introduction: Pawon Man is prehistoric human that found from the archaeological excavation done in Pawon Cavethat lies in the highlands of Northern Bandung, whose live around 5600 up to 9500 years ago, in the era which human survived by hunting and gathering simple type of food (Mesolithic era). Description of prehistoric life can be revealed partly through jaw structure. The objective of this study was to reveal the culture of Pawon Man culture through the image of mandibular cortical bone thickness and density as a function of the masticating load byusing Cone Beam Computed Tomography (CBCT) maxillofacial 3D imaging applications.

Methods: Descriptive research with samplesconsisted of CBCT 3D radiographic images of Pawon Man mandible with Ez Implant programby using three-dimensional aspect (axial, coronal and sagittal).

Results: In the mandible, the average of thickness and density of cortical bone in the mandibular corpus were as follows: cortical bone thickness was 3.43 mm; with. The average of density was 1042.26 pv, mean while thickness ofthe alveolar crest cortical bone was 0.89 mm and the density was 995.45 pv.

Conclusions: The thickness and density in the aspect of cortical mandible and alveolar crest of Pawon Man was larger than modern man.

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INTRODUCTION

Pawon man skeleton was found inside the cave which located about 716 m above the sea surface in Mount Masigit that was part of the formation of Rajamandala limestone. Pawon Cave excavation that was conducted by Pawon Cave Prehistoric Research Team, which headed by one of the main researcher of Bandung Archeology Center Lutfi Yondri, frequently done every year since the discovery of intact prehistoric human skeleton in folded condition on the period of 2003-2004. Then on July 22 – August 4, 2013, Bandung Archeology Center continued the advance excavation and found another prehistoric human skeleton which aged much older than the

age of the intact skeleton found on the period of 2003-2004, estimated about 9500 years old (Kompas, 2013). This findings indicated the existence of quite comprehensive prehistoric life inside the cave. Pawon Man was collecting food, farming, and hunting on the modest level. The excavations also found life-tools made of bones, fragments of animal bones, shells of mollusks, and human grave. Most of the obsidian artifacts was found at a depth of 20 cm to 150 cm. Chronologically, the age of the obsidian artifacts ranged between 5600 to 9500 years (Yondri, 2004, 2005). The Pawon Cave consists mostly from limestone (Sujatmiko, 1972, 2004). Bandung Archeology Center has conducted six excavations inside the cave, one of them was done along with West Java Management Center of Archaeological Heritage, History and Traditional Values on the period of 2003-2004, which resulted in the discovery of

many artifacts such as obsidian tools that was made of obsidian stones. Through dental radiology that specializes in the structure of oral and maxillofacial (Stavrianos *et al.*, 2009), this prehistoric human skeleton findings can be identified despite the incomplete condition of the skeleton, because skull and teeth were able to be used as the alternative identification material (Anuthama *et al.*, 2010). From the skeleton also found the jaw that reveals the culture related, such as life-habits associated with the jaw which was dietary habit. Dietary habitable to affects the microstructure and macrostructure of Pawon Manjaw cortical bone. The uniqueness of the cortical bone is its nature of forming external portion of the bones that contains calcified dense tissue with higher density than the trabecular bone. Approximately 80-90% of cortical bone volume consisting of calcium, whilst the trabecular bone consists only 15-25% calcium from the whole volume. With such density, we are able to reveal the load received, eating habit, dietary, food type, form of food and food processing (Khan *et al.*, 2001). The research objective was to reveal Pawon Man culture through the image of thickness and density of mandibular cortical bone and alveolar crest as a function masticating load by using Cone Beam Computed Tomography (CBCT) maxillofacial 3D imaging applications.

MATERIALS AND METHODS

After obtaining permission from the Head of Bandung Archeology Center, the sampling was done by using availability sampling methods that taken all samples available from all population (Daniel, 2012) which were all secondary data from full 3D CBCT image of Pawon Man mandible. Samples obtained from three archives of 3D CBCT radiographic image as shown in Figure 1.

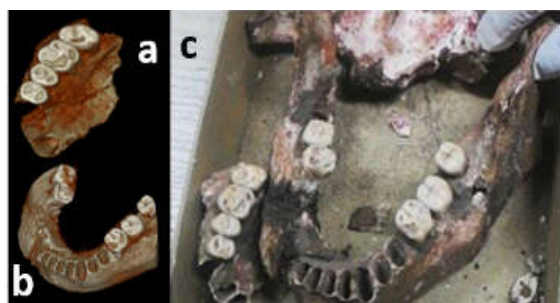


Figure 1. Pawon Man mandibular jaws (a, b, and c)

The measurement of thickness and density of mandibular body cortical bone and alveolar crest was done on the axial, coronal, and sagittal aspects by using 3D CBCT Ez Implant program (Figure 2).



Figure 2. CBCT Ez Implant program Measure menu (Coronal, Sagittal and Axial aspect)

The measurement of thickness and density of mandibular body cortical and alveolar crest was done in predetermined region between the teeth as follows:

Mandible of Pawon Man (a, b and c) in the region of: 37-38; 36-37; and 46-47. Ez Implant application was measuring cortical thickness and density by using the Profile feature on the Measure menu. When the position and distance was right, then left-clicked for one time and a graph will popped-up and showed the size of the cortical bone thickness and density.

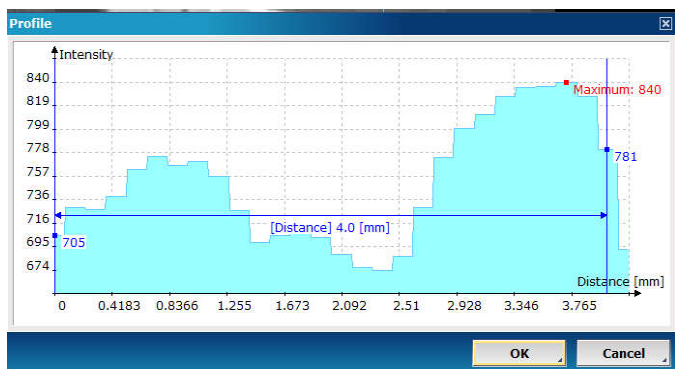


Figure 3. Graphic of Profile showed the thickness (distance) and density (intensity)

RESULTS

The measurement towards three part of mandibular corpus part in three aspects, which were axial, coronal and sagittal resulted as shown in Table 1.

Table 1. The average thickness of mandibular corpus cortical bone

No.	Samples	Aspect per jaw average		
		A	C	S
1	Pawon Man a Mandible	3.53	3.67	5.60
2	Pawon Man b Mandible	4.75	3.53	4.50
3	Pawon Man c Mandible	1.63	1.80	1.85
Overall aspect average		3.30	3.00	3.98
Mandibular corpus cortical bone thickness average (mm)		3.43		

Description: A = Axial aspects, C = Coronal aspects, S = Sagittal aspects

The measurements of alveolar crest cortical bone towards four parts of Pawon Man mandibular jaw in coronal and sagittal aspects resulted as shown in Table 2.

Table 2. The average thickness of mandibular alveolar crest cortical bone

No.	Samples	Aspect per jaw average		
		A	C	S
1	Pawon Man a Mandible	-	0.78	0.82
2	Pawon Man b Mandible	-	1.00	0.80
3	Pawon Man c Mandible	-	1.20	0.77
Overall aspect average		-	0.99	0.80
Mandibular alveolar crest cortical bone thickness average (mm)				0.89

After the thickness of mandibular cortical bone and alveolar crest were measured, then each density was measured with the unit pixel value as shown in Table 3.

Table 3. The average density of Pawon Man mandibular corpus cortical bone

No.	Samples	Aspect per jaw average		
		A	C	S
1	Pawon Man a Mandible	970.92	897.63	870.83
2	Pawon Man b Mandible	1316.50	1308.75	1262.63
3	Pawon Man c Mandible	916.00	953.83	883.25
Overall aspect average		1067.81	1053.40	1005.57
Mandibular corpus cortical bone density average (pv)				1042.26

pv = pixel value

Density average value in all mandibular body cortical region was almost the same which was 1042.26 pv. After that, the measurement was done in the alveolar crest which resulted as shown in Table 4.

Table 4. The average density of Pawon Man mandibular alveolar crest cortical bone

No.	Samples	Aspect per jaw average		
		A	C	S
1	Pawon Man a Mandible	-	1116.92	1140.67
2	Pawon Man b Mandible	-	1299.40	933.40
3	Pawon Man c Mandible	-	861.30	621.00
Overall aspect average		-	1092.54	898.36
Mandibular alveolar crest cortical bone density average (pv)				995.45

pv = pixel value

The cortical bone of alveolar crest had relatively lower density than the cortical bone of mandibular body.

DISCUSSION

Pawon Man has a large, thick, and solid jaw because allegedly often eat hard and rough textured food due to very modest food processing. Bandung Archeology Center was doing the excavation at Pawon Cave and found some tools that prove the allegation. Such tools were made of stones in the form of rock shale and hitting tools, and also bone-made tools in the form of bone taper and spatula. Pawon Man was processing food with such modest tools. Bandung Archeology Center was also found the remaining fragments of mollusks shells, and the remains of vertebrate animals. The most often consumed food by Pawon Man was likely derived from the group of freshwater mollusks, mammals, reptiles, and poultries (Yondri, 2005). Based on the results of excavations conducted during the period of 2003 and 2004, Bandung Archeology Center did not find any food storage, so there was a strong presumption that Pawon Man used to directly consuming the catch. In the mandible, the average thickness of mandibular corpus cortical bone in sagittal aspect was 3.95 mm with density average of 1042.26 pv, whilst the average thickness of alveolar crest cortical bone was 0.89 mm with density average of

995.45 pv. The result from this study indicated that Pawon Man mandible has higher masticating load than modern human mandible. The measurement results of Pawon Man maxillary showed that the highest thickness value of the cortical bone was in the region between Molar Tooth 1 and Molar Tooth 2, with thickness average of 1.29 mm and density average of 887.80 pv, whilst the highest thickness value of mandibular cortical bone was in the region between Premolar Tooth 2 and Premolar Tooth 1, with thickness average of 2.61 mm and density average of 999.22 pv. The result from this study indicated that Pawon Man was more accustomed using the posterior region of the teeth on masticating. The thickness of Pawon Man mandibular cortical was higher than modern human. In Taguchi (1997) and Sylvia (2011) research stated that the thickness of mandibular cortical of Asian people described using panoramic radiograph image was 2.8 mm, whilst European was 3.0 mm (sagittal aspect). From Epsilawati and Azhari (2014) research at Universitas Padjadjaran Dental Hospital Bandung found that the thickness of mandibular cortical bone of modern human was approximately 2.54 mm, whilst the Pawon Man was approximately 3.43 mm. Difference value at 25 % was a considerable value. This thickness difference indicated that Pawon Man having a different dietary habit from modern human, because of the habit of eating raw food required wider jaw movement with heavier pressure to soften the food. Large loads will affect the development and growth of the macro and micro structure of internal jaw. Mitchel (2001) stated that genetic factors and adaptation process towards environment able to affected the growth and development of macro and micro structure of human body, especially the jaw part. According to Tortora and Derrickson (2011), mandible was the only moving facial bones, the strongest and largest facial bone part which was having close links with masticatory muscles that affected the growth and development of the jaw structure itself. Masticating load of masticatory muscles was affected by the nature and texture of food as the environmental factors. Dixon and Sarnat (1982) revealed that there were local and general environmental factors that controlled bone growth in the skull including the jaw. Local environmental factors included the compressive force and muscle tension, whilst the general environmental factors generally was the food type, oxygen supply, and others. Dixon *et al.* (1997) added that the degree of the masticatory muscles and teeth development was able to modify the shape of the skull through the development of a sagittal crest, the size of mandibular ramus, as well as the thickness of cortical bone. All of these conditions were contributed towards the strength and the size of jaw. This theory proved that the muscle development able to affected the thickness of the jaw cortical bone. The adaptation process done by human continuously would becoming a habit or culture that can affected human physical evolution (Yunita, 1999), which in this study was the process of hard and rough-textured food mastication. The weakness of this study was incomplete part of Pawon Man jaw, which was not as intact as all integral part of the skeleton, and also the condition of Pawon Man jaw which was already fragile with many loss of bone part and teeth.

Conclusion

The mandible of Pawon Man was having the same number of teeth until M3, with the thickness of cortical in sagittal aspect larger than modern humans, and more coarse and dense alveolar crest structure.

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