



# Analysis of the panoramic radiographic density of the mandibular bone in the elderly due to increased cortisol levels

Noor Rachmawati<sup>1\*</sup>, Ria Noerianingsih Firman<sup>2</sup>,  
Lusi Epsilawati<sup>2</sup> , Merry Annisa Damayanti<sup>2</sup>

## ABSTRACT

**Objectives:** Mandibular bone is generally formed by intramembranous ossification. Bone density mandible can be assessed from the trabecular pattern. In the elderly, the hormone cortisol affects bone formation through bone resorption by blocking calcium. The purpose of this study was to determine the correlation of cortisol levels to mandibular bone density in elderly women and men.

**Materials and Methods:** This study was an analytic survey, where the population was determined from secondary patient data in the form of 31 panoramic radiographs and 31 laboratory results of cortisol examination, the research sample was divided into two groups. The bone density of the mandible was assessed from the trabeculae of the neck condyles region of the right and left. Density assessment

using the ImageJ software program on panoramic radiographs was an examination that is often done in dentistry.

**Results:** This study showed that the lowest density was in the group of women over 60 years. The results of the t-test with the independent sample obtained a p-value of > 0.05, which indicated there is no significant difference. The negative correlation value indicated that the relationship that occurs is opposite, p-value <0.05 which indicated the lower bone density, the higher cortisol level.

**Conclusion:** Based on the results of the study, there was a correlation that with the increasing age of both women and men there was an increase in cortisol levels and a decrease in mandibular density.

**Keywords:** Radiographic density, elderly, cortisol levels

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## INTRODUCTION

Mandibular bone is one of the elements that make up the skeleton of the human skull. This bone is generally formed by intramembranous ossification.<sup>1</sup> Bone density measured in units of area or volume.<sup>2,3</sup> Bone density in the mandible can be assessed from the trabecular pattern.<sup>3</sup> Trabeculae are considered to play an important role in imaging on radiographs, and loss of trabeculae can cause decreased density on the radiograph. One of the modalities used to see changes in the trabeculae is a panoramic radiograph.<sup>4</sup>

Panoramic radiograph is an imaging technique that is often used to evaluate the entire tooth as well as the jawbone. Several studies use panoramic radiographs of teeth to assess bone quality in the form of changes in density that can be influenced by certain systemic conditions. One of the systemic conditions is cortisol levels.<sup>5,6,7</sup> Physical aging process, according to biological theory, can occur due to many factors, through changes in organ function and structure. Naturally, the human body always maintains the balance of the body and one of the triggers for the imbalance, namely changes in cortisol levels.<sup>8,9</sup> Cortisol (11beta, 17alpha, 21-

trihydroxy-4-pregnene-3,20-dione) is a steroid hormone from the glucocorticoid group produced by the human body. Cells in the zona fasciculata of the adrenal glands in response to stimulation of the hormone ACTH secreted by the pituitary gland, and corticotropin-releasing hormone (CRH) corticoliberin secreted by the hypothalamus. The hormone cortisol affects bone formation through bone resorption by blocking calcium from entering the intestine. Although there is no direct analysis, the analysis of its effect on bone is very real. This is believed to be the cause of decreased bone density.<sup>10,11</sup>

There are several ways to determine the quality and quantity of the jawbone, including radiomorphometric indexes, Fractal Dimension Analysis, Densitometric analysis, Dual Energy X-Ray Absorptiometry (DEXA).<sup>10</sup> One of the modalities that can be used to measure bone quality is using panoramic radiographs. Examination with panoramic radiographs can be done macrostructural examination for example by using several measurement indices such as the mandibular cortical index (MCI), mandibular cortical



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<sup>1</sup>General Hospital of Tangerang City, Tangerang, Indonesia 15117

<sup>2</sup>Department of Dentomaxillofacial Radiology, Faculty of Dentistry, Universitas Padjadjaran, Bandung, Indonesia 40132

\*Correspondence to:  
Noor Rachmawati  
✉ [rahma700131@gmail.com](mailto:rahma700131@gmail.com)

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thickness (MCT) and panoramic mandibular index (PMI) to identify the elderly by assessing bone mass density (BMD), as well as for microstructural examination can be done with the help of software Image J.<sup>11</sup> Areas that can be selected to see bone quality are in the head and neck areas of the right and left condyles, because these areas are relatively constant, and are not affected by local factors.<sup>12</sup> According to data above, cortisol level will increase in some older people and this situation could affected bone density. One of the bone density assessments could use panoramic radiograph which is commonly used by dentist. Dentists could interpret panoramic radiograph and presumed bone density in elderly related to treatment plan. The author interested to study the correlation of cortisol levels to mandibular bone density in elderly women and men.

## MATERIALS AND METHODS

This study was a correlation analytic study. The population and sample used are secondary radiographic data of elderly patients at the clinic of Prolanis Izatti and Dr. Nur, the sample selection is Consecutive Sampling.<sup>13</sup> Meanwhile, the radiographic examination was carried out at the General Ahmad Yani University General Hospital and laboratory examinations were carried out at the Prodia. Laboratory examinations were used to find out cortisol level in patient.

The size of the sample was determined by independent sample test formulation. The selected samples are all radiographs that included the following criteria: 1). Archive data for elderly women / men or aged over 50 years, 2). Archives of cortisol examination data in elderly women / men or aged over 50 years, 3). Archive of panoramic radiographs of patients aged 40 – 75 years, 4). Patient agree by filling in informed consent, 5). Panoramic radiographs had the requirements of quality standards, 6). The patient's statement has never been treated by a psychiatrist / psychologist. While the exclusion criteria are: 1). Archives of panoramic radiographs that have growth and development abnormalities, 2). Archives of panoramic radiographs that have lost all teeth, 3) Patient with systemic disease such as osteoporosis, diabetes mellitus, and chronic kidney failure. This research has been approved by the Health Research Ethics Committee, Universitas Padjadjaran, Bandung.



**Figure 1.** ROI determination points on the head and neck of the right and left condyles through panoramic radiographs

The variable in this study was mandibular bone density. The density of the panoramic radiograph of the mandible is the bone density value expressed in the degree of blackness of the panoramic radiograph, which is taken in the center of ROI (Region of interest) with an area of 50x50 pixels, in four areas, namely the head and neck of the condyle on both sides of the mandible as measured using software Image J (Figure 1). The ROI was determined by radiologist specialist. The ROI of head condyle determined in the center of head condyle. The ROI of the neck condyle determined by making imaginary line at deepest portion of the sigmoid notch line (sigmoid notch line), then runs parallels below to ramus with height the posterior molar (subcondylar area line). The ROI of the neck condyle is the center of the perpendicular two imaginary line between sigmoid notch line and subcondylar (caudal) area (black line in Figure 1). For each ROI then undergo a measurement process with filtering stages, a-Gaussian blur, save the BMP file, the filtered image results are then extracted to remove noise by clicking process, binary, make binary, erode and delete, the procedure is repeated 3 times by 3 oral and maxillofacial radiologists. Particle calculation by clicking analyze particle and summery. The value obtained is in the form of a percentage of the value of the particle area and the non-particle area.<sup>7,13</sup> Data have been measured then tested statistically with normality test to determine whether sample data has been drawn from a normally distributed population. Statistical t-test was used to determine if there is a significant difference between the means of two groups and how they are related. Last, correlation statistical analysis used to measure the strength of association between density and cortisol level variables and the direction of the relationship.

## RESULTS

The results from this study was in the form of data from measurements of radiographic density in the area of the head and neck of the condyle on both sides of the mandible in elderly patients and its relationship with cortisol levels. The results showed that the lowest density decrease was in the group of women over 60 years (18.03%), shown in Table 1. The results showed that elderly patients, both female and male, experienced increased cortisol levels, the highest cortisol levels in women aged over 60 years (8,725), shown in Table 2.

Data have been measured then tested for normality test and statistic test. The results of the sample normality test of each group showed a p-value > 0.05, this indicates that the data is normally distributed, shown in Table 3. The results of the t-test with the independent sample obtained a p-value of > 0.05, this value indicates that although there are differences in cortisol levels between women and men, there is no significant difference, as shown in Table 4. The correlation value obtained between the mandibular density value and cortisol levels was -0.747. The negative correlation value

**Table 1.** Mandibular Radiograph Density Value in Elderly Patients

VARIABLE	n	Head of Condyle		Neck of Condyle		Average density value (%)
		Right	Left	Right	Left	
Women 50 – 60 years	15	19,71	18,84	19,24	18,5	19,08
> 60 years	6	17,69	17,49	18,41	18,51	18,03
Men 50 – 60 years	3	19,74	20,11	19,26	18,83	19,48
> 60 years	7	17,79	18,66	18,66	18,97	18,57
<b>Total patient data</b>	<b>31</b>					

**Table 2.** Cortisol Levels in Elderly Patients

VARIABLE	n	Average cortisol level (µgr/dL)
Women 50 – 60 years	15	7,34
> 60 years	6	8,725
Men 50 – 60 years	3	7,6
> 60 years	7	8,31
<b>Total patient data</b>	<b>31</b>	

**Table 3.** Data Normality Test

RESULT OF NORMALITY TEST	Group			
	Women		Men	
	p-value	Distribution	p-value	Distribution
Cortisol Level	0.988	Normal	0.98	Normal
Density	0.641	Normal	0.894	Normal
Cortisol 50 – 60 years	0.981	Normal	0.859	Normal
Cortisol > 60 years	0.861	Normal	0.977	Normal
Density 50 - 60 years	0.538	Normal	0.909	Normal
Density > 60 years	0.400	Normal	0.591	Normal

**Table 4.** T-test Results for Increased Cortisol Levels in Elderly Patients

VARIABLE	t-test				p-value
	Women		Men		
	Mean	SD	Mean	SD	
Cortisol level 50 – 60 years	7.34	2.80	7.60	2.96	0.886
Cortisol level > 60 years	8.73	0.87	8.31	4.16	0.818

**Table 5.** Correlation Test Results between Mandibular Density Values and Cortisol Levels

VARIABLE	R	p-value	Conclusion
Correlation between density and cortisol levels	-0.747	0.000	Negative

indicates that the relationship that occurs is opposite, p-value <0.05 which indicates a significant/significant correlation, shown in Table 5.

## DISCUSSION

The study was conducted to determine the value of mandibular density, cortisol levels and to analyze the relationship between mandibular density values and cortisol levels in the elderly. Density assessment using the image J software program on panoramic radiographs is an examination that is often done in dentistry. Mandibular density values were calculated from panoramic radiographs using Image J software on the mandibular condyle head and neck area.

Image J software becomes the most common software to measure density because it was easy to used and obtained. Mandibular condylar cartilage is the center of greatest growth in the craniofacial, and associated with maxillofacial skeleton

morphogenesis and temporomandibular joint. The condylar process grows in a wide range of directions from anterosuperior to posterior, resulting in highly diverse mandibular growth and morphology.<sup>14</sup> Geiger (2016) measured bone density in jaws to evaluated healing processes using Image J software. The relative bone density was a quick, easy, cheap parameter and also a close to practice tool which could have various possible uses in dentistry.<sup>15</sup> Gunawan (2020) also measured bone density in panoramic radiographs using Image J software. Panoramic radiograph is a routine examination in dentistry that could use to assess changes quality of bone density.<sup>16</sup>

The criteria for elderly according to the Ministry of Health of the Republic of Indonesia are over 50 years of age including early age (50 – 64 years) and over 65 years.<sup>17</sup> The WHO meeting in Africa at the Harare MDS Workshop in 2000 decided that the chronological age that is said to be old age is 60 years, and in 2001 it was revised to 50 years considering the different conditions in each

country.<sup>17</sup>

The results of this study found that the lowest mandibular density value was in women aged > 60 years (18.03 %), the highest was in men aged 50 - 60 years (19.48%). The results showed that as the age increased, the mandibular density value decreased. Different test with independent sample t-test obtained p-value of > 0.05, between men and women did not show a significant difference. This study is in accordance with Fikri (2020) that average width and density of neck condyle of women's age more than 46 years seen decrease when compared with previous age group. The bone quality of women aged > 60 years in the condyle is significantly less compared to other age groups is a direct result of the loss of estrogen that occurs during menopause with increasing age. Loss of estrogen increases the rate of bone remodeling and causes an imbalance by prolonging the life of osteoclasts, while shortening the lifespan of osteoblasts, causing bone resorption consisting of loss of bone quality and quantity.<sup>18</sup> Cakur (2009) also studied that decreased of bone density can also occur in the neck of the condyle. The condyle consists of the head and neck of the condyle, mostly trabecular bone (98.6%) and only a small fraction of compact bone (1.4%).<sup>19</sup>

The results of the correlation test value of R-0.747 showed a significant correlation indicating a negative correlation. The higher cortisol levels caused a significant decrease in mandibular density value, p-value <0.05, this is in accordance with the Popoola (2016) study that the main effect of increasing blood cortisol in the body is a reduction in bone mineral density as a result of calcium loss through urine.<sup>20</sup> Hypercortisol triggers bone mineral resorption into free amino acids to be used as an energy source through gluconeogenesis. Cortisol exerts its effect by blocking calcium absorption which reduces bone cell growth.<sup>21</sup> Manthis (2013) also studied cortisol triggers bone mineral resorption (removal) to free amino acids for use as an energy source through gluconeogenesis and indirectly acted on bone by blocking calcium absorption which decreased bone cell growth. The disruption to serum calcium homeostasis increased bone resorption and reduced bone density.<sup>22</sup>

## CONCLUSION

According to the study's findings, there was a link between increasing age in both men and women and an increase in cortisol levels and a decrease in mandibular density.

## 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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