AGE-RELATED MORPHOLOGICAL AND MORPHOMETRIC CHANGES OF THE LOWER JAW AND THEIR INFLUENCE ON THE PHYSIOGNOMY OF THE LOWER THIRD OF THE FACE

Alma Voljevica[1]*, Elvira Talović[1]

[1] Department of Anatomy, Faculty of Medicine, University of Sarajevo, Sarajevo, Bosnia and Herzegovina

*Corresponding author

Alma Voljevica
Department of Anatomy
"Prof. Dr Hajrudin Hadžiselimović",
Faculty of Medicine,
University of Sarajevo,
Čekalusa 90,
71000 Sarajevo,
Bosnia and Herzegovina
E-mail: alma.voljevica@mf.unsa.ba
Tel: + 387 33 665 949/505
Fax: + 387 33 203 670

ABSTRACT

Knowledge of the dynamics of growth and postnatal changes of the mandible is of great importance when planning orthodontic procedures and procedures in the field of oral, maxillofacial and aesthetic surgery.

The aim of this study was to evaluate relationship between loss of teeth and morphological and morphometric changes in the mandible. For this purpose, 147 mandibles (100 with and 47 without teeth) selected from the osteological collection of the Department of Anatomy, Faculty of Medicine in Sarajevo were analyzed.

Morphometric measurements were performed using an vernier caliper and goniometer so as morphological analysis consisting of analysis of the trigonum mental shape.

The study showed that partial or total tooth loss in adulthood leads to changes in the shape and dimensions of the mandible reflecting in the appearance of the lower third of the face, and thus the entire physiognomy.

Keywords: morphometry, mandible morphology, face's lower third, aging.

Introduction

It is known that the morphological and morphometric characteristics of bones are primarily genetically determined, but their definite shape and dimensions are also influenced by a number of external factors [1,2]. The upper and lower jaws form the bony base of the oral cavity. Their morphological characteristics are conditioned by the basic function that the jaws perform, and that is chewing food. The development of the upper and lower jaw is a complex process that is significantly affected by the eruption and loss of teeth. Tooth loss contributes to a change in the entire physiognomy of the face because the loss causes a fall in the corners of the lips, wrinkles, loss of muscle tone and skin around the lips, which ultimately initiates changes in physical appearance.

The shape and size of the lower jaw (mandible) are of great importance for the appearance of the front of the head, primarily the shape and dimensions of the lower third of the face. The morphological and morphometric characteristics of the mandible changed during the phylogenetic development of the human species. Thus, according to certain morphological characteristics such as: protuberantia mentalis, angulus mentalis, angulus mandibulae, foramen mentale and foramen mandibulae, and the dimensions of the bone itself, the phylogenetic age of found osteological remains can be approximately determined.

The mandible changes dynamically during growth and development. The first changes are already visible during fetal development, when the reduction of the mandibular angle begins [3,4]. This is followed by postnatal changes resulting from the adjustment of the mandible to the action of masticatory muscle force and occlusion with the teeth of the upper jaw [5]. Once growth and development are complete, morphological and morphometric characteristics are fixed and do not change significantly until the moment of loss of a large number of teeth. Tooth loss causes partial resorption of the alveolar process and disappearance of occlusion, and the consequence of these processes is a re-increase in the mandibular angle and change the position of the mental opening located in old age closer to the upper edge of the bone body.

Changes in the oral cavity occur continuously and require constant repairs to reduce further damage and correct aesthetic and functional irregularities being the task of dentists, oral, maxillofacial and aesthetic surgeons. The success of any intervention depends on a good knowledge of the dynamics of facial changes caused by tooth loss. The aim of this study is to determine what are the morphological and morphometric changes that occur on the mandible after the loss of a large number of teeth.

Material and methods

147 preserved mandibles of adults of both sexes, selected from the osteological collection of the Department of Human Anatomy, Faculty of Medicine, University of Sarajevo, were used as material in this study.

The mandibles used in this study were divided into two groups. The first group (100 mandibles) consisted of mandibles with preserved teeth, aged 22 to 55 years, and the second group of mandibles (47 mandibles), which showed the loss of a large number of teeth or completely toothless mandibles, aged 56 to 74 years.

Morphometric measurements were performed using vernier caliper 0-1000mm, 0,05mm, Metric 530-502 (Mitutoyo Corporation, Japan), with an error of 0.01 mm, and a goniometer with an error of 0.5 °. For the goniometric method, we used one 360° scale (1°-increments) plastic UG with two 25-cm arms (3 M© Modular Shoulder System, 3 M©, St Paul, MN, USA).

The goniometer was used to obtain the value of two angles:

- mandibular angle - the angle that forms the lower edge of the body and the posterior edge of the ramus of the mandible (A),

- mental angle - the angle between the lines connecting the mental tubercle with the left and right anthropological point gonion (B).

A sliding caliper was used to obtain the values of the vertical and horizontal diameters of the mandible with and without teeth. The vertical diameters measured in this paper are:

- distance between the anthropological point of the gnathion and the interalveolar septum (C),
- distance between the foramen of the mental and the alveolar edge of the mandible (D),
- the distance between the foramen of the mental and the lower edge of the mandible (E),
- height of the mandible body - the length of the vertical that connects the alveolar extension (between the first and second molar tooth) with the lower edge of the mandible in the area of the foramen mental (F),
- maximum height of the ramus - the distance from the highest point on the mandibular condyle to the anthropogenic point of the gonion (G),

The horizontal diameters measured in this paper are:

- length of the mandibular body - the distance between the gnathion point (lowest symphysis point) and the gonion point (the point corresponding to the angle that builds the tangents drawn from the posterior edge of the ramus and the lower edge of the mandibular body) (H),
- distance between mental foramen of opposite sides (I),
- minimum width of the ramus - the minimum width of the ramus of the mandible measured perpendicular to the height of the ramus (J),
- maximum width of the ramus - the distance between the most prominent point on the front of the ramus and the line connecting the most prominent point of the condyle with the angle of the mandible (K), (**Figure 1**).

Specially designed forms were used to record the obtained results, and statistical data processing was performed using the statistical program SPSS version 21.0.

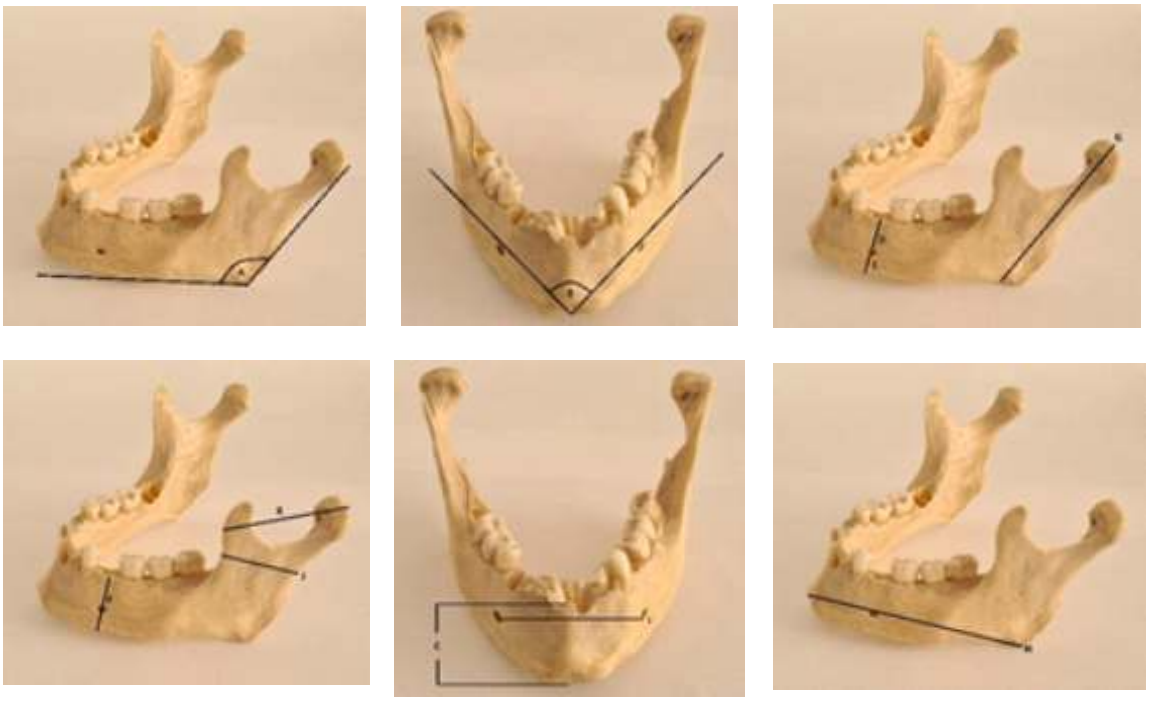

Figure 1. Mandible variables (A, B, C, D, E, F, G, H, I, J and K)

Morphological analysis in this paper referred to the analysis of the shape of the mental trigonum, and it consisted in registering the change in the size of the angle opposite the base of the triangle.

Results

The results of morphometric measurements on the mandibles with and without teeth are shown in the table. **Tables 1, 3 and 5** contain the results of measurements on the mandibles with teeth, and **Tables 2, 4 and 6** contain the results of measurements on the mandibles without teeth.

The analysis of the presented research results can state the following:

- due to tooth loss, the value of the mental angle changes significantly, i.e., it decreases by about 6.5 °, while changes in the value of the mandibular angle are statistically insignificant (Tables 1 and 2),
- all three diameters of mandibular body height are statistically significantly reduced with tooth

Table 1. Values of mandibular angles with teeth

	Mean value	SD	Min./Max.
Mandibular angle (A)	128.98°	±6.62	109°-146°
Mental angle (B)	61.96°	±7.90	41°-82°

Table 2. Values of mandibular angles without teeth

	Mean value	SD	T-test	P
Mandibular angle (A)	127.87°	±7.58	7.75	p > 0.05
Angulus mentalae (B)	55.56°	±7.15	0.14	p > 0.01

Table 3. Values of vertical dimensions of mandibles with teeth

	Mean value	SD	Min./Max.
Gnathion-interdental septum (C)	27.25	±4.55	7.8-39.5
Mental foramen - lower edge (D)	13.30	±1.67	7.8-17.7
Mental foramen - alveolar edge (E)	11.56	±3.92	0.01-19.9
Mandibular body height (F)	20.57	±3.91	10.8-28.9
Maximum ramus height (G)	58.74	±5.73	39.0-68.0

Table 4. Values of vertical diameters of mandibles without teeth

	Mean value	SD	T-test	P
Gnathion-interdental septum (C)	23.95	±4.86	6.52	p < 0.01
Mental foramen - lower edge (D)	12.91	±1.72	2.4	0.1 > p <0.05
Mental foramen - alveolar edge (E)	8.52	±3.67	7.74	p < 0.01
Mandibular body height (F)	17.58	±3.57	7.13	p < 0.01
Maximum ramus height (G)	58.56	±5.54	0.16	p > 0.05

Table 5. Values of horizontal diameters of mandibles with teeth

	Mean value	SD	Min./Max.
Mandibular corpus length (H)	84.21	±5.41	73.2-96.9
Distance between mental foramen (I)	43.48	±3.04	27.5-51.3
Minimum ramus width (J)	29.85	±3.75	18.0-38.9
Maximum ramus width (K)	35.29	±3.37	26.8-43.2

Table 6. Values of horizontal diameters of mandibles without teeth

	Mean value	SD	T-test	P
Mandibular corpus length (H)	83.77	±5.81	0.67	p > 0.05
Distance between mental foramen (I)	42.75	±3.93	2.86	p < 0.01
Minimum ramus width (J)	28.75	±4.27	2.61	p < 0.01
Maximum ramus width (K)	34.01	±3.87	2.91	p < 0.01

loss (diameters C, E and F) because the alveolar part of the bone is reduced, while the height of the mandibular ramus (diameter F) is not affected by tooth loss (Tables 3 and 4),

- loss of teeth does not lead to a statistically significant change in the length of the mandible (diameter H), but there is a significant reduction in its anterior width (diameter I),
- tooth loss also reduces the ramus of the mandible, i.e. its width and the distance between its processes (diameters J and K) are reduced, as presented in Tables 5 and 6,

Table 7. Influence of tooth loss on the shape of the trigonum mental

	Mental trigonum		
	Mandibles with teeth	Mandibles without teeth	
△	40	12	x^2=21.75
△	41	8	df = 2
△	19	27	p < 0.01

- tooth loss leads to a significant change in the shape of the mental trigonum, there is an increase in the angle opposite to the base of the triangle, as a result of which the chin becomes smaller and wider (**Table 7**).

Discussion

This study showed that the loss of the alveolar ridge had a statistically significant effect on the reduction of all analyzed vertical diameters of the mandible except for the height of the ramus of the mandible. The explanation lies in the fact that the alveolar ridge does not enter into the composition of the ramus of the mandible, and therefore cannot affect the values of its height. Similar results were noted by Merrot et al. In their study, they found that the reduction of vertical diameters causes a decrease in the width of the mandible consequently leading to a decrease in the height of the lower part of the face 6.

This study found that with tooth loss, the value of the mental angle decreases statistically significantly, but not the mandibular angle, which causes a sharper profile of the lower third of the face. Previous studies have shown that the value of the mandibular angle decreases with age, i.e. that the value of the angle decreases by about 10% during the process of tooth eruption and under the influence of the masticatory muscles. Over the years, the masticatory musculature has a stronger effect on the ramus of the lower jaw thus affecting its direction of growth [7,8]. This thesis is partially confirmed by Nahhas et al., who found a reduction in mandibular angle in the period aging from 4 to 24 years [9].

Morphological analysis in the presented study showed that tooth loss causes significant changes in the shape of the mental trigonum, in the sense that there is an increase in the angle opposite the base of the trigonum making the chin smaller and wider. Due to the scarce literature on this topic, we are not able to compare this and some of the results presented in this paper.

It is known that the mandible is the most important bone structure which, with its size and shape, affects the appearance of the lower third of the face. To date, numerous studies have been published in which detailed data on embryonic development of the upper and lower jaw can be found [10,11]. However, in addition to the study of embryonic development, studies related to changes that occur in the mandible during life, due to the action of numerous factors, are also very important. There are few studies dealing with morphological and morphometric changes in the mandible, which occur as a result of the loss of a large number of teeth. And this study of ours is a small contribution to the promotion of this topic because the success of a large number of dental and surgical procedures depends largely on knowledge of morphological and morphometric changes (bone remodeling) occuring during life in the mandible. Remodeling, as a continuous and irreversible process, is known to mostly affect the alveolar ridge because its formation and resorption are affected by tooth eruption and loss

[12]. But bone is known to reshape in response to both muscle activity, hormonal and metabolic changes, under the influence of genes and under the influence of a number of other local and systemic factors [13]. How and to what extent these factors affect morphological and morphometric changes in the mandible will be shown in future studies in which we, the authors, will actively participate.

Conclusion

Extensive tooth loss in adulthood leads to a reduction in the vertical diameters of the lower jaw, a reduction in the width of its body, a reduction in mental angle, and significant changes in the shape of the mental trigonum. These changes in the shape and dimensions of the lower jaw are reflected in the appearance of the lower third of the face, and thus the whole physiognomy. The success of a number of dental and surgical interventions depends on knowledge of these morphological and morphometric changes in the lower jaw. For this reason, this study was made as a small contribution to the popularization of this topic.

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