Research Article / Araştırma Makalesi

Correlation of Morphometric Parameters Taken from the Head of the Mandible with Other Parameters of the Mandible

Mandibula Başından Alınan Morfometrik Parametrelerin Mandibulanın Diğer Parametreleri ile Korelasyonu

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Abstract

Background: The mandible is a very important bone for forensic medicine, anthropology, anatomy and odontology sciences. This bone has many functions such as speaking, chewing and swallowing. This study was carried out to examine the relationship between morphometric parameters obtained from the head of the mandible and other parameters of the mandible.
Materials and Methods: In our study, 45 dry mandible bones were used. These bones were photographed and measured in the Image J program. These measurements were the distance of the head of the mandible to mental foramen (right, left), the distance of the head of the mandible to angle of the mandible (right, left), the distance of the head of the mandible to gnathion (right, left), the distance of the head of the mandible to coronoid process (right, left), the distance of the head of the mandible to the mandibular notch (right, left), the distance of the head of the mandible to alveolar juga (right, left) and the distance between right and left head of the mandible.
Results: While no difference was found in terms of direction in dry mandibles with correlation analysis ($p>0.05$), a high significant correlation was found in 18 parameters ($p\leq0.05$).
Conclusions: In our study, correlations were found between parameters obtained from the head of the mandible and other parameters of the mandible.

Key Words: Mandible, The head of the mandible, Morphometry, Dry bone

Öz

Amaç: Mandibula adli tıp, antropoloji, anatomi ve odontoloji bilimleri için çok önemli bir kemiktir. Bu kemiğin konuşma, çiğneme ve yutma gibi birçok işlevi vardır. Bu çalışma caput mandibuladan elde edilen morfometrik parametrelerin mandibulanın diğer parametreleri arasındaki ilişkinin incelenmesi amacıyla yapıldı.
Materyal ve Metod: Çalışmamızda 45 adet kuru mandibula kemiği kullanıldı. Bu kemiklerin fotoğrafları çekilerek Image J programında ölçümleri yapıldı. Bu ölçümler, caput mandibulanın foramen mentalaye olan mesafesi (sağ, sol), caput mandibulanın ramus mandibulaya olan mesafesi (sağ, sol), caput mandibulanın gnathion'a olan mesafesi (sağ, sol), caput mandibulanın processus coronoideusa olan mesafesi (sağ, sol), caput mandibulanın incisura mandibulaya olan mesafesi (sağ, sol), caput mandibulanın juga alveolariaya olan mesafesi (sağ, sol) ve sağ ve sol caput mandibula arasındaki mesafe.
Bulgular: Korelasyon analizi ile kuru mandibulalarda yön açısından fark bulunmazken ($p>0.05$), parametreler arası ikili ilişkilerde ise 18 parametrede yüksek anlamlı ilişki bulundu ($p\leq0.05$).
Sonuç: Çalışmamızda mandibula başından elde edilen parametreler ile mandibulanın diğer parametreleri arasında ilişkiler bulundu.

Anahtar Kelimeler: Mandibula, Caput Mandibula, Morfometri, Kuru kemik

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Received / Geliş tarihi: 09.10.2022

Accepted / Kabul tarihi: 30.11.2022

DOI: 10.35440/hutfd.1186395

Congress Presentation: *9th International Medicine and Health Sciences Researches Congress, 18-19 March 2022, Online*

Introduction

The mandible is the largest, strongest, single moving (1) and best preserved bone of the skull (2). This bone, which is single in adults, is combined with two half pieces on the midline in newborns and becomes a single bone through ossification after the first age (3). The mandible consists of the body of mandible, which extends horizontally in the middle and which has teeth on it, and two ramus of the mandible in the form of arms extending upwards both ways (4).

Morphological features of the mandible differ in terms of age, gender, dental condition and race (5). For example, while the head of the mandible is smaller and lower than the coronoid process at birth, it rises with the steepening and elongation of the ramus of the mandible with age. Teeth fall out with increasing age and alveolar part of the mandible is absorbed. As a result of this, only the lower part of the oblique of the mandible remains and the mental foramen gets closer to the upper edge. After the teeth fall out, body of mandible gets smaller, angle of the mandible extends and becomes approximately 140°. Knowing about such morphometric changes is important for clinical and forensic sciences (6-8).

Visual analysis of the human skeleton is difficult, for this reason, metric analysis, which provides objectivity, should be used for the evaluation of bones (9). Evaluation of the mandible before and after orthodontic treatment and mandibuloplasty is important in terms of both aesthetic and chewing and speech functions. Mandibular anatomy is important in terms of planning, intraoperative and postoperative success in diagnosis and treatment procedures in dentistry, in maxillo-facial and orthognathic surgery practices, especially in implant placement (10). Mandible is also important for forensic and anthropological studies because when compared with other facial bones, they do not change in terms of shape, there are only gender and age-related differences (11). For this reason, mandible is the most reliable indicator of sex in craniofacial skeleton (9).

The aim of this study is to obtain data on the morphological features of the mandible by means of osteometry based on the head of the mandible and to compare these with national and international studies.

Materials and Methods

Sample of the study and ethics committee permission

The study was accepted with the issue of 2021/739 of the Karabük University ethics committee (date: 14/12/2021). The 45 mandible bones used in the study were obtained using the anatomy laboratories of 3 different universities.

Image Protocol

The images were obtained with a professional camera from a height of 50 cm by holding the camera steady with the help of a stabilizer. The images obtained were trans ferred to image processing program ImageJ (Version 1.53e) in jpeg format. Length measurements were then performed based on the head of the mandible of all images (Figure 1).

Length measurements;

The distance of the head of the mandible to alveolar yokes of incisor tooth (right, left), (HMAJL-R/L),

The distance of the head of the mandible to gnathion (right, left), (HMGL-R/L),

The distance between the right and left head of the mandible, (RLHML),

The distance of the head of the mandible to mandibular angle (right, left), (HMMA-R/L),

The distance of the head of the mandible to the mental foramen (right, left), (HMMFL-R/L),

The distance of the head of the mandible to the coronoid process of the mandible (right, left), (HMCPML-R/L),

The distance of the head of the mandible to the mandibular notch (right, left), (HMMNL-R/L).

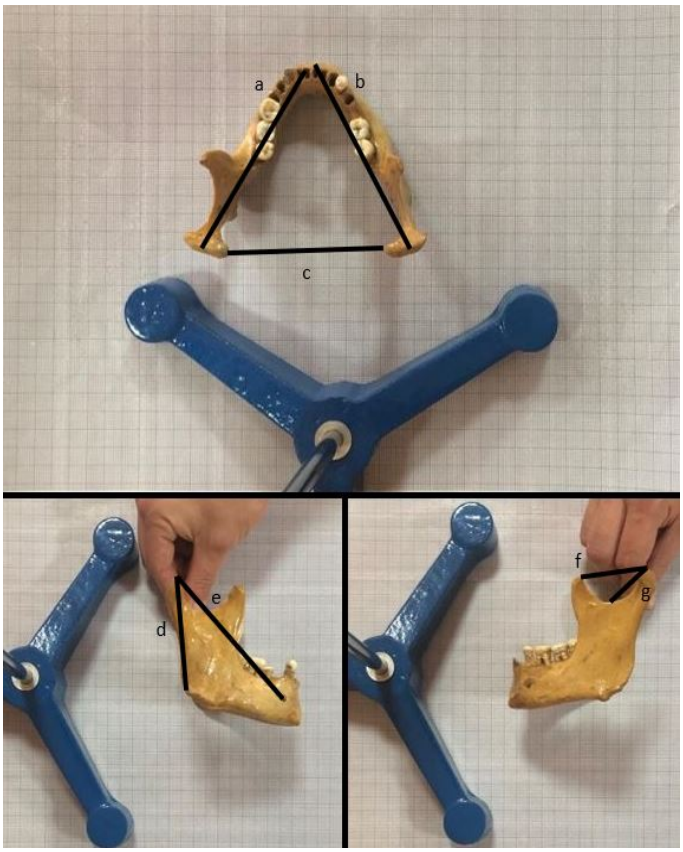

Figure 1. Demonstration of parameters (a; The distance of the head of the mandible to alveolar yokes of incisor tooth (right, left), (HMAJL-R/L), b; The distance of the head of the mandible to gnathion (right, left), (HMGL-R/L), c; The distance between the right and left head of the mandible, (RLHML), d; The distance of the head of the mandible to mandibular angle (right, left), (HMMA-R/L), e; The distance of the head of the mandible to the mental foramen (right, left), (HMMFL-R/L), f; The distance of the head of the mandible to the coronoid process of the mandible (right, left), (HMCPML-R/L), g; The distance of the head of the mandible to the mandibular notch (right, left), (HMMNL-R/L)).

Statistical Analysis

Shapiro Wilk test was used to test whether the parameters were normally distributed and it was determined that the data were not normally distributed. Descriptive statistics included median, minimum (min) and maximum (max) values. The correlation between parameters and the degree of the correlation were tested with Spearman rho correlation test. P≤0.05 was considered as statistically significant. Minitab 17 program was used in statistical analyses.

Results

Descriptive statistics of the parameters in the study and the results of Mann Whitney-U and Two Simple T test according to the direction of parameters are shown in Table 1. No significant difference was found according to the direction of parameters (p>0.05).

The correlation between parameters and the degree of correlation was tested with Spearman rho test. Statistically significant correlation was found between the other parameters except the distance between the right and left head of the mandible (p≤0.05).

Table 1. Descriptive statistics and p value table

Parameters (cm)	R/L	Median (Min – Max)	p
The distance of the head of the mandible to the mental foramen (HMMFL-R/L)	R	13.21 (8.09-16.08)	0.52*
	L	12.99 (8.33-16.15)	
The distance of the head of the mandible to mandibular angle (HMMA-R/L)	R	8.74 (4.39-11.07)	0.85*
	L	8.46 (4.56-10.80)	
The distance of the head of the mandible to gnathion (HMGL-R/L)	R	12.67 (8.9-14.29)	0.07*
	L	12.80 (8.12-15.10)	
The distance of the head of the mandible to the coronoid process of the mandible (HMCPML-R/L)	R	5.00 (3.07-6.55)	0.90**
	L	5.00 (3.14-6.93)	
The distance of the head of the mandible to the mandibular notch (HMMNL-R/L)	R	3.17 (2-4.56)	0.43**
	L	3.33 (2.35-4.61)	
The distance of the head of the mandible to incisor tooth alveolar yokes (HMAJL-R/L)	R	11.98 (8.57-13.19)	0.35*
	L	11.86 (8.78-13.97)	
The distance between the right and left head of the mandible (RLHML)	R-L	9.75 (7.84-11.35)	-

**Mann Whitney U testi, **Two Simple T testi, R: right, L: Left*

Table 2. Spearman rho correlation table

Parameters	r/p	HMMFL-R	HMMFL-L	HMMA-R	HMMA-L	HMGL-R	HMGL-L	HMCPML-R	HMCPML-L	HMMNL-R	HMMNL-L	HMAJL-R	HMAJL-L	RLHML
HMMFL-R	r	1.00												
	p	-												
HMMFL-L	r	0.57[b]	1.00											
	p	0.00	-											
HMMA-R	r	0.74[d]	0.58[c]	1.00										
	p	0.00	0.00	-										
HMMA-L	r	0.64[d]	0.71[d]	0.65[d]	1.00									
	p	0.00	0.00	0.00	-									
HMGL-R	r	0.43[c]	0.61[d]	0.43[c]	0.36[b]	1.00								
	p	0.04	0.00	0.00	0.02	-								
HMGL-L	r	0.58[c]	0.41[c]	0.44[c]	0.37[b]	0.61[d]	1.00							
	p	0.00	0.01	0.00	0.01	0.00	-							
HMCPML-R	r	0.62[d]	0.49[c]	0.61[d]	0.36[b]	0.33[b]	0.39[b]	1.00						
	p	0.00	0.00	0.00	0.02	0.03	0.01	-						
HMCPML-L	r	0.51[c]	0.61[d]	0.49[c]	0.49[c]	0.41[c]	0.47[c]	0.65[d]	1.00					
	p	0.00	0.00	0.00	0.00	0.01	0.00	0.00	-					
HMMNL-R	r	0.53[c]	0.54[c]	0.45[c]	0.37[b]	0.41[c]	0.42[c]	0.63[d]	0.36[b]	1.00				
	p	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.02	-				
HMMNL-L	r	0.47[c]	0.81[e]	0.64[d]	0.48[c]	0.49[c]	0.39[b]	0.59[c]	0.71[d]	0.56[c]	1.00			
	p	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	-			
HMAJL-R	r	0.61[d]	0.41[c]	0.56[c]	0.39[b]	0.61[d]	0.66[d]	0.45[c]	0.45[c]	0.45[c]	0.42[c]	1.00		
	p	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	-		
HMAJL-L	r	0.49[c]	0.46[c]	0.46[c]	0.33[b]	0.64[d]	0.68[d]	0.31[b]	0.49[c]	0.31[b]	0.50[c]	0.57[c]	1.00	
	p	0.00	0.00	0.00	0.03	0.00	0.00	0.04	0.00	0.04	0.00	0.00	-	
RLHML	r	0.12[a]	0.14[a]	0.10[e]	0.09[a]	0.04[a]	0.19[a]	0.20[a]	0.29[b]	0.10[a]	0.14[a]	0.10[a]	0.22[b]	1.00
	p	0.45	0.35	0.52	0.55	0.79	0.22	0.18	0.06	0.53	0.35	0.52	0.16	-

[a] very weak correlation, [b] weak correlation, [c] moderate correlation, [d] high correlation, [e] very high correlation, (HMAJL-R/L: The distance of the head of the mandible to alveolar yokes of incisor tooth (right, left), HMGL-R/L: The distance of the head of the mandible to gnathion (right, left), RLHML: The distance between the right and left head of the mandible, HMMA-R/L: The distance of the head of the mandible to mandibular angle (right, left), HMMFL-R/L: The distance of the head of the mandible to the mental foramen (right, left), HMCPML-R/L: The distance of the head of the mandible to the coronoid process of the mandible (right, left), HMMNL-R/L: The distance of the head of the mandible to the mandibular notch (right, left))

Discussion

This study was conducted to find out the morphometric correlation of the head of the mandible with other parameters taken from the mandible. Photos of the 45 dry mandible bones were transferred to ImageJ program and measurements were performed. As a result of the study, while no significant correlation was found between parameters in terms of direction, in the comparison of parameters with Spearman rho test, highly significant correlation was found in 18 and very high significant correlation was found in 1.

Direk et al. (11) found the distance between the head of the mandible and gnathion as 121.7±13.3 mm on the right side and as 120.6±13.1 mm on the left side with Computed Tomography (CT). Kano et al. (12) found the median value of the distance between gnathion and the head of the mandible as 117.1 mm in women and as 124.9 mm in men with CT. In this study, we found the median value of the distance between the heads of the mandible as 9.75 mm, the median value of the distance between the head of the mandible and gnathion as 12.67 cm on the right side and as 12.80 cm on the left side and the results were in parallel with the literature.

The distance of the head of the mandible to the angle of the mandible Ishwarkumar et al. (2) found 56.5 mm for the right side and 57 mm for the left side and found a difference between the right and left sides according to gender. Al-Shamout et al. (13). found 54.02 mm in men, 49.77 mm in women on the right side, 52.62 mm in men and 48.44 mm in women on the left side. In this study, we found it to be 8.74 (4.39-11.07) cm on the right side and 8.46 (4.56-10.80) cm on the left side, and a statistically significant difference was found between the directions (p=0.07).

The shape of the mandible and the condition of the anatomical structures in it gain importance in respiratory conditions, especially in clinical pictures such as sleep apnea. In a study examining the correlation between mandibular plane angle and respiratory symptom, significant correlations were found between mandibular plane angle and symptoms such as snoring, difficulty in breathing, daytime mouth breathing, drowsiness, dry mouth on waking up, difficulty starting sleep (14). In a study conducted by Chang et al. (15) on children with class II malocclusion and class III malocclusion, it was found that the mandible was shortened anteroposteriorly in children with class II malocclusion and lengthened anteroposteriorly in children with class III malocclusion. In a study Remy et al. (16) examined the mandibular growth pattern of primary teeth in children, a significant increase was found between head and ramus of the mandible and age. In a study they examined the correlation between chewing and mandibular growth, Enomoto et al. (17) found that individuals who started dietary education at an early age were significantly affected by mandibular growth. In a study conducted on mental foramen, Alam et al. (18) stated that knowing the precise location of mental foramen will guide anatomists, surgeons, forensic scientists and dentists and surgical interventions in this area could be performed more safely. In a study they conducted on mental foramen and mandibular foramen of individuals in Chilean population, they stated that these foramens can have different results in different populations and therefore surgeons who perform interventional procedures in this area should take regional differences into consideration (19). In a study they conducted on the anterior part of the mandible, Vasil'ev et al. (20) reported that the morphometric analysis of this region is important for local anaesthetic, dental implants and prosthetic applications.

In the mandible, the first ossification center is formed by the mandible cartilage, while the second ossification center is formed by the coronoid process (21). Due to this feature, the distance between the coronoid process and the head of the mandible is included in our study.

Literature review shows that showing the morphometry of the mandible has a critical importance in terms of revealing many symptoms related with the respiratory system and the digestive system. The inability to differentiate between gender and age in the dry bones used is a limitation of our study. The osteometric measurements performed in our study based on the head of the mandible will increase the information about the anatomy of the mandible in literature.

Acknowledge

There are no financial resources, contributing institutions, organizations and individuals.

Ethical Approval: *The study was accepted with the issue of 2021/739 of the Karabük University ethics committee (date: 14/12/2021).*

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Conflict of Interest: *The authors have no conflicts of interest to declare.*

Financial Disclosure: *Authors declared no financial support.*

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