



# Evaluation of The Relationship between the Mastoid Process and Some Anthropometric Points on the Skull with Computed Tomography

## Processus Mastoideus ile Kafatasında Bulunan Bazı Antropometrik Noktalar Arasındaki İlişkinin Bilgisayarlı Tomografi ile Değerlendirilmesi

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### Abstract

**Aim:** Facial reconstruction is a method that estimates the face shape of the unidentified person using clay and similar material in cases where only the skull is present. Due to natural events and animals, the integrity of the skeletal remains can be disrupted and this makes identification hard. The aim of the study is to estimate the skull shape by reference to the mastoid process in case of fragmentation of the skull at the scene.

**Material and Methods:** In the study, computerized tomography images of a total of 96 adult individuals of 51 females and 45 males which were obtained from Bursa Uludag University Faculty of Medicine, Department of Radiology, were used. The variables determined in the images taken in the Frankfurt Horizontal plan were measured using the Image J program. Statistics of the data obtained were carried out using SPSS 22.0 program.

**Results:** The descriptive values of the variables were given. While it was seen that linear distances differed between males and females, it was seen that angular variables did not show a gender difference. Regression formulas were developed to predict missing parts and the formulas which have the highest accurate percentage is for males;  $M5 = -2.945 + (0.548 \times M4) + (0.404 \times M6)$  and for females  $M5 = -7.457 + (0.409 \times M4) + (0.619 \times M6)$ .

**Conclusion:** In this study, we tried to evaluate the facial reconstruction from a different point of view. We have developed regression formulas with high reliability, taking into account the correlation coefficients between deciduous variables. We believe that all this data will benefit especially forensic anthropologists. In addition, we think that the fact that the angular values did not show a gender difference can be accepted as an indicator from a different perspective that the face develops at a certain rate of development.

**Keywords:** Skull, regression, temporal bone, mastoid process, facial reconstruction

### Öz

**Amaç:** Yeniden yüzlendirme, yalnızca kafatasının var olduğu durumlarda kil ve benzeri materyal ile kimliklendirilmesi yapılamayan kişinin yüz şeklinin tahmin edildiği bir yöntemdir. Doğa olayları ve hayvanlar nedeniyle iskelet kalıntılarının bütünlüğü bozulabilmektedir bu da kimliklendirmeyi zor hale getirmektedir. Çalışmanın amacı, kafatasının olay yerinde fragmente olması durumunda, processus mastoideus referans alınarak kafatası şeklinin tahmin edilmesidir.

**Gereç ve Yöntem:** Çalışma, Bursa Uludağ Üniversitesi Tıp Fakültesi Radyoloji Anabilim Dalı'ndan elde edilen erişkin 51 kadın ve 45 erkek olmak üzere toplam erişkin 96 bireyin bilgisayarlı tomografi görüntüleri kullanıldı. Frankfurt Horizontal planında alınan görüntülerde belirlenen değişkenler Image J programı kullanılarak ölçüldü. Elde edilen verilerin istatistikleri SPSS 22.0 programı kullanılarak gerçekleştirildi.

**Bulgular:** Değişkenlerin betimleyici değerleri verildi. Lineer mesafelerin kadın ve erkeklerde fark gösterdiği görülürken açısal değişkenlerin cinsiyet farkı göstermediği görüldü. Eksik parçaları tahmin etmek için regresyon formülleri geliştirildi ve en yüksek doğruluk yüzdesine sahip formüller erkekler için;  $M5 = -2,945 + (0,548 \times M4) + (0,404 \times M6)$ ; kadınlar için  $M5 = -7,457 + (0,409 \times M4) + (0,619 \times M6)$  olarak bulunmuştur.

**Sonuç:** Çalışmada yeniden yüzlendirmeyi farklı bir bakış açısıyla değerlendirmeye çalıştık. Değişkenler arasındaki korelasyon katsayılarını dikkate alarak yüksek güvenilirliğe sahip regresyon formülleri geliştirdik. Tüm bu verilerin özellikle adli antropologlara fayda sağlayacağına inanıyoruz. Ayrıca açısal değerlerin cinsiyet farkı göstermemiş olması yüzün belirli bir oranda gelişim gösterdiğinin farklı bir açıdan göstergesi olarak kabul edilebilir olabileceğini düşünmekteyiz.

**Anahtar Kelimeler:** Kafatası, regresyon, temporal kemik, processus mastoideus, yeniden yüzlendirme



## INTRODUCTION

Identification is one of the priority subjects of the forensic sciences. Age, gender, ethnicity and height form the biological profile of the individual and they are the basis of the identification.<sup>[1]</sup> There are so many methods to assess the identification of the person but DNA analysis is the most reliable among these. The only disadvantage is that after a long time and if the corpse is fully skeletonized, the appropriate quality and quantity of the DNA cannot be reached at the crime scene. In this case, skeletal forensic identification is preferred as the last method.<sup>[2]</sup> Because the skeletal elements are affected by taphonomic factors in a longer time, it usually takes longer times for them to disappear completely.<sup>[2,3]</sup> One of the methods that used to identify skeletal remains of unknown origin or to obtain information about the identity of the corpses in cases where there is little or no evidence at the crime scene is facial reconstruction. In this method, it is estimated that only the skull exists at the scene, and in cases where soft tissue cannot be obtained, the shape of the person's face. Depending on the tissue thickness at various anatomical points on the face, tissue depth markers such as vinyl or rubber are used in different lengths. Then, organs such as lips, cheeks, eyes and nose are placed.<sup>[4]</sup>

In facial reconstruction, the position of the soft tissue relative to the underlying bone structure and the consistency of the anatomical connection between it is an important issue. To assess this consistency, a comprehensive understanding of the anatomy of the skull and the relationship between the skull and the face is thoroughly required.<sup>[2]</sup> It causes deterioration of the integrity of skeletal remains due to natural events such as climate, wind and surrounding animals. For this reason, working with fragmented bones with impaired integrity makes identification hard.<sup>[5]</sup> In human skull sex determination, the petrous part of the temporal bone has a special importance among the bones used as the base due to its compact structure that can withstand mechanical effects and other destructive factors such as temperature.<sup>[6]</sup> By using the morphological features of bones, mathematical models can be made by means of morphometric methods, and an individual's age, height and gender can be estimated. Studies indicate that bones differ according to gender and ethnicity, so regression formulas for each population should be produced.<sup>[7,8]</sup>

The aim of the study is to give descriptive values for the estimation of the skull shape and to produce regression formulas, by taking the mastoid process as reference in case of fragmented or missing parts of the skull at the scene.

## MATERIAL AND METHOD

The study was conducted as a result of the decision of the Bursa Uludağ University Faculty of Medicine Clinical Research Ethics Committee dated 20 July 2020 and numbered 2020-12/23. Cranial, face and neck computed tomography (CT) images taken using Siemens Somatom Definition 128-section multi-detector computed tomography device in the xxx University Faculty of

Medicine, Department of Radiology are used. Images, protocol numbers, and three-dimensional computed tomography images obtained with Centricity RIS 6.0 Plus PACS system (General Electric Company, USA) were brought to jpeg format on Workstation. After selecting the 1.5 mm thick thin-section axial images in the GFPACS system, reformat images were created with the AW Suite 2.0 program and evaluated in the bone window. Sagittal and coronal images of skulls rendered in 3D with the volume rendering option on the program. It was brought to the Frankfurt Horizontal Plan separately and recorded in the PACS system via AW Suite 2.0. Afterwards, images of adult females and males individuals were filed separately in jpeg format and made ready for measurement.

### Study Group

In the retrospective study, 1260 computed tomography images that the report files could be accessed were examined. Individuals with fractures, deformities, or any pathological findings and a history of surgery and trauma were excluded from the study. A total of 96 adult individuals, 51 females and 45 males, were included in the study. The age range for males was 19-65, and the mean age was  $36.82 \pm 14.18$  years. The age range for females was 18-66, and the mean age was  $35.76 \pm 14.18$ .

### Measurements

Variables were chosen by selecting anthropometric points that reveal the convexity and concavity of facial features with reference to the mastoid process. The linear distances from the mastoid process to the anthropometric points that glabella, nasion, rhinion, nasospinale, A point, prosthion, infradentale, B point, pogonion, menton and gonion and the angles formed between the linear distances were measured.<sup>[9-12]</sup> The reference points were shown in **Figure 1**, the linear variables included in the study were shown in **Figure 2** and angular variables were shown in **Figure 3**. After calibrating in the ImageJ program with the help of the ruler on the images recorded as jpeg, linear distances were measured in millimeters. The measured parameters are:

**M1:** The linear distance between mastoid process and glabella

**M2:** The linear distance between mastoid process and nasion

**M3:** The linear distance between mastoid process and rhinion

**M4:** The linear distance between mastoid process and nasospinale

**M5:** The linear distance between mastoid process and A point

**M6:** The linear distance between mastoid process and prosthion

**M7:** The linear distance between mastoid process and infradentale

**M8:** The linear distance between mastoid process and B point

**M9:** The linear distance between mastoid process and pogonion

**M10:** The linear distance between mastoid process and menton

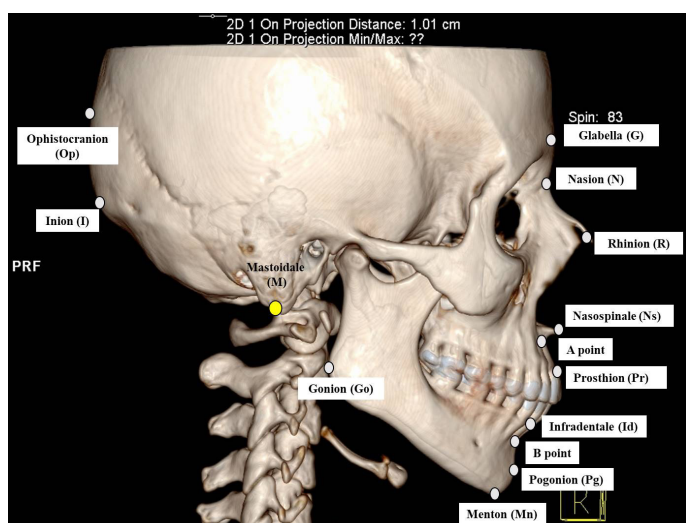
- M11:** The linear distance between mastoid process and gonion
- M12:** The linear distance between mastoid process and inion
- M13:** The linear distance between mastoid process and ophistocranium
- M14:** Angle between glabella, mastoid process and nasion
- M15:** Angle between nasion, mastoid process and rhinion
- M16:** Angle between rhinion, mastoid process and nasospinale
- M17:** Angle between nasospinale, mastoid process and A point
- M18:** Angle between A point, mastoid process and prosthion
- M19:** Angle between prosthion, mastoid process and infradentale
- M20:** Angle between infradentale, mastoid process and B point
- M21:** Angle between B point, mastoid process and pogonion
- M22:** Angle between pogonion, mastoid process and menton
- M23:** Angle between menton, mastoid process and gonion
- M24:** Angle between gonion, mastoid process and inion
- M25:** Angle between inion, mastoid process and ophistocranium
- M26:** Angle between ophistocranium, mastoid process and glabella

In the first phase of the facial reconstruction stages, the missing or broken parts of the skull must be completed. The parts that are broken or missing one side are completed by

using the mirror method technique by accepting them as symmetrical with respect to the existing side.<sup>[13]</sup> Accordingly, the lateral measurements of the variables on the right side of the skull were taken as reference.

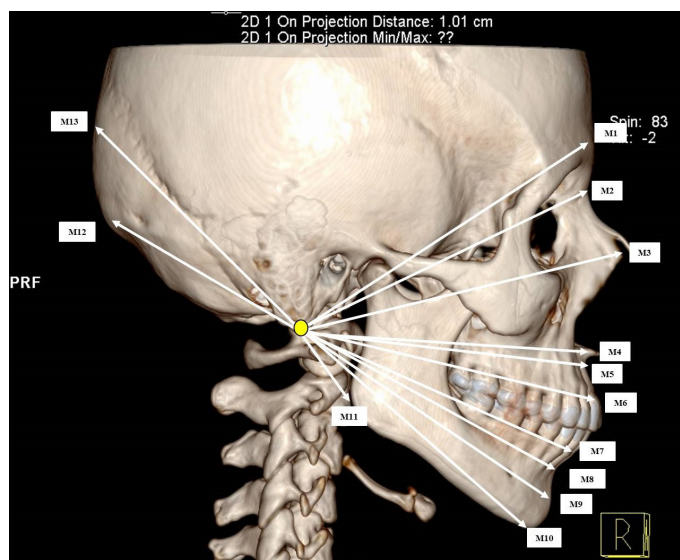
**Statistical Analysis**

Descriptive statistical values in the form of mean±standard deviation were examined for all variables in males and females individuals. Independent sample t-test was used to reveal the difference between gender. Pearson correlation analysis was performed to determine the relationship between the variables (p<0.05). Regression formulas were produced by using highly correlated variables as a result of correlation analysis. With these formulas, it was aimed to determine the shape of the face from broken or fragmented skulls. All statistical analyzes were performed using SPSS 22.0 (IBM).

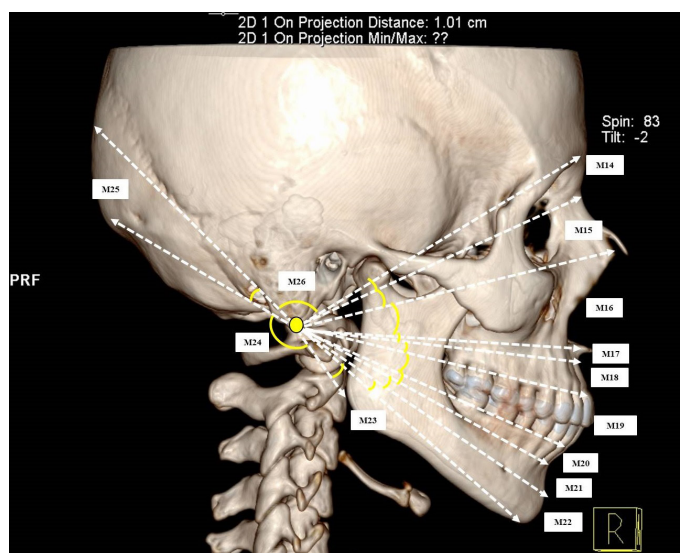


**Figure 1.** Anthropometric points used as reference

Mastoidale -(M): Lowest point of the mastoid process; Glabella -(G): The most prominent point between the superciliar arcs on the midline; Nasion -(N): Intersection point of midline and frontonasal suture; Rhinion-(R): The junction of the nasal bone and lateral nasal cartilages on the midline; Nasospinale-(Ns): anterior nasal spine crest; A point (Subspinale): Deepest point below the nasospinale; Prosthion (Supradentale)-Pr: The most anterior point of the alveolar process between the maxillary anterior incisors; Infradentale-(Id): The most anterior point of the alveolar process between the mandibular anterior incisors; B point (Supramentale): Deepest point between infradentale and pogonion; Pogonion-(Pg): The most prominent point of the mental tubercle on the midline; Menton-(Mn): The lowest point of the mandible on the midline; Gonion-(Go): The point on the outermost edge of the angle of mandible; Inion-(I): The most prominent point of the external occipital protuberance; Ophistocranium-(Op): The most prominent point of the occipital bone on the midline



**Figure 2.** Parameters measured with reference to the mastoid process



**Figure 3.** Angular parameters measured with reference to the mastoid process



## RESULTS

Descriptive statistical values of the variables for adult females and males individuals were examined. In males and females, the linear distances of the mastoid process to the glabella, nasion, rhinion, nasospinale, A point, prosthion, infradentale, B point, pogonion, menton and gonion, and the angles formed between the distances were shown in **Table 1**. It was determined that the linear distances of the mastoid process to other points differ between gender while the angle between glabella-mastoid process-nasion, nasospinale-mastoid process-A point and menton-mastoid process-gonion angles showed gender difference ( $p<0.05$ ).

Regression analysis based on the estimation of the face shape due to fractured or fragmented skull sections was performed using variables with high correlation between the variables, separately for males and females. While performing the regression analysis, formulas are created by testing more than one variable and its combinations. It has been tried to take into account the possibility that any part of the skull is absent or missing. The adjusted R2 value shows us the prediction rate of the formula as a percentage. It has been achieved to produce formulas with an accuracy of 90% and above in both genders. The regression formulas produced for males were shown in **Table 2**, and the formulas were produced for females were shown in **Table 3**. The formula which has the highest accuracy percentage is for males and females respectively:

$$M5 = -2.945 + (0.548 \times M4) + (0.404 \times M6) \text{ Adjusted R2 Value: } 0.945; \text{ S.E.: } 1.432$$

$$M5 = -7.457 + (0.409 \times M4) + (0.619 \times M6) \text{ Adjusted R2 Value: } 0.955; \text{ S.E.: } 1.006$$

**Table 2.** Regression formulas for males

Regression Formula	Adjusted R2 Value	Standart Error
M1=4.552+(1.047×M2)	0.898	2.063
M2=7.555+(0.860×M1)	0.898	1.869
M3=14.337+(0.459×M2)+(0.506×M4)	0.907	1.731
M4=10.144+(0.943×M5)	0.905	0.835
M4=3.886+(0.136×M1)+(0.836×M5)	0.915	1.758
M4=-3.341-(0.028×M1)+(0.381×M3)+(0.658×M5)	0.933	1.569
M4=4.077+(0.14×M1)+(0.901×M5)-(0.07×M6)	0.914	1.772
M5=-0.761+(0.965×M4)	0.908	1.857
M5=-11.616+(0.386×M3)+(0.629×M6)	0.927	1.656
M5=-2.945+(0.548×M4)+(0.404×M6)	0.945	1.432
M6=-7.174+(0.652×M5)+(0.439×M7)	0.931	1.688
M6=-6.551+(0.766×M5)+(0.325×M8)	0.903	1.996
M7=-0.558+(0.341×M6)+(0.669×M8)	0.909	1.743
M7=1.344-(0.228×M5)+(0.551×M6)+(0.661×M8)	0.914	1.690
M8=0.943+(0.243×M6)+(0.694×M9)	0.903	1.652
M8=1.143+(0.457×M7)+(0.492×M9)	0.929	1.412
M8=2.429+(0.477×M7)+(0.453×M10)	0.938	1.326
M9=8.446+(0.908×M10)	0.929	1.448
M9=6.818+(0.175×M7)+(0.762×M10)	0.938	1.352
M10=-0.753+(1.025×M9)	0.929	1.539
M10=-1.24+(0.233×M8)+(0.813×M9)	0.934	1.489

**Table 1.** Descriptive statistical values of distance (mm) and angle values between mastoid process and other parameters

Variable	Female			Male		
	Mean±S.D.	Median	Min. – Max.	Mean±S.D.	Median	Min. – Max.
M1	117.036±5.496	117.189	98.393 – 128.908	125.038±6.459	125.662	107.916 – 141.596
M2	108.573±5.339	108.528	91.405 – 120.453	115.047±5.852	115.170	99.253 – 129.168
M3	113.112±5.140	113.720	98.166 – 123.419	120.070±5.690	120.288	105.541 – 133.002
M4	100.462±4.807	100.260	91.158 – 114.265	104.722±6.048	103.990	91.193 – 120.000
M5	96.267±4.762	96.521	86.358 – 107.619	100.322±6.120	99.581	88.752 – 115.302
M6	101.141±4.587	101.185	90.625 – 111.519	104.172±6.418	103.574	90.814 – 120.731
M7	100.363±5.020	100.933	89.258 – 109.452	104.628±5.763	104.017	94.672 – 118.436
M8	99.009±5.535	99.606	86.580 – 108.689	104.112±5.309	103.368	94.234 – 114.716
M9	106.141±5.670	106.470	93.025 – 116.678	112.153±5.443	111.540	100.253 – 124.290
M10	107.726±5.977	108.084	94.206 – 118.869	114.227±5.784	113.205	103.636 – 126.416
M11	46.650±5.470	34.197	46.742 – 56.545	51.097±7.496	51.235	35.234 – 77.217
M12	70.595±10.909	73.301	33.861 – 91.942	79.910±8.435	77.881	67.612 – 114.964
M13	100.383±9.330	99.451	80.716 – 120.946	110.651±8.926	112.551	91.467 – 133.061
M14	5.258°±1.179°	5.461°	2.407°-7.762°	4.451°±1.101°	4.218°	2.827° – 8.374°
M15	11.785°±1.771°	11.570°	7.086°-17.667°	11.743°±1.963°	11.734°	8.273° – 16.189°
M16	15.782°±1.765°	15.844°	10.431°-21.256°	15.488°±1.795°	15.660°	11.780° – 18.836°
M17	3.541°±0.846°	3.386°	1.787°-5.678°	3.198°±0.869°	3.063°	1.728° – 5.869°
M18	6.432°±1.702°	6.116°	3.498°-11.302°	6.432°±1.497°	6.582°	3.112° – 10.274°
M19	11.538°±1.359°	11.568°	8.491°-14.804°	12.069°±2.080°	11.730°	8.163° – 17.361°
M20	5.402°±1.732°	5.343°	1.879°-9.712°	4.844°±1.607°	4.877°	1.570° – 8.133°
M21	5.640°±1.499°	5.625°	1.700°-10.238°	5.821°±1.368°	5.875°	0.818° – 8.497°
M22	4.794°±1.150°	4.723°	2.649°-7.028°	4.703°±1.122°	4.779°	2.605° – 7.519°
M23	18.017°±3.983°	18.393°	9.982°-26.220°	20.167°±5.025°	20.175°	8.584° – 32.724°
M24	144.37°±11.564°	145.954°	108.211°-166.04°	144.984°±9.344°	146.38°	116.243° – 166.48°
M25	23.525°±6.695°	23.480°	8.721°- 41.897°	23.777°±5.431°	23.957°	14.201° – 34.481°
M26	103.942°±7.512°	105.241°	90.337°-120.64°	102.201°±6.086°	102.58°	86.131° – 135.35°

SD. Standart deviation; Min.-Max., Minimum and Maximum

**Table 3.** Regression formulas for females

Regression Formula	Adjusted R2 Vlaue	Standart Error
M1=10.025+(0.986×M2)	0.927	1.472
M2=-5.261+(0.721×M1)+(0.261×M3)	0.938	1.331
M5=-4.279+(0.994×M6)	0.915	1.386
M5=-11.937+(0.227×M3)+(0.816×M6)	0.945	1.112
M5=-7.457+(0.409×M4)+(0.619×M6)	0.955	1.006
M5=-3.438+(0.752×M4)+(0.24×M7)	0.903	1.480
M5=0.491+(0.771×M4)+(0.185×M8)	0.891	1.570
M5=-3.42+(1.045×M6)-(0.057×M9)	0.916	1.328
M5=-3.772+(1.028×M6)-(0.037×M10)	0.915	1.391
M6=16.89+(0.15×M3)+(1.051×M5)	0.924	1.262
M6=8.322+(0.768×M5)+(0.188×M7)	0.931	1.205
M6=10.629+(0.789×M5)+(0.147×M8)	0.926	1.245
M6=8.405+(0.818×M5)+(0.132×M9)	0.929	1.222
M6=9.264+(0.831×M5)+(0.11×M10)	0.926	1.251
M6=12.344+(0.922×M5)	0.915	1.335
M7=13.852+(0.874×M8)	0.927	1.357
M7=9.402+(0.13×M6)+(0.786×M8)	0.930	1.325
M8=-12.163+(0.133×M4)+(0.974×M7)	0.933	1.436
M8=-8.135+(0.292×M4)+(0.722×M10)	0.909	1.671
M8=-9.589+(0.345×M5)+(0.711×M9)	0.901	1.745
M8=-7.522+(0.338×M5)+(0.687×M10)	0.916	1.603
M8=-9.585+(0.077×M6)+(1.004×M7)	0.927	1.498
M8=-9.751+(0.37×M6)+(0.662×M10)	0.915	1.618
M8=-3.181+(0.961×M7)+(0.123×M11)	0.932	1.443
M9=7.286+(0.918×M10)	0.935	1.451
M9=6.271+(0.173×M8)+(0.768×M10)	0.937	1.423
M9=11.984+(0.814×M10)+(0.138×M11)	0.939	1.397
M10=-0.518+(1.020×M9)	0.935	1.529

## DISCUSSION

Understanding the relationship between skull and soft facial tissue is important for forensic facial reconstruction.<sup>[2]</sup> There are so many studies about facial reconstruction, especially estimation of the facial organs like ear, nose, eye etc. for the various gender, age, and races. It is seen that these studies accept the skull as a whole without any deformity and reconstruction it in this way. Given that mass catastrophes, wars, and animal activity at the scene have disrupted the integrity of the skeletal remains, situations are likely to arise where it may be necessary to reveal the shape of the skull before attempting reconstruction. The study aims to estimate the anatomical points that make up the facial contours using the mastoid process in case the skull is fractured or fragmentary.

In the literature, there are studies that tried to estimate gender using many variables such as the length of the mastoid process and its distances from the neighboring anatomical structures.<sup>[14,15]</sup> In the study, unlike the literature, the linear distances between the mastoid process to the anthropometric points on the midline of the face and the angles between these distances were measured. When the difference between males and females individuals with comparative statistics were

examined, it is seen that all linear distances showed gender differences. Among the angles, it was determined that the angle between glabella-mastoid process-nasion, the angle between nasospinale-mastoid process-A point and the angle between menton-mastoid process-gonion showed gender differences, and all the other angles did not differ between males and females. It is not surprising that angular variables do not show gender differences since the rate of development of the face is constant in males and females.<sup>[16]</sup> It made us think that some points might not have been able to adapt to this rate of development. It is seen that some angular variables differ in the study.

Considering the stability of the skull bones, the harmony between the facial bones, the maxilla, and the mandible and the effect of these bones on the vertical development of their face it is usual to find differences between males and females individuals. In male, the sharp edge of the supraorbital margin of the orbita and its extension towards the region causes the glabella to have a more prominent appearance.<sup>[17]</sup> This explains to us the gender difference in the angle between the glabella-mastoid process-nasion.

The mandibular angle shows dimorphism due to the antero-inferior displacement of the gonion, which shortens the length of the gonial region, and the slight upward movement of the preangular notch. A longer lower margin (lower edge of the basal bone) in males and an allometric downward orientation of the preangular notch in females causes the lower margin to display a more curved appearance. These structures are also thought to be related to the enlargement of the nasopharyngeal cavity as a whole as a result of its clockwise rotation.<sup>[18]</sup> In the study, the angle between the menton-mastoid process-gonion which shows the gender difference think that it may be due to a functional difference originating from the chewing muscles as well as being an individual. The nasal cavity shows a gender difference in males and females due to their energy requirements.<sup>[19]</sup> We think that the shape and direction of anterior nasal spine in this region may show a gender difference because of the great differences in individuals.

In a study that use computed tomography images in the Turkish population, the distance between the mastoid process and the glabella was reported as 131.1±5.86 mm in males and 123.5±4.69 mm in females. In the same study, the distance between the mastoid process and the nasion was 121.7±5.60 mm in males and 115.1±4.20 mm in females; the distance between the mastoid process and the rhinion was 125.8±5.50 mm in males and 119.5±4.23 in females. The distance between the mastoid process and the nasospinale was 110.7±5.54 mm in males and 106.1±3.66 mm in females; the distance between the mastoid process and the prosthion was specified as 109.0±5.92 mm in males and 105.3±3.33 mm in females.<sup>[4]</sup> When the data of our study is compared with the thesis study, it is seen that the values are lower. Apart from this study, no study using dry bone has been encountered in the literature.

Macroscopic and radiographic measurements of dry bones or teeth are problematic due to changes in the skeleton because of taphonomic reasons. Huxley stated that postmortem shrinkage was observed in human fetal diaphyseal lengths when compared dry bones with the fresh bones.<sup>[20]</sup> This means that indicators based on fresh bones cannot be applied directly to dry bones.<sup>[21]</sup> The association of facial soft tissues with dry skulls is important for forensic identification or for inferring the facial morphology of extinct forms. It is known that the soft tissue of the face shows serious differences between individuals due to reasons such as embryology, growth and aging, and aesthetics.<sup>[22]</sup> It is seen that the compatibility of the data obtained from living individuals with the dry skull or the fact that the data obtained from the cadavers do not reflect the real image, and the large differences between individuals due to environmental conditions show that facial reconstruction cannot give us a definite result.

Forensic facial reconstruction is a method for predicting possible face shape. Especially estimation of the soft tissue thickness is the main point of the studies. Before the reconstruction, restoration of the skull can be necessary and in this study, we tried to evaluate the issue from a different point of view with the mastoid process. We believe this study set an example for future studies and help the forensic sciences.

**Limitations of the study:** The number of the images are can be increased by dividing them into the age groups. It is recommended to examine the study with other age groups as well as the adult group and also it is possible to estimate the soft tissue with the skull.

## CONCLUSION

In the case of fragmentation of the skull in the study, we tried to evaluate the skull from a different perspective in the light of the studies in the literature. In the study, we aimed to reveal the face shape on the bone by using mastoid process on the temporal bone. For this purpose, we have developed regression formulas with high reliability, taking into account the correlation coefficients between deciduous variables. We believe that all this data will benefit different disciplines, especially forensic anthropologists.

## ETHICAL DECLARATIONS

**Ethics Committee Approval:** Ethics committee approval was obtained from Ethics Committee of Bursa Uludag University School of Medicine (Date: 20/07/2020-Decision No: 2020-12/23).

**Informed Consent:** Because the study was designed retrospectively, no written informed consent form was obtained from patients.

**Referee Evaluation Process:** Externally peer-reviewed.

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

**Financial Disclosure:** The authors declared that this study has received no financial support.

**Author Contributions:** All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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