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Original Article / *Özgün Makale*

Correlation of second to fourth digit ratio with auricular dimensions

İkinci parmağın dördüncü parmağa oranının auriküler boyutlar ile ilişkisi

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ABSTRACT

Objectives: This study aims to investigate the correlation between the second to fourth digit ratio (2D:4D), which is a non-invasive indicator of the exposure to the prenatal sex hormones, and the auricular dimensions.

Patients and Methods: A total of 41 male patients (mean age 28.1±4.4 years; range 21 to 39 years), who applied for a routine check-up, were included in the study. The length and width of the auricula, the length and width of the concha and the length of the second and fourth fingers were measured with a digital caliper. After calculating the 2D:4D, all data were statistically compared.

Results: We detected a negative and statistically significant correlation between the 2D:4D and auricular dimensions.

Conclusion: Our findings confirmed the effect of the androgenic hormones on the development of the auricular cartilage.

Keywords: Auricula; dimension; finger; ratio.

ÖZ

Amaç: Bu çalışmada doğum öncesi cinsiyet hormonlarına maruziyetin invaziv olmayan bir endikatörü olan ikinci parmağın dördüncü parmağa oranı (2D:4D) ve auriküler boyutlar arasındaki ilişki araştırıldı.

Hastalar ve Yöntemler: Çalışmaya rutin genel sağlık kontrolü için başvuran toplam 41 erkek hasta (ort. yaş 28.1±4.4 yıl; dağılım 21-39 yıl) dahil edildi. Aurikülanın uzunluğu ve genişliği, konkanın uzunluğu ve genişliği ve ikinci ve dördüncü parmağın uzunluğu dijital kaliper ile ölçüldü. 2D:4D'nin hesaplanmasından sonra tüm veriler istatistiksel olarak karşılaştırıldı.

Bulgular: 2D:4D oranı ve auriküler boyutlar arasında negatif ve istatistiksel olarak anlamlı bir ilişki tespit edildi.

Sonuç: Bulgularımız androjenik hormonların auriküler kıkırdağın gelişimi üzerindeki etkisini desteklemektedir.

Anahtar sözcükler: Auriküla; boyut; parmak; oran.

The external ear consists of the auricle (pinna) and external auditory canal. The auricle is an anatomic structure that is not only important for hearing but also has cosmetic relevance. Knowing the normal values of auricular dimensions and auricular developmental patterns could be helpful in the development of industrial products such as hearing aids and auricular prosthesis as well as for diagnosis and therapy of congenital variations.[1] Postnatal growth patterns play an important role in determining the optimal time for surgical interventions with respect to congenital malformations.[2] 75-85% of auricular development is completed before the age of five and the adult size of the auricle is reached at age 11 in females and age 12 in males.[1]

Together with genetic and environmental factors, hormones also have an important role in determining face shape in humans. The literature has reports of sex hormones playing an active role in craniofacial differentiation as a result of their impact on cartilage, bone or soft tissues and in the development of the masculine and feminine facial appearance.[3] These effects start in the prenatal stage and continue in every stage of life.[3]

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Previous findings confirmed that the ratio between the length of the second (2D) and fourth finger (4D) differed according to gender and this phenomenon is determined by the exposure to sex hormones.[4-9] In males, the 4D is longer than in females; thus the 2D:4D ratio is relatively lower and this ratio is correlated with the in-utero androgen and estrogen equilibrium.[5] The postnatal 2D:4D ratio had a negative correlation with fetal testosterone levels previously measured from amniotic fluid.[6] In addition to high fetal androgen levels, there were evidences showing that a low 2D:4D ratio was correlated with increased androgenic receptor sensitivity.[5,7] In male patients with androgen insensitivity syndrome, the 2D:4D ratio was relatively higher.[8] In the light of these findings in the literature, this ratio was considered a retrospective indicator of in-utero androgen levels.[4-9] Although, fingers continue to grow with age, the 2D:4D ratio remains unchanged until young adulthood.[9] Fetal androgens are major hormones that affect differentiation of male gender. And fetal testesterone affects mainly the male fetus growth and development.[5,6] Studies demonstrated that auricular dimensions in males are larger than in females in the neonatal period and after the first 24 months of life.[1,2,10] Because it seems that the auricular size is not related to fetal testesterone which is almost missing in female fetus, in this study we investigated the relation between auricular size and 2D:4D ratio which is an indicator of fetal testesterone exposure in male adults.

PATIENTS AND METHODS

We obtained the approval of the Bakırköy Dr. Sadi Konuk Training and Research Hospital Ethics Committee for our study. Forty-one male patients (mean age 28.1±4.4 years; range 21 to 39 years), who applied to our hospital for a routine check-up between May 2016 and September 2016, were included in the study. All participants signed a consent form. The lengths of the auricles and fingers of the participants were measured with a digital caliper (0.01 mm resolution). The measured dimensions of the right auricles constituted of auricular length (distance between the top of the helical fold and the lowest point of the lobule), conchal length (distance between the top edge of the concha and incisura intertragica inferior), auricular width (distance between preaurale and postaurale), conchal width (distance between incisura anterior and the most prominent part of the antihelix) (Figure 1). Measurements of the second and fourth fingers were performed directly from the palmar side of the right hand and the length between the basal fold and the top point of the fingertip was measured. If there was more than one basal fold, the lowest one was used for the measurement. With simple proportioning of the second and fourth finger lengths, the 2D:4D ratio was calculated. The correlation between auricular dimensions and the 2D:4D ratio was statistically evaluated. Mean, standard deviation, median, minimum, maximum, frequency and ratio values were used for descriptive analysis of data. The distribution of variables was measured with the Kolmogorov-Smirnov test. Spearman correlation analysis was used for correlation. Analyses were performed with IBM SPSS version 22.0 (IBM Corp., Armonk, NY, USA) package software.

RESULTS

The average 2D length was 74.2±4.4 mm, 4D length was 76.1±4.9 mm and the average 2D:4D ratio was 1.

Figure 1. Reference points for digital caliper measurements.
- Auricular length (between 1 and 2): The distance between the top of the helical fold and the lowest point of the lobule
- Auricular width (between 3 and 4): The distance between preaurale and postaurale.
- Conchal length (between 5 and 6): The distance between the top edge of the concha and incisura intertragica inferior.
- Conchal width (between 7 and 8): The distance between incisura anterior and the most prominent part of antihelix.

Table 1
Data distribution

	Min-Max	Median	Mean±SD
2D	63.8-84.9	73.7	74.2±4.4
4D	66.7-86.2	76.0	76.1±4.9
2D:4D	0.9-1.1	1.0	1.0±0.0
Auricular length	50.5-77.3	64.7	64.1±7.9
Conchal length	20.8-36.7	26.6	27.8±4.5
Auricular width	22.5-42.5	34.8	34.9±4.7
Conchal width	12.2-25.0	19.4	19.3±3.5

Min: Minimum; Max: Maximum; SD: Standard deviation.

Table 2
Correlation of 2D:4D ratio and auricular measurements

	Auricular length	Conchal length	Auricular width	Conchal width
2D:4D				
r	-0.797	-0.803	-0.776	-0.753
p	0.000	0.000	0.000	0.000

Spearman correlation.

The average auricular length was 64.1±7.9 mm, average conchal length was 27.8±4.5 mm, average auricular width was 34.9±4.7 mm and average conchal width was 19.3±3.5 mm. The data distribution intervals are listed in Table 1. There was a significant negative correlation between 2D and 4D ratio and auricular length, conchal length, auricular width and conchal width ($p<0.05$) ($p=0.0004$; $p=0.0002$; $p=0.0002$ and $p=0.0001$) respectively (Table 2, Figure 2, Figure 3).

DISCUSSION

As far as we knew there is no other published study similar to our study in the English literature. There were several studies on the growth dynamics of the auricle in the literature. These studies demonstrated that auricular dimensions in males are larger than in females in the neonatal period and after the first 24 months of life.[1,2,10-12] However, in their anthropometric study of preterm and term healthy neonates, Kalcıoğlu et al.[13] did not detect any difference between male and female babies. On the other hand, Agnihotri et al.[14] conducted a study of 60 infants and stated that a difference between genders emerged from the first month of life, confirming that development of the auricular cartilage was affected by sexual dimorphism.

The 2D:4D ratio, which is defined as the proportion of the lengths of the second and fourth fingers and investigated in several recent studies, is

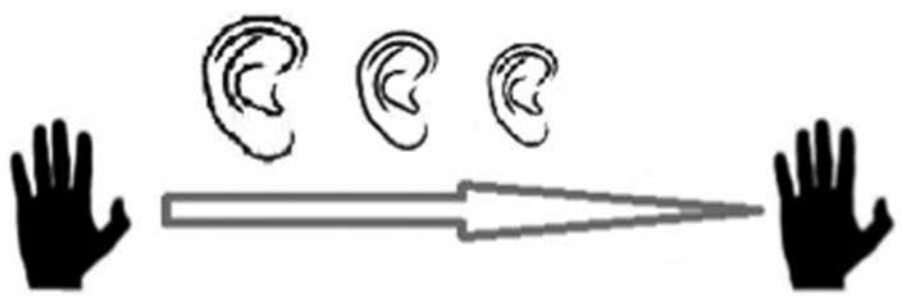

Figure 2. Illustration of correlation of 2D:4D ratio and auricular dimensions.

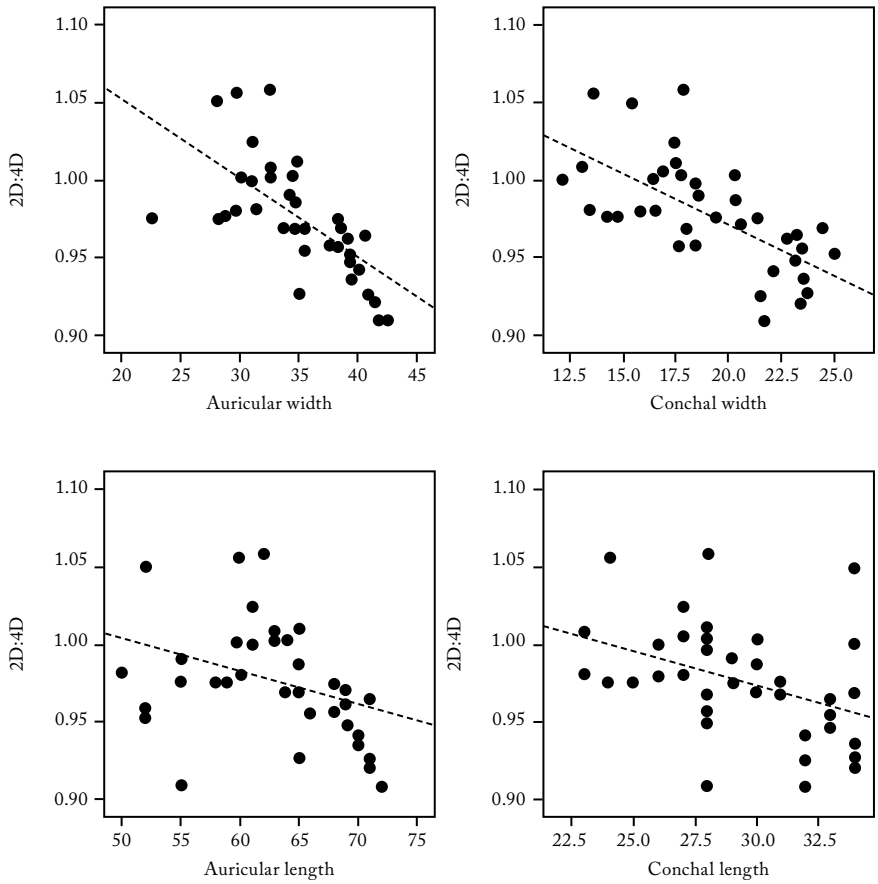

Figure 3. Correlation of auricular and conchal width with 2D:4D ratio.

a simple ratio showing prenatal androgenic exposure. It has a negative correlation with androgenic receptor sensitivity. Bilgiç et al.[5] determined a negative correlation between androgenic alopecia (frontal alopecia) and the 2D:4D ratio. Their study reported that in men who had a relatively longer fourth finger (low 2D:4D ratio), frontal alopecia was encountered more frequently and had a relatively more severe progress. Similarly, there were studies conducted with three-dimension technology in adult men which demonstrated that facial development was affected by intrauterine androgen exposure and androgenic receptor sensitivity.[3] Accordingly, it was reported that men who had a high 2D:4D ratio had a facial appearance long in the cephalo-caudal axis and short in the anteroposterior axis.[3] Meindl et al.[6] conducted a study of 17 boys and found that children with a low 2D:4D ratio had a more rough facial structure, more masculine and stronger body structure and a more lively personality. Leoni et al.[15] conducted a study on birds and reported that gender could be easily determined by the ratio of their toes.

In our study, we found a negative correlation between the 2D:4D ratio and auricular dimensions. According to the results of our study, the males with a lower 2D:4D ratio (more androgenic men), the length and width of auricles were longer than the other males with higher 2D:4D ratio. In other words, with a decrease in the 2D:4D ratio, the length and width of the auricle increased. We believe that this condition might be correlated with increased androgenic receptor sensitivity, as stated in the literature.[8] Furthermore, Maor et al.[16] demonstrated in animals that testosterone increased the level of insulin-like growth factor-1 (IGF-1) and expression of IGF-1 receptors in chondrocytes of the mandibular condyle and because these factors stimulated the proliferation and growth of chondrocytes, testosterone was correlated with cartilage growth. In their study, Takahashi et al.[17] experimented with 12 different factors in order to increase the proliferation of auricular chondrocytes and showed that fibroblast growth factor-2 (FGF2), insulin and IGF-1 contributed significantly to the growth of chondrocytes. However, they also suggested that testosterone alone had no (or a small) impact on the

growth of chondrocytes. In another study, the presence of androgenic receptors in thyroid cartilage and the stimulating effect of testosterone on the matrix and cartilage growth through these receptors was shown.[18] The larger dimensions of the auricle in men also showed that this phenomenon had a correlation with sex hormones.[1,2,10-12] We also believe that testosterone utilized a direct or indirect path to influence auricular cartilage growth.

The reason why we enrolled only male patients between the ages of 20-40 years into our study was that the growth of the auricle stopped at the age of 12 and with aging the microscopic structure and relevant dimension of the auricle changed due to the decrease in the number and density of elastic fibers in the auricular cartilage.[19]

In conclusion, we observed a negative correlation between 2D:4D ratio and auricular cartilage dimensions in men. This findings confirmed that male auricular size is related to fetal androgen exposure.

Declaration of conflicting interests

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