Acta Medica Alanya

RESEARCH ARTICLE

ARAŞTIRMA

Acta Medica Alanya

2024;8(1): 49-57

DOI: 10.30565/medalanya.1447887

Detailed Coccygeal Morphology on Multislice 3d Ct in 1000 Asymptomatic Turkish Adults

1000 Asemptomatik Türk Erişkinin Multislice 3d Ct'de Ayrıntılı Koksigeal Morfolojisi

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ABSTRACT

Aim: The morphology of the coccyx varies. This variety makes it difficult to understand the radiologic pathologies in idiopathic coccydynia. This study aimed to examine the coccyx morphology in Turkish society in order to establish a set of societal reference values.
Method: By retrospective analysis of computed tomography scans of one thousand adults, the following were evaluated: number of coccygeal segments, type of coccyxes, sacrococcygeal and intercoccygeal joint fusion, coccygeal spicules, sacrococcygeal straight length, sacrococcygeal and intercoccygeal curvature angles and lateral deviation of the coccyx tip.
Results:The most common number of coccygeal segments was determined to be four, and the most common coccyx type was II. Sacrococcygeal fusion was observed in 69.5%, and intercoccygeal fusion in 83.6%. Coccygeal spicule was seen in 3.7% of the cases. The mean sacrococcygeal straight length was 34.3 mm in males and 32.2 mm in females; this length was also significantly higher in the male group ($p<0.001$). The mean sacrococcygeal curvature angle was 108.8° in females and 112.7° males; this angle was significantly wider in the male group ($p<0.001$).
Conclusion: This study, conducted in asymptomatic Turkish individuals, is the most comprehensive study to date and can be used as a "set of societal reference values" in future studies with symptomatic cases to determine the societal morphology of the coccyx and the etiology of coccydynia.
Key words: Coccyx, Morphology, Turkish, Computed tomography

ÖZ

Amaç: Kuyruk sokumu morfolojisi değişiklik göstermektedir. Bu çeşitlilik idiyopatik koksidinideki radyolojik patolojilerin anlaşılmasını zorlaştırmaktadır. Bu çalışma, bir dizi toplumsal referans değeri oluşturmak için Türk toplumundaki kuyruk sokumu morfolojisini incelemeyi amaçlamıştır.
Yöntem: Bin yetişkinin bilgisayarli tomografi taramasının retrospektif analizi ile aşağıdakiler değerlendirilmiştir: koksigeal segment sayısı, koksiks tipi, sakrokoksigeal ve interkoksigeal eklem füzyonu, koksigeal spiküller, sakrokoksigeal düz uzunluk, sakrokoksigeal ve interkoksigeal eğrilik açıları ve kuyruk sokumu ucunun lateral sapması.
Bulgular: En sık görülen koksiks segment sayısı dört, en sık görülen koksiks tipi ise II olarak belirlenmiştir. Sakrokoksigeal füzyon %69,5, interkoksigeal füzyon ise %83,6 sıklıktadır. Olguların %3,7'sinde koksigeal spikül görülmüştür. Ortalama sakrokoksigeal düz uzunluk erkeklerde 34,3 mm, kadınlarda 32,2 mm idi; bu uzunluk da erkek grupta anlamlı olarak daha yüksekti ($p<0,001$). Ortalama sakrokoksigeal eğrilik açısı kadınlarda 108,8°, erkeklerde 112,7°; bu açı erkek grupta anlamlı olarak daha genişti ($p<0,001$).
Sonuç: Asemptomatik Türk bireylerde yapılan bu çalışma bugüne kadar yapılan en kapsamlı çalışma olup, gelecekte semptomatik olgularla yapılacak çalışmalarda kuyruk sokumu kemiğinin toplumsal morfolojisi ve koksidini etiyolojisinin belirlenmesi amacıyla "toplumsal referans değerleri seti" olarak kullanılabilir.
Anahtar kelimeler: Kuyruk Sokumu, Morfoloji, Türk, Bilgisayarlı Tomografi

Received: 06/03/2024 Accepted: 23/04/2024 Published (Online): 30/04/2024

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To cited: Kuytu T, Karaoğlu A. Detailed Coccygeal Morphology on Multislice 3d Ct in 1000 Asymptomatıc Turkish Adults. Acta Med. Alanya 2024;8(1): 49-57 DOI: 10.30565/medalanya.1447887

Introduction

The term coccydynia means pain in or around the coccyx. It most commonly develops secondary to axial trauma to the tailbone [1,2]. Although different studies have defined some etiological factors, such as abnormal coccygeal mobility secondary to a difficult birth, postural changes, tumors, and infections, in around one-third of the cases, the cause is idiopathic [2–4].

Pain is typical of leaning backward and sitting on hard surfaces [5]. It is observed to be more common in obese cases and female patients [6]. Since the morphology of the coccyx varies among people and societies, determining the detailed coccyx morphology for different ethnic groups may provide an advantage in understanding the etiopathogenesis of idiopathic coccydynia.

The coccyx is the last and lowest part of the vertebral column [5]. It comprises an apex, base, anterior surface, posterior surface, and two lateral surfaces [7]. The base is at the highest level, while the apex is at the inferior terminal portion of the vertebral column [8].

The coccyx is not a single bone structure; it consists of 2–5 bony structures. Within the framework of bone structures, fibrous tendons and ligaments restrict movement [9]. The coccyx is connected to the sacrum via the sacrococcygeal joint. Depending on the body position, the pelvis's coccyx and other bony structures move inward or outward to stabilize the spine [10]. Additionally, the coccyx provides support from below to the organs within the pelvis, offers positional support to the anus, and serves as a point of attachment for the pelvic floor tendons [5]. Studies on the structure of the coccyx in different populations use cadavers or plain radiographs and CT and MRI [11–17]. In these studies, in addition to the differences among people, variations were observed in the coccyx structure between societies [11].

In this study, the coccyx morphology of the Turkish population has been comprehensively investigated. The morphological analysis was conducted on cases with different complaints rather than coccydynia patients. Consequently, detailed information regarding the morphological characteristics of the coccyx will be standardized for the Turkish population. Standardization will play a beneficial role in understanding the etiopathogenesis of idiopathic coccydynia. This study aims to investigate the morphology of the coccyx in the Turkish population and compare our findings with other ethnically based studies in the literature. The goal is to identify inter-population differences and establish a "reference value set" specific to the Turkish population.

Materials and Methods

Study Design and Participants

This study is a retrospective investigation conducted between September 2021 and September 2022, based on the records of a tertiary healthcare center. The study utilized records from 1000 individuals, 534 females and 466 males. The study included individuals who presented to the hospital with complaints unrelated to coccygeal pain. The participants encompassed a broad range of preliminary diagnoses that suggested the necessity for abdominal tomography. The participants were registered in 64 different provinces within the borders of Turkey.

Measurements

Three-dimensional reconstructions of the participants' abdominal tomographies were performed for analysis. Experienced independent radiologists evaluated the CT scans. The non-contrast abdominal spiral CT scans (Siemens Somatom scope 16 slices) were reformatted for multiplanar reconstruction with a thickness of 1 mm, and 3D sacrococcygeal images were obtained. On sagittal CT imaging, the number of coccygeal segments, coccyx type according to the Postacchini and Massobrio classification (Figure-1), presence of fusion at the sacrococcygeal and intercoccygeal junction, presence of coccygeal spicule, sacrococcygeal straight length, sacrococcygeal-intercoccygeal curvature angles and lateral deviation of the coccyx were examined (Figure-2,3). The findings were documented and statistically analyzed separately in two different groups according to sex.

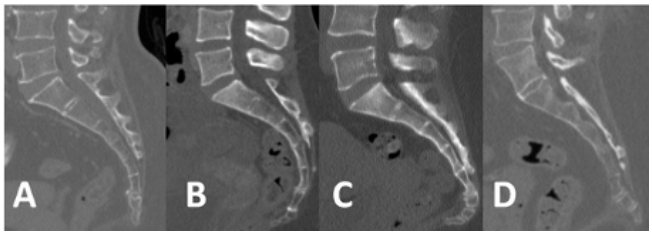

Figure-1: Sagittal reformats showing (A) type I (slightly curved coccyx pointing downwards), (B) type II (more curved coccyx pointing forward), (C) type III (sharply angulated at intercoccygeal joint) and (D) type IV (retroversion of the coccyx) coccyxes

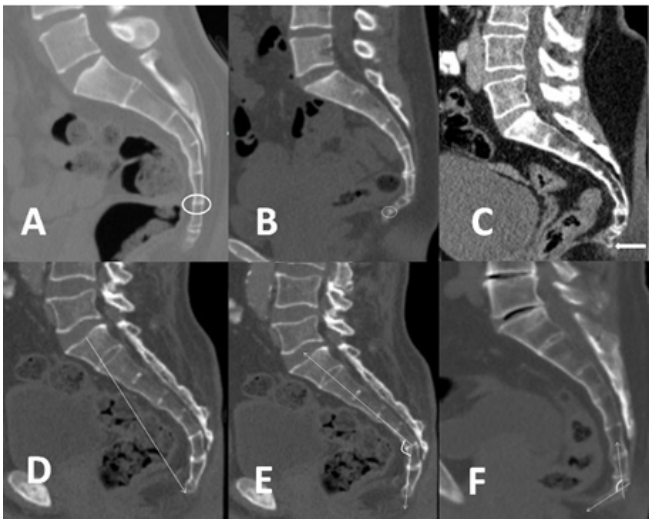

Figure-2; CT images for morphology and morphometry of the sacrococcygeal region. A; Sacrococcygeal fusion. B; Intercoccygeal fusion. C; Coccygeal spicule. D; Sacrococcygeal straight length. E; Sacrococcygeal curvature angle. F; Intercoccygeal curvature angle.

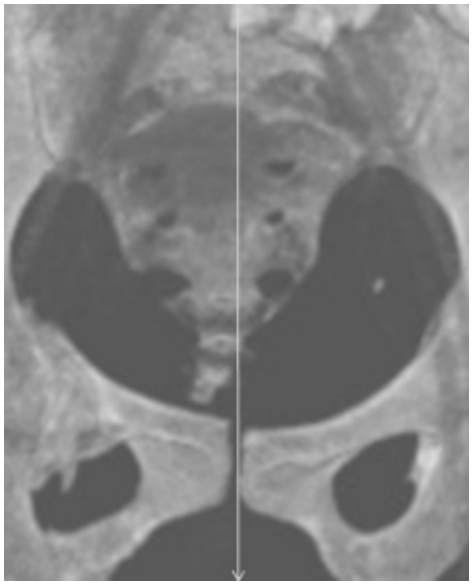

Figure-3; CT image of coccygeal lateral deviation (White arrow represents the midline)

Coccygeal Types

- Type I: Slightly curved coccyx pointing downwards,
- Type II: More curved coccyx pointing forwards,
- Type III: Sharply angulated intercoccygeal joint,
- Type IV: Retroversion of coccyx,
- Sacrococcygeal Fusion: Bony continuity between adjacent vertebrae on all sagittal slices at sacrococcygeal joints
- Intercoccygeal Fusion: Bony continuity between adjacent vertebrae on all sagittal slices at intercoccygeal joints.
- Coccygeal Spicule: Bone projection arising from the terminal coccygeal segment.
- Sacrococcygeal Straight Length: Measured in a straight line from the middle of the upper border of $1 to the tip of the coccyx.
- Sacrococcygeal Curvature Angle: The angle formed by the intersection of a line between the midpoint of the upper borders of the first sacral and first coccygeal vertebra and a line between the upper border of the first coccygeal vertebra and the tip of the coccyx.
- Intercoccygeal Curvature Angle: The angle formed between lines passing across the middle of the first and last coccygeal segments in the median plane.
- Lateral Deviation of the Tip of the Coccyx: This is determined by measuring the angle between the tip of the coccyx and a line passing through the middle of the sacrum.

Exclusion Criteria

- Coccydynia patients.
- Individuals of different ethnicities.
- Those with missing records

2.1 Examined Variables

- Coccyx type according to the Postacchini and Massobrio classification,

- The number of coccygeal segments,
- Presence of fusion at the sacrococcygeal and intercoccygeal junction,
- Presence of coccygeal spicule,
- Sacrococcygeal straight length,
- Sacrococcygeal-intercoccygeal curvature angles and
- Lateral deviation of the coccyx.

Ethics

The principles of the Helsinki Declaration conducted our research. The research has obtained ethical approval from the Istinye University clinical research ethics committee with protocol number 2/2021.K-53. Participation in the study was carried out voluntarily.

Statistical Analysis

The SPSS 25.0 (IBM Corporation, Armonk, New York, United States) program was used to analyze the variables. The data conformity to normal distribution was evaluated using the Shapiro–Wilkfrancia test. The Mann–Whitney U test was used together with Monte Carlo results to compare two independent groups according to quantitative variables. For the comparison of categorical variables, Pearson Chi-Square and Fisher–Freeman–Halton tests were used with the Monte Carlo Simulation technique, and the comparison of column ratios was expressed using Benjamini–Hochberg corrected p-value results. In order to show how many times those with a risk factor were more than those without, the odds ratio was used with a 95% confidence interval. The quantitative variables were expressed as mean (standard deviation) and median (1st Quartile–3rd Quartile) in the tables, while categorical variables were shown as n (%). The variables were analyzed at a 95% confidence level, and a p-value less than 0.05 was considered significant.

Results

The study included 1000 patients, 534 females and 466 males. The mean age was 55.4±16.8 years (18-99). The number of coccygeal vertebrae ranged between 2 and 5. The number of coccygeal vertebrae observed in the whole group in the order of frequency was 4 (631 cases, 63.1%), 3 (211 cases, 21.1%), 5 (147 cases, 14.7%), and 2 (11 cases, 1.1%). The ranking was the same in the male and female groups (Table 1). The most common coccyx type was type II (725 cases, 72.5%) by a large margin. The second most common coccyx type was type III (193 cases, 19.3%). The rankings for males and females were also the same here (Table 1).

Sacrococcygeal fusion was found in 695 cases (69.5%). The incidence of sacrococcygeal fusion is higher in women (384 cases, 71.9%) than in men (311 cases, 66.7%). However, this finding was not statistically significant (p=0.085). The sacrococcygeal fusion has been identified in 352 cases as complete fusion and in 343 cases as partial fusion. Type II is the most commonly encountered coccyx type characterized by sacrococcygeal fusion, with a prevalence rate of 50.2%. Conversely, type I coccyx is the least commonly observed variant, with a rarity of 0.6% (Table 2).

The number of cases with fusion between one or more coccygeal vertebrae was 836 (83.6%). In 84% (706 cases) of the cases with intercoccygeal fusion, fusion was observed at the most distal intercoccygeal junction. In 26 cases (2.6%), all intercoccygeal joints were fused. In 11 of these 26 patients (1.1%), fusion was observed in the sacrococcygeal and all intercoccygeal joints. In our study, type II was the most common type of coccyx with intercoccygeal fusion (Table 2).

An investigation was conducted to determine whether there was an increase in fusion rates and the number of coccygeal segments in the entire group. It has been observed that the prevalence of sacrococcygeal and intercoccygeal fusions significantly increases in individuals aged 55 and above. Furthermore, as the number of coccygeal segments increases, fusion rates demonstrate a significant increment ($p<0.001$) (Table 3, Figure-4).

The number of cases with coccygeal spicule was 37 (3.7%) (Fig-2); 21 patients were female, and 16 were male. The coccyx type was type II in 30 of 37 patients (81.1%) (Table 2).

Table 1. Sex distribution of coccyx types and coccygeal segments

Coccyx Type	FEMALE					MALE				
	Number of Coccygeal Segments					Number of Coccygeal Segments				
	2	3	4	5	Total	2	3	4	5	Total
I	4	15	18	2	39	1	13	19	0	33
II	3	85	257	46	391	2	73	196	63	334
III	0	12	71	16	99	0	4	70	20	94
IV	1	4	0	0	5	0	5	0	0	5
Total	8	116	346	64	534	3	95	285	83	466

Table 2. Sex-wise distribution of intercoccygeal fusion, sacrococcygeal fusion, spicules

Type	Sacrococcygeal Fusion			Intercoccygeal Fusion			Coccygeal Spicule		
	Female	Male	Total	Female	Male	Total	Female	Male	Total
I	36	28	64	37	31	68	2	3	5
II	280	222	502	329	280	609	17	13	30
III	64	59	123	78	74	152	2	0	2
IV	4	2	6	4	3	7	0	0	0
Total	384	311	695	448	388	836	21	16	37

Table 3. Sacrococcygeal and intercoccygeal fusion rates according to age and the number of coccygeal segments

	Sacrococcygeal Fusion		p	Intercoccygeal Fusion		p
	-	+		-	+	
Age						
Median (Q1-Q3)	53 (41-66)	58 (43-69)	0.019[U]	54 (41-67)	57 (42-69)	0.294[U]
Mean (SD.)	53.44 (17.46)	56.19 (16.48)		53.99 (17.28)	55.62 (16.73)	
	n (%)	n (%)		n (%)	n (%)	
Age						
≤55	167 (54.8)	315 (45.3)	0.007[c]	87 (53.0)	395 (47.2)	0.200[c]
>55	138 (45.2)	380 (54.7)		77 (47.0)	441 (52.8)	
Type of coccyx						
I	8 (2.6)	64 (9.2)	<0.001[f] <0.001	4 (2.4)	68 (8.1)	<0.007[f] <0.010
II	223 (73.1)	502 (72.2)		116 (70.7)	609 (72.8)	
III	70 (23)	123 (17.7)		41 (25)	152 (18.2	
IV	4 (1.3)	6 (0.9)		3 (1.8)	7(0.8)	
Number of coccygeal segments						
2	3 (1)	8 (1.2)	<0.001[f] ns	3 (1.8)	8 (1)	<0.001[f] ns
3	89 (29.2)	122 (17.6)	<0.001	56 (34.1)	155 (18.5)	<0.001
4	195 (63.9)	436 (62.7)	ns	95 (57.9)	536 (64.1)	ns
5	18 (5.9)	129 (18.6)	<0.001	10 (6.1)	137 (16.4)	<0.001
Number of coccygeal segments						
	3 (0-4)	4 (0-4)	<0.001[U]	3 (0-4)	4 (0-4)	<0.001[U]
	3.7 (4-0.6)	4 (4-0.6)		3.7 (4-0.6)	4 (4-0.6)	

U; Mann Whitney U Test(Monte Carlo), c; Pearson Chi-Square Test(Monte Carlo), f; Fisher Freeman Halton Test (monte Carlo); Post Hoc test: Benjamini-Hochberg correction SD.: Standard Deviation, ns.: Not significant, Q1: 1st quartile, Q3 3th Quartile; +:fusion is present, -: no fusion.

The mean sacrococcygeal straight length was 33.2±7.9 mm in the whole group, 34.3±8.1 mm in males, and 32.2±7.6 mm in females. This length was highest in type IV coccyxes (max 77.5 mm) and shortest in type III (min 11.5 mm). It was also significantly higher in the male group than in the female group (p<0.001, Table 4).

Table 4. Sex-wise distrubution of lateral deviation angle, sacrococcygeal straight length, mean sacrococcygeal and intercoccygeal curvature angles in different coccyx types

Type of Coccyx	Female					Male				
	n	Lateral deviation angle (°)	Sacrococcygeal straight length (mm)	Sacrococcygeal curvature angle (°)	Intercoccygeal curvature angle (°)	n	Lateral deviation angle (°)	Sacrococcygeal straight length (mm)	Sacrococcygeal curvature angle (°)	Intercoccygeal curvature angle (°)
I	39	4.0		0.1	129.6	161.3	33	7.0	31.9	131.7
II	391	5.0	32.6	109.7	145.3	334	6.0	34.4	113.0	144.9
III	99	5.0	31.8	94.9	127.9	94	6.0	34.6	102.7	127.9
IV	5	6.0	22.9	154.8	152.5	5	6.0	34.0	151.6	175.6
Total	534	5.0	32.2	108.8	143.3	466	6.0	34.3	112.7	143.0

The mean sacrococcygeal curvature angle was 110.6±14.9° in the whole group, 108.8±15.4° in the female group, and 112.7±14.2° in the male group. This angle was significantly wider in the male group than in the female group (p<0.001). The largest sacrococcygeal curvature angle (167.2°) was observed in type IV coccyxes, and the smallest sacrococcygeal curvature angle (69.9°) was observed in type III coccyxes (Table 4). The mean intercoccygeal curvature angle was 143.2±19.9° in the whole group, 143.3±20.8° in the female group, and 143.0±18.9° in the male group. The largest intercoccygeal curvature angle (180.0°) was observed in type IV coccyxes, and the smallest angle (76.3°) was observed in type III coccyxes (Table 4).

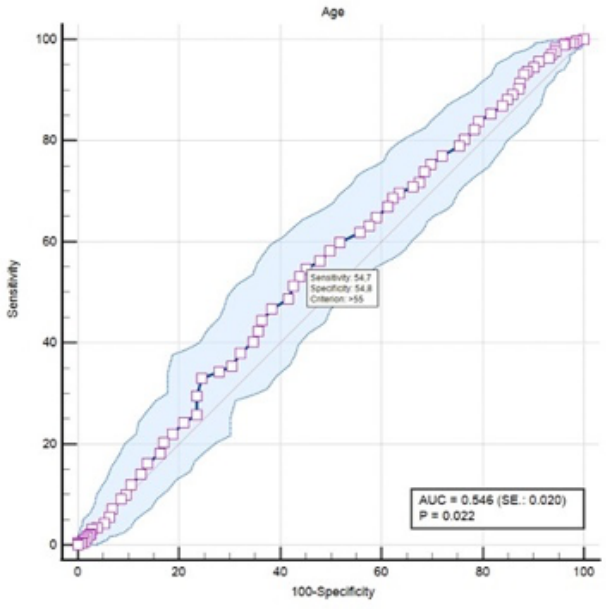

Figure-4; The prevalence of sacrococcygeal and intercoccygeal fusion increases significantly over 55 years of age.

Lateral deviation of the coccyx was observed in a total of 36 cases. A deviation to the right was observed in 21 cases, and a deviation to the left in 15 cases. The lateral deviation to the right was five times more common in the female group than in the male group. Similarly, a lateral deviation on the left side was observed five times more often in the male group than in the female group. This difference was statistically significant (p=0.041). The mean deviation angle was 5.6°; this value was 5.2° in the female group and 6.1° in the male group.

Discussion

Direct radiographs, CT scans, and MRIs can be utilized for the anatomical evaluation of the coccyx. In our study, we preferred 3D CT because we believed that the coccygeal spicule, one of the parameters examined in this study, could be visualized with this modality.

When we analyzed the number of vertebrae in the coccyx, four coccygeal vertebrae were observed in most of the cases. Woon et al. also reported a similar result, but in a study conducted in an Egyptian population, Gebba et al. reported that three vertebrae were observed in most cases [14,17]. Similarly, Przybylski et al. reported that three vertebrae were observed mainly in the Polish population [18]. In a study conducted on Turkish adults, Tetiker et al. reported that the most common number of vertebrae observed was four, which is compatible with our study results [19].

In our study, the most common type of coccyx was type II, and the second most common type was type III. Similar studies in the literature have also revealed that the most common types are type I and type II, respectively [11,12,14,16,19]. In addition, Przybylski reported that type II and type III were the most common in the Polish population, similar to the results in our study [18]. In a study based on pelvic CT scans in a sizeable Korean

population (606 cases), the most common type was also reported as type II coccyx [20].

Regarding sacrococcygeal fusion, 34.3% of our patients had partial fusion, and 35.2% had complete fusion. In total, this rate was 69.5%. There was no significant difference between the male and female groups. Yoon et al. found the rate of sacrococcygeal fusion to be 34% in the Korean population [20]. In the study by Woon et al., sacrococcygeal fusion was reported in more than 50% of the population [16]. Tague stated that the prevalence of sacrococcygeal fusion increased with age [21]. Our study observed that sacrococcygeal and intercoccygeal fusion rates increased significantly over 55 years of age.

This study identified the most common type of sacrococcygeal fusion type II, and the minor joint group was type I. Tetiker et al. have reported the prevalence of sacrococcygeal fusion as 23.8% in males and 21.6% in females. Consistent with our study, a significant increase in the rate of sacrococcygeal fusion was observed with an increase in the number of vertebrae [19].

In our study, intercoccygeal fusion was seen in 836 cases. In 84% of the 836 cases, fusion was observed at the last intercoccygeal joint. Tetiker et al. also reported a similar result [19]. In 26 cases, it was observed that all intercoccygeal joints were fused. In 11 of these 26 cases, fusion was observed in the sacrococcygeal joint and all intercoccygeal joints. These rates are close to the results obtained by Tetiker et al. [19]. In the report published by Woon et al., the rate of intercoccygeal fusion was reported to be 89% [16]. In our study, the most common type of coccyx in which intercoccygeal fusion was observed was type II, and the least common type of coccyx was type IV. As the number of coccygeal vertebrae increased, there was a significant increase in the rate of intercoccygeal fusion.

Coccygeal spicule was present in 3.7% of cases. In the study by Woon et al. [16], this rate was 23%, and Indiran reported it as 8.45% [11]. In the study of Indiran et al., the coccyx types of the patients with coccygeal spicule were mostly Type III and IV [11]. However, in our study, 30 (81.08%) of 37 cases with coccygeal spicule were determined as type II coccyx. The rate of spicule presence was much lower in our study, and the cases with spicule had a type II coccyx, which is a different result than that of other studies.

The mean sacrococcygeal straight length was 33.2±7.9 mm in the whole group, 32.2±7.6 mm in females, and 34.3±8.1 mm in males. This length was greatest in type IV coccyxes and shortest in type III. It was also significantly longer in the male group than in the female group. When studies conducted in different ethnic populations in the literature are examined, it is seen that this length is found to be higher in males than in females [11,14,16].

The mean sacrococcygeal curvature angle was calculated as 110.6±14.9° in the whole group, 108.8±15.4° in the female group, and 112.7±14.2° in the male group. This angle was significantly wider in the male group than in the female group. The largest sacrococcygeal curvature angle was observed in type IV coccyxes, and the smallest was in type III.

The mean intercoccygeal curvature angle was 143.2±19.9° in the whole group, 143.3 ±20.8°in the female group, and 143.0±18.9°in the male group. There was no significant difference between sexes in terms of intercoccygeal curvature angle. The largest intercoccygeal curvature angle was observed in type IV coccyxes, and the smallest was in type III. Both the sacrococcygeal curvature angle and intercoccygeal angles were found to be the highest in type IV coccyxes. The group with the lowest angles was type III.

Although the angles are similar in studies on coccyx morphology in the literature, in a report by Indiran et al., the sacrococcygeal angle was significantly higher in males than in females [11]. In this study, the mean sacrococcygeal angle was found to be 116.69±13.32° in males and 111.66±18.45° in females. In the same study, the intercoccygeal curvature angle was measured as 140.94±19.83° in males and 145.10±19.60° in females. They reported no significant difference between males and females in intercoccygeal angles [11]. Our results on the differences in angles according to sex are consistent with this study.

In the study of Woon et al., no significant male-female difference was observed in terms of

angles. In another study conducted in the Egyptian population, no male-female difference was observed when the mean sacrococcygeal and intercoccygeal angles were compared, similar to the study of Woon et al. [16]. In another study conducted by Yoon et al. in the Korean population, the mean sacrococcygeal angle was found to be 110°. The mean intercoccygeal angle (based on the narrow-angle in the study) was found to be 49° [20]. In a morphometric study of the coccyx conducted by Lee et al. in 136 adult patients using 3D reconstruction CT, as in our study, the authors reported that sacrococcygeal and intercoccygeal angles were found to be higher in females [3].

In our study, lateral deviation of the coccyx was found in 36 cases (20 females, 16 males). Of these cases, 21 were deviated to the right and 15 to the left. The deviation angles ranged from 4–10°. Statistically, there was no difference in deviation angles between males and females.

In the report by Indiran et al., the lateral deviation angle range was found to be 4–11°, and the mean angle was reported as 5.95°. This report stated no difference in the incidence of lateral deviation of the coccyx between males and females, and in 213 cases, lateral deviation of the coccyx was found in 10 patients (seven males, three females) [11]. In the study by Woon et al., the mean deviation angle was reported as 6° [16].

These values are close to our results. In addition, in our study, lateral deviation on the left side was five times more common in the male group than in the female group, and this difference was statistically significant.

Conclusion

There are similarities and differences between different ethnic populations in terms of the morphology of the coccyx. At the same time, in cases with idiopathic coccydynia, whose etiology has not yet been fully clarified, there may be different structural changes according to different ethnic populations. In this sense, this study conducted in asymptomatic individuals can be used as a “set of societal reference values” in future studies on symptomatic individuals to determine the ethnic morphology of the coccyx and the etiology of coccydynia.

Our study has both strengths and limitations. One of the strengths of our study is the high number of participants, which is crucial for ensuring the reliability of the obtained data. Another vital aspect of our study is the comprehensive examination of the subject. The variables analyzed encompassed the Postacchini and Massobrio classification, fusion at the sacrococcygeal and intercoccygeal junction, coccygeal spicule, sacrococcygeal-intercoccygeal curvature angles, and lateral deviation of the coccyx.

In our retrospective study, participants were evaluated solely in a static position using 3D CT scans, and measurements were derived from these static image data. However, the sacrococcygeal and intercoccygeal curvature angles may vary depending on the posture during seated or standing imaging. Further studies incorporating dynamic imaging may be required to obtain more precise data. This limitation should be acknowledged in our study.

Conflict of Interest: The authors declare no conflict of interest related to this article.

Funding sources: The authors declare that this study has received no financial support.

Ethics Committee Approval: Local ethics committee approval was obtained. The ethical approval code for this study is 2/2021.K-5.

ORCID and Author contribution: **T.K. (0000-0002-2992-7980):** Study conception and design, Analysis and interpretation of results, Draft manuscript preparation, Critical revision of the article, Other (study supervision, fundings, materials). **A.K. (0000-0002-0505-3027):** Data collection, Draft manuscript preparation, Other (study supervision, fundings, material)

Peer-review: Externally peer reviewed.

Note: The authors thank Enago – https://www.enago.com.tr/ceviri/ for their assistance in manuscript translation and editing.

Abbreviation list:

CT; Computed tomography

D; Dimensional

MRI; Magnetic resonance imaging.

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