Clinical reflection of anatomical evaluation in coccydynia

Emel Guler[1], Ilkay Guler[2], Ayla Arslan[3], Gökçe Bagci Uzun[4]

[1] *Sivas Cumhuriyet University Faculty of Medicine, Department of Physical Medicine and Rehabilitation, Algology, Sivas, Turkey*
[2] *General Surgery, Republic of Türkiye, Ministry of Health, General Directorate of Public Hospitals, Ankara, Turkey*
[3] *Ağrı İbrahim Çeçen University Faculty of Medicine, Department of Anatomy, 04200, Ağrı, Turkey*
[4] *Malatya Turgut Özal University, Faculty of Medicine, Department of Anatomy, Malatya, Turkey*

SUMMARY

Coccydynia is a pain in the coccyx and the surrounding anatomical structures. Our aim in the study was to evaluate whether the disease duration, pain assessment, and coccyx morphological type had an effect on this clinic in patients with a diagnosis of coccydynia. A total of 68 coccyx Magnetic Resonance Imaging (MRI) results were evaluated. Coccyx segment number, morphological typing, lumbosacral, sacrococcygeal, and intercoccygeal angle measurements were made. Disease duration, day and night movement and the rest of Numerical Pain Scale (NRS) values were recorded from existing records of patients with a diagnosis of coccydynia. When the morphological typing was evaluated, type 4 subluxation was found to be high in the group with coccydynia. Pain complaint duration was 13.94 ± 12.22 months, sitting time was 16.82 ± 14.22 minutes, and the numerical pain scale was 7.62 ± 1.48. Morphologically, type 1;14 (3 coccydynia), type 2;22 (9 coccydynia), type 3;14 (6 coccydynia), type 4;18 (16 coccydynia) images were also detected. A moderately statistically significant positive correlation was found between the sacrococcygeal and intercoccygeal angles ($p<0.05$). We believe that evaluating clinical data and anatomical measurements together will contribute to the treatment of coccydynia, which is especially difficult to treat.

Key words: Coccydynia – Sacrum – Pain – MRI

ABBREVIATIONS

MRI: Magnetic Resonance Imaging

NRS: Numerical Pain Scale

INTRODUCTION

Coccydynia is also known as coccygodynia or coccygeal neuralgia (Malik et al., 2014). Coccydynia was first defined by Simpson in 1859 as pain in the coccyx and surrounding anatomical structures (Lirette et al., 2014; Mabrouk et al., 2023). The coccyx consists of the union of the last 3-5 vertebrae that are not well developed. Its posterior surface is slightly convex, while its anterior surface is slightly concave (Nelson, 1991). There is a synarthrosis joint between the coccyx seg-

Shared corresponding authors:
Assist Prof. Dr. Emel Guler. Sivas Cumhuriyet University Faculty of Medicine, Department of Physical Medicine and Rehabilitation. Algology, Sivas, Turkey. Phone: +90 535 6492951; Fax: +90 346 487 00 00. E-mail: dremelguler@gmail.com - Orcid: 0000-0002-5049-8770

Submitted: January 5, 2024. **Accepted:** February 9, 2024

https://doi.org/10.52083/BKHP8714

ments. The sacrococcygeal and intercoccygeal joints forms are surrounded by ligaments (Andrés and Chaves, 2003). The coccyx has very important functions by carrying the weight of a person in a sitting position, helping voluntary bowel control, and supporting the anus positionally due to its anatomical neighbourhoods (Lirette et al., 2014). Although factors such as trauma, malignancy, and difficult delivery are listed in the etiology of coccydynia, one third of the cases are idiopathic. In patients with idiopathic etiology, there are radiology studies showing that pain is caused by anatomical changes in the coccyx and adjacent ligament structures (Maigne et al., 2006; Woon et al., 2013). Although coccydynia most commonly affects middle-aged women, it may be found in both sexes and in all age groups (White et al., 2022). In coccydynia, patients complain of pain, especially when sitting on hard places.

Internal and external trauma are significant etiological factors in the formation of coccydynia. While internal trauma occurs in difficult birth, external trauma is trauma caused by coccyx dislocation, coccyx fracture and supine fall. Anatomical knowledge of coccydynia is essential and its combination with radiological evaluation has a very important place in patients receiving appropriate treatment.

The goal of this work was to investigate the number of coccyx segments, morphological typing, lumbosacral, sacrococcygeal and intercoccygeal angle measurements and morphometric features, duration of complaints and pain in coccydynia.

MATERIALS AND METHODS

In our study, the images of patients who consulted to School of Medicine Physical Therapy and Rehabilitation clinic among 01/01/2021 and 31/12/2021 and were determined with coccydynia and healthy volunteers who were not diagnosed with coccydynia but had pelvic MRI images between the same dates were included. Consent was obtained with the consent forms prepared from the accessible patient and control groups.

In our study, a total of 68 coccyx Magnetic Resonance Imaging (MRI) results, 19 of women and 49 of men, were evaluated. Of these 68 coccyx MRIs, 34 were from patients with a diagnosis of coccydynia, and 34 were from healthy volunteers. In our retrospective study, the number of coccyx segments, morphological typing, lumbosacral, sacrococcygeal and intercoccygeal angle measurements were made in the current coccyx MRI. Disease duration was recorded from the existing records of patients with a diagnosis of coccydynia.

Inclusion criteria for the study: to be diagnosed with coccydynia, to have a history of trauma to the coccyx region, to be between the ages of 18-70, to accept the evaluation of their current images in the study

Exclusion criteria are: those under the age of 18 or over the age of 70, those with pilonidal sinus, those who underwent local surgery, and those who did not accept the evaluation of their current images.

Evaluation scales to be used during patient records:

Numerical pain scale (NRS): It is used to measure pain intensity and monitor pain. It provides a measurement from 0 to 10 (0 = no pain, 10 = most severe pain). The measurement was made by asking the patients to mark the number corresponding to their pain intensity.

Radiological evaluation: During the evaluation of coccyx bone anatomy, the classification created by Postacchini and Massobrio was used for segment number morphological typing. This grading showed that the morphology and morphometry of the coccyx can play a role in the formation of coccydynia. For instance,, the risk of developing coccygeal pain is higher in people who have a distinctly arcuate and forward-facing, sharply angled anterior coccyx or spicule and a posteriorly directed coccyx, scoliotic deformity or subluxation of the intercoccygeal or sacrococcygeal joints (Maigne et al., 2000; Nathan et al., 2010).

Classifications were made as follows:

- Type I: The coccyx is slightly arcuate anteriorly and the apex is directed downward.
- Type II: Increased coccyx tilt angle and apex forward.
- Type III: The coccyx is sharply angled.
- Type IV: It is in the form of subluxation at the

sacrococcygeal and first intercoccygeal joints (Nathan et al., 2010; Postacchini and Massobrio 1983).

In addition, lumbosacral, sacrococcygeal, and intercoccygeal angles were measured. In our study, three angle measurements were made (Figs. 1, 2):

1- Lumbosacral angle: The angle between the line passing entirely the middle of the 5th lumbar vertebra and the lines passing through the middle of the first sacral vertebra was calculated by measuring (Okpala, 2014).

2- Sacrococcygeal angle: The angle between the line passing entirely through the middle of the 1st coccygeal vertebra and the lines passing through the middle of the first sacral vertebra was calculated by measuring.

3- Intercoccygeal angle: The angle between the line passing entirely through the middle of the first coccygeal vertebra and the line passing through the middle of the other coccygeal vertebrae was calculated by measuring (Woon et al., 2013).

Ethics Committee Approval

This work was implemented with the approval School of Medicine Non-Invasive Clinical Research Ethics Committee dated 16.02.2022 and verdict number 2022-02/44. Informed assent forms were received from the control groups and patients included in the study.

Statistical analysis

The analysis of the data in the research was done with the SPSS (Statistical Program in Social Sciences) 25 program. Descriptive statistics were calculated as mean, number, median, percentage, min-max, and standard deviation. The Mann-Whitney U test was used for data that did not fit the normal distribution, and the t-test was used for the comparisons of the two groups in the data that fit the normal distribution. Kruskal Wallis analysis was used in multiple groups that did not show normal distribution. In the comparison of categorical data, the chi-square test was applied by composing cross tables. The significance value (p) was taken as 0.05. In the analysis of the relations between the variables, the Spearman rank correlation coefficient was used because normal distribution could not be achieved.

RESULTS

A statistically substantial dissimilarity was observed among coccydynia and healthy groups according to age and gender in the participants included in the study ($p<0.05$). The mean age was 36.62 ± 12.84 years in the coccydynia patient

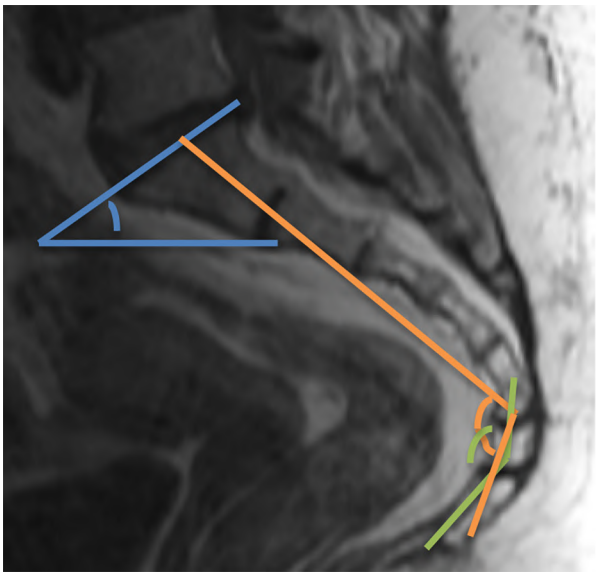

Fig. 1.- Angle measurement methods. Green line: Intercoccygeal angle. Blue line: Lumbosacral angle. Orange line: Sacrococcygeal angle.

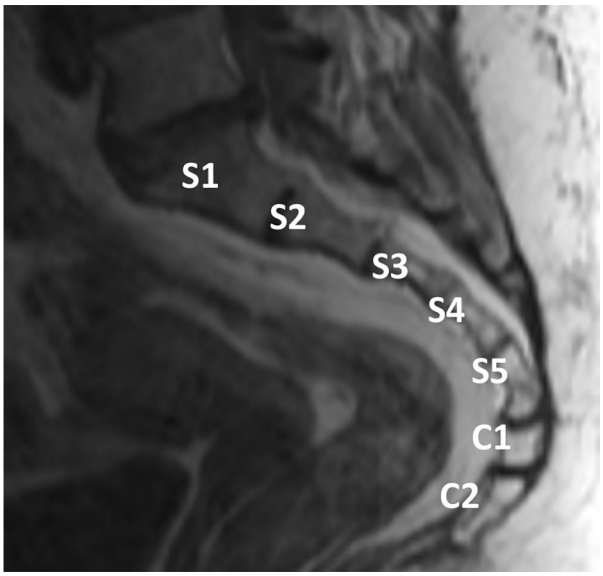

Fig. 2.- Sacrum and coccyx bone anatomy. S: Sacrum, C: Coccyx.

group and 44.35 ± 14.04 years in the healthy control group (Table 1). The duration of pain complaint was 13.94 ± 12.22 months, the sitting time was 16.82 ± 14.22 minutes, and the Numerical Pain Scale (NRS) was 7.62 ± 1.48 (Table 2). A statistically substantial difference was found among coccydynia and healthy groups according to morphological types (type I, type II, type III, and type IV) (p=0.001<0.05). Morphologically, type I;14 (3 coccydynia), type II;22 (9 coccydynia), type III;14 (6 coccydynia), type IV;18 (16 coccydynia) images were also detected (Table 3). When the morphological typing was evaluated, type IV with subluxation (partial dislocation) was found to be high in the coccydynia group. There was no statistically substantial dissimilarity among coccydynia and healthy groups according to the number of segments in the participants included in the study (p> 0.05). The number of segments was found to be 1 in 1 image, 2 in 16 images, 3 in 34 images, 4 in 16 images, and 5 in 16 images (Table 4). A statistically substantial dissimilarity was found among the groups (coccydynia and healthy) according to the measurement of sacrococcygeal angle (p=0.001<0.05, Table 5). A statistically substantial dissimilarity was found among the coccydynia and healthy groups according to the measurement of intercoccygeal angle (p=0.020<0.05, Table 5). In the coccydynia group, no statistically meaningful difference was found according to the morphological types (type I, type II, type III, and type IV) in point of duration of complaint, sitting time, and NRS variables (p>0.05, Table 4). A statistically important relationship was found between age and the number of segments in the negative direction (r =-0.365) and statistically meaningful

Table 1. Comparison of morphological types between groups.

Variable	Group	Value	coccydynia	healthy	Total	χ^2 Value	p Value
morphological type	Type I	n	3	11	14	0,492	0,001*
		%	8,8%	32,4%	20,6%		
	Type II	n	9	13	22		
		%	26,5%	38,2%	32,4%		
	Type III	n	6	8	14		
		%	17,6%	23,5%	20,6%		
	Type IV	n	16	2	18		
		%	47,1%	5,9%	26,5%		

n; number of samples, %; percent, p; Chi-square Test value (χ^2), *p<0.05; There is a statistically significant difference between the groups.

Table 2. Comparison of coccyx segment numbers between groups.

Variable	number	n %	group		Total	χ^2 Value	p Value
			coccydynia	healthy			
segment_number	1	n	1	0	1	4,152	0,386
		%	2,9%	0,0%	1,5%		
	2	n	9	7	16		
		%	26,5%	20,6%	23,5%		
	3	n	18	16	34		
		%	52,9%	47,1%	50,0%		
	4	n	6	10	16		
		%	17,6%	29,4%	23,5%		
	5	n	0	1	1		
		%	0,0%	2,9%	1,5%		
Total		**n**	**34**	**34**	**68**		
		100,0%	**100,0%**	**100,0%**	**100,00%**		

n; number of samples, %; percent, p; Chi-square Test value (χ^2),

Table 3. Comparison of number of segments and angles between groups.

Variable	Groups	Mean ± ss	Test	p Value
segment number	**coccydynia**	2,85 ± 0,74	-1,591	0,121
	healthy	3,15 ± 0,78		
lumbosacral angle	**coccydynia**	40,19 ± 10,64	0,303	0,772
	healthy	39,47 ± 9,46		
sacrococcygeal angle	**coccydynia**	96,82 ± 14,36	***-4,941***	***0,001****
	healthy	113,39 ± 13,26		
intercoccygeal angle	**coccydynia**	130,7 ± 26,63	***-2,472***	***0,020****
	healthy	143,71 ± 15,25		

Cover; mean, ss; standard deviation, Min; lowest score, max; highest score, test value; t Test Value, p value; statistical significance, *p<0.05; There is a statistically significant difference between the groups.

Table 4. Comparisons by morphological types for complaints, residence times and NRS in the coccydynia group.

Variable	Groups	M (Min - Max)	Test	p Value
complaint period	Type I	24(2-24)	0,758	0,859
	Type II	12(1-36)		
	Type III	15(1-48)		
	Type IV	10(1-36)		
sitting time	Type I	15(10-30)	3,528	0,317
	Type II	15(1-30)		
	Type III	22,5(10-60)		
	Type IV	10(3-60)		
NRS	Type I	6(6-8)	4,468	0,215
	Type II	7(6-10)		
	Type III	7(6-9)		
	Type IV	8(5-10)		

Cover; mean, ss; standard deviation, M; Median, Min; lowest score, max; highest score, test value; Kruskal Wallis Test Value, p value; statistical significance.

Table 5. Correlation analysis of the relationships between the variables in the coccydynia group.

Variable		complaint period	sitting time	NRS	segment number	lumbosacral angle	sacrococcygeal angle	intercoccygeal angle
age	r	0,293	-0,060	-0,026	***-0,365***	0,261	0,300	0,241
	p	0,093	0,738	0,886	***0,034****	0,136	0,085	0,170
complaint period	r		0,050	0,010	0,069	0,234	0,145	0,154
	p		0,780	0,953	0,698	0,182	0,414	0,386
sitting time	r			***-0,624***	-0,226	-0,088	0,160	***0,338***
	p			***0,001****	0,199	0,620	0,365	***0,049****
NRS	r				0,251	0,056	***-0,471***	-0,422
	p				0,153	0,752	***0,005****	0,013
segment number	r					0,016	-0,329	***-0,420***
	p					0,929	0,058	***0,013****
lumbosacral angle	r						-0,268	-0,002
	p						0,126	0,990
sacrococcygeal angle	r							***0,349***
	p							***0,043****

r; spearman rank correlation coefficient, p value; statistical significance, *p<0.05; There is a statistically significant relationship between the variables.

($p<0.05$). There was a moderate ($r=-0.624$) statistically significant negative correlation between sitting time and NRS ($p<0.05$, Table 5). A positive moderate ($r = 0.338$) significant correlation was found between sitting time and intercoccygeal angle ($p<0.05$, Table 5). A moderate ($r =-0.471$) statistically important negative connection was found between NRS and sacrococcygeal angle ($p<0.05$, Table 5). A moderate ($r =-0.420$) statistically important negative relationship was found between the number of segments and the intercoccygeal angle ($p<=0.05$, Table 5). A moderate ($r = 0.349$) statistically substantial positive relationship was observed between the sacrococcygeal angle and the intercoccygeal angle ($p<=0.05$, Table 5).

DISCUSSION

The anatomy of the coccyx, its neighbourhood with the surrounding anatomical structures, and the angle it makes with them are important for coccydynia. It has been reported that the coccyx has a highly variant structure, considering its morphology, inclusive of the number and segments of the coccygeal vertebrae (White and Folkens, 2005). Karayol et al. (2019) before this compared coccyx types as a morphological feature only in terms of the number of coccygeal vertebrae and determined a significant dissimilarity among the types. Guneri and Gungor (2021), according to the morphological shapes of the coccyx in their study, found type 1 and type 2 at the highest rate. In another study, type 2 was higher according to the Postacchini classification. In addition, pain intensity generally increased with higher angulation (Dalbayrak et al., 2014). Shams et al. (2023) found the most common coccygeal segment number to be 3 in both groups. Also, Shams et al. (2023) the most common coccygeal type in the coccydynia group was type 2. The most common in the control group was type 2, followed by type 3 and type 1. They found no statistically meaningful difference between the 2 groups in terms of intercoccygeal joint fusions. In our study, however, we found the highest number of segments to be 3 in the coccygodynia and healthy group. We found the highest morphological type to be type 4 in the coccydynia group, and the highest type 2 in the healthy group. Intercoccygeal joint subluxation was more common in the coccydynia groups than in the control group.

There are many studies in the literature evaluating changes in sacral, sacrococcygeal, and intercoccygeal angles, which are thought to cause disease in patients presenting with the diagnosis of coccydynia. Woon et al. (2013) found the sacral angle to be remarkably lower in coccydynia patients of both sexes compared to the control group, and they found the coccygeal curvature to be significantly lower in female patients with coccydynia. In addition, they did not find a remarkably significant dissimilarity in terms of sacrococcygeal curvature index in both genders in patients with coccydynia (Woon et al., 2013). Gupta et al. (2018) evaluated MRI to compare sacrococcygeal and intercoccygeal angles in their study, which included 10 volunteers with coccydynia and 106 volunteers in the control group. No statistically important difference was determined among the groups in sacrococcygeal and intercoccygeal angles. They observed that the intercoccygeal angle decreases with age. In another study, they found both intercoccygeal and sacral-angle coccydynia to be lower in the group than in the control group. There was no differentiation among the groups in the sacrococcygeal angle (Shams et al., 2023). Woon et al. (2013) found that the sacrococcygeal angle was not remarkably different between the coccydynia and control groups. In our study, we detected a statistically meaningful difference between the groups (coccydynia and healthy) according to the measurement of intercoccygeal angle and sacrococcygeal angle.

Ozkal et al. (2020) found a significant difference between the intercoccygeal angle and the sacrococcygeal angle and the number of segments in their study. They stated that 57 of the patients participating in the study had 3 segments and 98 had 4 segments, and type 1 was the most common morphological type.

Pain in coccydynia is the main symptom affecting the sitting time of patients. In the study conducted by Gonnade et al. (2017). The NRS worths were recorded after and before interventional treatment in 31 patients with coccydynia complaints, and they found the mean score before treatment was 7.90 ± 0.16. Similarly, in our study,

we found the NRS score to be 7.62 ± 1.48 (Gonnade et al., 2017). There are studies on the static and dynamic measurements of joint angles and the angles they make with neighbouring joints. However, there is no study in which patients' complaint duration and pain were evaluated together with all these parameters (Maigne et al., 2000). In addition, in our study, we found that the prolongation of sitting time was proportional to the decrease in NRS and that the increase in the intercoccygeal angle was correlated with the increase in the sitting time. Again, we found that the sacrococcygeal angle decreased with the increase in NRS value. We found that as the number of segments increases, the intercoccygeal angle decreases, and as the sacrococcygeal angle increases, the intercoccygeal angle increases. In the literature review, we did not find any study on this subject in which the number of segments, sitting time, pain scale, and angles were evaluated together.

CONCLUSION

Morphological typing of the coccyx has also gained more importance in terms of dynamic imaging studies, patient follow-up, and evaluation of the efficacy of treatment methods. There are few studies in the literature in which patients' pain, trauma history, and radiological images are evaluated. As a result, we believe that the evaluation of clinical data and anatomical measurements together will contribute to the treatment of the disease, especially in coccydynia, which is difficult to treat.

Study limitations

Our present study has some limitations: 1) This is not a sequential series of coccydynia patients. Because MR treatment was difficult and was done in serious cases. 2) The number of our patients is low due to the patients who do not want to have an MRI. Since it is difficult to find coccydynia patients, we do not have many patients.

Authors' contributions

Study concept and design: E.G. and I.G. Acquisition of data: E.G. Analysis and interpretation of data: E.G., I.G., A.A. and G.B.U. Drafting of the manuscript: E.G., I.G., A.A. and G.B.U. Critical revision of the manuscript for important intellectual content: E.G., I.G., A.A. and G.B.U Statistical analysis: E.G., I.G., A.A. and G.B.U. Administrative, technical, and material support: E.G., I.G., A.A. and G.B.U Study supervision: E.G.

Ethical approval

This work was implemented with the approval of Non-Invasive Clinical Research Ethics Committee dated 16.02.2022 and verdict number 2022-02/44.

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