

Magnetic Resonance Measurements of Sacrococcygeal and Intercoccygeal Angles in Normal Participants and those with Idiopathic Coccydynia

Abstract

Background: In the past, few studies have been done to objectively measure the sacrococcygeal (SC) and intercoccygeal (IC) angles in the population and in patients with coccydynia. Coccydynia is an age-old disorder, the exact incidence of which has not been determined. It is reported to be more common in females and the obese. The magnetic resonance imaging (MRI) studies done in the past have calculated the curvature indices. In this study, we used MRI to objectively measure the angles in the normal participants as well as those with idiopathic coccydynia. **Materials and Methods:** Two groups of patients were identified. Group A was “control group” of 106 normal participants and Group B comprised “study group” of ten patients suffering from idiopathic coccydynia. In all these patients, midsagittal T1-weighted MRI image acquired in supine position was used to calculate SC and IC angles. Data were analyzed, and angles were compared between the study and control groups. Statistical analysis was done with Chi-square test. **Results:** In the control group, the average SC and IC angles in the control group were 126.8° and 33.5°, respectively. In the study group, the average SC angle and the average IC angle turned out to be 127.1° and 43.2°, respectively. The difference between the SC angles in the control and study groups was not significant ($P = 0.7$), whereas the difference between the IC angles in the two groups was significant ($P = 0.002$). **Conclusions:** From our study, we observed that the IC angle shows a decreasing trend with increasing age. In addition, increased IC angle was identified as a possible cause of idiopathic coccydynia.

Keywords: Coccydynia, intercoccygeal angle, sacrococcygeal angle

MeSH terms: Magnetic resonance imaging; sacrococcygeal region; coccyx

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Introduction

Around three to five vertebral segments form the coccyx, the tailbone, which is placed inferior to the sacrum in the spine. The coccygeal segments are anatomically devoid of posterior arch structures, namely, the pedicles, spinous processes, and laminae and decrease in size caudally.

The coccyx plays an important role in weightbearing in the sitting posture, especially during the person leaning backward.

Coccydynia or coccygodynia is defined as pain in and around the coccyx. It was first described by Simpson in 1859.¹ However, descriptions of pain in the caudal end of spine date back to the 16th and 17th centuries.¹⁻⁴ The pain can be of varying intensity and related to locomotor activities of defecation. The classic symptom is pain when pressure is applied to the coccyx, such as when sitting on a hard chair. Symptoms usually improve with relief of pressure when standing or walking.

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In spite of being an age old disorder, coccydynia remains an enigma because the origin of pain still remains largely undetermined.⁵ The most common cause of coccydynia is single direct axial trauma such as a fall directly onto the coccyx or due to a subtle form of cumulative trauma.⁶ However, in around one-third of the patients, the cause of the pain remains unknown.^{7,8} Previous studies about coccydynia have concentrated on the cause, diagnostic method, radiologic classification^{9,10} as well as the treatment method.^{2,4,7,11,12} However, very few magnetic resonance imaging (MRI) studies¹³ have actually been done on objective measurement of the coccyx, and whatever studies have been done used either radiography or computed tomography.

The present study was done with the objective of measuring the sacrococcygeal (SC) and intercoccygeal (IC) angles in normal population and in cases of idiopathic coccydynia, using MRI. MR, due to high definition of bony margins

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and optimal visualization even in obese patients, aided unambiguous calculation of angles. Furthermore, lack of ionizing radiation added to the benefit.

Materials and Methods

Two groups of patients were identified visiting the Radiology Department at our institute between September 2014 and March 2015. Group A was “control group” of 106 normal patients with no history of coccydynia but referred for MRI lumbosacral spine for some other complaints. Group B comprised “study group” of ten patients suffering from coccydynia with no identifiable cause. Patients of both groups underwent MRI of lumbosacral spine on Philips 3 Tesla MRI scanner along with screening of whole spine to ensure accurate identification of the lumbosacral junction.

The inclusion criteria for study group comprised patients with a history of chronic coccydynia ≥ 6 months duration who did not have any direct known etiological factors for pain such as trauma, disc disease, infection, or neoplastic processes. Only patients with four coccygeal vertebrae were included in the study group to eliminate ambiguity in objective assessment.

Exclusion criteria for study group included coccydynia of known origin. Patients with atypical coccygeal configurations such as scoliosis and transitional vertebrae were excluded from the study.

In all these 116 patients of study and control groups, midsagittal T1-weighted MRI image acquired in supine position was used for assessment with similar study

parameters. Thereafter, in each patient, SC and IC angles were calculated as follows.

The SC angle was the angle between the sacrum and coccyx and is an objective measurement of the forward curvature of the sacrum. To calculate it, a line was drawn through the midpoints of superior and inferior endplates of S1, and another line was drawn through the midpoint of superior and inferior endplates of first coccygeal vertebra. The angle subtended by these two lines was measured to be the SC angle [Figure 1].

The IC angle was similarly calculated as the angle subtended between the lines drawn through midpoints of first and last coccygeal vertebrae and is an objective measurement of the forward curvature of coccyx [Figure 2] as cited in studies done by Woon *et al.* and Marwan *et al.*^{13,14}

This was an observational study, and prior approval was obtained from the Institutional Review Committee. Data were collected and analyzed, and angles were compared between the study and control groups. Statistical analysis was done with Chi-square test.

Results

In this study, the control group (comprising normal individuals, $n = 106$) had 44 males and 62 females. In males of this group, the average SC angle was 124.5° and average IC angle was 33.1° . Whereas in females of control group, the average SC angle was 128.4° and average IC angle was 33.6° [Table 1]. In total, the average SC and IC angles in the control group were 126.8° and 33.5° , respectively.

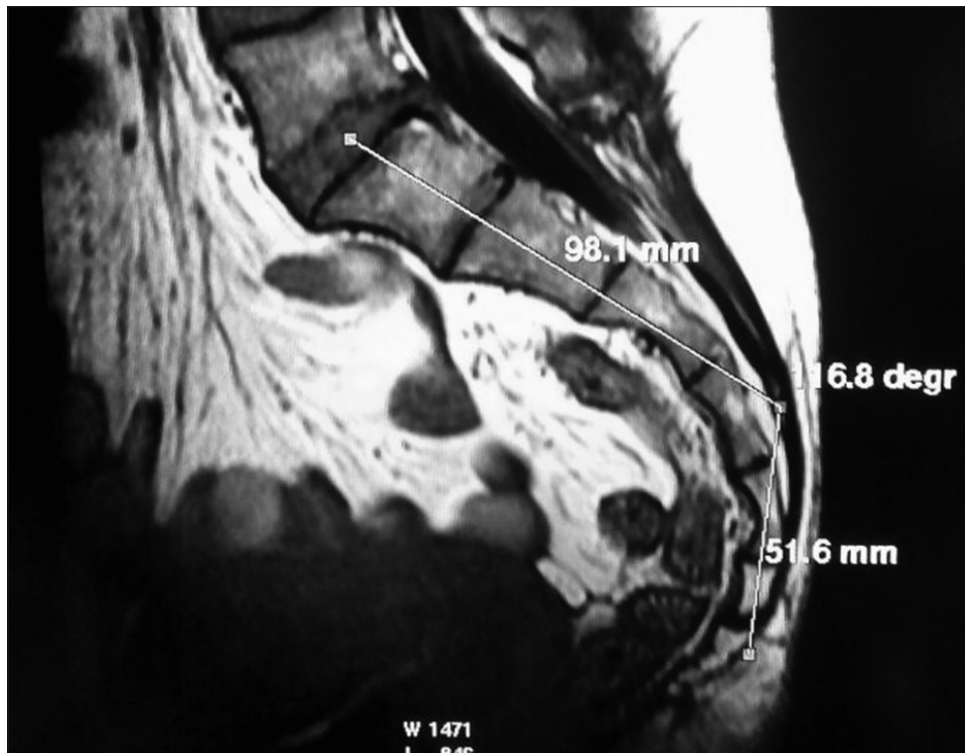


Figure 1: Magnetic resonance T1W1 midsagittal showing sacrococcygeal angle

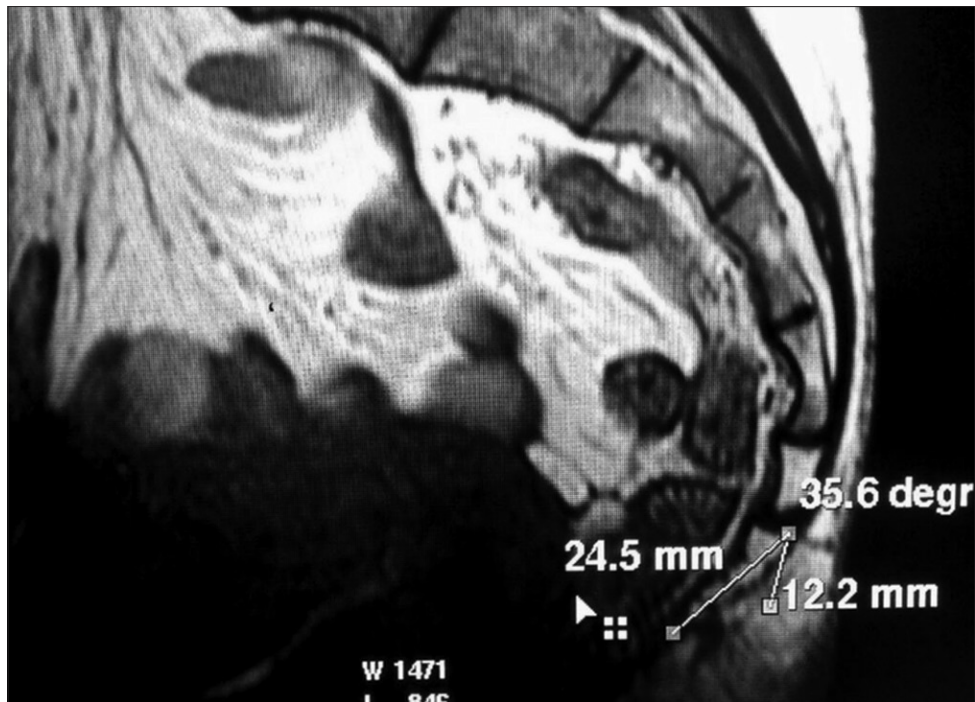


Figure 2: Magnetic resonance T1W1 midsagittal showing intercoccygeal angle

The age distribution of patients in both groups and their respective average SC and IC angles were also observed as in Tables 2 and 3.

In the study group (comprising patients with coccydynia, $n = 10$), the average SC angle turned out to be 127.1° and the average IC angle turned out to be 43.2° [Table 4].

Thereafter, using Chi-square test for analysis, we observed that the difference between the SC angles in the control and study groups was not significant ($P = 0.7$), whereas the difference between the IC angles in the two groups was significant ($P = 0.002$).

Discussion

Previous studies are centered on the cause, diagnostic methods, radiologic classification, and treatment methods of coccydynia. However, almost no study described the objective measurement of the coccyx as we did in this study by measuring the SC and IC angles.

Woon *et al.*¹⁵ and Kerimoglu *et al.*¹⁶ in their studies measuring IC angle in asymptomatic patients found no significant difference of angles between genders which corroborated with our finding.

However, on review of literature, we found a paucity of studies objectively measuring the SC angle or elucidating its difference between genders. In this study, we found the SC angle in females to be greater than that in males. However, the difference was not found to be statistically significant ($P = 0.7$). Studies with larger sample sizes might attain statistical significance.

Table 1: Sacrococcygeal and intercoccygeal angles in control group

Sex distribution	Sacrococcygeal angle in control group ($^\circ$)	Intercoccygeal angle in control group ($^\circ$)
Average in males ($n=44$)	124.5	33.1
Average in females ($n=62$)	128.4	33.6
Overall average	126.8	33.5

Table 2: Age cohorts in control group

Age (years)	Average sacrococcygeal angle ($^\circ$)	Average intercoccygeal angle ($^\circ$)
≤ 20	126.4	42.3
21-40	128.9	34.2
41-60	126.4	32.3
>60	117.0	28.5

Table 3: Age cohorts in coccydynia group

Age (years)	Average sacrococcygeal angle ($^\circ$)	Average intercoccygeal angle ($^\circ$)
≤ 20	125.5	34
21-40	122.6	30.6
41-60	122	45
>60	115.0	49

In this study, we also found that with increasing age of the participants, the IC angle showed a decreasing trend. Similar negative correlation of IC angle with age was cited in a study done by Przybylski *et al.*¹⁷ in normal asymptomatic individuals.

Table 4: Average sacrococcygeal and intercoccygeal angles in the control and study groups

Type of group	Average sacrococcygeal angle (°)	Average intercoccygeal angle (°)
Group A (control group) (n=106)	126.8	31.0
Group B (study group) (n=10)	127.1	43.2

Postacchini and Massobrio suggested that the morphology of the coccyx may have a role in the etiology of coccydynia.¹⁸ They classified the morphology of the coccyx according to the lateral coccyx radiographs, and their classification did not depend on the exact measurement. By contrast, we measured the angles between the sacrum and the coccyx and also the first and last coccygeal vertebrae which were expressed as an objective and exact measurement. Our findings corroborated with theirs in that the IC angle of the coccygodynia group was larger than the normal control group. However, our sample size for coccydynia group of patients was small ($n = 10$) owing to the criteria of including patients with only four coccygeal segments. Thus, studies with larger sample sizes are needed for extrapolation of results to general population.

We measured the same angles in the control group to determine the normal reference value. We concluded that the difference in intercoccygeal angle in the study group and control group was significant ($P = 0.028$). Thus, we thought that an increased intercoccygeal angle might be a possible cause of idiopathic coccydynia.

The results also correlated with the results of the study done by Kim and Suk⁴ who assessed IC angle difference between coccydynia patients and normal population (IC angle = 72.2° vs. 52.3° in normal participants). However, Kim and Suk used lateral spine radiographs for their study whereas we used MRI which was better not only in terms of not using ionizing radiation but also objective measurement as the margins of the vertebrae in MRI are very sharply defined with no superimposed structures.

Maigne *et al.*^{10,19} used discography and MRI in their studies; however, no objective measurements of the coccyx were made in their studies.

Although Woon *et al.*¹⁵ in the study using computed tomography calculated the IC angle, no exact correlation was made with coccydynia; however, the possibility of a relation was cited.

Woon *et al.* used MRI to study the morphology and morphometry of the coccyx in coccydynia, curvature indices were calculated along with the prevalence of joint fusions.

This study was unique where we measured SC and IC angles on lumbosacral MRI which could accurately determine the increased angular deformity of the coccyx. In our study group comprising patients with idiopathic coccydynia, no other significant MRI abnormality was observed apart from the significantly more IC angle. Based on this study, we thus formulated that an increased IC angle was a possible cause of idiopathic coccydynia.

Conclusion

From this study, we observed that the IC angle shows a decreasing trend with increasing age. In addition, increased IC angle was identified as a possible cause of idiopathic coccydynia. In this regard, studies with larger sample sizes are required to draw firm conclusions.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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