Imaging Coccygeal Trauma and Coccydynia

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Abbreviations: BMI = body mass index, STIR = short inversion time inversion-recovery

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SA-CME LEARNING OBJECTIVES

After completing this journal-based SA-CME activity, participants will be able to:

- Identify normal and variant coccygeal and pericoccygeal anatomy.
- Describe potential causes of idiopathic and traumatic coccydynia and choose appropriate imaging techniques to depict the coccyx.
- List common management strategies for chronic coccydynia and recognize other entities in the coccygeal region that may manifest clinically with coccydynia.

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The coccygeal region has complex anatomy, much of which may contribute to or be the cause of coccyx region pain (coccydynia). This anatomy is well depicted at imaging, and management is often dictated by what structures are involved. Coccydynia is a common condition that is known to be difficult to evaluate and treat. However, imaging can aid in determining potential causes of pain to help guide management. Commonly, coccydynia (coccygodynia) occurs after trauma and appears with normal imaging features at static neutral radiography, but dynamic imaging with standing and seated lateral radiography may reveal pathologic coccygeal motion that is predictive of pain. In addition, several findings seen at cross-sectional imaging in patients with coccydynia can point to a source of pain that may be subtle and easily overlooked. Radiology can also offer a role in management of coccygeal region pain with image-guided pain management procedures such as ganglion impar block. In addition to mechanical coccyx pain, a host of other conditions involving the sacrococcygeal region may cause coccydynia, which are well depicted at imaging. These include neoplasm, infection, crystal deposition, and cystic formations such as pilonidal cyst. The authors review a variety of coccydynia causes, their respective imaging features, and common management strategies.

Introduction

Pain involving the coccygeal region (coccydynia or coccygodynia) has an unreported overall incidence but is anecdotally common. It has been reported to be the source of pain in 2.7% of patients presenting to a hospital for back pain (1). Coccydynia was the cause of over 14 000 emergency department visits in the United States in 2014 (2), and over 1300 coccygectomies are performed in the United States each year (3).

While the clinical diagnosis of coccydynia is relatively straightforward with few differential considerations outside of mechanical irritation and traumatic fracture or dislocation, imaging the coccyx and its surrounding tissues presents a unique challenge to the radiologist because of the complex and variable regional anatomy. In addition, familiarity with coccyx region anatomy is essential when performing procedures such as image-guided biopsy and diagnostic or therapeutic analgesic injection.

An earlier incorrect version of this article appeared online. This article was corrected on July 7, 2020.

TEACHING POINTS

- While the number of sacral and coccygeal segments is somewhat consistent but with some variability, there is a high degree of variability in the degree of segmentation of the sacrococcygeal and intercoccygeal joints.
- The ganglion impar transmits sympathetic efferents to and nociceptive afferents from the perineum, distal rectum, distal vagina, distal urethra, and anus and therefore plays an important role in the genesis of pelvic and coccyx region pain.
- The two patterns of hypermobility associated with coccydynia are defined as *(a)* greater than 25% posterior subluxation (or luxation) with sitting compared with standing or *(b)* more than 25° of flexion when sitting compared with standing, with more than 35° being considered marked hypermobility.
- Conservative treatment is effective in approximately 90% of patients with idiopathic or traumatic coccydynia and typically consists of manual therapy, exercises, and pain management with oral analgesics and use of a doughnut-shaped coccyx pillow while sitting.
- In cases refractory to conservative treatment, steroid or anesthetic injection may be employed to great effect and often requires image guidance (typically CT).

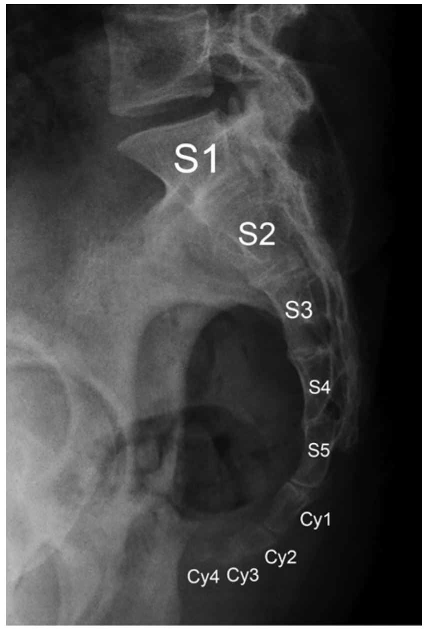
Anatomy

Osteology

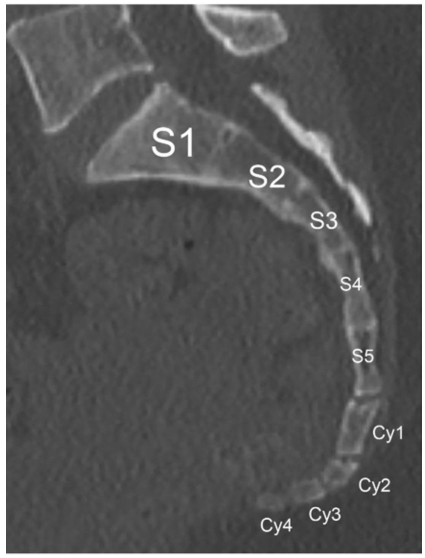
The coccyx is composed of four segments. However, the coccyx may occasionally have three segments (seen in 13% of the population) or five segments (11%) (4) (Fig 1). The first coccygeal segment has two prominent landmarks: the bilateral transverse processes and the vertically oriented coccygeal cornua posteriorly. The sacrum has five segments, and the fifth sacral segment has bilateral cornua posteriorly, with the centrally located sacral hiatus between them (Fig 2).

While the number of sacral and coccygeal segments is somewhat consistent but with some variability, there is a high degree of variability in the degree of segmentation of the sacrococcygeal and intercoccygeal joints. When depicted at CT, the sacral and coccygeal cornua or the sacrococcygeal joint appear fused in over 50% of patients (Fig 3). There may also be unilateral (in 5% of patients) or bilateral (7%) sacralization of Cy1 where the transverse processes are also fused. The first intercoccygeal joint (Cy1-Cy2) is the most consistently segmented joint in the coccyx, being fused in only 17% of patients, with 61% of Cy2-Cy3 joints fused and 89% at Cy3-Cy4 (4). This is important to note, as pathologic intercoccygeal motion may be (and often is) found at levels outside the true sacrococcygeal joint.

The normal curvature of the coccyx is highly variable. Initially classified into four types by Postacchini and Massobrio (5,6), that classification was modified into an expanded six types by Nathan et al (7) (Fig 4). Type I is found in over 50% of people, in whom the coccyx has a gentle ventral curvature that is a continuation of the natural curvature of the sacrum, and the coccyx has a caudally pointing apex. Type II is found in 8%–32% of people and has a more prominent ventral curvature, resulting in the coccyx apex pointing anteriorly. Type III is found in 4%–16%, where there is an acute anterior angulation of the coccyx, but notably there is no subluxation. Type IV is found in 1%–9% of people, and there is a focal anterior angulation with anterior subluxation.



a.



b.

Figure 1. Normal sacral and coccygeal anatomy. Lateral radiograph **(a)** and midline sagittal CT image **(b)** of the sacrum and coccyx show the normal five sacral and four coccygeal segments.

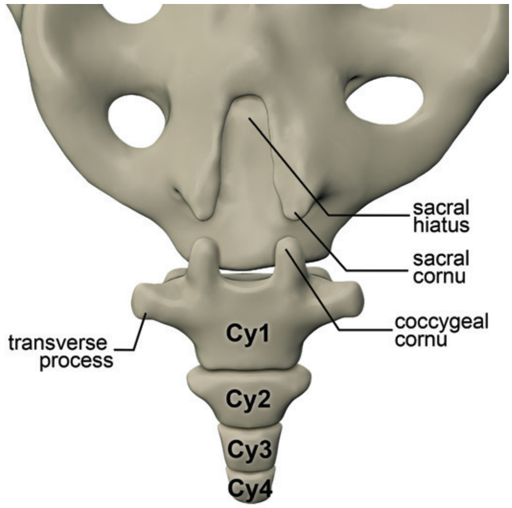
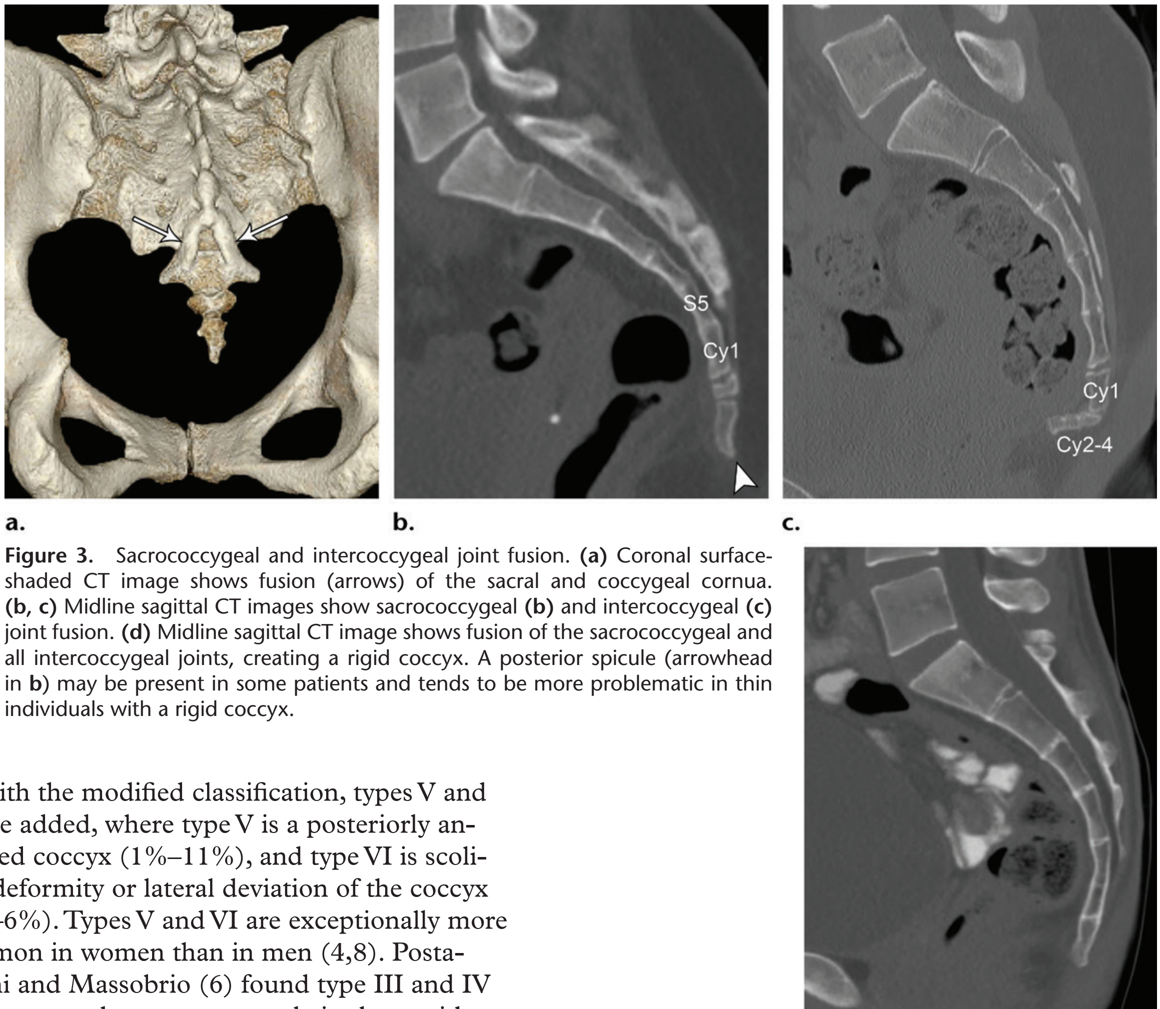


Figure 2. Normal anatomy of the posterior surface of the coccyx and distal sacrum. Illustration shows the normal anatomy of this region, including the bilateral sacral cornua, which are divided by the sacral hiatus, the bilateral coccygeal cornua and transverse processes, and four segmented coccygeal bodies.



a. b. c. d.

Figure 3. Sacrococcygeal and intercoccygeal joint fusion. **(a)** Coronal surface-shaded CT image shows fusion (arrows) of the sacral and coccygeal cornua. **(b, c)** Midline sagittal CT images show sacrococcygeal **(b)** and intercoccygeal **(c)** joint fusion. **(d)** Midline sagittal CT image shows fusion of the sacrococcygeal and all intercoccygeal joints, creating a rigid coccyx. A posterior spicule (arrowhead in **b**) may be present in some patients and tends to be more problematic in thin individuals with a rigid coccyx.

With the modified classification, types V and VI are added, where type V is a posteriorly angulated coccyx (1%–11%), and type VI is scoliotic deformity or lateral deviation of the coccyx (1%–6%). Types V and VI are exceptionally more common in women than in men (4,8). Postacchini and Massobrio (6) found type III and IV coccyges much more commonly in those with coccydynia (23% and 22%, respectively) than those without (6% and 9%, respectively). Type II was found somewhat more commonly in those with coccydynia compared to in those without (23% and 17%, respectively) and type I less commonly (31% and 68%, respectively) (6).

It is worth noting that anterior angulation of the coccyx may occur because of a sharp angulation in the S5 vertebral body rather than at the sacrococcygeal joint, which is found in 16% of people with type III morphology (Fig 4). An additional coccyx variant not included in the morphologic classification is the presence of a dorsal spicule (bump) at

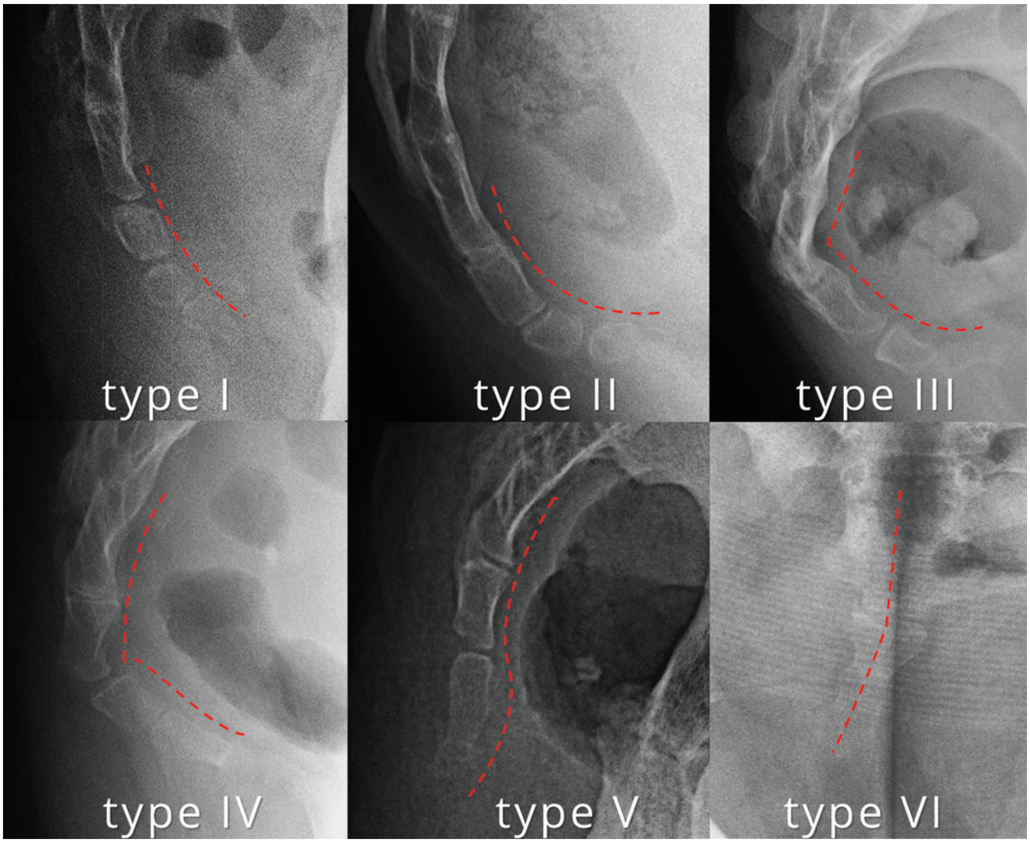


Figure 4. Coccygeal angulation is classified into six types on the basis of the expanded Postacchini and Massobrio classification. Type I is gently curved with the coccygeal tip directed inferiorly, type II is more curved with an anteriorly directed tip, type III is acutely angled anteriorly, type IV demonstrates anterior subluxation, type V is retroverted, and type VI has a scoliotic deformity.

the tip of the terminal coccygeal segment, reportedly seen in 23%–44% of patients (4,8).

Attachments

There are many attachments to the coccyx and sacrococcygeal region, including muscular, ligamentous, and fascial structures. The main ligamentous structures that attach to the coccyx anteriorly are the anterior sacrococcygeal ligaments, which are essentially the proximal extension of the levator ani tendons.

Additionally, the rectosacral ligament is seen anteriorly in the midline and is composed of the retrorectal fascia, which blends with the presacral fascia that attaches to the anterior sacrum and coccyx, blending with their periosteum (Fig 5). These fascial structures combined may be referred to as the Waldeyer fascia, or the presacral fascia alone may be considered the Waldeyer fascia (3,9). The parietal pelvic fascia that covers the piriformis, ischiococcygeus, and levator ani muscles blends medially with the presacral fascia (3) and could play a role in referred or traction-related coccyx pain.

Posteriorly, there are superficial and deep sacrococcygeal ligaments that extend across the sacral hiatus to become continuous with the supraspinous ligaments and provide dorsal stability. The sacrospinous ligament also has fibers that extend to the coccyx.

Another important posterior ligamentous structure is the filum terminale externum (coccygeal ligament), which is a continuation of the well-known filum terminale internum and dura that coalesce to form this structure. The filum terminale externum tethers the thecal sac distally to the sacrococcygeal region (Fig 6). This structure could be a source of traction on or irritation of the thecal sac with an angulated coccyx or coccygeal injury and may be transected to treat a tethered cord (10). The anococcygeal ligament tethers the tip of the coccyx to the anus. Muscular and tendinous attachments to the sacrococcygeal region include the coccygeus muscle, muscles of the levator ani, and gluteus maximus (Fig 7) (3).

Neurologic Structures

Closely surrounding the coccyx is the coccygeal plexus (Fig 8), consisting predominantly of the S4, S5, and coccygeal nerve (Co) ventral rami. The S5 ventral rami pass deep to the cornua—which are analogous to the facets in the spine—and over the Cy1 transverse processes. The Co ventral rami pass anterolaterally under the Cy1 transverse processes.

From this plexus the anococcygeal nerves arise, which provide sensory innervation to the skin of the anal triangle. Fibers from this plexus also join the terminal sympathetic chains anterior to the sacrum and coccyx. The sympathetic chains converge at their termination to form the ganglion impar (ganglion of Walther), which can be found anywhere from the anterior surface of the sacrococcygeal joint to the tip of the coccyx but is located most commonly about one-third of the distance distal from the sacrococcygeal joint to the tip of the coccyx. The ganglion impar transmits sympathetic efferents to and nociceptive afferents from the perineum, distal rectum, distal vagina, distal urethra, and anus and therefore plays an important role in the genesis of pelvic and coccyx region pain (3).

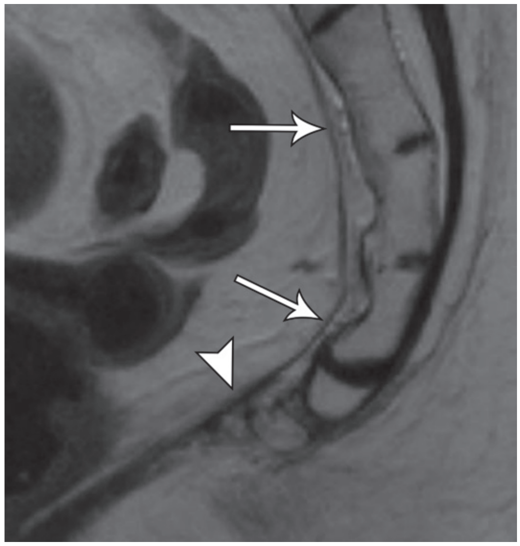


Figure 5. Sagittal T2-weighted image shows the presacral fascia (arrows), which appears as a hypointense band anterior to the sacrum and coccyx. The rectosacral ligament (arrowhead) blends with this fascia.

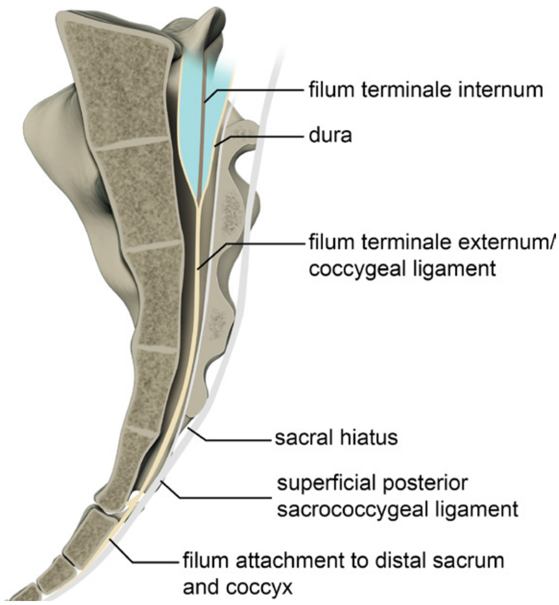


Figure 6. Filum terminale externum. Illustration shows the coalescence of the distal dura and filum terminale internum to form the filum terminale externum, also known as the coccygeal ligament, which travels though the sacral canal to attach to the sacrococcygeal region, anchoring the thecal sac.

Idiopathic and Traumatic Coccydynia

Coccydynia has a myriad of causes but is most commonly found in the posttraumatic setting. Patients often have a history of recent or remote trauma to the region and develop chronic mechanical symptoms (11). In these cohorts, and even in those with acute trauma and pain, fracture is rare, and static neutral radiography tend to appear normal with a similar distribution of abnormal imaging findings as in asymptomatic people.

Additionally, when emergency department radiography is positive for fracture, there is no significant change in pain medication ordering or follow-up recommendations, and advanced imaging shows little correlation of imaging findings with radiography (12). If acute fracture is of concern, CT is typically required to make a definitive diagnosis. However, fracture may be discovered at radiography in a minority of cases (Figs 9, 10).

Idiopathic and traumatic coccydynia is most commonly differentiated into categories of hypermobility, subluxation, and rigid coccyx (with or without a posterior spicule). There is a strong female predominance of coccydynia with a 4:1 female-to-male ratio (13). Increased body mass index (BMI) is a risk factor that is more significant in women than in men (11). Multiparity is also a risk factor among women (14). Regarding coccyx anatomy, risk factors include having a mobile sacrococcygeal joint, a more ventrally curved coccyx, and a posterior spicule formation. In men, intercoccygeal joint subluxation has been reported as a risk factor (8).

Dynamic Imaging

Dynamic imaging with standing and seated lateral radiography of the coccyx has been reported to reveal abnormal excessive coccygeal translational or angular motion in up to 69% of those with coccydynia (16). Excessive motion has not been reported in those without pain (5). The two patterns of hypermobility associated with coccydynia are defined as *(a)* greater than 25% posterior subluxation (or luxation) with sitting compared with standing or *(b)* more than 25° of flexion when sitting compared with standing, with more than 35° being considered marked hypermobility.

Because of the increased direct seat pressure on the coccyx in thin individuals, hyperflexion (Fig

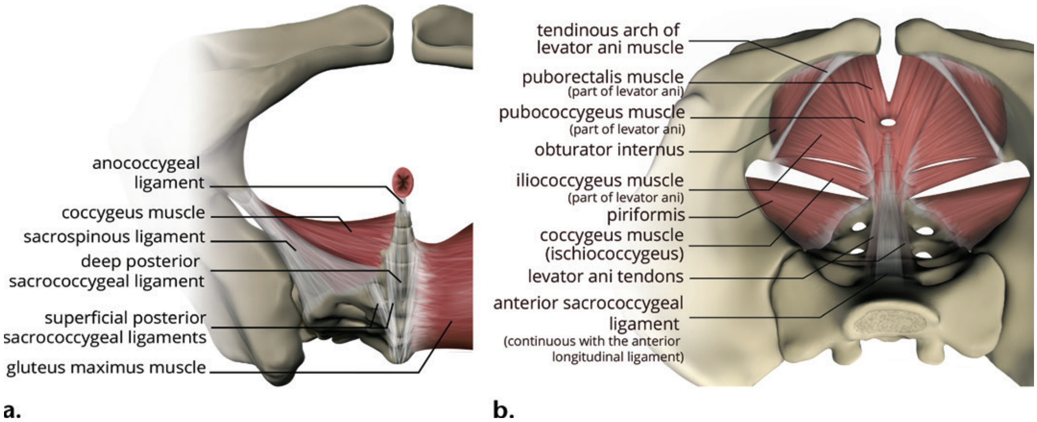


Figure 7. Muscular and ligamentous attachments to the coccyx. Illustrations of the inferior **(a)** and superior **(b)** surfaces of the pelvis show attachments to the coccyx, including the levator ani tendons, which become continuous with the anterior sacrococcygeal ligament and anterior longitudinal ligament, coccygeus, gluteus maximus, anococcygeal ligament, and superficial and deep posterior ligaments.

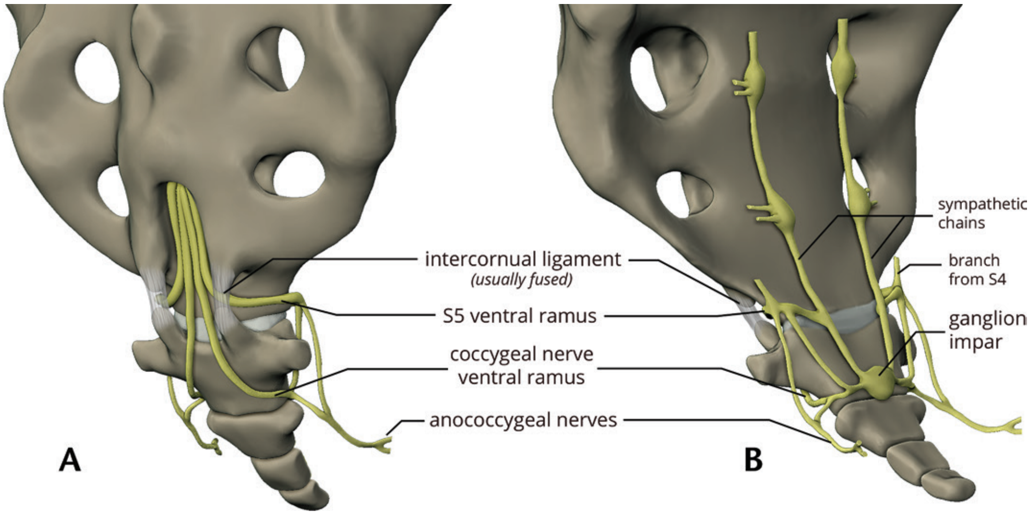


Figure 8. Coccygeal plexus. *A,* Oblique posterior, and *B,* anterior illustrations of the coccygeal plexus.

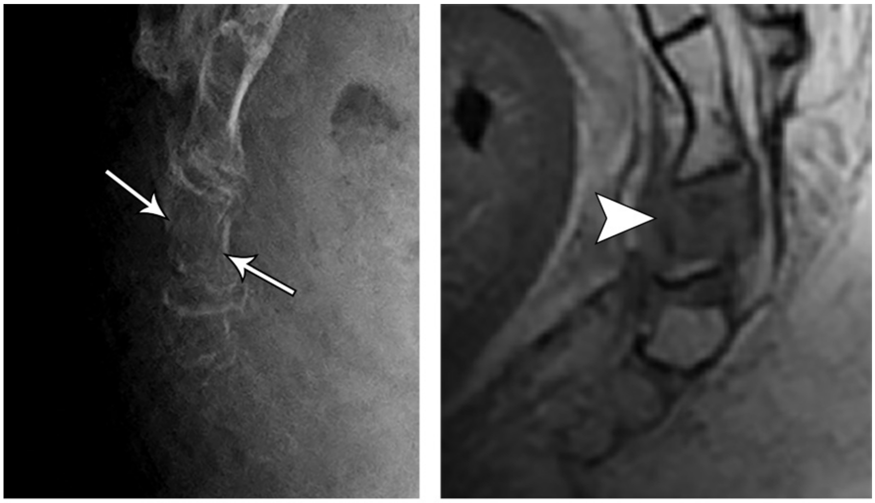
11) or a posterior spicule (Fig 12) are the more common impetus for pain, while posterior subluxation is the more common cause in obese individuals because of the increased intrapelvic pressure on the coccyx with sitting and lack of proper pelvic rotation to support the coccyx (Fig 13).

Less than 5° of motion is considered a rigid coccyx, which may also be painful, especially if there is a posterior spicule. Coccygeal angular motion was initially described by using the superimposition of radiographs and drawing a line from the center of the first mobile intercoccygeal joint to the tip of the coccyx on the superimposed radiograph and measuring the difference (Fig 14) (11,15,16). This method does not translate well to digital radiography, and no validated measure has since been developed.

However, drawing lines tangential to the anterior surface of the distal sacrum and anterior to the surface of the coccyx allows measurement of the sacrococcygeal angle, and the difference between this angle standing and seated could serve as a proxy for the original measurement (Fig 11a), but this method has not been studied. Note that while potentially useful and informative, dynamic imaging of the coccyx has not been widely accepted as an imaging protocol for coccydynia, and while suggested, it is not standard.

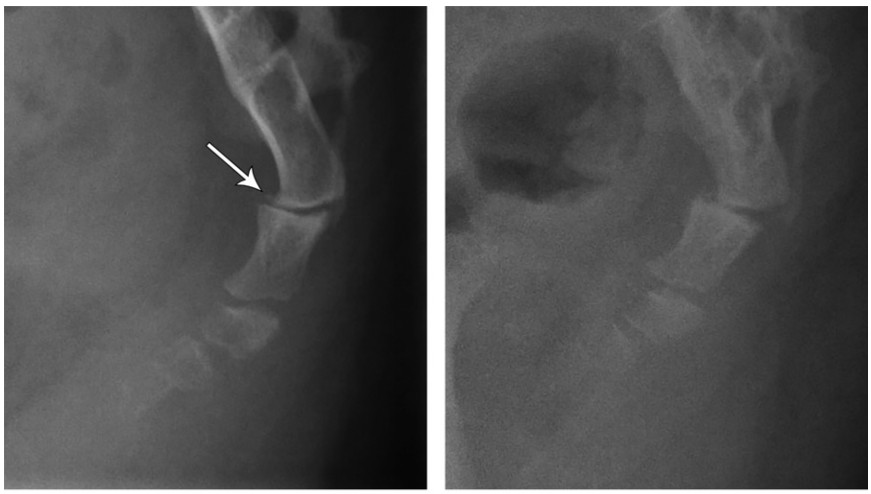
Standing lateral radiography of the coccyx is advocated to be performed after 10 minutes of standing to ensure a neutral position of the coccyx, and the seated radiograph performed on a hard stool. When seated, the patient should be positioned with their back straight and thighs horizontal with their feet on a footrest, if necessary. The patient is then instructed to lean back to the point of maximum tenderness, at which point the radiograph is obtained (Fig 15) (16).

Dynamic MRI performed during defecation has demonstrated that a large amount of normal motion occurs between contraction and straining evacuation in those with no coccydynia (17),



a. b.

Figure 9. Coccyx fracture in a 72-year-old man with coccygeal pain after falling off a chair. **(a)** Lateral radiograph shows a fracture (arrows) of the first coccygeal body. **(b)** Sagittal T1-weighted image demonstrates T1-hypointense and short inversion time inversion-recovery (STIR)–hyperintense (not shown) edematous signal intensity (arrowhead) corresponding to the suspected site of fracture, as well as cortical offset posteriorly, confirming the diagnosis. US-guided pericoccygeal injection was successfully performed for pain management.



a. b.

Figure 10. Coccyx fracture in a 22-year-old woman with coccyx pain after a fall skating. **(a)** Lateral radiograph shows mild anterior subluxation of the first coccygeal body with a subtle small fracture fragment anteriorly (arrow). **(b)** Lateral radiograph obtained 1 month later during reevaluation of the patient's persistent pain shows progression of the CY1 anterior subluxation, with an interval increase in angular deformity as well as CY2 posterior subluxation.

which is greater than that reported as abnormal by Maigne et al (5) at dynamic radiography as discussed previously, suggesting that while a large amount of transient motion while defecating may be normal, a large amount of motion with other activities—such as sitting—is not normal.

MR Imaging

When dynamic radiography does not reveal the cause of pain, MRI may be performed to depict signal intensity alterations in or surrounding the coccyx, which may be related to the specific site of irritation. In rare instances, MRI may reveal unexpected disease of a more sinister nature. Additionally, coccyx morphology is better appreciated at MRI given its cross-sectional nature, along with better visibility of the terminal coccygeal segments, which typically are not seen well at radiography.

Regarding MRI technique, delineation of the coccyx is preferred to be performed with a small field of view for more detailed imaging. Fat-sensitive and fat-suppressed fluid-sensitive sequences should be performed in all three

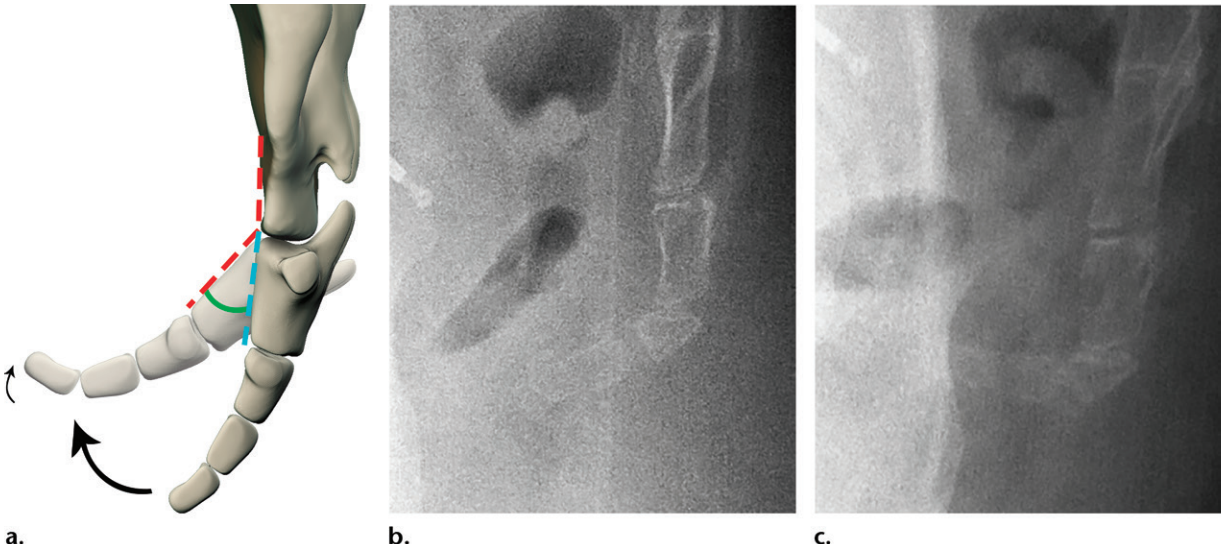


Figure 11. Hypermobility of the coccyx. **(a)** Illustration shows anterior flexion (large arrow) of the coccyx when moving from standing (blue dashed line) to a seated position (red dashed line). Posterior or less commonly anterior subluxation may be depicted on the seated radiograph. Anterior subluxation typically involves the most distal coccygeal segment (small arrow) and is more common in the angulated coccyx (types III and IV). **(b, c)** Lateral radiographs in a 34-year-old woman with coccydynia in the standing **(b)** and seated **(c)** positions show a 115° angle between the proximal and distal coccyx while standing, which decreases to 81° with sitting for a total change of 34°, indicating hypermobility (>25°) bordering on marked hypermobility (>35°).

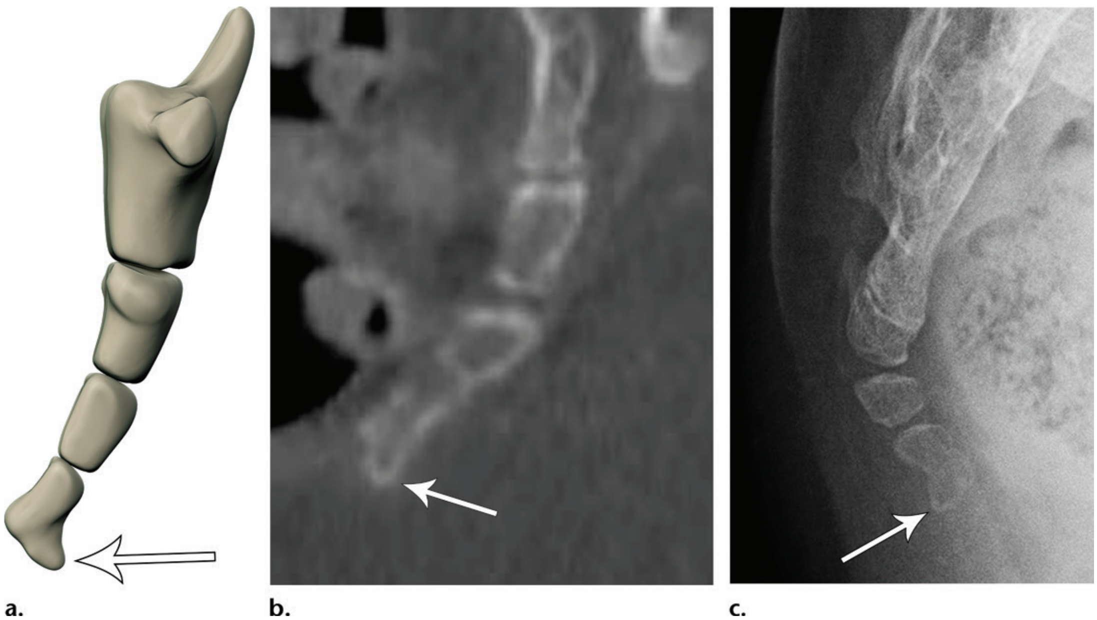


Figure 12. Posterior spicule. Illustration **(a)**, midsagittal CT image **(b)**, and lateral radiograph **(c)** in different patients show a posterior spicule at the terminal coccygeal segment (arrow).

planes, with oblique coronal and axial sequences oriented parallel and perpendicular to the sacrum or coccyx, respectively.

The normal coccyx should show normal fatty marrow signal within the coccygeal bodies, intermediate to low signal intercoccygeal discs on all pulse-sequences (when discs are present), and no surrounding hyperintensity on fluid-sensitive sequences within the adjacent fat, tendinous, or ligamentous structures. The only fluid-signal-intensity structures normally shown in the coccygeal region are adjacent veins, which are found anterior to the coccyx but not posterior, and tend to be linear structures paralleling the anterior surface of the coccyx.

An area of T2 hyperintensity adjacent to the sacrococcygeal or intercoccygeal joints with intermediate to low signal intensity at T1 imaging (ie, Modic type 1 endplate change) is seen frequently in those with chronic coccydynia (Fig 16), especially in patients with subluxation and hypermobility. Increased T2 signal intensity in

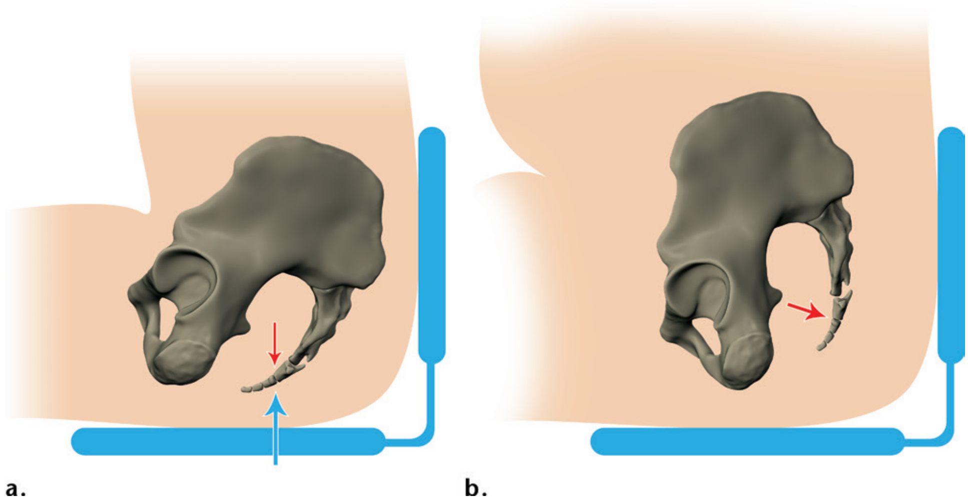


Figure 13. Illustration showing the hypothesized mechanism of posterior coccygeal subluxation in obese individuals. Normal sitting posture **(a)** involves pelvic rotation, tucking the coccyx into a supported position, countering intrapelvic pressures (red arrows). In obese individuals **(b)**, intrapelvic pressure is increased and sitting posture altered such that the coccyx is unsupported, and thus intrapelvic pressure can displace the coccyx posteriorly.

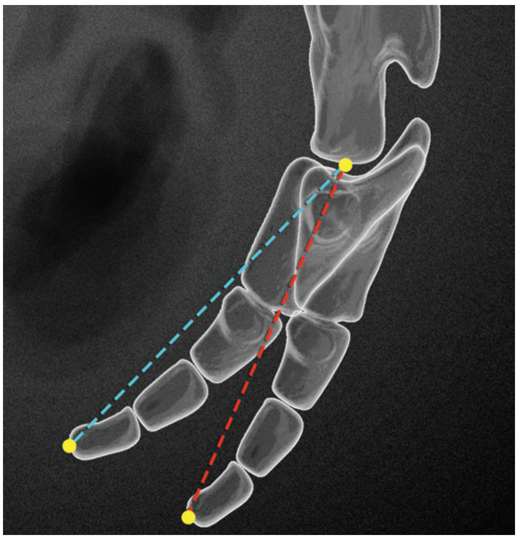


Figure 14. Measurement of coccygeal angular motion. Illustration shows the initial method of measurement of coccygeal angle change between neutral and seated plain radiographs used superimposition of the radiographs and alignment of the sacral shadows. A line is drawn from the center of the sacrococcygeal joint (or first mobile intercoccygeal joint if the sacrococcygeal joint is fused) to the tip of the coccyx on both radiographs, and the angle between the two superimposed lines is measured. It is not possible with digital images in the current PACS to superimpose radiographs with partial transparency, prohibiting this method of mensuration.

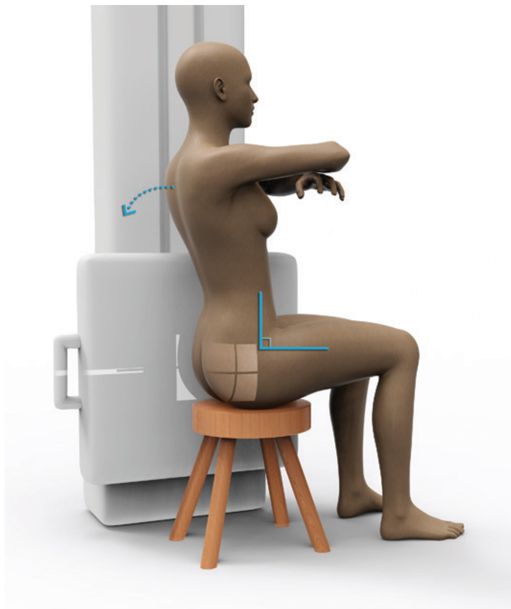
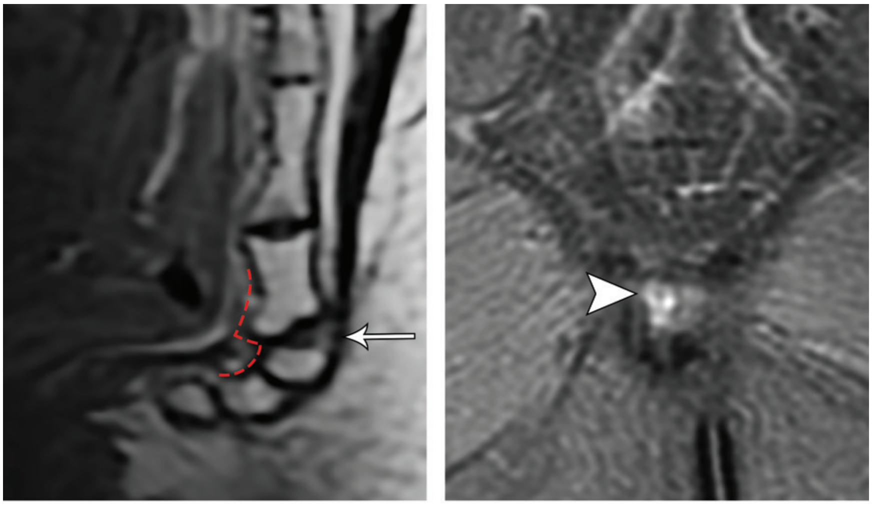


Figure 15. Patient positioning and setup for seated lateral radiography of the coccyx. Illustration shows the patient in a seated position on a hard-surface stool with their thighs horizontal, which may require placing their feet on a footrest, depending on the height of the stool. They are then instructed to lean back to the point of maximum tenderness and hold in this position for image acquisition. The arm position may vary depending on patient comfort and how far they recline.

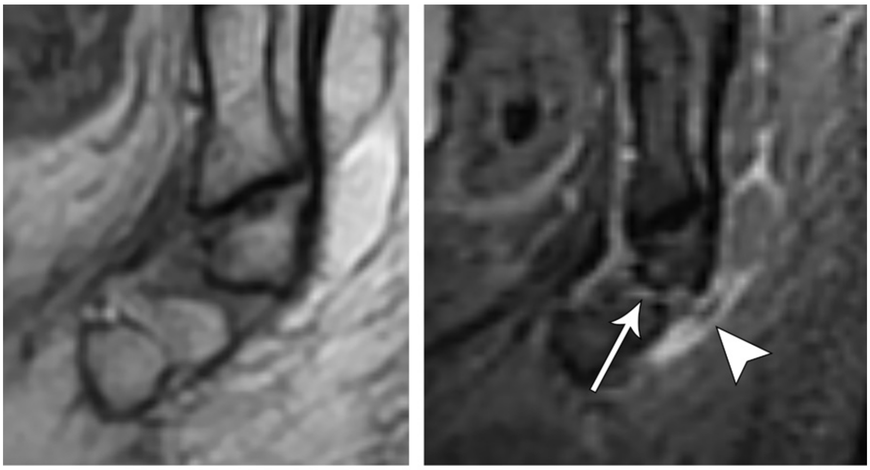
the sacrococcygeal or intercoccygeal discs may also be encountered (Fig 17).

In patients with coccydynia who have had coccygectomy, Balain et al (18) found histologic changes in the sacrococcygeal and intercoccygeal discs in almost half of those studied that could correspond to areas of T2 hyperintensity at MRI. These histologic changes include degenerative clefts, cystic and fibrocystic changes, or a synovial sacrococcygeal joint (18). With superficial irritation, such as in patients with a posterior spicule, edema may be seen posterior to or at the tip of the coccyx and may become confluent (Fig 18) (19).



a. b.

Figure 16. Endplate change in a 34-year-old woman. Sagittal T1-weighted **(a)** and coronal oblique T2-weighted fat-suppressed **(b)** images show dorsal subluxation of the coccyx at the first intercoccygeal joint (red dotted line) with T1 marrow hypointensity (arrow) in the second coccygeal body bordering this joint, which corresponds to T2 hyperintensity (arrowhead) at the same site, indicating edema.



a. b.

Figure 17. Coccydynia and edema in a 37-year-old woman. Sagittal T1-weighted **(a)** and sagittal STIR **(b)** images show STIR signal hyperintensity in the first intercoccygeal disc (arrow) as well as in the overlying soft tissue (arrowhead), suggesting edema related to mechanical irritation and abnormal motion.

Treatment

Conservative treatment is effective in approximately 90% of patients with idiopathic or traumatic coccydynia and typically consists of manual therapy, exercises, and pain management with oral analgesics and use of a doughnut-shaped coccyx pillow while sitting.

Manual therapy, typically performed by a chiropractor, osteopath, or physical therapist, has a high success rate and includes soft-tissue therapy or massage with or without manipulation of the coccyx (20–22). Manipulation may be attempted externally via cephalad traction of the superficial tissues overlying the sacrum and coccyx or internally via intrarectal contact of the coccyx with distraction of the sacrum superiorly using the opposite hand. Massage of the adjacent musculature that attaches to the coccyx (external or internal massage) is helpful in relieving pain in those with muscle spasm as a contributing factor, which is very common (22). In those with posterior subluxation or elevated BMI, weight management should be addressed (7).

In cases refractory to conservative treatment, steroid or anesthetic injection may be employed to great effect and often requires image guidance (typically CT). Injection targets include the ganglion impar anterior to the coccyx, pericoccygeal

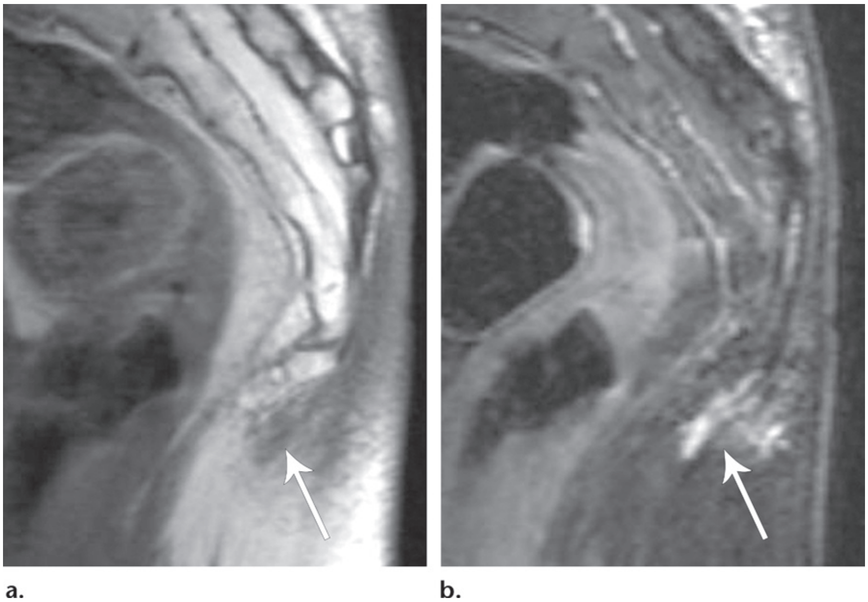


Figure 18. Edema in a 74-year-old woman with coccydynia. Sagittal T1-weighted image **(a)** and sagittal STIR image **(b)** show a region of T1 hypointensity **(a)** and STIR signal hyperintensity (**b**, arrow) overlying the dorsal aspect of the distal coccyx, which represents edema or adventitial bursa formation.

directly at the reported site of pain (23), or in the sacrococcygeal or intercoccygeal discs.

After CT-guided ganglion impar block, up to 75% of patients report complete or significant reduction in pain at 6-month follow-up (24). This procedure involves placing the patient prone with the hips slightly flexed by placing a pillow under the abdomen and with the legs internally rotated. A typical aseptic site is prepared, and the needle is introduced laterally at least 6–9 cm from the midline (a lateral approach reduces the risk of rectal perforation and fecal contamination), targeted toward the ganglion impar, which is found at the sacrococcygeal joint or just inferior to it, or as determined at preinjection planning.

Once the needle reaches its target, the needle tip location is confirmed anterior to the sacrococcygeal joint in the retroperitoneal space with injection of a small amount of nonionic contrast material (Fig 19). Once confirmed, a mixture of 40 mg of triamcinolone and 3 mL of 0.25% bupivacaine is injected (24). A transsacrococcygeal approach may be performed under fluoroscopic or US guidance (25). Some practitioners advocate neuroablation (ethanol, radiofrequency, or cryotherapy) if pain recurs after a temporary block, with success rates of 80%–90% in those with perineal pain (26,27).

For persistent and debilitating cases of coccydynia, neuromodulation by dorsal root ganglion or spinal cord stimulation has been used successfully, or coccygectomy may be considered. Reported cases of successful neuromodulation implementation have targeted the conus region and L1 and S2 dorsal root ganglia, but data are limited (27,28).

Coccygectomy has reported success rates from 60% to 92%, and patients with severe degenerative changes tend to have a greater rate of pain relief than those with less severe changes. As with any surgery, infection is a risk factor but especially so in the coccygeal region, given the proximity to the anus. Infection and skin necrosis risk are as high as 50% with coccygectomy. However, 48 hours of prophylactic antibiotic therapy before surgery reduces this risk substantially (29).

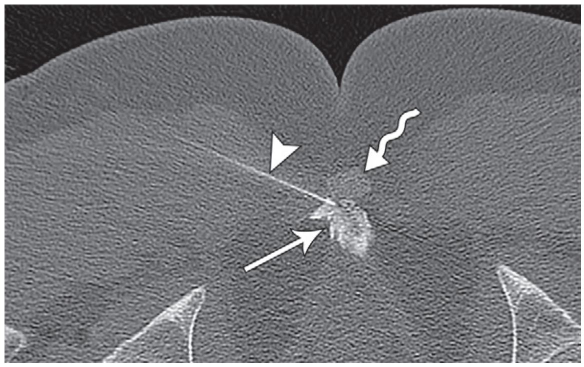
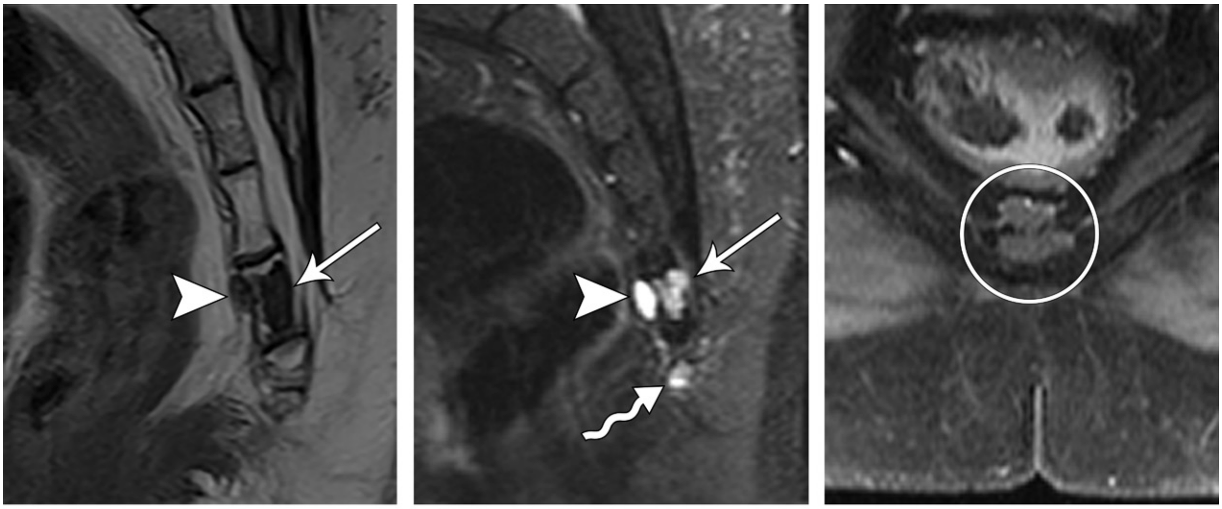


Figure 19. 51-year-old man with coccyx pain after a fall onto his low back. Axial CT image shows a posterolateral (transgluteal) approach, with the needle (arrowhead) directed immediately anterior to the coccyx (squiggly arrow) near the sacrococcygeal junction, in the expected location of the ganglion impar. Contrast is used to confirm needle tip location in the precoccygeal soft tissues (straight arrow), without extension beyond the puborectalis sling.

Other Causes of Coccydynia

Neoplasm

A number of benign and malignant tumors may be found in the coccygeal region, which often manifest as coccydynia. Because of the relatively high prevalence of mechanical coccydynia and relative rarity of neoplasm, diagnosis may be delayed until



a. b. c.

Figure 20. Chordoma in a 30-year-old man with a history of lymphoma who reported coccyx pain. Sagittal T1-weighted **(a)**, sagittal STIR **(b)**, and axial contrast-enhanced T1-weighted fat-suppressed **(c)** images show a region of fluid signal intensity in the first coccygeal body (straight arrow) that extends anterior to the bone (arrowhead) but does not enhance (circle). These imaging features were interpreted initially as a fracture. However, the well-defined peripheral rim of preserved marrow fat signal intensity and the lobular mass present anteriorly are suggestive of a different cause. This proved to be a chordoma at biopsy. A focus of fluid signal intensity (wavy arrow) is also present at the tip of the coccyx, likely representing a second focus of chordoma.

advanced imaging is performed. Even at advanced imaging, findings may appear nonspecific and could be misinterpreted, which could further delay diagnosis and treatment (Fig 20) (30).

Chordomas are the most common neoplasm of the sacrum or coccyx, with approximately 50% of chordomas occurring there, and they account for 2%–4% of all primary malignant bone neoplasms.

Chordomas appear nearly identical in signal intensity to their normal notochordal counterpart—the nucleus pulposus of the intervertebral disc—with intermediate to low T1 signal intensity and high T2 signal intensity. Moderate heterogeneous enhancement is most common. However, little to no enhancement or thick peripheral and septal enhancement may also be encountered.

Typically, the mass is lobular, divided by fibrous septations (31) (Fig 21). Other neoplasms and masses affecting the coccyx or coccygeal region include chondrosarcoma, paraganglioma (Fig 22), schwannoma, neurofibroma, plasmacytoma, metastasis (Fig 23), lipoma, developmental cysts, sacrococcygeal teratoma (rare in adults), osteosarcoma, and Ewing sarcoma.

Infection

Infection involving the sacrococcygeal region is usually caused by direct spread from overlying pressure-related decubitus ulcers in patients with limited mobility (Fig 24). An Australian study found that in those with pressure related injury, the sacrococcygeal region was involved in 22% of intensive and 25% of nonintensive care patients (32). Other adjacent infections include perianal abscess and perianal fistulae, which could involve the coccyx, as well as infected pilonidal or other cysts, which are discussed subsequently.

Findings of coccygeal osteomyelitis are typical of osteomyelitis elsewhere, demonstrating lytic destruction on radiograph and/or CT, with T1 hypointense, T2/STIR hyperintense marrow signal on MRI, and surrounding inflammatory change.

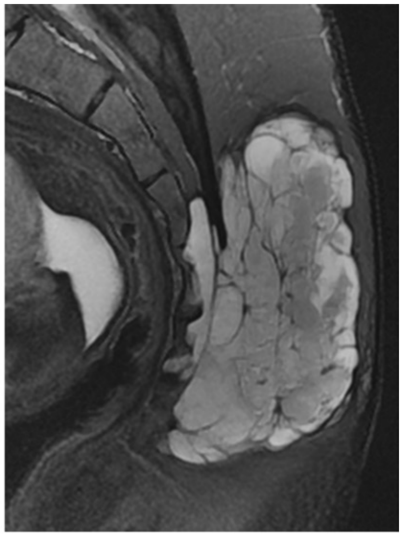
Cysts

Several superficial cystic lesions may be encountered in the coccygeal region, but a pilonidal cyst or sinus is most commonly encountered. Epidermal inclusion and sebaceous cysts, among other dermatologic entities, may also be found in this region as well as perineural or Tarlov cysts (Fig 25).

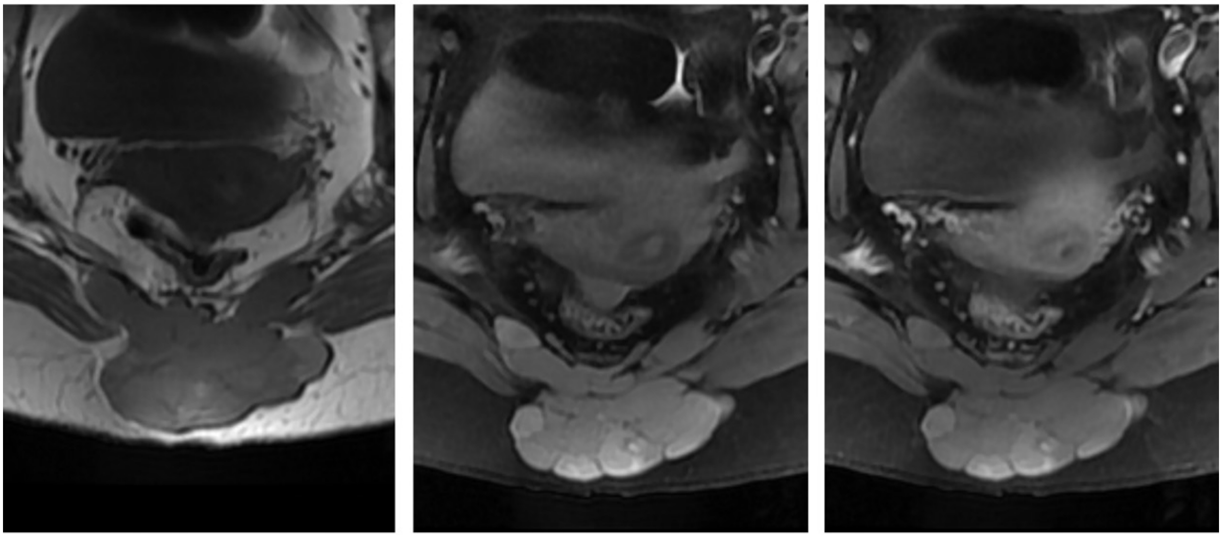
Pilonidal cysts and sinuses occur secondary to an abnormal hair or group of hairs becoming entrapped, creating a keratin- and sebum-filled cystic cavity. MRI and CT typically demonstrate a midline fluid-filled tubular structure in the subcutaneous fat, which has a retrococcygeal or retrosacral cutaneous opening (Fig 26).

Pilonidal cysts are most commonly found in patients who are overweight, hirsute, and male, with up to a 10:1 male-to-female ratio. The cystic cavity may become acutely symptomatic if infected. However, no treatment is needed for asymptomatic nodules, but shaving and regular hygiene may be recommended. Surgical excision is performed

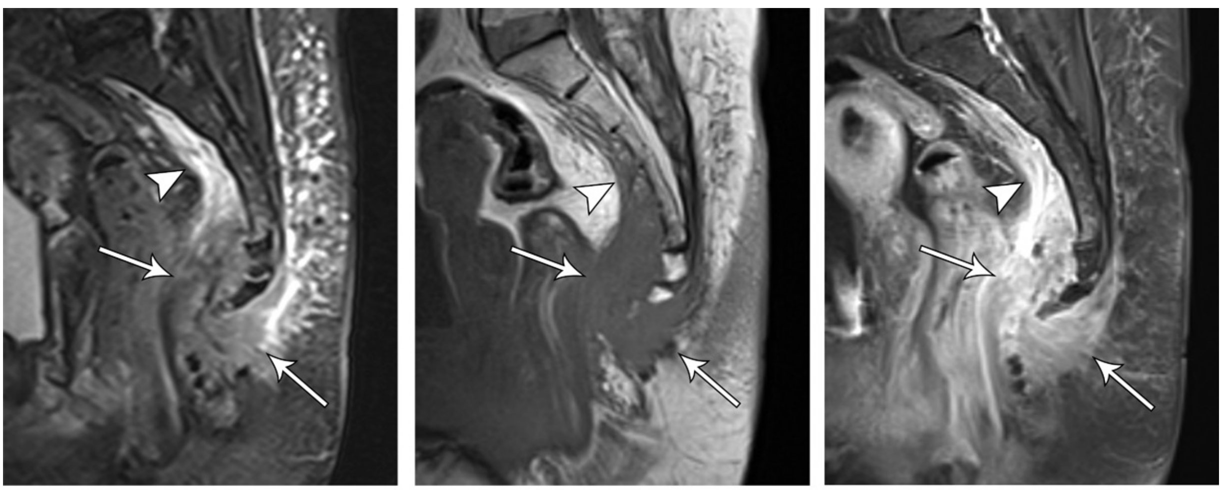
Figure 21. Chordoma in a 22-year-old woman. Sagittal T2-weighted fat-suppressed image **(a)**, axial T1-weighted image **(b)**, and axial T1-weighted fat-suppressed nonenhanced **(c)** and contrast-enhanced **(d)** images show a large, T2-hyperintense, multilobulated midline mass arising from the coccyx and lower sacrum with no significant enhancement. This proved to be a chordoma.



a.



b. **c.** **d.**



a. **b.** **c.**

Figure 22. Paraganglioma in a 68-year-old woman with 2 years of worsening sacrococcygeal pain. Sagittal STIR **(a)**, T1-weighted **(b)**, and contrast-enhanced T1-weighted fat-suppressed **(c)** images show an enhancing mass lesion surrounding the coccyx (arrows), extending cephalad into the presacral fat (arrowhead). This proved to be a paraganglioma.

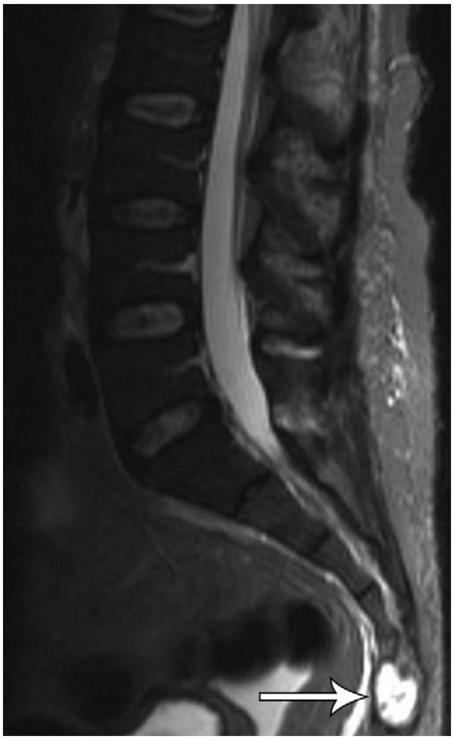
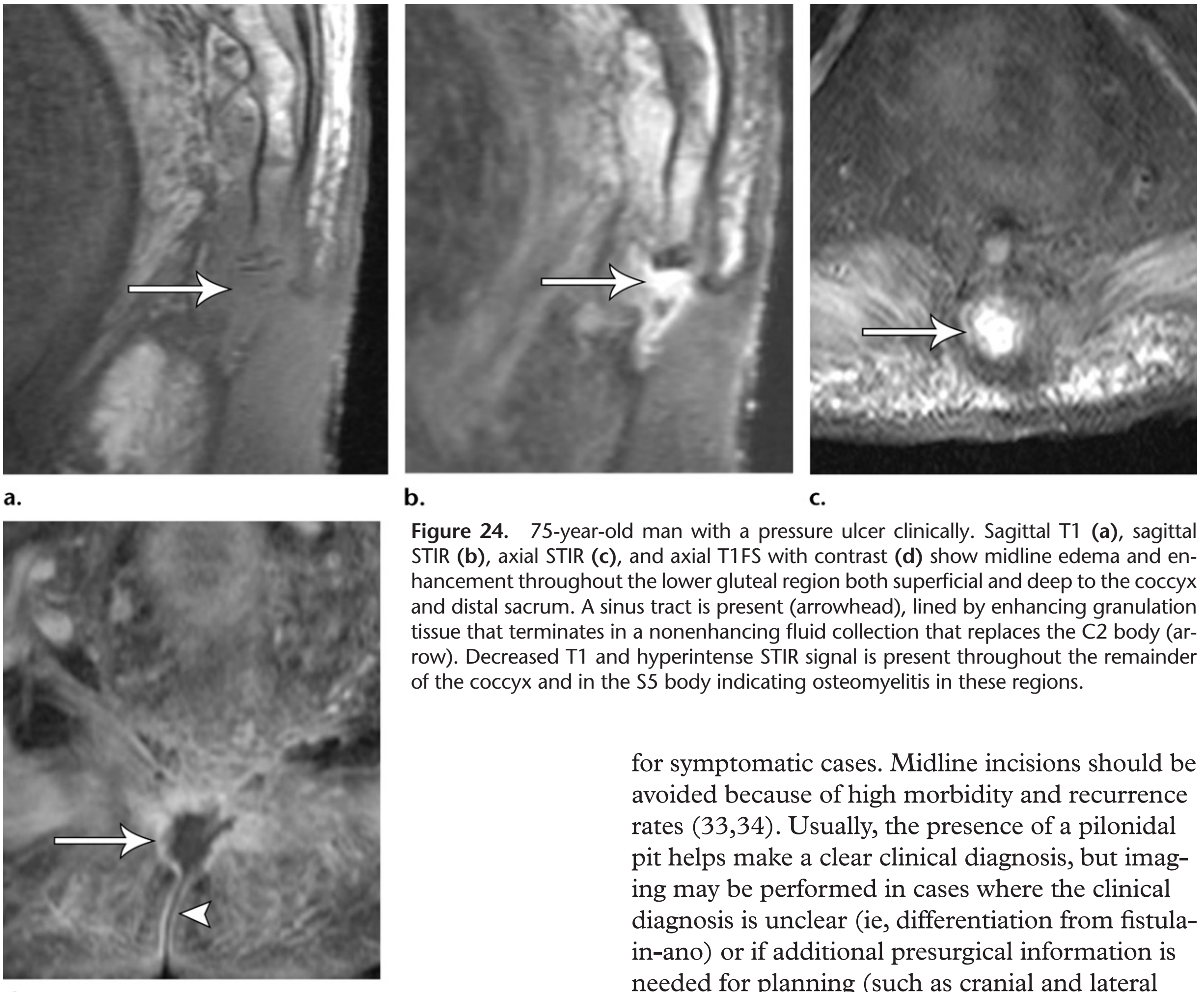


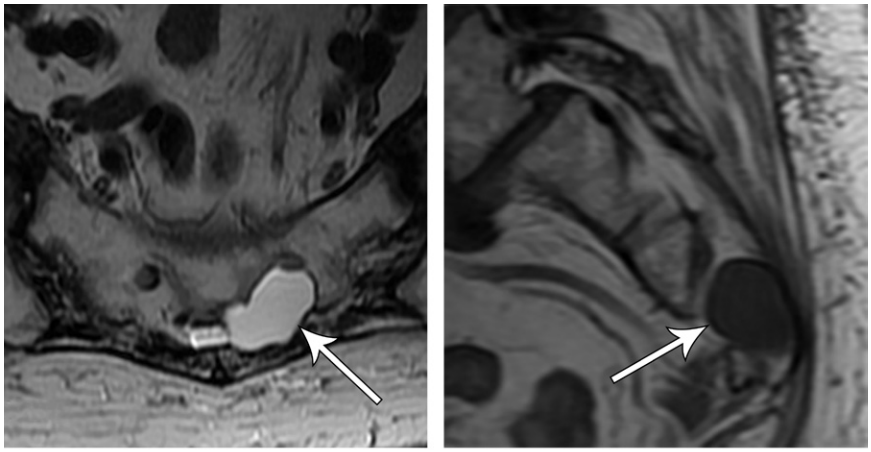
Figure 23. Renal cell carcinoma metastasis in a 47-year-old man. Sagittal STIR image depicts a renal cell carcinoma metastasis (arrow) in the sacrococcygeal region.



a. b. c. d.

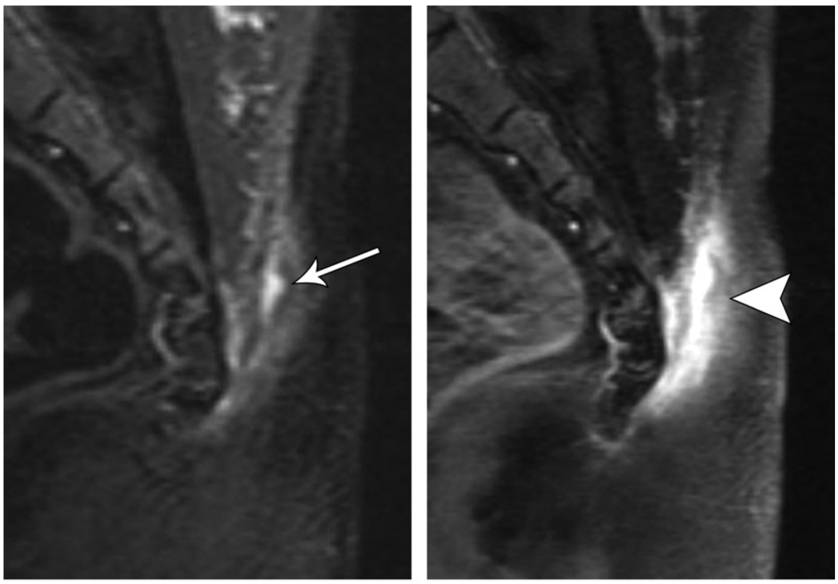
Figure 24. 75-year-old man with a pressure ulcer clinically. Sagittal T1 **(a)**, sagittal STIR **(b)**, axial STIR **(c)**, and axial T1FS with contrast **(d)** show midline edema and enhancement throughout the lower gluteal region both superficial and deep to the coccyx and distal sacrum. A sinus tract is present (arrowhead), lined by enhancing granulation tissue that terminates in a nonenhancing fluid collection that replaces the C2 body (arrow). Decreased T1 and hyperintense STIR signal is present throughout the remainder of the coccyx and in the S5 body indicating osteomyelitis in these regions.

for symptomatic cases. Midline incisions should be avoided because of high morbidity and recurrence rates (33,34). Usually, the presence of a pilonidal pit helps make a clear clinical diagnosis, but imaging may be performed in cases where the clinical diagnosis is unclear (ie, differentiation from fistula-in-ano) or if additional presurgical information is needed for planning (such as cranial and lateral extent) (34).



a. b.

Figure 25. Cystic mass in a 78-year-old woman with coccydynia. Axial T2-weighted **(a)** and sagittal T1-weighted **(b)** images show a cystic mass (arrow) associated with the S2 nerve root (perineural or Tarlov cyst) that has caused enlargement of the left lateral aspect of the sacral canal and left S2 foramen. It is uncertain if this was related to the coccydynia.



a. b.

Figure 26. Pilonidal cyst. Sagittal STIR **(a)** and contrast-enhanced T1-weighted fat-suppressed **(b)** images show a focal region of STIR hyperintensity along the superior gluteal cleft, in the subcutaneous fat, and overlying the coccyx (arrow), consistent with a pilonidal cyst. The diffuse surrounding enhancement (arrowhead) indicates superimposed infection.

Crystal Deposition

In the sacrococcygeal or intercoccygeal joints, calcium deposition is found rarely (Fig 27). When calcium deposition causes coccydynia, its course differs from that of typical coccydynia. Its onset is acute and usually without trauma and then is self-resolving or resolves with oral or injected corticosteroid therapy. In some of these reported cases, resorption of the calcium deposit was observed, suggesting apatite crystals as the histologic entity, but coccygeal calcium crystal composition has yet to be verified.

In the spine, calcium crystals affecting the discs have reportedly included apatite, calcium pyrophosphate dihydrate, and oxalate crystals (35). Additionally, pericoccygeal calcium deposition may be seen as part of calcific tendinosis involving the attachments in this region (Fig 28).

Referred and Neurogenic

In some cases, coccydynia may result from a remote process that is perceived as occurring at the coccyx (referred pain) or involving the nerves which provide nociception for the sacrococcygeal region. Referred pain is not uncommon with

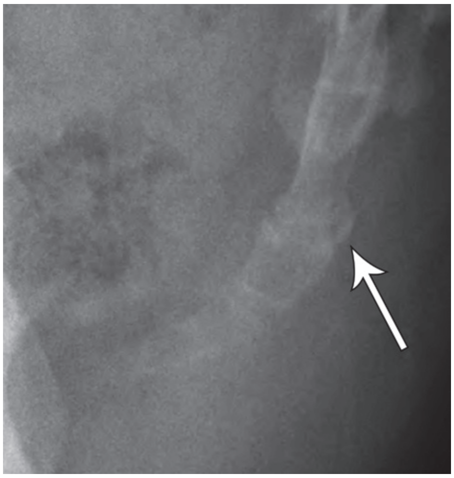
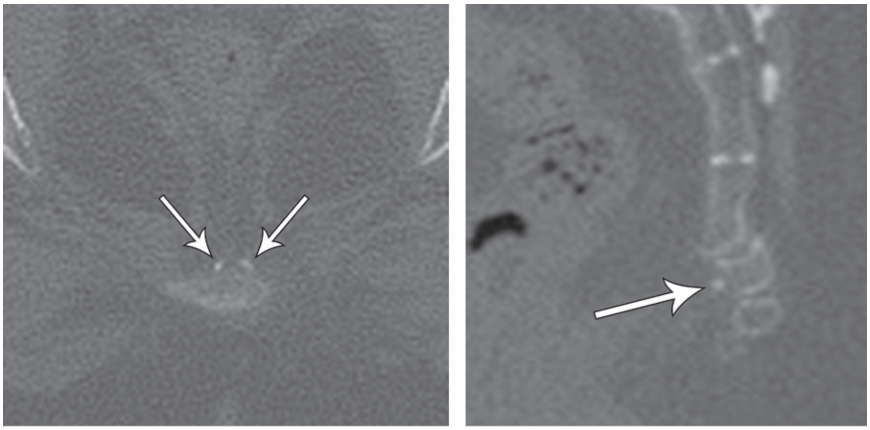


Figure 27. Lateral radiograph of the coccyx in a 31-year-old man with coccygeal pain demonstrates calcification (arrow) along the dorsal aspect of the sacrococcygeal joint with irregularity and sclerosis of the articular surfaces at the same level.



a. b.

Figure 28. Axial **(a)** and sagittal **(b)** CT images in a 69-year-old man show two focal calcifications anterior to the first coccygeal body, which is dorsally subluxed. This imaging finding is presumed to represent calcific tendinosis of the anterior sacrococcygeal ligament or levator ani tendons.

pelvic malignancies and is a common indication to perform a ganglion impar block or ablation (36). Neurogenic pain typically stems from the upper lumbar spine, with upper lumbar disc disease or other disease in the upper lumbar region being a potential cause of coccydynia that warrants consideration and possible investigation (37).

Conclusion

Understanding the dynamic nature of coccydynia and its relevant anatomy is important for accurate assessment of potential abnormalities. The suggested imaging work-up includes dynamic radiography with CT in acute trauma and MRI when dynamic radiography does not depict a cause. Awareness of subtle imaging findings and differential considerations that are associated with coccydynia improves the radiologist's role in consulting on these often difficult cases. The radiologist can play a central role in providing pain management in patients with chronic coccydynia with minimally invasive image-guided procedures.

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RadioGraphics

Errata

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Imaging Coccygeal Trauma and Coccydynia
Matthew R. Skalski, George R. Matcuk, Dakshesh B. Patel, Anderanik Tomasian, Eric A. White, Jordan S. Gross

Erratum in:
RadioGraphics 2020:40(5):1504
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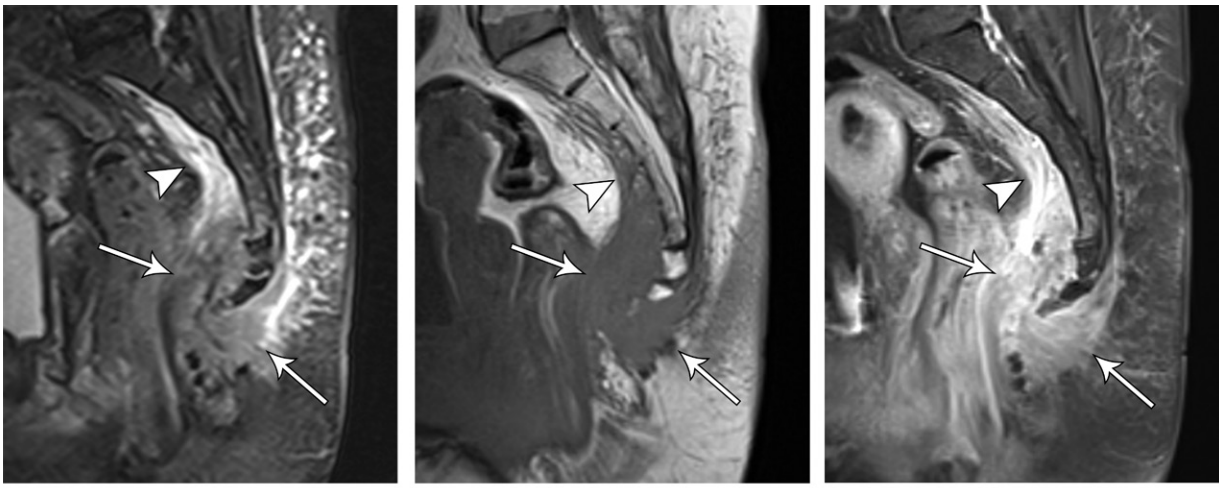
Page 1102, Figure 22: The incorrect image was shown for Figure 22c. Figure 22 and the figure legend are reprinted correctly here.



a. b. c.

Figure 22. Paraganglioma in a 68-year-old woman with 2 years of worsening sacrococcygeal pain. Sagittal STIR **(a)**, T1-weighted **(b)**, and contrast-enhanced T1-weighted fat-suppressed **(c)** images show an enhancing mass lesion surrounding the coccyx (arrows), extending cephalad into the presacral fat (arrowhead). This proved to be a paraganglioma.