

COCCYDYNIA: A NARRATIVE REVIEW OF PATHOPHYSIOLOGY, ETIOLOGY AND TREATMENT

Ezgi Akar¹, Ahmet Öğrenci¹, Sedat Dalbayrak¹

Correspondence: oa7006@gmail.com

¹Haydarpaşa Numune Training and Research Hospital, Istanbul, Turkey.

Article History:

Received: May 23, 2022

Accepted: December 15, 2022

Published: January 1, 2023

Cite this as:

Akar E, Öğrenci A, Dalbayrak S.

Coccydynia: A narrative review

of pathophysiology, etiology and

treatment. *Malang Neurology*

Journal; 2023.9:33-39. DOI:

<http://dx.doi.org/10.21776/ub.mnj>

.2023.009.01.7

ABSTRACT

Pain and discomfort in the coccyx or tailbone area is called as coccydynia or coccygodynia. Despite its small size, the coccyx, which forms the terminal of the spine, has an important role to support the balanced distribution of body weight, especially in the sitting position, due to its relationship with the surrounding muscles, ligaments and bone structures. The problems of this area for various reasons manifests itself with localized discomfort and pain in the sacrococcygeal region. Our aim in this paper is to review the etiology, pathophysiology, clinical findings, diagnosis and treatment methods of coccydynia in light of the current literature.

Keywords: Coccyx, coccydynia, pain, tailbone pain

Introduction

Pain in the coccyx area is called coccydynia-coccygodynia or tail bone pain. The term Coccydynia was first defined by Simpson in 1859 as the pain of the terminal region of the spine.^{1,2} Coccydynia is the discomfort and chronic pain that we often see for idiopathic reasons, felt in the sacrococcygeal and perianal region. Pain that develops due to coccygeal disc or joint damage or fractures as a result of acute trauma is acute coccydynia. Pain that lasts longer than two months is defined as chronic coccydynia.^{2,3} The most common associated factors are female gender, obesity, rapid weight loss, chronic microtraumas, and delivery.^{3,4} It is typical for prolonged standing or sitting position to exacerbate the pain. Coccygeal fracture or posterior sacrococcygeal subluxations may be due to recurrent microtraumas.^{2,3,4} In the diagnosis, the patient's complaints and examination findings are essential, while radiological examinations prove very helpful as well. Dynamic lateral radiographs taken in sitting and standing positions are particularly useful in evaluating coccygeal hypermobility and instability. Furthermore, computed tomography (CT) and magnetic resonance imaging (MRI) are the tests commonly used for diagnosis.^{4,5,6,7} Conservative methods are primarily recommended in the treatment of coccydynia whereas invasive options, including surgery, should be considered in cases which do not respond to treatment and becomes chronic. In this paper, we will discuss the anatomy, etiopathology, diagnosis and treatment options of this frequently encountered disorder.

Anatomy

The coccyx, the terminal part of the spine, consists of 3 to 5 fused segments and has a triangular shape (figure 1a, 1b).⁹ The term Coccyx is a word of Greek origin, because its lateral view resembles the "beak of a cuckoo bird".^{8,9} Its first segment joining with the sacral cornua is called the coccygeal cornua and it has a rudimentary articular process. The coccygeal cornua located at the posterior, contains the posterior divisions of the fifth sacral nerve. The enlarged lateral edges of the first segment joint the fifth sacral vertebra and contains the anterior fibers of the fifth sacral nerve. The lower three segments are often combined and appear to be one piece. The lowest part of the filum terminale is called the coccygeal ligament and is attached to the first segment. The coccyx is bounded anteriorly by the sacrococcygeal ligament (anterior longitudinal ligament) and the levator ani muscle group (iliococcygeus, pubococcygeal and puborectalis muscles). The muscles and ligaments surrounding the coccyx from anterior to posterior respectively are the coccygeal muscles, the sacrospinous ligament, the sacrotuberous ligament, and the gluteus maximus fibers. Iliococcygeus muscle tendon surrounds the coccyx from the inferior. This muscle and ligament complex forms the pelvic floor and supports the rectum and contributes to the voluntary control of the bowel.^{8,9}

Coccyx's sensations such as pain related to bone and ligamentous structures are carried by the somatic nerves. The sympathetic nervous system network, including the coccyx's ganglion impar (also known as the ganglion of Walther), is the source of sympathetic pain of the coccyx and pelvic area. It is located in the anterior of the

sacrococcygeal joint and is involved in the nociceptive innervation of the anal and perianal area.^{6,8,9}

Disc space is highly variative in the sacrococcygeal and intercoccygeal area. Intervertebral-intersegmental disc structures are found in the synovial joint structure including cystic or fibrotic changes in most of the cases. Besides, fusion of disc structures has been observed in some cases¹⁰. With the triple structure formed by the coccyx together with the ischial tuberosities, many muscles and ligaments adhering to and surrounding the coccyx, the coccyx acts like the center of gravity of the body and supports the spine, especially in the sitting position. The pressure on the coccyx increases especially when moving from sitting and lying position to sitting position. Therefore, the morphology and joint structure of the coccyx may provide the basis for coccydynia.¹¹

Etiology

Although there are many assumingly associated factors, coccydynia is often encountered for idiopathic reasons and its true incidence is yet unknown. The most common reasons are direct trauma, recurrent microtraumas (related to sitting), obesity and rapid weight loss.^{4,6,12} It is an adult disease (rare in childhood) and encountered five times more often in women than in men, probably due to high body mass index and sacral anatomy of the female.^{5,13} The coccyx tends to displace towards posterior with sitting in obese people due to insufficient sagittal pelvic rotation. This situation causes subluxation in the coccyx with increased intrapelvic pressure and repeated increased angular movement of the coccyx.¹⁴ Trauma is the most common associated factor: It may occur by a fall or direct trauma to the coccyx, or it may be encountered as internal trauma during delivery. Depending on the severity of the trauma, strain of the pelvic muscles, injury, fracture or sacrococcygeal dislocation in the pericoccygeal ligament structures can occur^{13,14}. Minor traumas such as sitting on hard and uncomfortable surfaces for a long time may cause fractures or dislocations in the coccyx. It is speculated that rapid weight loss may cause coccydynia due to decreasing mechanical support of coccyx.^{4,5} Dannel and Nathan reported that a palpable bone spur (spicule) on the posterior surface of the coccyx is associated with coccydynia¹⁵. This spur structure causes pain by squeezing the subcutaneous tissue and skin between the spur and the outer surface while in the lying or sitting position. In another series of cases, it has been reported that 14-28% of coccydynia cases have spur on the posterior coccygeal surface and these cases proved to have anterior subluxation¹⁴. Degenerative disc or joint disease, hyper- or hypomobility of the sacrococcygeal joint, infectious, and variations in the anatomical structure of the coccyx constitute scoliotic deformities of the spine¹⁶ and nontraumatic causes of neoplastic coccydynia.^{6,16}

The coccyx is classified into 4 types according to its radiographic appearance: Type 1: end of coccyx is curved slightly forward tip is towards lower caudal. Type 2: The anterior curvature is sharp and the tip is directed forward. Type 3: The coccyx is angled more sharply forward. Type 4: The coccyx is subluxated from the sacrococcygeal joint or intercoccygeal joint¹¹. Maigne et al.¹⁰ classified coccygeal mobility into four groups. According to this;

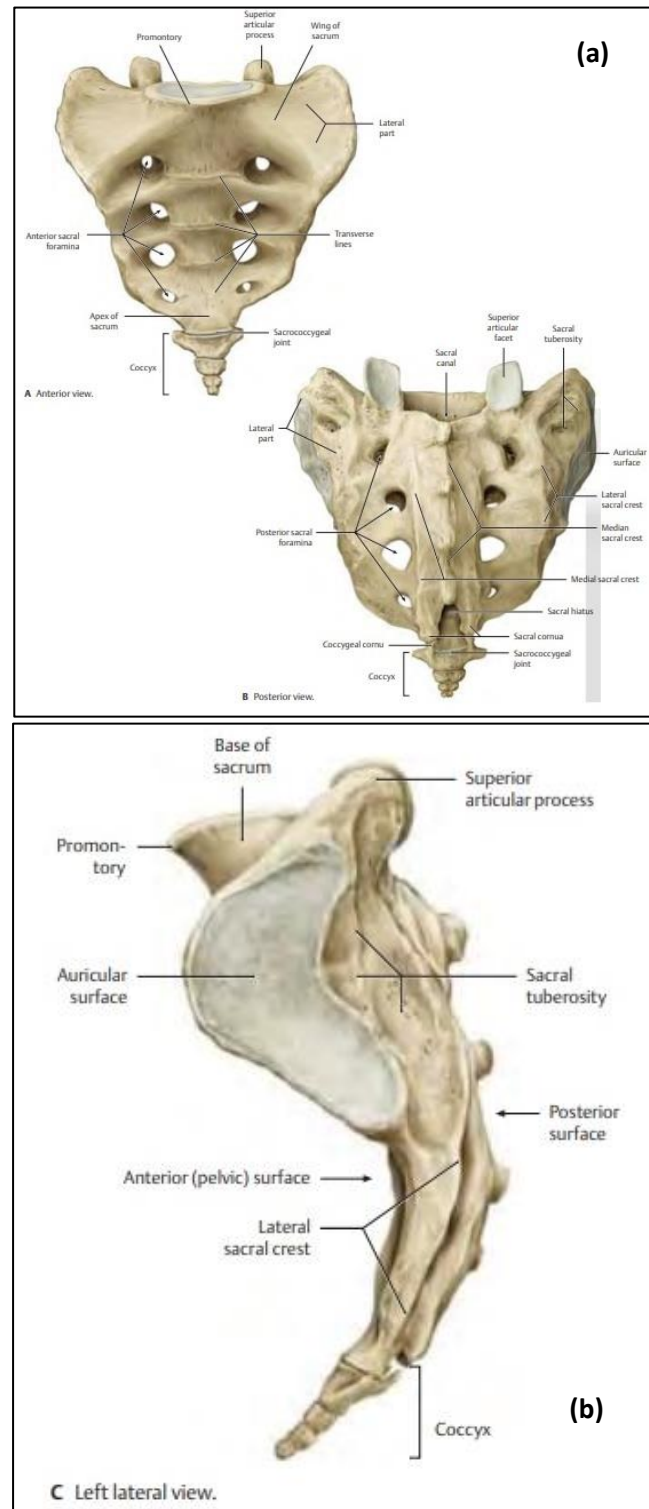


Figure 1. Anatomy of the coccyx³⁸

while the patient is in a sitting position; displacement of coccyx towards posterior is defined as *luxation*; flexion of coccyx towards posterior more than 25 degrees is defined as *hypermobility*; 5-25 degrees mobility in flexion or extension is defined as *normal mobility*; Less than 5 degrees mobility in flexion-extension has been defined as *immobile coccyx*. Coccygeal dynamic instability is one of the most common causes of coccydynia. Luxation and hypermobility are abnormal mobility patterns of the coccyx

and have also been associated with posterior spur development¹⁰. Hyperactivity or irritation of the ganglion impar due to a tumor located in the anterosuperior neighborhood of the coccyx may also cause coccydynia.^{17,18} Sometimes psychosomatic reasons can also be underlying.

Clinical Findings and Examination

The content consists of the discussion about the finding. It should be written using Times New Roman 10 with single space and each new paragraph indents in 3 pt.

Because the pain increases with the vertical pressure, it increases during sitting for a long time, sitting leaning partly backward, and and defecation^{4,6,12}. In cases of hypermobility or instability, the relationship of the coccyx with the vertebral column is abnormally changed, thus sitting or passing from sitting position to standing position may provoke pain. The patient with coccydynia needs to adjust his/her sitting position due to the relationship of pain with sitting¹³. The patient prefers to stretch his legs and hips while sitting and lie in the side position. Repetition of these positions may cause secondary musculoskeletal pain syndromes such as ischial bursitis, piriformis syndrome, sciatic nerve related pain, lumbosacral facet joint pain, and paraspinal myofascial pain^{5,6}. All these secondary painful conditions cause pelvic floor dysfunction and local increased muscle tensions and consequently may contribute to the coccygeal pain.^{4,13}

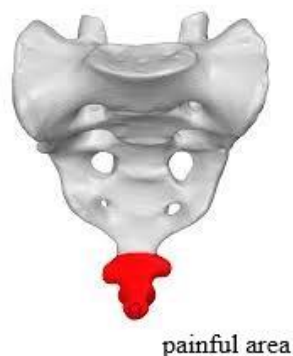


Figure 2. Painful area⁸

On physical examination, tenderness and pain is present with palpation of the coccyx, the surrounding soft tissue and even on the sacrum. The most important diagnostic question for these patients is: "Can you point the most painful area with your finger"(figure 2).⁸ Patients will directly point out the coccyx.^{4,6} This demonstrates that the pain is not low back pain, but coccydynia. As the sitting duration increases, the pain may arise or intensify. It can be stated that pain increases in the premenstrual period in women or pain occurs during sexual intercourse.¹³ The sacral, presacral and perianal areas should be carefully examined (redness, swelling, etc.) during examination. Other painful lesions of this area (pilonidal cyst, cellulitis, osteomyelitis, fistula, etc) should be excluded with examination.⁶ A "bone spur" on the coccyx can be noticed as a skin dimple. With rectal examination, pelvic floor muscles can be evaluated for hyperactivity or the presence of a trigger point.¹² Examination of the surrounding tissue will be useful for differential diagnosis. Ischial bursitis, piriformis muscle and anococcygeal ligament tenderness

and pelvic floor should be evaluated. In addition, sacroiliac joint (palpation, FABER test), lumbosacral facet joints (palpation and pain assessment with waist extension and lateral flexion), trochanteric bursitis (palpation) and radiculopathy should be evaluated.^{5,13}

Radiological Findings

Radiography

In most cases, it is possible to diagnose coccydynia by physical examination and standard radiography. However, the coccyx cannot always be evaluated with routine lumbosacral radiographs. The "coned-down technique" should be used in coccyx imaging. Thus, radiation exposure is reduced and image quality is increased.^{19,20} Since coccydynia is a dynamic disorder, it must be evaluated with dynamic radiographs. Lateral views should be taken in a standing and sitting position and they should be compared.^{6,18,21} The probability of diagnosis with standing radiographs is very low. However, when sitting and standing radiographs are examined together, the etiology of coccydynia can be determined by up to 70% of cases.^{12,13} The sacrum images are matched in the radiographs taken while standing and sitting, and the coccygeal mobility angle is calculated by calculating the gap between the coccyx images. The angle drawn vertically to the length of the coccyx with the sitting surface on sitting position is called "angle of incidence" or "base angle".²² This angle is used to describe the mobility of the coccyx in the sagittal direction, and its increase is associated with increased intrapelvic pressure and coccydynia. Normally, a flexion of up to 20 degrees anterior to the coccyx in the sitting position (forward) or listhesis below 25 degrees in any coccygeal joint can be seen.^{18,20}

While posterior subluxation is seen in the majority of cases, anterior subluxation is rarely encountered. Coccygeal instability is mentioned higher than this angle.^{21,23} Maigne et al.¹² described a method to evaluate coccygeal instability. According to this method, the position in which the patient is brought to hip flexed (hips flexed) and the spine is extended while the patient is sitting on a firm surface is the most painful posture, and the sagittal rotation of the coccyx is evaluated by comparing the direct X-ray taken in this position with the standing lateral radiograph. According to the mobility of the coccyx on the radiography, it is classified as normal, subluxed, immobile and hypermobile.¹² In approximately 15% of the cases, a bone spur can be seen posterior to the coccyx²². Spur structure is often not related to trauma and causes pain by pressure on the surrounding tissue during sitting and chronic inflammation. It is seen that the pain is relieved by giving local anesthetic around the spur, which is helpful in diagnosis.¹⁴ Provocative discography has also been described.²²

Computerized Tomography (CT)

Although in most cases, direct radiography and the patient's history are sufficient to diagnose, CT is more sensitive than direct radiography in detecting a fracture line. However, CT is not highly recommended due to the risk of direct radiation to intrapelvic organs.^{18,22,23}



Figure 3. 43 years old male patient with history of trauma about 4 months ago has admitted to our clinic with coccydynia. After the evaluation of clinically and radiologically, coccyx fracture and dislocation were observed in preoperative standing X-Ray (marked with an arrow). Significantly coccyx angulation was observed. In preoperative MRI the angulation was less than X-Ray. In preoperative CT, sacrococcygeal dislocation and separation between the coccygeal segments were seen. Total coccygectomy was performed under sacral 5 vertebrae. Patient was fully recovered (marked with an arrow).

Magnetic Resonance Imaging (MRI)

It is a useful evaluation to detect bone edema, especially in acute-subacute coccygeal fractures.^{12,16} In those cases, especially STIR sequence MRI should be preferred to evaluate bone edema. Bone edema is compatible with hypointensity in T1 and hyperintensity in T2 in the coccyx and pericoccygeal area. Luxation may be seen in cases with instability. In cases with instability or fracture line, effusion in the intersegmental joint and subchondral bone marrow edema may be observed.^{12,16,20} Moreover, MRI evaluation is recommended in patients with 'red flags' findings (fever, weight loss, history of malignancy, etc.). Other painful lesions of this area such as pilonidal cyst, coccygeal chordoma, metastatic cancers, soft tissue tumors can be diagnosed by MRI. Bone scintigraphy is also among the tests which is rarely resorted.

Treatment

Conservative Methods

Conservative treatment methods are sufficient in more than 90% of the cases. In fact, it is known that the pain completely regresses in about 1 month without any medication in many cases of coccydynia.^{4,6} Changing the sitting surface and suggestions about sitting position are sufficient in most of the cases since they reduce the factors which increase the pain.^{6,12} Sitting-related solutions with coccygeal cushions help reduce the patient's pain by reducing the pressure on the coccyx. Especially

recommended ones are U or wedge-shaped cushions. Donut-circular-shaped cushions are also recommended in cases of coccydynia, but with these, pressure may build up on the anterior coccyx which may not be helpful for coccydynia. Local hot or cold applications to the pericoccygeal area may be beneficial, but there is no difference described by patients regarding the degree of temperature.^{6,13,23}

Medical Treatments

The agents which are primarily preferred for the medical treatment of coccydynia are nonsteroidal anti-inflammatory drugs (NSAIDs), and they are often sufficient. Topical NSAIDs application is also beneficial in pain caused by osteoarthritis or musculoskeletal reasons. However, topical agents cannot be effective to relieve the pain caused by the coccyx, due to its difficulty to apply on this area. Opioid agents can be considered especially in the group which are caused by acute injuries, etc. and cannot get adequate response by medical treatment. In addition, there is a study reporting that intranasal calcitonin administration is therapeutic in cases of coccydynia with acute fracture.^{21,23}

Manipulation and Physical Therapy

According to Thiele's hypothesis, the major cause of coccydynia is the spasm of the pelvic floor muscles.²⁴ Pelvic floor rehabilitation is useful in cases of coccydynia associated with pelvic muscle spasm. In these cases, manipulation and manual massage are both helpful and therapeutic.^{21,23} Postural retraining exercises, stretching and Kegel exercises, diaphragmatic breathing training, vaginal or anal dilators, oral baclofen or peripheral muscle relaxants can be recommended.^{6,12,21} In cases with sacrococcygeal dislocation, it may be possible to correct coccyx with rectal manipulation. When applying the manipulative method, muscle spasm and ligament pain can be reduced by massage.^{6,14} With rectal massage, the levator ani, coccygeus muscle, and piriformis muscles are massaged for 3 minutes. However, it has been reported that only 25% of the cases achieved successful results with manipulation and recurrence was observed in cases up to 2 years.²⁰ Manipulation is contraindicated in patients with acute coccyx fracture and dynamic coccygeal instability detected on imaging, and distal bone spur.^{5,6} Transcutaneous electrical nerve stimulation can be performed with external or internal (rectal) probes.^{7,21}

Interventional Methods

Interventional pain injection techniques can be used in cases where conservative methods cannot give the expected response or in cases where systemic side effects are desired to be avoided or in cases where maximum therapeutic effect on coccyx is desired. By injection techniques; the accuracy of the diagnosis is ensured with response to treatment.^{17,23,25} These methods are performed with fluoroscopy. Thus, direct visualization of the coccyx is provided and the rectum, caudal epidural space, vascular structures, etc. are protected.^{13,21} As an interventional method for the treatment of coccydynia, local corticosteroid application, ganglion impar sympathetic nerve block, and nerve ablation procedures can be performed. Along with local corticosteroids or local anesthetics, it can be applied both locally to the pericoccygeal area or directly to unstable coccygeal insertion or bone spur.^{6,26,27}

In cases with a response to the treatment, repeated injection can be performed at intervals. It has been reported that pain control can be achieved only by applying injection in 59% of the cases, and the success rate reaches to 85% in cases where injection and manipulation are combined.²⁸ Ganglion impar block can be applied for coccygeal pain of sympathetic origin.^{18,25} Coccygeal nerve in radiofrequency ablation or chemical ablation (with ethyl alcohol or phenol) can be performed. Nerve ablation is preferred in cases where there is no response to steroid injection or ganglion impar sympathetic nerve techniques. However, before resorting to this method, it should be ensured that the pain is relieved with local injection.^{19,21,23} Caudal epidural steroid injection can be performed in the treatment of lower sacral radicular pain caused by Tarlov cyst (felt like coccygeal pain).^{22,29} There are limited data on spinal cord stimulation in resistant cases.³⁰ Complications of interventions can include bleeding, infection, and rectal injury.^{3,19,23} All these interventional procedures are performed transcoccygeally; and during the procedure, the patient is kept in the prone position and supported by abdominal cushions. Sacrococcygeal disc and coccyx visualization is provided by using C-arm fluoroscopy in anterior and lateral positions.

Coccygeoplasty is a procedure described by Dean et al. which is performed by applying cement to the coccyx through a wig in patients with osteoporotic fractures who do not respond to other treatments.²⁵ This method provides both pain control and mechanical stabilization of the coccyx with polymethylmethacrylate (PMMA) injection with a mechanism similar to vertebroplasty or sacroplasty. Coccygeoplasty can be performed in patients with acute-subacute fractures who do not respond to alternative treatment methods, since it is less invasive and the risk of surgical complications is low. Coccygeoplasty is an effective alternative in patients with acute-subacute osteoporotic coccygeal fracture in which we see hyperintensity in the STIR sequence on MRI revealing edema in the coccyx.^{25,26} This method can be used safely with local anesthesia and has a low risk of complications, especially in patients with osteoporotic fractures. During the procedure, fluoroscopy imaging in antero-posterior and lateral planes should be performed. Since there is no spinal canal at the coccygeal level, the risk of neurological complications is very low. Cement escaping to the pericoccygeal area can cause painful defecation. The advantages of this method are rapid pain control, early mobilization, low risk of morbidity, short hospital stay. For these reasons, it is recommended as an alternative method in patients with Coccydynia who have osteoporotic fractures and who do not respond to treatment.^{25,26}

Surgical Options

Surgical procedures should be considered in a small number of cases who do not respond to all treatment methods. Surgery can be performed in patients who do not respond to conservative treatment for 3-6 months. Surgical treatment of coccydynia is called coccygectomy, and two different surgical methods have been defined.^{4,10,31} (figure 3). The most used and most effective method is the total resection of the coccyx described by Key, in which a total coccygectomy is performed under S5 from proximal to distal.³² The procedure is performed from sacrococcygeal

junction to coccyx tip with approximately 7.5 cm incision applied on the midline coccyx. After the fascia is opened vertically, the gluteus maximus muscle on the coccyx is stripped subperiosteally from both sides of the midline and the coccyx is visualized. The coccygeus vessels are bound and disconnected. After the tip of the coccyx is revealed by sharp dissection, it is elevated and then stripped from the external sphincter with sharp dissection.^{17,28,30} Following mobilization of the coccyx, the sacrococcygeal joint is cut away from its proximal. In the method described by Gardner; the coccyx is stripped and resected from the distal to the proximal area, but the possibility of rectal injury is higher in this method.^{15,29} Postacchini and Massobrio³³ defined subtotal resection of the coccyx, revealing successful results can be obtained with this method. Subperiosteal resection of the coccyx is an alternative method used instead of total coccygectomy.³¹ There are studies reporting that successful pain control can be achieved with this method and the risk of infection is lower.^{7,31} Perioperative second-generation cephalosporins are recommended for antibiotic prophylaxis.^{31,34,35} After surgery, laxatives and a low residual diet are often recommended for facilitating defecation and painless defecation.^{34,35} Success rate has been reported in 60 to 92% of the cases in coccygectomy.¹ In a study, it was found that partial coccygectomy pain control was less and recurrence of coccydynia after surgery was higher.³⁶ Revision surgery is often required in these cases. Similarly, in another study, since 67% success was observed in 27 patients who underwent partial coccygectomy, total coccygectomy is preferred rather than partial coccygectomy in the surgical treatment of coccydynia.^{15,37} In a study comparing the effectiveness of coccygectomy and local anesthetic and steroid injections; while local anesthetic and steroid injection was an effective method in patients with type 1 coccyx according to Postacchini and Massobrio classification, coccyx excision was found effective in patients with type 2,3,4 coccyx with a history of trauma.^{11,33} In addition to the possibility of persistence of pain, there is also a risk of surgical morbidity in this procedure. Its main complication is wound infection. A study reveals that the postoperative wound infection rate is 8.34% (superficial or deep tissue) and the most common agents are *Escherichia coli* and *Staphylococcus aureus*.^{7,27} Second generation cephalosporins, gentamycin, metronidazole are antibiotics that can be used and intravenous use should be preferred.^{7,27} This surgical procedure has complication risks such as wound infection, osteomyelitis, persistent pain, and pelvic floor prolapses, sphincter injury, and incontinence (10.9-56%).^{1,23}

Conclusion

Coccydynia is a pain that we encounter frequently in daily practice. STIR sequence MRI is important in evaluating osteoporotic acute-subacute fracture. Medical treatment and sitting arrangements are sufficient in most of the cases. For decision making, standing and sitting dynamic graphs may be useful. Interventional methods can be used for diagnosis and treatment in cases who do not respond to conservative treatment. However, more aggressive treatment approaches such as Coccygeoplasty or Coccygectomy may be required in some patients based on the severity and etiology of the

cases. With appropriate indication and right patient selection, the chance of success in treatment will increase with different modalities.

Acknowledgement

The authors would like to thank Prof. Dr. Cumhuri Kılınçer for technical assistance.

Conflict of Interest

There is no conflict of interest in this paper.

References

- Ramsey ML, Toohey JS, Neidre A. Coccygodynia: treatment. *Orthopedics*; 2003. 26(4):403–405. DOI: 10.3928/0147-7447-20030401-18
- Simpson J. Clinical lectures on the diseases of women Lecture XVII: Coccydynia and diseases and deformities of the coccyx. *Medical Times Gazette*; 1859. 40:1-7
- Dalbayrak S, Yaman O, Yilmaz T, Yilmaz M. Treatment principles for coccygodynia. *Turk Neurosurg*; 2014. 24(4):532-537. DOI: 10.5137/1019-5149.JTN.9505-13.0
- Eng JB, Rymaszewski L, Jepson K. Coccygectomy. *J R Coll Edinb*; 1989. 33:202-239. PMID: 3221340
- Karadimas EJ, Trypsiannis G, Giannoudis PV. Surgical treatment of coccygodynia: An analytic review of the literature. *Eur Spine J*; 2011. 20(5):698-705. DOI: 10.1007/s00586-010-1617-1
- Lirette LS, Chaiban G, Tolba R, Eissa H. Coccydynia: an overview of the anatomy, etiology, and treatment of coccyx pain. *Ochsner J*; 2014.14(1):84-87. PMID: 24688338; PMCID: PMC3963058
- Pennekamp PH, Kraft CN, Stutz A. Coccygectomy for coccygodynia: Does pathogenesis matter? *J Trauma*; 2005. 59(6):1414–1419. DOI: 10.1097/01.ta.0000195878.50928.3c
- Howorth B. The painful coccyx. *Clin Orthop*; 1959. 14:145-160
- Woon JT, Stringer MD. Clinical anatomy of the coccyx: A systematic review. *Clin Anat*; 2012. Mar;25(2):158-67. DOI: 10.1002/ca.21216
- Maigne JY, Guedj S, Straus C. Idiopathic coccygodynia. Lateral roentgenograms in the sitting position and coccygeal discography. *Spine (Phila Pa 1976)*; 1994.19(8):930-934. DOI: 10.1097/00007632-199404150-00011
- Postacchini F, Massobrio M. Idiopathic coccygodynia. Analysis of fifty-one operative cases and radiographic study of the normal coccyx. *J Bone Joint Surg*; 1983. 65:1116-1124. PMID: 6226668
- Maigne JY, Pigeau I, Roger B. Magnetic resonance imaging findings in the painful adult coccyx. *Eur Spine J*; 2012.21(10):2097-2104. DOI: 10.1007/s00586-012-2202-6
- Nathan ST, Fisher BE, Roberts CS. Coccydynia: a review of pathoanatomy, aetiology, treatment and outcome. *J Bone Joint Surg Br*; 2010. 92(12):1622-1627. DOI: 10.1302/0301-620X.92B12.25486
- Maigne JY, Doursounian L, Chatellier G. Causes and mechanisms of common coccydynia: role of body mass index and coccygeal trauma. *Spine*; 2000.25:3072-3079. DOI: 10.1097/00007632-200012010-00015
- Dennell LV, Nathan S. Coccygeal retroversion. *Spine*; 2004.29:256-257. DOI: 10.1097/01.brs.0000127194.97062.17
- Kim NH, Suk KS. Clinical and radiological differences between traumatic and idiopathic coccygodynia. *Yonsei Med J*; 1999.40:215-220. DOI: 10.3349/ymj.1999.40.3.215
- De Andres J, Chaves S. Coccygodynia: a proposal for an algorithm for treatment. *J Pain*; 2003.4(5):257–266. DOI: 10.1016/s1526-5900(03)00620-5
- Foye PM. Sympathetic nervous system pain at the coccyx. *Tailbone pain relief now! Newark (NJ): Top Quality Publishing*; 2015. p. 79–84
- Foye PM. Coccydynia: Tailbone Pain. *Phys Med Rehabil Clin N Am*; 2017.28(3):539-549. DOI: 10.1016/j.pmr.2017.03.006
- Foye PM. Manipulation of the coccyx. *Tailbone pain relief now! Newark (NJ). Top Quality Publishing*; 2015. p. 169–174
- Foye PM, Shupper P, Wendel I. Coccyx fractures treated with intranasal calcitonin. *Pain Physician*; 2014. 17(2):229-233. PMID: 24658491
- Maigne JY, Tamalet, B. Standardized radiologic protocol for the study of common coccygodynia and characteristics of the lesions observed in the sitting position. *Spine*; 1996. 21:2588–2593. DOI: 10.1097/00007632-199611150-00008
- García FJ, Franco JD, Márquez R. Posterior hernia of the rectum after coccygectomy. *Eur J Surg*; 1998. 164(10):793–794. DOI: 10.1080/110241598750005462
- Thiele GH. Coccydynia and pain in the superior gluteal region and down the back of the thigh: causation by tonic spasm of the levator ani, coccygeus and piriformis muscles and relief by massage of these muscles. *JAMA*; 1937.109:1271-1275
- Dean LM, Syed MI, Jan SA, Patel NA, Shaikh A, Morar K, Shah O. Coccygeoplasty: Treatment for fractures of the coccyx. *J Vasc Interv Radiol*; 2006. 17(5):909-912. DOI: 10.1097/01.RVI.0000217953.74013.87
- Akar E, Koban O, Öğrenci A, Yılmaz M, Dalbayrak S. Polymethylmetacrylate Cement Augmentation of the Coccyx (Coccygeoplasty) for Fracture: A Case Report. *Balkan Med J*; 2020.37:348-350. DOI: 10.4274/balkanmedj.galenos.2020.2020.4.68
- Doursounian L, Maigne JY, Faure F. Coccygectomy for instability of the coccyx. *Int Orthop*; 2004.28(3):176–179. DOI: 10.1007/s00264-004-0544-3
- Mahmood B, Pasternack J, Razi A, Saleh A. Safety and efficacy of percutaneous sacroplasty for treatment of sacral insufficiency fractures: a systematic review. *J Spine Surg*; 2019. 5(3):365-371. DOI: 10.21037/jss.2019.06.05
- Gardner RC. An improved technique of coccygectomy. *Clin Orthop*; 1972.85:143–145. DOI: 10.1097/00003086-197206000-00025

30. Haider N. Coccydynia Treated with Spinal Cord Stimulation; A Case Report. American Academy of Pain Medicine 24th Annual Meeting. 2008: Poster 144. Available from: <http://aapm.confex.com/aapm/2008am/techprogram/P2716.HTM>. Accessed December 2, 2013.
31. Bilgic S, Kurklu M, Yurttas, Y. Coccygectomy with or without periosteal resection. *Int Orthop*; 2009. 34(4):537–541. DOI: 10.1007/s00264-009-0805-2
32. Key JA. Operative treatment of coccygodynia. *J Bone Joint Surg Am*; 1937. 19:759–764. PMID: 6226668
33. Postacchini F, Massobrio M. Idiopathic coccygodynia. *J Bone Joint Surg Am*; 1993. 5:123–126. PMID: 6226668
34. Capar B, Akpınar N, Kutluay E. Coccygectomy in patients with coccygodynia. *Acta Orthop Traumatol Turc*; 2007. 41(4):277–280. PMID: 18180556
35. Wood KB, Mehbod AA. Operative treatment for coccygodynia. *J Spinal Disord Tech*; 2004.17(6):511–515. DOI: 10.1097/01.bsd.0000128691.36652.16
36. Hellberg S, Strange- Vognsen HH. Coccygodynia treated by resection of the coccyx. *Acta Orthop Scand*; 1990. 61:463-465. DOI: 10.3109/17453679008993564
37. Wray AR, Templeton J. Coccygectomy: a review of thirtyseven cases. *Ulster Med J*; 1982. 51:121-124. PMID: PMC2385865
38. Thieme. Vertebral column: Overview. Available from: <https://web.thieme.com/media/samples/pubid-455606490.pdf>