

## Coccygodynia and Coccygectomy

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**Objective:** A review of the literature on coccygectomy and our patients was performed to assess the effectiveness of coccygectomy for chronic refractory coccygodynia.

**Methods:** An English language PubMed search was conducted with the terms “coccygodynia” and “coccygectomy” from January 1980 to January 2012. We retrospectively reviewed the medical records and performed telephone questionnaire on 61 patients who underwent coccygectomy at UCDCMC between 1997 and 2009.

**Results:** There were 28 case series from 1980 to 2012 for a total of 742 patients who underwent coccygectomy following failed conservative management. The mean age ranged from 26.4 to 52.8 years. The most common cause was direct trauma (58.5%) with a male:female ratio of 1:5.2. Most patients (84%) had a good to excellent outcome after coccygectomy. The most common complication is wound infection (10.0%). The overall complication rate was 13.3%. Similarly, 84.6% of patients from our own surgical case series reported good to excellent outcomes with 11.5% wound infection.

**Conclusion:** Coccygectomy is an effective treatment for chronic refractory coccygodynia. The surgery is relatively simple to perform but precaution must be taken to avoid wound infection.

**Key Words:** Coccygodynia · Coccygectomy · Surgical Results · Wound infection

### INTRODUCTION

Coccygodynia, first described by Simpson in 1859, is disabling pain in the coccyx that is usually provoked by sitting or changing from a sitting to a standing position. This tail bone pain may radiate rostrally to the sacrum or lumbar spine or laterally to the buttocks. Patients may rarely present with associated rectal pain or radicular symptoms. One third of patients have associated back pain, contributing to misdiagnosis<sup>1,2,23,24</sup>. Due to unfamiliarity with this condition by spine specialist, many patients may suffer for years without proper treatment<sup>11-13,16,24</sup>. Compounding the problem, most neurosurgeons and orthopedic spine surgeons are uncomfortable treating coccygodynia due to lack of surgical training with coccygectomy. Fortunately, the knowledge to properly diagnose and surgically treat chronic refractory coccygodynia may be easily acquired. Diagnosis is based on the history and physical exam, supple-

mented by imaging findings and local injection of the coccyx.

To raise awareness among our neurosurgical colleagues on coccygodynia and surgical treatment, we review the literature on coccygectomy and describe the surgical technique based on our extensive experience at University of California, Davis Medical Center (UCDCMC).

### MATERIALS AND METHODS

#### Systemic data selection using PubMed

Relevant articles were retrieved with PubMed using the key words, “coccygodynia” and/or “coccygectomy”. We limited the search to the English-language literature published from 1980 to January 2012. Case reports, caseseries of less than 8 patients, and editorials were excluded. Selected manuscripts were analyzed for the number of patients, age, gender, symptom duration, etiology, radiographic classification, type of surgery, use of antibiotics or drain, complications, and follow-up period. Statistical analysis of the data was performed using the Statistical Package for the Social Sciences (SPSS), version 16.0 (SPSS, Inc., Chicago, IL, USA). Continuous variables were expressed as the mean±standard deviation, and categorical variables were expressed as frequencies and percentages. The Chi-square test was used to evaluate any potential association

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**Table 1.** Radiographic classification of the coccyx

Authors	Classification
Postacchini and Massobrio	Type I: Curved slightly forward Type II: More marked curve, straight forward Type III: Sharply angled anteriorly Type IV: Subluxation of the sacrococcygeal or intercoccygeal joints
Maigne et al.	Type I: Curving more than 25 degree Type II: Displaced or subluxed posteriorly Type III: Immobile with a spicule in the dorsal surface of the last coccygeal segment

of the two different surgical procedures with the postoperative outcome and complication rate. Odds ratios (OR) and 95 % confidence intervals (CI), were calculated by means of simple logistic regression analysis. Statistical significance was defined as p-values <0.05.

### Coccygectomy case selection at UCDMC

After the UC Davis Institutional Review Board approval was obtained, 61 patients who had coccygectomy for chronic refractory coccygodynia between 1997 and 2009 were identified. For a variety of reasons, only 26 patients participated in a telephone survey. X-rays of responders were classified according to the Postacchini and Masobrio methods (Table 1). Outcomes were categorized as excellent (complete pain relief), good (relief of most pain but mild discomfort after prolonged sitting), fair (minimal or no pain relief), or poor (pain worse after the surgery).

### Surgical technique of coccygectomy

All patients received a bowel preparation preoperatively to help prevent fecal contamination of the wound and to minimize complications in the unlikely event of a rectal perforation. Intravenous antibiotics were administered prior to skin-incision. After the induction of general anesthesia, the patient was positioned prone on a Wilson frame. The buttocks are retracted laterally with adhesive tape to expose the gluteal cleft. The coccygeal region and anus are prepared with iodine or chlorhexidine. Following the skin preparation, the perianal area is isolated with a 3M 1010 Steri-Drape, and the incision site is then draped with sterile towels. The skin is infiltrated with lidocaine and epinephrine. Lateral fluoroscopic images are used to locate the sacrococcygeal junction. A midline vertical incision is made over the coccyx followed by an exposure from proximal to distal direction. After removal of the sacrococcygeal disc The coccyx is elevated and separated from the surrounding tissues circumferentially in a subperiosteal plane using monopolar electrocautery, proceeding with an en bloc resection in a rostral to caudal direction in the manner of Key at al. (Table 2).

**Table 2.** Surgical options for coccygectomy

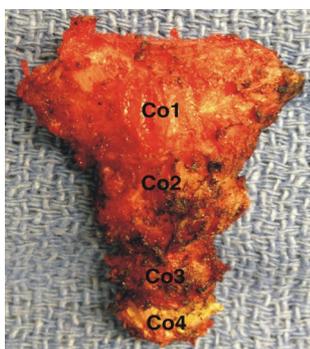
Authors	Options
Key	Proximal to distal coccygectomy
Gardner	Distal to proximal coccygectomy
Postacchini and Massobrio	Total coccygectomy or partial coccygectomy
Bilgic et al	Sub-periosteal resection instead of periosteal

Dissection from a proximal to distal direction avoids the risk of rectal injury, especially in the case of an anteverted coccyx. In some cases of posterior intercoccygeal subluxation, the distal segment may be removed first. En bloc resection prevents treatment failures secondary to incomplete resection. The Co-1 is identified anatomically by the cornua at the articulation with the caudal sacral segment, and is usually twice as wide as the Co2 segment. It is often helpful to resect the cornu with a Kerrison rongeur to facilitate mobilization of the coccygeal segment. In the case of a fused S5-Co1 disc, the resection proceeds distal to the first mobile segment, or alternatively an osteotomy is performed between S5 and Co1 to effect a total coccygectomy. Total coccygectomy is preferred for thinner patients, where the Co1 segment may present a symptomatic bony prominence if it is not removed. Cutting monopolar electrocautery current on a low setting is favored over coagulating current to limit damage to surrounding tissues that could result in wound infection or rectal injury. A clamp may be applied at the lateral aspects of the coccyx to aid in posterior elevation and retraction. A complete resection may be ascertained by examining the resected specimen (Fig. 1) and by comparing a lateral C-arm fluoroscopic radiograph with preoperative imaging to ensure complete resection. All remaining sharp prominences on the caudal sacrum are smoothed using a rongeur, and bone wax is applied. After hemostasis is ensured, the overlying fascia and skin are closed in layers, with subcutaneous sutures for the skin. A liquid skin adhesive (Dermabond) is applied to help protect the wound from contamination. Broad-spectrum antibiotics are continued for 48-72 hours, and the patient receives nursing care in a lateral position or supine on a specialized sacral cutout cushion to avoid direct pressure on the surgical wound.

**Table 3.** Systemic review data

Authors	Year	Design	No of pts (F/M)	Favorable outcomes (%)	Infections (%)	Follow-up times (months)
Kerr et al	2011	Retro	26 (19/7)	22 (84.6)	3 (11.5) 2 redo	37
Trollegaard et al	2010	Retro	41 (39/2)	33 (80.5)	5 (12.2) 1 redo	ns
Bilgic et al	2010	Retro	25 (15/10)	21 (84.0)	4 (16.0)	20.4
Traub et al	2009	Retro	8 (6/2)	7 (87.5)	0 (0.0) 4 dehiscence	21.7
Sehirlioglu et al	2007	Retro	74 (64/10)	71 (95.9)	5 (6.8)	4.1 yrs
Cebesoy et al	2007	Retro	21 (15/6)	21 (100)	0.0	26
Capar et al	2007	Retro	24 (23/1)	20 (83.3)	2 (8.3)	Minimum 9 months
Mouhsine et al	2006	Retro	15 (9/6)	14 (93.3)	1 (6.7)	2.8 yrs
Balain et al	2006	Retro	31 (29/2)	22 (71.0)	1 (3.2)	6.75 yrs
Pennekamp et al	2005	Retro	16 (14/2)	10 (62.5)	3 (18.8)	7.3 yrs
Feldbrin et al	2005	Retro	9 (7/2)	5 (67.0)	nm	Minimum 12 months
Wood et al	2004	Retro	20 (17/3)	18 (90.0)	3 (15.0), 3 persistent drainage	26
Karalezli et al	2004	Retro	14 (14/0)	12 (85.7)	2 (14.3)	30
Hodges et al	2004	Retro	11 (9/2)	9 (81.8)	3 (27.2), 1 dehiscence	28
DDoursounian et al	2004	Retro	61 (49/12)	53 (86.9)	9 (14.8)	12
Ramsey et al	2003	Retro	15 (14/1)	13 (86.7)	4 (26.7)	14
Perkins et al	2003	Retro	13 (9/4)	12 (92.3)	1 (7.7), 1 dehiscence	43
Maigne et al	2000	Prospective	37 (28/9)	34 (91.9)	3 (8.1)	minimum 2 yrs
Valen et al	1999	Retro	25	20 (80.0)	nm	1-16 yrs
Kim & Suk	1999	Retro	11	10 (91.0)	nm	
Zayer	1996	Retro	10 (10/0)	10 (100)	1 (10.0)	5 yrs
Grosso & van Dam	1995	Retro	9 (6/3)	9 (100)	1 (11.1)	56
Wray et al	1991	Prospective	23 (20/3)	21 (91.3)	nm	nm
Hellberg & Strange-Vognsen	1990	Retro	55 (49/6)	50 (90.9)	4 (7.3), 1 redo	15 yrs
Eng et al	1988	Retro	27 (25/2)	18 (67.0)	0 (0.0), 6 delayed healing	nm
Bayne et al	1984	Retro	48 (38/10)	29 (60.4)	8 (16.7), 2 hematoma	7 yrs
Postacchini & Massobrio.	1983	Retro	36 (32/4)	32 (88.0)	1 (2.7)	7.8 yrs
Wray & Templeton	1982	Retro	37 (32/5)	27 (73.0)	nm	5.5 yrs
Total (28 articles)			742 (592/114,5,2/1)	623 (84.0)	64 (10.0)	

nm; not mentioned



**Fig. 1.** Photograph of a resected coccyx specimen. This specimen from total coccygectomy shows widened Co-1 segment with its paired cornue.

## RESULTS

Total of 28 manuscripts met the inclusion criteria and were analyzed (Table 3). Only two of them were prospective series<sup>19,32</sup>. The majority were retrospective uncontrolled case series. In total, the reviewed series included 742 patients with coccy-

godynia that had coccygectomy as definitive pain management. The youngest patient was 11 and the oldest was 78 with the mean age ranging from 26.4 to 52.8 years<sup>3,8</sup>. Out of 706 patients with their sex identified, 592 were females (83.9%) and 114 were males (16.1%), with the male to female ratio of 1:5.2. The etiology of the coccygodynia was reported in all except for five articles, totalling 556 patients<sup>6,17,19,26,31</sup>. The most common cause of coccygodynia was direct trauma, reported in 325 patients (58.5%). Idiopathic coccygodynia, childbirth, and recent lumbar spinal surgery or rectal surgery or epidural injection comprised of 174 cases (31.3%).

Abnormal imaging characteristics have been described, most often using a classification system introduced by Postacchini and Massobrio which characterizes kyphotic angulation and/or subluxation (Table 1)<sup>4,8,11,15,16,24,30</sup>. Out of 176 X-rays analyzed, there were 64 type I (36.4%), 55 type II (31.3%), 31 type III (17.6%) and 26 type IV (14.8%). Other studies describe subluxation and hypermobility of the coccyx<sup>6,19,21</sup>. Abnormal imaging on plain and dynamic x-rays, including hyper-

mobility, ventral angulation, and subluxation, are associated with coccygodynia but are not sine qua non characteristics.

There were four (one prospective) comparative studies assessing the efficiency of injections to coccygectomy<sup>13,25,30,32</sup>. Their findings showed that injection with manipulation is effective in providing pain relief, but they also suggested that coccygectomy is a reasonable choice for those in whom the conservative management failed. Prior to coccygectomy, the majority of patients had undergone non-operative treatment modalities for a variable period of time, ranging from 3 months to 15 years.

In four papers<sup>3,6,13,30</sup> a second generation cephalosporin was administered for 48 hours postoperatively, while the rest of the studies vary significantly as to the type and duration of their chemoprophylaxis. Maigne et al., Doursounian et al. and Pennekamp et al. have recommended the use of a drain for avoiding the void space which could compromise the results<sup>6,19,22</sup>. On the other hand, several authors deemed drain unnecessary<sup>1,11,12,33</sup>. We have not used drains at our institution. The usage of drain in close proximity to rectum may be considered as a cause for increased infection rate, but this systematic review could not confirm any direct relation between the usage of drain and rate of infections. Following surgery, laxative or enema together with a low residual diet were often used to facilitate patient's postoperative elimination management. Patient follow-up ranged from 4 months to 16 years after the surgery, with the vast majority of the studies having a mean follow-up period of more than 2 years.

Our literature review revealed that 623 out of 742 patients treated with coccygectomy had excellent or good outcome (84.0%). Some of the authors used visual analogue scale (VAS) and the Oswestry disability index (ODI) for evaluating their results<sup>3,5,6,13,16,22,23,27</sup>. Perkins et al.<sup>23</sup> and Hodges et al.<sup>13</sup> presented a decrease of VAS from 8.3 to 4.5 and 7.3 to 3.6, respectively. Similarly the reduction of ODI was from 35.6 to 12.5 and 55 to 36, respectively. Cebesoy et al.<sup>5</sup> also commented that there was a progression of VAS reduction through time from 5.18 pre-operatively to 3.18 at 6 months and 2.94 and 2.76 at 12 and 24 months, respectively. Kerr et al.<sup>16</sup> reported that the outcome appeared to be durable over time and not dependent on the cause of pain. Perkins et al.<sup>23</sup> reported only 54% with a good outcome (7/13) probably due to the fact that most of their patients also had associated lumbar spinal disorders (10/13).

Bayne et al.<sup>2</sup> reported 40% fair to poor outcome (19/48) and advocated against the Gardner surgical technique (Table 3) and for the use of perioperative antibiotics. Key's proximal to distal surgical technique was reported in seven studies<sup>3,4,6,16,23,25,26,30</sup>, whereas in only one study was Gardner's distal to proximal exposure used<sup>2</sup>. Statistical analysis of the incidence

of complications between the two different techniques revealed a trend toward a higher complication rate in patients treated with the Gardner method (10 of 48 patients; 20.8%) compared with Key's operation (30 of 232 patients; 12.9%), but this difference did not reach statistical signifi. Overall, the risk of complications was increased by almost 80% among patients who underwent Gardner's surgical exposure compared with patients managed with Key's technique (OR, 1.77; 95% CI, 0.80-3.93). Patients who underwent Key's operation were more likely to have better results compared with those who were operated with the Gardner method; the results of Key's operation were excellent in 203 (87.5%) patients, fair in 11 (4.7%) patients and poor in only 18 (7.8%) patients, while 29 (60.4%), 11 (22.9%) and 8 (16.7%) of the patients who were managed with the Gardner method had excellent, fair and poor results, respectively. Patients who underwent Key's operation were almost five times more likely to experience an excellent result than those who were managed with the Gardner method (OR, 4.59; 95% CI, 2.28-9.21).

The complication rates in the reviewed series varied from 0 to 50%<sup>5,26,27</sup>. All but five studies were referring to post-operative complications<sup>8,17,29,31,32</sup>. Overall wound infection rate was 10.0% (64 cases). *Escherichia coli* and *Staphylococcus aureus* were the most frequently recorded bacteria in those series with reported microbiology results. Moreover, there were 2 hematomas, 6 wounds dehiscence that lead to further surgical management, 3 persistent drainage and 6 delayed healings. There were 4 cases (0.6%) of re-do operation to excise to re-operation for excision of remnant coccyx or the distal cornua of the sacrum. The overall complication rate was 13.3%.

### Coccygectomy series at UCDMC

The average patient age was 42 years (range 25-78 years), and the male to female ratio was 1:4. The median duration of patient-reported symptoms prior to surgery was 24 months. 58% of patients had tried local injections of steroids and/or anesthetics prior to surgery. Follow-up telephone survey was able to be obtained only from 26 patients from the entire series (42.6%). The most common cause of coccygodynia was direct trauma, recorded in 15 patients (57.7%). Idiopathic coccygodynia was 8 cases (30.8%). Of note, three cases (11.5%) developed after esophagectomy, lumbar fusion and lumbar discectomy (1 case each). The median duration of follow up from the time of surgery was 37 months (range 2-133 months). Patients had been evaluated with lateral sacrococcygeal radiographs. Of the 26 respondents, we could classify the coccyx according to the schema described by Postacchini and Massobrio in 24 patients (Table 2). Of these coccyges, seven were Type I (29.2%), seven were Type II (29.2%), two were Type III (8.3%), and seven

were Type IV (29.2%).

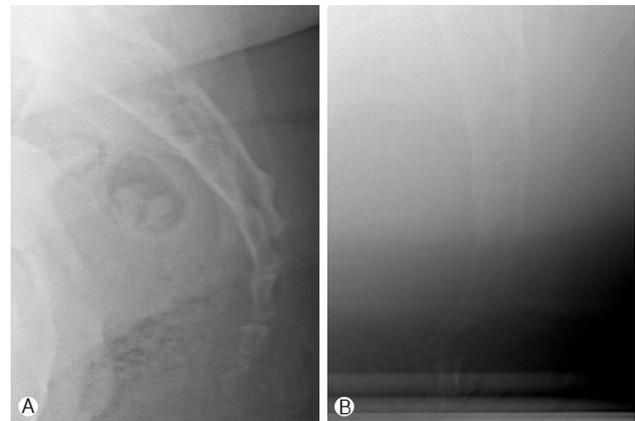
The number of patients with outcomes rated as “excellent,” “good,” “fair,” and “poor” were 13, 9, 2, and 2, respectively. The favorable result (excellent or good) was 84.6%. 31% of respondents claimed they had been misdiagnosed as having some other pathological condition explaining their coccygodynia. 85% of respondents stated they would undergo the operation again if faced with the same situation. 96% of respondents would have had the procedure sooner if they had been given the option, and 85% would recommend the surgery to others. The self-reported VAS score was significantly improved by surgery. The mean VAS score preoperatively was  $9.6 \pm 0.8$ , and postoperatively it was  $3.1 \pm 3.1$  ( $p < 0.001$ ). There were 3 infections (11.5%) among the 26 patients. There were no rectal injuries. Two patients underwent redo coccygectomy to resect residual coccyx after initial partial coccygectomy, resulting in 1 good and 1 fair result at the time of telephone follow-up. No significant difference in outcome could be detected based on traumatic versus nontraumatic causes ( $p = 0.33$ ). Our numbers were small, but the outcome appeared to be durable over time and not dependent on the cause of pain.

## DISCUSSION

Coccygodynia is a disabling pain in the coccyx exacerbated by sitting or rising from sitting. The pain is often pulling or lancinating in quality, may radiate to the sacrum or buttock, and may coexist with lower back pain. It may be traumatic or idiopathic in origin and is more common in women. Also coccygodynia is known as coccydynia or coccygeal neuralgia.

### Imaging studies

All patients should receive a dynamic lateral sacrococcygeal x-ray in both the standing and sitting positions. This reveals the patient’s coccygeal configuration (Table 1). Four types of coccygeal configurations have been described by Postacchini and Massobrio: type I (normal, curved slightly forward, seen in 68% of the general population), type II (more curved, straight forward), type III (sharply angulated), and type IV (subluxed)<sup>24</sup>. In coccygodynia, patients are less likely to have type I (31%) and more likely to have type III and IV configurations. Fusion of the sacrococcygeal joint appears to be a predisposing factor in coccygeal pain (51% versus 37% in people without coccygodynia)<sup>24</sup>. Dynamic lateral sacrococcygeal radiographs are used to compare changes between standing and painful sitting. Radiographic instability as evidenced by posterior subluxation and hypermobility ( $> 20^\circ$  of sacrococcygeal or intercoccygeal angulation) is seen in approximately 70% of patients with



**Fig. 2.** Dynamic lateral sacrococcygeal X-ray with standing (A) and sitting (B) in a patient with chronic idiopathic coccygodynia. Note the subluxation after sitting indicating coccygeal instability.

coccygodynia (Fig. 2). Radiographic instability has been shown to predict excellent or good results after coccygectomy<sup>19</sup>.

Other lesions include anterior subluxation and a bony spuricle on the dorsal tip of the coccyx (seen in 5% and 14% of coccygodynia, respectively). Lumbosacral MRI with contrast is recommended in all patients to define normal and abnormal bony anatomy and to rule out less common causes of coccygodynia, such as abscess or tumors. CT is superior to MRI in defining normal and abnormal bony anatomy. CT should be ordered in cases of acute pelvic trauma, and as an adjunct to MRI in evaluating neoplastic disease.

### Treatment approach

Coccygodynia is managed in a stepwise fashion with increasing invasiveness. Acute coccygodynia (symptoms  $< 2$  months) is managed differently from chronic coccygodynia (symptoms  $> 2$  months). Coccygectomy surgery is reserved for refractory cases. The goal of treatment is to eliminate or significantly reduce coccygeal pain and allow the patient to resume a pre-morbid lifestyle. Incidentally discovered tumors or other pathologies are referred immediately to appropriate specialists.

### Acute coccygodynia

All patients with acute coccygodynia (symptoms  $< 2$  months) are prescribed rest and a nonsteroidal anti-inflammatory drug (NSAID) for a period of 8 weeks<sup>9</sup>. A stool softener is recommended in patients who have a history of pain with defecation, also for 8 weeks. Adjustments in seating with U-shaped cushions can relieve pressure on the coccyx. Additional therapies include sitz baths, hot mud application, acupuncture, and chiropractic manipulation. Patients who do not respond in

this time frame are treated the same as patients with chronic disease who have failed acute management.

### Chronic coccygodynia: initial conservative management

No universally accepted guidelines for conservative interventional management exist, but various nonoperative treatment options are available according to the experience and expertise of the physician. Non-operative treatment includes ergonomic adjustments such as a specialized cushion for sitting, application of local heat, and oral analgesics<sup>14,16,20</sup>.

Patients with newly diagnosed chronic coccygodynia (symptoms >2 months) should receive the same therapies recommended for acute coccygodynia before trying more invasive measures. Patients who have failed acute management should obtain dynamic sacrococcygeal X-rays and MRI to rule out tumor or other pathology.

Favorable results are reported after corticosteroid and local anesthetic injections given on an as-required basis<sup>20,23</sup>. They may be given alone or in combination with invasive manipulation (i.e., transrectal flexion and extension) under general anesthesia, the latter being considered more successful<sup>32</sup>. The corticosteroid plus local anesthetic should either be injected into the soft tissues around the sides and tip of the coccyx (using methylprednisolone) or the sacrococcygeal (SC) junction and dorsolateral periosteum of the coccyx (using triamcinolone). However, percutaneous sacrococcygeal junction injection is sometimes recommended if local injection and/or manipulation fails, and may be accomplished fluoroscopically, or with digital rectal localization of the SC junction. If corticosteroid injections have no effect after 2 successive monthly injections, physical therapy combined with corticosteroid injection is an effective second-line option. Physical-therapy measures include transrectal pelvic floor massage and coccygeal mobilization<sup>32</sup>.

### Chronic coccygodynia: surgery - Coccygectomy

In cases of persistent symptoms unresponsive to conservative treatment, however, coccygectomy is offered as the definitive treatment option<sup>24,28</sup>. Different types of surgical treatment have been described but Key's method is most popular (Table 2)<sup>3,4,6,7,15,16,19,21-26,30</sup>. The coccyx can be removed either totally or partially. Surgical series have reported success rates ranging from 60% to 100% after coccygectomy<sup>1,3-6,8,11-13,15,19, 21-23,25, 26,28-30,32,33</sup>. Nevertheless, controversy exists<sup>11,24</sup>. Some have even advised against coccygectomy because they found that coccygectomy frequently failed to relieve the symptoms<sup>9</sup>.

Statistical analysis revealed that patients who underwent coccygectomy according to Key had five times more chances

to have a better outcome. According to Postacchini and Massobrio, the coccyx can be removed either totally or partially with comparable good results<sup>24</sup>. In most papers, however, total resection had better outcomes than partial resection and was recommended to reduce the chance of re-do operation<sup>11,12,15,16,21,25</sup>. Total resection requires an S5-Co1 osteotomy in the case of a sacrococcygeal synostosis. A periosteal resection instead of a subperiosteal resection has also been reported as an option<sup>3,22</sup>. We feel that the subperiosteal resection, which preserves the ligamentous attachments and anococcygeal ligament, is a safer and more straightforward than a periosteal and ligamentous resection, and could theoretically decrease the rare complication of rectal hernia. In our surgical case series, we encountered no cases of intraoperative rectal perforation or delayed rectal hernia associated with internal wound dehiscence. The prognosis according to etiology is variable. Kerr et al. reported that no significant difference in outcome could be detected based on traumatic versus nontraumatic causes ( $p=0.33$ )<sup>16</sup>. On the other hand, coccygectomy is more successful in cases of traumatic and postpartum coccygodynia than in idiopathic coccygodynia (75% success versus 58% success)<sup>2,22</sup>. Bayne et al. reported that coccygectomy is seldom successful for pain associated with lumbar disc disease requiring lumbar laminectomy and spine fusion<sup>2</sup>.

Surgical series have reported success rates ranging from 60% to 100% after coccygectomy<sup>1,3-6,8,11-13,15,19,21-23,25,26,28-30,32,33</sup>. The favorable outcome from the 28 papers was 84%. Confining coccygectomy to patients with radiographic instability on dynamic x-rays can result in good or excellent outcomes in 92% of cases (Fig. 2)<sup>19</sup>, but may exclude patients with normal imaging who would otherwise benefit.

### Complications - Wound infection

Wound infection is the most common complication after surgery, with rates ranging from 2% to 22%<sup>9</sup>. Wound infection is facilitated by the location of the skin incision in the interlineal fold in proximity to the anus. The complication rates in the reviewed series varied from 0 to 50%<sup>5,6,13,26,27</sup>. Infection rates as high as 50% have been reported, although in recent series the rates are much lower (0-3%)<sup>1,5</sup>. Overall infection from 28 papers was 64 cases (10.0%) (Table 3). It is notable that small case series had the highest complication rates, ranging from 26.7 to 50%<sup>5,13,25,30</sup>. Bayne et al. reported also a large number of complications (20.6%) that was attributed to no antibiotic prescription in contrast to the rest of the authors and protocols<sup>2</sup>.

The majority were infections that resolved with antibiotic treatment or surgical debridement. *Escherichia coli* and *Staphylococcus aureus* were the most frequently recorded bacteria

in those series with reported microbiology results. We were also unable to identify a direct relationship between infection and poor outcome.

There were several options to decrease the wound infection. Among the surgical approaches, Key's surgical exposure showed lower incidence of complications compared with Gardner's technique. Patients who underwent Key's operation were almost five times more likely to experience an excellent result than those who were managed with the Gardner method.

It is of note that some authors reported that sub-periosteal resection gives better results and reduce the risk of infection compared with total coccygectomy<sup>3,22</sup>.

The use of a drain along with postoperative antibiotics may reduce the incidence of postoperative wound problems including infection. There is a debate, however, on use of drainage. Bayne et al. reported a large number of complications (20.6%), but also mentioned that the lack of preoperative antibiotics, which is standard now<sup>2</sup>. There is no consensus how long antibiotics should be used postoperatively. In most papers, antibiotics were used for 72 hours after the surgery and covered both aerobic and anaerobic organisms. Patient may be given a low residual constipating diet to avoid the need for bowel movements in the immediate post-operative period.

### Complications other than infection

Apart from infection, other complications were rare. There were 2 hematomas, 6 wounds dehiscence that lead to further surgical management, 3 persistent drainage, and 6 delayed healings. There were 4 cases (0.6%) of re-do operation to excise remnant coccyx or the distal cornua of the sacrum. None of the published case series have reported the complication of rectal hernia or rectal injury but two case reports exist.<sup>10, 18</sup> The overall total complication rate was 13.3%.

It is notable that there were 4 case of re-do operation to resection the remnant of the coccyx. Several authors reported the advantages of performing total coccygectomy compared with partial one, which appears to be associated with an increased incidence of recurrent pain and revision surgery<sup>11,12, 15,16,21,25</sup>. Residual coccygeal fragments or a prominent sacral edge in a thin patient may lead to poor outcomes and necessitate reoperation for redo coccygectomy, or rongeur of the edge of the sacrum. We recommend total coccygectomy instead of partial coccygectomy to reduce the need for re-do operation. It can be helpful to confirm for any protrusion or remnant with C-arm just before closing the wound.

### CONCLUSION

Coccygectomy has a favorable outcome as high as 84% in

surgical case series. Coccygectomy has a relatively high surgical wound infection rate. When performed for an appropriate indication, coccygectomy provides an effective and long-lasting pain relief. Careful measures must be taken to reduce surgical wound infection.

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