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Clinical Outcomes of Coccygectomy for Coccydynia: A Single Institution Series With Mean 5-Year Follow-Up

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ABSTRACT

Background: Prior studies of coccygectomy consist of small patient groups, heterogeneous techniques, and high wound complication rates (up to 22%). This study investigates our institution's experience with coccygectomy using a novel "off-center" wound closure technique and analyzes prognostic factors for long-term successful clinical outcomes.

Methods: Retrospective review of all patients who underwent coccygectomy from 2006 to 2019 at a single center. Demographics, mechanism of injury, conservative management, morphology (Postacchini and Massobrio), and postoperative complications were collected. Preoperative and postoperative Oswestry Disability Index (ODI), visual analog scale (VAS), Patient-Reported Outcomes Measurement Information System-29 (PROMIS-29), and EuroQol-5D (EQ-5D) were compared. Risk factors for failing to meet minimum clinically importance difference for ODI and PROMIS-physical function/pain interference were identified. Risk factors for remaining disabled after surgery (ODI <20) and factors associated with VAS and EQ-5D improvement were investigated using stepwise logistic regression.

Results: A total of 173 patients (77% women, mean age = 46.56 years, mean follow-up 5.58 ± 3.95 years). The most common etiologies of coccydynia were spontaneous/unknown (42.2%) and trauma/accident (41%). ODI, VAS, and several PROMIS-29 domains improved postoperatively. Older age predicted continued postoperative disability (ODI >20) and history of prior spine surgery, trauma etiology, and women had inferior outcomes. No history of spine surgery (cervical, thoracic, or lumbar) prior to coccygectomy was found to predict improved postoperative VAS back scores. No outcome differences were demonstrated among the coccyx morphologies. Sixteen patients (9.25%) were noted to have postoperative infections of the incision site with no difference in long-term outcomes (all $P < 0.05$).

Conclusions: This is the largest series of coccygectomy patients demonstrating improvement in long-term outcomes. Compared to previous studies, our cohort had a lower wound infection rate, which we attribute to an "off-center" closure.

Clinical Relevance: Patients should be counseled that their surgical history, along with age, gender, and etiology of pain can influence success following coccygectomy. These data can help surgeons set realistic expectations following surgery.

Level of Evidence: 3.

Complications

Keywords: coccyx, coccydynia, coccygectomy, spine

INTRODUCTION

Coccydynia, a term first introduced by Simpson in 1859, refers to pain in the coccyx region, which encompasses the terminal vertebral segments of the human spine.[1,2] The coccyx is often perceived as a vestigial structure, but it does play an important role in supporting the pelvic floor as well as voluntary bowel control.[1,3] Coccydynia is 4 times more common in women compared to men, and obesity is also a major risk factor.[4,5] The most common cause of coccydynia is trauma, usually a direct fall onto the coccyx or cumulative trauma from awkward positioning during childbirth, which leads to sacrococcygeal (SC) or intercoccygeal joint instability.[6] While the exact incidence of coccydynia has not been reported, it is a relatively rare, accounting for less than 1% of patients presenting with lower back pain.[7,8]

Treatment options for coccydynia can be divided into nonoperative vs operative. Some common noninvasive conservative measures include ring-shaped cushions, posture modifications, hot baths, heat or cold, manipulation, nonsteroidal anti-inflammatory drugs, and physical therapy.[9] One prospective study found that injections around the SC joint with steroids or local anesthetics along with manipulation "cured" 85% of patients with coccydynia.[10] Recent studies have also used radiofrequency ganglion impar blocks in patients with severe coccydynia and found significant improvements in quality-of-life measures at 6 months postintervention.[11–13]

Coccygectomy, which involves partial or complete surgical removal of the coccyx, is generally reserved for patients with anatomic defect in the coccyx, failure of nonoperative management, and substantial disability. Current literature supports many successful outcomes following coccygectomy for persistent coccydynia or unstable coccygeal fracture.[14–18] For example, one of the largest prospective studies in the literature to date followed 98 patients who underwent coccygectomy for chronic coccydynia and found significant improvement in patient-reported quality-of-life outcomes at 2 years postoperatively.[19] This same study also found that failure was associated with preoperative characteristics, such as psychiatric illness, opiate use, and more than 3 comorbidities. In terms of those patients who are most likely to benefit from surgical intervention, Bayne et al found that traumatic and postpartum coccydynia had the highest success rate (75%) followed by the idiopathic group (58%).[20]

Despite the established effectiveness of surgical treatment, postoperative complication rate remains high. A recent literature review of 671 coccygectomies found the complication rate to be 10.9%.[5] The most common complication of coccygectomy is wound infection, which is reported to be as high as 22%.[21] Proximity of perianal flora to the incision site, excessive tension on the incision site when sitting, and the coccyx being a difficult area to reach for wound care are the main causes of wound complications.[22] This study describes a novel "off-center" approach for coccygectomy that aims to minimize wound infection rates. To our knowledge, this study reports the largest series in the literature reporting our institution's clinical experience with coccygectomy patients and analyzing prognostic factors for long-term successful clinical outcomes.

PATIENTS AND METHODS

Patient Selection

This study was a retrospective review of all patients who underwent coccygectomy between 2006 and 2019 at a single academic center by a single orthopedic surgeon. There was no other inclusion or exclusion criteria.

Data Collection

Demographic information, symptomatology, mechanism of injury, attempted conservative management, such as ganglion impar injection, prior lower back treatments and/or procedures, coccyx morphology (Postacchini and Massobrio classification system[18]) presence of postoperative wound infection, treatment of postoperative wound infection if applicable, and preoperative qualitative outcome assessments such as Oswestry Disability Index (ODI), visual analog scale (VAS), Patient-Reported Outcomes Measurement Information System-29 (PROMIS-29) scores, and EuroQol-5D (EQ-5D) were collected at a single timepoint (April 2020).

Morphology Classification

For patients who had preoperative lateral radiographs of the coccyx, morphology was divided into 4 categories as described by Postacchini and Massobrio.[18] Type I coccyx is curved slightly forward with the apex pointing down and caudal. Type II coccyx points straight forward. Type III coccyx is sharply angulated forward between the first and second or second and third segments. Type IV coccyx is subluxated anteriorly at the level of the SC joint. For patients who did not have lateral radiographs, preoperative magnetic resonance imaging, or computerized tomography scans were used if the coccyx could be visualized. Radiology reports were also used as supplemental information. If any part of the coccyx was described as "subluxed" or "dislocated" in the radiology report, then the coccyx was classified as Type IV. A total of 110 patients had adequate information in their charts to classify coccyx morphology.

Statistical Analysis

Statistical analysis of the data was performed using the Statistical Package for the Social Sciences, version 20.0 (SPSS, Inc., Chicago, IL, USA). In terms of descriptive statistics, continuous variables were expressed as the mean ± standard deviation, and categorical variables were expressed as frequencies and percentages. One-way analysis of variance with post hoc Tukey testing was done to compare the age and duration of symptoms among patients with different coccyx morphologies. A Fisher exact test was performed to determine which patient factors were significant for meeting minimum clinically importance difference (MCID) for ODI. A threshold for successful treatment was based on an MCID of 20 points at follow-up and an overall ODI score of <22.[23,24] Fisher exact tests were also used to determine which patient characteristics were associated with meeting the MCID for PROMIS-29 pain interference (PI) and physical function (PF) domains. The MCID for PI was set as 3.5 to 5.5 points based on a previous study of PROMIS-29 PI scores in patients with lower back pain.[25] The MCID for PF was set as 4.5 based on a previous study of PROMIS-29 PF scores in patients undergoing cervical spine surgery.[26]

A stepwise linear regression was calculated to predict postoperative ODI scores <20, which indicate "minimal disability." Another stepwise linear regression was done to determine which variables were significant for higher "health self-scores" (scale of 0–100) as part of the EQ-5D survey. A stepwise logistic regression was done looking at predictors for decrease from preoperative to postoperative back pain VAS scores (scale 1–10) by at least 2 points. Some of the independent variables included in these regression analyses were sex, age, whether age was above or below 65 years old, etiology, conservative management, duration of symptoms, history of back surgery before coccygectomy, concomitant lumbar spine pathology, and postoperative wound infection. Regression coefficients, 95% confidence intervals, and *P* values were recorded.

A paired sample *t* tests were used for comparison of continuous variables, such as preoperative vs postoperative ODI, VAS, and PROMIS-29 quality-of-life scores. The Wilcoxon signed-rank test was used for head-to-head comparisons of preoperative and postoperative VAS, PROMIS-29, and ODI scores that were available for a limited number of patients (7 patients). A probability value of $P < 0.05$ was considered statistically significant.

Surgical Technique

All cases were operated upon by a single orthopedic surgeon at a tertiary academic medical center. With the patient in the prone position, the drapes were stapled to the patient with one on each side of the gluteal cleft. The anus was not prepped within the surgical procedure site. Great care was taken to keep the anal area sequestered to help prevent infection. Before making the incision, the SC joint was palpated and intravenous antibiotics were administered. An x-ray was used if needed to locate the joint before the incision was made. Pre-emergent injection of local anesthetic was administered over the area of the incision. A skin incision of approximately 1 inch in length was made lateral to midline (Figure 1). A surgical electrode with a sheath that reduces the cutting tip to just a few millimeters, a short-tipped bovie, was used to dissect to the SC joint. A short-tipped bovie was used because this protects the tissue from excessive ablation or thermal injury. Suction was used simultaneously with the bovie to remove tissue debris, evacuate surgical smoke, retract, and dissect. Then, a subperiosteal dissection of the SC joint was performed while maintaining close contact with the bone. The SC joint was dissected with the electrocautery on the dorsal coccygeal surface. Following the dorsal resection, the coccyx was carefully everted through the SC joint to move to the ventral surface. The resected coccyx was removed with minimal trauma to the surrounding tissues (Figure 2). The sacral bone was chamfered with osteotome if needed to smooth and round the surface. Bone wax was then applied to prevent hematoma from bony bleeding surface. Tissues were then irrigated. For closure, the fascia was sutured deep and the skin was sutured subcuticular (Figure 3). Dermabond Prineo Skin Closure System or Tegaderm and Dermabond was then applied on the incision. For dressing, a roll of sterile gauze was taped over the incision site and covered with compressive dressing (Figure 4). This provided compression directly over the incision site to reduce swelling and hematoma.

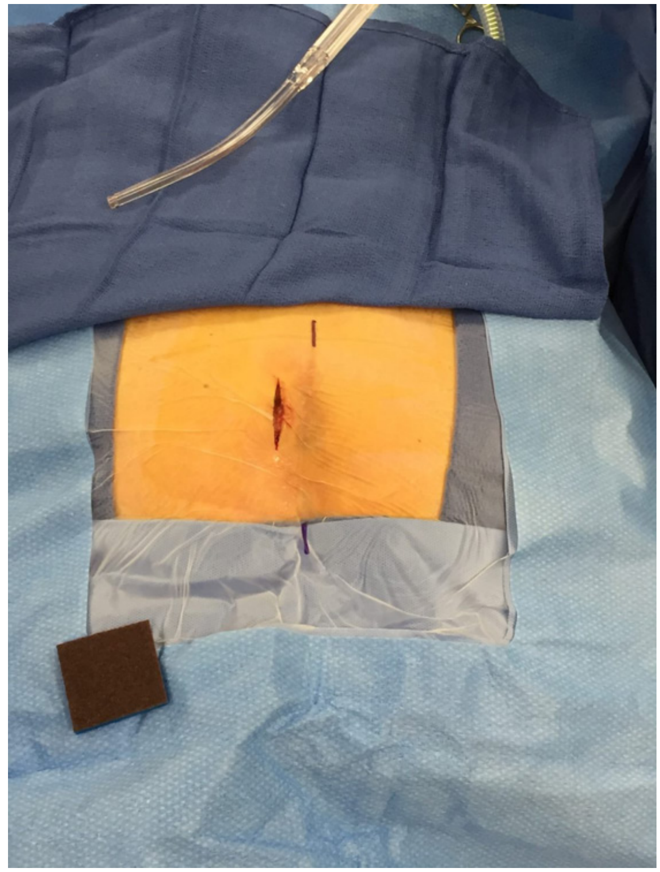

Figure 1. A 1-inch incision lateral to midline.

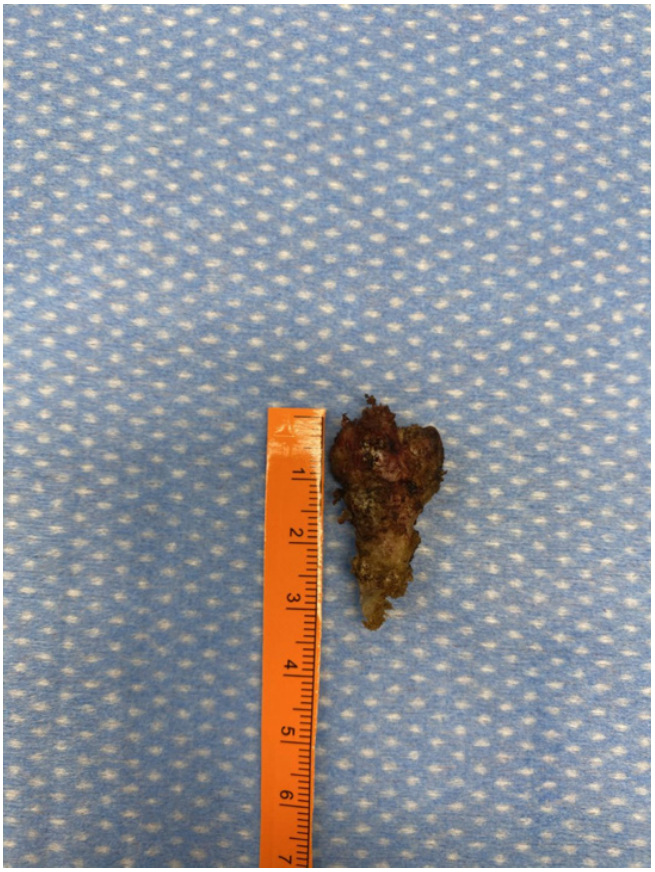

Figure 2. Excised coccyx.

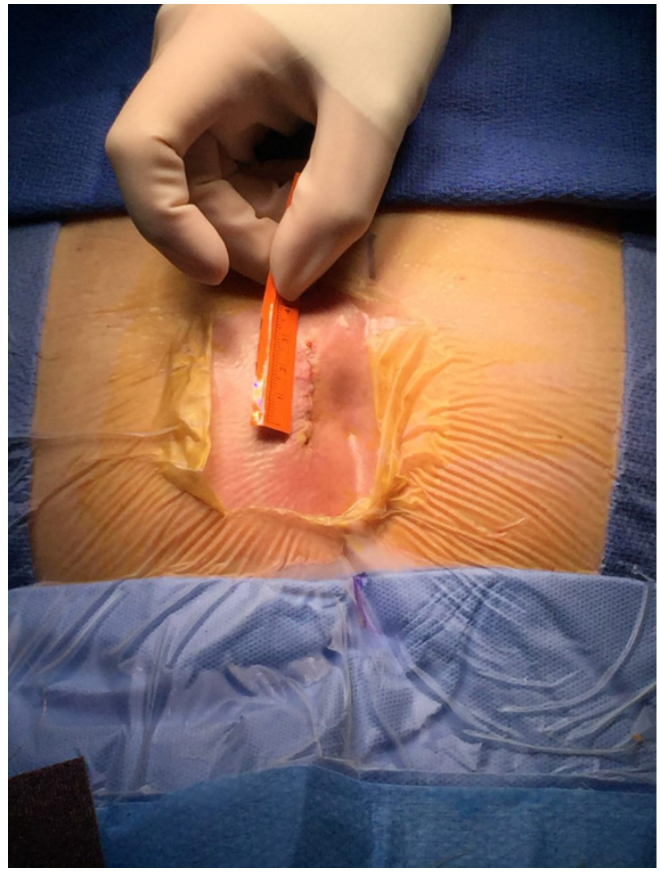

Figure 3. Skin closure.

RESULTS

Patient Characteristics

The demographic data of 173 patients are summarized in Table 1. There were 134 women (77%) and 39 men (23%), and the mean age on the date of surgery was 46.56 years (range 17–83 years). Regarding etiology of coccydynia, as reported by the orthopedic surgeon in the patient records, most were idiopathic (42.2%) or fall/accident (41%). Among patients with falls/accidents attributed to be primary cause of coccydynia, 26.8% (19/70) of those patients had a coccygeal fracture as a result (based on preoperative x-rays and clinic notes). Other causes included vaginal delivery (6.9%), sports (2.3%), rapid weight loss (1.7%), previous back surgery (1.7%), or congenital (4%). About 13.3% of patients had any history of spine surgery prior to coccygectomy, though this was rarely attributed to be the primary cause of coccydynia. Some of the prior spine surgeries included anterior cervical discectomy and fusion, transforaminal lumbar interbody fusion, total disc replacement, partial coccygectomy, and spinal tumor resection. In terms of conservative management prior to surgery, the methods included pain medications (51.2%), heat/cold (51.2%), physical therapy (42.2%), rest (44.6%), exercise (36.1%), manipulation (36.7%), transcutaneous electrical nerve stimulation (21.1%), acupuncture (10.8%), steroid injections (66.3%), ganglion impar injection (13.9%), and radiofrequency ablation (4.8%).

Morphology Classification

A total of 111 patients had information in their chart (based on radiographs or radiology reports) that allowed their coccyx to be classified based on the Postacchini and Massobrio classification system. As shown in Table 2, there were 35 Type I (20.2%), 26 Type II (15%), 18 Type III (16.2%), and 21 Type IV (12.1%). There was a statistically significant difference between the age of patients in groups Type I, Type II, Type III, and Type IV coccyx as determined by one-way analysis of variance test ($F[3, 106] = 3.285$, $P = 0.024$) (Table 3). There was no statistically significant difference in duration of symptoms between any of the groups (P = 0.829). Post hoc comparisons using the Tukey Honestly Significant Difference test revealed that older patients had Type IV coccyx morphology (54.05 ± 12.73 years old,

Figure 4. Incision dressing.

Table 1. Patient characteristics and conservative management.

Demographics	*N* = 173
Age at the time of surgery, y	
Mean	46.6 ± 14.1
Range	17–83
Gender, female, *n* (%)	134 (77%)
Mechanism of injury, *n* (%)	
Chronic/spontaneous pain (unknown)	73 (42.2%)
Fall/motor vehicle crash/other accident	71 (41%)
Previous back surgery	3 (1.7%)
Vaginal delivery	12 (6.9%)
Sports	4 (2.3%)
Rapid weight loss	3 (1.7%)
Other (eg, osteophyte on coccyx, achondroplasia, spina bifida occulta)	7 (4%)
History of prior spine surgery, *n* (%)	
Yes	23 (13.3%)
No	139 (80.3%)
Unknown	11 (6.4%)
Mean duration of symptoms, y	6
Mean time to follow up following surgery, y	5.6
Conservative therapy, *n* (%) (*n* = 166)	
Medications	85 (51.2%)
Heat/Cold	85 (51.2%)
Physical therapy	70 (42.2%)
Rest	74 (44.6%)
Exercise	60 (36.1%)
Manipulation	61 (36.7%)
TENS (transcutaneous electrical nerve stimulation)	35 (21.1%)
Acupuncture	18 (10.8%)
Injections (eg, steroid)	110 (66.3%)
Ganglion impar injection	23 (13.9%)
Radiofrequency ablation	8 (4.8%)
Coccyx morphology,[a] *n* (%) (*n* = 110)	
Type I	35 (20.2%)
Type II	26 (15%)
Type III	28 (16.2%)
Type IV	21 (12.1%)

[a]Based on the Postacchini and Massobio classification system.[18]

P = 0.013) compared to Type III coccyx (41.86 ± 12.03 years old).

Postoperative Complications

Among 173 total patients, 16 (9.2%) patients were noted to have postoperative infections of the incision site. All the postoperative infections occurred within 30 days of coccygectomy. Among the 16 patients with postoperative wound infections, 7 (43.8%) had wound cultures collected from the incision site and the breakdown of organisms obtained from the wound cultures included *Staphylococcus aureus* (4/7), *Escherichia coli* (1/7), diphtheroids (1/7), and *Streptococcus agalactiae* (1/7). Postoperative infection was adequately managed with local wound care and antibiotics, except in one case, which required incision and drainage before symptoms resolved.

Success of Treatment

Table 4 shows the postoperative patient questionnaire responses for 49 patients who were available to complete surveys via telephone. It also shows the preoperative responses that were collected in clinic. The paired *t* test comparing preoperative and postoperative outcomes was significantly improved for ODI (*P* = 0.001), VAS back pain (*P* = 0.000), and several PROMIS-29 domains such as fatigue (*P* = 0.008), sleep disturbance (*P* = 0.024), satisfaction with social role (*P* = 0.016), and PI (*P* = 0.000).

As shown in Table 5, the Wilcoxon signed-rank test was done for head-to-head comparisons of preoperative and postoperative VAS, PROMIS-29, and ODI scores that were available for a limited number of patients. There was a statistically significant improvement in VAS back pain scores (*P* = 0.048) and PROMIS-29 PI (*P* = 0.016) and pain intensity domains (*P* = 0.016). ODI and all other components of PROMIS-29 were not significantly different, though there was an overall trend toward improvement.

Determinants of Success Following Coccygectomy

Based on regression analysis, one patient characteristic identified as a predictor of disability (ODI > 20)

Table 2. Postoperative EQ-5D scores reported by dimension and level (*N* = 48).

Level	Mobility	Self-Care	Usual Activities	Pain/Discomfort	Anxiety/Depression
1 (No problems)	35	40	29	15	34
2 (Slight problems)	7	4	8	14	4
3 (Moderate problems)	3	2	6	13	9
4 (Severe problems)	1	1	3	2	0
5 (Extreme problems)	2	1	2	0	1

Mean (SD) health self-score (possible range, 0–100) = 71.44 ± 19.26.

postoperatively was older age (OR = 1.054, 95% CI 1.004–1.107, *P* = 0.035). Of note, sex (OR = 1.346, *P* = 0.404), trauma etiology (OR = 0.599, *P* = 0.398), prior ganglion impar injection (OR = 0.496, *P* = 0.186), prior steroid injection (OR = 1.053, *P* = 0.631), physical therapy (OR = 1.554, *P* = 0.391), history of back surgery (OR = 2.056, *P* = 0.170), duration of symptoms (OR = 0.051, *P* = 0.732), childbirth (OR = 0, *P* = 0.999), postoperative wound infection (OR = 5.877, *P* = 0.150), and concomitant lumbar spine pathology (OR = 0.880, *P* = 0.348) were not associated with postoperative disability based on ODI scores.

Patient characteristics identified as predictors of lower self-reported "health scores" were history of prior spine surgery (β = 0.651), coccydynia due to trauma (β = 0.363), and women (β = 0.264). Age (β = –0.003, *P* = 0.983), age older than 65 years (β = 0.044, *P* = 0.702), ganglion impar injection (β = 0.0), steroid injection (β = –0.002, *P* = 0.987), and physical therapy (OR = –0.106, *P* = 0.355) were not associated with lower self-reported health scores.

Having no history of spine surgery to coccygectomy (OR = 0.161, 95% CI 0.031–0.844, *P* = 0.031) was found to predict improved postoperative VAS back pain scores. Age (OR = 0.088, *P* = 0.767), age older than 65 years (OR = 1.179, *P* = 0.355), sex (OR = 1.754, *P* = 0.185), trauma (OR = 1.265, *P* = 0.261), ganglion impar injection (OR = 0.500, *P* = 0.479), steroid injection (OR = 1.733, *P* = 0.188), physical therapy (OR = 0.598, *P* = 0.439), radiofrequency ablation (OR = 0.174, *P* = 0.676), exercise (OR = 0.198, *P* = 0.656), and childbirth (OR = 0.002, *P* = 0.961) were not found to predict postoperative VAS back pain scores. As shown in Table 6, none of the patient factors was associated with meeting the MCID for ODI or PROMIS-29 PI and PF domains.

DISCUSSION

This is the largest series of coccygectomy patients to date that underwent coccygectomy at a single institution by a single surgeon. This is also the only study investigating a novel "off-center" wound closure technique for coccygectomy. This cohort had significant improvement in average preoperative vs postoperative ODI scores, VAS back pain scores, and many PROMIS-29 domains, such as fatigue, sleep disturbance, satisfaction with social role, and PI with daily activities. Predictors of improvement in quality-of-life measures in this cohort included younger age, no history of prior back surgery, and nontrauma etiology of coccydynia. There was a significantly lower wound infection rate (9.42%) compared to previous studies, and presence of postoperative wound infection did not affect success following surgery.[21] Coccyx morphology was not found to be associated with postoperative outcomes.

In terms of age and gender, this cohort of patients was 77% women and had an mean age of 46.6 years old at the time of surgery, similar to a previous study that found that women (mean age of 40 years) are 5 times more likely to develop coccydynia.[21] Similar to previous studies, our cohort reported trauma (41%) and unknown (42%) to be the most common etiologies of coccydynia, though patients may not realize that repetitive and prolonged sitting on hard surfaces can cause "minor trauma" that is less obvious.[3] Coccygectomy has been offered as a definitive treatment option for

Table 3. One-way analysis of variance of age and duration of symptoms among 4 groups of coccyx morphologies.

Source of Variation	Sum of Squares	*df*	Mean Square	*F*	*P* value
Age					
Between groups	1816.248	3	605.416	3.285	0.024
Within groups	19533.242	106	184.276		
Total	21349.491	109			
Duration of symptoms					
Between groups	44.599	3	14.866	0.295	0.829
Within groups	5339.469	106	50.372		
Total	5384.068	109			

Table 4. Patient quality-of-life questionnaire responses.

Quality of Life Measure	Preoperative *N*	Preoperative Mean (SD)	Postoperative *N*	Postoperative Mean (SD)	*P* value (paired *t* test)
Oswestry Disability Index (0–100)	12	62.67 (29.16)	49	22.90 (22.47)	0.001
Visual analog scale (0–10)	58	6.97 (1.99)	51	3.49 (3.24)	0.000
Physical function[a]	15	41.40 (8.79)	50	46.61 (11.04)	0.069
Depression[a]	15	52.35 (10.43)	50	47.94 (9.69)	0.134
Anxiety[a]	15	44.51 (11.53)	50	49.74 (11.76)	0.105
Fatigue[a]	15	59.49 (9.06)	50	50.27 (10.50)	0.008
Sleep disturbance[a]	15	55.55 (9.33)	50	48.29 (10.97)	0.024
Satisfaction with social role[a]	15	43.85 (14.28)	50	52.47 (10.98)	0.016
Pain interference[a]	15	64.91 (6.39)	50	54.75 (11.63)	0.000
Pain intensity[b]	15	5.80 (2.11)	50	3.86 (2.96)	0.021

[a]Patient-Reported Outcomes Measurement Information System-29 domain T score (mean = 50, SD = 10).
[b]Patient-Reported Outcomes Measurement Information System-29 score (0–10).

those with coccydynia refractory to conservative measures, and success rates have ranged from 60% to 100% based on various studies.[27] Still, there is significant controversy regarding the procedure, especially given the relatively high surgical wound infection rate due to the proximity of the skin incision to abundant perianal skin flora and difficulty of performing wound care in that region.[4] The use of preoperative antibiotics as well as the unique “off-center” approach to wound closure used by our surgeon may explain the lower wound infection rate (9.42%) compared to previous studies that have reported wound infection rates of up to 22%.[21] This may be attributed to several factors, including the presence of a thicker fat pad beneath the incision, subjecting the incision to less pressure than a midline incision, and avoiding the often thin and compromised skin in many patients with coccydynia secondary to repeated steroid-containing injections. Other important factors that are demonstrated in this surgical technique for a successful coccygectomy include subperiosteal dissection (which controls bleeding and prevents hematoma), short duration of procedure, and a dorsal approach preventing injury to ventral structures. Additionally, no significant association was found between postoperative wound infection and success following surgery.

Better outcomes in younger patients as well as those with no history of prior back surgery in this cohort could be explained by having relatively fewer comorbidities or pre-existing pain interfering with recovering from surgery. Interestingly, having a history of prior lumbar

Table 5. Wilcoxon signed-rank test (preoperative vs postoperative ODI, VAS, PROMIS-29).

Quality of life measure	*Z*	*P* Value
PROMIS-29		
Pain intensity	−2.414	0.016
Pain interference	−2.414	0.016
Social role	−1.051	0.293
Fatigue	−1.859	0.063
Sleep disturbance	−1.859	0.063
Depression	−1.604	0.109
Anxiety	−0.944	0.345
Physical function	−0.841	0.400
ODI	−1.363	0.173
VAS	−1.980	0.048

Abbreviations: ODI, Oswestry Disability Index; PROMIS-29, Patient-Reported Outcomes Measurement Information System-29; VAS, visual analog scale.

Table 6. Fisher exact tests: patient characteristics associated with meeting MCID.

Variable	*P* value (2-Sided)
PROMIS-29 pain interference (*n* = 7)	
Sex	NA[a]
Trauma	0.486
Ganglion impar injection	0.429
Steroid injection	0.429
Physical therapy	1.000
Back surgery	1.000
Delivery	1.000
Age >65 y	0.429
PROMIS-29 physical function (*n* = 7)	
Sex	NA[a]
Trauma	0.486
Ganglion impar injection	0.429
Steroid injection	0.429
Physical therapy	1.000
Back surgery	1.000
Delivery	1.000
Age >65 y	0.429
ODI (*n* = 6)	
Sex	NA[a]
Trauma	0.400
Ganglion impar injection	1.000
Steroid injection	1.000
Physical therapy	0.400
Back surgery	NA[b]
Delivery	0.467
Age >65 y	1.000

Abbreviations: NA, not applicable; ODI, Oswestry Disability Index; PROMIS-29, Patient-Reported Outcomes Measurement Information System-29; VAS, visual analog scale.
[a]No statistics computed because sex was constant.
[b]No statistics computed because back surgery was constant.

spine pathology was not associated with postoperative disability. In contrast to previous studies that found that patients with a traumatic etiology tended to have better outcomes following coccygectomy, our cohort had lower self-reported "health scores" among trauma patients.[17,28] Bayne et al did find that coccygectomy was more successful in cases due to trauma or postpartum coccydynia (75%) compared to idiopathic causes (58%), but the reason for this is still unclear.[20] The "health scores" were encompassing physical as well as emotional well-being, so trauma may contribute to this measure differently than a quality-of-life measure based purely on lower back disability. Unlike a previous study that found that Type II/III/IV coccyx configurations are more likely to have pain relief following coccygectomy, analysis of this cohort did not find any association between morphology and outcomes following surgery.[18]

In our cohort, there was no difference in PROMIS-29 anxiety and depression domains preoperatively and postoperatively. There has been a significant body of emerging literature related to the effect of psychological comorbidities, such as depression, on spine surgery outcomes. An early prospective study of 125 orthopedic trauma patients from 10 different orthopedic clinics found that 1 in 5 patients met criteria for psychological distress.[29] A more recent retrospective database study found that more than 1 in 3 adult spinal deformity or degenerative disc disease patients had some type of psychological condition, especially among young, white women.[30] The relationship between pain and psychological distress is reciprocal; preoperative anxiety and depression have significant influence on postoperative pain, and the pain and disability associated with musculoskeletal conditions generates psychological distress.[31]

With respect to limitations of this study, as with any retrospective review, there is occasionally missing data in addition to difficulty establishing causation rather than association between variables. In terms of the preoperative questionnaires, they were mostly only administered to more recent patients. For the postoperative questionnaires, patient responses may not be completely accurate since they were administered via phone instead of in-person as intended. Nonresponse bias may have been present as well. For example, certain patients who were not satisfied with their results following surgery may have opted out of completing postoperative questionnaires or attending postoperative appointments. Temporal relationships were also difficult to assess since the follow-up time varied significantly between earlier and more recent patients. The postoperative questionnaire results could also be affected by confounding variables given that many different intrinsic and extrinsic factors can affect quality-of-life measures and back pain.

CONCLUSION

Although controversial given the risk of wound infection, coccygectomy is an important option to consider for patients with coccydynia refractory to conservative management. Patients should be fully educated on the risk of wound infection and other complications following coccygectomy, but they should be reassured that proper preventive measures, such as antibiotics and an "off-center" wound closure technique, can abate their individual risk. Counseling patients that their age, etiology of pain, and past surgical history can influence their response to surgery is helpful in creating realistic expectations for outcomes following coccygectomy. There is also a need to counsel patients that sleep and pain may improve following surgery, but any psychological issues may be persistent and will need appropriate attention pre-and postoperatively.

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