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Caudal regression syndrome and interventional pain techniques

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Dear Editor,

Caudal regression syndrome (CRS) is a rare, congenital disorder primarily characterized by improper development of the lower body – vertebral spine, spinal cord, limbs – due to an absent or non-progressing mesoblastic caudal bud during early fetal development [1]. Sacral agenesis (SA) is frequently associated with CRS.2 Other syndromic features may affect the gastrointestinal, genitourinary, and cardiovascular systems.1.

The Renshaw classification system describes CRS by the amount of remaining sacrum and the articulation between the spine and pelvis [2, 3]. Type 1 indicates partial or total unilateral SA. Type 2 has partial bilateral or symmetrical SA. Type 3 is total SA with lumbar articulation between the portion of the iliac wings that remain. Type 4, the most severe, is defined by total SA with or without fusion of the iliac wings behind the last vertebrae if those are present. While types 1 and 2 have a more favorable prognosis, there is a higher concurrence of organ system abnormalities and neonatal death in types 3 and 4.4,5.

Perhaps due to the rarity of the disease, literature pertinent to interventional pain management for patients with CRS is lacking. To the authors' knowledge, this is the first case reported of a middle-age patient with Type 2 CRS for interventional pain management. Written consent was obtained from the patient for the presentation of this case.

Our patient is a 50-year-old female with chronic low back and buttock pain had been referred to our pain clinic. The patient reported having low back pain issues of waxing and waning intensity since adolescence, but had become more persistent after a motor vehicle collision three years ago. It is currently at 8/10 severity using the Numerical Pain Rating Scale.

She has the diagnoses of Arnold-Chiari malformation, spina bifida, tethered cord syndrome, and CRS. She underwent a C1 laminectomy and suboccipital craniectomy for posterior fossa decompression of her Arnold-Chiari malformation at age 40. She had two cord detethering surgeries in the past, but still has persistent urinary and rectal incontinence. CRS was radiologically diagnosed at least 10 years prior with shortening of her sacral segments.

On examination, she had minimal tenderness to her lumbar paraspinal musculature. The range of motion at her lumbar spine included a 75-degree forward flexion, 20-degree backward extension, and 30-degree lateral bending. The straight leg raise test and facet loading maneuver were negative. Her right posterior superior iliac spine was tender to palpation. The FABER (Flexion ABduction External Rotation), Gaenslen, and Yeoman maneuvers were positive on the right side indicating sacroiliac joint (SIJ) dysfunction as an etiology of her right sided buttock pain. Motor strength was 5/5 in all lower extremity myotomes with normal gait.

X-ray imaging of her lumbar spine [Fig. 1] showed a levo-convex curvature of the lumbar spine at the L2 level with a moderate rotational component. A sagittal MRI view of the lumbar spine [Fig. 2] showed expected postsurgical changes from her prior surgeries with laminectomies at L4-S1. The spinal cord was normal with a low-lying conus at the L2-L3 interspace. Clumping of cauda equina nerve roots was observed as well, which was unchanged compared to the prior exams. No lumbar spinal stenosis was seen, but minor facet arthropathy was noted in the lower lumbar facet joints. Notably, there was a diminutive S1 vertebral body. Additionally, there was a complete absence of the remaining sacral segments, which is consistent with the axial MRI view at the S1 level [Fig. 3]. Right SIJ inflammation was the suspected etiology of her pain based on clinical examination findings with a lower likelihood of other etiologies (*e.g.* discogenic pain, radiculopathy, spondylosis) based on imaging studies, so a diagnostic and therapeutic right SIJ injection under fluoroscopic guidance was recommended.

After obtaining procedural consent, the patient was positioned prone with standard monitoring and conscious sedation was provided at the patient's request. The right lumbosacral area was cleansed with chlorhexidine. Using fluoroscopic imaging at a 20-degree contralateral oblique and 10-degree caudal tilt, the inferior and posterior borders of the right SIJ were identified. The skin over the entry point was anesthetized with 2-mL of 1% lidocaine. A 22-gauge 3.5-inch spinal needle was then advanced through the skin under fluoroscopic guidance until the tip of the needle contacted the lateral aspect of the inferoposterior border of the right SIJ. The needle was rotated medially and advanced gently into the inferoposterior joint space. After intraarticular spread was confirmed [Fig. 4] with injection of 0.25-mL of radiopaque iohexol contrast (Omnipaque^{TM}, GE Healthcare), therapeutic administration of 1-millilter of 40-mg methylprednisolone and 0.5-mL of 1% lidocaine into the right SIJ was performed.

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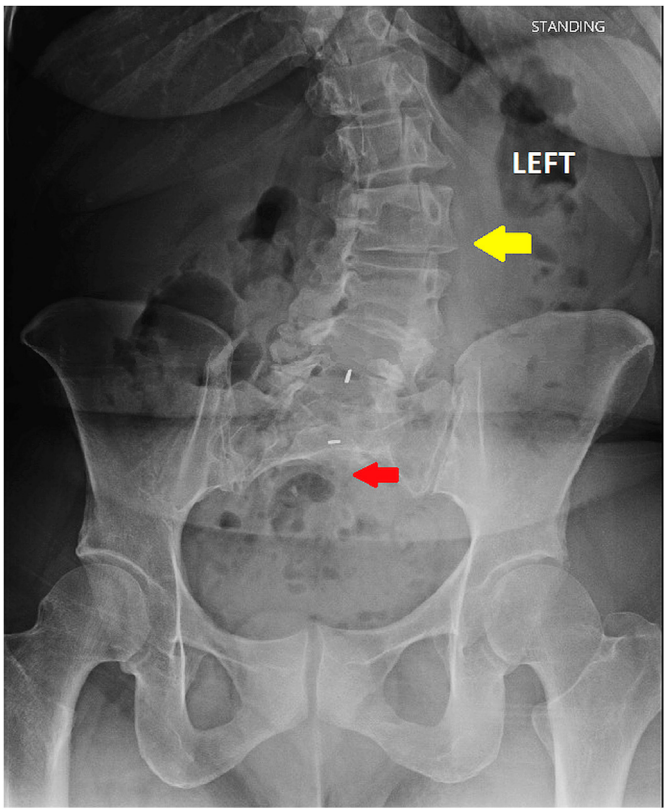

Fig. 1. AP X-ray of the lumbar spine.
A moderate rotary lumbar levoscoliosis is present. The levoconvex curvature (yellow arrow) of the lumbar spine is seen at the L2 vertebral body level. The sacral segments (red arrow) are absent inferior to S1. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

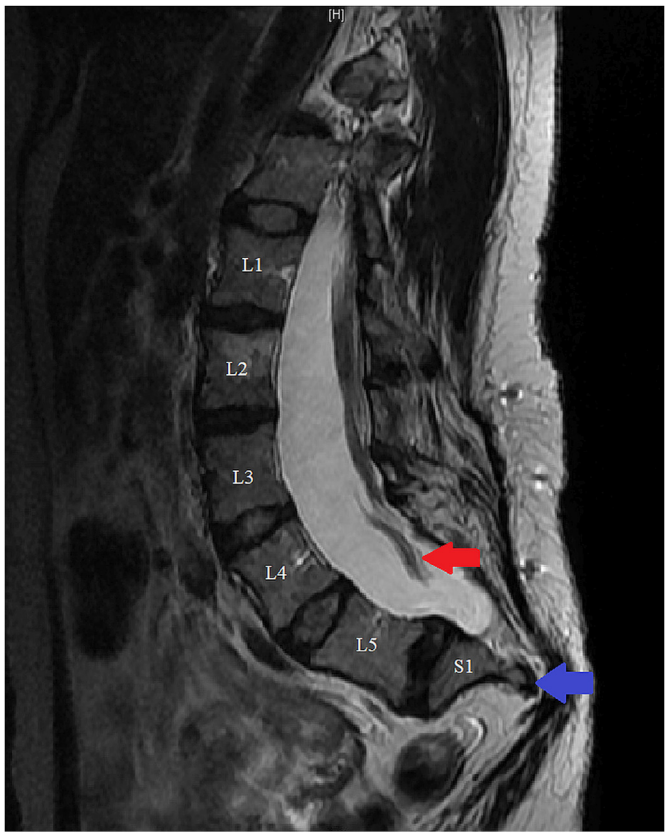

Fig. 2. Sagittal MRI of the lumbar spine.
Cauda equina nerve root clumping (red arrow) is seen in this sagittal view of the lumbar spine. Lumbar vertebral segments are labeled. Sacral agenesis is commonly associated with caudal regression syndrome. A hypoplastic S1 is visible (blue arrow) with no inferior sacral segments. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

The patient tolerated the procedure well. On her 2-week follow up visit, she reported 2/10 right buttock pain. She was able to sit and lie on her right buttock without discomfort, ambulate easier, and self-reported a 60% improvement in the performance of her activities of daily living since the injection. The patient reported great satisfaction with the procedure and its results. Upon follow up, the relief lasted for 3 months and she was able to start physical therapy in that time.

CRS was first described in 1961 by Bernard Duhamel and is thought to occur during the fourth weeks of gestation [1,4]. Its incidence is approximately 1 per 10,000 live births in healthy women, but increases to 1 per 350 births in parturients with gestational diabetes mellitus [1]. CRS has an unequal distribution among sexes with a male to female ratio of 2.7:1 [6].

The etiology of CRS is not well understood, but is known to be a multisystemic disorder resulting from a neural tube defect. Thus, a wide variety of morbidity can be seen with developmental failures most commonly arising in the lower extremities as well as the thoracolumbar or sacrococcygeal regions of the spine [1,2,5]. While orthopedic, urogenital, gastrointestinal, and neurological complications are most common, respiratory and cardiac dysfunction have been reported as well [2,7,8]. Clinical presentation often includes postural abnormalities, lower limb deformities, shrunken pelvis, flat buttocks with bilateral dimples, and abbreviated intergluteal cleft. Patients frequently have neurogenic bladder and bowel, as well as renal problems. Around 20% of patients with CRS present with cutaneous lesions related to occult spinal dysraphisms [6]. Agenesis of the coccyx, sacrum and lower limbs has been reported in most literature, but it is not uncommon for the lumbar or thoracic spinal segments to also contain malformations as the disease itself has been shown to be progressive in some instances [2].

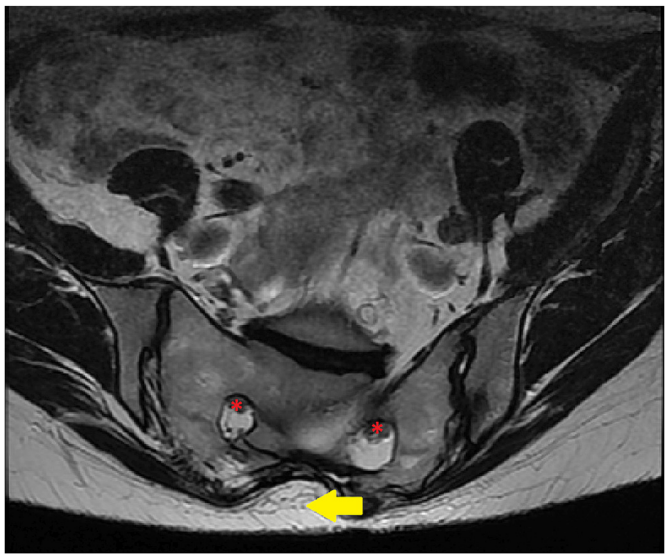

Fig. 3. Axial MRI at the vertebral level at S1.
Bilateral S1 nerve roots (red asterisks) are visible within their respective foramen. The thecal sac is absent (yellow arrow). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

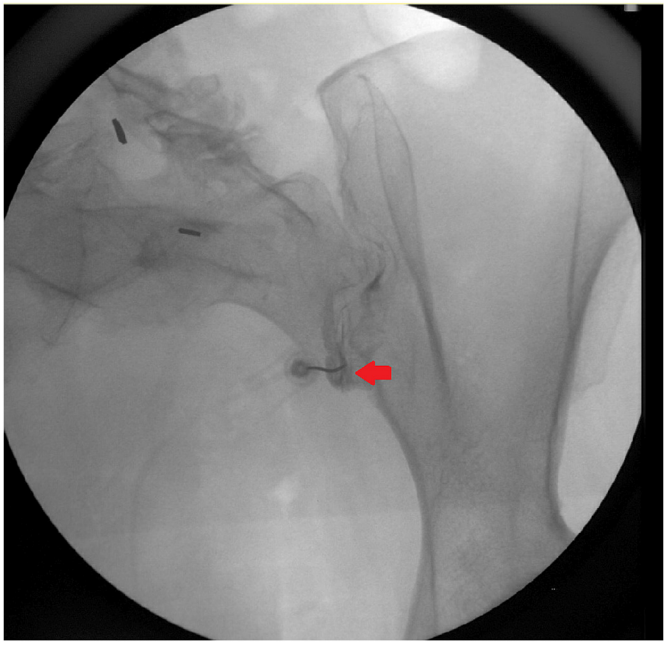

Fig. 4. Fluoroscopic image of a sacroiliac joint injection
The intraarticular spread of contrast (red arrow) within right sacroiliac joint shows the correct target for injection. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Musculoskeletal anomalies include scoliosis, SIJ deformation leading to spinopelvic instability, hip contractures or dislocations, knee contractures and lower limb deformities. Symptoms can range from asymptomatic (*e.g.* isolated partial agenesis of the coccyx) to paralysis or death (*e.g.* thoracolumbar agenesis or sirenomelia) [2,8]. SA at or above S1 carries a worse prognosis due to suboptimal articulation of the femoro-acetabular joint, which diminishes the likelihood of ambulation [2,8–10]. Radiological evidence of anomalies at or above S1 indicate a need for medical attention. Unfortunately, there is no consensus to date regarding the proper management of spinopelvic instability in those with caudal regression [8,10].

Neurological symptoms frequently involve fecal and urinary incontinence, limb hypoplasia, and sensory or motor deficits. Associated neural tube defects such as spina bifida, meningocele and holoprosencephaly [4,11] as well as syndromic complexes (Currarino's Triad: partial SA, anorectal abnormalities, presacral masses) may occur [6].

Diagnoses can be obtained through ultrasound, MRI, x-ray, or computerized tomography. X-ray may be limited during early *in utero* diagnosis due to incomplete sacral ossification [5]; however, ultrasound diagnosis may be made by the end of the first trimester [4]. Ultrasound is also useful in examining other potentially affected organs [12]. MRI is preferred for visualizing vertebral and spinal cord pathologies beneficial in the evaluation of nerve root abnormalities (*e.g.* tethered cord, radiculopathy), especially when performing neuraxial techniques [1,13].

Management for CRS is highly complex and often multidisciplinary depending on the extent and severity of the condition. Treatment options to date are palliative or for symptomatic relief: surgical corrections and repairs may be performed for orthopedic and neurologic malformations [1,8,14], while non-invasive options such as human growth hormone injection and physiotherapy have been pursued with limited improvement [15]. Likewise, interventional pain techniques may offer benefit for symptomatic treatment of CRS patients, as with this case.

Unfortunately, there is limited published information regarding neuraxial analgesia in those with CRS, but might be extrapolated from reports from patients with associated conditions. When considering bony spine issues like scoliosis, insights from obstetric anesthesia literature suggests a mostly successful (66% epidural success rate in patients with surgically corrected scoliosis) but difficult placement of epidural catheters in patients with isolated scoliosis without the other orthopedic or neurological symptoms, though with a higher failure rate compared to the general parturient population [16]. Dural abnormalities such as cord tethering or compressive lesions are present in 70% of patients with SA [2]. Spinal dysraphisms or tethered cords can be accompanied by a low-lying and posteriorly placed conus medullaris and thickened filum terminale [17]. Such neural abnormalities may cause unreliable blockade or complications such as unintentional dural puncture or direct neural injury. However, reports of successful epidural catheterization for postoperative pain control have been published in patients with lumbosacral spine anomalies including SA [18,19]. Thus, pre-procedural identification of vertebral and spinal cord anomalies on imaging studies is imperative, and an expectation for technical challenges may be reasonable when performing neuraxial procedures for CRS patients.

Similarly, there is little published on the feasibility or efficacy of other common interventional pain procedures such as neuromodulation therapy (*i.e.* spinal cord stimulation, SCS), branch blocks, joint injections, or radiofrequency ablation. We may infer based on reported six-month long efficacy of SCS in patients with isolated thoracolumbar scoliosis [20] that SCS may be a reasonable option in select CRS patients depending on pain indication and source as well as disease extent. As in this patient, lateral branch blocks may not be technically feasible due to regression or absence of sacral segments. Likewise, the SIJ integrity depends on the severity of the CRS.

As our patient presented with a less severe type CRS, the intact structural integrity of S1 and proper articulation at the femoro-acetabular joint allowed for successful intervention at the SIJ which appeared normal. Fortunately, epidural injection was not indicated, but would still need to be considered if our suspected diagnosis of SIJ inflammation proved incorrect.

This is the first case to illustrate the challenges and considerations involved with interventional pain management in caudal regression syndrome. Greater awareness of this disease and its presentation as well as its anatomical implications is relevant to interventional pain physicians.

Author disclosures

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Authors' contributions

EA: This author helped with the information collection, figure illustration, editing and revision of the manuscript.MR: This author helped with literature search and writing the initial manuscript draft. AP: This author helped with the conception, literature search, writing and revision of the manuscript, and manuscript guarantor.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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