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EDITED BY

Debra Weiner,
University of Pittsburgh, United States

REVIEWED BY

Benjamin Johnston,
Mass General Brigham, United States
Ketan Verma,
Virginia Commonwealth University Health
System, United States

*CORRESPONDENCE

Rourke M. Stay
✉ rourke@alumni.virginia.edu

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Intradural spinal arachnoid cysts versus spinal arachnoid webs: a retrospective analysis of incidence, imaging findings and clinical presentation at a single institution

Rourke M. Stay^{1*}, Blake S. Cromie², Christopher D. Rogers³ and Douglas W. Pahl¹

¹Hughston Clinic, Columbus, GA, United States, ²TriStar Skyline Medical Center, Nashville, TN, United States, ³Augusta University, Augusta, GA, United States

Purpose: Intradural spinal arachnoid cysts (SACs) and spinal arachnoid webs (SAWs) are rare extramedullary lesions in the spine. We aimed to assess the relative incidence of the two entities while also better assessing the similarities and differences in imaging appearance and clinical presentation.

Methods: A retrospective analysis was performed of the incidence, imaging features, and clinical presentation of SACs and SAWs at a single institution from 2015 to 2021.

Results: There were 12 cases of SACs and 9 cases of SAWs. The incidence of cysts was .050% and the incidence of webs was .037%. The clinical presentation was similar in the two groups, with the most common signs and symptoms being back pain followed by leg pain. Other signs of myelopathy were common in both groups including absent or diminished reflexes, decreased sensation, and decreased strength. The locations of the cysts were: 1 cervical (8%), 6 thoracic (50%), 5 lumbar (42%). All of the cervical and thoracic cysts caused cord compression. All 9 webs caused focal cord compression (scalpel sign).

Conclusion: SACs and SAWs are both rare lesions that we believe have a similar incidence, with cysts being only a little more common in our cohort. As they both often present with signs and symptoms of myelopathy, imaging findings are more useful in distinguishing between the two entities. The location of the cyst and the appearance of mass effect on the cord are helpful, as webs cause a focal compression, the scalpel sign, while cysts cause broader and smoother compression.

KEYWORDS

myelopathy, cord compression, back pain, MRI, CT myelogram, arachnoid web, spinal arachnoid cyst

Introduction

Spinal arachnoid cysts (SACs) are rare but well described benign cysts that are most often intradural (1). They can be primary or can be secondary to insults such as surgery, trauma, or infection (2). SACs can be seen in any part of the spine but are most common in the thoracic spine. SACs can cause cord compression, syringomyelia,

and abnormal increased T2 signal in the cord (3, 4). Patients can be asymptomatic but clinical presentations often include back pain, radiculopathy, and myelopathic signs such as decreased or absent reflexes (5). SACs are sometimes treated conservatively but are often treated with surgery, with good surgical outcomes (2, 5, 6). Primary cysts have better surgical outcomes than secondary cysts (2).

Spinal arachnoid webs (SAWs) are more recently described entities that occur exclusively in the dorsal aspect of the thoracic spine. They are characterized by an intradural band of arachnoid tissue in the subarachnoid space that results in mass effect on the posterior cord (7–9). On MR imaging, SAWs exhibit a characteristic “scalpel sign”, a dorsal indentation on the cord due to the web (10). The web itself is usually not seen. The scalpel sign distinguishes SAWs from the c-shaped indentation seen in spinal cord herniation (11, 12).

Like SACs, SAWs can also result in syringomyelia and increased T2 cord signal abnormality. Patients with SAWs also often present with back and leg pain and myelopathic signs (9). SAWs are sometimes treated conservatively, with definitive treatment coming from surgical techniques including fenestration and complete excision of the aberrant intradural membrane (13, 14).

To date, no study concurrently analyzing SACs and SAWs exists in the literature. We assess the relative incidence of SACs and SAWs as well as their overlapping and unique imaging features, signs, and symptoms.

Methods

This retrospective analysis first received institutional review board approval. A PACS search was performed for all instances of cervical spine MRIs, cervical CT myelograms, thoracic spine MRIs, thoracic CT myelograms, lumbar spine MRIs, and lumbar CT myelograms over the time period from January 2015 through the end of December 2021. The MRI exams were performed without intravenous contrast, with and without contrast, or only with contrast. The reports for each of these exams were reviewed for mention of possible arachnoid cysts or webs.

All examinations and reports were reviewed in the NovaPACS system. The cases were all reviewed by a radiologist (R.S.) and an orthopedic spine surgeon (D.P.) with 12 years and 14 years of experience, respectively. The positive cases were agreed upon by consensus. When possible, operative reports were used as evidence of positive cases.

The sequences performed for the spinal MRIs in general include: axial T2 weighted images, sagittal T1 weighted images, sagittal T2 weighted images, and sagittal STIR images. The CT exams included axial 2.5 mm with 2.0 mm coronal and sagittal reconstructions.

The MRI scans were performed on one of the following magnets: GE 450W 1.5T, GE Signa Echospeed 1.5T, GE Optima MR 360 1.5T, Philips Achieva 1.5T, Esaote S-scan.25T. All of the CT myelograms were performed on a GE Lightspeed 64-slice VCT.

The 22 confirmed cases were assessed for location including primarily cervical, thoracic, or lumbar, and anterior vs. posterior position in the spinal canal. The lesions were categorized as cysts

or webs, with webs exhibiting the scalpel sign and cysts consisting of cystic lesions. The cord was assessed for compression, syringomyelia, and increased T2 signal. The cysts were assessed for morphology: fusiform vs. lobulated. Each of the cysts was measured in three planes. For the lumbar cysts beyond the cord, the presence or absence of spinal canal stenosis was determined.

The clinical features of the lesions were assessed by a review of the patient's medical record in Athena.

Results

Over the period of January 2015–December 2021, there were 22 positive cases of spinal arachnoid cysts and webs (22 studies in 21 unique patients—two of the patients had both an MRI and a CT myelogram) out of a total of 23,372 MRI exams and 768 CT myelograms. There were 12 SACs and 9 SAWs. The incidence of SACs was .050% and the incidence of SAWs was .037%.

The mean age of the SACs was 62.1 years old (range of 36–80). There were 4 males and 8 females. The locations of the SACs were: 1 cervical (8%), 6 thoracic (50%), 5 lumbar (42%). All 12 SACs were posterior. All 12 SACs were intradural. The largest SAC by volume was $9.0 \times 2.2 \times 1.2$ cm (CC \times ML \times AP), 7.56 cm³. The smallest SAC by volume was $2.0 \times 0.8 \times 0.3$ cm (CC \times ML \times AP), 0.16 cm³. 9 of 12 SACs were fusiform and 3 were lobulated.

Of the cervical and thoracic SACs, 6 of 6 caused cord compression. 1 of 6 (17%) caused increased T2 signal in the cord. 1 of 6 (17%) caused syringomyelia. Of the lumbar SACs, 4 of 5 (80%) caused canal stenosis. 1 of 5 (20%) lumbar SACs resulted in syringomyelia.

All 9 SAWs were by definition seen posteriorly in the thoracic spine and caused cord compression. There were 5 males and 4 females. The mean age of the patients was 55.9 years old (range of 40–65). Of the 7 SAWs identified on MRI, 1(14.3%) caused increased T2 signal in the cord. 0 of 9 SAWs caused syringomyelia.

The most common symptoms in patients with SACs were: back pain (12/12, 100%), leg pain (7/12, 58%), and sleep disturbance (3/12, 25%). The most common physical exam findings in patients with SACs were: back tenderness (5/12, 42%), absent or diminished reflexes (5/12, 42%), decreased strength (3/12, 25%), and decreased sensation (3/12, 25%). The average body mass index (BMI) was 29.1.

The most common symptoms in patients with SAWs were: back pain (8/9, 89%), leg pain (5/9, 56%), and sleep disturbance, arthralgia, popping, and neck pain (each 4/9, 44%). The most common physical exam findings in patients with SAWs were: back tenderness (5/9, 56%), decreased flexion (4/9, 44%), decreased sensation and absent or decreased reflexes (each 2/9, 22%). The average BMI was 29.5. (see Tables 1–5 for summary of Results).

Discussion

SACs and SAWs are both rare entities that we believe have a similar incidence, with cysts being only a little more common in

TABLE 1 Demographics and social history of cysts and webs.

| | Age | Sex | Ethnicity | Smoking history | Alcohol use | BMI |
|------|-------|-----|-----------|-----------------|-------------|-------|
| Cyst | 62.08 | M:4 | C:9 | Y:3 | Y:4 | 29.11 |
| | | F:8 | B:3 | N:8 | N:7 | |
| Web | 55.89 | M:5 | C:8 | Y:3 | Y: 2 | 29.53 |
| | | F:4 | B:1 | N:6 | N:7 | |

TABLE 2 Clinical presentation.

| | Back pain | Leg pain | Sleep disturbance | Arthralgia | Neck pain | Popping | Leg tingling |
|------|-----------|----------|-------------------|------------|-----------|---------|--------------|
| Cyst | 12 | 7 | 3 | 2 | 0 | 1 | 2 |
| Web | 8 | 5 | 4 | 4 | 4 | 4 | 3 |
| Cyst | 100% | 58% | 25% | 17% | 0% | 8% | 17% |
| Web | 89% | 55% | 44% | 44% | 44% | 44% | 33% |

TABLE 3 Physical exam findings of cysts and webs.

| | Back pain | Leg pain | Sleep disturbance | Arthralgia | Neck pain | Popping/Crepitus | Paresthesia |
|------|-----------|----------|-------------------|------------|-----------|------------------|-------------|
| SACs | 100% | 58% | 25% | 17% | 0% | 8% | 17% |
| SAWs | 89% | 55% | 44% | 44% | 44% | 44% | 33% |

TABLE 4 Features of arachnoid cysts.

| Cyst# | Age (years) | Modality | Level | Column position | Cord compression ^a | Inc. T2 | Syrinx | CC × ML × AP (cm) | Volume (cm ³) | Fusiform vs. lobulated |
|-------|-------------|-------------------|--------------------|-----------------|-------------------------------|---------|--------|---------------------|---------------------------|------------------------|
| 1 | 36 | MRI | Cervical (C3-C5) | Posterior | Y | N | N | 3.40 × 0.40 × 0.90 | 1.22 | F |
| 2 | 75 | MRI, CT myelogram | Thoracic (T4-T8) | Posterior | Y | N | N | 9.00 × 2.10 × 1.20 | 22.68 | F |
| 3 | 55 | MRI | Thoracic (T5-T8) | Posterior | Y | N | N | 7.00 × 2.00 × 1.30 | 18.2 | F |
| 4 | 77 | CT myelogram | Thoracic (T6-T9) | Posterior | Y | N | N | 7.60 × 1.00 × 0.70 | 5.32 | F |
| 5 | 69 | MRI | Thoracic (T9-L1) | Posterior | Y | N | N | 12.60 × 1.10 × 0.50 | 6.93 | L |
| 6 | 73 | MRI | Thoracic (T10-T12) | Posterior | Y | N | Y | 4.20 × 0.80 × 0.30 | 1.01 | F |
| 7 | 70 | MRI | Thoracic (T11) | Posterior | Y | Y | N | 2.00 × 0.80 × 0.30 | 0.48 | F |
| 8 | 80 | MRI | Lumbar (L1-L3) | Posterior | Y | N | N | 9.80 × 1.90 × 0.90 | 16.76 | F |
| 9 | 36 | MRI | Lumbar (L1-L3) | Posterior | Y | N | N | 11.30 × 1.90 × 0.80 | 17.17 | F |
| 10 | 46 | MRI | Lumbar (L2-L4) | Posterior | N | N | Y | 12.70 × 1.60 × 0.50 | 10.16 | F |
| 11 | 69 | MRI | Lumbar (L2-L5) | Posterior | Y | N | N | 9.20 × 0.90 × 0.60 | 4.97 | L |
| 12 | 59 | MRI | Lumbar (L3-S2) | Posterior | Y | N | N | 10.80 × 1.40 × 1.10 | 16.632 | L |

^aCanal stenosis for lumbar arachnoid cysts.

our experience. This refutes the notion that webs are extremely rare. In their research, Ben Ali et al. wondered whether SAWs were extremely rare or just being under-diagnosed/underreported (9). We believe the latter to be true. Spinal arachnoid webs are likely underreported in the literature, perhaps reported as cysts in many of the studies before the description of the scalpel sign (10).

The age of presentation of the two groups was similar, both occurring on average in late middle age. Cysts were found twice as often in women, while webs had a slight male predominance. Both groups were of similar average weight (BMI of 29).

The clinical presentation of each group was also similar, with most patients presenting with back pain and many patients presenting with other myelopathic signs including leg pain, leg

tingling, altered sensation, and decreased or absent reflexes. Patients also presented with sleep disturbance, sensation of popping in the spine, and decreased flexion.

Absent reflexes was more common in SACs, sensation of popping was more common in SAWs, and decreased flexion was only seen in SAWs. Given the overall clinical similarities between SACS and SAWs, though, the clinical presentation is more helpful in directing the image reader’s attention to the possible presence of either entity, rather than useful in distinguishing the two.

In our cohort, SACs were found most commonly in the thoracic spine, but only half of the cases were thoracic. This is in contrast to the reported literature of 80% thoracic. The authors wonder whether some previous literature has included some

TABLE 5 Features of arachnoid webs.

| Web # | Age (years) | Modality | Level | Column position | Cord compression (Canal stenosis for lumbar) | Increased T2 | Syrinx |
|-------|-------------|-------------------|------------------|-----------------|--|--------------|--------|
| 1 | 53 | MRI | Thoracic (T2-T3) | Posterior | Y | N | N |
| 2 | 40 | MRI | Thoracic (T3) | Posterior | Y | N | N |
| 3 | 49 | MRI | Thoracic (T3-T4) | Posterior | Y | Y | N |
| 4 | 62 | MRI, CT myelogram | Thoracic (T4-T5) | Posterior | Y | N | N |
| 5 | 50 | MRI, CT myelogram | Thoracic (T6) | Posterior | Y | N | N |
| 6 | 57 | MRI | Thoracic (T6-T7) | Posterior | Y | N | N |
| 7 | 62 | CT myelogram | Thoracic (T7-T8) | Posterior | Y | N | N |
| 8 | 65 | MRI | Thoracic (T7-T8) | Posterior | Y | N | N |
| 9 | 65 | MRI | Thoracic (T8-T9) | Posterior | Y | N | N |

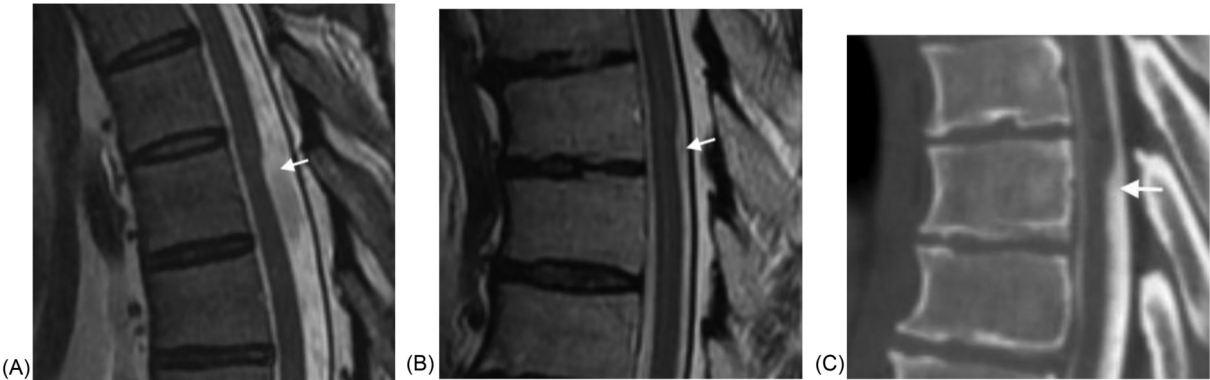


FIGURE 1
(A) Sagittal T2W MRI demonstrates a scalpel sign of SAW at the T6-T7 level in a 57 year old male with back and leg pain. (B) Sagittal T2W MRI demonstrates a scalpel sign of SAW at the T8-T9 level in a 65 year old male with back pain and absent reflexes and other diminished reflexes. (C) Sagittal CT post myelogram demonstrates a scalpel sign of SAW at T6 in a 50 year old male presenting with back pain, leg pain, and decreased flexion.

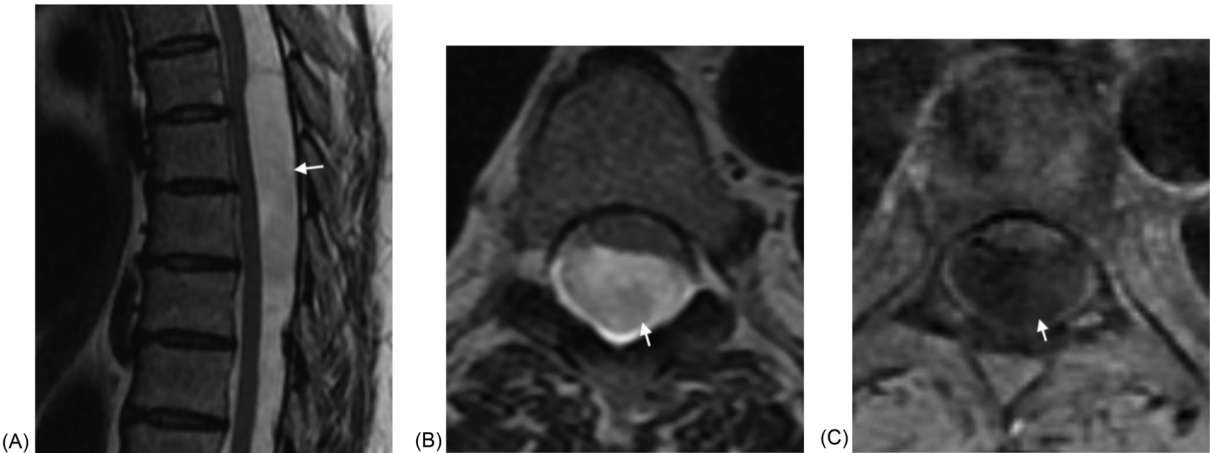


FIGURE 2
(A) Sagittal T2W MRI demonstrates a large fusiform intradural SAC in the mid thoracic spine with cord compression and anterior displacement of the cord in a 55 year old woman presenting with back pain and leg pain. The lower margin of the cyst is poorly defined. (B) Axial T2W MRI again demonstrates the SAC with resultant cord compression and anterior displacement of the cord. (C) Axial T1W fat saturated post contrast image demonstrates absent enhancement.

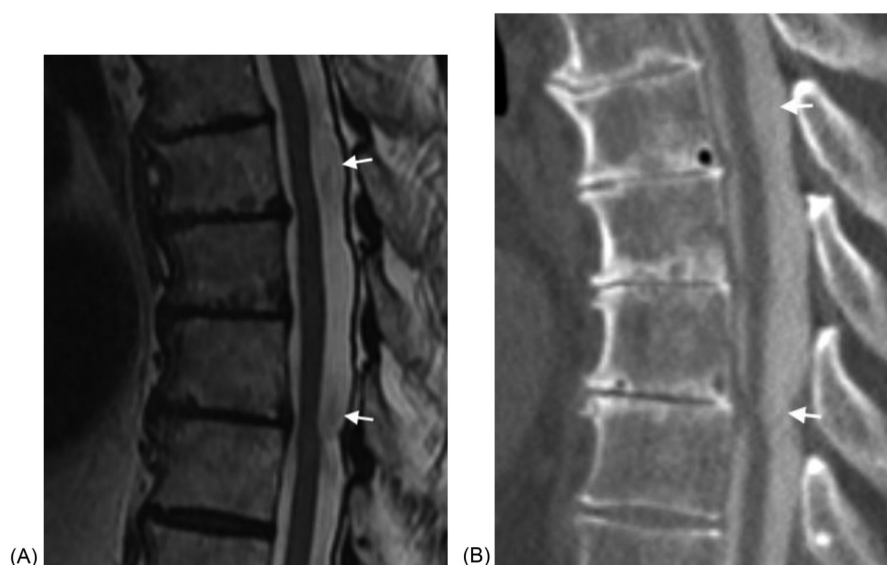


FIGURE 3

(A) Sagittal T2W MRI demonstrates a large fusiform intradural SAC in the mid thoracic spine with compression of the cord in two locations in a 77 year old male with back pain, leg pain, and absent reflexes. (B) Sagittal CT post myelogram again demonstrates the two sites of cord compression. The cyst fills with intrathecal contrast material.

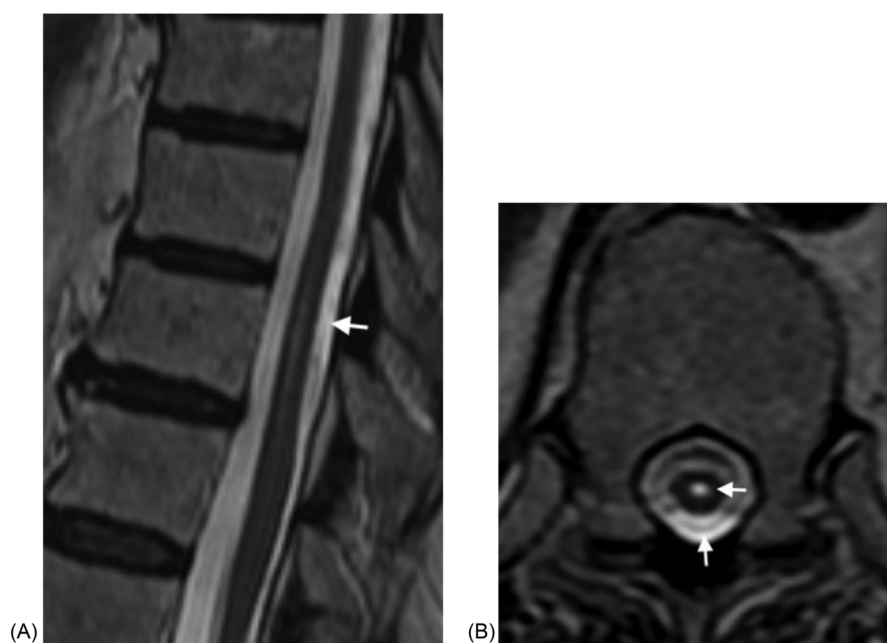


FIGURE 4

(A) Sagittal T2W MRI demonstrates a fusiform intradural SAC resulting in mild mass effect on the cord at T10 and T11 in a 73 year old woman presenting with back pain, bilateral leg pain, and absent reflexes. (B) Axial T2W MRI at the upper T11 level demonstrates the SAC and small syringomyelia.

webs along with cysts, or whether the differences may just be due to the small sample size. When taking into account the SAWs, 15 of 21 cases (71%) of our cases were in the thoracic spine. Our research focused on SAWs and intradural SACS, and so conclusions cannot

be reached about extradural SACS, which tend to be less symptomatic (15).

SACs and SAWs are often similar in appearance on MRI and CT myelography. By definition, SAWs have focal cord

compression that occurs at a single level. They demonstrate the scalpel sign (Figure 1). The thin web itself was not demonstrated in any of our cases.

In our cohort all of the SACs were posterior and all the ones at the level of the cord caused cord compression. SACs in the thoracic spine, then, can be difficult to distinguish from SAWs, particularly when the cyst walls are not well defined. The most helpful imaging finding is that the cord compression in SAWs is smoother and lacks the sharp angle of the scalpel sign (Figure 2). In addition, in some cases SACs can have more than one site of cord compression (Figure 3). SACs can result in syringomyelia (Figure 4).

SACS in the lumbar spine can be fusiform or lobulated, and can result in spinal canal stenosis. They can also result in syringomyelia (Figure 5). It should be noted that our

data yielded a low rate of syringomyelia in SACs (16.7%). Studies have shown variable rates of syringomyelia in SACs, ranging from 10%–86% (7). None of our webs demonstrated syringomyelia. In the series of Reardon and Raghavan, 7 of 13 patients undergoing MRI (54%) had syringomyelia (10). Cord signal abnormality was only seen in one patient in each group.

There are a few limitations of this study. Due to the rarity of both SACs and SAWs, we had a relatively small sample size from which to draw conclusions. In addition, these lesions can be hard to identify and so some lesions may have been missed. The incidence of SACs, in particular, was likely underestimated as they can be very difficult to detect in the absence of cord compression, and these lesions are less likely to result in signs



FIGURE 5

(A) Sagittal T2W MRI demonstrates a lobulated intradural SAC in the lumbar spine causing marked canal stenosis at several levels in a 55 year old woman presenting with back pain and left leg pain. (B) Axial T2W MRI through the L5 level again demonstrates the SAC with resultant canal stenosis. (C) Sagittal T2W MRI demonstrates a fusiform intradural SAC in the upper and mid lumbar spine causing canal stenosis and associated syringomyelia in a 46 woman with back pain, left foot pain, and absent reflexes. (D) Axial T2W MRI at the L3-L4 level demonstrates mild canal stenosis. (E) Sagittal STIR MRI image demonstrating the syringomyelia.

and symptoms. A prospective study where the exams were specifically analyzed for these entities would likely yield a greater number of cases.

Another limitation of our study is the lack of patient outcomes in our cohort. After the diagnosis was made, the patients with both SAWs and SACs were referred to neurosurgery outside of our clinic. As such, we don't know how many of the patients went for surgery, what was seen at the time of surgery, and how the patients fared.

Our study was based on conventional MR imaging techniques and CT myelography. Other imaging sequences and techniques have been used to increase sensitivity. These include constructive interference in steady state (CISS) imaging (16) and cine MRI (17, 18).

In our experience, SACS and SAWs are rare lesions that have similar clinical presentations, usually presenting with myelopathic signs and symptoms, and must be distinguished by their imaging findings. Besides location (all SAWs are thoracic and SACs can be seen anywhere in the spine), the appearance of mass effect on the cord is helpful, particularly in cases of SACs with poorly seen margins. SAWs cause a focal compression, the scalpel sign, while SACS cause broader and smoother compression. Proper recognition of both these entities is important, as multiple studies have shown good outcomes from various surgical techniques.

Data availability statement

The datasets presented in this article are not readily available because data set has medical record numbers and other demographic information. Requests to access the datasets should be directed to Corresponding author.

Ethics statement

The studies involving humans were approved by Hughston Foundation Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements.

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Author contributions

RS: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. BC: Data curation, Investigation, Writing – review & editing, Methodology. CR: Data curation, Investigation, Methodology, Writing – review & editing. DP: Conceptualization, Data curation, Formal analysis, Investigation, Writing – review & editing.

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