Scientific Research Publishing

Open Journal of Modern Neurosurgery, 2026, 16(3), 264-273
https://www.scirp.org/journal/ojmn
ISSN Online: 2163-0585
ISSN Print: 2163-0569

Spinal Arachnoid Web as a Rare, Well-Known but Underdiagnosed Entity: A Report of Three Cases

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How to cite this paper: Sy, E.H.C.N., Onifade, M.M., Gbenou, F., Atakla, H.G., Kweidjartey, I.W., Jacquier, K.N.S., Blanc, J.L., Thiam, A.B., and Ba, M.C. (2026) Spinal Arachnoid Web as a Rare, Well-Known but Underdiagnosed Entity: A Report of Three Cases. *Open Journal of Modern Neurosurgery*, **16**, 264-273.
https://doi.org/10.4236/ojmn.2026.163025

Received: May 22, 2026
Accepted: July 19, 2026
Published: July 22, 2026

Abstract

Background: Spinal arachnoid web is an abnormality of the arachnoid membrane in the subarachnoid space which may cause progressive spinal cord compression and myelopathy. Its diagnosis is often delayed due to its nonspecific presentation and limited awareness. We report three managed cases of spinal arachnoid web, with highlights on the diagnostic and therapeutic challenges. **Methods:** We retrospectively reviewed three patients diagnosed with spinal arachnoid web between January 2020 and December 2022. Clinical presentation, imaging findings, management strategy, and outcomes were analysed. **Results:** All patients were male, with a mean age of 56.3 years. Two presented with progressive myelopathy and underwent surgical decompression with intradural excision of the arachnoid web. The final patient with mild symptoms was managed conservatively. MRI revealed the characteristic "scalpel sign" in all cases with associated syringomyelia in two patients. Their postoperative neurological statuses either plateaued or slightly improved with respect to gait. No recurrence was observed during follow-up. **Conclusion:** Spinal arachnoid web is a rare and potentially reversible cause of spinal cord compression. MRI plays a key role in diagnosis. From our experience, complete surgical resection of spinal arachnoid web was associated with clinical stabilisation and the absence of recurrence during the short follow-up period observed in this series. However, treatment should be individualized, taking into consideration the severity of symptoms, clinical and radiological findings.

Keywords

Arachnoid Web, Spinal Cord, Scalpel Sign, Decompression

1. Introduction

Spinal arachnoid web (SAW) is an abnormal thickening of the intradural arachnoid bands that extend to the pial surface of the posterior aspect of the spinal cord. The first case was described in 1997 by Mallucci *et al.* [1] It is a rare and probably underdiagnosed pathology characterized by focal thickening of arachnoid tissue causing dorsal compression of the spinal cord [2]. The SAW or arachnoid web (AW) is considered as a variant of spinal arachnoid cysts (SAC). According to Nisson *et al.*, SAW predominantly affects men and is most commonly located in the thoracic spine, posterior to the spinal cord and frequently associated with syringomyelia [3]. SAW is sometimes regarded as the remnants of a ruptured or collapsed arachnoid cyst, or even resulting from incomplete formation of an arachnoid cyst. Post-traumatic, post-infectious and post-operative causes have been reported. Research into idiopathic forms remain ongoing. Patients with SAW present with neuropathic pain and signs of compressive myelopathy, accompanied by episodic lower limb weakness [2] [3]. Typical MRI features include ventral displacement of the spinal cord, syringomyelia, and the characteristic "scalpel sign" [4]. Surgical decompression with adhesiolysis remains the most effective therapeutic option [5].

The aim of this study is to report three cases of arachnoid web managed in our department and to discuss diagnostic and therapeutic considerations in light of the literature.

2. Clinical Cases

CASE NUMBER 1:

A 49-year-old male with a history of multiple knee surgeries, including left leg pinning and right hallux valgus correction in 2018, presented in October 2020 to a peripheral hospital with reports. He reported progressive symptoms evolving over 2 years symptoms, including difficulty rising from a chair, rest-related radicular pain in the lower limbs while supine, gait and balance disturbances, and inability to climb or descend the stairs. Neurological examination revealed proprioceptive ataxia, bilateral pyramidal syndrome with hyperreflexia, and impaired deep sensation. Initial MRI (July 2020) demonstrated a dorsal syrinx at T5 - T7 associated with T5 - T6 myelopathy, anterior deviation of the spinal cord, and posterior cord impression at T6. A follow-up contrast-enhanced MRI 6 months later, confirmed a T2-hypointense oblique arachnoid band at T5 - T6 producing the cord impression and the classic "scalpel sign" diagnostic of spinal arachnoid web (SAW), and stable T2-hyperintense T6 myelopathy posterior to the vertebral body.

A T5-T6-T7 laminectomy was performed. After dural opening, a markedly thickened arachnoid membrane was identified displacing the spinal cord anteriorly. The SAW was completely resected, revealing a clear imprint on the decompressed cord, which was now freely mobile. Adhesions below were resected. Histological analysis confirmed fibroconnective tissue consistent with an arachnoid cyst wall. Immediate postoperative course was marked pain resolution. The patient neurologically plateaued and was discharged on postoperative day 3 to continue rehabilitation (Figure 1 and Figure 2).

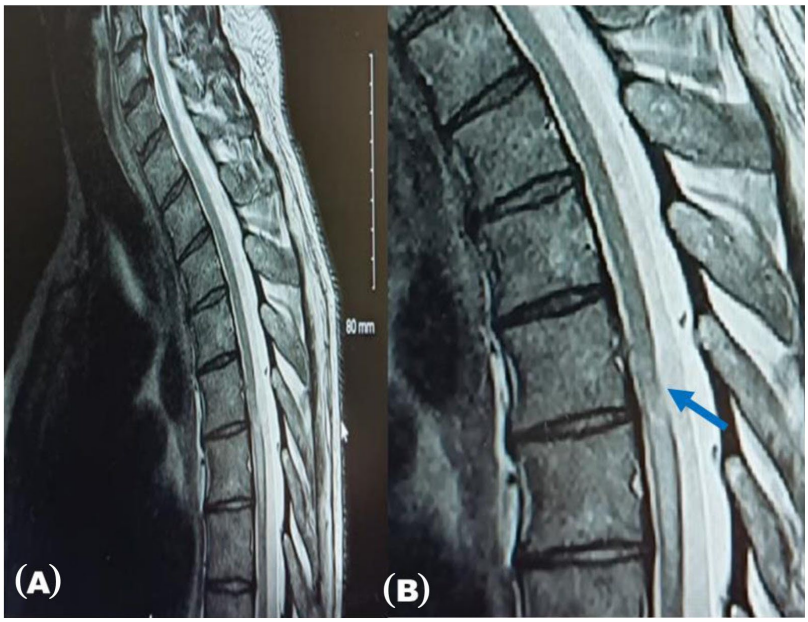

Figure 1. Preoperative sagittal T2-weighted MRI showing myelopathy and syrinx (A) and the arachnoid web as a T2-hypointense band (arrow) (B) [Case 1].

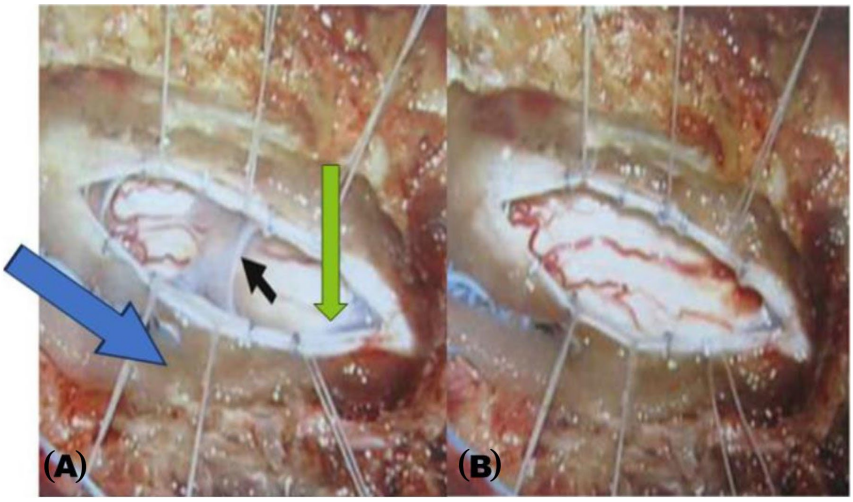

Figure 2. Intraoperative photograph of Case 1 after durotomy showing the dura mater (blue arrow), the compressive arachnoid web with clear spinal cord imprint (black arrow), and normal spinal cord (green arrow) (A). Intraoperative photograph after arachnoid web resection showing adequate spinal cord decompression (B).

CASE NUMBER 2:

A 52-year-old male patient with no significant medical history presented in November 2021 with left-predominant lower limb weakness. A progressive gait disturbance had begun in July 2021, evolving into spastic paraparesis causing falls and difficulty climbing and descending stairs. Initial lumbar spine MRI was unremarkable and failed to explain the clinical findings. Subsequent thoracic spinal MRI revealed anterior spinal cord displacement with a posterior T3 myelomalacia. Neurological examination showed marked ankle spasticity, brisk knee jerks, left Babinski sign, spastic gait with left lower limb scissoring (particularly stiff ankle), and motor deficits (foot dorsiflexion 3/5, plantar flexion 4/5). Multidisciplinary neuroradiology review concluded on the diagnosis of SAW. Surgical intervention was indicated for spinal cord compression from SAW. Surgical procedure involved midline dural opening, exposing notably thickened arachnoid. Arachnoid incision revealed clear cord impression with severe anterior displacement. SAW was completely excised, restoring cord mobility and decompression. Intraoperative findings confirmed arachnoid remodelling. Postoperative course was uneventful. Neurologically, the patient stabilized. He was discharged on postoperative day 3 to rehabilitate. Four-month follow-up MRI was satisfactory (Figure 3 and Figure 4).

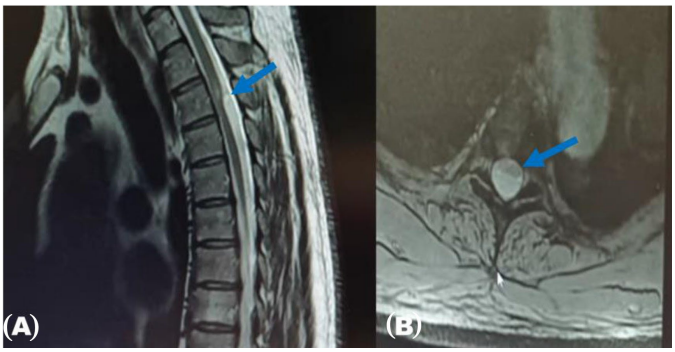

Figure 3. Preoperative T2-weighted sagittal MRI (A) showing spinal cord deformation (scalpel sign: arrow) responsible for myelopathy (A) and axial view showing dorsal spinal cord flattening with anterior displacement (arrow) (B).

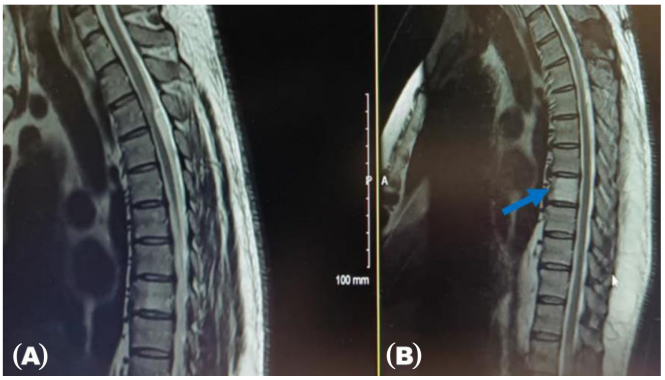

Figure 4. Preoperative sagittal T2-weighted MRI (A) and postoperative MRI at 4 months showing improvement of myelopathy and resolution of the arachnoid web (B). Note the incidental vertebral hemangioma (blue arrow).

CASE NUMBER 3:

A 68-year-old male with a history of traumatic brain injury and neck pain in 2018 presented in September 2021 with 6-month history of nocturnal upper limb dysesthesia with intermittent electric shock-like sensation. Neurological examination revealed no sensory or motor deficits. Cervical spine MRI (June 2021) demonstrated a large syrinx extending from C7 to T2, with a T2-level indentation suggestive of SAW and T2-hyperintensity at the inferior margin of the syrinx. Electrophysiological studies showed no radicular, plexus or trunk involvement on upper limb electromyography (EMG). Four-limb somatosensory evoked potentials (SSEPs) confirmed bilateral long-tract involvement with prolonged central conduction times consistent with syringomyelia. Follow-up MRI (October 2021) showed stable radiographic findings with no evidence of transdural herniated disc or thoracic spinal arachnoid cyst. Considering our patient's clinical condition was stable and his symptoms were mild, and despite electrophysiological abnormalities associated with syringomyelia, a conservative management plan was put in place after consulting with the patient. However, regular clinical and radiological monitoring every six months (currently annual) has been prescribed to monitor the condition's progression (Figure 5).

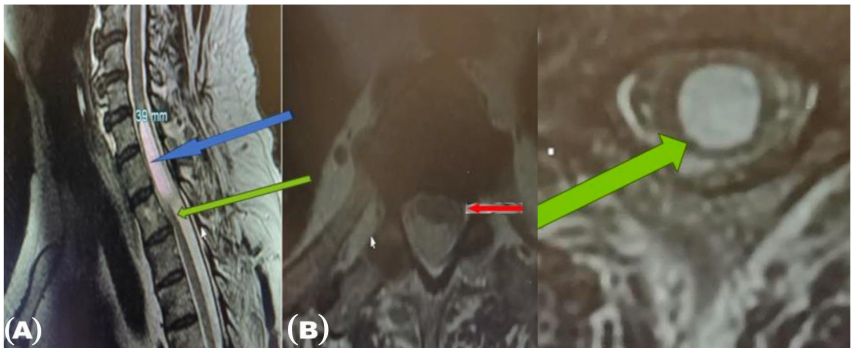

Figure 5. Preoperative T2 sagittal showing spinal cord deformation (scalpel sign, green arrow) and syringomyelic cavity "blue arrow" (A), and axial T1 view showing anterior displacement of the spinal cord (red arrow) (B). Axial T2-weighted image showing the syringomyelic cavity indicated by the green arrow.

3. Discussion

SAW is a rare intradural meningeal pathology of uncertain etiology. The most widely accepted hypothesis suggests that AW represents an incomplete or disrupted form of arachnoid cyst development, possibly arising from collapsed or embryonic cystic structures. Its marked dorsal thoracic predominance supports the theory of origin from the diverticula of the septum posticum, a thin longitudinal membrane dividing the posterior subarachnoid space. Structural alterations of the septum posticum may generate complex arachnoid bands capable of obstructing cerebrospinal fluid (CSF) flow and producing focal cord compression, as hypothesized by Nisson [3].

Since its first description by Mallucci *et al.* in 1997, fewer than 300 cases have

been reported, most within the last decade [1] [6]. Increased MRI accessibility and heightened clinical awareness likely explain the rising number of diagnoses. Symptom onset typically occurs between the fourth and seventh decades. A male predominance has been reported by Nisson (72%) [3] [7], whereas Laxpati *et al.* observed slight female predominance [8]. Our findings confirm the progressive and frequently insidious course of AW. The median duration of symptoms prior to consultation was 13 months which is consistent with previously published series that reported delays ranging from one to several years. Such delays are likely to contribute to irreversible spinal cord damage and may limit postoperative recovery.

Clinically, symptomatic AW most often manifests as progressive thoracic myelopathy with gait disturbance and imbalance. MRI remains the diagnostic cornerstone. The characteristic "scalpel sign," first described by Reardon *et al.*, reflects focal dorsal indentation of the spinal cord and is considered highly suggestive of AW. However, this sign alone does not reliably distinguish AW from arachnoid cysts or ventral spinal cord herniation. Advanced MRI sequences (phase-contrast cine MRI, CISS, T2-TrueFISP) may further delineate CSF flow obstruction and arachnoid membranes [2] [4] [7].

The pathophysiology of spinal arachnoid web is still not fully understood. It has been hypothesized that these lesions may represent an arachnoid remnant, a focal arachnopathy, or a variant within the spectrum of spinal meningeal disorders. Whatever the exact mechanism, the resulting focal obstruction of CSF flow appears to be a key driver of cord deformation and syrinx formation [7].

Syringomyelia is a frequent association. Voglis *et al.* reported syrinx formation in 83% of cases, while Nisson *et al.* observed it in 67% [3] [9]. Lower rates were described by Laxpati [8]. The syrinx may extend rostrally, caudally, or bidirectionally relative to the web, likely reflecting unidirectional CSF flow dynamics [10] [11].

The MRI-based classification proposed by Carr *et al.* (Type 1: cord deformation; Type 2: deformation with myelomalacia; Type 3: deformation with myelomalacia and syringomyelia) provides a pragmatic framework for therapeutic decision-making. In contrast to prior series where Type 1 predominated, our cohort was mainly Type 3, reflecting more advanced disease at diagnosis [11].

Management should be individualized. Conservative treatment is limited to symptomatic control and does not appear to halt progression. Surgical decompression with intradural microsurgical excision remains the treatment of choice in patients with progressive myelopathy or associated syrinx [2] [12] [13]. Nisson *et al.* reported neurological improvement in 91% of surgically treated patients [3]. Conversely, isolated cord indentation without myelopathy or syrinx may be observed, as suggested by Carr *et al.* [11]. In our series, two patients underwent laminotomy with intradural web excision due to progressive neurological deterioration, while one pauci-symptomatic patient was managed conservatively. Laminotomy may offer theoretical advantages over laminectomy in selected thoracic cases, potentially reducing postoperative pain, CSF leakage, and hospital stay, alt-

hough high-level comparative data are lacking [14].

No recurrence was observed during a mean follow-up of 7.5 months. Although recurrence is rarely reported, longer follow-up and larger prospective studies are necessary to define true recurrence rates and long-term functional outcomes. Postoperative outcomes showed modest functional improvement, particularly in gait, but persistent spastic paraparesis. The prolonged preoperative symptom duration and established myelopathy likely limited neurological recovery, underscoring the critical importance of early diagnosis and timely surgical intervention. Notably, surgery appeared to halt further neurological decline in both progressive cases [8] [15]. As in the case of the third patient in this study, conservative treatment may be offered to patients who do not have a disabling neurological disorder. As the risk of post-operative neurological deterioration is not negligible in this context, patients without neurological symptoms should be kept under observation with regular clinical and radiological monitoring. Let us remember that we operate on patients, not on images.

3.1. Limits of the Study

Its retrospective single-center design is associated with inherent information and selection biases.

The small sample size limits statistical analysis and generalizability.

Follow-up remains relatively short, preventing strong conclusions on long-term recurrence, late neurological recovery, or delayed progression in the conservatively managed patient.

MRI strongly suggested the diagnosis in the three patients of this study and histopathological confirmation was not available in every patient, which may limit diagnostic certainty.

3.2. Highlights

- Spinal arachnoid web is a rare and underdiagnosed cause of progressive myelopathy.
- MRI "scalpel sign" is pathognomonic and crucial for diagnosis.
- Surgical excision leads to neurological stabilization or improvement.
- Early diagnosis is key to optimizing functional outcomes.

4. Conclusion

Spinal arachnoid web is a rare and underestimated cause of spinal cord injury that is complex to diagnose due to subtle MRI findings and similarities to other well-known diseases. Early recognition of SAW is essential since delay in diagnosis can lead to potentially deleterious neurological sequelae. Increased awareness among clinicians and radiologists is key to improve diagnostic accuracy and outcomes.

Contributions

All authors contributed to the study conception and design. Data collection and

analysis were performed by M.M.O Onifade, the first draft of the manuscript was written by M.M.O Onifade and F. Gbenou. The review of the literature, including the selection of abstracts and full-text articles, was carried out by H.G. Atakla and El C. N. Sy. And all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Ethics Approval

The study was approved by the institutional review board of National teaching hospital Fann of Dakar. The patients/relatives, provided informed consent for the inclusion of their clinical data in this study.

Consent to Participate

Informed consent was obtained from the patients.

Consent for Publication

Informed consent was obtained from the patients.

Acknowledgements

The authors would like to thank the participant and the ethics committee for consenting to this study.

Conflicts of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Abbreviations

AW	Arachnoid web
CISS	Constructive Interference in Steady State
CSF	Cerebrospinal fluid
EMG	Electromyography
SAC	Spinal arachnoid cysts
SAW	Spinal arachnoid web
SSEP	somatosensory evoked potentials
MRI	Magnetic resonance imaging