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Original Research Article

Synovial Cysts Confounding Access to the Dorsal S1 Neural Foramen in Transforaminal Epidural Steroid Injections

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Abstract

Objectives. The S1 dorsal foramen is the route for 30% of lumbar transforaminal epidural injections; it is therefore important to identify structures impeding S1 foraminal access. The study objective was to characterize the imaging findings, prevalence, and anatomic origin of synovial cysts presenting within the S1 neural foramen. **Methods.** A case series (N = 14) established imaging characteristics of S1 synovial cysts. Imaging studies of 400 patients undergoing epidural injections were reviewed for lesions compromising S1 foraminal access. Cadaveric dissections defined the relationship of the inferior recess of the L5-S1 facet to the S1 dorsal foramen. **Results.** Elderly patients (mean age = 76) exhibited S1 synovial cysts. Synovial cysts were typically 1–2 cm in diameter, hyperintense on sagittal T2 weighted magnetic resonance images (MRIs), fluid-density on computed tomography, and dorsal to the S1 spinal nerve. Sixty percent of cysts exhibited complex MRI signal characteristics (thick wall, internal structure). Tarlov cysts, in contrast, were larger, lobular, and exhibited pure fluid intensity. Lesions impeded access to the S1 dorsal foramina in 5% of reviewed imaging studies (16 Tarlov cysts, three synovial cysts, one conjoint S1-S2 nerve root). The multifidus muscle was interposed between the L5-S1 facet inferior recess and the S1 dorsal foramen on dissection specimens; severe atrophy of the ipsilateral multifidus was noted on imaging in 17/18 synovial cysts. **Conclusions.** The S1 neural foramina should be inspected on sagittal MRI, when available, for confounding lesions before performing S1 epidural injections. Tarlov cysts are more common than synovial cysts; the latter are seen in elderly patients with severe multifidus atrophy.

Key Words: Epidural steroid injection; S1 foramen; Synovial cyst; Tarlov cyst

Introduction

Lumbar transforaminal epidural steroid injections (TFESIs) have demonstrated efficacy and clinical effectiveness in treating patients with radicular pain with or without radiculopathy; the best-quality evidence available is for patients with disc herniations. The vast majority of symptomatic lumbar disc herniations occur at the L4-5 and L5-S1 interspaces, causing L5 or S1 radicular pain patterns [1]. Depending on the foraminal and lateral recess anatomy, an S1 radicular pain syndrome could be treated via an infraneural L5 access or an S1 dorsal foramen access. In a prior report encompassing >3,000 lumbar TFESIs, 30% of lumbar transforaminal epidurals were performed at the S1 level [1]. Therefore, any lesion compromising access to the S1 dorsal foramen may be procedurally significant. Tarlov or meningeal cysts have been described in this location [2]. Synovial cysts arising from the L5-S1 facet have not been previously described as a lesion confounding access to the S1 dorsal foramen.

The objectives of the study were 1) to characterize the imaging findings of L5-S1 synovial cysts within the

dorsal S1 neural foramen; 2) to define the prevalence of any lesions, including synovial cysts, which may confound access to the dorsal S1 foramen; and 3) to define the anatomic pathway by which L5-S1 synovial cysts may come to lie in the S1 dorsal foramen.

Methods

This retrospective study was approved by the Mayo Clinic Institutional Review Board and was Health Insurance Portability and Accountability Act compliant. A case series consisting of 12 patients bearing 16 S1 synovial cysts (S1SCs) compiled by the senior author (TPM) at the Mayo Clinic Rochester over several years during fluoroscopically guided (15) or computed tomography (CT)–guided [1] injection procedures, and two patients each with a single S1SC identified in the prevalence cohort, was reviewed to define the imaging characteristics of S1SCs and the relevant regional anatomy. Magnetic resonance imaging (MRI) examinations were available for 12 patients, CT examinations for 10 patients. Two patients had CT examinations only. The lesions were evaluated for size, shape, wall thickness, signal intensity, visible communication with the L5-S1 zygapophyseal joint, and presence of L5-S1 zygapophyseal joint effusion.

The MRI examinations of a cohort of 400 patients undergoing lumbar imaging for radicular pain were reviewed by neuroradiologists active in the Mayo interventional pain practice (FED, TJK, JTW, TPM) to establish the prevalence of any lesion compromising access to the S1 dorsal foramen, including L5-S1 synovial cysts within the S1 dorsal foramen. The L5-S1 synovial cysts identified in this cohort were included in the aforementioned case series. The imaging characteristics of Tarlov cysts observed in this location were also tabulated as above.

Cadaveric dissections (N = 2) of the regional anatomy of the L5-S1 zygapophyseal joint and the S1 dorsal foramen, prepared as teaching specimens at the University of New England College of Osteopathic Medicine, were examined by an anatomist with expertise in spine and neuraxial anatomy (FHW). The dissection examination sought to define the relationship of the L5-S1 facet capsule and inferior recess to the S1 dorsal foramen, to identify anatomic barriers to a synovial cyst entering the S1 dorsal foramen, and to identify conditions that would allow such entry.

After identification of multifidus atrophy as a potential anatomic substrate for S1 synovial cysts, the imaging studies of all the cases of S1SC were reviewed and the degree of multifidus atrophy scored as follows [3–5]: 0 = normal; 1 < 10% fatty replacement of muscle; 2 = 10–50% fatty replacement of muscle; 3 > 50% fatty replacement of muscle. Only descriptive statistics are presented.

Results

The case series consisted of 14 elderly patients, with a mean age of 76 years. Sixty percent of the patients were male. There were 18 total L5-S1 synovial cysts extending into the S1 dorsal foramen; four cases had bilateral cysts (Table 1).

On MRI, the cysts were situated dorsal to the S1 ventral ramus, and many were relatively hyperintense on T2 weighted images and hypointense on T1 weighted images, having fluid-like signal characteristics (Figure 1). The synovial cysts were always seen on all sagittal MRI images; axial images did not extend far enough caudally to demonstrate them. A majority (60%) of the synovial cysts had MRI findings not typical of pure fluid, with signal intensity less hyperintense than cerebrospinal fluid, a relatively thick, hypointense, or dark wall on all MRI sequences, and internal structure seen within the cyst on the T2 weighted images. Two-thirds of the cysts were between 1 and 2 cm in diameter; one-third were <1 cm in diameter. They were all observed to be either contiguous with, or connected by a stalk to, the L5-S1 facet joint. Facet effusions were present in 72% (13/18) of joints from which cysts arose. On CT images, the cysts were of fluid attenuation.

Review of imaging studies of 400 radicular pain patients (mean age = 63 years) yielded a 5% prevalence for lesions that impeded access to the S1 dorsal foramen. These consisted of 16 Tarlov cysts (4%), three synovial cysts (0.8%), and one conjoint S1-S2 nerve (0.2%).

Tarlov cysts were more common than synovial cysts (Figure 2). Tarlov cysts were distinguished from synovial cysts by their known imaging characteristics: Tarlov cysts demonstrated greater T2 hyperintensity, signaling like cerebrospinal fluid, and had a thin wall and no internal structure [2]. Tarlov cysts were often multiple, lobular, larger than synovial cysts, expanded bone, and showed no connection to the facet joint.

In the cadaveric specimens examined by a spine anatomist (FHW), the multifidus muscle was normally interposed between the inferior recess of the facet joint capsule and the S1 dorsal foramen. There was no other anatomic barrier. It was postulated that fatty atrophy of the multifidus may predispose to a posterior L5-S1 synovial cyst presenting in the S1 dorsal foramen.

The degree of fatty atrophy of the multifidus muscle ipsilateral and contralateral to the S1SC is shown in Table 1. In 17 of 18 synovial cysts, there was grade 3 atrophy of the multifidus on the side of the synovial cyst; in one case, the atrophy was grade 2. On the side contralateral to the S1SC, grade 3 multifidus atrophy was present in eight of the 10 subjects with a single S1SC. Of the 16 Tarlov cyst patients in the imaging review, 15 exhibited symmetric grade 3 multifidus atrophy.

Discussion

Although lesions compromising access to the S1 dorsal foramen are of low prevalence, due to the frequency of S1 foraminal access for lumbar epidural steroid injections, they are likely to be encountered in clinical practice and prevent adequate epidural distribution of

Table 1. Clinical and imaging characteristics of synovial cysts in the S1 dorsal foramen

Age, y	Sex	CT	MRI	Size Laterality, cm	Facet Effusion	Multifidus Atrophy Ipsilateral	Multifidus Atrophy Contra	Stalk, Y/N	MRI: T2 Hypointensity, Thick Wall, Internal Structure
80	M	Y	Y		Y (L)	3	1	N	Y
				1–2 (R)	Y (R)				
70	M	Y	Y	1–2 (L)	Y (L)	3	3	Y (L)	Y (L)
				<1 (R)	Y (R)			N (R)	N (R)
83	M	Y	N		N (L)	3	3	Y	N
				<1 (R)	N (R)				
75	F	Y	Y	1–2 (L)	Y (L)	3	3	N (L)	Y (L)
				1–2 (R)	Y (R)			N (R)	N (R)
75	F	Y	Y	1–2 (L)	Y (L)	3	3	N	N
					N (R)				
76	F	Y	Y		N (L)	3	3	Y	N
				<1 (R)	N (R)				
82	F	N	Y	1–2 (L)	Y (L)	3	3	Y (L)	N (L)
				1–2 (R)	Y (R)			N (R)	Y (R)
74	F	Y	Y	1–2 (L)	Y (L)	3	3	N	Y
					Y (R)				
82	M	Y	Y	1–2 (L)	N (L)	3	3	Y	Y
					N (R)				
81	M	Y	Y	L1–2 (L)	Y (L)	3L	2R	Y (L)	Y (L)
				<1 (R)	Y (R)			N (R)	N (R)
81	M	Y	N		N (L)	3	3	N	N
				1–2 (R)	N (R)				
75	M	N	Y		N (L)	3	3	N	N
				<1 (R)	Y (R)				
62	F	N	Y		N (L)	3	3	N	N
				<1 (R)	Y (R)				
69	M	N	Y		N (L)	3	2	N	Y
				<1 (R)	N (R)				

CT = computed tomography; L = left; MRI = magnetic resonance image; N = no; R = right; Y = yes.

injected therapeutic or diagnostic agents (examples of such cases from our clinical practice are shown in Figure 3).

Tarlov cysts, also described as type II meningeal cysts, are developmental lesions that were more frequently seen as S1 foraminal lesions than synovial cysts. Tarlov cysts are common, identified in 1–2% of sacral MRI exams, but are usually asymptomatic [6]. They may be an unusual cause of pelvic or S1-S2 radicular pain, with potential treatment by percutaneous drainage and fibrin sealant instillation [7]. Tarlov cysts are recognized by their multiplicity, larger size, lobular contour, and uniform T2 hyperintensity comparable to cerebrospinal fluid and are frequently associated with benign osseous expansion/erosion.

Synovial cysts arising from the L5-S1 facet joint have not been previously described within the S1 dorsal foramen. Lumbar synovial cysts are common (10% of lumbar MRI examinations) [8] and arise most frequently from the L4-5 facet (60–70%) [9], but are less commonly intraspinal (2.3% of lumbar MRI exams) [8]. They are associated with facet joint osteoarthritic change and may be symptomatic as a neural compressive lesion. Synovial cysts presenting in the S1 dorsal foramen demonstrated continuity or a communicating stalk with the L5-S1 arthritic joint, which had an effusion in 72% of joints. They were typically smaller than meningeal cysts, <2 cm in diameter. Sixty percent of S1SC had MRI signal characteristics atypical for a purely cystic lesion, with a thick wall that was hypointense on all MRI sequences, an internal T2 signal less hyperintense than CSF, and the appearance of internal septa or structure. These MRI findings may reflect prior intracystic hemorrhage and the presence of proteinaceous material, calcification, or gas [9,10]. S1SCs can obstruct access to a symptomatic S1 nerve and can potentially act as the inciting compressive lesion (Figure 1F). S1 synovial cysts were seen in association with multifidus atrophy (Figure 4). Multifidus atrophy is common in this elderly population, however, and it remains uncertain if this association reflects a necessary precondition for descent of a synovial cyst into the S1 dorsal foramen. Multifidus atrophy was also common in the Tarlov cyst patients.

Knowledge of the potential for the S1 dorsal foramen to harbor a confounding lesion should obligate the interventionalist to examine the sagittal MRI images of the target foramen, when available, before an S1 epidural injection. If a Tarlov or synovial cyst is identified, an alternative access (such as an infraneural L5 approach) may be employed, or a more advanced level of image guidance (CT) may be used to avoid the cyst within the S1 foramen (Figure 3). Consideration should be given as

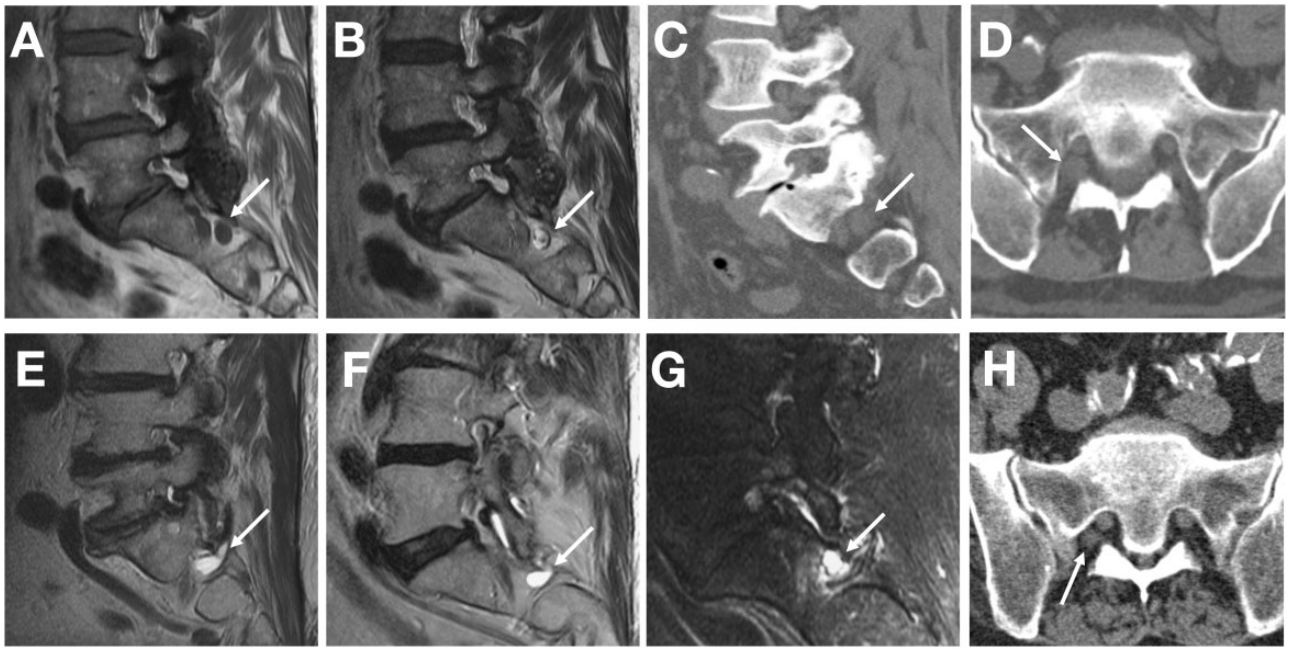

Figure 1. Magnetic resonance image (MRI) and computed tomography (CT) appearance of S1 dorsal foramen synovial cysts. T1 weighted sagittal MRI (A), T2 weighted sagittal MRI (B), sagittal CT (C), and axial CT (D) all demonstrate a synovial cyst (arrows) in the S1 dorsal foramen. The cyst signals like fluid on MRI (low T1, high T2 signal) and CT (intermediate attenuation). There is subtle internal structure on the T2 weighted MRI image (B). Sagittal T2 weighted MRI images show S1 dorsal foramen synovial cysts (arrows in E, F, G) in three different additional patients. Fluid is identified in the L5-S1 facets in (F and G). Note that in (G), fat saturation is employed, and there is inflammatory T2 hyperintensity around the cyst, which may play a causal role in the patient's radicular pain. An axial CT image (H) in another patient demonstrates the synovial cyst (arrow) separated by a fat plane from the S1 neural sleeve.

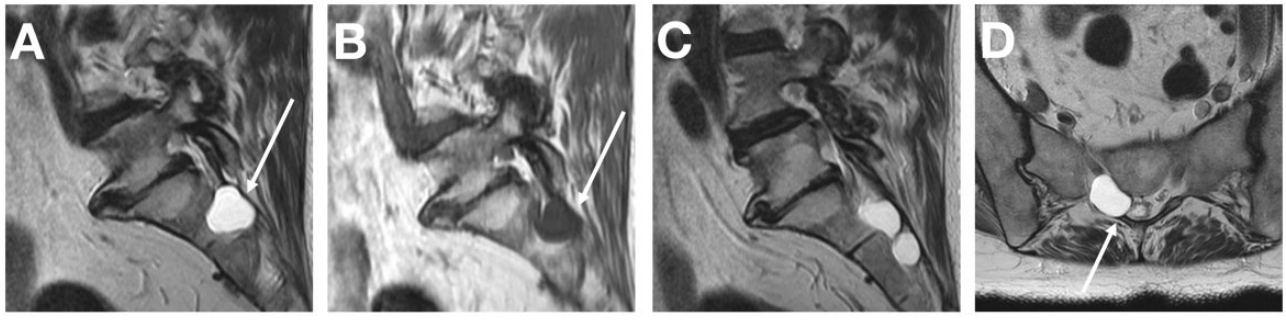

Figure 2. Magnetic resonance image (MRI) appearance of Tarlov (meningeal) cysts. Sagittal T2 weighted (A, arrow) and T1 weighted (B, arrow) MRI images reveal a Tarlov cyst in the S1 dorsal foramen. The cyst signals like cerebrospinal fluid, is lobular, and has a very thin wall. T2 weighted sagittal (C) and axial MRI images (D) of the same patient reveal other characteristics of Tarlov cysts, multiplicity (C), and benign osseous erosion (D, arrow).

to whether the foraminal lesion is causal of the pain syndrome, and hence the lesion may be amenable to an image- guided therapy such as synovial cyst rupture or in the unusual case of a symptomatic Tarlov cyst, aspiration of the cyst and /or cyst ablation with fibrin glue.

The study is limited by the small numbers of index lesions examined, but the imaging characteristics were relatively uniform. Although lesions obstructing the S1 foramen are uncommon, knowledge of their existence and imaging features will likely impact clinical practice given the high frequency of S1 access for transforaminal epidural steroid injections. Pathophysiologic mechanisms of synovial cyst positioning are acknowledged to be speculative.

Conclusions

Here we report lesions confounding access to the S1 dorsal foramen, with a prevalence of 5%. Sagittal MRI images, when available, should be examined for such lesions before S1 transforaminal epidural steroid injections. Tarlov cysts are more common than synovial cysts in the S1 dorsal foramen. Synovial cysts in the S1 dorsal foramen, a newly described lesion at this site, are seen in

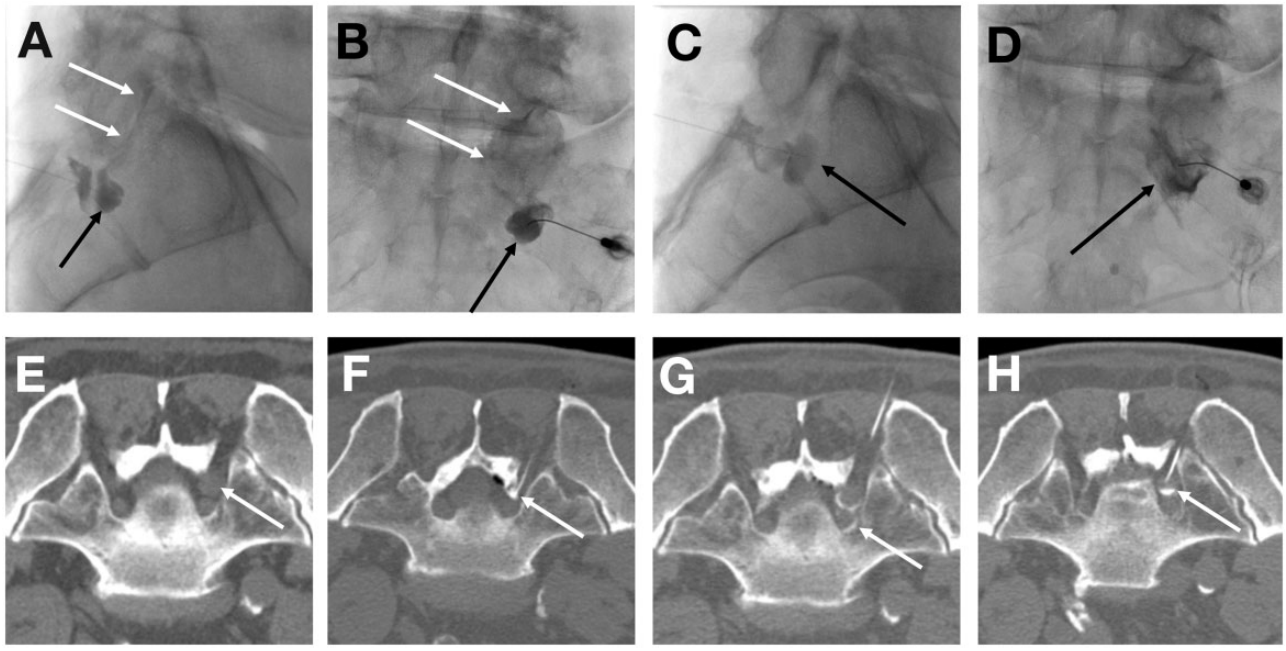

Figure 3. Contrast flow patterns obtained with fluoroscopic and computed tomography–guided access to the S1 dorsal foramen bearing a synovial cyst. In lateral fluoroscopic (A) and frontal images (B), contrast fills a synovial cyst (black arrow) and tracks cephalad into the L5-S1 facet joint (white arrows). Contrast media was aspirated from the cyst, and the needle was advanced by 1–2 mm. Injected contrast media now fills the epidural space around the S1 nerve (black arrows in C and D). In another patient, a synovial cyst impeded access to the S1 neural sleeve (arrow in E). A needle was advanced through the cyst, with epidural contrast then injected immediately anterior to the cyst (arrow, F). With injectate delivery, contrast was distributed around the S1 neural sleeve (arrow, G). Finally, the needle was withdrawn into the cyst (layering contrast, arrow in H), and the cyst was aspirated.

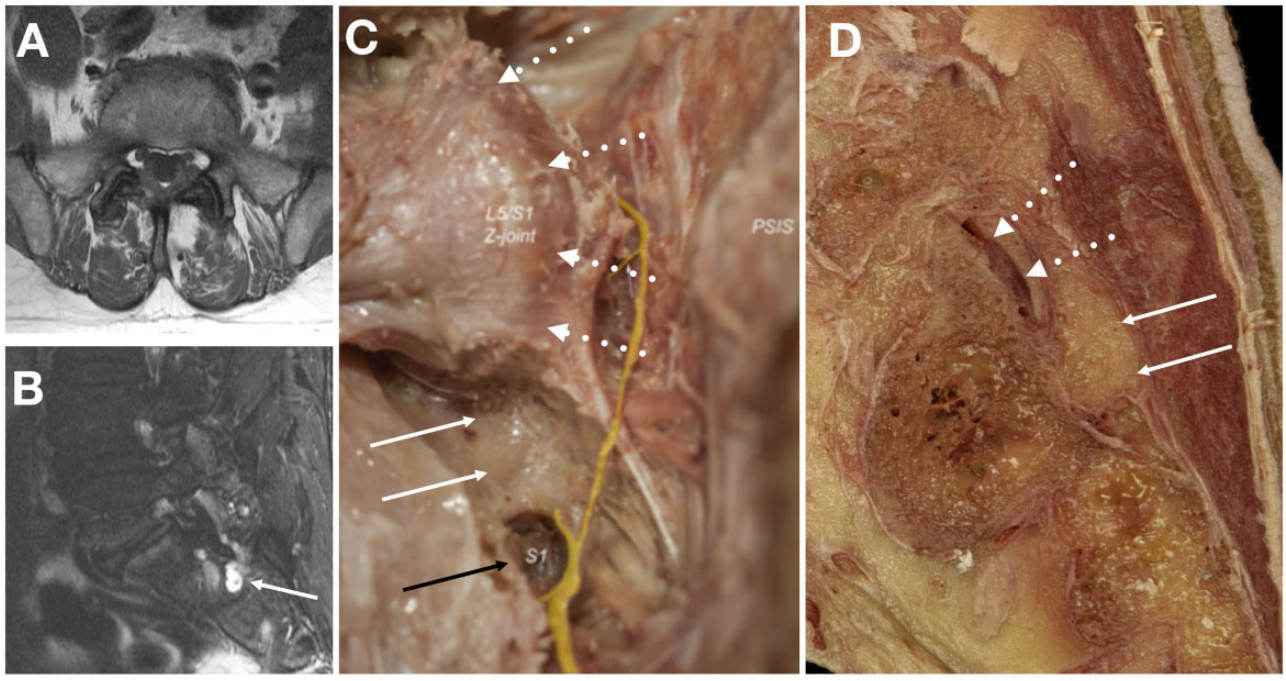

Figure 4. Multifidus muscle atrophy may allow an L5-S1 synovial cyst to enter the dorsal S1 foramen. A T1 weighted axial magnetic resonance image (A) demonstrates asymmetric left-sided multifidus atrophy. A synovial cyst was identified (arrow in B) in the left S1 dorsal foramen on the T2 weighted sagittal image. An anatomic dissection specimen in a different subject (C) revealed that the multifidus muscle (removed; position indicated by solid white arrows) would normally be interposed between the facet joint (dotted white arrows) and the S1 dorsal foramen (black arrow). In a sagittal section from another specimen (D), fatty replacement of the multifidus (solid arrows) is seen immediately caudal to the L5-S1 facet joint (dotted arrows) along the expected trajectory of a synovial cyst descending into the S1 dorsal foramen.

elderly patients with severe multifidus atrophy and zygapophyseal joint effusions.

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