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REVIEW

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Classification, mechanism and surgical treatments for spinal canal cysts

Jianjun Sun

Abstract

A variety of cystic lesions may develop in spinal canal. These cysts can be divided into intramedullary, intradural, extradural, cervical, thoracic, lumbar, and sacral cysts according to anatomical presentation, as well as arachnoid, meningeal, perineural, juxtafacet, discal, neurenteric cysts, and cyst-like lesions according to different etiologies. Mechanisms of initiation and growth vary for different cysts, such as congenital, trauma, bleeding, inflammatory, instability, hydrostatic pressure, osmosis of water, secretion of cyst wall, and one-way-valve effect, etc. Up to now, many treatment methods are available for these different spinal canal cysts. One operation method can be applied in cysts with different types. On the other hand, several operation methods may be utilized in one type of cyst according to the difference of location or style. However, same principle should be obeyed in surgical treatment despite of difference among spinal canal cysts, given open surgery is melely for symptomatic cyst. The surgical approach should be tailored to the individual patient.

Keywords: Spinal canal cysts, Classification, Mechanism, Treatments, Outcomes

Background

Since the appearance of magnetic resonance imaging (MRI), the diagnostic rates of spinal cystic lesions have increased rapidly. A variety of cystic lesions may develop in spinal canal. Various types of cystic lesions are confronted in the spinal canal and are classified based on their relationship to the adjacent structures and nature of the cyst content. Base on anatomical presentation, these cysts include intramedullary, intradural, extradural cysts, perineural cysts, as well as synovial, and discal cysts. The most common lesion site is arachnoid, followed by meninx, peripheral nerve, juxtafacet, discal and neurenteric sites. In addition, other cyst-like lesions include epidermoid cyst, teratoma, and hydatid cysts [21]. We reviewed and summarized classification, mechanisms and treatments of these true spinal canal cysts respectively, except for the cyst-like lesions.

Classification

Classifications of cysts vary based on etiology, histopathology, and localization. Extradural cysts include arachnoid cysts, synovial cysts, ganglias, cysts of ligamentum flavum, and discal cysts. Spinal meningeal cysts are classified as intradural and extradural ones. Intradural cysts include arachnoid cysts, enterogen (endodermal, neuroenteric) cysts, and ependymal cysts [11]. Among the cysts in the spinal canal, the arachnoid derived lesions are most common.

Arachnoid cysts can be observed anywhere along the length of the spinal canal, middle, and lower thoracic regions, which constitute for the most frequently involved areas [20]. Arachnoid cysts locates in the intradural, extradural, or perineural spaces. Spinal arachnoid cysts develop as accumulations of cerebrospinal fluid within an extradural or intradural diverticulum/cavitation of the arachnoid membranes (Fig. 1). A concise categorization of spinal meningeal or arachnoid cysts in humans has been established by Nabors et al. [22], in which three types are identified by operative and light microscopic examination. Type I cysts are extradural without involvement of spinal nerve root fiber; Type II cysts are extradural cysts with spinal nerve root fiber involvement; and Type III are intradural cysts.

However, Qi J et al. [26] advocated another classification strategy. This strategy fills a critical need for an improved classification of spinal arachnoid cyst patients, and potentially improve treatment selection and overall

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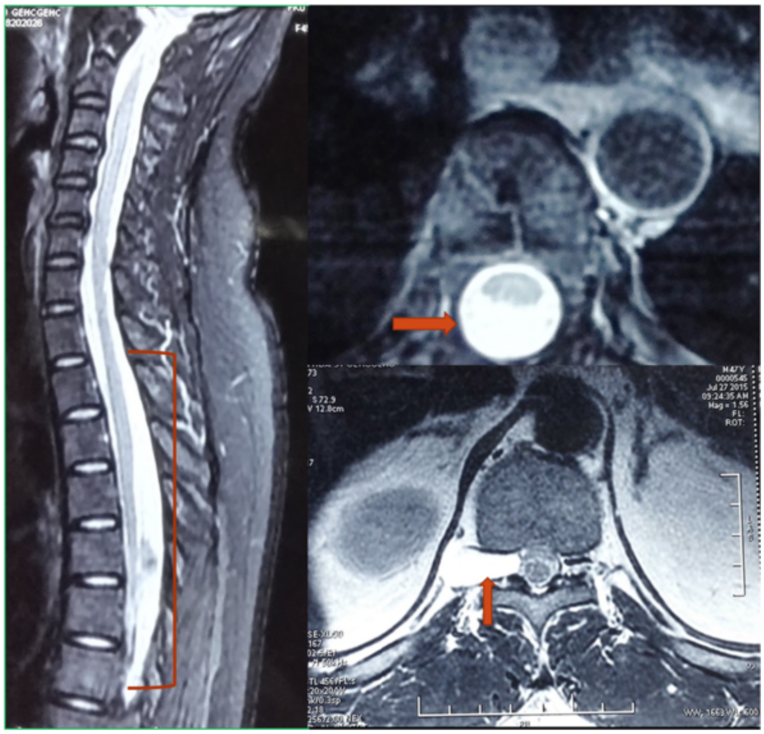

Fig. 1 A giant extradural and intradural arachnoid cyst occupied more than six segments intracanal (Left image, shown by right square bracket). Two axial magnetic resonance images (MRI) scan showed the arachnoid cyst located at intradural (Right upper image, showed by arrow) and extradural (Right bottom image, showed by arrow)

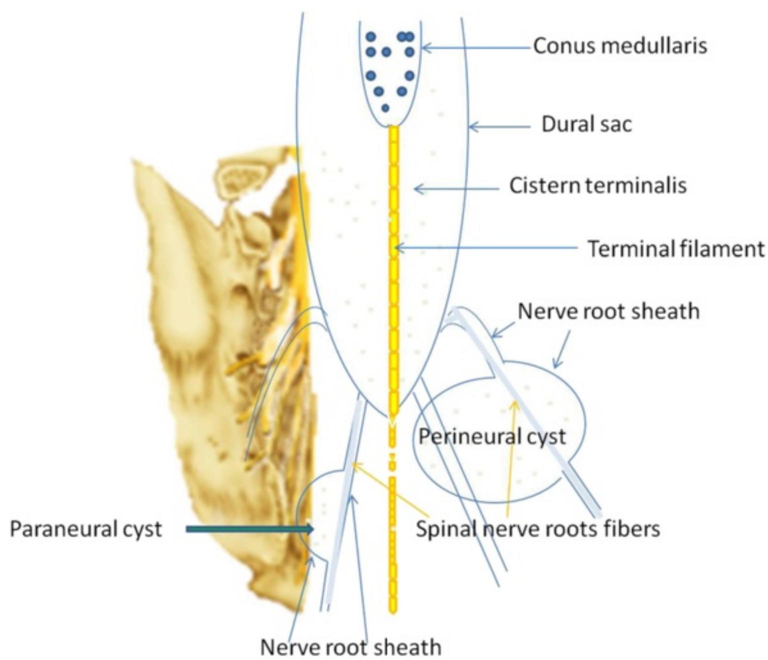

Fig. 2 Two types of sacral extradural spinal meningeal cysts with spinal nerve root fibers

prognosis. Spinal arachnoid cysts are subdivided into five types: 1) intramedullary cysts/syrinxes, 2) subdural extramedullary, 3) subdural/epidural, 4) intraspinal epidural, and 5) intraspinal/extraspinal. Intraspinal epidural spinal arachnoid cysts are more common than other cyst types, followed by subdural extramedullary and intramedullary cysts/syrinxes. Notably, conventional systems of classification fail to consider intraspinal epidural spinal arachnoid cysts as a distinct type given it only uses anatomical location for diagnosis. Cysts could also be classified according to their etiology. However, such classifications need to be validated, because cysts at different locations could share the same etiology cause, and the same kind of cysts could be initiated by different factors of etiology. Nevertheless, the predilection sites vary with the types of cysts.

It is important to differentiate perineurial cysts, meningeal cysts, diverticula, and unusually long arachnoidal prolongations over nerve roots, in order to avoid unnecessary operations [30]. Perineurial cysts occur along the nerve roots, at or distal to the junction of the posterior root and the dorsal ganglion. They begin in the perineurial space between the endoneurium derived from the pia mater and the perineurium formed by the arachnoid mater. Unlike meningeal cysts, at least a part of the lining of perineurial cysts contain nerve fibres. The entire cyst may be surrounded by nerve tissue. These cysts are usually seen on the sacral nerve roots but they may occur at other levels. The diameter of the cysts can be around 3 cm, with severely compressing or invading nerve roots, or they may be small without clinical symptoms. They often occur with clusters (Figs. 2 and 3).

Sacral extradural spinal meningeal cysts are extradural meningeal cysts located in the sacral canal. According to the classification of sacral spinal canal cysts by Nabors MW et al. [22], sacral extradural spinal meningeal cysts are divided into two types: the ones with spinal nerve roots fibers and the ones without (Figs. 4, 5 and 6). Sacral extradural spinal meningeal cysts with Spinal nerve roots fibers, also called Tarlov cysts, are characterized by collections of cerebrospinal fluid (CSF) between the endoneurium and perineurium of the nerve root sheath near the dorsal root ganglion [28].

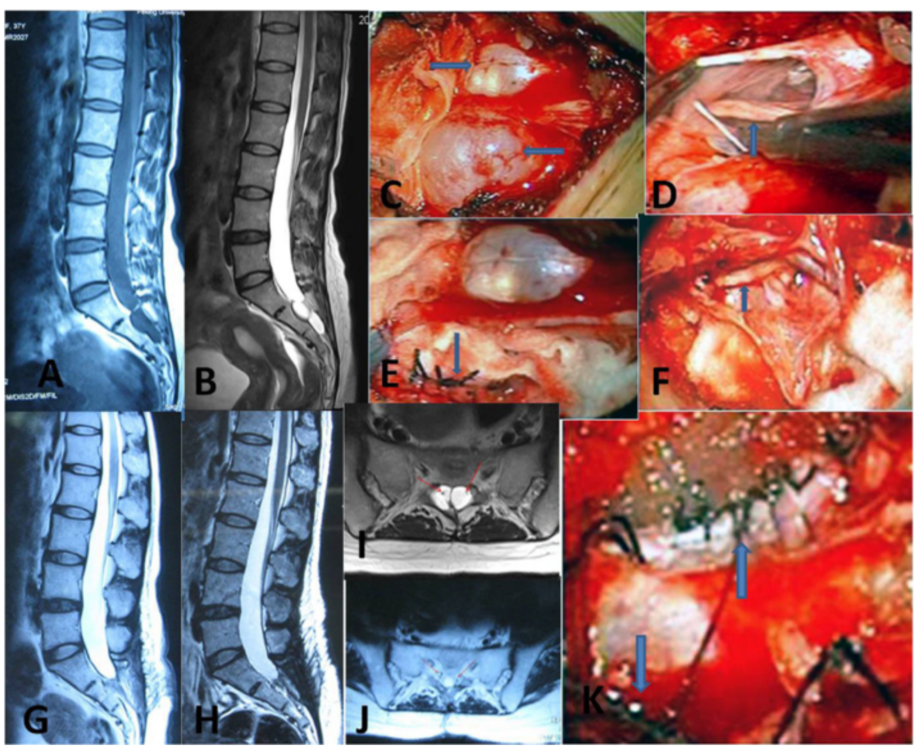

Fig. 3 A magnetic resonance imaging (MRI) scan showed multiple small cysts in sacral canal. The beadlike cysts showed very low signal intensity on T1-weighted images (**a**), and very high signal intensity on T2-weighted images (**b**). Two adjacent perineural cysts were showed on axial view (**i**, arrow showed the nerve root). Two cysts were found under microscope intraoperative (**c**, arrow showed the cysts). After opening the cysts, the nerve roots were found inside (**d** and **f**, arrow showed the nerve roots). Reconstructed nerve sheaths were performed (**e** and **k**, arrow showed the reconstructed nerve sheaths). Two weeks after surgical intervention, no residual cyst was observed in the sacral canal on T2-weighted images (**g**). Two reconstructed nerve sheaths showed on axial view (J, arrow showed the nerve root). One year later, no recurrent cyst was found on T2-weighted images (**h**)

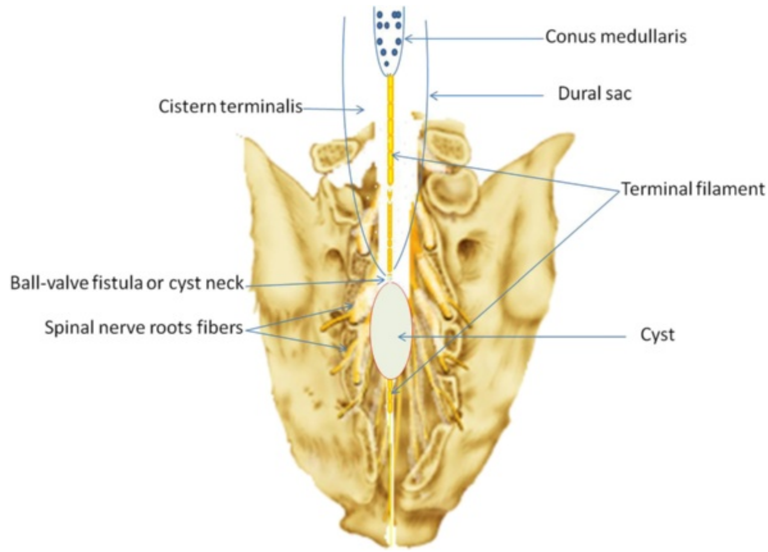

Fig. 4 Sacral extradural spinal meningeal cysts origin directly from extremity of terminal pool without spinal nerve roots fibers

According to their location, juxtafacet cysts can be classified into three groups, joint (facet) cyst, flavum cyst and posterior longitudinal ligament cyst. Their locations seem to be appropriate as an origin of the cysts. Regarding to the next step of histopathological classification, only two types are roughly considered, true cysts and pseudo cysts. A true cyst, so-called synovial cyst, has a synovial lining membrane. Based on this finding, a synovial cyst seems to be generated from synovium of facet. A pseudo cyst (ganglion) may also be generated from a synovial cyst after degeneration or destruction of synovial lining membrane ([24]; Fig. 7). In consequence, it is naturally to believe that flavum cysts and posterior longitudinal ligament cysts originated from degenerated ligamentum flavum and posterior longitudinal ligament, respectively are due to a chronic trauma, because: (1) a pseudo cyst was detected in almost all cases in which an amyloid deposit was found, and (2) a hemosiderin deposit was also detected in all the cases in which an amyloid deposit was found. Thus, it seems that amyloid is especially deposit in the course of the degeneration progress. In response to greater exercise loading and more advanced tissue degeneration, hemorrhagic episodes may occur in a repeated manner (hemosiderin deposits and intra-cystic haematoma), and also amyloid may deposit in the soft tissue [8].

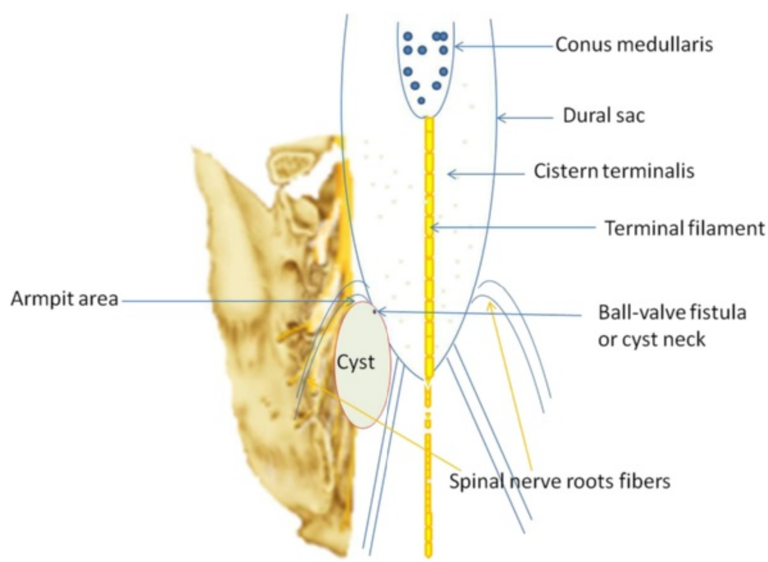

Fig. 5 Sacral extradural spinal meningeal cysts origin in the armpit of spinal nerve roots fibers

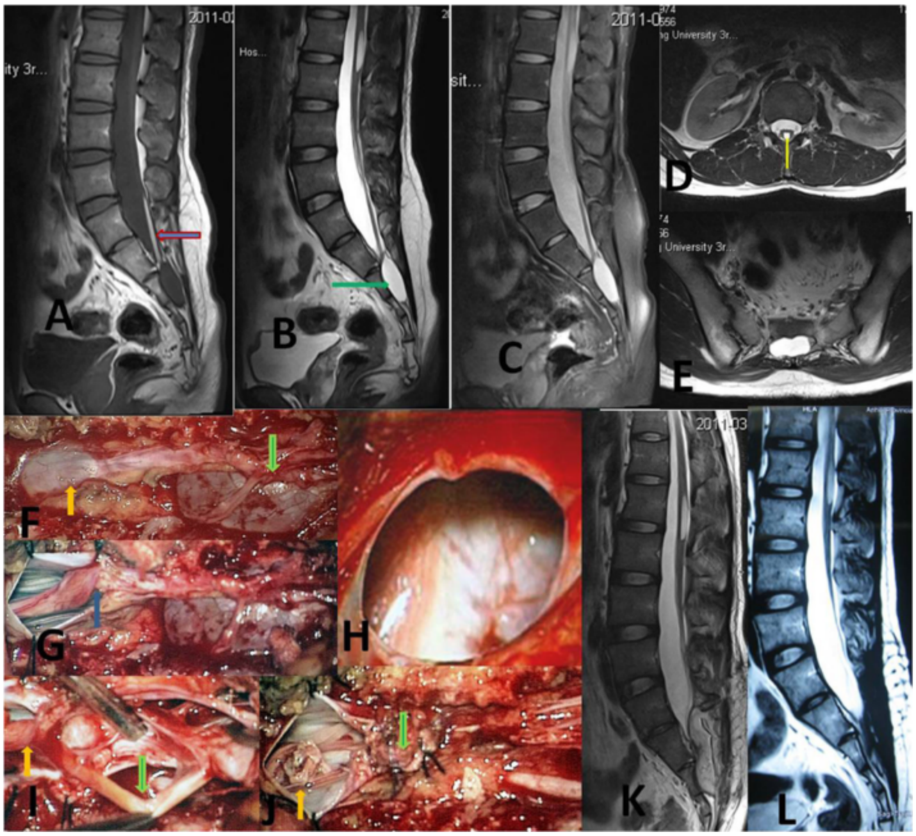

Fig. 6 A magnetic resonance imaging (MRI) scan showed single great cyst in sacral canal. The single cyst combined with tethered cord was showed on T1-weighted images (**a**, an arrow showed thickening inner terminal filament), and T2-weighted images (**b**, an arrow showed the high signal cyst). The inner terminal filament showed slight low signal intensity on T1 -weighted fat-suppression phase view (**c**). The thickening inner terminal filament showed high signal intensity on T2-weighted axial view (**d**, yellow arrow). Extending cyst without sacral nerve roots fibers was showed on T2-weighted axial view (**e**). Terminal thecal sac and cyst were shown under microscope intraoperative (**f**, yellow arrow showed terminal thecal sac and green arrow showed cyst). After the dura opening, the thickened inner terminal filament (**g**, arrow) was shown. The cyst was opened to confirm without nerve root inside (**h**). During dissection the distal cyst wall, inner (I, yellow arrow) and outer (green arrow) terminal filament were shown together. The neck of cyst was transfixed, ligated (**j**, green arrow) and untethering (yellow arrow) was also performed during the same procedure. No residual cyst was seen in the sacral canal two weeks after surgical intervention, as shown on T2-weighted images (**k**). No cyst recurrence was observed at one year follow up on MRI T2-weighted images (**l**)

Neurenteric cysts are uncommon lesions and represent approximately 0.5 % of spinal cord spaceoccupying lesions (Figs. 8). Bronchogenic cyst also represents a type of neurenteric cyst lined by respiratory epithelium. It demonstrated ciliated columnar cells, which is consistent with respiratory epithelium, and was therefore classified as a bronchogenic cyst. The dorsal location of this thoracic-level cyst differs from the several reports, which showed the typical location of solitary neurenteric cysts at the ventral cervical spine region [1].

In summary, the spinal canal cysts can be divided into spinal arachnoid cysts, spinal meningeal cysts, juxtafacet cysts, ligamentum flavum cysts and neurenteric cysts based on etiology or histopathology; and into extradural (include perineural cysts), subdural, intramedullary cysts or cervical, throracic, lumbar, and sacral cysts based on the location (Table 1).

Mechanism

Spinal arachnoid cysts are benign dilatations of the dorsal aspect of the subarachnoid space filled with cerebrospinal fluid. The etiology of spinal arachnoid cysts is complicated. Congenital, idiopathic, and acquired cases are secondary to bleeding, inflammation, infections, or puncture-related traumas [26]. It is documented that congenital asymptomatic cysts could enlarge due to trauma and become symptomatic. Increasing intra-abdominal and intra-thoracic pressure may lead to size change of the spinal arachnoid cysts [11]. Arachnoid cysts in humans may develop secondary to the congenital diverticula of the meninges, traumatic herniation of the arachnoid membranes through the dura mater, chronic arachnoiditis, or abnormal arachnoid membrane proliferation, creating a one-way valve between the subarachnoid space and the cyst and resulting in aberrant

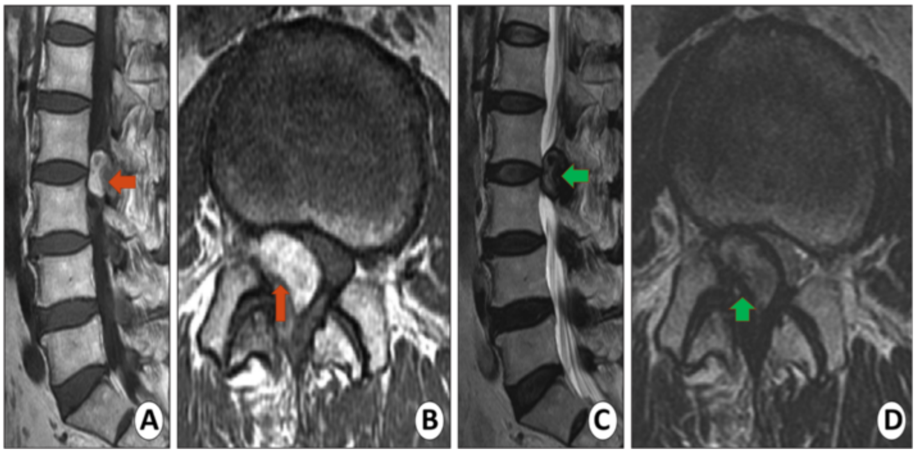

Fig. 7 A cystic mass mixture with hemorrhage was shown in four images in the right L2-L3 facet joint with arthritis compressing the L3 right root and the dural sac. A sagittal (**a**, red arrow) and an axial (**b**, red arrow) T1-weighted image showed a hyper-signal mixture with equisignal cystic mass. A sagittal (**c**, green arrow) and an axial (**d**, green arrow) T2-weighted image showed a hypo-signal mixture with equisignal cystic mass

CSF accumulation within the cystic cavity. Thus, it is unlikely that a single etiology can induce spinal arachnoid cysts [12].

Upright walking is a uniquely human behavior, and is the foundation of human civilization. The hydrostatic pressure of cistern terminalis and the terminal thecal sac during standing is higher than that of the other positions. Some individuals may have congenital weakness of the dural diverticulum or nerve sheath. Similar to hemodynamic mechanism of aneurysms formation, years of hydrostatic pressure may cause the weak wall to gradually expand outwards into the spinal canal space. Upright walking therefore underlies the formation of arachnoid cysts. The CSF enters cysts with systolic pulsation when standing and walking, but unable to exit through the same portal during diastole or motionless activity. A one-way-valve effect of the cyst neck results in a gradual increase in the size of the cyst [28].

Asamoto S et al. [2] also considered the formation of the primary extradural arachnoid cyst results from check-valve (one-way-valve) mechanism. Because pressure within the cyst is greater than that in the subarachnoid space, contrast medium does not flow easily into the cyst. The check-valve mechanism is

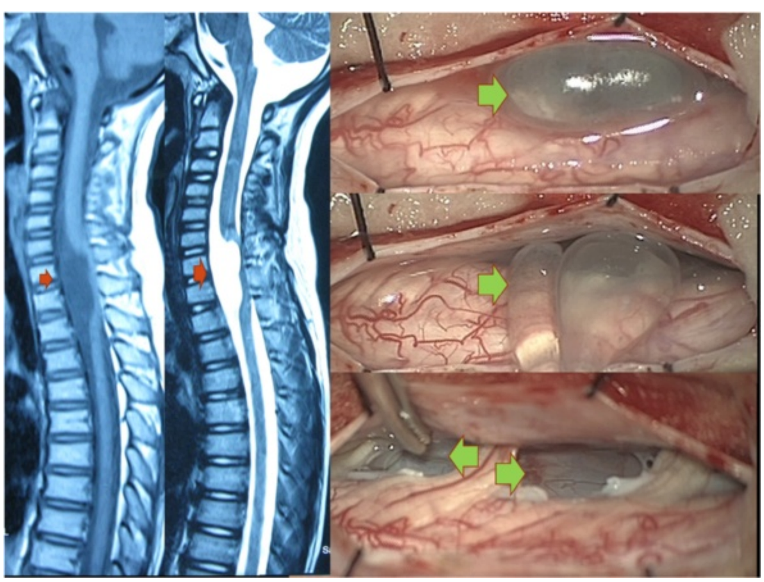

Fig. 8 A typical solitary neurenteric cyst located at the ventral cervical spine region (showed on left T1-weighted and T2-weighted images, red arrow). The process of neurenteric cyst being removed was shown under microscope intraoperative (showed on right intraoperative images, green arrow)

Table 1 The classification of the spinal canal cysts by different authors in literatures

Author	Year	Journal	Classification of the cyst	Number of cases	Special point
Hamamcioglu MK	2006	Eur Spine J	arachnoid cyst	1	intradural and extradural
Nabors MW	1988	J Neurosurg	spinal meningeal cysts	22	extradural cysts without spinal nerve root fibers (Type I) and with spinal nerve root fibers (Type II); and spinal intradural meningeal cysts(Type III)
Qi J	2014	Neuropsychiatric Disease and Treatment	Spinal arachnoid cysts	81	Five types
Sun JJ	2013	Plos One	Sacral extradural meningeal cysts	56	those with spinal nerve roots fibers and those without
Christophis P	2007	European Spine Journal	juxtafacet cysts	53	synovial cyst and ganglion cyst
Chan AP	2010	J Orthop Surg Res	ligamentum flavum cysts	3	embedded in the inner surface of ligamentum flavum
Arnold PM	2009	J Spinal Cord Med	Neurenteric cysts	1	Bronchogenic cysts are a type of neurenteric cyst

responsible for the one-way flow of CSF from the caudal sac to the cyst.

Pathogenesis of the discal cysts may be explained on the basis of more acute and more stressful mechanical loads, which result in more acute formation of the disc herniation, followed by acute degeneration with formation of reactive pseudomembrane. In addition, the theory that discal cyst formation is secondary to epidural hematoma and develops from hemorrhage of the epidural venous plexus, supports the role of the acute mechanical impact in the pathogenesis of discal cysts [3]. This explains the similarity of age group of the patients reported with discal cysts and synovial cysts, as these patients mostly are active and in their mid-age. Pathologically, a discal cyst consists of a fibrous tissue capsule and some myxoid degeneration [32].

The etiology of spinal lumbar synovial cysts is still unclear, but underlying spinal instability, facet joint arthropathy and degenerative spondylolisthesis have a strong association with worsening symptoms and formation of spinal cysts [3, 15]. Synovial cysts occur most frequently at the level of greatest motion and prevalence of degenerative changes, L4-5, followed by L5-S1 and L3-4 [31]. Several factors focused on possible pathophysiologic mechanisms. First, synovial cysts may grow due to the motion resulting in a mass effect over time. Secondary changes of the cyst, such as intra-cystic hematoma after trauma, presence of a calcified cystic wall, or an inflammatory response can induce neurologic changes. Third, regardless of changes in cyst size, patients with degenerative static synovial cysts may undergo direct trauma or hyperextension resulting in spinal cord or nerve root damage [16].

On the other hand, ganglion cysts are believed to originate from mucinous degeneration within periarticular dense fibrous connective tissue [7]. Ligamentum flavum cyst represent a unique entity being embedded in the inner surface of ligamentum flavum with no epithelial lining and no association with spinal facets. The ligamentum flavum cyst is regarded to be associated with microtrauma due to increased motion at a particular

Table 2 The mechanism of the spinal canal cysts by different authors

Author	Year	Journal	Main mechanism of the cyst	Number of cases	Special point
Maiuri F	2006	J Neurol Neurosurg Psychiatry	Valve mechanism	1	arachnoid cyst
Tarlov IM	1970	Journal of Neurology, Neurosurgery & Psychiatry	Pulsatile hydrostatic pressure	7	Perineurial cysts
Sun JJ	2013	Plos One	Upright walking	56	congenital weakness
Kim DS	2014	Journal of Korean Neurosurgical Society	direct trauma or hyperextension resulting in spinal cord or nerve root damage	1	synovial cysts
Chan AP	2010	J Orthop Surg Res	microtrauma due to increased motion at a particular motion segment or segmental instability	3	ligamentum flavum cysts
Asamoto S e	2013	Acta Neurochirurgica	check-valve mechanism	10	sacral meningeal cysts
Aydin S	2010	European Spine Journal	acute degeneration with formation of reactive pseudomembrane	5	discal cysts
Arnold PM	2009	J Spinal Cord Med	developmental abnormalities of central nervous system	1	Neurenteric cysts

Table 3 Surgical treatments for different spinal canal cysts

Author	Year	Journal	Surgical treatments for the cyst	Number of cases	Classification of cyst
Manzo G	2013	The Neuroradiology Journal	resection	1	Epidermoid Cyst
Qi J	2014	Neuropsychiatric Disease and Treatment	Combined surgical resection and overlapping or tight suturing, and ligation of the cervix	81	Spinal arachnoid cysts
Tarlov IM	1970	Journal of Neurology, Neurosurgery & Psychiatry	Complete excision	7	Perineurial cysts
Sun JJ	2013	Plos One	Oversewn to reconstruct the nerve root sheath or transfixed, ligated and the remaining cyst wall	56	Sacral extradural spinal meningeal cysts
Christophis P	2007	European Spine Journal	gross-total cyst removal	53	juxtafacet cysts
Kahraman S	2008	J Spinal Cord Med	radical cyst removal and dura cleft repair	1	Extradural Giant Multiloculated Arachnoid Cyst
Petridis AK	2010	European Spine Journal	interlaminar approach and surgical decompression and fenestration	1	Intradural spinal arachnoid cysts
Chynn KY	1967	American Journal of Roentgenology	posterior spinal fusion for longest laminectomy	2	spinal extradural cyst
Lee HJ	2013	Korean J Spine	minimal skipped hemilaminectomy	1	Large thoracolumbar extradural arachnoid cyst
Neulen A	2011	Acta Neurochirurgica	Microsurgical fenestration	13	Sacral perineural cysts
Aydin S	2010	European Spine Journal	partial hemilaminectomy and microscopic resection	5	discal cysts
Kim J	2009	European Spine Journal	percutaneous working channel endoscope	2	discal cyst
Trummer M	2001	J Neurol Neurosurg Psychiatry	surgical excision	19	synovial cysts
Shi W	2010	Skull Base	Microsurgical Excision	1	Neurenteric Cysts

motion segment or segmental instability and local stress associated with degeneration at the level of occurrence. It's noted that patients with ligamentum flavum cysts have co-existence of facet joint degeneration, and incidence of degenerative spondylolisthesis at a range of 42 % and 65 % [5, 6]. Pathologic ligamentum flavum cysts contain hemorrhage. The previous degeneration of the ligament may create conditions for the formation of hematoma. Rupture of vessels in degenerated lumbar ligamentum flavum may develop secondary to stretching forces on the back. The pathogenesis of the hematoma originates from the minor acute or chronic trauma such as minor back injury, physical exertion or heavy lifting. Taha et al. [29] considered that continuous stress to the ligamentum flavum due to minor chronic trauma such as listhesis may predispose to the formation of the cyst.

Bronchogenic cysts are developmental abnormalities that may affect the central nervous system. The cyst is therefore a remnant of the foregut, so it can differentiate into tissues of the gut or any of the endodermal derivatives. Vertebral anomalies, more commonly seen at the lumbosacral level, are often associated with the split notochord syndrome. Bronchogenic cysts grow slowly owing to tight junctions between epithelial cells, limiting expansion of the cyst [1].

In summary: the etiological, pathological mechanisms of spinal canal cysts are different and complex; spinal canal cysts may be associated with congenital weakness, check-valve mechanism, pulsatile hydrostatic pressure, upright walking, direct or micro trauma, acute degeneration or developmental abnormalities, etc (Table 2).

Surgical treatments

Up to now, there are many methods for these different spinal canal cysts. Same operation method may be used for different kind of cysts (Table 3). On the other hand, several operation methods may be utilized in the same cyst according to the location or style. However, same principle should be obeyed in the surgical treatment for different spinal canal cysts. Open surgery is melely for the symptomatic cyst. When progressive neurological defect findings exist, surgical treatment is warranted.

Optimal treatments for intraspinal cysts remain controversial. Conservative treatment consists of bed rest, analgesics plus anti-inflammatory drugs, physical therapy, bracing, transcutaneous electrical stimulation, epidural or intra-articular steroid injections [14].

We explained different surgical methods for different spinal canal cysts. The surgical approach should be tailored to the individual patient [4].

Surgical techniques include resection, fenestration, fixation, or placement of a cyst-to- subarachnoid shunt, as well as some less invasive techniques, which have been proposed recently, such as microsurgery, endoscope and CT-guided aspiration. The aim of surgical treatment should be neural decompression and prevention of refilling of the cyst, which means complete resection of the cyst and closure of the communication between cyst and subarachnoid space. Surgical treatment of spinal arachnoid cysts should not only provide neural decompression but also prevent cyst refilling. Simple aspiration or shunting is inadequate and not recommended. Radical cyst removal and dura cleft repair should be the choice of the treatment. Formation of a postoperative CSF fistula may require external lumbar drainage [13].

Dr. Qi J et al. [26] propose better choice for individual operation method should be based on five-category classification. For intramedullary cyst, partial cyst wall should be removed and residue cyst wall should be sutured to the pia mater and ensured the connection of the cyst cavity and the subarachnoid space to prevent the recurrence of the cyst. (2) For subdural extramedullary spinal arachnoid cysts, the endorrhachis should be excised carefully assisted with endoscopy to avoid injuries to the spinal cord. The adhesive arachnoid between the spinal cord and the adjacent endorrhachis was separated carefully and removed as much as possible to release the spinal cord. (3) For subdural/epidural cysts, the cyst should be separated from the neck of the cyst, and then tight suturing should be performed after resection of the cyst. (4) For intraspinal epidural cysts, ligation of the cervix should be performed, and the muscle mass should be isolated and summed in the access hole. (5) For intraspinal and extraspinal cysts, the cyst should be removed through enlarged intervertebral foramina.

Petridis AK et al. [25] discuss the approaches in resection of the spinal canal cyst and postoperative instability. The cyst removal is performed through a laminectomy or hemilaminectomy for dorsal cysts. If these cysts lie ventrally a fenestration through a posterolateral laminectomy can be performed. If, however, the cysts are many and expand through many vertebras, it should be taken into consideration that laminectomies in many segments would negatively influence the spinal column stability [12]. Chynn K et al. [9] consider that large lesions extending over five or more vertebral segments require extensive laminectomy particularly in the cervical and thoracic region and might result in anterior subluxation or kyphosis of the spine. To obviate these postoperative changes, the length of laminectomy should be kept at a minimum. It may not be necessary to remove the laminae until the upper and lower end of the cyst is exposed. The loose fibrous strands attached to the dura can be dissected free and the end withdrawn beneath a lamina. In this manner one or two laminae may be saved. With extensive bone removal, a posterior spinal fusion should be included in the operation, or a secondary fusion procedure may be required. A hyperextension brace is recommended after removal of large thoracic extradural cysts in adolescents. If changes of epiphysitis are present in the thoracic vertebra, the brace should be worn until spinal lesions are healed or the vertebral body growth is complete. Lee HJ et al. [19] suggest that the minimal skipped hemilaminectomy could be used as a feasible technique for the treatment of large Spinal extradural arachnoid cysts, removing the cyst wall as much as possible and preventing the postoperative instability.

In Sun JJ's [28] opinion, in order to prevent patients from lifelong nerve dysfunction, early surgical intervention should be performed for symptomatic Sacral extradural spinal meningeal cysts. It is advocated that redundant cyst walls should be resected, communicating fistulae overlap sewn to prevent cysts recurrence, and sacrificing the entire nerve root should be avoided. Based on this principle, the redundant cyst wall should be removed if the Sacral extradural spinal meningeal cysts are identified with Spinal nerve roots fibers, and the communicating fistulae should be oversewn to prevent leakage of CSF from the subarachnoid space and to reconstruct the nerve root sheath. If the Sacral extradural spinal meningeal cysts are identified as those without Spinal nerve roots fibers originating in the armpit of

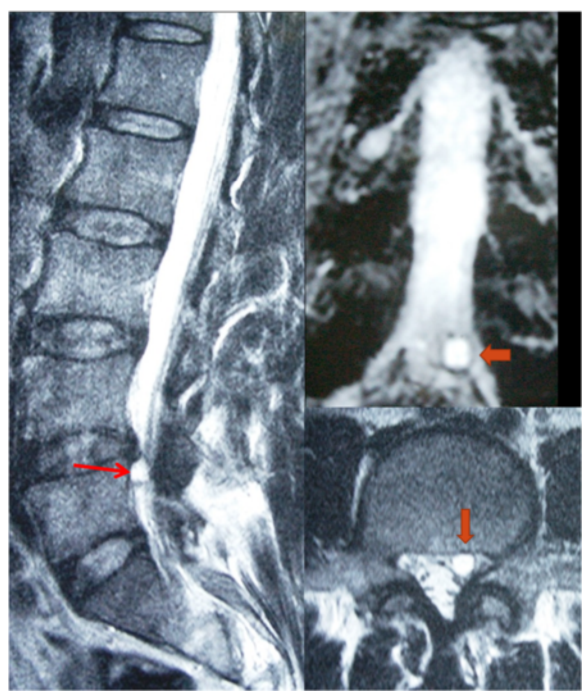

Fig. 9 A small round discal cyst located at the right L4-L5 intervertebral disc level (showed by sagittal, coronary and axial images, red arrows)

sacral nerve root fibers or the extremity of terminal pool, the fistulae neck of cyst should be transfixed, ligated and the remaining cyst wall should be excised distal to the ligation. However, Neulen A et al. [23] considered that microsurgical fenestration between perineural cysts and the thecal sac was a safe surgical approach in the treatment of symptomatic cysts.

Surgical techniques in the treatment of discal cysts include CT-guided aspiration of the cyst contents, and microsurgical and endoscopic resection of the cyst ([17]; Fig. 9). Aydin S et al. [3] advotes that discal cysts managed by partial hemilaminectomy and microscopic resection of the cyst (69.6 %). Microscopic resection of the cyst is a favorable treatment method, as it is a simple technique, with no reported related morbidity or mortality, good clinical results, and low rate of cyst recurrence. On the other hand, Kim J [18] consider a minimally invasive percutaneous endoscopic procedure for the treatment of the discal cyst. The success rate of percutaneous endoscopic procedures for lumbar disc herniation was also comparable to that of open surgery with the aid of specialized instruments. Aydin S et al. [3] also summarized that only CT guided aspiration of the discal cyst contents maybe effective in the treatment of these lesions; however, the high recurrence rate may support the need for more radical resection of the cyst.

If neurological deficits are caused by synovial cysts, surgical excision is recommended [31]. Epstein NE et al. [10] advocate that operating microscope is extremely helpful in avoiding cerebrospinal fluid fistulas during decompression and removal of synovial cysts as these fistulas are more likely to arise secondary to dense adhesions between the cyst capsule and underlying dura/nerve roots.

Surgical resection is the first-line treatment for neurenteric cysts with the goal of gross total resection. Shi W et al. [27] advise that the first choice of surgical treatment for neurenteric cyst is the early complete resection with preservation of functional neural tissue of the brain stem and spinal cord. The incomplete resection of neurenteric cysts may be associated with postoperative malignant transformation or widespread cranial-spinal dissemination.

Intraoperative somatosensory evoked potential monitoring, electromyographic monitoring, and sphincter monitoring are also useful intraoperative approach. In particular, monitoring these potentials alerts the surgeon to inadvertent, excessive traction that may occur during dissection/manipulation of the cysts, in order to keep away from the underlying thecal sac and/or nerve roots, thereby avoiding permanent injury (e.g. cauda equina syndrome, root and sphincteric deficits).

In order to prevent from postoperative complications, some intraoperative measures should be performed . It is emphasized that postoperative CSF leakage and cyst recurrence should be avoided by careful microscopic surgical techniques. All communicating fistulas should be identified and transfixed by ligation or oversewn, and a Valsalva maneuver should be performed to ensure that there is no residual leakage. Even with appropriate operative techniques, residual small cysts cannot be completely avoided. Further research is required to develop surgical techniques and improve treatment. Resection of giant cysts that have developed over a long period of time results in a giant cavity in the sacral canal. As the relatively weak sacrococcygeal muscles and soft tissues cannot effectively fill this cavity, pseudomeningocoele in the canal cavity after surgical intervention is unavoidable. To reduce this effusion in the canal cavity, it is necessary to stay prone in the bed for several days. There is less fluid exudation if the hydrostatic pressure in the cisterna terminalis is kept stable with this positioning. We also used moderate sacral wound compression with a 1 kg clean sandbag, and this resulted in less pseudomeningocoele [28].

Conclusion

Spinal canal cysts seem like featherweight, which never result in paralysis and other life-threatening adverse outcomes. There are a great variety of cyst names, diverse classification, diverse mechanism reviewed extensively in the literature. It seems a mission impossible when trying to summarize an overwhelming and creditable classification standard, mechanism theory as well as simple, uniform and easy-to-promote surgical method for all kinds of spinal canal cysts. In order to summary a special classification standard and mechanism theory as well as uniform surgical method, all of the following should be given overall consideration in future clinical studies, such as stability of vertebral column, approaches, recurrence of cysts, the relationship between spinal cord and nerve roots as well as adjacent structures. In future, different spinal canal cysts require easy and uniform treatments with satisfied outcome.

Competing interests

The authors declare that they have no any competing interests.

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