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HOW I DO IT - SPINE - OTHER

Midline sacral meningeal cyst decompression and repair

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Abstract

Background Symptomatic midline sacral meningeal cysts (MSMC) are rare, and, as a consequence, so are reports on the surgical techniques to address these lesions. Here we provide a description of the senior author's (ATC) technique.

Method A sacral laminectomy is performed. The cyst's relation with the dural sac and sacral nerves is inspected; it is then opened and drained. Its lumen is explored for its point of communication with the dural sac, and this ostium is closed off with non-penetrating clips. A lumbar drain is inserted in select cases.

Conclusion Cyst wall resection is unnecessary and closing the ostium is sufficient to treat MSMC.

Keywords Sacrum; Meningeal cyst; Meningeal diverticulum; Meningocele; Surgical technique

Abbreviations

CSF	Cerebrospinal fluid
LD	Lumbar drain
MSMC	Midline sacral meningeal cyst
MRI	Magnetic resonance imaging

Relevant surgical anatomy

The sacrum constitutes a fused block of five vertebrae. In the anteroposterior view, it resembles a triangle with its apex pointing inferiorly. In the sagittal view, it is curved, with a convex dorsum. From midline to lateral, the fused posterior elements of the sacral vertebrae form the median sacral crest (fused rudimentary spinous processes), the sacral grooves (fused laminae), the intermediate sacral crests (fused articular processes) and the lateral sacral crests (fused transverse processes). The four pairs of posterior sacral neuroforamina lie just lateral to the intermediate sacral crests. Cranially, the intermediate sacral crests lead to the superior articular processes of S1, which articulate with the L5 vertebra, and caudally to the inferior articular processes of S5, palpable prominences on either side of the sacral hiatus also called the sacral cornua. The median sacral crest and sacral grooves are absent beyond the inferior portion of S4 and so form the sacral hiatus [1]. However, variations are not infrequent, and the hiatal apex can extend as high up as S2 [6]. Also, the presence of transitional vertebrae may be associated with a persistent S1/S2 interlaminar space.

The space located between the intermediate crests, capped by the fused laminae, constitutes the sacral spinal canal. It contains the caudal end of the dural sac—which usually terminates at the level of S2—five pairs of sacral and one pair of coccygeal nerve roots, epidural adipose tissue, a rich epidural venous plexus that is mostly ventrally situated and the filum terminale [7].

Midline sacral meningeal cysts (MSMC) are also referred to in the literature as sacral meningeal diverticula or sacral meningoceles. They are often confused with sacral perineurial cysts—also called Tarlov cysts—due to their sacral localisation, their cerebrospinal fluid (CSF) content and their tendency for bony erosion (Fig. 1). They are however distinct patho-anatomical entities [5, 8]. Whilst both are extradural cysts, in contrast to Tarlov cysts, MSMC do not incorporate nerve root fibres within their cyst wall or within their lumen (Fig. 1b; Fig. 2), which is at the base of their classification into type II and type Ib spinal meningeal cysts, respectively [5]. MSMC have fibrous walls (dural diverticula) with a pedicle leading to the terminal dural sac (Fig. 2; Fig. 3). The aim of surgery is to identify and close this communication [5].

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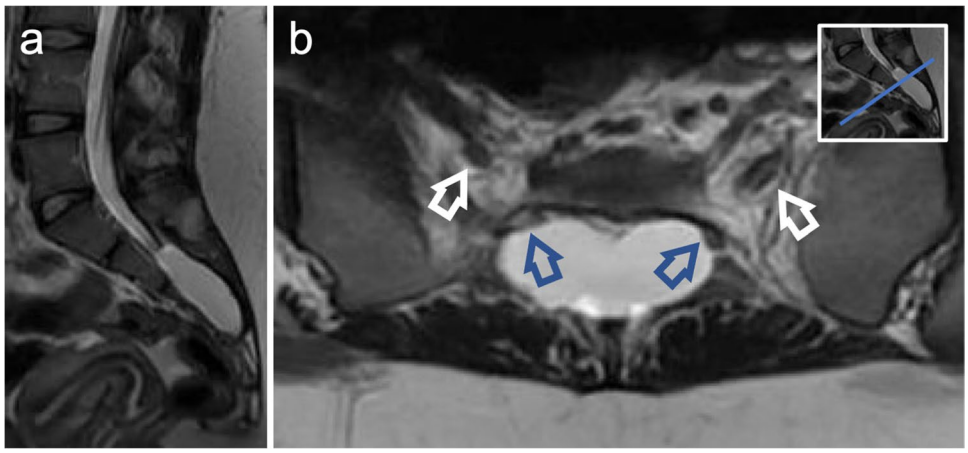

Fig. 1 **a** Sagittal T2-weighted lumbosacral MRI slice demonstrating a midline sacral meningeal cyst extending from mid S2 to the S4/S5 junction. **b** Axial slice from the same imaging study. The inset in the right upper corner indicates the level of the axial slice. The blue arrows indicate the S3 nerve roots pushed ventrally by the dorsally growing cyst, and the white arrows indicate the exited S2 nerve roots. Note the ventral and dorsal sacral bony erosion on both panels

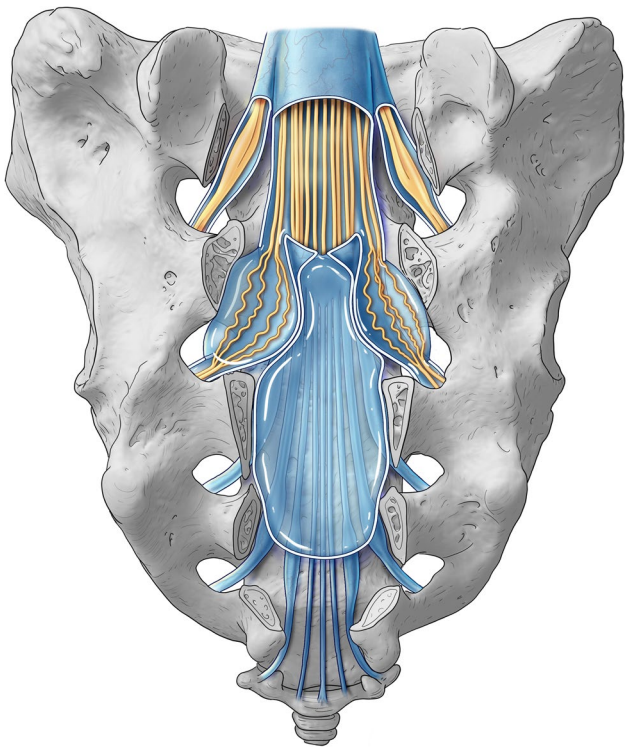

Fig. 2 Illustration demonstrating the patho-anatomical distinction between perineurial (Tarlov) and midline sacral meningeal cysts. A posterior view of the sacrum is shown, following complete laminectomies, with sections of dura removed to provide a window view within. The depicted S1 nerve roots exemplify normal anatomy. The S2 nerve roots are affected by Tarlov cysts, which are perineurial space dilatations of the nerve root sheaths (i.e. between the endoneurium and perineurium). The nerve root fibres are either splayed out in the cyst's wall or run through the cyst's lumen. In comparison, a midline sacral meningeal cyst—seen here overlying the tip of the thecal sac, with its ostium located on the thecal sac's dorsal surface—does not contain nerve roots. This cyst type is a meningeal diverticulum and has a dural lining. Its trans-ostial communication with the subarachnoid space can cause it to progressively fill up with cerebrospinal fluid and build up pressure on the sacral nerves coursing around it

Description of the technique

After prone positioning, a fluoroscopy identifies the projection to the skin of the L5/S1 segment and of the level of the diverticulum's ostium. A midline incision is made, the thoracolumbar fascia is incised on either side of the midline and the underlying musculature is stripped laterally to expose the L5/S1 interlaminar space and the dorsal sacral surface (Fig. 4a). The L5/S1 midline ligamentous structures are resected, and a multilevel sacral laminectomy is performed by drilling cranio-caudally at the interface between the sacral groove and the intermediate crest, and transversally through the caudally exposed sacral grooves and median crest.

The exposed contents of the sacral canal are inspected. The cyst's relation to the dural sac and nerve roots is explored (Fig. 4b). MSMC can either grow dorsally to the sacral nerve roots (Fig. 1; Fig. 4b) or ventrally to them, in which case the nerve roots are displaced dorsally and may need to be dissected off the cyst's dome. The cyst is incised and its lumen is explored for its communication with the terminal dural sac (Fig. 4c). The ostium may not be readily identifiable. This may be due to complex septations within the pedicle leading to the dural sac (Fig. 3; Fig. 4c–f). A Valsalva manoeuvre may help to identify the location of the ostium, as it begins to pearl with CSF. It may also present with vessels passing through it and leading to the cyst wall (Fig. 4c) [5]. An intraoperative fluoroscopy is useful to confirm the level of interest identified on preoperative MRI.

If the ostium is evident, it can simply be closed off. For this, we use non-penetrating clips (AnastoClip®; LeMaitre Vascular, Inc., Burlington, MA, USA). If the ostium is not evident, it may be necessary to open its septations and search for the communication with the subarachnoid space (Fig. 4d–f), before closing it off (Fig. 4g). A lumbar drain (LD) is advised in cases of significant leakage of

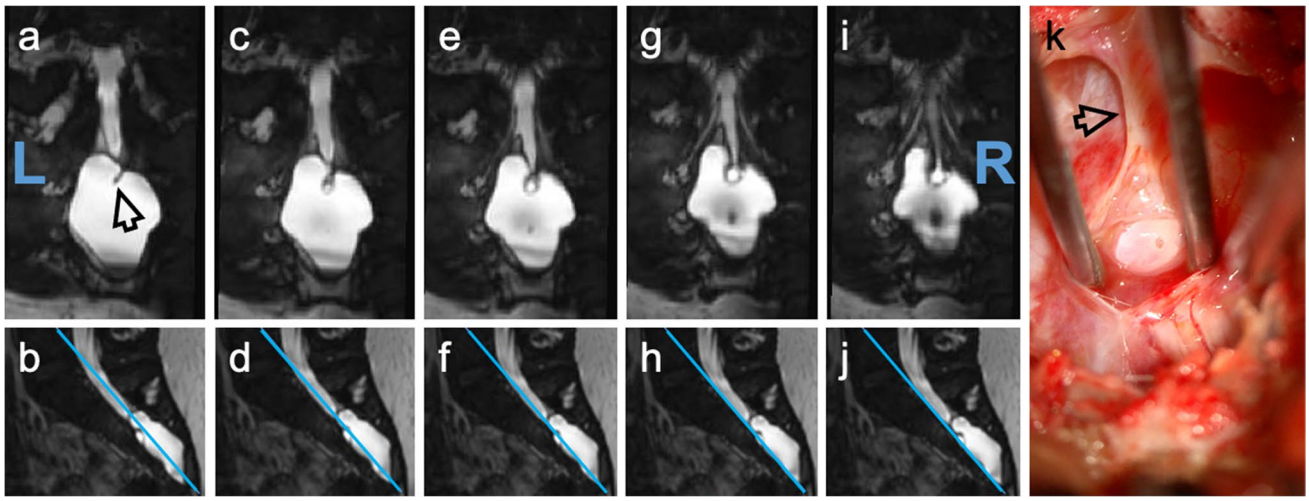

Fig. 3 **a**–**j** High-resolution T2-weighted sacral MRI in patient from Fig. 1. **a**, **c**, **e**, **g**, **i** Oblique coronal slices through the midline sacral meningeal cyst (MSMC) and **b**, **d**, **f**, **h**, **j** sagittal slice through the midline, with blue line indicating the level of each oblique slice above it. The laterality of the oblique slices has been inversed to match the intraoperative view (**k**) so that the left side of each panel corresponds to the patient's left (L: left; R: right). **k** The intraoperative view is within the MSMC's lumen, looking at the region of its ostium. The tip of the dural sac communicates with the MSMC through a pedicle with complex septations: A fold in the MSMC's wall forms a septum (**a**, **k**; hollow arrowhead). Towards its base, the septum splits into two smaller septations, between which a small CSF-filled cyst is found. This small structure is in communication with the lumbosacral cistern (**g**, **i**). **k** It is seen between the two branches of the forceps. It has an arachnoid lining and is covered by a thin membrane, continuous with the thicker fibrous wall of the MSMC. This covering is only partial so that a portion of the small cyst's arachnoid lining effectively protrudes into the lumen of the MSMC, likely constituting a ball-and-valve mechanism that opens when the lumbar cistern's hydrostatic pressure is greater than that within the MSMC (e.g. when standing or straining). CSF can be seen pearling during the dissection of the thin membrane of the dome of the small cyst. **a**–**j** Note a sedimentation level, corresponding to haematic contamination from a CT-guided drainage performed 2 weeks earlier (see *Video legend* for patient history)

CSF and is inserted intraoperatively through the L5/S1 interlaminar window. Closure involves epidural layers of collagen-based dural regeneration matrix and fibrin sealant (Fig. 4h).

Indications

Invalidating symptoms attributable to MSMC that have failed conservative management and for which alternative causes have been explored.

Symptoms include lumbosacral pain, radicular pain, sensorimotor disturbance in the perineum and lower limbs, and uro-anal sphincter disturbance. Symptoms may worsen with standing or Valsalva manoeuvres [2, 4, 5, 8].

Limitations

In MSMC growing ventrally to the dural sac, the ostium will likely be in relation to the dural sac's ventral surface. It is therefore hidden from the surgical line of view and so requires the sac to be rotated to a degree [3].

How to avoid complications

Detailed study of preoperative imaging to avoid neural injury intraoperatively:

- Variation of bony anatomy (e.g. persistent S1/S2 interlaminar space, high apex of sacral hiatus);
- MSMC-induced thinning of dorsal sacral bone;
- Ventrally growing MSMC relative to the dural sac, causing dorsal displacement of nerve roots against the sacral laminae [3].

Copious disinfection due to incision's proximity with the gluteal region.

Drape wide in anticipation of an eventual LD (lateral exit point) so that it does not pass through the drapes during tunnelling, as this carries a risk of pull out during undraping.

Seeing that aggressive resection of the MSMC's walls is not necessary, the caudal extent of the skin incision and sacral laminectomy can be limited to exposing only the portion of the cyst harbouring the ostium.

Avoid passing the LD through the fascial incision, as it may get caught into the suture or interfere with

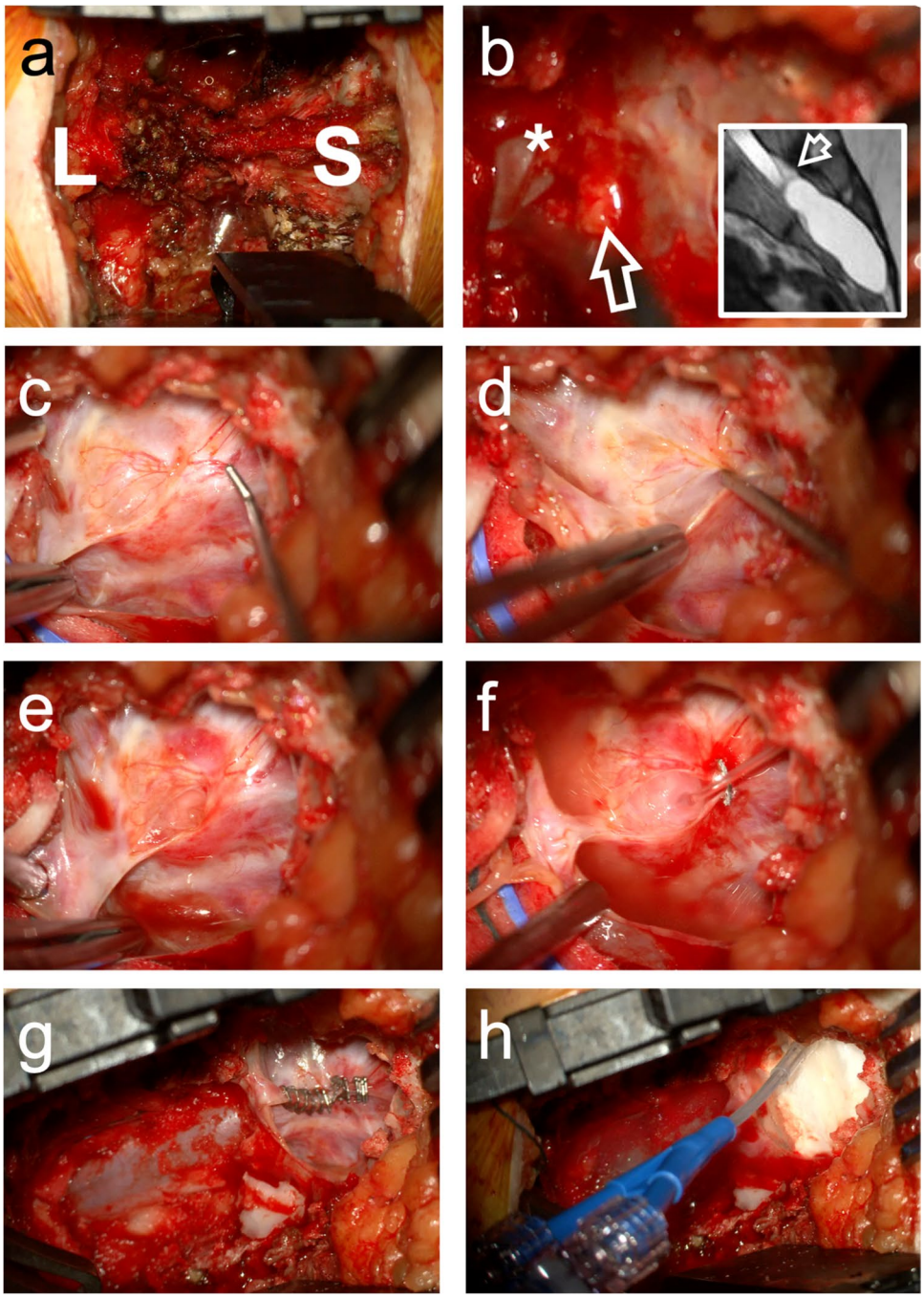

Fig. 4 Intraoperative views through the surgical microscope, in the patient from Figs. 1 and 3, following **a** a midline approach to the L5/S1 interlaminar window and dorsal sacrum (L, lumbar; S, sacrum; the patient's left is to the bottom of the panel) and **b** sacral laminectomy from S1 to S3. The asterisk indicates the dural sac. The hollow arrow indicates the epidural fat pad at the junction between the dural sac and the MSMC, seen on the sagittal 2-weighted MRI inset. **c**–**f** View within the cyst's lumen: **c** The ostium presents as a thinning in the MSMC's wall. Vessels are seen entering through it. **d** The ostium is widened with a blunt hook, **e** revealing a CSF-filled cyst in continuity with the lumbosacral cistern. The arachnoid lining of this small cyst is incised (**f**) and this opening is enlarged with a blunt hook allowing to bring down arachnoid septations within. This allows to incorporate the sheets of arachnoid into the ostial closure *along with* the opposing sheets of the diverticular wall. **g** For this, we use non-penetrating clips (AnastoClip®; LeMaitre Vascular, Inc., Burlington, MA, USA). **h** The dural repair is reinforced with alternately applied layers of collagen-based dural regeneration matrix (shown here, DuraGen®; Integra®, Plainsboro, NJ, USA) and fibrin sealant (Evicel®; Ethicon™, Somerville, NJ, USA)

adequate fascial closure. Instead, tunnel the LD at a distance from the fascial incision.

Watertight closure of fascia.

Specific information for the patient

If LD is inserted, 3–5 day flat bed rest before LD removal. Risk of cyst recurrence (dependent on the solidity of ostial closure).

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00701-021-04948-3.

Author contribution All authors contributed to the manuscript's conception and design. The first draft was written by Ivan Cabrilo and critically revised by all three authors. All authors read and approved the final manuscript.

Data availability Not applicable.

Declarations

Competing interests The authors declare no competing interests.

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Key points

- Although rare, the intracystic buildup of CSF within MSMC can cause symptomatic compression of the sacral nerve roots.
- MSMC are meningeal diverticula, connected to the tip of the dural sac through a pedicle that is thought to function as a ball-and-valve mechanism [5].
- Simple drainage is therefore usually associated with recurrence [2] and closure of the ostium is required.
- Closure of the ostium is usually sufficient to treat MSMC, and aggressive resection of the cyst's walls is not necessary.
- The incision and approach are therefore limited to exposing the portion of the cyst where the ostium is located.
- Careful muscle stripping and drilling, to avoid inadvertently breaking into thinned down or absent dorsal sacral bone.
- The ostium may not be apparent.
- Valsalva manoeuvres may help to locate the ostium.
- Complex septations may need to be taken down before the ostium can be closed off.
- Non-penetrating clips are used for closure, to avoid suturing needle puncture holes.