Synovial Cysts of the Lumbar Spine
—Pathological Considerations and Surgical Strategy—

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Abstract

Symptomatic lumbar synovial cysts (LSCs) are a rare cause of degenerative narrowing of the spinal canal, with thecal sac or nerve root compression. True synovial cysts have a thick wall lined by synovial cells, containing granulation tissue, numerous histiocytes, and giant cells. In contrast, pseudo-cysts lack specialized epithelium, have a collagenous capsule filled with myxoid material, and may be classified into ganglion cysts, originating from periarticular fibrous tissues, and ligamentous cysts, arising from the ligamentum flavum or even from the posterior longitudinal ligament. Here we present the surgical series of the Chair of Neurosurgery at the University of Cagliari (Italy) including a total of 17 LSCs. Surgical technique consisted of facet sparing excision of LSC, achieved by simple hemilaminectomy/laminectomy, and diagnosis was always confirmed by histological specimen examination, which detected the typical synovial epithelium, the intracystic presence of hemosiderin, histiocytes, and calcifications. Further immunohistochemical investigation revealed positive staining for cytokeratin: CK5, CK6, and AE1/AE3. Clinically, our cohort experienced rapid and complete resolution of symptoms, without perioperative complications, or recurrence of cysts or vertebral instability at a median follow up of 28 months, when the MacNab score was generally excellent. A review of the literature, retrieving articles published from 1973, collected a total of 101 articles concerning all the cases of LSC scientifically described to date. Both clinical and histological findings described in our study support the theory of degenerative microtraumatic pathogenesis of synovial cysts.

Key words: cyst excision, lumbar spinal stenosis, histology, immunohistochemistry, surgical management

Introduction

Synovial cysts, firstly described by Baker,⁵,⁶) originate as an excrescence of the zygapophyseal joint capsule,⁹) and may occur anywhere throughout the body articulations, but generally behave as benign lesions with limited clinical consequences.³⁶) Synovial cysts of the spine are relatively rare, and may occur in the cervical,²¹) thoracic,⁴) and lumbar spine, with the latter segment being the most common localization, accounting for 94%¹⁹) to 85%¹⁵) of the total reported cases. Most spinal synovial cysts occur at the L4-5 intervertebral level, and to a lesser extent at the L5-S1 and L3-4 intervertebral levels.¹³,²⁹,³⁴)

Lumbar synovial cysts (LSCs) typically arise from arthrotic overlying facet joints, and consist of a thick wall lined by synovial cells, containing granulation tissue, numerous histiocytes, and giant cells. In contrast, pseudo-cysts lack specialized epithelium, have a collagenous capsule filled with a myxoid material, and may be classified into ganglion cysts, originating from periarticular fibrous tissues, and ligamentous cysts, arising from the ligamentum flavum or even from the posterior longitudinal ligament.¹⁹)

Pathogenesis and biomechanical implications of LSCs are not well elucidated. Several studies have reported that LSCs may occur in association with trauma,³¹) rheumatoid arthritis,²⁹) and degenerative disorders of the spine in older individuals,¹³) contributing to attendant degenerative spondylolisthesis.³³) LSCs may project from the anterior or posterior aspect of the facet joints, protruding internal or external, respectively, to the spinal canal,¹⁹) and diameter may range between 3 to 30 mm.³⁵) Accordingly, some surveys on their prevalence, based on computed tomography (CT) or magnetic resonance (MR) imaging of the lumbar spine in a symptomatic population, revealed that LSCs are responsible for neurological complaints only in
0.5% to 2.3% of patients. Generally, those patients tend to be in their sixth decade of life, with a slight female predominance, and their clinical presentation may mimic that related to most other intracanal mass lesions, because symptomatic LSCs contribute to central and/or lateral recess stenosis with nerve root compression. The most common complaint is radiculopathy, followed by neurological claudication, and even cauda equina syndrome. To date, there is still a lack of widespread consensus over the best clinical management, since conservative, percutaneous, and surgical treatments are still controversial. Surgical results are generally reported in the form of small series or case reports, whereas larger clinical series of facet joint steroid injections generally report poor long-lasting benefits, despite early pain relief.

Here we describe the surgical series of the Chair of Neurosurgery at the University of Cagliari (Italy), and compare our results with those obtained from a review of the literature from 1973 up to the present.

Materials and Methods

Fifteen patients complaining about various signs and symptoms of neural compression into the lumbar canal or lateral recesses were referred to our department at the University of Cagliari for neurosurgical evaluation between 2000 and 2009. Radiography of the spine was the initial diagnostic study, and subsequent neuroimaging work up included MR imaging and/or CT. Clinical data from our cohort were retrospectively collected with particular regard for: duration of complaints, preoperative signs and symptoms, radiological and intraoperative findings (see Table 1 for a complete description of the surgical series).

Patients were considered for surgical treatment only after conservative therapy, consisting of rest, analgesic and anti-inflammatory drugs, and physiotherapy, had failed to provide a long-lasting resolution of sciatica. Patients experiencing only partial and limited in time (less than 2 months) resolution of symptoms were all reconsidered for surgical decompression later on. All patients finally advised to undergo surgical decompression signed an appropriate informed consent, and received the same antibiotic prophylaxis (one dose of third-generation cephalosporin 20 minutes prior to surgical incision). Surgical treatment consisted of excision of the LSC achieved via hemilaminectomy or laminectomy sparing the facet, with the former technique chosen in cases of unilateral symptoms or mild sensory deficits, and the latter in cases of bilateral symptoms or motor deficits. All procedures were conducted with a microsurgical technique. Fluoroscopy, despite routine setup, was used only in cases of facetectomy requiring subsequent posterior stabilization. The postoperative course of every patient was objectively assessed at discharge and at serial steps during follow up with clinical tools, such as physical examination and visual analogue scale (VAS) score, and radiologically, with radiography and MR imaging or CT. Finally, patients were objectively stratified for perception of clinical outcome.

Table 1 Clinical characteristics of the patients

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Sex</th>
<th>Age (yrs)</th>
<th>Signs and symptoms on admission</th>
<th>Surgical technique</th>
<th>VAS score</th>
<th>MacNab grade at follow up</th>
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<tr>
<td>1</td>
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<td>62</td>
<td>bil sensory</td>
<td>laminectomy</td>
<td>8</td>
<td>1</td>
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<td>hemilaminectomy</td>
<td>8</td>
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</tr>
<tr>
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<td>F</td>
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<td>9</td>
<td>2</td>
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<tr>
<td>4</td>
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<td>1</td>
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<tr>
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<td>F</td>
<td>58</td>
<td>unil normal</td>
<td>hemilaminectomy</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>F</td>
<td>74</td>
<td>unil sensory</td>
<td>hemilaminectomy</td>
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<td>1</td>
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<tr>
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<tr>
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<td>laminectomy</td>
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<td>2</td>
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<tr>
<td>11</td>
<td>M</td>
<td>58</td>
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<td>hemilaminectomy</td>
<td>8</td>
<td>1</td>
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<tr>
<td>12</td>
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<tr>
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<td>0</td>
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<td>76</td>
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<td>laminectomy</td>
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<td>15</td>
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<td>73</td>
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Fig. 1 Case 14 with right L5-S1 synovial cyst. Sagittal T2-weighted magnetic resonance image (A) showing a sharply defined round structure isodense with the cerebrospinal fluid. Sagittal (B), axial (C), and coronal (D) computed tomography scans revealing diffuse signs of spinal degeneration, and slight calcification of the cystic wall. The neuroimaging work up, confirming that the cyst arises from the facet joint, is consistent with the diagnosis of lumbar synovial cyst, and accurately describes the obstruction of the right lateral recess and contralateral displacement of the thecal sac.

Results

Our 15 patients, 8 women and 7 men aged from 57 to 76 years, underwent neurosurgical evaluation for radiculopathy non-responsive to analgesic or rest therapy, neurogenic claudication, or incomplete cauda equina syndrome in one case. Symptoms were unilateral in 11 patients and bilateral in 4, and onset ranged from 2 to 6 months prior to hospitalization, but all complaints were rapidly progressive. Patients shared a history of microtraumatic spinal insults and arthrosis; anamnesis was positive for recurrent low back pain, and none had any previous surgical intervention at the lumbar spine. Physical examination was normal in six patients, whereas dysesthesia or mild sensory deficits were present in eight, and motor deficits in four. Mean VAS score on admission was 8.1.

All patients underwent radiography of the lumbar spine, which showed moderate to severe degenerative changes, associated with spondylolisthesis in two cases, without evident spinal instability. Diagnoses of LSC were obtained based on MR imaging and/or CT (Fig. 1), showing 17 cysts (located at L4-5 in 12 cases, L3-4 in 3 cases, and L5-S1 in 2 cases); two patients presented contiguous cysts on adjacent spinal levels, but no cases of bilateral cysts were encountered (Table 2). No arthrography was performed in the neuroradiological workup. CT and MR imaging showed many LSCs as isodense or even hyperintense to the cerebrospinal fluid (CSF). Three patients showed intraarticular-intracystic gas or calcification of the capsule, and noteworthy evidence of cystic wall hemorrhage was detected in one patient with cauda equina syndrome.

Facet sparing excision of the LSC was achieved by simple laminectomy or hemilaminectomy (Fig. 2) in all patients but one, who was treated with extensive facetectomy and required additional posterior stabilization. Surgical excision was often associated with recalibration of the spinal canal and foraminotomy allowing for satisfying neural decompression. Communication between the cyst and the synovial sheath or joint capsule was demonstrable during surgical removal in all cases, and most LSCs were filled with clear or xanthochromic fluid. A
Table 2  Findings of histological examination

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Location of LSC</th>
<th>Diameter of LSC (cm)</th>
<th>Wall characteristics</th>
<th>Macroscopic findings</th>
<th>Histological findings</th>
<th>Immunohistochemical positive staining</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>lt L4-5</td>
<td>1.1</td>
<td>granulation tissue</td>
<td>gas</td>
<td>few giant cells</td>
<td>n/a</td>
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<tr>
<td>2</td>
<td>lt L3-4</td>
<td>0.2</td>
<td>granulation tissue</td>
<td>–</td>
<td>histiocytes</td>
<td>CK5, CK6, AE1/AE3</td>
</tr>
<tr>
<td>3</td>
<td>rt L4-5</td>
<td>1.0</td>
<td>granulation tissue</td>
<td>–</td>
<td>histiocytes</td>
<td>CK5</td>
</tr>
<tr>
<td>4</td>
<td>lt L3-4</td>
<td>0.8</td>
<td>normal synovial villi</td>
<td>–</td>
<td>dispersed fibers</td>
<td>n/a</td>
</tr>
<tr>
<td>5</td>
<td>rt L4-5</td>
<td>1.0</td>
<td>—</td>
<td>calcification</td>
<td>crystals of calcium</td>
<td>CK5, CK6, AE1/AE3</td>
</tr>
<tr>
<td>6</td>
<td>rt L5-1</td>
<td>0.9</td>
<td>hyalinized scar</td>
<td>—</td>
<td>histiocytes</td>
<td>CK5, CK6, AE1/AE3</td>
</tr>
<tr>
<td>7</td>
<td>rt L4-5</td>
<td>0.8</td>
<td>granulation tissue</td>
<td>–</td>
<td>histiocytes</td>
<td>CK5</td>
</tr>
<tr>
<td>8</td>
<td>rt L4-5</td>
<td>0.8</td>
<td>hyalinized scar</td>
<td>–</td>
<td>few giant cells</td>
<td>CK5</td>
</tr>
<tr>
<td>9</td>
<td>lt L4-5</td>
<td>1.1</td>
<td>—</td>
<td>calcification</td>
<td>crystals of calcium</td>
<td>n/a</td>
</tr>
<tr>
<td>10</td>
<td>lt L3-4</td>
<td>0.8</td>
<td>granulation tissue</td>
<td>adhesion</td>
<td>few giant cells</td>
<td>n/a</td>
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<tr>
<td>11</td>
<td>lt L4-5</td>
<td>0.7</td>
<td>hyalinized scar</td>
<td>–</td>
<td>–</td>
<td>CK5</td>
</tr>
<tr>
<td>12</td>
<td>rt L4-5</td>
<td>1.0</td>
<td>granulation tissue</td>
<td>adhesion</td>
<td>numerous giant cells</td>
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<td>histiocytes</td>
<td>CK5</td>
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<tr>
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<td>1.9</td>
<td>hyalinized scar</td>
<td>–</td>
<td>–</td>
<td>n/a</td>
</tr>
<tr>
<td>15</td>
<td>rt L4-5</td>
<td>0.7</td>
<td>iron pigment</td>
<td>hemorrhage</td>
<td>Prussian blue stain</td>
<td>positive</td>
</tr>
</tbody>
</table>

LSC: lumbar synovial cyst, lt: left, n/a: not available, rt: right.

Fig. 2  Case 14 with right L5-S1 synovial cyst.  A, B: Intraoperative photographs showing a laminectomy and exposure of the lumbar synovial cyst (A, asterisk), and decompression of the thecal sac after gross total excision of the cyst (B).  C: Photomicrograph showing thick cystic wall with synovial lining cells (arrows) and dispersed hyalinized scar tissue.  Hematoxylin and eosin stain, original magnification × 50.

clear plane of cleavage between the cyst and the thecal sac allowed for easy and safe excision in most patients, whereas adhesions were evident only in two cases, and required more invasive removal of the facet joint and accurate neural dissection. No intraoperative or perioperative complication occurred in our series, and blood loss was limited to mean 460 ml, without any need for postoperative blood transfusion.

At discharge, all patients experienced dramatic pain relief, reporting a significant decrease in mean VAS score (0.9, p < 0.05 compared with preoperative score of 8.1). Patients with preoperative lower motor deficits showed significant improvement, but the degree of dysesthesia was either unchanged or decreased, and the only case of cauda equina syndrome immediately resolved. Later on, patients with neurogenic claudication or persistent extremity weakness reported complete resolution within the first postoperative month and remained pain-free at subsequent follow-up visits. No case of recurrent LSC or vertebral instability was disclosed by neuroradiological evaluation obtained after median 28 months. Moreover, at the last follow up, every patient was classified according to the MacNab modified criteria: surgery seems to guarantee long-lasting results since 10 patients reported grade I (excellent) and 5 grade II (good) perception of clinical outcome (see Table 1 for surgical technique and clinical results).

In all cases, the diagnoses were confirmed by histological study, which revealed a thick wall lined by specialized synovial-type epithelium, containing granulation tissue, numerous histiocytes, and giant cells. In some specimens, synovial epithelium was
Fig. 3 Case 4 with left L3-4 synovial cyst. A–C: Photomicrographs showing advanced degeneration of the cystic wall, in which the synovial epithelium is completely altered and replaced by fibrin layers (asterisk) (A: hematoxylin and eosin [HE] stain, original magnification ×100); identification of fibrin layers precipitated on the luminal side of synovial cells (B: HE stain, original magnification ×200); and well-preserved cystic wall with normal appearing synovial villi (arrow) (C: HE stain, original magnification ×200). D: Photomicrograph of the same section as in A but at higher magnification showing the synovial lining cells of villi (arrow). HE stain, original magnification ×400.

Discussion

Intraspinal LSCs are relatively uncommon lesions, and represent a pathology that must be ruled out in the differential diagnosis of spinal lesions causing symptoms of radicular compression. Cysts appear to be located at the L4-5 intervertebral level in up to 82% of cases, and may be correlated to degenerative Meyerding grade I spondylolysis in up to 40%, and arthrosis in as much as 100% of cases. Low back pain or radiculopathy are often the only clinical findings (85%), less frequently patients complain about motor deficits (27%), and lastly the onset with cauda equina syndrome is rare (13%), as well as intracystic hemorrhage with only 24 cases described.

Diagnosis can be made by arthrography, CT, or MR imaging. The characteristic aspect is a regularly shaped extradural mass, and gas within the cyst may be present and is thought to originate from the vacuum cleft of the contiguous degenerated lumbar facet joint. The signal intensity pattern on MR imaging is variable, and is apparently due to the composition of the cyst. LSCs containing clear serous fluid show an isointense T1-weighted and hyperintense T2-weighted pattern, whereas those with more viscous content show a signal pattern slightly hyperintense to the CSF on all pulsing sequences. Moreover, hemorrhagic cysts demonstrate marked hyperintensity on all sequences, and the pattern may also vary because of the presence of a thick, occasionally calcified capsule. In our series, MR imaging appears to be the most reliable diagnostic examination tool, also enabling detection of the loss of joint space and diffuse facet degeneration.

The etiology of LSC is unknown and has been the subject of speculation in the literature but little formal study. However, the formation process is supposed to be progressive, since morphologically the cysts may exhibit three shapes, which could depend on the stage of their development: small juxta-articular protrusion, semicircular cyst, and round cyst. It is thought that over time microtraumas associated with excessive joint mobility and degeneration processes lead to weak areas in the joint capsule, through which herniation of synovia likely occurs. Other theories include myxoid degeneration and cyst formation in collagen connective tissue, increased production of hyaluronic acid by fibroblasts in response to repeated stress, latent growth of a developmental rest of synovial tissue, or joint metaplasia.

The communication with the joint allows synovial fluid and gas from the vacuum phenomenon to fill the newly formed cavity and by this mechanism de-
termine its growth over time.40) Hemorrhage within the LSC may cause rapid increase in the cyst volume, and initiate acute back and radicular pain, or may dramatically increase existing pain, as demonstrated by the 24 cases of hemorrhagic LSC so far reported.10,32 The higher incidence at L4-5 (82%), the level of greatest spinal motion, and the association with spondylolisthesis (40%) support the involvement of underlying spinal instability in formation of the cyst and worsening of the symptoms.23)

While many authors have considered that there is no clinical relevance to differentiating between true synovial cysts and pseudo-cysts, as presentations, treatments, and prognoses are identical,36 the distinction is important from a histopathological perspective, and may be helpful in understanding LSC etiology. LSCs arise within the synovium, which is often hyperplastic or irritated, and, unlike synovial cysts in the extremities, have a thick wall containing granulation tissue, numerous histiocytes, giant cells, and calcification.3 Tissue fragments received by the pathologist from surgical removal of spinal synovial cysts usually do not provide clues to evaluate the presence or absence of communication between the cyst and the articular space; whereas this could be established preoperatively by arthrography or intraoperatively by the surgeon.40 The pathologist can, however, examine and analyze the nature of cyst lining as it appears at the time of surgical resection; in most instances, the need for excision develops a long time after the cyst formation, and during that period secondary changes due to mechanical pressure, inflammation, and hemorrhage into the cyst lumen can alter the delicate synovial villi, originally lining the cyst. In our series, many of those characteristics were noticed both intraoperatively and microscopically: as already indicated, cysts possessed demonstrable communication to a joint or the synovium-lined anatomic space, and while synovial villi, with well-vascularized stalk covered by layers of normal appearing synovial cells, were observed in the best preserved cysts, conversely the synovial lining cells had almost completely disappeared and were replaced by dense, practically acellular, hyalinized scar tissue with moderate to severe calcification in more degenerate specimens. The mild presence of iron pigment deposition and chondroid metaplasia might suggest that LSCs originate as postransferential synovial excrescences, with different pathogenesis from pigmented villonodular synoviti-s. Moreover, the entire spectrum of findings in the material obtained from our patients could support the traumatic hypothesis, since widespread degenerative aspects were found in spite of the typical inflammatory changes in the peripheral joints and bursae.

Our results have been matched with those obtained from a literature review, which was conducted by retrieving articles published from 1973 up to the present. We were able to collect a total of 6 articles supporting only conservative treatment, 21 papers focused on percutaneous image-guided aspiration and steroid intraarticular injection, and 74 articles dealing with the surgical treatment of LSC. This review indicates that among treatment options only surgical removal of excrescences protruding into the spinal canal provides durable relief of symptoms. Conservative attitude may be justified by the possible spontaneous resolution of LSC, as reported by some authors, however, the chances for progression of symptoms are much higher and indicate the need for invasive treatment of such cysts.38 In fact, only seven cases of spontaneous resolution of LSC have been reported, while up to date 271 patients have undergone percutaneous cyst aspiration with or without intraarticular steroid injection. In those patients, relief of pain was often transient, ranging between 33%30 and 72%1 at 6–12 months, and more than half of them required subsequent surgery.27 For those reasons, surgery is the mainstay of treatment, as confirmed by the 877 LSCs surgically treated and histologically confirmed, which are nowadays reported.

The review of the literature suggests that gross total cyst excision via laminotomy, laminectomy, or hemilaminectomy is the most adopted procedure, whereas the need for facetectomy depends on the size of the cysts and its interface with the thecal sac.19 Many reports have confirmed that gross total resection, usually without the need for extensive facetectomy or spinal fusion, provides satisfactory results in 80–90% of patients with excellent to good outcomes.7,28,39 The significant reduction of VAS score at discharge (p < 0.05) and the remarkable MacNab score at follow up in the present study further confirm the effectiveness of this technique. Gross total resection is also particularly safe because the rate of perioperative complications is low at 3%,20 including CSF fistula, epidural hematoma, seroma, discitis, and phlebitis, compared to instrumented procedures.12,26 The average blood loss reported may range between 930 ml23 in open surgical removal and 31 ml35 in minimally invasive excision. In particular, only 3 papers, for a total of 38 patients, have dealt with the minimally invasive approach for LSC,20,34,35 so this technique still requires more data to corroborate the good results achieved.

Recurrence rates of LSC after surgery range from 1.3%20 to 10.8%.31 This risk of postoperative instability following only decompression, although
Spinal instability (only 2%) reported in the Mayo Clinic experience, with lower rates of revision surgery for facetectomy or evidence of preoperative instability. Nevertheless, according to the data found in the literature, adjuvant arthrodesis (overall rate accounts for up to 9.2%) is routinely performed only in a small portion of patients, and only in cases of facetectomy or evidence of preoperative instability. In this regard, the low rate of revision surgery for spinal instability (only 2%) reported in the Mayo Clinic experience, which is the largest series to date, suggests that this risk might be overrated. Noteworthy, in our series, we did not perform primary fusion, except in a case of extensive facetectomy, and overall no evidence of spinal instability has developed despite a median follow up of 28 months. Moreover, the attitude to routinely perform instrumented stabilization did not appear to provide better results. Outcome data at an average of 10 years follow up after surgical excision of 46 LSCs, with arthrodesis always performed in the presence of degenerative spondylolisthesis, found that subsequent additional surgery was necessary in 15%, with no statistical differences for any outcome measure between patients undergoing concomitant fusion and those undergoing only decompression. In this aspect, minimally invasive techniques might be particularly useful, as the use of tubular retractors may minimize the risk of spinal instability even in a case of spondylolisthesis. The review of the literature on this subject did not yield new satisfactory insights: in fact, no significant difference in clinical outcomes between endoscopic versus open surgery, except for the lower blood loss and soft tissue trauma of the minimally invasive techniques, has been reported.

Both clinical and histological findings described in this study support the theory of degenerative microtraumatic pathogenesis of synovial cysts. Even if some patients may partially respond to percutaneous image-guided cyst aspiration and intraarticular steroid injection, gross total surgical excision seems to give much higher chances to achieve complete resolution of the symptoms. Indeed, our experience confirms the efficacy and safety of open surgical removal of symptomatic LSC, and particularly we advocate the facet sparing technique as the method of choice. Since no differences in clinical outcome emerge comparing many reports of cyst excision with or without primary fusion, despite the higher risk of perioperative complications, we may conclude that the decision to perform concomitant spinal arthrodesis, to prevent spinal instability or cyst recurrence, should depend on cyst size, involvement of surrounding structures, degree of preoperative spondylolisthesis, and facet joint degeneration.

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**Conflicts of Interest Disclosure**

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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