Diagnosis and Safe Excision of Lumbar Synovial Cysts and Accompanying Pathology: A Perspective

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ABSTRACT

Background: Lumbar synovial cysts are often not sufficiently diagnosed prior to spine surgery. Utilizing both MR and CT studies is critical for recognizing the full extent/severity of these lesions.

Methods: In patients with chronic, acute, or subacute lumbar disease, obtaining both MR and CT studies is critical to correctly diagnose; disc disease, hypertrophy/ossification of the yellow ligament (OYL), stenosis, with/without degenerative spondylolisthesis, and/or synovial cysts (SC).

Results: MR T2 weighted images directly demonstrate hyperintensity within a SC. They initially cause lateral recess/caudal nerve root and/foraminal compromise, with larger extrusions causing significant lateral thecal sac, and far lateral/superior cephalad root compromise. CT 2 mm cuts often better demonstrate mid-vertebral level compression of cephalad nerve roots with/without SC calcification, along with the extent of mid-vertebral stenosis, hypertrophy/OYL, and DS. When CT studies directly document SC calcification, it alerts the surgeon to the increased potential risk of creating a cerebrospinal fluid fistula with full SC excision, and should prompt the adoption of alternative measures such as decompression/partial removal. Most critically, surgery for synovial cysts often warrants a 2-level laminectomy for fuller visualization of the cephalad and caudal nerve roots, and clearer differentiation of neural tissues from the large fibrotic SC capsule, to effect safer removal.

Conclusions: Preoperatively, establishing the full cephalad and caudal extent of lumbar synovial cysts with both MR and CT studies is critical. Anticipation and better visualization of the foraminal/far lateral and superior extent of these lesions often warrants more extensive multilevel laminectomies for thecal sac and both cephalad and caudal root decompression.

Keywords: Computed tomography, Degenerative spondylolisthesis, Magnetic resonance, Multilevel laminectomy, Noninstrumented fusion, Rare instrumented fusion, Safe surgery, Synovial Cysts: Lumbar stenosis

INTRODUCTION

Both MR and CT studies are essential to preoperatively document the full extent of lumbar stenosis, hypertrophy/ossification of the yellow ligament (OYL), with/without degenerative spondylolisthesis (DS), and synovial Cysts (SC) [Tables 1 and 2; Figures 1-16].[1-15] The smaller, more typical unilateral SC occupies not only the lateral recess where they compress the caudal nerve root, but extend significantly foraminally, far laterally, and often superiorly to the mid-pedicle level where they impinge on the ipsilateral cephalad nerve root.[2] Due to double nerve root compression (e.g. at the L4-L5 level, there is compression of the cephalad L4 and caudal L5 nerve roots), two-level lumbar...
laminectomies are often warranted to adequately/more safely excise SC. Larger/massive SC may occupy the majority/entire spinal canal, resulting in not only nerve root, but also severe cauda equina compression. SC occurring alone or in combination with DS, may be managed without fusions in many patients, particularly older individuals with multiple significant comorbidities. However, for those with evidence of instability, noninstrumented vs. instrumented postlateral fusions (PLF) vs. rarely, interbody fusions (e.g. transforminal lumbar interbody fusions (TLIF) particularly for spondylolisthesis/lysis or full unilateral facetectomies).

Anatomy of Synovial Cysts and Radiological Appearance on MR

Pathoanatomically, synovial cysts are comprised of cystic dilatations of synovial sheaths that have directly extruded from the overlying facet joints into the spinal canal due to disruption of the facet joint capsule [Table 1]. On T2 weighted MR images, SC frequently demonstrate a hypointense outer perimeter indicative of an enlarged/hypertrophied, and/or ossified/calcified multi-layered fibrinous capsule. The centers are inhomogeneously hyperintense reflecting the variegated soft synovial tissue intermixed with hemorrhage, and/or thick cranck case fluid (e.g. rarely clear) [Table 1].

Radiological Diagnosis of Synovial Cysts with MR

MR studies are usually the first and best examinations performed to identify lumbar synovial cyst extrusions in conjunction with lumbar stenosis, OYL, with/without DS (e.g. some cite a 40% incidence of OYD with SC) [Figures 1,3,5,6,9,10 and 12] [Tables 1 and 2]. SC occur typically at L4-L5, followed by the L5-S1, L3-L4, and L2-L3 levels. Lateral/foraminal/far lateral SC contribute to ipsilateral thecal sac and dual cephalad/caudad root compression, while larger central/dorsolateral lesions often fill the spinal canal resulting in cauda equina syndromes.

Limitations of MR

MR axial 5 mm thick sections are focused at the disc space levels. Typically, one image is taken above, another at, and the final section just below the interspace. A limitation of axial MR studies is that they may mis/underrepresent mid-level vertebral pathology [Figures 1,5,10 and 12]. Here, sagittal/parasagittal 5 mm MR images may detect/document the missed mid-level disease [Figures 3,6 and 9].

Utility of CT Examinations in Diagnosing Lumbar Stenosis, OYL, DS, and SC

However, the non-contrast CT 2 mm axial and sagittal scans may better demonstrate mid-level vertebral disease along with stenosis, OYL, DS, spondylolisthesis/lysis, and SC, especially when considering surgery [Tables 1 and 2] [Figures 4,7,8,11,13 and 16]. Further, CT studies show ossification/calcification of SC capsules, warning of probable significant dural adherence, and prompting surgeons to consider decompression rather than full excision of SC to avoid intraoperative dural tears.

Case: When MR/CT Examinations are Interpreted as Disc, Missing Synovial Cyst

A 77-year-old female presented with several weeks of increasing left lower extremity neurogenic claudication/radiculopathy accompanied by proximal left leg weakness (2/5), and numbness (pin loss L2-L3 distributions) [Table 2]. The preoperative MR and CT studies both “showed” L2-S1 lumbar stenosis, and a “typical” large left L2-L3 herniated disc with inferior migration to the mid-pedicle level. At surgery, the “disc” proved to be a massive, extruded left L2-L3 synovial cyst. Following the L2-S1 laminectomy, no fusion was performed as there was no documented instability. Postoperatively, the patient was neurologically intact, and remained so two years later.

Case: PM Fail to “Rupture/Aspirate” Synovial Cyst Critically Delaying Surgery

PM followed an elderly male (e.g. >75) for over 6 months with progressive low back pain, neurogenic claudication, and radiculopathy [Table 2]. At 3 months, PM obtained an MR showing a massive L3-L4 synovial cyst with severe stenosis at L3-L4 and DS, and moderate L2-L3 stenosis. Despite continued clinical worsening, PM chose to perform 3 ESI with...
Table 1: Synovial Cyst Articles 2004-2016.

| Author Journal Year | Study Design | History Diagnostic Studies | History Diagnostic Studies | Surgery | Complications Outcomes Conclusions |
|---------------------|-------------|-----------------------------|-----------------------------|---------|-------------------------------------|
| Epstein Spine 2004[1] | Lumbar Lam SC/SS or DS | 45 Lam SC/SS (45 (3.8 levels) | 2 years postop: SC/SS Slip | Good/excellent | Conclusion; Consider initial fusion with SC-reflect disruption of facet joints/ Degree instability |
| Outcome Short-Form 36 Evals | 35 Lam SC/SS/DS (3.5 levels) | SC/SS/DS > slip 2/11 (Grade II) | vs 63% (35) | SF-36 Improvement Physical Function |
| | LBP 40 vs. 33 | +45vs. +38 points | Both-Moderate Improvement |
| | R 43 vs. 33 | |
| | INC 41vs. 26 | |
| Epstein JSDT 2004[2] | Review Diagnosis Surgery | SC: arthritic disruption facet | SC Levels | Surgery; Laminotomy, HemiLam, Lam |
| Outcomes of Lumbar SC | DS 40% with SC | L4-L5 | Lam NI PLF vs. Instrumented Fusions |
| | Patients age 60's | L5-S1 | |
| Epstein JSDT 2007[3] | Dural Tears DT:Incidental | Older DT: 74 yo DT/69 yo No DT | outcomes; SF-36 Improved 4-5 Health Scales 1st yr | 3 Factors > Risk DT: 5/10 SC/severe OYL (vs. 8/100 SC without DT) |
| 10/110 Geriatric Lam NI PLF | Surgery: 5.5 DT vs. 5.0 No DT | No DT | 2/10 scar DT (vs. 10% without DT) |
| Epstein TSJ 2008[4] | 60 Pts. Avg. 5.4 | 60 Patients | Pathology 60 SS | SF-36 Data |
| Level Lam +1-2 | Avg. 70 yo | 46 OYL | Improved 6/8 Health Scales in ALL patients |
| Level NI | Outcomes Odom's Criteria | 20 Discs | |
| PLF Using Lamina | SF-36 | 8 SC | |
| Autograft Vitoss (B-TCP) | Followed 2 postop yrs | 48 DS | |
| | | 2 Lysis | |
| | | 10 Deg. Scoliosis | |
| Epstein SNI 2012[5] | Efficacy Surgery vs. SC Rupture/Aspiration | Pathology: Gelatinous, Non Aspirable Crank Case Fluid/Thick Fibrous Capsule | Failed Aspiration Rates 50-100% | |
| | | Vitosis Lam | 9 (15%) Pseudarthrosis | |
| | | 4.6 Levels | 23 Excellent | |
| | | 1.3 PLF | 23 Good | |
| | | Nanoss Lam | 5 Fair | |
| | | 4.5 Levels 1.2 LPLF | 4 Poor | |
| Epstein SNI 2015[6] | Nanoss vs. Vitoss Bone Graft | Fusion Mass | Vitosis Lam | Best Outcomes SC Surgery |
| | | Autograft Lamina+ (213) Vitoss vs. (45) | 4.6 Levels | High Failure Rate Aspiration or Rupture |
| | | Nanoss ; Both with BMA | 1.3 PLF | 4.8 mos Nanoss (100%) |
| | | | | Pseud 0% |
| | | | | 0 Seroma and 0 Infection |
| Epist SNI 2015[7] | Rate CSF Fistulas /DT Lumbar SS Review Range 3-27% | 2000-2015 Incidence DT 336 pts | Risk DT: 5 OYL | DT 24 (7.14%)/336 Pts. |
| | | 4.7 Lam | 3 Scar (postop) | 4.2% DT when Omit ESI and Intradural Tumors |
| | | 1.4 NI PLF | 7 ESI | |
| | | | | 6 SC |
| | | | | 3 Intradural Tumors |
| Epstein SNI 2016[8] | Efficacy NI PLF 336 Multilevel Lam SS vs. | 4.7 Level Lam | 2nd Surgery | Conclusion |
| | | 1.4 Level NonInstr. PLF | Required Avg. 7 DS Grade I | 9 (2.7%) Reop NI PLF |

(Contd...)
3 failed attempts at SC “rupture/aspiration” over these final 3 months [Table 2].[12] When ultimately seen by neurosurgery, the patient had a cauda equina syndrome with repeat MR and a new CT study confirming the prior findings without a documented decrease in the size of the SC. Following a L2-L4 laminectomy, the patient fully recovered without further sequelae.

More Extensive “Open” Surgery for Safe Synovial Cyst Excision

A 2-level decompression simultaneously provides safe excision of SC, along with decompression of bilateral stenosis/OYL with/without DS. This is typically warranted due to SC’ foraminal, far lateral, and superior extension [Tables 1 and 2].[1-15] The decompression, therefore, initiated at the superior level, allows for full visualization/decompression of the cephalad nerve root, while the inferior extension of the laminectomy facilitates decompression of the lateral thecal sac and inferiorly exiting nerve root.

Undercutting Laminectomy/Decompression of Stenosis/OYL with/without DS/SC

Using an angled Kerrison rongeur, performing an undercutting laminectomy for SC/stenosis/OYL/DS decompression/excision involves working under an operating microscope from the opposite side of the table; further the patient is rotated/angled away from the surgeon. This technique largely provides adequate exposure while facilitating preservation of the overlying laminae/facets, use; maintaining stability, and averting fusion. It is essential to attain sufficient exposure to avoid the minimally invasive (MI) (e.g. including TLIF) increased complications that too often include; inadvertent neural/dural injury, and incomplete cyst removal.

Documentation of Location/Level of Synovial Cyst Removal with 2 X-rays

When opening at the level of a SC, the lesion may not be readily apparent. It is imperative to obtain two intraoperative radiographs to confirm the correct level; first, a cross table lateral X-ray with a clamp on the correct interspinous ligament, and second, placing a Penfield elevator in the correct disc interspace (e.g. not just in the canal). This is how to both confirm the level of the SC extrusion, as well as to avoid wrong-level surgery.

Surgery for Multilevel Stenosis/OYL, Synovial Cysts (SC), and a Foraminal (FOR)/Far Lateral Disc (FLD)

A patient (2018) presented with L2-L5 stenosis/OYL, a left L3-L4 foraminal (FOR)/far lateral disc (FLD), and bilateral L3-L4/L4-L5 synovial cysts [Table 2].[13] Utilizing the operating microscope, and performing L2-L5 laminectomies with medial facetectomy/foraminotomy, and undercutting the laminae/facet joints, avoided the need for fusion.

Fusion vs. No Fusion for Lumbar Synovial Cysts with Other Pathology

Fusion options following lumbar decompressions include; non-instrumented posterolateral fusions (PLF) vs. instrumented PLF, or rarely TLIF [Figure 16] [Table 2].[13]

2004: Recommended Possible Fusion for SC with Lumbar Stenosis/OYL with/without DS

In a 2004 study, Epstein evaluated the outcomes/frequencies of instability 2 years after multilevel laminectomies for stenosis/OYL (average 3.8 levels: 45 patients) with SC vs. multilevel laminectomies for stenosis/OYL (average 3.5 levels: 35 patients) with

Table 1: (Continued).

| Author | Study Design | History Diagnostic Studies | History Diagnostic Studies | Surgery | Complications | Outcomes | Conclusions |
|--------|--------------|-----------------------------|-----------------------------|---------|---------------|----------|-------------|
| Preop SS/DS | 195 Grade I | Avg. Age 66.5 | 4.8 Level Lam 1.1 | Other studies+ Instrumentation | Reop Rates up to 80% |
| 67 Grade II | 154 Discs | Followed mean 7.1 yrs | 1 DS Grade II | at 5 yrs postop |
| 66 SC | 9 Reop ASD | Average 6.3 yrs postop | 2 Discs | |
|       |               |               | 1 Synovial Cyst | |

Lam=Laminectomy, MR=Magnetic Resonance Image, NSAID=Non-steroidal anti-inflammatories, yo=Year Old, F=Female, M=Male, LE=Lower Extremity, INC=Neurogenic Claudication, DS=Degenerative Spondylolisthesis, LS=Lumbar Stenosis, CAD Stents=Cardiac Stents, LV=Left Ventricular, FLD=Far Lateral Discs, FOR=Foraminal, IONM=Intraoperative Neural Monitoring, ESI=Epidural Steroid Injections, NSGY=Neurosurgery, LAM=Laminectomy, SC=Synovial cyst, OYL=Ossification Yellow Ligament, instrumented PLF=Posterolateral fusion, TLIF=Transforaminal Lumbar interbody Fusion BMA=Bone Marrow Aspirate, NI=Noninstrumented, SS=Spinal Stenosis Avg.=Average, Reop=Reoperation, B-TCP=Beta TriCalcium Phosphate, LBP=Low Back Pain, R=Radiculopathy, SF-36=Short Form-36, yo=Years Old, mos=Months, Pts.=Patients, SNI=Surgical Neurology International, TSJ=The Spine Journal, JSDT=Journal Spinal Disorders Techniques, yrs=Year(s)
Table 2: Synovial Cyst Articles 2017-2019.

| Author Journal Year | Study Design | History Diagnostic Studies | History Diagnostic Studies | Surgery | Complications Outcomes Conclusions |
|---------------------|--------------|----------------------------|----------------------------|---------|-------------------------------------|
| Epstein SNI 2017[9] | 59 Lam NI PLF Fusion Mass Lam Autograft Nanoss BMA | Surgery for SS, DS, FOR/FLD Synovial Cysts Facet Resection Avg. age 66.1 | 48 Osteoporosis 14 Obesity 13 Morbid Obesity DS Most at L4-L5, then L3-L4 and L5-S1 | MR/CT Stenosis/ OYL 51 DS 2 Lysis 11 Discs 10 FLD Followed 3.12 yr Surgery Grade I-II DS: Lam vs. Lam +NI or Instrumented PLF vs. TLIF Reduced Drain Drain 2-3 Lam 87.6 (1), 59.2 cc (2 days); Home 2nd day | Lam+NI PLF 97% Fusion Rate Lam Autograft Nanoss+BMA for Lumbar Stenosis+ DS, FOR/FLD, SC, Facet resections No Reoperations Multilevel SS/DS require Lam vs. Lam + NI PLF vs. Instrumented fusion (PLFTLIF) |
| Epstein SNI 2017[10] | Nursing Review Lumbar Lam+ DS MR/CT SS/DS, OYL, Discs, SC | F vs. M Symptoms: R, INC, Cauda Equina | | No Instability No Fusion X-ray Marker in Disc Space At Surgery Used Undercutting Technique +IONM +Microscope Avoid DT | Lam+NI PLF 97% Fusion Rate Lam Autograft Nanoss+BMA for Lumbar Stenosis+ DS, FOR/FLD, SC, Facet resections No Reoperations Multilevel SS/DS require Lam vs. Lam + NI PLF vs. Instrumented fusion (PLF/TLIF) |
| Epstein SNI 2017[11] | Tisseel Used Hemostasis Lam | 58 2-3 Level Lam: 48 Discs, 20 SC, 1 DS 79 4-6 Level Lam: 45 SC, 39 Discs, 26 DS | | Reduced Drain Drain 2-3 Lam 87.6 (1), 59.2 cc (2 days); Home 2nd day | 4 Postop DT; 1 Recurrent disc 3 Huge SC/Calcified through dura |
| Epstein SNI 2018[12] | Elderly M 6 mos INC/R 3 mos ago Cauda Equina Syndrome MR Huge SC Filling Spinal Canal L3-L4 | Pain MD (Anesthesia) obtained MR 3 mos ago: Huge L3-L4 SC Marked Stenosis Moderate Stenosis L2-L3 | For 3 mos Pain MD Treated with 3 ESI (1/month) Plus Attempted SC Aspiration/ Rupture | Cauda Equina Syndrome Confirmed Prior Findings | Surgery Delayed 3-6 mos. Lam L2-L4; Resection of Huge SC; Decompress Stenosis L2-L3, L3-L4; No fusion Postop: Regained Normal Function At Surgery Used Undercutting Technique +IONM +Microscope Avoid DT Multiple Spine Surgeons Offered: TLIF L3-L4/L4-L5 Epstein Offered NO SURGERY Medical Treatment Excellent Outcome MR/CT Failed to Diagnose Huge Left L2-L3 SC |
| Epstein SNI 2018[13] | Manage Multilevel Stenosis/ OYL L34/L45 SC Left L34 FOR/FLD | MR/CT Multilevel SC+ FOR/FLD | Surgery: Lam L2-L5 SS; Huge L3-L4 FOR/ FLD, Bilateral SC L3-L4/ L4-L5 Cardiac Meds: Full ASA 325 mg Clopidogrel 75 mg po bid | At Surgery X-ray Marker in Disc Space No Fusion No Instability | At Surgery Used Undercutting Technique +IONM +Microscope Avoid DT Multiple Spine Surgeons Offered: TLIF L3-L4/L4-L5 Epstein Offered NO SURGERY Medical Treatment Excellent Outcome MR/CT Failed to Diagnose Huge Left L2-L3 SC |
| Epstein SNI 2019[14] | Cardiac Risks 5 CAD-Stents Last 2 Years Bovine Cardiac Valve; Repair LV Aneurysm | | | | |
| Epstein SNI 2019[15] | Case 77 yo F L2-S1 SS, OYL, Huge Left L2-L3 Disc | Misdiagnosed MR: Disc L23-Left/ inferior migration to mid pedicle | Misdiagnosed on CT; Disc L23 Left with inferior migration to mid pedicle level | Surgery: Lam L2-S1 Excision massive left L2-L3 SC | |
Figure 1: T2 axial weighted MR demonstrating extrusion of a synovial cyst originating from the right facet joint (also containing a high T2 weighted signal) at the disc space level. This resulted in marked right root and severe dorsolateral thecal sac/cauda equina compression. Also note fluid in both facet joints.

Figure 2: Large central synovial cyst extrusion resulting in diffuse bilateral thecal sac/cauda equina compression. Note on this study there are hyperintense signals within both facet joints, and it is difficult to determine whether this cyst originated from the right or left facets. Further, observe the hypertrophy/ossification (hypointense signal) of the yellow ligament.

Figure 3: T2-weighted Parasagittal MR demonstrating L3-L4 dorsolateral extruded synovial cyst. There is a hypointense rim around the hyperintense cyst/thecal sac likely indicative of a hypertrophied and partially ossified capsule.

Figure 4: Parasagittal CT at the L3-L4 level (same patient as Figure 3) demonstrating dorsolateral compression from the extruded synovial cyst that is partially ossified/calcified.

Increased olisthy (to Grade I) was seen postoperatively in 5 of 45 of the former no-DS patients, while Grade I olisthy progressed to Grade II olisthy for 11 of 35 of those with preoperative DS. Interestingly, both groups showed nearly comparable moderate postoperative improvement (e.g. good/excellent results (58% and 63% using Odom’s Criteria), and improvement in SF-36 scores (e.g. Physical Function Scale +44 and +38 points respectively). The conclusion was; “As synovial cysts reflect disruption of the facet joint and some degree of instability, primary fusion should be considered to improve operative results for patients in both categories.”

2017: No Fusion Typically Required for Laminectomy Stenosis/OYL with/without SC/DS

In 2017, Epstein documented no need for fusion following 2-3 level (58 patients) vs. 4-6 level (79 patients) lumbar laminectomies for spinal stenosis/OYL with/without SC, and DS. [Table 2]. For those undergoing 2-3 level laminectomies, all 58 had stenosis/OYL, while 48 additionally had herniated discs, 20 (34.4%) additionally had synovial cysts, and one had DS. For the 79 patients having 4-6 level laminectomies, all 79 had stenosis/OYL, 45 (56.9%) additionally had synovial cysts, 39 had lumbar...
Figure 5: Massive left L3-L4 extruded synovial cyst (documented intraoperatively) on this T1 weighted axial MR filling the lateral recess and extruding superiorly mimicking a disc herniation.

Figure 6: In the same patient as Figure 5, this patient on the T2 parasagittal MR had a massive superiorly extruded synovial cyst that mimicked a disc herniation extending toward the mid-vertebral/parapedicular level.

Figure 7: This non-contrast axial CT scan (soft tissue) showed a large left-sided, partially hyperdense foraminal/superiorly extruded synovial cyst.

Figure 8: The parasagittal 2D-CT study (soft tissue) showed a left-sided hypodense (e.g., partially ossified) synovial cyst extrusion at the level of the disc space with hyperdense additional tissue seen extending cephalad to the mid vertebral level.

discs, and 26 had DS. Despite 26 of the latter 79 patients undergoing 4-6 level laminotomies with preoperative DS, none developed postoperative instability requiring fusion [Table 2].[10] This represented a significant change in opinion, regarding no necessity for fusion, compared to the 2004 study.

Tisseel: Promotes Hemostasis Following Lumbar Laminectomies

Tisseel (Baxter International Inc., Westlake Village, CA, USA), a fibrin sealant, was also routinely used to minimize postoperative bleeding, facilitate hemostasis following the 2-3 (58 patients) vs. 4-6 (79 patients) level lumbar laminectomies for stenosis/OYL with/without SC, and DS [Table 2].[11] For both procedures, the postoperative drainage was reduced. For the 2-3 level procedures, the average drainage was 87.26 cc, and 59.62 cc on postoperative days 1 and 2 respectively, allowing for routine discharged. For those undergoing 4-6 level laminectomies, average drainage was 156.63 cc (79 patients), 115.8 cc (79 patients), 85.7 cc (44 patients), and 93.6 cc (6 patients) respectively on postoperative days 1-4; discharges followed at postoperative day 2 (29 patients), day 3 (44 patients), and day 4 (6 patients). Further, Tisseel was used to treat 3 dural tears (DT) attributed to calcified synovial cysts, and one DT due to scar associated with a recurrent disc out of the box 79 patients undergoing 4-6 level decompressions.
Figure 9: Large dorsolateral synovial cyst on a T2 parasagittal MR study measuring 11 mm in the cephalad-caudal dimension. Notes its origin from the L4-5 level with cephalad extension beyond the mid-vertebral level. The cyst itself exhibits multiple inhomogeneous densities indicative of the variegated solid contents, and minimal actual crank-case fluid.

Figure 10: On the axial T2 weighted MR scan there is a mildly hyperintense structure on the left and the right sides in continuity with the facet joint indicating likely bilateral synovial cysts rather than just hypertrophy of the yellow ligament. On the left, this results in mild/moderate compromise of the nerve root in the lateral recess.

Figure 11: On this axial non-contrast CT scan, at the L4-L5 level, the capsule of the synovial cyst on the right side of the spinal canal is ossified with central inhomogeneous and hypodense components. Such synovial cysts are often comprised of multiple layers of dense fibrous ossified capsule, and may contain minimal amounts of actual fluid (e.g. crank case fluid or more typically hypodense soft tissue).

Figure 12: The same patient as in Figure 11 had a large right-sided synovial cyst at the L4-L5 level showed marked thecal sac and right L5 root compression. On the axial T2 weighted MR, the lesion’s perimeter is hypointense (e.g. consistent with ossification) while its contents are variegated (e.g. containing hyperintense and hypointense components indicative of a combination of calcified/not calcified soft tissue and crank-case fluid).

Noninstrumented PLF for Laminectomy with Stenosis/OYL with/without SC/DS Using Different Bone Graft Expanders

Non-Instrumented PLF Rates Using Vitoss

Select patients undergoing decompressive lumbar laminectomies for stenosis/OYL, foraminal/far lateral discs, synovial cysts, and DS requiring full facetectomy with major comorbidities may warrant noninstrumented posterolateral fusions (PLF) [Tables 1 and 2]. In 2008, in 60 patients averaging over 70 years of age underwent average 5.4 level lumbar laminectomies and 1-2 level noninstrumented PLF; This included 48 DS, 10 degenerative scoliosis, 8 patients with synovial cysts, and 2 with spondylolysis [Table 1]. The fusion mass consisted of lamina autograft, Vitoss/B-TCP (Orthovita, Malvern, PA, USA), and bone marrow aspirate (BMA). The fusion rate was 85% based on dynamic X-rays/CT studies obtained up to 2 years postoperatively; only
Figure 13: Parasagittal CT image of L4-L5 partially calcified/ossified synovial cyst filling the right side of the spinal canal.

Figure 14: In this illustration by Joseph A. Epstein, M.D., the right side shows a multilevel hemilaminectomy that would potentially be used for excision of an L4-L5 synovial cyst (e.g. with lateral, foraminal, far lateral superior extension compressing the L4, and L5 roots), as long as there is also significant stenosis L3-S1 requiring decompression.

1 patient of the 15% with pseudarthrosis required secondary fusion. He was a mid-fifties vasculopathy who had to immediately go back on Aspirin therapy.

In a second study in 2016, 336 patients underwent multilevel laminectomies with noninstrumented multilevel fusions using Vitoss/B-TCP/lamina autograft/BMA [Table 1]. Patients averaged 66.5 years of age, and had average 4.7 level lumbar laminectomies, and 1.4 level noninstrumented fusions addressing: stenosis/OYL (336), DS (Grade I (195 patients), Grade II spondylolisthesis (67 patients), disc herniations (154 patients), and/or synovial cysts (66 patients). Over the average follow-up of 7.1-years, only 9 (2.7%) patients required secondary surgery an average of 6.3 years postoperatively; 7

Figure 15: This axial illustration by Joseph A. Epstein, M.D. demonstrates marked right-sided facet hypertrophy with hypertrophy of the yellow ligament resulting (short thick arrows) in use severe compression of the nerve root (thin white arrow) in the lateral recess. In many similar cases. There is also an accompanying component of synovial cyst extrusion as well.

Figure 16: In some cases, particularly where there is degenerative spondylolisthesis at the level of a synovial cyst extrusion, one might consider performing a non-instrumented posterolateral fusion as shown here at the L2-L3 level. Note the marked fusion mass consisting of autologous bone combined with Vitoss/BMA placed posterolaterally and bilaterally over the transverse processes at the L2-L3 level. developed Grade I DS, one progressed to a Grade II DS, 2 to new disc herniations, and/or 1 a synovial cyst.

Noninstrumented Fusion Rates for Vitoss vs. Nanoss

In 2015, Epstein compared the relative efficacy of Vitoss (213 patients) vs. Nanoss (45 patients; Regeneration Technologies Corporation: RTI, Alachua, FL, USA) using comparable noninstrumented PLF techniques [Table 1]. The average times/rates for fusion based on dynamic X-rays/2-3D-CT studies were nearly comparable; Vitoss (5.3 months;
98.6%) vs. Nanoss (4.8 months: 100%), with pseudarthroses respectively occurring in 3 (1.4%) vs. 0 patients.

Noninstrumented Fusion Using Nanoss Alone

Subsequently, Epstein (2017) assessed 59 patients undergoing average 4.0 level laminectomies and average 1.2 level noninstrumented fusions for stenosis/OYL, DS (51 patients), synovial cysts (32 patients), and other pathology using Nanoss (RTI Surgical Alachua, FL, and USA) with lamina autograft/BMA [Table 1].[10] Postoperative dynamic X-rays and CT studies documented a 97% fusion rate occurring at an average of 4.9 mos. postoperatively. Notably, the 2 (3%) patients with pseudarthrosis had severe osteoporosis, were morbidly obese, and were smokers; neither, nevertheless, was sufficiently symptomatic to require additional surgery.

Frequency of Dural Tears (DT) with Lumbar Synovial Cyst Surgery

The presence of synovial cysts increases the risk of intraoperative dural tears (DT) (range 3-27%) during multilevel lumbar laminectomies with/without noninstrumented vs. instrumented lumbar fusions [Table 1].[1,7] In a 2007 retrospective analysis of 110 patients undergoing multilevel laminectomies with noninstrumented PLF, Epstein identified DT in 10 of the 110 patients [Table 1].[10] These patients averaged 74 years of age (e.g. vs. 69 seen for those without DT), and also correlated with slightly more extensive laminectomies (5.5 with DT vs. 5.0 without DT), and noninstrumented PLF (1.8 vs. 1.6 levels). Additionally, 3 factors positively correlated with DT; 10 DT with severe OYL, 5 of 10 patients with synovial cysts (e.g. vs. 8 synovial cysts out of 100 without DT), and 2 with prior operative scar (e.g. vs. 10 of 100 patients with scar but without DT). Next, in 2015, Epstein evaluated the incidence of DT for 336 patients undergoing average 4.7 level laminectomies, and 1.4 level noninstrumented PLF [Table 2].[7] DT were attributed to (in descending order); preoperative epidural spinal injections (ESI) (7 patients), synovial cysts with marked dural adhesions (6 patients), severe OYL extending through the dura (5 patients), postoperative scar (3 patients), and intradural tumors (3 patients). The overall frequency of DT was 24 (7.14%) out of 336 patients, but this number was readily reduced to 4.2% by eliminating preoperative ESI, and intradural tumors.

Recommended Repair Techniques for DT

Recommended repair techniques for DT include using 7-0 Gore-Tex (Newark, Delaware, USA) sutures (e.g. where the needle is smaller than the suture itself, thus filling the needle holes), micro-dural staples (1.4 mm), muscle patch/bovine pericardial grafts, application of Duragen (Integra LifeSciences, Hawthorne, NY, USA), and use of a fibrin sealant (e.g. safely used Tisseel; Baxter International Inc., Westlake Village, CA, USA).

Intraoperative Neural Monitoring; Critical Adjunct to Lumbar Surgery

Extremely useful in performing multilevel laminectomies with/without non instrumented fusions is intraoperative neural monitoring. It typically consists of electromyography (EMG: some also including sphincteric monitoring), and somatosensory evoked potential monitoring (SEP); the EMG will signal root and/or sphincteri compromise, while SEP may indicate significant thecal sac/cauda equina compression. Anesthesia's utilization of TIVA (total intravenous anesthesia) best protects the quality of these continuous EMG/SEP recordings [Tables 1 and 2].[1,2,6,8,9,10]

When to Say No to Surgery Due to Major Comorbidities

Not all patients with significant MR/CT documented spinal stenosis, OYL with/without synovial cysts and/or DS are appropriate surgical candidates. Major comorbidities must be carefully taken into consideration, as the risks of surgery may outweigh the benefits. The following case report illustrates this point. A 65-year-old male presented with 6 months of 2-block neurogenic claudication, but a normal neurological exam [Table 2].[14] MR/CT studies documented multilevel L2-S1 stenosis/OYL, Grade I L4-L5 DS, and bilateral multilevel L3-L4, and L4-L5 synovial cysts. However, he had required over 5 stents placed within the last five years, and 2 years ago, underwent placement of a bovine aortic valve, and left ventricular wall aneurysmal repair; he still required full-dose ASA (325 mg/day) and Clopidogrel 75 mg po bid therapy. Due to these multiple comorbidities and the normal physical exam, the patient was referred for conservative management (e.g. exclusive of ESI or other invasive procedures).

CONCLUSIONS

Lumbar synovial cysts should be more fully diagnosed preoperatively utilizing both MR and CT to demonstrate foraminal/far lateral, and superior compression of the cephalad, cauda nerve roots, and lateral thecal sac [Tables 1 and 2]. Surgery for SC with accompanying stenosis/OYL with/without DS, typically requires 2 or more-level decompressions, avoiding the higher risks of neural/dural injury seen with inadequate exposures provided by minimally invasive approaches.[1-13]

Declaration of patient consent

Not required as there are no patients in this study.
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Conflicts of interest
There are no conflicts of interest.

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