

COX FLEXION-DISTRACTION UTILIZED IN THE MANAGEMENT OF A LOWER BACK PAIN PATIENT WITH AN L4-L5 SYNOVIAL CYST: A CASE REPORT

Bret White, DC, MHSc, DABCO¹, Ralph Kruse, DC, FACO¹, Kurt Olding, DC, FACO²

ABSTRACT

Objective: To describe the chiropractic treatment of a patient with a chronic, symptomatic L4-L5 synovial cyst using the Cox[®] flexion-distraction manipulation.

Clinical Features: A 75-year-old retired postal worker had lower back pain radiating into his right buttock, of non-traumatic onset. The pain was present for 4-5 months and was rated as severe when standing or walking. Magnetic resonance imaging documented a large synovial cyst at L4-L5.

Intervention and Outcomes: Treatment consisted of Cox[®] flexion-distraction to the lumbar spine for a total of 6 treatments over approximately 3 weeks. The initial numerical pain rating scale (NPR) was 3-4 at rest and was rated as severe when standing or walking. The Oswestry Disability Index (ODI) was 48%. The final NPR was rated as 0 at rest, and the ODI was 36%. This represents a 25% improvement in the ODI and a 100% improvement in resting pain.

Conclusion: The Cox[®] flexion-distraction manipulation may be an effective conservative option for symptomatic lumbar synovial cysts. This becomes important in a patient who has several co-morbidities which make surgery a riskier option. (*J Contemporary Chiropr* 2022;5: 50-56)

Key Indexing Terms: Chiropractic; Synovial Cyst; Low Back Pain; Flexion-Distraction

INTRODUCTION

Historically, symptomatic lumbar synovial cysts have been treated with either surgical decompression, with and without fusion, or by percutaneous cyst aspiration. Wilby described the synovial cyst in 27 surgical patients

undergoing laminectomy, containing fragments of articular cartilage and bone which were found in 89% of the cysts. Wilby discovered a channel connecting the medial facet joint capsule to the ligamentum flavum. In the presence of advanced osteoarthritis, pieces of cartilage and bone fragment have been found in the joint space as well as in this communicating channel. The resulting inflammatory response will cause granulation tissue and synovial cyst development. (1)

The triple-joint complex in the spine is comprised of the 2 facet joints and the intervertebral disc. The intervertebral disc is the primary load bearing structure in the triple-joint complex; however, as disc degeneration progresses more load is transferred on to the facet joints creating a cascade of changes that can lead to synovial cyst development. (2,3) Synovial cysts most commonly occur at the L4-L5 level, but can be seen at the L3-L4 and L5-S1 levels. A third of synovial cyst cases are associated with degenerative spondylolisthesis. (4-8) If degenerative spondylolisthesis is evident on plain radiographs in a patient with radicular symptoms, a synovial cyst should be suspected and advanced imaging considered. (9)

Kahn *et al.* reported that most patients with synovial cysts are in the 6th decade of life. The cysts may be asymptomatic and can be either unilateral or bilateral. Surgical intervention is recommended if the synovial cyst is resistant to conservative care such as an epidural steroid injection of the facet joint, physical therapy, or cyst aspiration. (10) Kahn *et al.* further explained that resection and decompression may be done with or without fusion depending on 3 factors: severity of symptoms, radiological findings (especially stability), and co-morbidities. (10) A grading system has been developed for cysts based on cyst size, the percentage of the canal occupied by the cyst, and the degree of spondylolisthesis to help identify the proper pathway for intervention. (11)

Shah and Lutz discussed the efficacy of the nonsurgical management of 10 patients with symptomatic lumbar synovial cysts. Five of the patients underwent cyst aspiration followed by steroid instillation and five had

¹ Keiser University College of Chiropractic Medicine, West Palm Beach, FL

² Minster Chiropractic Center, Minster, OH

cyst aspiration followed by trans-foraminal epidural steroid injection. Of the 10 patients; only 1 achieved sustained benefits, 8 underwent surgery, and 1 had no benefit but refused surgical intervention. (12) Eshraghi *et al.* reported on the efficacy of fluoroscopically guided lumbar synovial cyst rupture in relation to the relief of radicular symptoms. This study showed immediate relief of symptoms with this procedure and 80% of the patients studied were able to avoid surgery over the time period of the study. (13) Hatgis *et al.* reported a decrease in recurrence of synovial cysts when targeted radiofrequency ablation is added to the cyst aspiration procedure. (14)

In the medical literature, conservative care is considered non-surgical intervention. For back pain, conservative care primarily focuses on epidural steroid or facet injections, pharmaceutical prescriptions, and physical therapy. To a lesser extent, chiropractic management is also considered. Particularly in the case of the conservative management of lower back pain due to a lumbar synovial cyst, the chiropractic management of this condition is not described in the literature as a viable option. Among the accounts of lower back pain patients with synovial cysts that were managed with chiropractic care, there are 4 case reports published in the literature describing the use of Cox® flexion-distraction technic protocols with good results. (4,15-17)

CASE REPORT

History

A 75-year-old male retired mailperson sought care for lower back and right buttock pain. His medical history was significant for Merkel Cell Carcinoma (neuroendocrine carcinoma) of the skin on the left lower extremity 10 years prior, with chronic lymphedema in the left leg as a residual effect from the radiation therapy, controlled hypertension, controlled atrial fibrillation, and a lumbar synovial cyst that was newly diagnosed by his neurologist. He was a non-smoker who reportedly consumed 1-2 alcoholic beverages per week. He had progressively worsening lower back pain radiating into the right buttock, of 4-5 months duration and of non-traumatic origin. He described the pain as a sharp-stabbing pain that worsened when standing, walking downstairs, and during ambulation, notably at right-foot heel-strike. The pain was somewhat relieved when sitting but remained present. During the initial evaluation, he rated his pain as a 3-4 out of 10 (10 being the worst pain possible) while at rest and sitting and was reportedly “fairly severe” when standing or walking.

Examination

He was right-handed, stood 74” tall and weighed 190 lbs. His blood pressure was measured as 147/99 in the right

arm while in the seated position. His right radial pulse was 63 bpm and his respirations were 16 rpm while in the seated position. His postural analysis revealed a left head tilt, high left shoulder, a high right iliac crest, and right rib humping. There was significant swelling in the left lower extremity, for which he wore a compression stocking. He walked with an antalgic, unassisted gait. His active lumbar spine ranges of motion were all decreased (40° flexion, 11° extension, 11° right lateral flexion, 12° left lateral flexion). Right lateral flexion was particularly painful. The patellar and Achilles deep tendon reflexes were assessed as normal (2+/4+) bilaterally. Vibratory sensation was intact at the mid-tibial shaft bilaterally. There was too much swelling in the distal aspect of the left lower extremity to allow for vibratory assessment at the malleoli. Similarly, it was not prudent to have the patient remove the compression stocking for sharp sensory dermatomal assessment with the pinwheel. The motor strength in his lower extremities were considered normal (5/5) bilaterally. Minor’s sign was not present. The straight leg raise test elicited localized low back pain on the right side at approximately 45° of elevation. The well-leg raise test did not elicit any subjective changes to his



Figures 1a



Figures 1b



Figures 1c



Figures 1d

Figures 1a-d. Magnetic resonance imaging. These non-contrast sagittal views demonstrate a large synovial cyst at the L4-L5 level with severe canal stenosis.

condition. The Cox® tolerance test is performed with the patient positioned prone on the treatment table. Starting with the L5-S1 segment, the doctor contacts the spinous process of L5 in a cephalad direction, while flexing the table and holding for 4 seconds, without the patient's ankles restrained. This process is performed at each successive lumbar segment. Provided this maneuver does not exacerbate the patient's condition, the test is next performed while the doctor holds the uninvolved ankle and then the involved ankle, repeating the 4-second distractions at each level, which mimics the use of the ankle restraints. In this case, the tolerance test was considered negative as the patient's complaints were not exacerbated, indicating that there was no contraindication to using flexion-distraction manipulation.

Imaging

An MRI was performed prior to his presentation at our office, revealing the large synovial cyst at the L4-L5 level (see Figures 1a-d).

Treatment

Although there were no specific contraindications to using a high-velocity low-amplitude thrust manipulation in this case, based on the clinical experience of the treating physician, it was determined that a low-force flexion-distraction manipulation would be better tolerated by the patient and provide the best overall outcomes. The treatment plan required him to be treated 3 times per week for 2-4 weeks solely with the Cox® flexion-distraction technic Protocol II, applied to the lumbar spine, seeking 50% relief of pain according to the Cox® Technic System of Back Pain Management protocols. 50% relief is measured subjectively by the patient reporting on a numerical pain scale of 0 (no pain) to 10 (worst pain) and objectively via straight leg raise test, Kemp test, and active lumbar spine range of motion assessment. Cox® Protocol II is a specific spinal manipulation and mobilization in all ranges of motion to the affected segment, L4-L5 for this patient, and is appropriate for patients whose pain does not extend below the knee and/or for those patients that have attained 50% relief of pain from initiation of treatment for radiculopathy. Throughout his chiropractic treatment during this case he remained under the care of his primary care physician, neurologist, and cardiologist. At home, he performed the Cox® Lower Back Home Exercises (#1-4: pelvic tilt, pelvic lift, knee-chest, and hamstring stretch) daily.

Outcome

He was treated a total of 6 visits over 2.5 weeks. Despite the consistent but infrequent care, he felt markedly better following his fourth visit, and we agreed to re-evaluate on his 6th visit. His final evaluation revealed a high left shoulder and high right pelvis. The lumbar spine active

ranges of motion remained somewhat decreased but were non-painful. Minor's sign was not present. The straight leg raise test was negative. Kemp test was negative. His initial subjective pain was rated as a 3-4 out of 10 on the numeric pain scale while at rest and while sitting and although he would not give a numerical value to his pain while standing or walking, he described the pain as "fairly severe". Upon his final visit the subjective pain was rated as a 0 out of 10 while at rest and only a 1-2 out of 10 while standing and walking.

His ODI score improved by 24% with treatment, from the initial visit to the final visit, with improvement noted in the "personal care" and "social life" categories and significant improvement with "lifting" and "changing degree of pain." His active lumbar spine ranges of motion were all non-painful upon final evaluation. His active ranges of motion all demonstrated improvement; with flexion increasing by 3% (42°), right lateral flexion increasing by 4% (12°), and extension and left lateral flexion increasing by 8% (13° and 14° respectively).

At re-evaluation, he determined that his condition was the best that it had been in many months and decided he did not wish to continue with further care. His pain improved significantly with the consistent conservative care and during his last visit he only noted pain in his lower back and no longer experienced pain radiating into the right buttock. His pain was less severe and was only present while standing and walking. He no longer suffered from pain while sitting or bending. We let him know that he had not reached maximum medical improvement and further improvement could be achieved; however, he was discharged as per his request with the recommendation to continue with his prescribed home exercises and to return to my office for any exacerbations. Follow-up conversations via telephone at 3-weeks and 22-months post-discharge revealed he was still feeling well and had not experienced any exacerbations.

DISCUSSION

There is a paucity of information in the literature regarding the chiropractic management of a lower back pain patient with a lumbar synovial cyst. We conducted a PubMed literature search through February of 2022, using "chiropractic management," "chiropractic treatment," "conservative management," "lumbar synovial cyst," and "lumbar facet cyst". Only 6 original papers meeting these criteria were found during our PubMed search, with several other papers citing the original papers.

Two other case reports were discovered during our literature review. Among the 8 original papers that were reviewed, 1 publication described the resolution of symptoms in a 58-year-old female following "chiropractic care" which consisted only of "needle acupuncture,"

“stretches” for the gluteal and hamstring musculature, and “neurogliding” techniques, followed by acupuncture performed by a Traditional Chinese Medicine provider. (18) No chiropractic manipulative procedures were performed in the first case report. High-velocity low-amplitude chiropractic manipulation (HVLA) was the treatment of choice in 3 of the publications. The first case described the unsuccessful application of HVLA in a 70-year-old male. (19) The second case described a 52-year-old female who was unsuccessfully treated with HVLA. (20) Both of these cases resulted in surgical intervention. The last paper described the complete resolution of symptoms of a 76-year-old male who was treated with a combination of HVLA, flexion-distraction manipulation, drop technique, and soft tissue techniques. (21)

The final 4 papers included the successful treatment of 5 individuals with a lumbar synovial cyst, using the Cox® flexion-distraction method. Hazen reported on a case of a 76-year-old female with lower back and left hip pain that extended into the buttock and posterolateral hip to the knee with discogenic spondylarthrosis from L3-S1 and a large L4-L5 left intraspinal extradural synovial cyst that compressed the left L3 nerve root and thecal sac. The treatment consisted of Cox distraction manipulation, positive galvanism, and hydrocollator packs. Although the patient’s symptoms did not completely resolve, she experienced significant improvement and was able to avoid the epidural or facet injections that were recommended by her orthopedic surgeon. (15) Taylor described relief in a 67-year-old female with recurrence of bilateral lower back pain, leg pain, and neurological compromise with a history of lumbar synovial cysts and synovectomy. The treatment consisted of flexion-distraction manipulation, therapeutic exercises, and interferential current therapy. Taylor concluded that surgical intervention may not be necessary for similar cases in the absence of progressive neurological signs. (16) Cox described a case of a 75-year-old man with lower back and radicular pain with synovial cyst-induced spinal stenosis at the L3-L4 level on the right with bilateral stenosis at the L4-L5 level. Treatment consisted of Cox® flexion-distraction and physiological therapeutics and resulted in 80% pain relief after 16 treatments over a 3-month period. (17) Cox and Cox II reported on 2 patients with MRI diagnosed lumbar synovial cysts presenting with lower back and radicular pain. Treatment consisted of Cox® flexion-distraction, physiologic therapeutics, and therapeutic exercise, and resulted in 100% pain relief in both cases with an MRI-documented reduction of the synovial cyst. (4)

Surgical intervention has been recommended for synovial cysts resistant to conservative therapy, (22,23) with resection and decompression with or without fusion the appropriate option. (10) Epstein reported a case of severe spinal stenosis due to large bilateral synovial cysts

at the L3-L4 level which responded well to decompressive laminectomy after failed attempts at relief using 3 successive epidural steroid injections accompanied by attempts at percutaneous cyst aspiration/rupture. (24) A complete or partial laminectomy with resection of the synovial cyst is a standard surgical procedure for symptomatic cysts refractory to conservative management. It is often best accomplished via a contralateral laminotomy to spare the facet. (25)

Controversy about conservative vs. surgical treatment and the need for concomitant fusion exists. The current literature indicates a more favorable outcome with surgery when compared to conservative management. (26) Kratz *et al.* described the frequent relief of radiculopathy with cyst aspiration, but axial back pain relief is often temporary due to the facet arthropathy that created the problem. (27) Shah, in a retrospective case series, reported that 86% of patients undergoing CT guided aspiration had some relief although at 49-month follow-up, 44% had gone on to surgery. (28) Wang described using iGuide navigational software for cyst aspiration in difficult cases where, due to severe arthropathy of the facet, it is difficult to aspirate. (29) A retrospective study of 7 patients with a symptomatic, MRI documented lumbar facet joint cysts having undergone surgical cyst excision without fusion revealed total resolution of symptoms with sustained benefit. All patients had symptoms of lower back and leg pain which was unresponsive to conservative care consisting of bed rest and non-steroidal anti-inflammatory drugs. (26) Khan *et al.* reported on 39 patients who all underwent surgery for synovial cysts with excision with additional fusion performed on 26 of the patients, 22 of whom had degenerative spondylolisthesis. (22) Surgery at the L4-L5 level produced good results, and those at the L5-S1 level and multilevel revealed excellent results. Superior outcomes were noted in patients having undergone spinal fusion. Khan *et al.* concluded that synovial cysts resistant to conservative therapy should be treated surgically. (22)

Domenicucci *et al.* reported on 34 cases of symptomatic lumbar synovial cysts surgically treated with spinal canal decompression with or without spinal fusion. All the patients underwent microsurgical cystectomy through laminotomy or hemilaminotomy, with all 14 spondylolisthesis patients having instrumented fusion. Immediately following surgery, all patients demonstrated remission of pain and a gradual recovery from radicular deficits or claudication symptoms. This study concluded the treatment of choice for symptomatic lumbar synovial cysts was microsurgical cystectomy generally not requiring stabilization. (30) Amato *et al.* concluded that most patients undergoing excision of lumbar synovial cysts will experience excellent or good results, with microsurgery being the treatment of choice. (31) Scholz

performed a retrospective examination of 148 patients who had undergone resection of synovial cysts. In 8 of these patients, full resection was not possible due to the risk of dural tear. Schulz found that none of these 8 patients had a recurrence of the cyst. His conclusion was not to risk full removal if the risk to the dura is high. (32)

Bruder *et al.* reported on the surgical treatment of 141 patients with lumbar synovial cysts and found favorable results with excellent or good clinical outcomes persisting for a long-term follow-up in most cases. They also concluded that facet-sparing surgical techniques preserve the stability of the segment, possibly negating the necessity of fusion. (33)

Spinal fusion has been advocated in cases of spinal synovial cyst excision when pre-operative instability is present, such as in spondylolisthesis. (22,30,34,35). Bruder *et al.* recommend surgical fusion only in cases of severe instability. (36) However, in patients with spondylolisthesis, minimally invasive resection of synovial cysts, without fusion, could provide good relief without inducing segmental instability. (34) Fifty-three patients, 18 with concomitant spondylolisthesis, underwent minimally invasive lumbar synovial cyst resection without fusion. The patients with spondylolisthesis reported good short- and long-term results with no significant post-operative segmental instability. (34)

The importance of this case is concerning the selection of patients. This patient suffered from numerous comorbidities which would render him a surgical risk. He suffered from hypertension, atrial fibrillation, and lymphedema from prior cancer treatment in the left leg for Merkel Cell Carcinoma. A conservative trial of care, if there is not progressive neurological deficit, is warranted especially in a patient with risk factors for surgery. Epstein commented that spine surgeons need to weigh these comorbidities when making surgical decisions. In this case, the patient was neurologically stable and had multiple cardiac morbidities. He was recommended for surgery with fusion by 3 other specialists. Epstein recommended a conservative trial of care because she did not feel spine surgery was safe in this situation. (37)

Limitations

This is a case report and the results in this case may be different for other patients. The Kemp test was not deemed necessary during the initial visit, but it was considered a helpful provocative maneuver during the final visit. For consistency and comparison, it would have been ideal to perform the test during both assessments. No follow-up imaging was done to investigate any changes to the cyst after treatment. During the initial visit, the patient gave a numerical pain rating for his lower back while seated, however, after several attempts to have the patient give a

numerical rating for his pain while standing and walking, he would only mention the pain was "fairly severe." Unfortunately, this prevented us from being able to fully compare the numerical level of pain from the initial to the final visit. Although the ODI and other outcomes assessment tools are the current standard for objectifying that which is inherently subjective, the questionnaires do not always accurately reflect the patient's condition during a specific moment in time, as is the case with this patient during his final visit. According to his final ODI, he was still considered "moderately" disabled, even though his pain was markedly improved on the day and time of his final visit. It is opined that the patient's level of disability during the final visit was not as dire as the ODI rating suggests.

CONCLUSION

The patient's resting pain was reduced to 0 from 3-4/10 and standing pain was reduced from severe to 1-2/10 in this case of lower back and right buttock pain treated with Cox® flexion-distraction manipulation. This improvement was achieved in 6 visits in just less than 3 weeks. The patient suffered from co-morbidities including hypertension, lymphedema, and atrial fibrillation, thus a higher surgical risk. We conclude that the Cox® flexion-distraction manipulation may be a viable conservative treatment option for symptomatic lumbar synovial cysts.

REFERENCES

1. Wilby M, Fraser R, Vernon-Roberts B, Moore R. The prevalence and pathogenesis of synovial cysts within the ligamentum flavum in patients with lumbar spinal stenosis and radiculopathy. *Spine J* 2009;34:2518-2524. doi:10.1097/BRS.0b013e3181b22bd0
2. Gellhorn A, Katz J, Suri P. Osteoarthritis of the spine: The facet joints. *Nat Rev Rheumatol* 2013;9:216-224. doi:10.1038/nrrheum.2012.199
3. Kalichman L, Hunter D. Lumbar facet joint osteoarthritis: A review. *Semin Arthritis Rheum* 2007;37:69-80. doi:10.1016/j.semarthrit.2007.01.007
4. Cox JM, Cox JM II. Chiropractic treatment of lumbar spine synovial cysts: A report of two cases. *J Manipulative Physiol Ther* 2005;28:143-147. doi:10.1016/j.jmpt.2005.01.011
5. Howington J, Connolly E, Voorhies R. Intraspinous synovial cysts: 10-year experience at the Ochsner clinic. *J Neurosurg* 1999;91:193-199. doi:10.3171/spi.1999.91.2.0193

6. Charest D, Kenny B. Radicular pain caused by synovial cyst: An underdiagnosed entity in the elderly? *J Neurosurg.* 2000;92:57-60. doi:10.3171/spi.2000.92.1.0057
7. Bozzao A, Floris R, Fraioli C, Ticca L, Simonetti G. Relapsing-remitting bilateral synovial cysts of the lumbar spine. *Neuroradiology* 2001;43:1076-1078. doi:10.1007/s002340100642
8. Tillich M, Trummer M, Lindbichler F, Flaschka G. Symptomatic intraspinal synovial cysts of the lumbar spine: Correlation of MR and surgical findings. *Neuroradiology* 2001;43:1070-1075. doi:10.1007/s002340100682
9. Reust P, Wendling D, Lagier R, Pageaut G, Reverdin A, Jacquet G, *et al.* Degenerative spondylolisthesis, synovial cyst of the zygapophyseal joints, and sciatic syndrome: Report of two cases and review of the literature. *Arthritis and Rheumatism* 1988;31:288-294. doi:10.1002/art.1780310220
10. Khan A, Girardi F. Spinal lumbar synovial cysts: Diagnosis and management challenge. *Eur Spine J* 2006;15:1176-1182. doi:10.1007/s00586-005-0009-4
11. Mobbs R, Campbell R, Phan K. NeuroSpine surgery research group (NSURG) classification system for grading lumbar synovial cysts. *Orthopaedic Surgery* 2018;10:3-7. doi:10.1111/os.12363
12. Shah RV, Lutz GE. Lumbar intraspinal synovial cysts: Conservative management and review of the world's literature. *Spine J* 2003;3:479-488. doi:10.1016/S1529-9430(03)00148-7
13. Eshraghi Y, Desai V, Cajigal C, Tabbaa K. Outcome of percutaneous lumbar synovial cyst rupture in patients with lumbar radiculopathy. *Pain Physician* 2016;19:e1019-e1025.
14. Hatgis J, Granville M, Berti A, Jacobsen R. Targeted radiofrequency ablation as an adjunct in treatment of lumbar facet cysts. *Cureus* 2017;9:e1318. doi:10.7759/cureus.1318
15. Hazen L, Cox J. Lumbar intraspinal extradural synovial cyst: A case study. *J Neuromusculoskeletal Syst* 1993;1:167-169.
16. Taylor D. Spinal synovial cysts and intersegmental instability: A chiropractic case. *J Manipulative Physiol Ther* 2007;30:152-157. doi:10.1016/j.jmpt.2006.12.002
17. Cox JM Chiropractic management of a patient with lumbar spine pain due to synovial cyst: A case report. *J Chiropr Med* 2012;11:7-15. doi:10.1016/j.jcm.2011.08.007
18. Ngo T, Decina P, Hsu W. Spontaneous resolution of symptoms associated with a facet synovial cyst in an adult female: A case report. *J Can Chiro Assoc* 2013;57:87-92.
19. Firth R. Lumbar intraspinal synovial cyst containing gas as a cause for low-back pain. *J Manipulative Physiol Ther* 2000;23:276-278. doi:10.1067/mmt.2000.106096
20. Arthur B, Lewkonja P, Quon J, Street J, Bishop P. Acute sciatica and progressive neurological deficit secondary to facet synovial cysts: A report of two cases. *J Can Chiropr Assoc* 2012;56:173-178.
21. Timchur M, McCarthy P. Lumbar radiculopathy and synovial cyst in the elderly, with re-imaging following long term conservative intervention: A case report. *Chiropr J Aust* 2016;44.
22. Khan A, Synnot K, Cammisa F, Girardi F. Lumbar synovial cysts of the spine: An evaluation of surgical outcome. *J Spinal Disord Tech* 2005;18:127-131. doi:10.1097/01.bsd.0000156830.68431.70
23. Supe A, Badole C, Babhulkar S, Wandile K. Spinal synovial cyst. *J of Mahatma Gandhi Institute of Medical Sciences* 2015;20:82-84. doi:10.4103/0971-9903.151745
24. Epstein N. Spinal case of the month with short perspective: How would you treat this L3-L4 synovial cyst? *Surg Neurol Int* 2018;9:56. doi:10.4103/sni.sni_27_18
25. Rhee J, Anaizi A, Sandhu F, Voyadzis JM. Minimally invasive resection of lumbar synovial cysts from a contralateral approach. *J Neurosurg Spine* 2012;17:453-458. doi:10.3171/2012.8.SPINE12101
26. Boviatsis E, Staurinou L, Kouyialis A, Gavra M, Stavrinou P, Themistokleous M, *et al.* Spinal synovial cysts: Pathogenesis, diagnosis and surgical treatment in a series of seven cases and literature review. *Eur Spine J* 2008;17:831-837. doi:10.1007/s00586-007-0563-z

27. Kratz B, Buck T, Cramer D. Improvement in radicular symptoms but continued facet arthropathy and axial back pain following rupture of a facet joint synovial cyst. *Neuroscience & Medicine* 2018;9:46-52. doi:10.4236/nm.2018.91006
28. Shah, V, von Fischer N, Chin C, Yuh E, Amans M, Dillon, W, *et al.* Long-term effectiveness of direct CT-guided aspiration and fenestration of symptomatic lumbar facet synovial cysts. *American J of Neuroradiology* 2018;39:193-198. doi:10.3174/ajnr.A5428
29. Wang D, Lownie S, Pelz D. A novel approach to symptomatic lumbar facet joint synovial cyst injection and rupture using iGuide navigational software: A case report and review. *Interventional Neuroradiology* 2016;22:596-599. doi:10.1177/1591019916653253
30. Domenicucci M, Ramieri A, Marruzzo D, Missori P, Miscusi M, Tarantino R, *et al.* Lumbar ganglion cyst: Nosology, surgical management and proposal of a new classification based on 34 personal cases and literature review. *World J Orthop* 2017;8:697-704. doi:10.5312/wjo.v8.i9.697
31. Amato V, Giannachi L, Irace C, Corona C. Lumbar synovial cysts: Microsurgical treatment and outcome in 40 cases: Review and critical analysis of the literature. *J of Spine and Neurosurgery* 2014;3. doi:10.4172/2325-9701.1000139
32. Scholz C, Hubbe U, Kogias E, Klingler JH. Incomplete resection of lumbar synovial cysts: Evaluating the risk of recurrence. *Clin Neurology and Neurosurgery* 2015;136:29-32. doi:10.1016/j.clineuro.2015.05.028
33. Bruder M, Cattani A, Gessler F, Droste C, Setzer M, Seifert V, *et al.* Synovial cysts of the spine: Long-term follow-up after surgical treatment of 141 cases in a single-center series and comprehensive literature review of 2900 degenerative spinal cysts. *J Neurosurgical Spine* 2017;27:256-267. doi:10.3171/2016.12.SPINE16756
34. Denis D, Hirt D, Shah S, Lu D, Holly L. Minimally invasive surgery for lumbar synovial cysts with coexisting degenerative spondylolisthesis. *Int J of Spine Surgery* 2016;10. doi:10.1444/3037
35. Epstein N. Lumbar synovial cysts: A review of diagnosis, surgical management, and outcome assessment. *J Spinal Disord Tech* 2004;17:321-325. doi:10.1097/01.bsd.0000096267.75190.eb
36. Bruder M, Gessler F, Cattani A, Droste C, Seifert V, Setzer M, Marquardt G. Surgical treatment of spinal synovial cysts in elderly patients: Symptoms, treatment course, and outcome in patients >75 years of age. *World Neurosurgery* 2018;110:e520-e525. doi:10.1016/j.wneu.2017.11.031
37. Epstein NE. Avoiding inappropriate spine surgery in a patient with major cardiac comorbidities. *Surg Neurol Int* 2019;10:44. doi:10.25259/SNI-57-2019