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Video Article

Transforaminal Endoscopic Lumbar Foraminotomy for Iatrogenic Foraminal Stenosis Following Vertebroplasty

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We present a case of iatrogenic lumbar foraminal stenosis caused by bone-cement leakage during vertebroplasty, successfully managed using transforaminal endoscopic lumbar foraminotomy (TELF). Vertebroplasty is an effective treatment for osteoporotic vertebral compression fractures (VCFs); however, complications such as bone-cement leakage can lead to vascular or neurological issues, including lumbar radiculopathy. TELF is a minimally invasive surgical option for addressing various forms of lumbar foraminal stenosis. An 82-year-old female patient presented to Gachon University Gil Medical Center with severe right inguinal pain radiating to the anterior thigh and knee. Six months prior, she had undergone vertebroplasty at the L3 level for an osteoporotic VCF at another hospital. Following the procedure, she developed radicular leg pain with a diminished knee jerk reflex, which progressively worsened despite extensive conservative treatment. Magnetic resonance imaging and computed tomography revealed right-sided L3–4 foraminal stenosis caused by bone-cement leakage from the prior vertebroplasty. TELF was performed under local anesthesia to decompress the affected area. Bone-cement fragments, along with hypertrophic bone and ligaments, were successfully removed, achieving sufficient decompression of the exiting nerve root. The patient experienced immediate postoperative pain relief. This case represents the first documented instance of endoscopic decompression for iatrogenic foraminal stenosis following vertebroplasty. TELF, performed safely under local anesthesia, demonstrates its effectiveness as a minimally invasive solution for this rare complication.

Keywords: Bone cement, Endoscopy, Foraminotomy, Lumbar vertebrae, Vertebroplasty

INTRODUCTION

This video demonstrates the transforaminal endoscopic lumbar foraminotomy (TELF) technique for iatrogenic foraminal stenosis caused by cement leakage following vertebroplasty, detailing both the diagnostic and therapeutic processes.

CASE REPORT

An 82-year-old female patient presented with pain in the right inguinal region and anterior thigh and knee. The patient had undergone vertebroplasty due to an osteoporotic vertebral compression fracture (VCF) at the L3 vertebra at another hospital 6 months ago; subsequently, the patient began to experience radicular pain. The visual analog pain score was 9. The physical examination revealed a positive femoral nerve stretch test and diminished knee jerk, whereas the straight leg raising test was negative. The patient underwent transforaminal nerve root blocks three times at the L3–4 level. The patient's symptoms temporarily improved but relapsed the following day.

Written informed consent was obtained from the patient for the use of the surgical video.

1. Preoperative Evaluation

Plain radiographs revealed vertebroplasty at the L3 vertebral body. Magnetic resonance imaging (MRI) of the lumbar spine revealed suspiciously low signal intensity in the right L3–4 foramen; however, compression on the exiting nerve root was not well-defined. Computed tomography (CT) scan of the lumbar spine confirmed leaked bone-cement fragments within the right L3–4 foramen, narrowing the passage of the exiting nerve root.

The history and physical examination were suggestive of right upper lumbar radiculopathy. The imaging (MRI followed by CT scan) confirmed the L3–4 foraminal stenosis caused by bone-cement leakage. Accordingly, we decided to perform a full-endoscopic exploration and decompression of the right L3–4 foramen.

2. TELF Procedure

TELF consists of a percutaneous transforaminal approach and endoscopic decompression of the spine. The patient was placed in a prone position on a radiolucent spine table and the procedure was performed under local anesthesia. First, the transforaminal approach was performed under fluoroscopic guidance; after serial dilation, the working sheath was located in the foraminal zone with an approach angle of approximately 45°.

An ellipsoidal working channel endoscope was inserted for endoscopic exploration. After trimming the tissue debris with a tip-control radiofrequency coagulator, we checked the superior articular process to secure the correct endoscopic orientation. We found a white hypertrophic mass mixed with the facet bone which was compressing the exiting nerve root.

The first step in foraminal decompression was undercutting the superior articular process, including the abnormal lump, using an endoscopic burr. As the bone resection proceeded, we realized that the lump was a whitish bone-cement mixture compressing the exiting nerve root. Foraminal unroofing continued until the ligamentum flavum was sufficiently exposed.

After completing the bone work, the exposed ligamentum flavum was removed. As the soft tissue was progressively decompressed, the exiting nerve root began to emerge and the remaining bone-cement mass was removed. We meticulously controlled any epidural or bone bleeding using a tip-control radiofrequency coagulator and intermittent application of a hemostatic agent, allowing us to continue bone and soft tissue decompression until the axillary epidural space of the exiting nerve root was completely exposed.

After ensuring complete axillary decompression of the exiting nerve root, we proceeded to resect the isthmic portion and part of the pedicle wall along the exiting nerve root. The remaining bone-cement debris and lesions on the ventral side of the dural sac were meticulously removed. This allowed us to confirm a sufficient neural decompression margin around the exiting nerve root and ensure the success of the procedure.

The endpoint of the endoscopic intervention was determined by the presence of free movement and strong pulsations in the exposed exiting nerve root and the dural sac. After confirming the endpoint, the procedure was completed without drain insertion or skin sutures.

3. Postoperative Outcome

The patient experienced immediate pain relief postoperatively and was discharged the following day. She was doing well at the 1-year follow-up visit.

The postoperative axial CT images revealed a well-decompressed foraminal zone with a partially resected superior articular process and bone cement. The postoperative sagittal CT image showed a well-decompressed foraminal zone with a partially resected superior articular process, a part of the pedicle, and bone cement. The postoperative coronal CT image revealed a well-decompressed foraminal zone with partial resection of the pedicle and bone cement. There were no signs of progressive segmental instability or balance problems at the 1-year follow-up visit.

4. Summary

Briefly, the surgical procedure was performed in the following order: local anesthesia in the prone position, transforaminal approach under fluoroscopic guidance, endoscopic bony unroofing using endoscopic burrs, endoscopic soft tissue work using micropunches, full-scale decompression around the exiting nerve root, and determination of the finishing point.

Bone cement-induced lumbar foraminal stenosis may occur after vertebroplasty. During the procedure, the bone cement may leak through the vertebral body and pedicle into the neural foramen, compressing the exiting nerve root.

In conclusion, bone-cement leakage during vertebroplasty can lead to iatrogenic lumbar foraminal stenosis. In such cases, relying only on simple radiography and MRI may be insufficient, and CT can help accurately diagnose bone-cement leakage. TELF is an effective treatment for uncertain foraminal stenosis.

DISCUSSION

Vertebroplasty is a widely accepted, safe, and efficient mini-

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mally invasive procedure for the treatment of VCFs refractory to medical therapy.[1-3] Some authors have reported the development of radicular pain after vertebroplasty,[4-6] considering radiculopathy as a possible complication of vertebroplasty. Herein, we present a unique case of symptomatic lumbar foraminal stenosis caused by bone-cement (polymethylmethacrylate) leakage after vertebroplasty.

In our case, the diagnosis of cement-induced foraminal stenosis was possibly missed because the signal intensity of the leaked cement was not evident on the MRI. CT scans of the patient were not performed at other hospitals; she received only symptomatic treatment, including repeated blocks. When the patient came to our institute, a CT scan was performed which showed the location of leaked cement that compressed the exiting nerve root. Presumably, the bone cement leaked through the weak pedicle wall into the foramen, forming a hard mass that compressed the L3 nerve root. MRI or simple radiography may have limited application in diagnosing abnormalities in bone tissue or solid substances such as bone cement; in such cases, CT may be a more effective tool. Hence, a definitive diagnosis of cement leakage complications after vertebroplasty can be made through detailed anamnesis, physical examination, and comprehensive imaging, with a CT scan playing a crucial role. Despite these efforts, diagnostic accuracy may remain challenging in some cases.

TELF is a percutaneous, full-endoscopic foraminal decompression technique with the typical benefits of minimally invasive spinal surgery. It can effectively decompress the pinched exiting nerve root by removing hypertrophic tissues while preserving the normal surrounding musculoskeletal structures under local anesthesia.[7-9] However, a steep learning curve and technical difficulties associated with the procedure remain critical barriers for aspiring endoscopic spine surgeons.[10]

In clinical practice, lumbar foraminal stenosis may present with different characteristics in terms of the type, degree, and etiology of stenosis. In ambiguous situations such as ours, TELF under local anesthesia can be effective because of its simultaneous diagnostic and therapeutic value. The source of pain can be identified through the patient's response to intraoperative probing as well as visual exploration. Direct probing or stimulation of suspicious structures may reproduce radicular symptoms in awakened patients[8,11]; once recognized, the foraminal stenosis and pinched nerve roots can be decompressed using endoscopic devices. We removed the hypertrophic facet, part of the pedicle, and thickened ligaments using endoscopic burrs and tip-control devices. Our patient complained of concordant radicular pain on probing the exiting nerve root (L3) and gradually experienced symptom relief as foraminal decompression proceeded.

In foraminal stenosis, simple undercutting of the superior articular process and exposure of the exiting nerve root bundle are insufficient. Therefore, TELF should focus on releasing the exiting nerve root, and not just widening the neural foramen. Achieving complete release and sufficient decompression margin at all costs is crucial. To achieve this, the surrounding tissues, including the tip of the superior articular process, isthmus, and a portion of the pedicle wall around the nerve root, should be carefully observed and resected. This wide decompression and extended TELF approach may be necessary to achieve thorough neural release in cases of complicated foraminal stenosis.

It is important to remember that full-scale decompression encompasses both "full exposure" and "enough margin." It has been reported that achieving full-scale decompression ensures improvement in the patient's symptoms and eliminates the occurrence of restenosis.[8,12]

This video holds substantial educational value in highlighting the possibility of iatrogenic foraminal stenosis caused by bone-cement leakage following vertebroplasty, which may be identified based on refractory radicular pain. We also highlight the relevance of endoscopic decompression as an effective treatment for iatrogenic ambiguous lumbar foraminal stenosis.

NOTES

Video File: The video file for this article is available at https://doi.org/10.14245/ns.2449052.526.

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REFERENCES

1. Galibert P, Deramond H, Rosat P, et al. Note préliminaire sur le traitement des angiomes vertébraux par vertébroplastie acrylique percutanée [Preliminary note on the treatment of vertebral angioma by percutaneous acrylic vertebroplasty]. Neurochirurgie 1987;33:166-8. French.
2. Gangi A, Sabharwal T, Irani FG, et al. Quality assurance guidelines for percutaneous vertebroplasty. Cardiovasc Intervent Radiol 2006;29:173-8.
3. Jay B, Ahn SH. Vertebroplasty. Semin Intervent Radiol 2013; 30:297-306.
4. Kelekis AD, Martin JB, Somon T, et al. Radicular pain after vertebroplasty: compression or irritation of the nerve root? Initial experience with the "cooling system." Spine (Phila Pa 1976) 2003;28:E265-9.
5. Laredo JD, Hamze B. Complications of percutaneous vertebroplasty and their prevention. Skeletal Radiol 2004;33:493-505.
6. Kelekis AD, Martin JB. Radicular pain after vertebroplasty: complication and prevention. Skeletal Radiol 2005;34:816.
7. Knight M, Goswami A. Management of isthmic spondylolisthesis with posterolateral endoscopic foraminal decompression. Spine (Phila Pa 1976) 2003;28:573-81.
8. Ahn Y, Oh HK, Kim H, et al. Percutaneous endoscopic lumbar foraminotomy: an advanced surgical technique and clinical outcomes. Neurosurgery 2014;75:124-33; discussion 132-3.
9. Hofstetter CP, Ahn Y, Choi G, et al. AOSpine consensus paper on nomenclature for working-channel endoscopic spinal procedures. Global Spine J 2020;10(2 Suppl):111S-121S.
10. Morgenstern R, Morgenstern C, Yeung AT. The learning curve in foraminal endoscopic discectomy: experience needed to achieve a 90% success rate. SAS J 2007;1:100-7.
11. Knight MT, Jago I, Norris C, et al. Transforaminal endoscopic lumbar decompression & foraminoplasty: a 10-year prospective survivability outcome study of the treatment of foraminal stenosis and failed back surgery. Int J Spine Surg 2014; 8:21.
12. Jasper GP, Francisco GM, Telfeian AE. A retrospective evaluation of the clinical success of transforaminal endoscopic discectomy with foraminotomy in geriatric patients. Pain Physician 2013;16:225-9.

 https://doi.org/10.14245/ns.2449052.526