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Case Report

Transtubular Endoscopic Posterolateral Decompression of the L5 Root under Navigation and O-arm: A Technical Note

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Among studies evaluating minimally invasive surgical (MIS) decompression of the L5 root, techniques involving transtubular endoscopic decompression under O-arm navigation are rare. We present the case of a 68-year-old woman with left leg pain, muscle weakness and gait disturbance of one month duration. The patient underwent transtubular endoscopic decompression under O-arm navigation. There is no radiation hazard to the operating room staff with this procedure. After surgery, the patient had significant pain relief and her left lower limb motor function had improved by follow-up at one year. C-arm-free endoscopic L5 root decompression is a safe and effective procedure.

Key words: C-arm-free, navigation, O-arm navigation, endoscopic surgery, L5 root decompression

L5 radicular symptoms are caused primarily by L4-5 pathology, but may also occur due to foraminal or extraforaminal L5-S1 lesions. Extraforaminal lesions may be discogenic, ligamentous or bony [1,2]. Of all symptomatic lumbar disc herniations, L5-S1 extraforaminal herniations account for approximately 2-4% [3,4]. Because of the very narrow surgical passage at this level, approach is difficult and often requires resection of part of the L5-S1 articular facet, which can lead to instability. The above reasons limit the surgeon's exposure to and familiarity with extraforaminal L5 root decompression. A microendoscopic procedure in combination with navigation can help the surgeon to decompress the L5 root with precision. Additionally, the use of the O-arm system provides intraoperative 3D imaging and presents no risk of radiation exposure to operating room staff and surgeons. To the best of our knowledge, there have been very few studies to date on the use of O-arm navigation for L5 root decompression. This study was approved by the institutional ethics committee of Okayama Rosai Hospital.

Surgical Technique

This procedure is performed under general anesthesia and neuromonitoring. The patient is positioned prone. A navigation reference frame (RF) is placed percutaneously into the contralateral sacroiliac joint, and O-arm (Medtronic, Inc., Minneapolis, MN, USA) images are obtained and transferred to a Medtronic Stealth Station S7 Navigation system (Medtronic). With the help of a navigated probe, the L5-S1 foraminal level is confirmed and the entry point for the skin incision is marked. The subcutaneous tissue and muscles are dissected, and the navigated first dilator is docked at the base of the L5 transverse process. Sequential dilators are inserted over the first dilator, and the final tube is inserted and fixed to the frame held firm by the table (Fig. 1). The level is reconfirmed with the navigated

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probe (Fig. 2). The bone at the base of transverse process and the adjoining lamina are removed with a navigated burr. Further surgical steps are planned according to the pathology. For a ruptured disc, the root is identified and retracted gently, and the disc fragment is removed. In the case of foraminal stenosis, the foramen is widened using a burr. Any compressing soft tissue is removed and the L5 root is identified by its surrounding perineural fat and vessels (Fig. 3).

Postoperatively, the drain is removed after 48 hours. The patient is mobilized as per his or her pain tolerance and discharged with instructions to avoiding lifting weight heavier than 5 pounds and bending forward for 6 weeks.

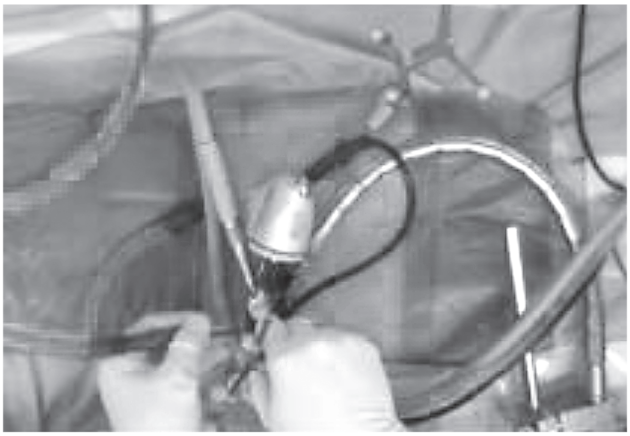


Fig. 1 Placement of the percutaneous reference frame, sequential docking of tubes, and fixture of the final frame.

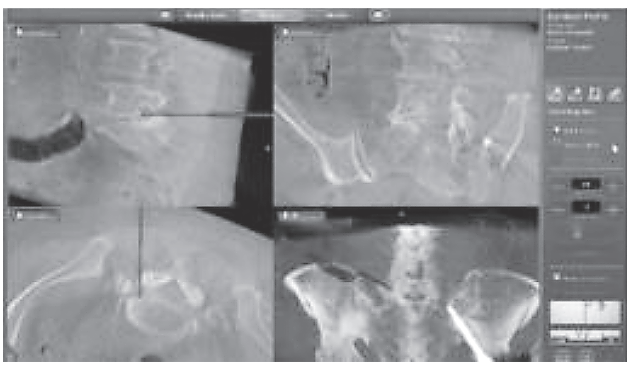


Fig. 2 The level is reconfirmed with the navigated probe.

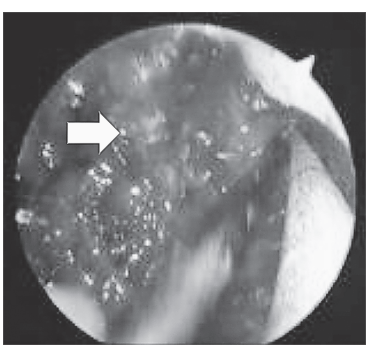


Fig. 3 Identifying the L5 root (white arrow).

Case Presentation

A 68-year-old woman presented to us with left lower limb radicular pain which had progressed over 1 month and was not relieved with oral medication. It was associated with L5 dermatomal paresthesia, a straight leg raising test was negative, and gluteus medius power was grade 4/5, the tendoachilles was 4/5 and the extensor hallucis longus was 4/5 on the left side. Deep tendon reflexes were normal, and there were no signs of upper motor neuron lesions. The patient had a Trendelenburg gait. Magnetic resonance imaging (MRI) demonstrated left L5-S1 foraminal and extraforaminal stenosis without L4/5 central stenosis (Fig. 4A, B). A computed tomography (CT) scan showed osteophytes at the superior articular process and the posterior aspect of the end plates of L5 and S1 (Fig. 5A, B). A diagnostic left L5 root block was performed, which relieved pain. The patient underwent left L5-S1 transtubular endoscopic posterolateral decompression under O-arm navigation. A postoperative CT scan showed adequate decompression of the foramen and extraforaminal stenosis (Fig. 6A, B).

There was significant immediate postoperative pain

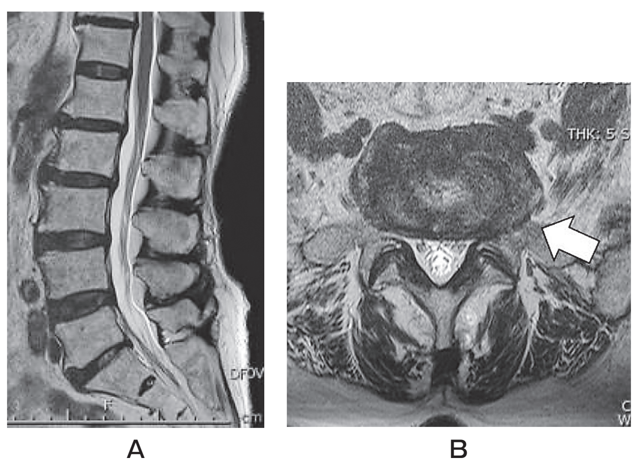
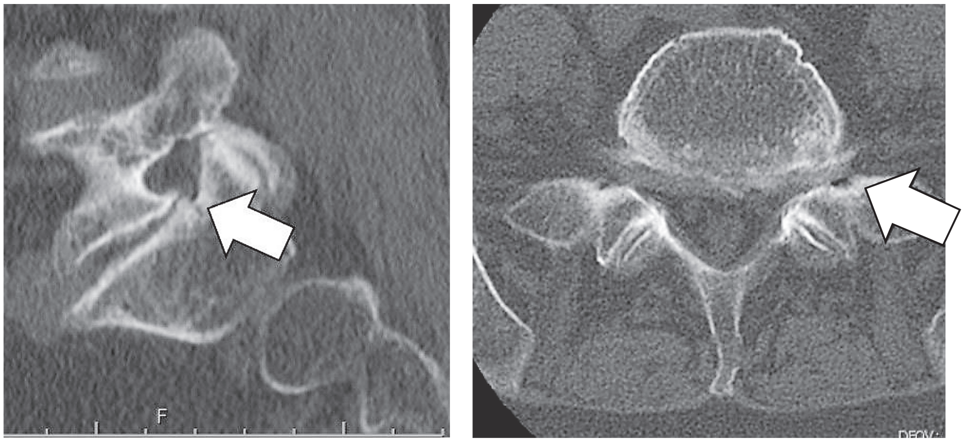
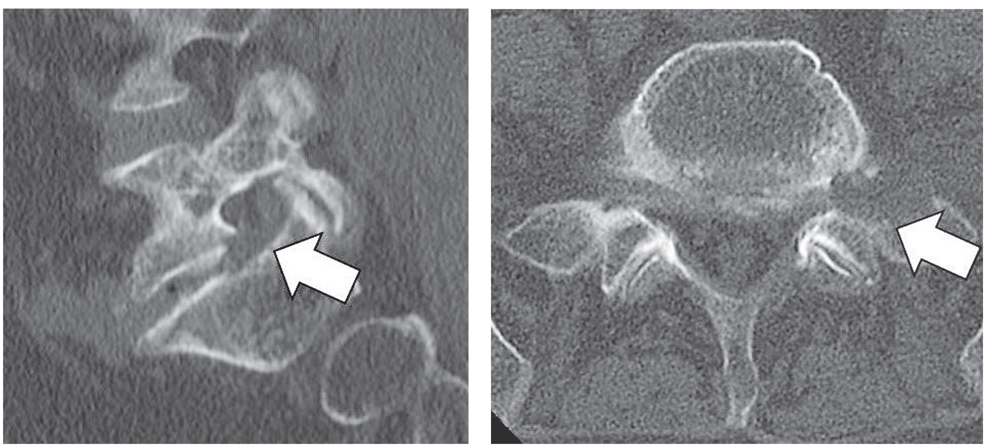


Fig. 4 A, A preoperative magnetic resonance imaging (MRI) sagittal section shows no central stenosis; B, A preoperative MRI axial section demonstrates left L5-S1 foraminal and extraforaminal stenosis (white arrow).



A B

Fig. 5 A, A preoperative computed tomography (CT) scan sagittal section shows osteophytes at the L5-S1 foramen on the left side (white arrow); B, A preoperative CT scan axial section demonstrates osteophytes at the L5-S1 foramen on the left side (white arrow).



A B

Fig. 6 A, A postoperative CT scan sagittal section shows adequate decompression of the foramen and extraforaminal stenosis (white arrow); B, A postoperative CT scan axial section demonstrates adequate decompression of the foramen and extraforaminal stenosis (white arrow).

relief and by the patient's one-year follow-up, her motor function had improved to grade 5/5.

Discussion

The diagnosis and surgical management of foraminal/extraforaminal stenosis and extraforaminal disc herniation at the L5-S1 level is a challenge to every spine surgeon [5]. The broad L5 transverse process, the small space between the sacral ala and the L5 transverse process, the iliac crest, and degenerative changes make the operating window very narrow. Using the conventional open approach for foraminal/extraforaminal decompression requires significant removal of the facet joint, which leads to instability and may further accelerate the rate of degeneration [6]. However, limiting bony removal to prevent instability may lead to inadequate decompression. The literature reports good results with minimally invasive surgery (MIS) techniques (microscopic/endoscopic), provided that adequate decompression of the root is achieved [7-9]. The use of navigation for extraforaminal decompression of the L5 root has been recently studied with good surgical outcomes [10].

Adding O-arm navigation to these procedures provides 3D image guidance and thus helps with accurate placement of the tube. Other benefits are safe decompression of the root, the adequacy of the decompression, and precision in the degree of facet resection, thus avoiding additional instability. The use of a navigated burr during the procedure reduces the surgical time and ensures safety during the decompression. An L5-S1 bony spur that compress the L5 nerve from the ventral aspect can be removed with a navigated burr accurately and safely. Navigation accuracy may decrease if the RF is attached to the operation table instead of to the patient as the distance between the navigated instruments and the RF is greater and there may be movement [11]. If the RF is attached to the spinous process away from the target disc space, navigation accuracy may be hampered. Guha reports in a quantitative study that working within 2 levels to the RF minimizes the risk of navigational error [12]. In our procedure, the RF is placed percutaneously into the contralateral iliac bone through the sacroiliac joint, so it is very stable and close to the L5-S1 disc space. A small stab incision is sufficient for RF placement. With this technique, we can reduce radiation exposure for the surgeon and the operating room staff at centers where a large number of MIS procedures are performed. There might be concern about radiation exposure to the patient. We usually use a small field of view (FOV) and the low-dose mode of the O-arm 3D scan, so one scan takes 24 sec. The radiation/second of O-arm 3D scanning is 4 times that of fluoroscopy, so one O-arm scan is the equivalent of approximately 1.5 min of fluoroscopy in terms of radiation measurement [13].

Although there are many advantages, there are also certain drawbacks to the procedure, such as the need for infrastructure and instruments, and an additional stab incision for the navigation reference frame. Additionally, the accuracy of navigation may be compromised due to movement of the RF, and a new scan may be needed in such a situation.

Conclusion

O-arm and navigation-guided C-arm-free endoscopic L5 root decompression is a safe and effective procedure. There is no radiation hazard to the surgeon or operating room staff.

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