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Technical Report

Step-By-Step Explanation of Full-Endoscopic Lumbar Foraminotomy at the L5/S1 Level Under Local Anesthesia: An Editorial Technical Note

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Abstract

Foraminal stenosis is a type of lumbar spinal canal stenosis. This pathology is a good indication for full-endoscopic decompression surgery using a transforaminal approach, called foraminotomy. However, considering the proximity to the iliac crest, decompression at L5/S1 may be challenging. In this technical note, the technique used to perform foraminotomy at L5/S1 is explained step by step. After local anesthesia with 1% lidocaine, an 8-mm skin incision is made, usually 4 to 5 cm away from the midline. Using a serial dilating maneuver, an 8-mm cannula is docked on the lateral aspect of the superior articular process (SAP). Decompression is started at the SAP and pedicle junction. Drilling then proceeds cranially to the tip of the SAP. About 80% to 90% of the SAP is usually removed, after which the thickened ligamentum flavum (LF) is exposed. The attachment of the LF to the inferior articular process (IAP) of L5 is confirmed. The thickened LF is then detached by drilling the IAP using the high-speed drill. Following removal of the floating LF, the decompressed exiting nerve is visible. Anatomically, the radicular artery runs with the exiting nerve. Pulsation of the nerve is a good indicator of adequate decompression.

Keywords: *Full-Endoscopic Decompression; Foraminal Stenosis; L5/S1 Level*

Introduction

The term "full-endoscopic spine surgery" was adopted worldwide in 2020 after various names had been proposed, including "selective endoscopic" and "percutaneous endoscopic" surgery [1]. The procedure started as discectomy for stenosis and later came to include decompression [2].

There are three types of lumbar spinal canal stenosis, namely, foraminal, lateral recess, and central. Foraminal stenosis is a good indication for decompression via a transforaminal approach [3]. There have been many studies on transforaminal full-endoscopic lumbar foraminotomy (TELF), and good clinical outcomes have been reported [4-7]. However, in terms of anatomical considerations, TELF at the L5/S1 level is more challenging than at other levels from L1/2 to L4/5 due to the iliac crest.

There are several reports of TELF at L5/S1 in the literature but none that provide a precise step-by-step description of the procedure [4-7]. In this editorial technical note, the TELF technique at L5/S1 is explained in detail.

Technical Note

This technical note describes a case of TELF. The patient was a 75-year-old man who presented with a complaint of right leg pain but no neurological deficit. He had undergone posterior decompression at L3/4 and L4/5. However, the right leg pain persisted, so he was referred to us. Magnetic resonance imaging (MRI) revealed obvious foraminal stenosis at L5/S1 (Figure 1). An axial MRI scan also indicated a herniated nucleus pulposus (HNP) on the right lateral side. A hypertrophic superior articular process (SAP) was seen at S1 on a sagittal computed tomography (CT) scan. The diagnosis was foraminal stenosis on the right at the L5/S1 level.

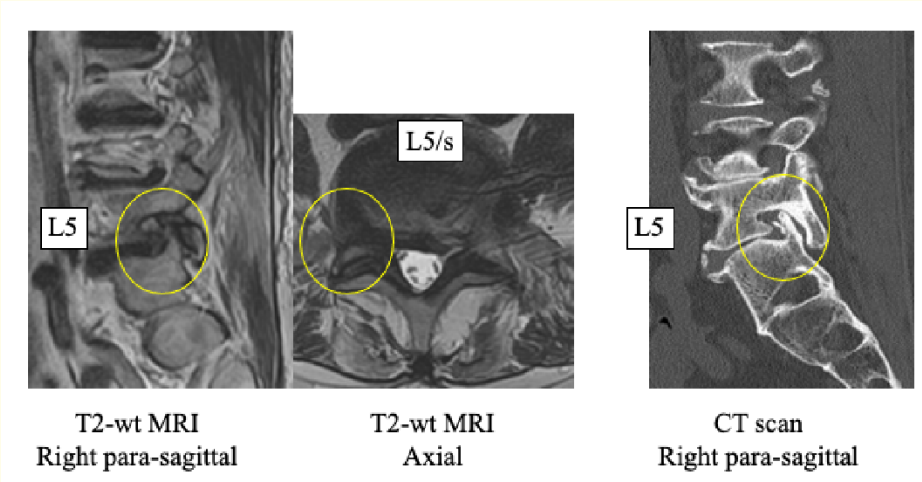

Figure 1: *MRI and CT scans obtained before surgery. The left panel is a sagittal MRI scan showing foraminal stenosis at L5/S1. The middle panel is an axial MRI scan showing herniated nucleus pulposus on the right lateral side. The right panel is a sagittal CT scan showing a hypertrophic SAP at S1. The final diagnosis in this patient was right-sided foraminal stenosis at L5/S1. CT, computed tomography; MRI, magnetic resonance imaging; SAP, superior articular process.*

Surgical technique

For TELF, the skin incision is typically made 4 to 5 cm away from the midline. After local anesthesia with 1% lidocaine, an 8-mm skin incision is made. A total of 20 ml of lidocaine is usually used (i.e. 3 ml for skin, 7 ml for soft tissue, 6 ml for the intra-facet articular space, 2 ml for the endplate, and 2 ml for the surface of the annulus). Blue dye is injected into the disc so that the surface of the disc is easily identifiable. Using a serial dilating maneuver, an 8-mm cannula is docked on the lateral aspect of the SAP.

Figure 2-5 show the endoscopic views in this patient. A view at the start of endoscopic surgery is shown in the left panel of figure 2. Using bone as a landmark, the initial view is the lateral aspect of the SAP. Drilling is started from the S1 pedicle to the SAP junction using a high-speed drill (Figure 2, right). Drilling proceeds cranially from the bottom to the tip of the SAP. The shaved SAP and its tip are seen in the left panel of Figure 3. After removal of the SAP, the L5/S1 facet joint cartilage and ligamentum flavum (LF) are exposed (Figure 3, right panel). The SAP is drilled further, exposing the inferior articular process (IAP) at L5 and the LF (Figure 4, left panel). The dorsal aspect of the IAP at L5 is then shaved with the drill to detach the LF, using a technique known as lumbar undercutting laminectomy (LUL) [8]. Following this maneuver, the thickened LF is completely floating and shows pulsation (Figure 4, right panel). In the case shown here, the blue-colored HNP on the right lateral side was removed (Figure 5, left panel). After removal of the HNP and thickened LF, the decompressed exiting nerve root (ENR) at L5 was seen. The ENR shows pulsation, indicating complete decompression (Figure 5, right panel).

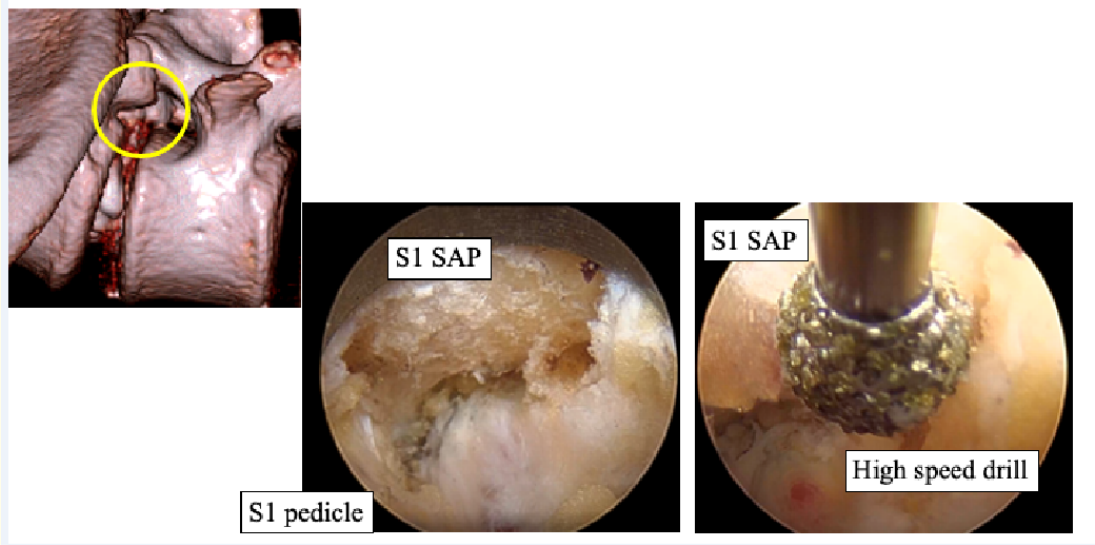

Figure 2: *Endoscopic view, part 1. Bone is a good landmark that the operator can use for orientation. The initial view is the lateral aspect of the SAP (left panel). Drilling is started from the S1 pedicle and the SAP junction at S1 using a high-speed drill (right panel). SAP, superior articular process.*

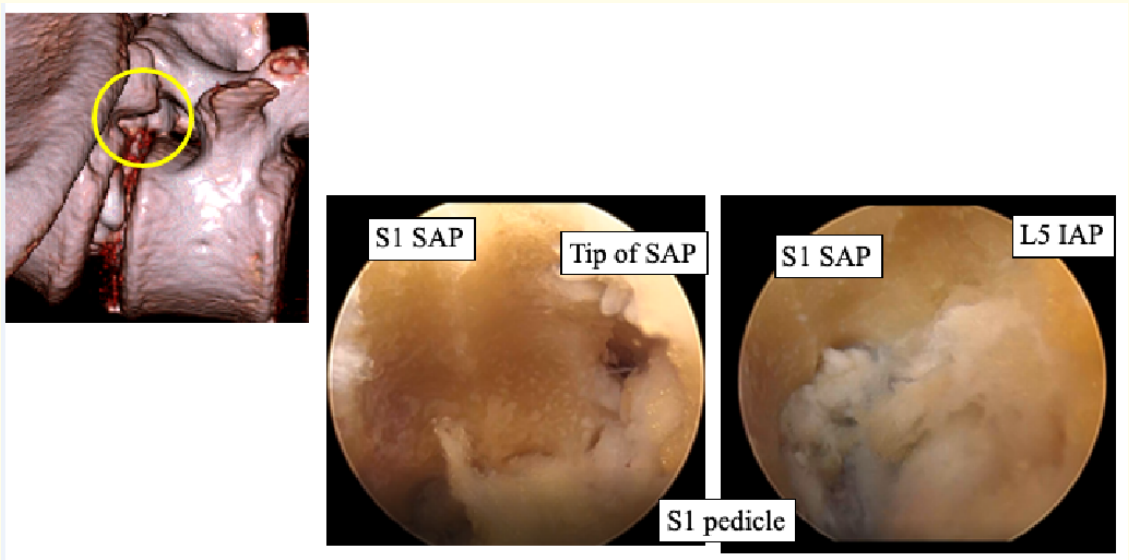

Figure 3: *Endoscopic view, part 2. Drilling proceeds from the bottom to the tip of the SAP. The left panel shows the shaved SAP and its tip. The right panel shows the cartilage at the L5/S1 joint and ligamentum flavum after removal of the SAP. IAP, inferior articular process; SAP, superior articular process.*

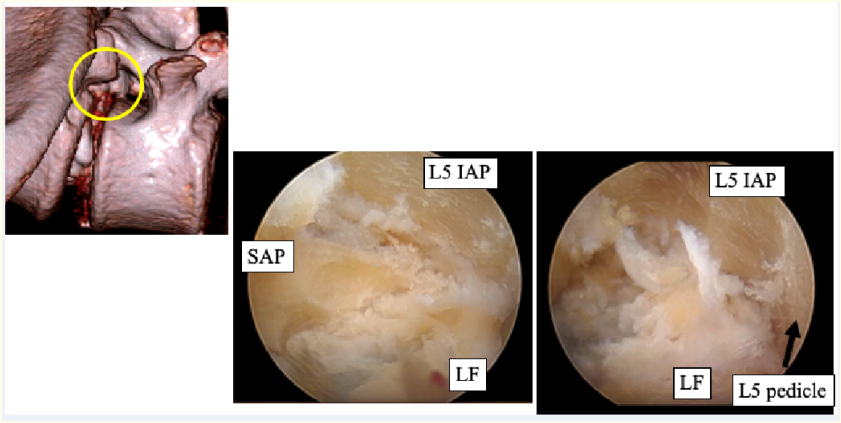

Figure 4: *Endoscopic view, part 3. The SAP is further drilled, after which the L5 IAP and LF can be clearly seen (left panel). The dorsal aspect of the L5 IAP is shaved to detach the LF. Following this maneuver, the thickened LF is floating and has started pulsation (right panel). IAP, inferior articular process; LF, ligamentum flavum; SAP, superior articular process.*

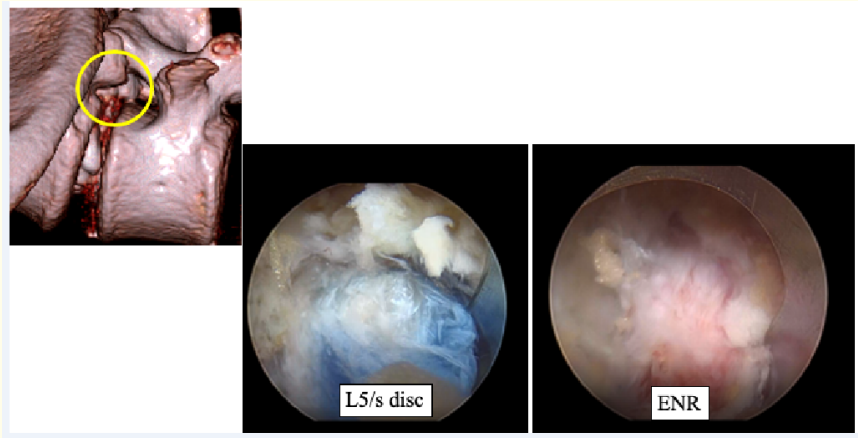

Figure 5: *Endoscopic view, part 4. The herniated nucleus pulposus on the lateral side is dyed a blue color and then removed (left panel). After removal of the herniated nucleus pulposus and thickened ligamentum flavum, the decompressed ENR at L5 appears. The ENR shows pulsation, indicating complete decompression. ENR, exiting nerve root.*

In this case, the right leg pain disappeared immediately after surgery. The CT scans obtained before and after TELF confirmed removal of the SAP and significant enlargement of the foraminal area (Figure 6). A three-dimensional CT scan (Figure 7) showed resection of the SAP with more than 50% of the facet contact space remaining at L5/S1.

Discussion

In this technical note, we have explained the technique used for efficient decompression of foraminal stenosis at L5/S1. Unlike the other lumbar levels, access to the foramen at the L5/S1 level may be anatomically challenging. However, access is technically possible if

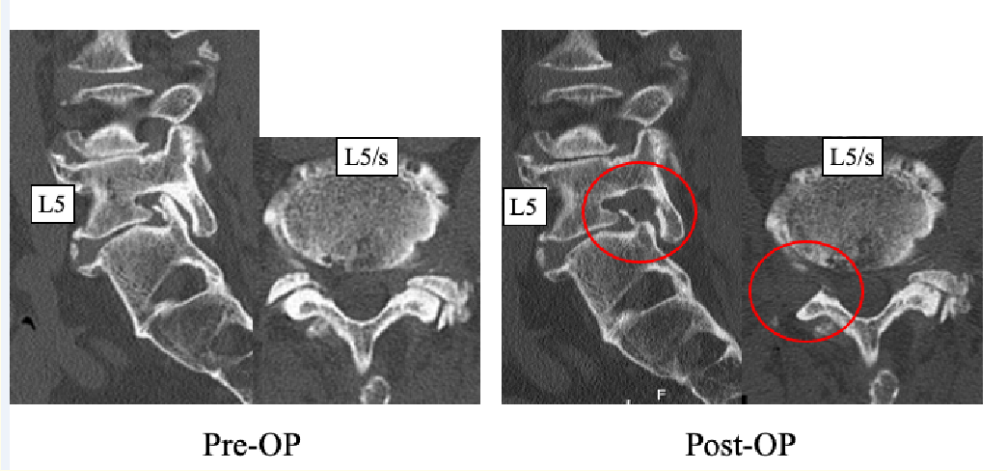

Figure 6: *Computed tomography scan before and after full-endoscopic lumbar foraminotomy. After surgery, the superior articular process is removed and the foraminal area is significantly enlarged.*

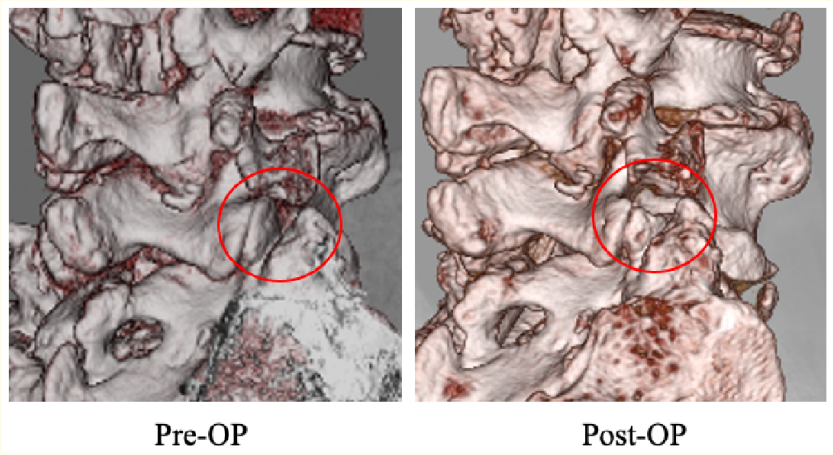

Figure 7: *Three-dimensional computed tomography scans obtained before and after surgery confirm complete resection of the superior articular process. However, the facet contact space at L5/S1 is still more than 50%.*

the needle reaches the junction of the SAP and pedicle. Using the needle and guidewire, a cannula can be placed at the junction. A useful mnemonic is “bone is my friend” or “bone is home”. The starting point of TELF must always be bone and not soft tissue. The left panel in figure 2 shows the initial endoscopic view when this procedure is used.

The steps that are important for successful TELF can be summarized as follows:

1. Docking the cannula onto the SAP bone
2. Identification of the bone

3. Removal of the SAP
4. LUL of the IAP and detachment of the LF from the bone
5. Removal of the LF
6. Confirmation that the nerve root is decompressed.

As described above, steps 1 and 2 are important initial steps. We would like to emphasize that step 4 is also important. Following LUL at the L5 IAP, the hypertrophic LF is detached [8]. This bony resection procedure is essential for effective and complete removal of the LF. Until the introduction of LUL during TELF surgery, it was very difficult to remove the LF via the small working channel. We strongly recommend LUL for significant and effective osseous and soft tissue decompression of the exiting nerve root.

Having adopted this 6-step procedure for TELD, we can regularly conduct effective and efficient decompression by foraminotomy even at the L5/S1 level. We also present the case of an 82-year-old woman in whom TELD was performed for left leg pain caused by foraminal stenosis at the left aspect of L5/S1. CT scans obtained before and after osseous decompression of the foraminal stenosis are shown in figure 8. The full-endoscopic view in the final step of TELD is shown in the middle panel of this figure.

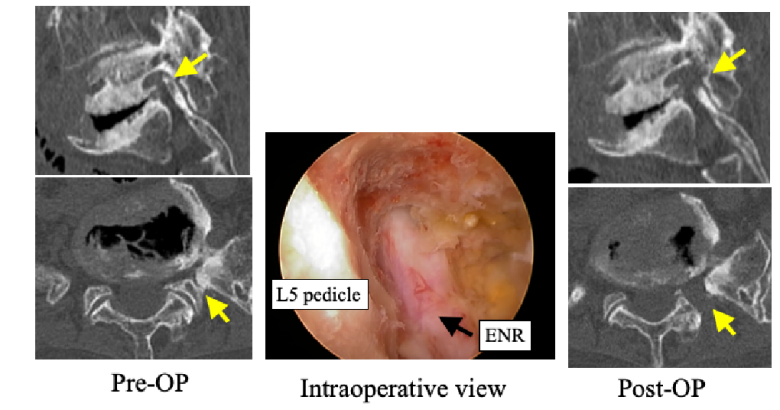

Figure 8: *Computed tomography scans and an endoscopic view for an 82-year-old woman who presented with left leg pain caused by left-sided foraminal stenosis at L5/S1. Comparison of the computed tomography scans obtained before and after surgery confirms osseous decompression of the foraminal stenosis. The full-endoscopic view at the final step of lumbar decompression is shown. Complete decompression of the exiting nerve is obvious. ENR, exiting nerve root.*

To our knowledge, the report by Ahn., *et al*. [9] was the first to describe TELF. For decompression, they used a bone reamer, endoscope forceps, and a laser. Unlike with our technique, they initially did not use a high-speed drill. More recently, Song., *et al*. [10] described their technique in detail. For bony resection, they mainly use an endoscopic trephine. Ahn., *et al*. [11] subsequently used a high-speed drill, as in our technique, and also described their procedure in detail. Their technique differs from ours in two ways. The first difference is that their starting site is the disc surface whereas ours is facet bone, reflecting the concept of "bone is my friend". The second difference is that our technique includes LUL, which allows us to detach the thickened LF from the lamina and remove it easily and completely.

Conclusion

Given that this article is a technical note, the clinical results of TELF are not described in detail. Using this procedure, the short-term results are often acceptable. However, it is important to have information on the long-term outcomes when this technique is used.

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