



## Review Article

# State-of-the-art transforaminal percutaneous endoscopic lumbar surgery under local anesthesia: Discectomy, foraminoplasty, and ventral facetectomy<sup>☆</sup>

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## ABSTRACT

Transforaminal (TF) percutaneous endoscopic surgery for the lumbar spine under the local anesthesia was initiated in 2003 in Japan. Since it requires only an 8-mm skin incision and damage of the paravertebral muscles would be minimum, it would be the least invasive spinal surgery at present. At the beginning, the technique was used for discectomy; thus, the procedure was called PELD (percutaneous endoscopic lumbar discectomy). TF approach can be done under the local anesthesia, there are great benefits. During the surgery patients would be in awake and aware condition; thus, severe nerve root damage can be avoided. Furthermore, the procedure is possible for the elderly patients with poor general condition, which does not allow the general anesthesia. Historically, the technique was first applied for the herniated nucleus pulposus. Then, foraminoplasty, which is the enlargement surgery of the narrow foramen, became possible thanks to the development of the high speed drill. It was called the percutaneous endoscopic lumbar foraminoplasty (PELF). More recently, this technique was applied to decompress the lateral recess stenosis, and the technique was named percutaneous endoscopic ventral facetectomy (PEVF). In this review article, we explain in detail the development of the surgical technique of with time with showing our typical cases.

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## 1. Introduction

In the last century percutaneous nucleotomy (PN) was developed by Hijikata [1]. Since the skin incision was minimal and small cannula was inserted into the canal, it can be performed under local anesthesia. According to the Hijikata method, the position of the cannula was confirmed under the C-arm fluoroscopic not the endoscopic guidance; therefore, it was unable to introduce a cannula into a herniated mass in the neural canal. Following some frontiers tried to introduce the spinal endoscope with the PN technique [2–6], with single-portal endoscopic discectomy being developed around the end of the last century [4–6]. This technique is called as the percutaneous endoscopic lumbar discectomy (PELD). This procedure was introduced by

Dezawa in 2003 in Japan [7]. The PELD was initially indicated for herniated nucleus pulposus (HNP) [4–8].

Basically, the PELD cannula is inserted through the intervertebral foramen from the posterolateral side of the back like the Hijikata's PN technique [4–6], and this procedure is called transforaminal (TF) approach. It can be done under the local anesthesia. The shortcoming of TF-PELD would be difficulty of the access into the spinal canal through the L5-s intervertebral foramen in cases with high iliac crest. In such cases, a cannula would be very hard to safely inserted appropriately into the spinal canal from the posterolateral aspect; thus, interlaminar (IL) approach was developed [9,10]. However, IL-PELD usually requires general anesthesia, which is its main disadvantage compared with TF-PED. TF-PED can be done with the local anesthesia.

The greatest benefit of the TF-PELD would be what can be done with the local anesthesia. Kitahama et al. [11] reported a successfully treated HNP case by TF-PELD under the local synesthesia, who were combined with severe general comorbidities and were not allowed to have the general anesthesia. In the developed countries, the population is getting elderly year by year, and aging society is quickly coming. Many aged patients would be combined with

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general comorbidities such as lung, heart, and kidney dysfunction, may not be indicated for procedures performed under general anesthesia. For such standpoint, the endoscopic surgery under the local anesthesia must be beneficial for elderly patients.

The TF-PELD technique has been developing recently with the invention of the ultra-thin high speed surgical drill [9,10,12]. Using the drill, bone resection can be safely done under the endoscopic guidance. Percutaneous endoscopic lumbar foraminoplasty (PELF) is the second stage following the PELD, and it is the enlargement surgery of the foraminal stenosis of the lumbar spine using trephine and/or the high speed drill [13–15]. Finally, more recently, the PEVF (percutaneous endoscopic ventral facetectomy) was proposed [16]. Using the PEVF technique, both of foraminal and lateral recess stenosis can be decompressed. In this review article, we explain in detail the PELD, PELF and PEVF surgery with introducing the typical cases.

## 2. PELD (percutaneous endoscopic lumbar discectomy)

As described in the introduction section, the PELD was established early in the 21st century [4–6]. In Japan, the PELD was introduced by Prof. Dezawa in 2003 [7]. Initially, the PELD would be the endoscopic technique based on the Hijikata's PN technique [1]; thus, the transforaminal approach was the main procedure [4–8]. Most of the type of the herniated nucleus pulposus (HNP) except intra-canicular type at L5-s with the high iliac crest would be the good indication. According to the review article by Gore and Yeung [17], the clinical results of TF-PED was good, and almost 90% of the patients reported satisfactory. Morgenstern et al. [18] analyzed the learning curve of this procedure. They stated that after 72 cases of experience, one may reach the goal of 90% of good/excellent results for TF-PELD.

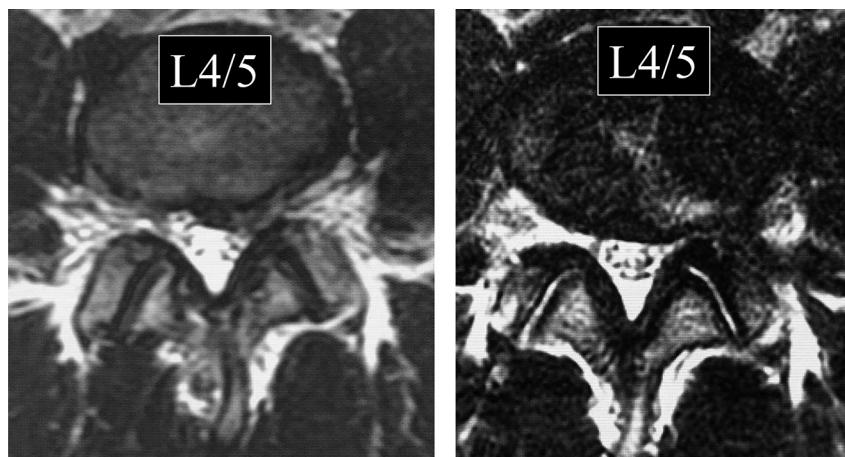
Fig. 1 is a typical case of the TF-PELD. This patient was 16 y.o. girl, and long jump athletes. After the 3 months conservative treatment, she was referred to us with the severe left leg pain and muscle weakness. SLRT was positive at 10° at the left side. T2-MRI at L4-5 indicates herniated nucleus pulposus (HNP) at the left side (Fig. 1, left). Immediately after the surgery, pain disappeared. By the TF-PELD, the HNP was successfully removed under the local anesthesia (Fig. 1, right). There were no surgery-related complications.

For four weeks after the surgery, she concentrated on stretching and trunk core muscle training. Thereafter, jogging and jumping was started. Eight weeks after the surgery, she attended local competition.

### 2.1. Advanced technique of the PELD – foraminoplasty PELD

If you insert the cannula in the narrow foramen, the cannula may compress the exiting nerve root, causing post-operative dysesthesia. To prevent this complication, foraminoplasty, high speed drill and/or trephine reamer have been used [14,15,19–22]. Henmi et al. [22] measured foraminal distance (distance between posterior edge of the disc and ventral aspect of the facet joint) and found that in most of the cases the distance was less than 8 (mm), which is the diameter of the cannula of PELD. After the foraminotomy, it increased over 8 (mm); thus, they concluded that the foraminoplasty would be effective to prevent the exiting nerve injury. Fig. 2 demonstrates the endoscopic view after the foraminoplasty. The superior articular process of L5 was shaved smoothly and cancellous bone was observed. Ligamentum flavum is also clearly identified, and migrated HNP fragment was dyed in blue. With looking at the color, the HNP could be safely removed.

Fig. 3 presents the HNP case at L4-5 with hypertrophy of facet joint. This case is 86 years old, male. He complained of severe left leg pain. As for the pre-surgical planning, the insertion of the cannula on an appropriate location would be considered to be hard because of the hypertrophy of the facet joint. The right panel indicates CT-discography. Due to the hypertrophy of the facet joint, the cannula seems to be hard to access close to the HNP fragment in the spinal canal. We conducted enlargement of the intervertebral foramen by the foraminoplasty to safely insert the cannula just beneath the HNP (Fig. 4, left). Arrows in the Fig. 4 (left) indicate the area of the foraminoplasty. The HNP was successfully removed by TF-PELD after the foraminoplasty (Fig. 4, right). Immediately after the surgery, the strong leg pain decreased. There was no surgery-related complication. This patient was very old aged over 85; thus, the surgery under the local anesthesia was helpful for him. He started walking 1 h after the surgery.



**Fig. 1.** Typical case of the TF-PELD. This patient was 16 y.o. girl, and long jump athletes. T2-MRI at L4-5 indicates herniated nucleus pulposus (HNP) at the left side (left). The HNP was successfully removed under the local anesthesia (right).

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