Percutaneous Endoscopic Lumbar Discectomy on L5-S1: Comparison of Modified Knee-Chest and Prone Position in Terms of Foraminal Height and Puncture Time

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To the Editor: Percutaneous endoscopic lumbar discectomy (PELD) becomes increasingly popular among spine surgeries in recent years. PELD is one of the minimally invasive spine surgeries with significant advantages including small incision, less muscle stripping, and enhanced postoperative recovery.[1]

Theoretically, PELD can be used in lumbar intervertebral disc herniation of all segments including L5-S1. However, due to high crista iliaca, intervertebral foramen stenosis, transverse process, and sacral ala hypertrophy at L5-S1 level, the establishment of the working access remains a challenge.[2] Different surgical positions may produce influence on intervertebral foramen height. Prone position is the common position used for access to the spine during spinal surgery, which could cause an increase in lumbar lordosis and minimized foramen height. The aim of this study was to assess the difference for foramen height between modified knee-chest (MKC) position and prone position during the PELD procedure and the influence on puncture time on L5-S1 with different positions.

The study was conducted in accordance with the *Declaration of Helsinki* and was approved by the Ethics Committee of PLA Army General Hospital. As a retrospective study and data analysis was performed anonymously, this study was exempt from the informed consent from patients.

Medical records of sixty consecutive patients who underwent L5-S1 PLED were reviewed retrospectively. MKC position was used in thirty of patients from May 2014 to May 2015 (23 male and 7 female patients, aged 16–41 years with an average of 31.7 years). The duration of the symptoms ranged from 2 months to 24 years with an average of 92 months. Thirty patients underwent L5-S1 PLED in prone position from June 2013 to April 2014 (19 male and 11 female patients, aged 17–35 years, with an average of 25.6 years). The puncture time with a 18G needle in two different positions was recorded. The puncture time was defined as the duration from lidocaine infiltration anesthesia to the establishment of working channel. The intraoperative and postoperative complications were also recorded in all the patients.

All the patients involved met the inclusion criteria: diagnosed with L5-S1 intervertebral disc herniation by preoperative magnetic resonance imaging scan, radiating limb pain, and positive straight leg raise test. The patients who met the exclusion criteria were excluded from the study: previous operation history on L5-S1 level, lumbar instability, patients with transitional lumbosacral vertebral, and ankylosing spondylitis and other types of spinal deformity. All the surgeries were performed by two surgeons having specialized training in spinal neurosurgery.

A tangent line was drawn along the inferior border of L5 pedicle, and another parallel line passing the tip of S1 superior facet joint was also made on the lateral fluoroscopic images in different position. The vertical distance between the two parallel lines was recorded [Figure 1a], and the intervertebral foramina enlargement ratio was calculated as follows.

Foramen enlargement ratio = Modified knee-chest position − prone position/prone position.

The patients were placed prone with the arms away from the side of the body. Care is taken to line up the patient with the C-arm to ensure a perfect lateral view for fluoroscopic imaging. The surgical level must be centered to avoid parallax error. First, a standard lateral X-ray of the lumbar spine was taken using C-arm (SIEMENS ARCADIS Orbic, Germany), and then the patient was requested to change the posture to knee–chest position on the antilordotic frame. The patient rested on the knees and chest with head was turned to one side, arms extended on the bed, and elbows flexed and resting so that they partially bear the patient's weight; the abdomen remained unsupported, though a small pillow might be placed under the chest; with bilateral 45° hip flexion as well as a 30° knee flexion until the "flat-back" of the patient could be seen. Under the knee–chest position, another lateral X-ray of lumbar spine was taken. In order to eliminate the influence of the magnification rate under different

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position, we marked the both horizontal and vertical distance from the tube to the patients' skin in every different case [Figure 1b].

For the statistical analysis, SPSS15.0 was used (SPSS Inc., USA). The *t*-test was performed to analyze the difference the duration time of puncture and foraminal height under different position. Statistical significance was set at $P < 0.05$.

All the patients received surgery under local anesthesia. No postoperative infection of intervertebral space, dural tear, or abdominal organ injury was recorded in both groups. One (3.33%) patient with prone position presented postoperative pain hypersensitivity of the right leg after surgery, which was considered as postoperative dysesthesia (POD). The patient was treated with medications of dehydration and nerve nutrition. The symptoms completely disappeared 3 weeks after the operation. Patients in knee–chest position had shorter puncture time compared with those in prone position ($P < 0.05$). Foramen height under prone position was 7.49 ± 0.69 mm, while it was 11.76 ± 1.80 mm in knee–chest position. There was also a significant difference in foramen height ($P < 0.05$). The changes of puncture time, foramen height, and foramen enlargement ratio under different positions are shown in Table 1 and Figure 1c.

The use of PELD has been rapidly increasing in the last decade since the introduction of fully endoscopic spine surgeries. As a minimally invasive surgery, PELD has less bleeding volume and surgical trauma, lower anesthetic risk, and shorter hospital stay than conventional open surgery.[3] However, even for experienced surgeon with specialized training in spinal neurosurgery, the learning curve in PLED is still very steep. The unique anatomic features of the L5–S1 space include a large facet joint, narrow foramen, small disc space, and a wide interlaminar space. Endoscopic lumbar discectomy is performed via 2 routes: transforaminal and interlaminar. The two techniques are distinct in the involved surgical anatomy and utilized instruments. The surgical route depends on several variables: relative placement of the iliac bone and L5-S1 disc space, disc location, and surgeon's preference.[4] Most of surgeons prefer to use the prone position during PELD, while most foreign spine surgeons prefer lateral position.[5]

Table 1: Comparison of puncture time, foramen height, and enlargement ratio of foramen

Items	Prone position ($n=30$)	MKC position ($n=30$)	Enlargement ratio	*P*
Puncture time (min)	42.4 ± 8.2	36.2 ± 7.1		0.0038
Foramen height (mm)	7.49 ± 0.69	11.76 ± 1.80	57.0%	<0.05

MKC position: Modified Knee–Chest position.

When the lateral position was adopted, the patient was asked to bend the body to facilitate increased lumbar kyphosis. With the lateral position, the working channel is more accessible to be introduced due to the widening foramen.[6] Another advantage of the lateral position in PELD operation is that the patient with severe leg pain might be more comfortable in this position. However, adopting lateral position in PELD also has some limitations, such as eye–hand coordination problem due to the rotation of the image on the monitor, difficult to maintain the proper position during the operation, and poor satisfaction.

Prone position is an anatomical term that indicates a face-down body position, which is often used during the lumbar surgeries. PELD is performed under local anesthesia, the tolerance of the patients should be considered during the operation due to aggravated sciatica. Because transforaminal endoscopic discectomy surgery has a steep learning curve which requires many years of training and experience, patients who were treated at the beginning of the learning curve sometimes have bad experience of pain during the procedure. Most of spine surgeons prefer knee–chest position during the lumbar spine surgery instead of prone position.[7] The classic knee-chest position with 90° hip flexion may easily slow down the velocity of blood flow and lead to the postoperative thromboembolic complications. In our study, knee–chest position is modified with bilateral 45° hip flexion as well as a 30° knee flexion, which means the femur and knee angels are little more than classic knee-chest position. The patient was well padded at the pressure points. We found that patients with knee–chest position had shorter puncture time compared with those with prone position and the difference was significant. The possible reasons are that the entry point of puncture at the L5-S1 level is 12–14 cm away

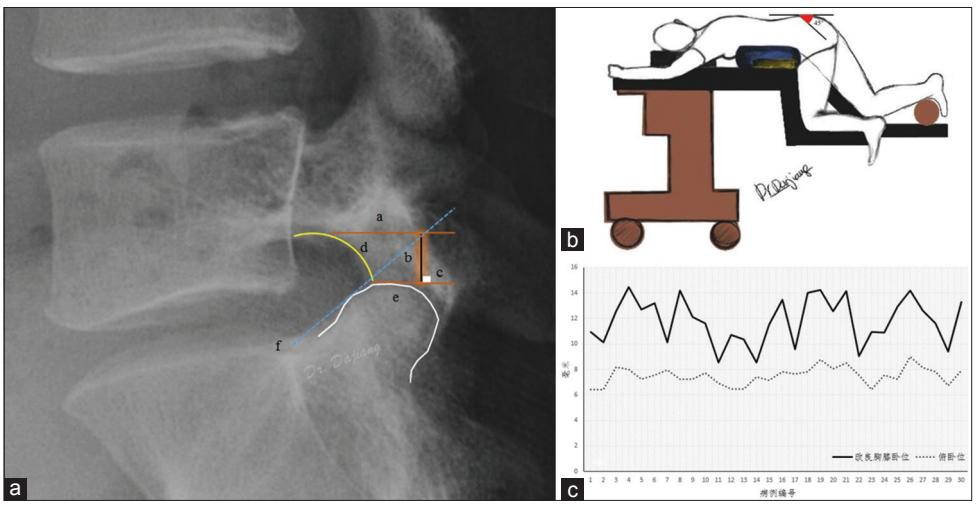

Figure 1: Foramen height measurement. a: Inferior margin of L5 pedicle; b: foramen height; c: parallel line crossing superior facet of S1 to line a; d: superior facet of S1; f: puncture trajectory (a). Comparison of modified knee-chest position and prone position. A diagram of modified knee-chest position with hip flexion (45°) and knee flexion (30°) (b). Posture pads are also indicated. Changes of foramen height in different positions (c).

from the spinal midline, which is greater than that at the L4/5 level. With the more lateral entry point, hypertrophy of L5 transverse process and the sacral wing would obstruct the puncture pathway and the duration of puncture time might be prolonged accordingly. The foramen height will be widened in MKC position with an enlargement ratio of 57% compared with classic prone position. Besides, with the enlargement of the foramen height, the distance between inferior articular facet of S1 and existing nerve root was increasing accordingly, which might lower the risk of neurologic deficit. POD was occurred in one patient in prone position. During the operation, the patient felt radiating leg pain when the foraminoplasty was performed. In our study, the incidence of POD was similar with other studies.[8,9]

At the L5-S1 level, PELD via a transforaminal route is challenging due to the obstructive anatomy. The iliac crest and the inclination of the L5-S1 level frequently obstruct transforaminal approach, leading to a steeper trajectory angle that reached far from the extruded disc.[10] Many factors may be responsible for the establishment of working channel during the PELD. Prone position could cause a significant rise in the caval pressure and diversion of blood into the vertebral vein. MKC position could disperse the body weight, especially in some obese patients, the respiratory complication can be altered because of a decreased respiratory compliance. In addition, the increased distance between L5 transverse process and sacral wing and enlarged foramen height could put the patient at lower risk of neurological complications.

In conclusion, there were more advantages in L5-S1 PELD using MKC position than prone position during the PELD procedure. In addition, enlarged foramen height might put the patient at lower risk of neurological complications.

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Conflicts of interest

There are no conflicts of interest.

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