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Percutaneous lumbar foraminoplasty and percutaneous endoscopic lumbar decompression for lateral recess stenosis through transforaminal approach: Technique notes and 2 years follow-up

Zhen-zhou Li*, Shu-xun Hou, Wei-lin Shang, Zheng Cao, Hong-liang Zhao

The Department of Orthopedic Surgery, The First Affiliated Hospital of Chinese PLA's General Hospital, People's Republic of China

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ABSTRACT

Objective: To evaluate the outcome and safety of percutaneous lumbar foraminoplasty (PLF) and percutaneous endoscopic lumbar decompression (PELD) with specially designed instrument for lumbar lateral recess stenosis with/without herniated discs (HDs).
Method: From August of 2011 to August of 2013, 96 patients met the inclusion criteria were treated with PLF-PELD and 85 cases were followed up to 2 years postoperatively. MRI or CT checkup performed in the next morning after operation. Outcomes of symptoms were evaluated by follow-up interviews at 3 months, 6 months, 1 year and 2 years after surgery. Low back pain and leg pain were measured by Visual Analog Scale (VAS) score (1–100). Functional outcomes were assessed by using Oswestry Disability Index (ODI) and modified MacNab criteria.
Result: Two years follow-up data were obtained from 85 cases, including 14 cases on unilateral L3-4, 1 case on bilateral L3-4, 49 cases on unilateral L4-5, 3 cases on bilateral L4-5, 12 cases on unilateral L5S1, 1 case on bilateral L5S1, 3 cases on unilateral L3-5 and 2 cases on unilateral L4-S1. So totally 95 lumbar lateral recesses were decompressed. Patients ranged in age from 46–78 years (mean age, 56.7 years), including 36 males and 49 females. 56 cases combined with HDs. Low back pain and leg pain were significantly relieved after surgery in all patients. 3 patients were complicated with dysesthesia in distribution of exiting nerve that was all operated at L5S1. Postoperative MRI/CT examination showed adequate decompression of lateral recess and removal of combined HDs in all patients. No patient had postoperative infection, dysfunctional nerve root injury or iatrogenic segmental instability. 2 cases experienced recurrence of combined HDs (2.4%), but could not undertake further revision surgery because of infirm condition. All the 85 cases were analyzed with complete follow-up data. VAS scores and ODI values were significantly lower in all time-points after surgery than before surgery. MacNab scores at 2 years after surgery were obtained from all the 85 patients. 29 cases were given "excellent"; 48 were given "good". 6 patients experienced heavier low back pain, thus being classified as "fair". 2 cases with recurrence were given "poor".
Conclusions: PLF-PELD with specially designed instrument is a less invasive, effective and safe surgery for lumbar lateral recess stenosis with/without combined HDs.

1. Introduction

For an isolated lumbar lateral recess stenosis, traditionally posterior direct decompression with or without fusion was the best available treatment [1,2], but this involved significant disruption to the posterior elements that would cause postoperative segmental instability and scar formation around nerve tissues. Besides, the risk of general anaesthesia especially for elderly and infirm individuals is also a big concern.

Transforaminal endoscopic surgery is an ultra-minimally invasive outpatient surgical option available to patients that does not require general anesthesia and does not involve the same amount of destabilizing facet joint removal as a traditional laminotomy and medial facetectomy. The procedure can be performed in wakeful patients under local anaesthesia and conscious sedation, thereby

* Corresponding author at: The Department of Orthopedic Surgery, The First Affiliated Hospital of Chinese PLA's General Hospital, No. 51, Fucheng Road, Beijing 100048, People's Republic of China. Fax: +86 1068989121.
E-mail address: dr_lizhenzhou@163.com (Z.-z. Li).

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avoiding the risk of general anaesthesia especially for elderly and infirm individuals [3–6].

Currently, transforaminal endoscopic decompression for lateral recess stenosis was still focused on lateral and ventral structures, such as removal of the ventral of the superior articular process (SAP), removal of a herniated disc (HD), and reduction of the superior endplate to treat lumbar radicular symptoms that resulted from a spondyloslisthesis [4,6]. Dorsal compression arisen from hypertrophied SAP and flavum ligament is difficult to deal with [7,8]. In order to achieve effective dorsal decompression of lateral recess, we invented specially designed instrument for percutaneous lumbar foraminoplasty (PLF) that had been successfully applied in the treatment of complex lumbar disc herniation [9]. From August of 2011 to August of 2013, 85 patients with lateral recess stenosis were treated with PLF under fluoroscopic guidance with specially designed instrument and percutaneous endoscopic lumbar decompression (PELD) and were followed up to two years. Technique note and outcome of 2-year follow-up are included in this report.

2. Patients and methods

2.1. Patients

From August of 2011 to August of 2013, 96 patients met the inclusion criteria were treated with PLF-PELD and 85 cases were followed up to 2 years postoperatively.

Inclusion criteria: (1) clinical signs of neurogenic claudication with or without sciatica; (2) concordant imaging evidence of lateral recess stenosis (the anteroposterior diameter of the lateral recess was less than 4 mm) with or without HD at the same level demonstrated on preoperative magnetic resonance images (MRI) and/or computed tomography (CT) scans; (Fig. 1A and B); (3) unsuccessful non-operative treatment for at least 12 weeks; (4) patients who were able to provide voluntary, written informed consent to participate in this evaluation and willing to return for follow-ups.

Exclusion criteria: (1) segmental instability on preoperative extension–flexion radiographs; (2) severe central stenosis on preoperative MRI or CT; (3) cauda equina syndrome; (4) combined very highly migrated HDs beyond the low rims of adjacent pedicles; (5) high iliac crest higher than L5 transverse process without enough space for extreme lateral approach to L5S1 foramen.

2.2. Interventions

Approval to conduct the study was granted by the ethics committees of the first affiliated hospital of Chinese PLA's General Hospital. Institutional Review Board approved informed consent and protocols were provided to all the patients, which described details of the surgery including mechanism of treatment, predictive outcome, potential risks and side effects.

2.3. Surgical tools

Specially designed instrument for PLF [9]: consist of a guidewire, an obturator, a sequential graded duck-mouth protective cannulas and 10-mm-diameter trephine. The distal end of duck-mouth protective cannulas is 2 cm in length. Half of it is flat; the other half is bevel design. The bevel part is thin, so that it may go through the lower half of the intervertebral foramen between SAP and posterior wall of distal vertebra. The tip of the cannulas will be fixed on the posterior aspect of superior endplate of distal vertebrate, preventing the cannulas from moving. The trephine works inside the cannulas avoiding any damage to exiting and transversing nerve roots.

A Percutaneous Endoscope Spine Surgical System (Spinendos GmbH, Germany) and tip-flexible electrode bipolar radiofrequency system (Elliquence LLC, USA) were used in PELD.

2.4. Surgical procedures

In all the patients, the PLF-PELD procedure was performed under local anesthesia in the prone position on a radiolucent Table using C-arm fluoroscopy. Entry point of needle was determined at the intersection of skin and horizontal line from posterior aspect of spinal process and the needle trajectory can be planed on preoperative MRI/CT to target intervertebral foramen while avoiding the contents of the peritoneal sac (Fig. 1C).

After infiltrating the intended needle entry tract with 8–10 ml of 0.5% lidocaine, 15-gauge needle was inserted by posterolateral approach. In lateral view, needle tip should lie at posterior rim of the upper endplate of distal vertebra while the tip of the needle in the anteroposterior (AP) view should be at the medial pedicular line. The inclination of the needle trajectory depended on whether combined HD is a down-migrated or up-migrated disc. In case of a down-migrated herniation, skin entry of the needle starts slightly above the level of the disc with the needle tip directed downwards making an angle of 20–30° with the lower endplate. For an up-migrated disc the skin entry point was placed along the level of the disc.

After infiltrating 15–20 ml of 0.5% lidocaine in intervertebral foramen, the needle is replaced with a 1-mm-diameter guide wire. A blunt tapered cannulated obturator is passed over the guide wire under fluoroscopic control till its tip reaches posterior rim of the endplate in lateral view. Sequential protective cannulas were introduced over the obturator until the final protective cannula was placed in proper position. The tip of the cannulas will be fixed on the posterior rim of the upper endplate of distal vertebrate in lateral view (Fig. 1D) while positioned at the medial pedicle line in AP view (Fig. 1E). The bevel half of the cannula' distal end faced dorsally and the flat half was press-fit on the lateral aspect of SAP.

A 10-mm-diameter trephine was used to perform foraminoplasty through transforaminal approach: With the tip of protective cannula anchored in foramen and treated as fulcrum, trephine should be advanced nearly horizontally utilizing the mobility of back muscle (Fig. 1F). Trephine was advanced with carefully rotation under fluoroscopic guidance (Fig. 1F). The ventral portion of SAP and part of inferior articular process (IAP) could be taken out along with the trephine once they were cut off.

Obturator was inserted into the enlarged foramen; protective cannula was replaced with 8-mm working cannula. A 25° endoscope with a working channel of 4.3 mm and length of 205 mm is introduced. Hypertrophied ligament flavum lateral and posterior to transversing nerve root was endoscopically resected to achieve lateral recess decompression (Fig. 1G and H).

In lateral recess stenosis combined with focal HDs and/or hypertrophied posterior longitudinal ligaments (PLL), working cannula was further advanced into epidural space anterior to dural sac under endoscopic visualization. After intradiscal decompression performed firstly, working cannula was adjusted to find and completely remove migrated or sequestered discs and hypertrophied PLL. Since intervertebral foramen was adequately enlarged, additional maneuvers like levering the cannula to make it more horizontal, downward or upward tilting, even contralateral exploration could be easily achieved so that direct visualization and excision of the HDs and hypertrophied PLL could be finished. After that, the decompression of traversing root and dura sac can be confirmed easily.

All the patients undergo postoperative MRI/CT 1 day after surgery (Fig. 1I and J) and were permitted to discharge.