

The effect of additional transforaminal epidural blocks on percutaneous epidural neuroplasty with a wire-type catheter

A retrospective observational study

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Abstract

Percutaneous epidural neuroplasty (PEN) is an effective interventional treatment for radicular pain. However, in some cases, contrast runoff to the spinal nerve root does not occur. We investigated whether contrast runoff to the spinal nerve root affects the success rate of PEN and whether additional transforaminal epidural blocks for intentional contrast runoff affect the success rate of PEN in cases in which contrast runoff is absent.

This study was registered at ClinicalTrials.gov (Identifier: NCT03867630) in March 2019. We reviewed the medical records of 112 patients who underwent PEN with a wire-type catheter from May 2016 to August 2018. Patients were divided in 3 groups (Runoff group, Non-runoff group, Transforaminal group).

Patients with low back pain and leg radicular pain who did not respond to lumbar epidural steroid injections

PEN was performed in 112 patients with a wire-type catheter in target segment. We compared the success rate of PEN between

- (1) the Runoff group and the Non-runoff group,
- (2) the Runoff group and the Transforaminal group, and
- (3) the Non-runoff group and the Transforaminal group.

The success rate was significantly different between the Runoff group and the Non-runoff group ($P < .0007$) and between the Non-runoff group and the Transforaminal group ($P = .0047$), but not between the Runoff group and the Transforaminal group ($P = .57$).

Contrast runoff influenced the success rate of PEN. In cases without contrast runoff, additional transforaminal epidural blocks for intentional contrast runoff increased the success rate of PEN with a wire-type catheter.

Abbreviations: ODI = Oswestry disability index, PEN = percutaneous epidural neuroplasty, SD = standard deviation, VAS = visual analogue scale.

Keywords: anesthesia, epidural, epidural space, lumbar vertebrae, pain, retrospective studies

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1. Introduction

The purpose of percutaneous epidural neuroplasty (PEN) is the removal of epidural fibrosis and delivery of injected drugs (hypertonic saline, steroids, and local anesthetics) through placement of a catheter in the target lesion. In patients with spinal stenosis, the effect of PEN has been demonstrated to be superior to that of caudal steroid injection.^[1,2]

Choi et al^[3] reported no previous lumbar surgery and root compression with herniated lumbar disc or foraminal stenosis as good prognostic predictors. Knowledge of the prognostic predictors is expected to contribute to the establishment of indications for PEN. However, we have encountered many cases without contrast runoff following nerve root shadow in our clinical experience with PEN with a wire-type catheter. Han et al^[4] reported that cervical PEN with contrast runoff pattern had a higher success rate than PEN without contrast runoff. Contrast runoff should be observed during PEN, even in the presence of foraminal stenosis.

To our knowledge, there has been no research about contrast runoff in lumbar PEN. In the clinical practice, we have tried to perform additional transforaminal blocks in the same segments

as lumbar PEN in cases in which contrast runoff does not occur. The aims of this study were to investigate whether contrast runoff to the spinal nerve root affects the success rate of lumbar PEN and whether additional transforaminal epidural blocks for intentional contrast runoff affect the success rate of lumbar PEN without contrast runoff.

2. Materials and methods

This retrospective observational study was approved by the Institutional Review Board of Ajou University Hospital of Korea (IRB No. AJIRB-MED-OBS-18-554) and registered at ClinicalTrials.gov (Identifier: NCT03867630) in March 2019. The requirement for informed consent was waived because of the retrospective case-control nature of the study.

2.1. Participants

We retrospectively enrolled 112 consecutive patients with low back pain and leg radicular pain who did not respond to lumbar epidural steroid injections. As the next stage of treatment, PEN with a wire-type catheter was performed. The patient's symptoms, neurological examination, and imaging studies were evaluated to make a diagnosis. Inclusion criteria were:

- (1) age between 20 and 80 years old,
- (2) low back pain and leg radicular pain,
- (3) unresponsiveness to lumbar epidural steroid injections, and
- (4) PEN with a wire-type catheter.

Exclusion criteria were:

- (1) loss to follow-up,
- (2) inability to evaluate the outcome of PEN because of other severe diseases such as cancer, and
- (3) incomplete medical records.

Patients were regularly followed up until 3 months after PEN.

2.2. PEN

Patients were placed in prone position and draped in a sterile manner. The skin was infiltrated with 1% mepivacaine, and an 18-gauge epidural needle was inserted into the epidural space via the sacral hiatus under fluoroscopic guidance. Entry into the epidural space was confirmed by injection of contrast medium. An epidural catheter (ABEL catheter; GS Medical, Cheongwon, Korea) was inserted through the needle and advanced to the targeted lesion. The catheter was positioned such that the injected drugs could spread into both the anterior and posterior epidural spaces. Oh et al^[5] reported that in lumbar PEN, placement of the catheter tip at the ventral position has a better outcome. The targeted lesion had been determined by magnetic resonance imaging prior to PEN, and the location of the catheter was finally confirmed under a fluoroscope using 1 to 2 mL of contrast medium. In cases without runoff to the spinal nerve root, additional transforaminal epidural blocks were performed based on the operator's decision. When an epidurogram without intravascular or subarachnoid filling was obtained, 1500 units of hyaluronidase in 2 mL of preservative-free normal saline were injected via the epidural catheter, followed by injection of 2 mL of 0.3% mepivacaine and 2.5 mg of dexamethasone mixture. When the procedure was completed, the epidural catheter was removed carefully and patients were allowed to rest for 30 to 60 minutes.



Figure 1. Contrast runoff (arrow) from the lumbar spinal nerve.

The entire procedure was carried out by 1 pain physicians (JBC) with more than 10 years of experience in the field.

2.3. Clinical evaluations

Patients evaluated their symptoms by completing questionnaires (visual analogue scale, Oswestry disability index score) before and 3 months after the procedure. Success was defined as a 50% or greater reduction in pain score on the pre-procedural visual analogue scale. The fluoroscopic images taken during PEN were reviewed. An anteroposterior view of the lumbar spine was obtained using 1 to 2 mL of contrast medium. When contrast spread out from the neural foramen, flowing past the dorsal root ganglion, the pattern was considered as contrast runoff (Fig. 1). If the contrast did not spread out of the neural foramen, contrast runoff was deemed to be absent (Fig. 2). These images were



Figure 2. Contrast runoff absent (arrow) from the lumbar spinal nerve.

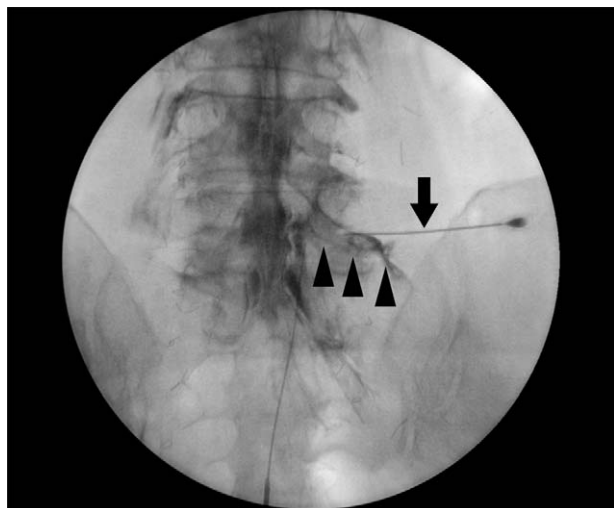


Figure 3. Contrast runoff was absent at the lumbar spinal nerve, and additional transforaminal epidural block (arrow) was performed for intentional contrast runoff (arrowheads).

investigated by 2 clinicians (HYG and JBC) with more than 6 years of experience in the field.

After analysis of fluoroscopic images, we divided patients who underwent PEN into 3 groups:

- (1) the Runoff group,
- (2) the Non-runoff group, and
- (3) the Transforaminal group.

The Runoff group comprised the patients whose images showed root shadow by the contrast medium (Fig. 1). The Non-runoff group comprised the patients whose images did not show nerve root shadow by the contrast medium and in whom no additional transforaminal blocks were done (Fig. 2). The Transforaminal group comprised the patients whose images did not show root shadow by the contrast medium and in whom additional transforaminal blocks were done (Fig. 3).

We compared the success rate of PEN between

- (1) the Runoff group and the Non-runoff group,
- (2) the Runoff group and the Transforaminal group, and
- (3) the Non-runoff group and the Transforaminal group.

2.4. Statistical analysis

Sample size was determined based on α and β errors of 0.05 and 0.2, respectively. Considering a dropout rate of 20%, a sample

size of 110 was calculated from pilot data. The Kruskal-Wallis test and chi-square test were used to compare the outcomes among the three groups. Statistical analysis was performed using Statistical Analysis Software ver. 9.4 (SAS Institute Inc., Cary, NC). Values of $P < .05$ were considered statistically significant.

3. Results

The demographic data are shown in Table 1. Visual analogue scale and Oswestry disability index scores are shown in Table 2. Success rates and comparisons of success rates are shown in Tables 3 and 4, respectively. As shown in Table 4, first, the success rate was significantly different between the Runoff group and the Non-runoff group ($P = .0007$). Second, the success rate was not significantly different between the Runoff group and the Transforaminal group ($P = .57$). Third, the success rate was significantly different between the Transforaminal group and the Non-runoff group ($P = .0047$).

4. Discussion

This study showed that contrast runoff to the spinal nerve in patients with low back pain and leg radicular pain resulted in a high success rate of PEN with a wire-type catheter, reduced pain score, and improved functional status. This is consistent with a previous study in the cervical PEN.^[4] Furthermore, in our study, we were able to increase the success rate by performing additional transforaminal epidural blocks in patients without contrast runoff to the spinal nerve. Additional transforaminal epidural blocks could be an important factor for successful in lumbar PEN with a wire-type catheter.

Han et al^[4] found that contrast runoff pattern had a higher success rate in cervical PEN. Contrast runoff is significantly correlated with a successful outcome because it can wash away the inflammatory substances around the nerve roots. Injection of local anesthetics and steroids reduces pain caused by inflammatory responses. Similar to Han et al, we had a higher success rate in the patients with contrast runoff in lumbar PEN.

The distinct point of this study was the additional transforaminal epidural blocks in the patients without contrast runoff. In both cervical and lumbar PEN, patients are in prone position; it is impossible to perform a cervical transforaminal epidural block during cervical PEN, but it is possible during lumbar PEN. Furthermore, cervical transforaminal epidural blocks have been associated with severe complications; therefore, they are no longer recommended.^[6] However, lumbar transforaminal epidural blocks can be performed safely during lumbar PEN. In this study, we had a significantly higher success rate in the Transforaminal group.

Caudal epidural blocks, interlaminar epidural blocks, and transforaminal epidural blocks are common methods of pain

Table 1

Demographic data.

Parameters	Runoff group (n=50) (Mean ± SD)	Non-runoff group (n=21) (Mean ± SD)	Transforaminal group (n=41) (Mean ± SD)	P value
Men/women	24/26	8/13	20/21	.70
Age (years)	62.48 ± 15.48	62.19 ± 17.96	69.98 ± 10.70	.09
Height (cm)	164.11 ± 7.23	161.23 ± 8.26	159.46 ± 5.97	.01*
Weight (kg)	63.01 ± 10.87	62.07 ± 12.27	60.51 ± 8.67	.73

SD=standard deviation.

* $P < .05$.

Table 2
Visual analogue scale and Oswestry disability index scores before and 3 months after percutaneous epidural neuroplasty.

Parameters	Runoff group (n=50) (Mean ± SD)	Non-runoff group (n=21) (Mean ± SD)	Transforaminal group (n=41) (Mean ± SD)	P value
VAS before PEN	6.68 ± 1.73	7.00 ± 1.18	6.39 ± 1.80	.35
VAS after PEN	3.02 ± 1.08	4.67 ± 1.62	3.71 ± 1.57	.0006*
ODI before PEN	35.88 ± 10.36	39.67 ± 9.20	39.07 ± 12.24	.25
ODI after PEN	20.68 ± 13.05	33.76 ± 11.69	26.56 ± 12.94	.0005*

ODI=Oswestry disability index, PEN=percutaneous epidural neuroplasty, SD=standard deviation, VAS=visual analogue scale.
* P<.05.

Table 3
Success rate of percutaneous epidural neuroplasty.

Parameter	Runoff group (%)	Non-runoff group (%)	Transforaminal group (%)	Total (%)	P-value
Successful/Total	38/50 (76.0)	7/21 (33.3)	29/41 (70.7)	74/112 (66.1)	.0018*

* P<.05.

relief in patients with chronic low back pain and leg radicular pain. Among the three methods, transforaminal epidural blocks are the most effective because they can deliver steroids and other drugs directly into the ventral epidural space where the lesion is located.^[7,8] However, even when all 3 methods are ineffective, PEN shows good results.^[9] Lumbar epidural adhesions occur most frequently postoperatively or because of fibrocyte deposition or inflammatory responses to intervertebral disc extrusion into the epidural space.^[10] Adhesion physically prevents the spread of drugs around the nerves.^[11] According to previous study,^[12] PEN is a minimally invasive and more effective treatment for patients with epidural adhesions because a catheter is placed directly at the epidural adhesion area. Mechanical adhesiolysis by the steering-type catheter occurs because the catheter is introduced into the scar tissue at the epidural space more easily via the sacral hiatus during PEN. PEN also ensures the delivery of drugs to the target area more precisely and accurately, thus overcoming the limitations of epidural injection.^[1,13] Manchikanti et al^[14] found that PEN reduces pain by more than 50% in 76% of patients at the 1-year follow-up. Furthermore, a systematic review found Level I to Level II-1 evidence that PEN is an effective treatment for managing chronic lower back pain in patients with post-surgery syndrome.^[15]

The factors related to the poor success rate of PEN are spondylolisthesis, post-surgery syndrome, and foraminal stenosis.^[11] Spondylolisthesis is associated with diminished cross-sectional area of the vertebral canal, apparent thickening and buckling of the ligamentum flavum, and hypertrophy of the adjacent facet joints.^[16] Post-surgery syndrome is also associated with perineural scarring.^[17] These 2 structural characteristics

could block catheter advancement and effective adhesiolysis in lumbar PEN. Lee and Lee^[11] showed that patients with foraminal stenosis had poor outcomes at 3 months. Although the central canal or subarticular area was narrowed by stenosis, it could provide adequate space for the catheter to be advanced or placed at target areas because of its relatively larger size than the neural foramen. On the contrary, even a one-third reduction of normal foraminal diameter could hardly block catheter advancement and effectively eliminate adhesion. Although Lee and Lee had poor results with PEN in patients with foraminal stenosis, Han et al^[4] reported good results in the cases with contrast runoff. We observed a higher success rate for PEN even in the absence of contrast runoff, and intentional contrast runoff was obtained by transforaminal epidural blocks, even in patients with lumbar foraminal stenosis.

In different points of view, the results of this research seem to be confusional and somewhat not logical. Because transforaminal epidural blocks were performed and failed before PEN. It does not make sense that foraminal adhesiolysis (run off) can be successfully accomplished by transforaminal approach in patients who were refractory to epidural injection before. But in author's opinion, the success rate of PEN with wire type catheter performed with transforaminal epidural blocks at the same time would increase synergistically rather than performed separately, especially in cases of PEN without runoff. These author's opinion must be confirmed by further studies.

This study has some limitations. First, this study was retrospective. Second, this study had a small sample size. Third, there was no randomization to the Transforaminal group. Fourth, the study population was not homogeneous in terms of diagnosis. Fifth, the observation periods were relatively short.

In lumbar PEN, additional transforaminal epidural blocks in cases without contrast runoff in the spinal nerve might improve the outcome of PEN.

Table 4
Comparison of the success rates of percutaneous epidural neuroplasty.

Parameter	P value
Runoff group vs Non-runoff group	.0007*
Runoff group vs Transforaminal group	.57
Non-runoff group vs Transforaminal group	.0047*

* P<.05.

5. Conclusions

Lumbar PEN with contrast runoff pattern had a higher success rate than PEN without contrast runoff. Additional transforaminal epidural blocks might increase the success rate of PEN without contrast runoff.

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