Percutaneous Endoscopic Lumbar Discectomy for Adolescent Lumbar Disc Herniation:

Surgical Outcomes in 46 Consecutive Patients

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Abstract

Background: The surgical outcome of percutaneous endoscopic lumbar discectomy (PELD) for adolescent lumbar disc herniation has rarely been reported on. We performed this study to evaluate the surgical outcome of PELD for adolescent lumbar disc herniation.

Methods: We analyzed the surgical outcomes in 46 consecutive adolescent patients between 13 and 18 years of age (mean age, 16.5 years) who underwent PELD for single level lumbar disc herniation from June 2000 to May 2002. Using the clinical charts and mailed questionnaires, we evaluated the patients preoperatively by the postoperative Visual Analogue Scale (VAS) for back and leg pain, and by the postoperative Macnab criteria.

Results: PELD was performed at L3–4 on one patient, at L4–5 on 40 patients and at L5–S1 on 5 patients. One patient complained of transient dysesthesia after the operation. Another patient underwent subsequent open discectomy because only incomplete decompression was achieved with PELD. At a mean follow-up duration of 37.2 months (range: 25–48 months), the mean VAS scores of both the back and leg pain decreased significantly. In terms of the Macnab criteria, 91.3% of the patients showed excellent or good outcomes. Recurrent disc herniation developed in one patient 14 months after surgery.

Conclusions: Adolescents who underwent PELD for single level soft lumbar disc herniation showed favorable results that were comparable to the results of open discectomy.

Key Words: Adolescent, lumbar, disc herniation, percutaneous endoscopic lumbar discectomy (PELD).

Introduction

LUMBAR DISC HERNIATION is a rare clinical condition in children. Adolescent lumbar disc herniations are only 1–5% of all the lumbar disc herniations that undergo surgery (2, 3). Open discectomy has been considered a standard treatment for adolescent soft lumbar disc herniation (4–12); however, the long-term outcomes of open discectomy have not always been as good as the short-term outcomes, and a significant number of patients suffer from residual back pain on long-term follow-up (7, 12–15). A minimally invasive surgical technique, chemonucleolysis, has been performed by several surgeons and has showed results similar to or better than those of open discectomy (2, 16–18). However, this technique has not gained popularity because of the possibility of severe complications such as systemic reaction or transverse myelitis (19).

With the rapid evolution of surgical instruments and techniques for minimally invasive spine surgery, percutaneous endoscopic procedures for adult lumbar disc herniation have shown results that are comparable to those of open discectomy, even in cases of recurrent disc herniation (20–30). The main concept of percutaneous endoscopic lumbar discectomy (PELD) has evolved from indirect decompression of the central disc to a direct targeted fragmentectomy (20, 31). Based on the successful results of PELD for adult lumbar disc herniation, we thought that PELD might also be a good treatment option for adolescent lumbar disc herniation. However, the surgical outcomes of PELD for soft disc lumbar herniation in adolescents have rarely been reported on (32). The purpose of this study was to evaluate the surgical outcome of PELD in 46 consecutive adolescent patients with lumbar disc herniation.

Materials and Methods

Patient Population and Outcome Evaluation

A retrospective review was done for 46 consecutive adolescent patients (aged 13–18, middle

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school or high school students in Korea) who underwent PELD for single level lumbar disc herniation between June 2001 and May 2003. The inclusion criteria of this study were as follows: (a) soft lumbar disc herniation was demonstrated on the computed tomographic (CT) scan and/or magnetic resonance imaging (MRI), (b) the patients exhibited radicular symptoms and/or back pain that was consistent with the radiologic findings, and (c) unsuccessful conservative therapy had been administered for at least 6 weeks. Excluded were patients with apophyseal ring fracture, a sequestrated fragment, chronic discogenic back pain and/or severe neurological deficits. Patients with segmental instability were also excluded.

The patients' clinical charts and radiological examinations were reviewed. To analyze the clinical outcomes, we compared the preoperative Visual Analogue Scale (VAS) scores of patients' back and leg pain with their postoperative VAS scores for back and leg pain, and the Macnab criteria (1) were checked via mailed questionnaires. A successful outcome was defined as excellent or good based on the Macnab criteria.

Statistical analysis was performed using the Student *t* test, and two-tailed *p* values less than 0.05 were considered significant.

Surgical Technique

The procedures were performed with the patients under local anesthesia, in the prone position on a radiolucent table. Prior to surgery, the procedure, the patients were informed about all the steps of the procedure. Patients could communicate with the surgeon during the entire procedure.

The skin entry point was usually about 10–11 cm from the midline for the L4–5 and L5–S1 levels. For the L3–4 level, the skin entry point was usually more medially located than for the L4–5 level, i.e., about 7–9 cm from the midline. After the entry point was numbed with local anesthetics, an 18-gauge spinal needle was introduced under fluoroscopic image guidance. The final target of the spinal needle was the medial pedicular line on the anteroposterior image and the posterior vertebral line on the lateral image. An epidurogram was then taken with contrast media to confirm the location of the exiting root and the traversing root (Fig. 1A). After insertion of a spinal needle into the disc, an intraoperative discogram was performed with a mixture of 6 mL of contrast media and 1 mL of indigo carmine. The next steps were as follows: (a) a guidewire was inserted through the spinal needle, (b) the spinal needle was removed, (c) a small skin incision was made at the entry site, (d) a tapered, cannulated obturator was inserted along the guidewire (e) after touching the annulus, the obturator was inserted into the disc after the annulotomy was performed (f) finally, a bevel-ended, oval-shaped working cannula was inserted into the disc along the obturator and then the obturator was removed (Fig. 1B, C).

First, manual discectomy was performed through the cannula under fluoroscopic guidance. The endoscope was inserted through the cannula. The blue-stained disc was removed with small forceps and a side-firing Holmium yttrium-aluminum-garnet (Ho:YAG) laser using the 'in and out' technique, that is, working from the central portion to the lateral portion of the disc space on the anteroposterior image (Fig. 1D-F). The herniated fragment had a characteristic feature: the intradiscal portion of the herniated fragment was stained blue with indigo carmine, but the subligamentous portion was only slightly stained by the dye (Fig. 1G). After removing this distinctive herniated fragment, we removed the endoscope and applied a sterile dressing with a one-point suture.

Results

The male:female ratio was 26:20. The mean age at the time of the operation was 16.5 years. Before their operations, 44 of the 46 patients (95.7%) suffered from low back pain and leg pain. Two patients (4.3%) presented with leg pain only. Fourteen patients (20.4%) also showed motor weakness before their operations. All 14 of these patients showed weakness upon great toe dorsiflexion (power grade IV). Three patients (6.5%) had a history of trauma before the onset of their symptoms. The mean duration of the symptoms was 7.7 months (range: 1.5–36 months). The spinal levels of PELD were L3–4 in one patient, L4–5 in 40 patients and L5–S1 in 5 patients. The demographic findings are summarized in Table 1.

The mean operation time was 51.4 minutes (range: 30–75 minutes). One patient (2.2%) complained of transient dysesthesia after the operation. All the patients except one showed improvement of their symptoms immediately after their operations (Fig 2). One patient (2.2%) underwent a subsequent open discectomy because only incomplete decompression was achieved with PELD.

The mean follow-up period was 37.2 months (range: 25–48 months). The mean VAS scores of the leg pain decreased significantly after the operations (before operation: 8.52±1.60; at the final follow-up: 1.46±1.57, $p < 0.0001$). The mean VAS score of the back pain also decreased significantly

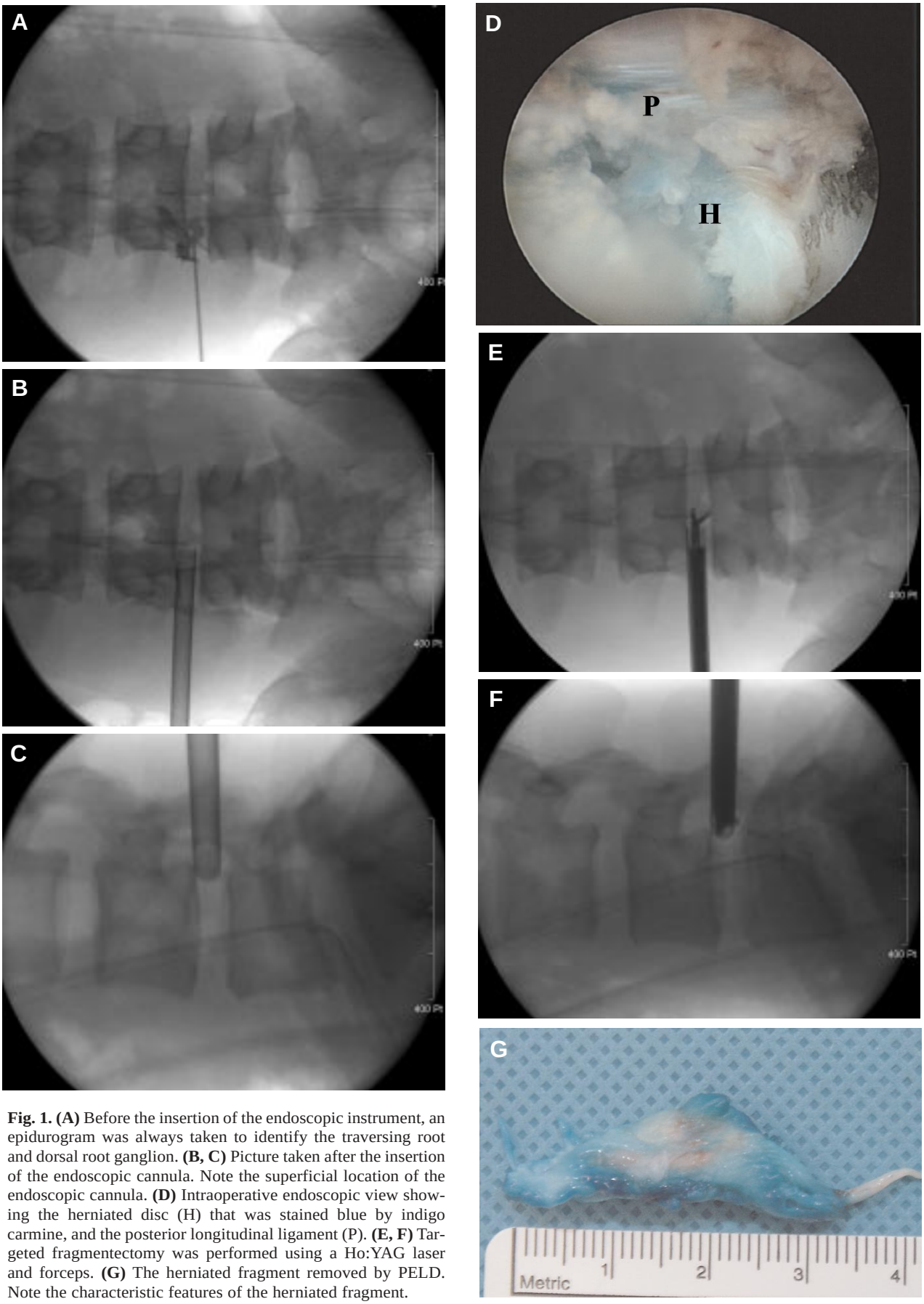

Fig. 1. (A) Before the insertion of the endoscopic instrument, an epidurogram was always taken to identify the traversing root and dorsal root ganglion. **(B, C)** Picture taken after the insertion of the endoscopic cannula. Note the superficial location of the endoscopic cannula. **(D)** Intraoperative endoscopic view showing the herniated disc (H) that was stained blue by indigo carmine, and the posterior longitudinal ligament (P). **(E, F)** Targeted fragmentectomy was performed using a Ho:YAG laser and forceps. **(G)** The herniated fragment removed by PELD. Note the characteristic features of the herniated fragment.

TABLE 1
The Demographics of the Patients Who Underwent PELD

Characteristics	
Number of cases	46
Gender	
Male	
	26
Female	
	20
Mean age (years)	16.5
Mean duration of symptoms (months)	7.7 (range 1.536)
Level	
L3–4	1
L4–5	40
L5–S1	5

PELD = percutaneous endoscopic lumbar discectomy.

after the operation (before operation: 7.74±2.38; at the final follow-up: 1.89 ±1.74, $p < 0.0001$). Based on the Macnab criteria, the surgical outcomes were excellent for 10 patients (21.7%), good for 32 patients (69.6%) and fair for 4 patients (8.7%), and so the rate of symptomatic improvement was 91.3%. All 4 patients with fair outcomes showed moderate back pain at the final follow-up (mean VAS score: 5.8) (Table 2). Recurrent disc herniation occurred in one patient (2.2%) at 14 months after his operation. We instituted conservative care, and he showed a good outcome at the final follow-up.

Discussion

With the evolution of such instruments as the endoscope and the Ho:YAG laser, surgical PELD techniques have also advanced very rapidly. As form of minimally invasive surgery, PELD has several advantages over conventional open discectomy. For example, PELD is usually performed with the patient under local anesthesia. Also, the postoperative pain is quite minimal, so patients can usually be discharged within 24 hours after PELD. And during the procedure, the normal paraspinal structures such as ligaments, muscle, lamina and facet joints are preserved. Therefore, the risk of postoperative epidural scar formation and instability can be minimized (20, 33–35).

With children's and adolescents' lumbar disc herniations, the long-term results of disc surgery depend not only on the disc disease itself, but also on the degree of surgical trauma. Mayer et al. recommended that disc herniations in children and adolescents should be treated with minimally invasive procedures (32). They reported on 4 patients who underwent percutaneous endoscopic discectomy for contained or small noncontained disc herniation, all of whom showed excellent or good results. Although we agree with the recommendation of Mayer et al., the number of patients in their report was very small. Moreover, the surgical instruments and techniques of percutaneous endoscopic procedures have improved significantly since the time of their report. Thus, we believe that the present study is the first large series about PELD in adolescents that reflects the current state of percutaneous endoscopic surgery.

In the present study, the surgical outcomes of PELD in adolescents were satisfactory, i.e., 91.3% of all the patients showed successful outcomes at a mean follow-up of 37.2 months. The surgical outcomes in the present study were nearly the same or better than those of open discectomy in adolescents (4–12). When performing percutaneous endoscopic procedures, proper patient selection and narrow inclusion criteria are the most important factors for obtaining successful outcomes (20). Improper selection of patients can result in incomplete decompression and subsequent open discectomy, and this can sometimes result in a poor surgical outcome. Several highly experienced endoscopic surgeons have recently expanded the indications for PELD and have reported successful outcomes even in cases of migrated disc herniation (36). However, the learning curve of PELD is usually steep and the clinical outcomes are especially affected by the surgeon's skill and personal tech-

TABLE 2
Summary of the Patients with Fair Outcomes

Gender/Age	Sx duration (months)	Level	VAS (pre)		VAS (post)		Follow-up (months)
			BP	LP	BP	LP	
M / 15	5	L4–5	10	10	7	7	44
M / 17	1.5	L4–5	5	5	5	4	41
F / 17	24	L4–5	8	9	5	2	38
M / 17	5	L5–S1	6	8	6	2	28

BP = back pain; F = female; M = male; LP = leg pain; pre = preoperative; post = postoperative; Sx = symptom; VAS = visual analogue scale.

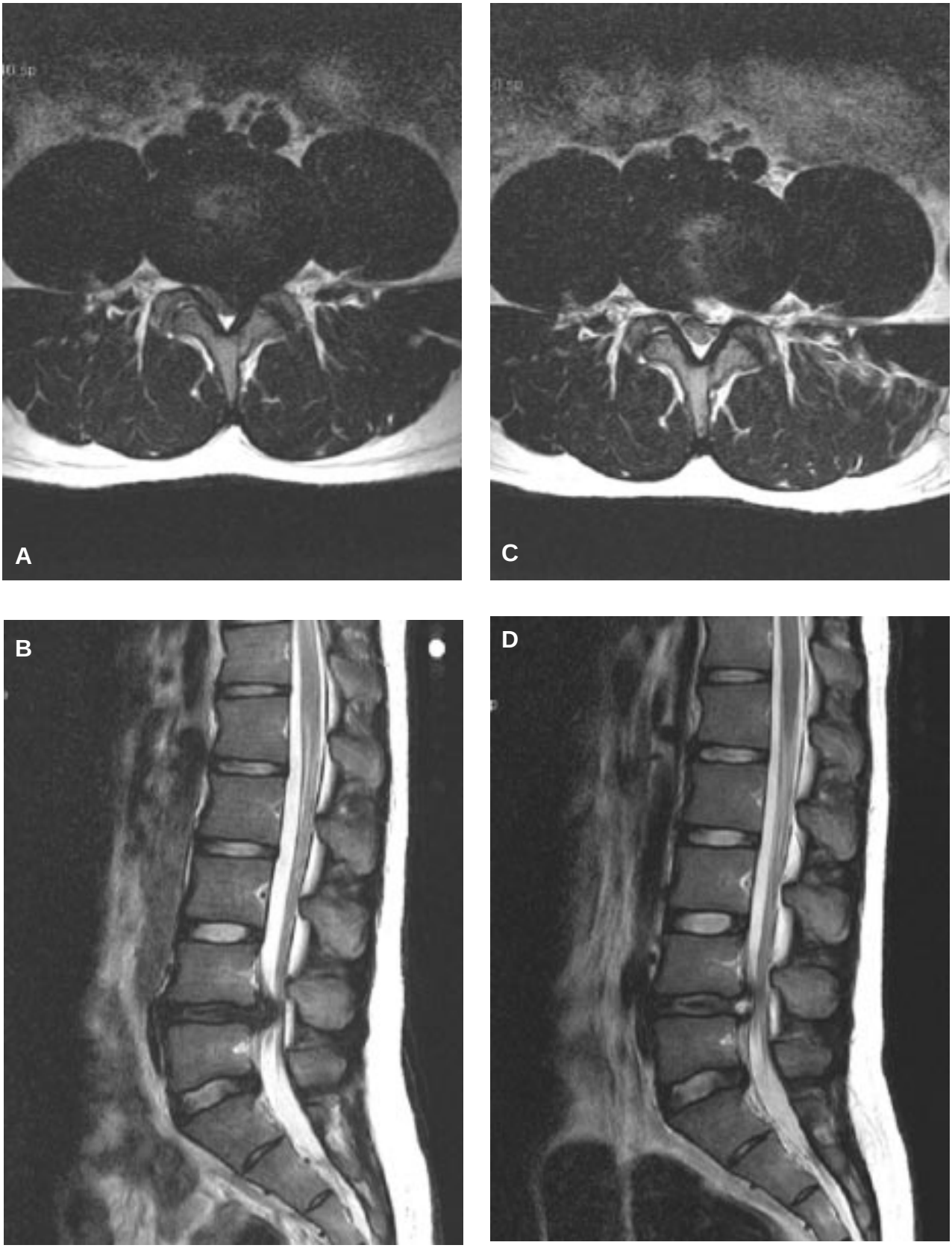

Fig. 2. An 18-year-old boy suffered from back pain and left leg pain for 6 months. His symptoms immediately improved after PELD. The preoperative **(A, B)** and postoperative **(C, D)** magnetic resonance images show the effective result of targeted fragmentectomy.

nique (20). Therefore, in this study we adopted narrow inclusion criteria, i.e., soft disc herniation with radiculopathy with/without back pain that didn't respond to more than 6 weeks of conservative therapy. We excluded those patients who had apophyseal ring fracture, sequestrate fragments, chronic discogenic back pain and severe neurological deficits. In those cases, we usually performed open discectomy. In cases with spinal instability, spinal fusion was considered the first option. Using these indications, appropriate decompression was achieved with PELD for all patients except one in the present study. Regarding the prognostic factors for PELD, Ahn et al. have analyzed 43 consecutive adult patients who underwent PELD for recurrent disc herniation (20). They showed that a better outcome was obtained for the patients who were younger than 40 years, the patients with a duration of symptoms less than 3 months and the patients who were without concurrent lateral recess stenosis. We believe the good surgical outcomes that were achieved in the present study are also attributable to the young age of the patients. Adolescents with lumbar disc herniation usually do not have severe degenerative changes such as lateral recess stenosis. Therefore, obtaining appropriate decompression is usually possible with PELD, which resulted in the successful outcome of this present study.

After conventional discectomy, a significant number of patients suffer from residual back pain (7, 12–15). Postoperative degenerative changes such as gradual disc space subsidence and facet joint degeneration could explain this negative outcome (12, 20). Unlike open discectomy, the posterior paraspinal structures are preserved during PELD. Furthermore, only the targeted removal of the herniated fragment is usually performed during PELD. Therefore, in the beginning of this study, we assumed that PELD might show a better result than open discectomy in terms of postoperative back pain. In the present study, the mean VAS scores of back pain were significantly decreased after PELD at a mean follow-up of 37.2 months (from 7.74 ±2.38 to 1.89 ±1.74, respectively). However, all 4 of the patients (8.7%) who showed fair outcomes still suffered from moderate back pain (mean VAS score: 5.8; range: 5–7), although one of them underwent subsequent open discectomy. Therefore, we cannot definitely say that PELD is superior to open discectomy in regard to postoperative back pain. Further long-term follow-up evaluation is warranted to elucidate the effect of PELD on postoperative back pain.

The most frequent complication of PELD in this study was temporary dysesthesia, and this was probably the result of thermal or mechanical irritation of the traversing root or the dorsal root ganglion (29). Temporary dysesthesia has been reported to develop in up to 20% of the patients undergoing PELD (24, 29). Sympathetic mediated pain, causalgia, quadriceps atrophy, psoas muscle hematoma and wound infections are other complications reported after PELD (24, 29, 37). Recently, the postoperative complications of PELD have been decreasing as a result of advances in minimally invasive surgical techniques. Ahn et al. have reported transient dysesthesia in 4.7% of their patients (20). In this series, only one patient (2.2%) showed transient dysesthesia. Because PELD is performed via the posterolateral transforaminal route, the precise identification of a safe "triangular working zone" during the procedure is of utmost importance to avoid complications (24). In this study, we always took an epidurogram to identify the location of both the traversing root and the dorsal root ganglion. We then carefully checked as to whether the patient felt severe leg pain or not during each step of the procedure.

Conclusions

In selected cases, performing PELD for adolescent soft lumbar disc herniation shows a high success rate comparable to success rates for open discectomy or chemonucleolysis. We believe that PELD is a good treatment option for adolescent soft lumbar disc herniations.

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