

Retrospective Review

Percutaneous Endoscopic Debridement and Drainage with Four Different Approach Methods for the Treatment of Spinal Infection

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Background: The incidence of spinal infection seems to be increasing in recent years. Percutaneous endoscopic debridement and drainage (PEDD) has become an effective alternative to extensive open surgery.

Objective: This study reviewed the charter of patients who received PEDD using 4 different approach methods to evaluate the clinical results.

Study Design: An Institutional Review Board (IRB)-approved retrospective chart review.

Setting: University hospital inpatient referred to our pain clinic.

Methods: A retrospective patient chart analysis of PEDD procedures in spinal infections over a 7-year period was done for the evaluation of structural location, symptoms and signs, etiologic agents, and outcomes.

Results: Seventeen patients (11 men and 6 women, mean age 70.4 ± 11.1 years) with spinal infections received PEDD. According to the structural localization of the spinal infections, 6 cases of spondylodiscitis alone, 5 cases of spondylodiscitis with a psoas abscess, one case of spondylodiscitis with an epidural abscess, 4 cases of spondylodiscitis with epidural and psoas abscesses, and one case of spondylodiscitis with a facet joint abscess were found. All patients had preoperative symptoms of unremitting backache and febrile sensation, and signs of paravertebral muscle tenderness and limitation of spine motion. The most common etiologic bacteria were *Staphylococcus aureus*. Most patients (14/17) improved; the 2 failed patients received a second PEDD after recurrence, and the other received open surgery without re-PEDD. Both the numeric rating scale and Oswestry disability index scores were significantly reduced after PEDD. No complications related to PEDD were found.

Limitation: This study is limited by its retrospective design.

Conclusions: PEDD using 4 different routes brought immediate pain relief and reduced disability in treating spinal infections, especially in elderly patients with comorbid underlying disorders.

Key words: Percutaneous discectomy, psoas abscess, spinal epidural abscess, spondylodiscitis, surgical endoscopy

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Spinal infections are defined as infections in the vertebral body, intervertebral disc, spinal canal, and adjacent muscle caused by bacteria, fungus, or *Mycobacterium tuberculosis* (1). The incidence

of spinal infection seems to be increasing in recent years as a result of the higher life expectancy of older patients with chronic debilitating diseases, the rise in the prevalence of immunosuppressed patients,

and the increase in spinal surgery and techniques (2). In a previous study, common predisposing factors for pyogenic spinal infections, excluding postoperative infections, were smoking, intravenous drug abuse, diabetes, liver disease, end stage renal disease, malignancy, and human immunodeficiency virus, in order of frequency (3).

Most cases of spinal infections can be managed by antibiotic therapy without surgical interventions before the development of neurologic deficits, cauda equina syndrome, spinal instability or vertebral collapse, progressive spinal deformity, abscesses not responding to antibiotics, and failed radiologically guided biopsy necessitating open surgical biopsy (4). However, it is essential for the effective management of spinal infections to find the exact infectious agent before using empirical antibiotic therapy.

The diagnosis of spinal infection is usually delayed before finding a specific neurologic deficit, because its onset of symptoms and signs, such as back pain and fever, are insidious and nonspecific. Patients with spinal infections at the time of diagnosis are usually older and debilitated, along with having other chronic general disorders (4).

It is difficult for these debilitated older patients with spinal infections to receive open surgery under general anesthesia in a prone position. The evolution of both minimally invasive spine surgeries/techniques and monitored anesthetic care (MAC) led to the development of percutaneous endoscopic debridement and drainage (PEDD) in an awake or sleeping state (5).

Objective

This study evaluated the clinical results of PEDD retrospectively in patients with spinal infections who were not unresponsive to conservative medical treatment.

METHODS

Study Design

A retrospective patient chart review of PEDD procedures on patients with spinal infections was done for the evaluation of their location, symptoms and signs, etiologic agents, risk factors, and outcomes.

Setting and Participants

After institutional review board (IRB 05-2015-076) approval, data from patients, who referred from the department of infectious medicine, were collected and analyzed during a 7-year period from November

2008 to November 2015 at a pain clinic in a university hospital.

They were referred for biopsies to define the causative agent and debridement/drainage of abscesses which were resistant to empirical antibiotics. Patients received PEDD after a biopsy of infected tissue, including pus and adjacent tissues, for culture. Patients were placed in a prone position with a pillow to reduce lumbar lordosis. Basic monitoring, such as electrocardiogram, pulse oximetry, non-invasive blood pressure, and bispectral index (BIS) monitoring, was performed.

The MAC was started using a continuous infusion of a mixture of dexmedetomidine with 25 mg of ketamine after an intravenous bolus injection of 30 mg of ketorolac and 50 µg of fentanyl. Usually, the percutaneous endoscopic procedures start after administration of the first mixture of 25 mg of ketamine and 0.2 mg dexmedetomidine and before administration of the second mixture. Most procedures finished with continuous infusion of the second mixture. Continuous infusion for the third dexmedetomidine did not contain ketamine even though the procedure is prolonged (5-7).

Variables, Data Sources/Measurement, Bias, and Study Size

Preoperative symptoms and signs, structural location and region of infection, and risk factors

- ◆ Frequent symptoms and signs were identified from patients' charts and listed in order of frequency. Preoperative and postoperative laboratory findings including C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), and white blood cells (WBCs) were compared.
- ◆ The site of needle insertion was determined according to preoperative measurement of the magnetic resonance image for the location of the infection focus, such as spondylodiscitis, epidural abscess, facet joint abscess, and psoas abscess (Fig. 1).
 - For spondylodiscitis, a needle was introduced into the infected disc and discography with contrast medium and indigo carmine was done. A guide-wire was introduced into the needle and an obturator dilator was inserted along the guide-wire. A working channel was inserted along the obturator dilator. Before irrigation through a spinal endoscope, infected nucleus pulposus was extracted to identify the causative agent.

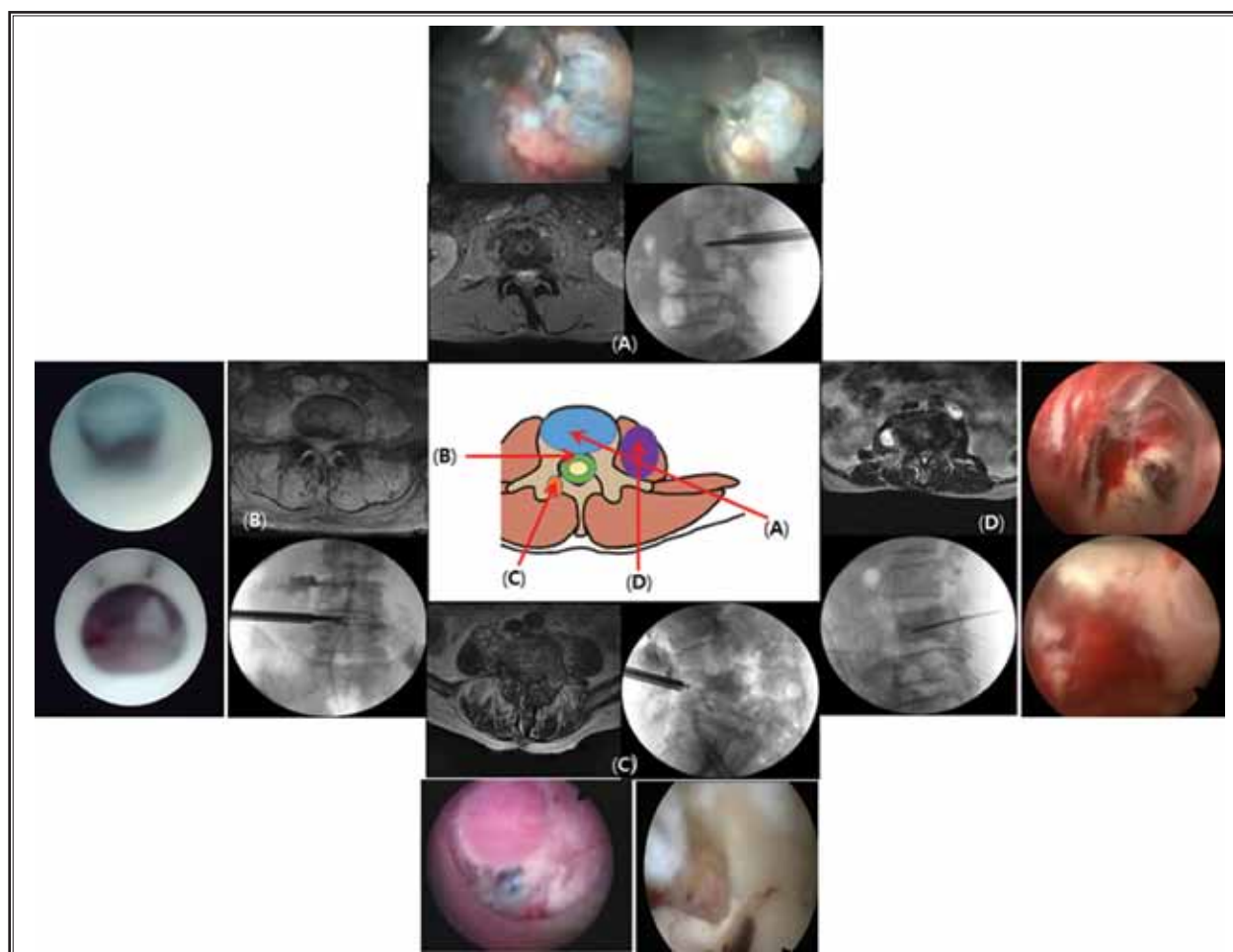


Fig. 1. Four different approach methods according to infected sites on a postoperative magnetic resonance image and intraoperative fluoroscopic and endoscopic/epiduroscopic views. The site of needle insertion was determined according to preoperative measurement of the magnetic resonance image for the location of the infection focus, such as (A) spondylodiscitis, (B) epidural abscess, (C) facet joint abscess, and (D) psoas abscess. (A) The endoscope was placed in the infected intervertebral space from the inserting 10 – 12 cm apart from the midline. The blue-stained nucleus pulposus with infection (Left Upper) by indigo carmine was extracted and sent for culture. The endoscopic field became clear after extraction of the infected nucleus pulposus and irrigation (Right Upper). (B) After preparing chromodiscography with a mixture of indigo carmine and contrast medium, an epiduroscope was placed to the targeted and infected epidural space. The blue-stained disc material in the anterior epidural space (Left Upper) was removed, and the epidural space became clear (Left Lower). An endoscope and an epiduroscope were placed in the targeted intervertebral disc simultaneously (Right Lower). (C) To reach the spondylodiscitis with a facet joint abscess, a spinal endoscope was placed in front of the facet joint and irrigation and resection of superior articular process (SAP) (Right Upper, Lower) was performed if hypertrophied SAP with infected material provokes radicular pain, while placing a block needle and injection of a mixture of indigo carmine and contrast medium in the same joint. The blue indigo carmine was running down from the targeted facet joint (Left Lower). (D) For the approach for the psoas abscess, a spinal endoscope was inserted after introducing the needle straight from the skin into the targeted psoas abscess and aspirating the pus (Left Lower). The endoscopic view of the psoas abscess caused by bacteria seemed to be dirty and yellow (Right Upper); however, psoas abscess caused by the *Mycobacterium tuberculosis* was clean and reddish (Right Lower).

- In cases of spondylodiscitis with an epidural abscess, an additional epiduroscope was inserted into the sacrococcygeal ligament, and

directed until it reached the targeted point of the epidural abscess, whether located in the anterior, lateral, or posterior epidural

space. Aspiration and irrigation was done in the epidural space via the epiduroscope as well as in the intervertebral disc space via the spinal endoscope.

- For the approach for spondylodiscitis with a psoas abscess, another spinal endoscope was inserted after introducing the needle straight from the skin into the targeted psoas abscess and aspirating the pus. A drain was placed at the focus of the psoas abscess for better drainage of the remaining abscess before finishing the PEDD.
- To reach the spondylodiscitis with a facet joint abscess, a spinal endoscope was inserted in front of the facet joint and irrigation and resection of superior articular process (SAP) was performed if hypertrophied SAP with infected material provokes radicular pain, while placing a block needle and injection of a mixture of indigo carmine and contrast medium in the same joint (Fig. 1).
- ◆ Common risk factors that may affect spinal infection were evaluated from a previous study (3).

Intraoperative endoscopic distinct views and postoperative outcomes

- ◆ Intraoperative endoscopic views were compared in cases of psoas abscesses due to bacteria and tuberculosis. Etiologic agents from the biopsies during the PEDDs were listed in order of frequency.
- ◆ The outcomes of the PEDDs were divided into 3 categories as follows: success, re-PEDD, and failed/open surgery. (1) The success group included patients who had successful clinical outcomes after PEDD with conservative treatment such as antibiotics and antituberculosis drugs. (2) The re-PEDD group was comprised of patients who received repeated PEDD because of persistent infection and low back pain. (3) The failed group included patients who underwent open surgery due to persistent infection and low back pain, even after PEDD.
- ◆ Duration of hospitalization was compared among the 3 groups.
- ◆ Pain assessment using the numeric rating scale (NRS) score and disability assessment using the Oswestry disability index (ODI) score, excluding sexual activity, were recorded before, as well as one week, one month, and 3 months after the procedure.

- ◆ Complications related to PEDD were also evaluated.

Statistical Methods

Age and duration of admission after PEDD were expressed as mean \pm standard deviation. Outcomes, including NRS and ODI, were expressed as median \pm standard error. The scores of one week, one month, and 3 months after the procedure were compared with the scores before the procedure. They were analyzed with Friedman test and Wilcoxon signed-rank test for post hoc test using the IBM SPSS Statistics software package for Windows (SPSS version 23.0, IBM, Armonk, NY). A P value < 0.05 was considered statistically significant and Bonferroni's correction was done for multiple comparison.

RESULTS

Participants

Seventeen patients (11 men and 6 women, aged 49 to 86, mean age 70.4 ± 11.1 years) with spinal infection received PEDD.

Data and Main Results

Preoperative symptoms and signs, structural location and region of infection, and risk factors (Table 1)

- ◆ All patients had preoperative symptoms of unremitting backache and febrile sensation. The preoperative presenting signs in all patients were paravertebral muscle tenderness and limitation of spine motion with a bedridden state. There was one patient who had a motor deficit with foot drop. Although all patients felt febrile sensation, only 8 of 17 patients actually had a fever on admission. Although only 8 of 17 patients had elevated WBC count, all patients had an elevated ESR and CRP level preoperatively.
- ◆ The structural localization of the spinal infection involved 6 cases of spondylodiscitis only, 5 cases of spondylodiscitis with a psoas abscess, one case of spondylodiscitis with an epidural abscess, 4 cases of spondylodiscitis with epidural and psoas abscesses, and one case of spondylodiscitis with a facet joint abscess. The infected levels of the spine were the lumbosacral (15) and thoracic (2) vertebrae.
- ◆ Risk factors according to a previous study (4) in-

cluded diabetes mellitus (7), malignancy (7), and recent invasive spinal procedures (3), followed by non-spinal infections including a liver abscess (1) and infective endocarditis (1). However, 3 patients had no identifiable risk factors in this study.

Intraoperative endoscopic distinct views and postoperative outcomes (Table 2)

◆ The etiologic bacteria included Staphylococcus aureus (5), Klebsiella pneumoniae (3), E. coli (3), Mycobacterium tuberculosis (2), Bacteroides fragilis (1), and cases of unknown origin, due to no growth in the culture (3). Two of the 3 patients who had spondylodiscitis alone with unknown agents recovered from the infection and were discharged 17 and 35 days after PEDD. In addition, the endoscopic view of the psoas abscess in 2 cases of spinal infections caused by the Mycobacterium tuberculosis showed them to be clean

and reddish. However, the endoscopic view of the psoas abscess caused by bacteria appeared dirty and yellow (Fig. 1). Two patients, aged 49 and 65 years old, had spondylodiscitis and spondylodiscitis with psoas abscesses caused by Mycobacterium tuberculosis in the lumbar L3-L4 and L2-L3 levels, respectively.

◆ Most patients (14/17) improved; 2 failed patients received a second PEDD after recurrence, and the other received open surgery without re-PEDD. The 73-year-old man, who underwent open surgery 2 weeks after failed PEDD, had suffered from hepatocellular carcinoma and prostate cancer and had spondylodiscitis with psoas and epidural abscesses. There was no growth in the culture. Postoperative CRP and ESR started to decrease from 3 and 5 days after PEDD, respectively. The patients who had elevated ESR before PEDD started to return to the normal range at least 7 days later.

Table 1. Demographic data, structural location and region of infection, and risk factors..

Patient	Gender /Age (y)	Infected structural location and regions				Risk factors			
		Spondylodiscitis	Psoas abscesses	Epidural abscesses	Facet joint abscesses	Diabetes mellitus	Cancer	Recent invasive spinal procedure	Non-spinal infections
1	M/60	+ (L2-L3)	-	-	-	-	+	-	+ (Infective endocarditis)
2	F/54	+ (L5-S1)	-	-	-	-	-	+	-
3	M/49	+ (L3-L4)	-	-	-	-	-	-	-
4	M/67	+ (T6-T7)	-	-	-	+	+	-	-
5	F/78	+ (L2-L3)	-	-	-	-	-	-	-
6	M/85	+ (T8-T9)	-	-	-	+	-	+	-
7	F/79	+ (L3-L5)	+	-	-	+	-	-	-
8	M/65	+ (L2-L3)	+	-	-	+	+	-	-
9	F/77	+ (L1-L2)	+	-	-	-	-	+	-
10	M/78	+ (L3-L5)	+	-	-	-	-	-	+ (Liver abscess)
11	M/67	+ (L4-L5)	+	-	-	+	+	-	-
12	M/69	+ (L5-S1)	-	+	-	-	+	-	-
13	F/80	+ (L4-S1)	+	+	-	+	-	-	-
14	F/54	+ (L4-L5)	+	+	-	-	+	-	-
15	M/73	+ (L4-5)	+	+	-	-	+	-	-
16	M/86	+ (L1-L3)	+	+	-	+	-	-	-
17	M/76	+ (L4-L5, L5-S1)	-	-	+	-	-	-	-

Table 2. Etiologic agent and postoperative outcomes of PEDD.

Patient No.	Etiologic agent	S/R/F	Days of admission	Postoperative outcomes							
				NRS score				ODI (%)			
				Pre	1 w	1 m	3 m	Pre	1 w	1 m	3 m
1	<i>Staphylococcus aureus</i>	S	41	6	2	2	2	82.2	53.3	48.9	33.3
2	No growth	S	35	5	1	1	1	93.3	53.3	48.9	28.9
3	<i>Mycobacterium tuberculosis</i>	S	6	5	1	1	1	55.6	40	40	20
4	No growth	S	17	6	2	2	2	77.8	44.4	35.6	22.2
5	<i>Staphylococcus aureus</i>	S	25	6	2	2	1	77.8	48.9	40	35.6
6	<i>Escherichia coli</i>	S	43	4	2	2	1	71.1	42.2	33.3	33.3
7	<i>Escherichia coli</i>	S	20	4	2	2	1	88.9	51.1	44.4	35.6
8	<i>Mycobacterium tuberculosis</i>	S	1	5	2	2	1	55.6	44.4	35.6	24.4
9	<i>Escherichia coli</i>	S	55	6	3	2	2	84.4	55.6	48.9	42.2
10	<i>Klebsiella pneumoniae</i>	S	30	5	2	2	2	75.6	53.3	51.1	40
11	<i>Bacteroides fragilis</i>	S	39	7	3	3	2	75.6	44.4	40	26.7
12	<i>Klebsiella pneumoniae</i>	R	43	6	3	3	2	82.2	66.7	62.2	51.1
13	<i>Staphylococcus aureus</i>	S	46	6	1	1	1	95.6	57.8	57.8	42.2
14	<i>Klebsiella pneumoniae</i>	R	66	6	4	3	2	93.3	82.2	66.7	55.6
15	No growth	F	112	4	3	3	2	93.3	84.4	66.7	48.9
16	<i>Staphylococcus aureus</i>	S	18	4	1	1	1	88.9	55.6	46.7	35.6
17	<i>Staphylococcus aureus</i>	S	15	5	3	3	2	77.8	44.4	37.8	33.3

S/R/F: Success/Re-PEDD/Failed and Open surgery, NRS: Numeric rating scale, ODI: Oswestry disability index, Pre: Preoperative, 1 w: 1 week after PEDD, 1 m: 1 month after PEDD, 3 m: 3 months after PEDD.

- ◆ Duration of admission after PEDD for the success group was 27.9 ± 15.9 days. The 2 patients who received re-PEDD discharged 66 and 43 days after the first PEDD, respectively. The patients who underwent open surgery after PEDD discharged after 112 days.
- ◆ All median NRS scores at one week, one month, and 3 months after PEDD (2.2 ± 0.9 , 2.1 ± 0.7 , and 1.5 ± 0.5) compared to the median score before PEDD (5.3 ± 0.9) were reduced significantly ($P < 0.001$). All median ODI scores at one week, one month, and 3 months after PEDD (54.2 ± 12.8 , 43.7 ± 10.7 , and 35.8 ± 10.0) compared to the median score before PEDD (80.5 ± 11.6) were reduced significantly ($P < 0.001$).
- ◆ Complications related to PEDD, such as bleeding or nerve injury, were not observed.

DISCUSSION

Patients with spinal infections in this study, aged 70 years old on average, were in a bedridden state at their first visit. Almost half of patients had diabetes mellitus and/or cancer with an immunosuppressive state, or sometimes a history of recent spinal intervention.

It is difficult for these debilitated older patients with spinal infection to receive open surgery under general anesthesia in a prone position. The evolution of both minimally invasive spine surgery/techniques and MAC with dexmedetomidine led to the development of PEDD in an awake or sleeping state (5). The great merits of MAC without ventilatory support during the operation in debilitated older patients are a reduction of postoperative pneumonia, followed by mechanical ventilatory care in an intensive care unit and early detection of potential nerve damage without using muscle relaxants.

In all patients, preoperative dominant symptoms were unremitting backache and febrile sensation; preoperative presenting signs were paravertebral muscle tenderness and limitation of spine motion. All infected patients had elevated ESR and CRP levels, but only half of patients had elevated WBC counts. Serologic tests, such as ESR and CRP levels, for diagnosis of spinal infections, are known to have high sensitivity, but low specificity (8).

All spinal infections in this study involved the vertebral body and intervertebral disc, coexisting with infection in the epidural space, psoas muscle, and/or facet

joint, in order of frequency. The structural distribution of spinal infections in this study was consistent with a previous study, in which 95% of pyogenic spinal infections involved the vertebral body and intervertebral disc, with only 5% involving the posterior elements of the spine (9).

The interlaminar approach is an alternate route for the control of the unilateral posterior, lateral, and anterior epidural space. However, if the epiduroscope is placed from the sacrococcygeal ligament, it can observe the infected epidural space, irrigate with normal saline or antibiotics, and correct infected debris using the forceps to the upper level of the lumbar spine, simultaneously. If the complete removal of infected material is the main purpose of using the endoscope, it is preferable to use the interlaminar approach by the left and right side of the same level. However, if infections exist in the intervertebral disc and epidural space simultaneously, it is better to obtain a collection of culture material from the infected intervertebral nucleus using the posterolateral approach and to irrigate the infected epidural space with normal saline. These procedures may reduce time and effort if the infections exist at the multiple levels.

For the chromodiscography, a mixture of indigo carmine and contrast medium was used for visualization of the degenerated acid matrix of the nucleus pulposus in the field of the endoscope and under the fluoroscope, respectively. There are 2 distinct stain materials for the human body; indigo carmine and methylene blue. Methylene blue stains the chondrocytes, not the matrix; indigo carmine stains the matrix, not the chondrocytes in the nucleus pulposus of the intervertebral disc. Some studies insisted that intradiscal injection of methylene blue might reduce discogenic pain, resulting from destroying the nerve endings or nociceptors ingrown into the painful disc along the tear without damaging nerve root injury (10). The indigo carmine has a molecular weight of 466.35 with its pH 11.6 – 14.0. Therefore, it attaches to the acidic degenerated nucleus pulposus, resulting from accumulation of lactic acid and carbon dioxide (11). In a vitro study, ioxitalamate, indigo carmine, and their combination induced statistically significant nucleus pulposus (NP) cell injury that was both time- and dose dependent. Also, at the same concentration, ioxitalamate was more cytotoxic than was indigo carmine or the combination. All 3 treatments also showed dose-dependent cytotoxicity according to flow cytometry and immunostaining. They recommended that ioxitalamate and indigo carmine should be used

carefully at low concentrations (12). Fortunately, 14 of 17 cases revealed organisms from the culture after extraction of infected nucleus pulposus. It seemed that indigo carmine did not affect the culture results.

Motor deficit, such as foot drop, had developed in a patient with epidural space and psoas muscle involvement at the level of L4-S1, but disappeared after combined treatment of PEDD and epiduroscopy. In cases of a coexisting epidural abscess with spondylodiscitis, special attention for early detection and treatment is recommended (13). In addition, open surgical biopsy is recommended in cases where there is a development of neurologic deficits, cauda equine syndrome, spinal instability, or vertebral collapse; progressive spinal deformity, where there are abscesses not responding to antibiotics; or in cases of failed radiologically guided biopsy (4). A cancer patient who received open surgery after PEDD had spinal infections in the vertebral body, intervertebral disc, and psoas muscle at the level of L4-L5. No infective agent was found in the culture from the endoscopic biopsy. However, despite no indication for open surgery, the patient wanted to have open surgery.

PEDD had a success rate of over 82% for spinal infections, and if successful re-PEDD is included, the rate increased to 94% without any complications in this study. They had immediate pain relief and reduced physical disability in the success group. There are a few limited reports related to treatment of spinal infection with PEDD. Ito et al (14) reported that 15 patients with pyogenic spondylodiscitis recovered with combined use of posterolateral PEDD and antibiotics without complications. Yang et al (15-17) reported success in 26 of 32 PEDD cases for the treatment of infected spondylitis, respectively. Fu et al (18), a member of the same research group, also reported favorable results in 5 patients using PEDD in 6 immunocompromised patients with complicated infectious spondylitis. A successful bi-portal approach for PEDD was reported in 18 of 22 patients with lumbar pyogenic spondylitis (19). Four different approach methods, according to the infection sites, may increase the chance of identification of the causative agent and reduce the hospitalization, according to this study. In addition, dexmedetomidine-related monitored anesthesia in this study was introduced to reduce the risk of complications related to PEDD.

Pyogenic spinal infections in the lumbar regions, caused by *Staphylococcus aureus*, are known to commonly affect men twice as often as women in those over 50 years of age (9,20-21). In this study, the lumbosacral level was the most commonly involved region,

and the most common causative agents were *Staphylococcus aureus*, followed by *Klesiella pneumoniae* and *E. coli*. Spinal infection by *Mycobacterium tuberculosis* is usually known to involve the thoracic regions (9,19). However, both patients in this study had suffered from spinal tuberculosis in the lumbar regions. Causative agents could not be identified in 3 patients, presumably resulting from previous empirical antibiotic therapy. However, it is generally accepted that the infective organisms are not identified in 1/3 of patients (20,21).

PEDD, using 4 routes according to infection sites, was an effective method for identification of etiologic agents, using disc material and other pus or necrotic tissues, and for unlimited irrigation in the targeted infected sites. In addition, the development of MAC using dexmedetomidine reduces the risk of nerve injury during PEDD with general anesthesia in a prone position. Recently, introduction of epiduroscopy is also an evolutionary method for the diagnosis and treatment of epidural abscesses (22).

Despite good results, this was a retrospective study

without a control group and the number of patients was small. A prospective study with a larger number of patients is required while comparing results with open surgery.

CONCLUSION

PEDD appears to be an effective alternative to extensive open surgery for the treatment of spinal infections, especially in elderly patients, those who require surgery owing to a lack of response to antibiotic treatment, or those with poor general health.

Declaration of interest and funding

There is no interest for this study.

There is no financial support for this study.

The protocol was approved by the policy of the Ethic Committee at Pusan National University Hospital Institutional Review Board (IRB 05-2015-076).

This paper collects 7 years' data with Eun-Ji Choi's Master thesis in 2016.

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