Systematic Review

Unilateral or Bilateral Percutaneous Endoscopic Debridement and Drainage for Thoracolumbar Infections: A Systemic Review and Meta-analysis

Yi Mao, MMED, Junchao Zhang, MMed, Yunzhong Zhan, MMed, and Zhou Ye, MMed

From: Department of Orthopedics, The Quzhou Affiliated Hospital of Wenzhou Medical University, Quzhou People's Hospital, Quzhou, Zhejian, People's Republic of China

Address Correspondence:
Zhou Ye, MMed
Department of Orthopedics, The Quzhou Affiliated Hospital of Wenzhou Medical University, Quzhou People's Hospital,Quzhou, Zhejiang 324000, People's Republic of China
E-mail: yezhou133@163.com

Disclaimer: There was no external funding in the preparation of this manuscript.

Conflict of interest: Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted manuscript.

Manuscript received: 09-21-2023
Revised manuscript received: 11-15-2023
Accepted for publication: 11-28-2023

Free full manuscript: www.painphysicianjournal.com

Background: Unilateral percutaneous endoscopic debridement and drainage (UPEDD) and bilateral PEDD (BPEDD) are commonly implemented, and have consistently yielded favorable clinical outcomes. Nevertheless, there is a scarcity of literature contrasting the advantages and disadvantages between these 2 procedures.

Objective: The goal of this research was to conduct a meta-analysis to compare the clinical effects of UPEDD and BPEDD.

Study Design: A systematic review and meta-analysis.

Methods: A systematic review of studies reporting outcomes following UPEDD and/or BPEDD procedures was performed. The extracted data were used for meta-analysis. Pooled event rates for positive bacteria culture, pain control satisfaction, reoperation, and complications were estimated. The pooled operation time and blood loss were also calculated.

Results: Among 764 retrieved articles, 28 studies with 661 patients met the inclusion criteria and were used for our meta-analysis. A total of 21 studies (462 patients) investigated UPEDD outcomes and 7 studies (199 patients) investigated BPEDD outcomes. For the UPEDD group, the pooled event rates for positive bacteria culture, pain control satisfaction, reoperation, and complications were 72%, 91%, 9% and 4%, respectively; the pooled operation time and blood loss were 89.90 minutes and 59.77 mL. For the BPEDD group, these were 79%, 92%, 4%, 8%, 93.23 minutes and 64.93 mL, respectively.

Limitations: First, all included studies were retrospective series, limiting our study design to a single-arm meta-analysis. Second, there was a limited amount of studies that were determined to be fitting, particularly on BPEDD; the sample size was also small. Third, the clinical effects of UPEDD and BPEDD needed to be compared in greater detail, such as the time it took for inflammatory markers to return to normal, the incidence of local kyphosis, and whether the duration of antibiotic use could be shortened after adequate debridement with BPEDD. Lastly, further studies are necessary to compare the clinical outcome of PEDD and percutaneous endoscopic interbody debridement and fusion.

Conclusions: Both UPEDD and BPEDD can provide a relatively reliable causative-pathogen identification and satisfactory clinical outcome. The 2 techniques are not significantly different in terms of positive bacteria culture rate, pain control satisfaction rate, complication rate, and reoperation rate.

Key words: Percutaneous endoscopic debridement and drainage, unilateral, bilateral, spinal infection

Pain Physician 2024: 27:111-119

The incidence of spinal infections is between one in 20,000 and one in 100,000, accounting for 2% – 7% of all musculoskeletal infections (1,2). These infections can be caused by invasive lumbar surgery, long-term hormone therapy, hemodialysis, or intravenous medication (3,4). The growth of the elderly population, alongside advances in diagnostic technology, are reasons for their steady annual rise (5). Due to nonspecific symptoms, diagnosing spinal infections is challenging (3,6).

As endoscopic technology advances and matures, percutaneous endoscopic debridement and drainage (PEDD) is increasingly being used for treating spinal infections. It can minimally extract biopsy samples and cleanse lesions (7-9). It has been reported that the positive rate of bacterial culture in biopsy specimens of PEDD is much higher than that in computed tomography (CT)-guided puncture biopsy (10).

In clinical practice, both unilateral PEDD (UPEDD) (11-13) and bilateral PEDD (BPEDD) (14-16) are widely used and have achieved good clinical results. However, compared with the UPEDD, BPEDD is accompanied by greater trauma. For surgeons, there is an urgent need to estimate whether conservative treatment can achieve similar clinical results with less trauma. Despite the limited number of articles evaluating the merits and drawbacks of both UPEDD and BPEDD procedures, our study aimed to comparatively analyze their clinical effects using meta-analysis.

Methods

Search Strategy

A comprehensive search for relevant studies on the use of PEDD for spinal infection treatment was carried out on MEDLINE, PubMed, Web of Science, and Cochrane databases. This search included literature from 1980 through June 2023, aligning with the initial use of percutaneous endoscopic discectomy for the treatment of lumbar disc herniation in the early 1980s (17).

The key words included in our searches were "spondylodiscitis," "spondylitis," "diskitis," "vertebral osteomyelitis," "spondylodiskitis," "epidural abscess," and "endoscopic." These search terms were used in a variety of ways with the operators "AND,""NOT," and "OR." To find more studies, we also checked references listed in the publications and pertinent review articles.

Selection of Studies

Mao and Zhang, 2 review authors, separately went over each title and abstract that matched our search criteria; when necessary, full publications were reviewed. If no consensus could be established, the ultimate judgment was determined by a third reviewer (Ye). Our inclusion criteria were as follows: 1) The papers that addressed percutaneous endoscopic surgery for treating spinal infections; 2) a retrospective study, prospective study, or cohort study, regardless of sample size; 3) the most current or largest study was chosen in cases of duplicate publication; 4) papers written in English. Exclusion criteria included: 1) review articles, comments, case reports, letters, animal trials, or cadaver studies; 2) the type of procedure (unilateral or bilateral) was unclear; 3) papers concerning PEDD combined with internal fixation.

Data Extraction

Two reviewers (Mao and Zhang) came to an agreement on each item after separately extracting the data from the relevant research. Each study that was included in the analysis provided the following information: 1) the names and nationalities of the authors; 2) the size of the sample and demographics of the patients, including age and gender; 3) measurement of the clinical outcome, for instance, results of the bacteria culture, time taken for the operation, intraoperative blood loss, scores on the Visual Analog Scale, or Oswestry Disability Index, levels of C-reactive protein, and a comparison of the erythrocyte sedimentation rate before and after surgery; 4) complications, and reoperation (included re-PEDD and open surgery). Reviewer Ye double-checked the extracted data.

Data Analysis

The majority of PEDD research being case series led to the implementation of a single-arm meta-analysis. All obtained data underwent analysis via Stata 15.1 (StataCorp, LLC) using either a random or fixed model to determine the effects. Study heterogeneity was evaluated using the Cochran Q statistic and the I^2 test. When a significant Q test ($P < 0.10$) or $I^2 > 50\%$ indicated heterogeneity across studies, meta-analysis was conducted using the DerSimonian and Laird method random effects model. However, in the absence of these indicators, the Mantel-Haenszel method fixed-effects model was applied. To evaluate the possibility of publication bias within our meta-analysis, we employed funnel plots and Egger's regression test. In cases where publication bias was potentially present, both cumulative forest plots visual evaluation and the application of Classic and Orwin's fail-safe N tests were employed for additional investigation. Upon the detection of noteworthy publication bias, the adjustment for potential bias was made using the Duval and Tweedie trim and fill technique.

Results

Eligible Studies and Study Characteristics

Among 764 retrieved searched articles, 26 studies (3,4,8,10-14,16,18-34) with 661 patients met the inclusion criteria and were used for meta-analysis (Fig.1). A total of 21 studies (n = 462) (3,4,8,10-13,18,19,21-23,25-31,33,34) investigated UPEDD outcomes and 7 studies (n = 199) (14,16,20,24,29,32,34) investigated BPEDD outcomes. All 28 studies were retrospective.

The sample size ranged from 4 to 87 patients, with a median of 19. The average follow-up of all included studies ranged from one to 60 months. The patients' mean age at the time of surgery varied from 39.7 to 70.4 years. The distribution of the studies included 11 articles from The Republic of China (Taiwan), 10 from The People's Republic of China, 3 The Republic of Korea, and 2 from Japan. The remaining 2 were from Mexico and India. The complete list of pertinent information and the basic descriptions of the articles are in Appendix 1.

Postoperative Outcomes Meta-analysis

Bacteria Culture

Bacteria culture data were available for 98% of patients who underwent UPEDD (n = 453) and 56% of those who underwent BPEDD (n = 112).There was no statistically significant difference observed between the 2 groups ($P = 0.48$) in the concentrated positive bacteria culture rate, which was 72% (95% CI, 65% – 78%) in UPEDD studies and 79% (95% CI, 61% – 99%) in BPEDD studies. For all studies, including UPEDD and BPEDD, the pooled positive bacteria culture rate was 73% (95% CI, 67% – 79%). There was heterogeneity among all studies reporting a positive bacteria culture rate ($I^2 = 55\%$; $P < 0.01$) and within both groups (UPEDD: $I^2 = 50\%$; $P < 0.01$; BPEDD: $I^2 = 70\%$; $P < 0.01$) (Fig. 2A). A funnel plot (Fig. 2B) did not reveal any significant publication bias.

Operation Time and Blood Loss

Operation times were available for 36% of patients who underwent UPEDD (n = 166) and 29% of those who underwent BPEDD (n = 58). The pooled operation time was 89.90 minutes (95% CI, 83.44 – 96.87) in UPEDD studies and 93.23 minutes (95% CI, 88.39 – 98.33) for BPEDD studies. For all studies, the pooled operation time was 92.09 minutes (95% CI, 88.18 – 96.17). There was heterogeneity among all studies reporting operation time ($I^2 = 98\%$; $P < 0.01$) and within both groups (UPEDD: $I^2 = 93\%$; $P < 0.01$; BPEDD: $I^2 = 99\%$; $P < 0.01$) (Fig. 3A). A funnel plot (Fig. 3B) did not reveal any significant publication bias.

Blood loss data were available for 18% of patients who underwent UPEDD (n = 85) and 50% of those who underwent BPEDD (n = 100). The pooled blood loss was 59.77 mL (95% CI, 53.60 – 66.64) in UPEDD studies and 64.93 mL (95% CI, 59.68 – 70.64) in BPEDD studies. For

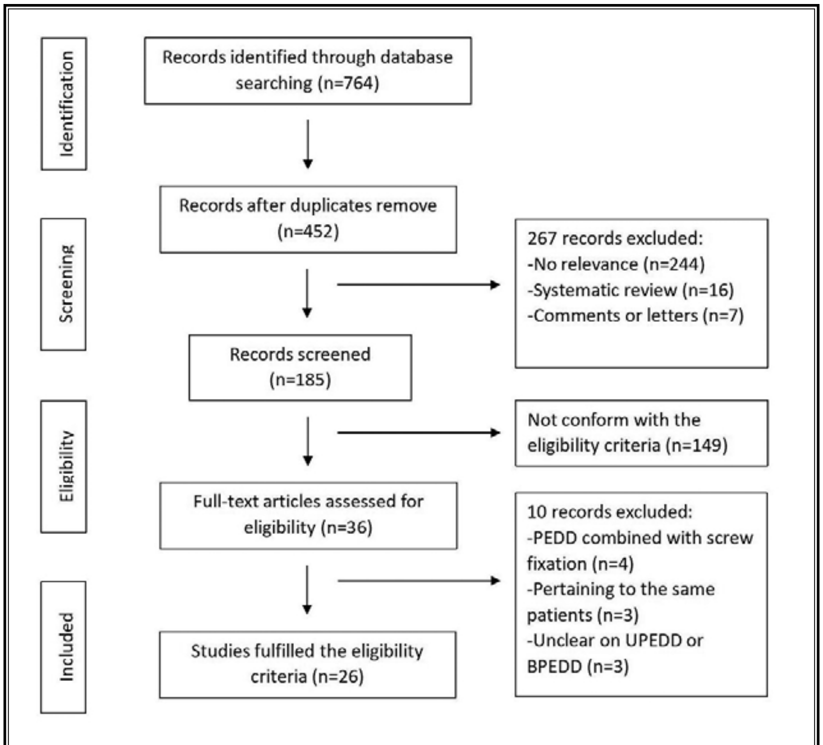

Fig. 1. *Article selection flow chart.*

all studies, the pooled blood loss was 62.94 mL (95% CI, 58.88 – 70.64). There was heterogeneity among all studies reporting blood loss (I^2 = 98%; $P < 0.01$) and within both groups (UPEDD: I^2 = 99%; $P < 0.01$; BPEDD: I^2 = 97%; $P < 0.01$) (Fig. 4A). A funnel plot (Fig. 4B) did not indicate any significant publication bias.

Pain Control

At the last postoperative follow-up an excellent or good outcome was based on the patient's modified Macnab criteria or a Visual Analog Scale score ≤ 3, which was considered as satisfactory pain control. Although some articles didn't employ a pain score, they did mention their patients' contentment with pain control, and so were included in our meta-analysis. Finally, data on pain management was obtained for 69% of patients who underwent UPEDD (n = 320) and 44% of patients who underwent BPEDD patients (n = 88). The

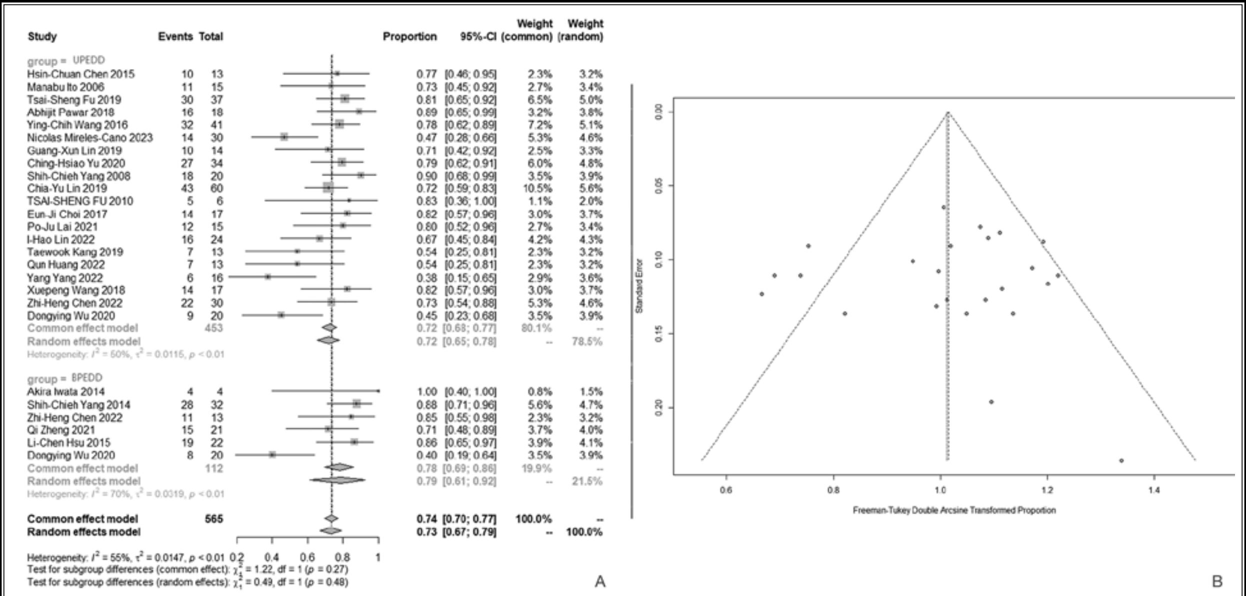

Fig 2. *A. Forest plot of the pooled positive bacteria culture rate between UPEDD and BPEDD. B. Funnel plot of the positive bacteria culture rate in all studies.*

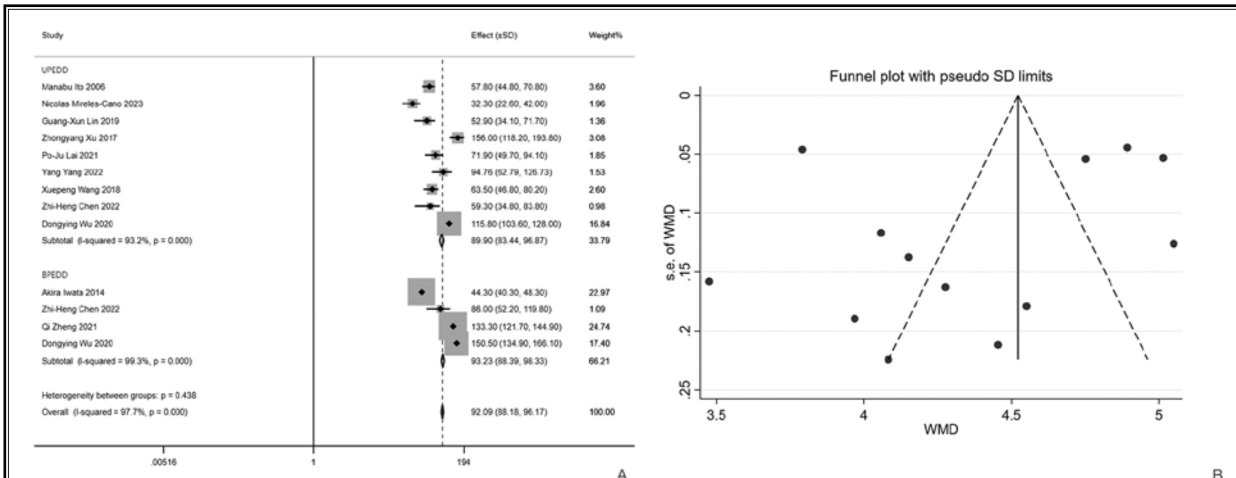

Fig 3. *A. Forest plot of the pooled operation time between UPEDD and BPEDD. B. Funnel plot of the operation time in all studies.*

satisfaction rate for pain control in UPEDD studies was 91% (95% CI, 84% – 97%) while it was 92% (95% CI, 85% – 97%) in BPEDD studies. There was no statistically significant difference noted between the 2 groups (*P* = 0.73). For all studies, the pooled pain control satisfaction rate was 92% (95% CI, 86% – 96%). All studies reporting on the satisfaction rate of pain control exhibited heterogeneity (I^2 = 61%; *P* < 0.01), as did the UPEDD group (I^2 = 68%; *P* < 0.01) (Fig. 5A). A funnel plot did not reveal any significant publication bias (Fig. 5B).

Reoperation

Reoperation data were available for all patients who underwent UPEDD (n = 462) and 56% of those who underwent BPEDD (n = 112). The pooled reoperation rate was 9% (95% CI, 4% – 15%) in UPEDD studies and 4% (95% CI, 0 – 14%) in BPEDD studies. For all studies, the pooled reoperation rate was 8% (95% CI, 3% – 13%) (Fig. 6A). No serious publication bias was observed in the funnel plot (Fig. 6B). The reasons for reoperation included uncontrolled infections, persisting back pain, spinal instability and kyphotic deformity. The majority of reoperations were in the UPEDD group (n = 44, 9.5%). All reoperations in the BPEDD group (n = 10, 8.9%) were open surgeries.

Complications

Complication data were available for 84% of the patients who underwent UPEDD (n = 388) and all patients who underwent BPEDD (n = 199). The pooled complication rate was 4% (95% CI, 1% – 9%) in UPEDD studies and 8% (95% CI, 1% – 16%) in BPEDD studies; there was no statistically significant difference between the 2 groups (*P* = 0.32). For all studies, the pooled complication rate was 5% (95% CI, 2% – 9%). There was heterogeneity among all studies reporting the complication rate (I^2 = 63%; *P* < 0.01) and within both groups (UPEDD: I^2 = 64%; *P* < 0.01; BPEDD: I^2 = 57%; *P* = 0.03) (Fig. 7A). No serious publication bias was observed in the funnel plot (Fig. 7B). The most common complications for UPEDD were radiating pain (n = 11; 2.8%) and paresthesia (n = 10; 2.6%). The incidence of paresthesia or radiating pain in BPEDD was 7% (n = 14). There was statistical heterogeneity across all studies reporting complication rates (I^2 = 45.9%; *P* = 0.035), the UPEDD group (I^2 = 36.0%; *P* = 0.142) and the BPEDD group (I^2 = 56.8%; *P* = 0.055).

Table 1 summarizes the outcomes of the included studies.

Discussion

Our meta-analyses yielded 26 studies with 661 patients who underwent UPEDD and/or BPEDD procedures. A total of 21 studies (n = 462) investigated UPEDD outcomes and 7 studies (n = 199) investigated BPEDD outcomes. For the UPEDD group, the pooled event rates for positive bacteria culture, pain control satisfaction, reoperation and complications were 72%, 91%, 9% and 4%, respectively; the pooled operation time and blood loss were 89.90 minutes and 59.77 mL. For the BPEDD group, these were 79%, 92%, 4%, 8%, 93.23 minutes and 64.93 mL. There was no significant difference in terms of positive bacteria culture rate,

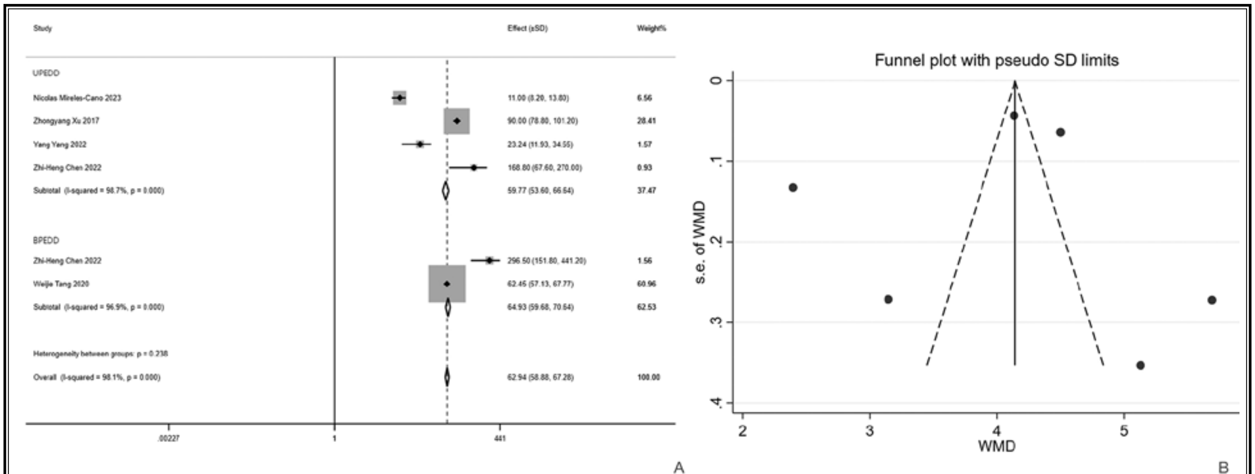

Fig 4. *A. Forest plot of the pooled blood loss between UPEDD and BPEDD. B. Funnel plot of the blood loss in all studies.*

pain control satisfaction rate, complication rate, and reoperation rate.

Administering antibiotics to eradicate an infection is the fundamental principle for effective spinal infection treatment (35). The premise of targeted antibiotics is to identify the pathogenic bacteria. While up to 59% of spinal infections can have their causative pathogens identified through blood cultures, the only way to conclusively diagnose these conditions is through microscopic or bacteriological analysis of the infected tissue (35,36).

CT-guided puncture or intraoperative removal of tissue samples are needed to make a diagnosis. The drawback of using CT-guided puncture is its provision of a limited quantity of tissue, resulting in successful pathogen detection in only approximately 50% of patients (37,38). Open surgery is usually more invasive and has a high incidence of complications and mortality

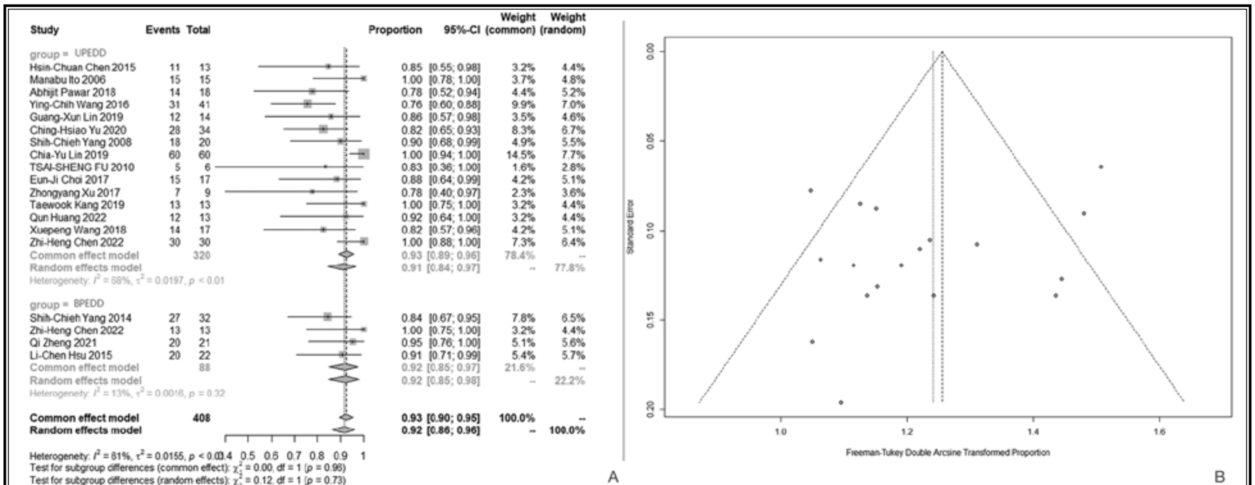

Fig 5. *A. Forest plot of the pooled pain control satisfaction rate between UPEDD and BPEDD. B. Funnel plot of the pain control satisfaction rate in all studies.*

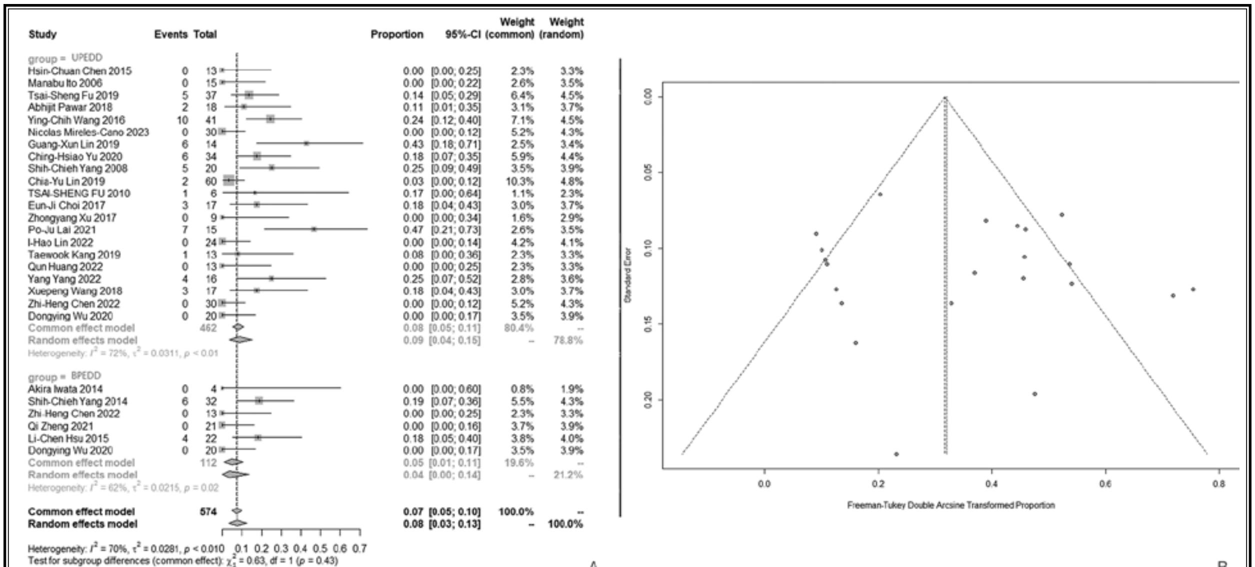

Fig 6. *A. Forest plot of the pooled reoperation rate between UPEDD and BPEDD. B. Funnel plot of the reoperation rate in all studies.*

(27). PEDD's positive culture rate is not only comparable to the results from open biopsy, but it is also superior to the outcomes of CT-guided biopsy (10). In our study, the positive rates of bacterial culture were similar between UPEDD and BPEDD samples. Both UPEDD and BPEDD could directly collect sufficient specimens for microbiological examination (31). Wu, et al (34) reported that BPEDD has no advantage over UPEDD in terms of acquiring a sample quantity.

There is no doubt that the time needed to place a unilateral working sleeve is shorter than for bilateral sleeves, and blood loss in BPEDD is more than that in UPEDD.

Some researchers (16,34) believe that, unlike UPEDD to target the unilateral infected disc, the bilateral portal approach focuses on the entire disc. As endoscopic instruments gradually enter the center of the infected disc, there is a common connection between the paraspinal abscess and the infected disc, which is the actual origin of the spinal infection. A bilateral portal technique allows for different endoscopic views and an enhanced operating space. This helps to obtain

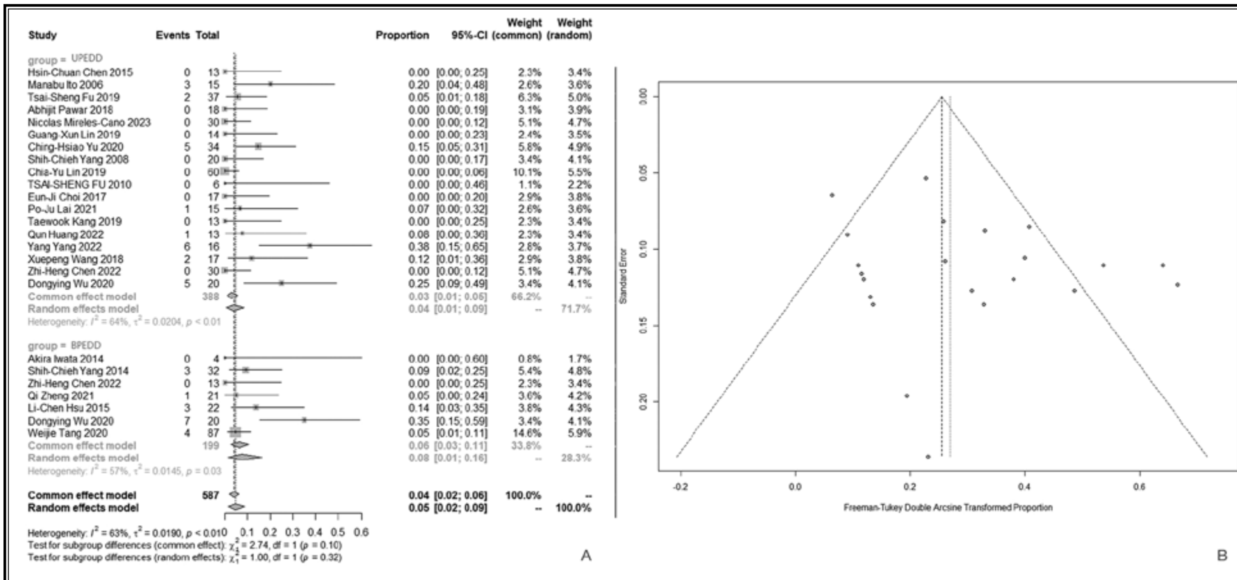

Fig 7. *A. Forest plot of the pooled complication rate between UPEDD and BPEDD. B. Funnel plot of the complication rate in all studies.*

Table 1. *Outcomes summary of the included studies.*

Pooled event rate	**Number of Studies**		**Patients**		**%**		**95% CI**		**Heterogeneity**	
	UPEDD	**BPEDD**	**UPEDD**	**BPEDD**	**UPEDD**	**BPEDD**	**UPEDD**	**BPEDD**	**UPEDD**	**BPEDD**
Positive Bacteria Culture	20	6	453	112	0.72	0.79	0.65 - 0.78	0.61 - 0.92	I^2 = 50%, $P < 0.01$	I^2 = 70%, $P < 0.01$
Operation Time	9	4	166	58	89.90min	93.23min	83.44 - 96.87	88.39 - 98.33	I^2 = 93%, $P < 0.01$	I^2 = 99%, $P < 0.01$
Blood Loss	4	2	85	100	59.77 mL	64.93 mL	53.60 - 66.64	59.68 - 70.64	I^2 = 99%, $P < 0.01$	I^2 = 97%, $P < 0.01$
Pain Control Satisfaction	15	4	320	88	0.91	0.92	0.84 - 0.97	0.85 - 0.97	I^2 = 68%, $P < 0.01$	I^2 = 13%, $P = 0.32$
Reoperation	21	6	462	112	0.09	0.04	0.04 - 0.15	0.00 - 0.14	I^2 = 72%, $P < 0.01$	I^2 = 62%, $P = 0.02$
Complications	18	7	388	199	0.04	0.08	0.01 - 0.09	0.01 - 0.16	I^2 = 64%, $P < 0.01$	I^2 = 57%, $P = 0.03$

sufficient specimens to identify the causative pathogen and remove more infected tissue, even from adjacent vertebral endplates. As a result, a radical debridement might be performed. In addition, the irrigation and drainage tubes in BPEDD surgery are in different portals. When rinsing, the liquid is more smooth than in UPEDD, and the drainage tube is not easily blocked (34). Also, by sufficiently reducing the pressure within the intervertebral disc, this procedure can effectively relieve back pain (34). However, in our meta-analysis, the pain control satisfaction rate of BPEDD (92%) was similar with that of UPEDD (91%). More evidence regarding this should be obtained in further studies.

Paresthesia and local kyphosis are common complications of PEDD (19,22,24). In most cases, paresthesia is transient and the patient eventually recovers. However, severe local kyphosis requires open surgical intervention. Further open surgery is needed for those with intractable back pain, persisting infection, mechanical spine instability, or severe local kyphosis (22,33,39).

Some believe that bilateral surgery is more likely to require open surgical revision (16). It could be that invasive debridement via a bilateral route to the contaminated anterior disc might cause its destructive collapse, potentially leading to additional mechanical instability (16); in addition, BPEDD causes damage to the bilateral posterior ligament complex, which further damages spine stability. Open surgery is associated with significant trauma, a high rate of perioperative complications, and a lengthy postoperative recovery (4,29). Several surgeons have combined PEDD with bone graft interbody fusion and percutaneous posterior instrumentation to enhance infection control, kyphosis correction, and spinal stability; satisfactory clinical results were obtained (27,40,41).

As far as we are aware, our study is the first review to evaluate the effectiveness of UPEDD and BPEDD in managing spinal infection. However, there were several limitations. First, all included studies were retrospective series, limiting our study design to a single-arm meta-analysis. Second, there was a limited amount of studies that were determined to be fitting, particularly BPEDD, and the sample size was small. Third, the clinical effects of UPEDD and BPEDD need to be compared in greater detail, such as the time it took for inflammatory markers to return to normal, the incidence of local kyphosis, and whether antibiotic use duration could be shortened after adequate debridement of BPEDD. Lastly, further studies are necessary to compare the clinical outcome of PEDD and percutaneous endoscopic interbody debridement and fusion.

Conclusion

Both UPEDD and BPEDD can provide a relatively reliable causative-pathogen identification and satisfactory clinical outcome. The 2 techniques are not significantly different in terms of positive bacteria culture rate, pain control satisfaction rate, complication rate, and reoperation rate. Future studies should incorporate additional measures to assess the clinical outcomes for both.

Supplemental material is available at www.painphysicianjournal.com

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Appendix 1. *Characteristics of the included studies.*

Trial	NO. of Patients	Men	Women	Age	Country	Recruitment Period	No. of Patients With Positive Bacteria Culture	No. of Patients With Satisfactory Pain Control	Operation Time (mins)	Blood Loss (mL)	Study Design	No. of Reoperations	Complications	Follow-up (mos)
UPEDD														
Hsin-Chuan Chen 2015	13	5	8	65.6	Republic of China	October 2006 through March 2014	10	11	NR	NR	Retrospective Study	0	0	42.5
Manabu Ito 2006	15	10	5	60	Japan	NR	11	15	57.8 ± 13.0	NR	Retrospective Study	0	3	25
Tsai-Sheng Fu 2019	37	27	10	56.5	Republic of China	2004 through 2012	30	NR	NR	NR	Retrospective Study	5	2	NR
Abhijit Pawar 2018	18	6	12	46	India	May 2015 through May 2017	16	14	NR	NR	Retrospective Study	2	0	17
Ying-Chih Wang 2016	41	29	12	55.2	Republic of China	August 2002 through August 2012	32	31	NR	NR	Retrospective Study	10	NR	24
Nicolas Mireles-Cano 2023	30	15	15	58.1	Mexico	NR	14	NR	32.3 ± 9.7	11 ± 2.8	Retrospective Study	0	0	7
Guang-Xun Lin 2019	14	9	5	69.3	Republic of Korea	November 2015 through September 2017	10	12	52.9 ± 18.8	NR	Retrospective Study	6	0	20.9
Ching-Hsiao Yu 2020	34	22	12	62.3	Republic of China	June 2016 through June 2018	27	28	NR	NR	Retrospective Study	6	5	12
Shih-Chieh Yang 2008	20	12	8	62.9	Republic of China	January 2001 through January 2006	18	18	NR	NR	Retrospective Study	5	0	12
Chia-Yu Lin 2019	60	39	21	60	Republic of China	October 2006 through March 2017	43	60	NR	NR	Retrospective Study	2	0	42
Tsai-Sheng Fu 2010	6	4	2	61.7	Republic of China	2011 through 2007	5	5	NR	NR	Retrospective Study	1	0	NR
Eun-Ji Choi 2017	17	11	6	70.4	Republic of Korea	November 2008 through November 2015	14	15	NR	NR	Retrospective Study	3	0	3

Appendix 1 continued. *Characteristics of the included studies.*

Trial	NO. of Patients	Men	Women	Age	Country	Recruitment Period	No. of Patients With Positive Bacteria Culture	No. of Patients With Satisfactory Pain Control	Operation Time (mins)	Blood Loss (mL)	Study Design	No. of Reoperations	Complications	Follow-up (mos)
UPEDD														
Zhongyang Xu 2017	9	5	4	64.4	People's Republic of China	August 2014 through December 2016	NR	7	156 ± 37.8	90 ± 11.2	Retrospective Study	0	NR	1
Po-Ju Lai 2021	15	12	3	63.1	Republic of China	April 2014 through July 2018	12	NR	71.9 ± 22.2	NR	Retrospective Study	7	1	12
I-Hao Lin 2022	24	12	12	61	Republic of China	September 2006 through December 2019	16	NR	NR	NR	Retrospective Study	0	NR	60
Taewook Kang 2019	13	7	6	54.7	Republic of Korea	January 2016 through June 2017	7	13	NR	NR	Retrospective Study	1	0	24
Qun Huang 2022	13	5	8	58	People's Republic of China	November 2016 through December 2019	7	12	NR	NR	Retrospective Study	0	1	14
Yang Yang 2022	16	10	6	49.3	People's Republic of China	November 2017 through April 2019	6	NR	94.76 ± 31.97	23.24 ± 11.31	Retrospective Study	4	6	28
Xuepeng Wang 2018	17	11	6	59.5	People's Republic of China	January 2014 through July 2017	14	14	63.5 ± 16.7	NR	Retrospective Study	3	2	3
Zhi-Heng Chen 2022	30	22	8	62.4	People's Republic of China	January 2017 through February 2019	22	30	59.3 ± 24.5	168.8 ± 101.2	Retrospective Study	0	0	24
Dongying Wu 2020	20	9	11	47.8	People's Republic of China	February 2014 through February 2018	9	NR	115.8 ± 12.2	NR	Retrospective Study	0	5	18
BPEDD														
Akira Iwata 2014	4	4	0	59.8	Japan	January 2001 through December 2009	4	NR	44.3 ± 4	NR	Retrospective Study	0	0	42.5

Appendix 1 continued. *Characteristics of the included studies.*

Trial	NO. of Patients	Men	Women	Age	Country	Recruitment Period	No. of Patients With Positive Bacteria Culture	No. of Patients With Satisfactory Pain Control	Operation Time (mins)	Blood Loss (mL)	Study Design	No. of Reoperations	Complications	Follow-up (mos)
UPEDD														
Shih-Chieh Yang 2014	32	23	9	57.4	Republic of China	January 2005 and July 2010	28	27	NR	NR	Retrospective Study	6	3	38.5
Zhi-Heng Chen 2022	13	7	6	65.3	People's Republic of China	January 2017 through February 2019	11	13	86 ± 33.8	296.5 ± 144.7	Retrospective Study	0	0	24
Qi Zheng 2021	21	12	9	58.1	People's Republic of China	June 2014 through July 2017	15	20	133.3 ± 11.6	NR	Retrospective Study	0	1	20.3
Li-Chen Hsu 2015	22	16	6	57.8	Republic of China	January 2007 through December 2011	19	20	NR	NR	Retrospective Study	4	3	38.7
Dongying Wu 2020	20	10	10	49.1	People's Republic of China	February 2014 through February 2018	8	NR	150.5 ± 15.6	NR	Retrospective Study	0	7	18
Weijie Tang 2020	87	54	33	39.7	People's Republic of China	October 2017 through May 2019	NR	NR	NR	62.5 ± 5.3	Retrospective Study	NR	4	3

NR = not reported