Systematic Review

Posterior Cervical Foraminotomy Via Full-Endoscopic Versus Microendoscopic Approach for Radiculopathy: A Systematic Review and Meta-analysis

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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: 04-07-2018 Accepted for publication: 06-01-2018

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Background: Recently posterior cervical foraminotomy (PCF) performed using a minimally-invasive surgery (MIS) approach for cervical radiculopathy due to lateral disc herniation or osseous foraminal stenosis has gained popularity. As 2 dominating MIS techniques, whether FE-PCF or MI-PCF provides superior clinical outcomes remains controversial.

Objectives: To compare clinical success rate, overall incidence of complications and reoperation rate between full-endoscopic posterior cervical foraminotomy (FE-PCF) and microendoscopic posterior cervical foraminotomy (MI-PCF) for cervical radiculopathy.

Study Design: A systematic review and meta-analysis.

Methods: A literature search of Pubmed, Embase and Web of Science was conducted to identify comparative or single-arm studies concerning FE-PCF or MI-PCF. The pooled results were performed by calculating the effect size based on the logit event rate and reported with 95% confidence intervals (CI).

Results: A total of 26 articles with 2003 patients (FE-PCF, 377; MI-PCF, 1626) were included. The pooled clinical success rate was 93.6% (CI: 90.0%~95.9%) for the FE group and 89.9% (CI: 86.6%~92.5%) for the MI group, which was not statistically significant (P = 0.908). Overall complication rates were 6.1% (CI: 3.2%~11.3%) and 3.5% (CI: 2.7%~4.6%) for the FE group and the MI group, respectively, with no significant difference (P = 0.128). Nevertheless, the specific constituents showed apparent disparity, with transient nerve root palsy in the FE group (12/16, 75.0%) and dural tear in the MI group (20/47, 42.6%) being the most commonly reported. the pooled reoperation rate, the FE group (4.8%, CI: 2.9%~7.8%) and the MI group (5.3%, CI: 3.4%~8.2%), also demonstrated no statistical difference (P = 0.741).

Limitations: The indirect comparison eroded the reliability of results inevitably due to the paucity of randomized clinical trials or high quality prospective cohort studies.

Conclusions: Both FE-PCF and MI-PCF can offer an effective and relatively secure treatment for cervical radiculopathy. There was no significant difference in the pooled outcomes of clinical success rate, complication rate and reoperation rate between the 2 approaches.

Key words: Cervical radiculopathy, full-endoscopic, microendoscopic, posterior cervical foraminotomy, clinical outcome, complication, reoperation, meta-analysis

Pain Physician 2019: 22:41-52

Cervical radiculopathy is known as a common disease leading to neck and arm pains, typical manifestations of nerve root compression, which is mainly caused by intervertebral disc herniation or foraminal stenosis (1,2). For such a disease that can affect study, work and daily life severely, surgical

strategies should be taken into account when patients failconservative treatments. Nevertheless, the optimal choice is still controversial. Posterior cervical foraminotomy (PCF) was initially described by Spurling and Scoville (3) in 1944. Anterior cervical discectomy and fusion (ACDF) was originally pioneered by Smith and Robinson (4) in the late 1950s. The past decade has been witness to enormous advancements in cervical disc replacement (CDR). Although satisfactory relief of symptoms can be achieved by these methods (5,6), there are some disadvantages including postoperative neck pain and spasm resulting from damage to the dorsal cervical musculature. In traditional open PCF (7), dysphagia and adjacent segment degeneration can result as complications in ACDF and CDR (8-10) related to access and fusion-With minimally invasive theories and techniques flourishing in spine surgery, microendoscopic (MI) PCF was first reported by Adamson (11) in 2001 and full-endoscopic (FE) PCF by Ruetten et al (12) in 2007. Both proved to be similarly effective when compared with open PCF for cervical radiculopathy (13), and had lower blood loss, less inpatient analgesic use, shorter surgical time, and shorter hospital stays (14,15), making MI and FE techniques promising for the treatment of lateral disc herniation and osseous foraminal stenosis.

There are several distinctions between MI and FE instruments. The imaging medium in the MI optic system is air, whereas FE, uses water. The outer diameter of the MI working sheath ranges 16-20 millimeters; whereas FE ranges 6-8 millimeters. In FE-PCF, continuous irrigation of normal saline and the intrinsic nature of the larger refractive index than air, facilitate better visualization of surgical fields (12,16-22) and potentially better surgical results. However, a much steeper learning curve accompanies the smaller working channel, probably inducing higher incidence of complications and revisions than those of MI-PCF. To date, the heated debate over which of the 2 minimally invasive techniques provides superior clinical outcomes with fewer adverse effects remains to be settled. The purpose of this article was to compare clinical success, complications, and reoperation results between FE-PCF and MI-PCF for cervical radiculopathy.

Methods

Literature Search

This meta-analysis was performed in conformity to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISRMA) statement (23) and Meta-analysis and Systematic Review of Observational Studies in Epidemiology (MOOSE) guidelines (24). We searched the electronic databases of Pubmed, Embase and Web of Science for literature concerning FE-PCF and MI-PCF published in English from inception to October 2017. Advanced retrieval strategies were implemented using title/abstract as search field; search terms with Boolean operators were as follows: (cervical radiculopathy) AND (foraminotomy OR laminoforaminotomy OR discectomy) AND (microscopic OR microendoscopic OR endoscopic OR full-endoscopic).

Eligibility Criteria

Inclusion criteria were: randomized or nonrandomized controlled studies and case series; diagnosis of cervical radiculopathy, confirmed by clinical symptoms and physical examinations in accordance with imaging findings of lateral disc herniation or osseous foraminal stenosis; patients conservatively treated for more than 6 weeks; surgical intervention of FE-PCF or MI-PCF; and outcomes of clinical success, complications and reoperation at least 1 of which was reported in detail.

Exclusion criteria were: less than 10 patients enrolled in 1 study; patients whose diagnosis covered cervical myelopathy, tumor, tuberculosis, fraction, infection or malformation; patients with previous history of cervical surgery; FE or MI surgery of anterior approach; imaging, cadaveric, or biomechanical studies; and case reports, reviews, editorials, letters or commentary articles.

Quality Assessment

Level of evidence was assessed according to Oxford Centre for Evidence-based Medicine (25). Risk of bias was evaluated using the checklist by Downs and Black (26). The checklist consists of measurements of reporting items, sample representativeness and confounding factors, and culminates in a total score directly proportional with overall quality of individual study. Specifically, this checklist comprises 27 items for which an answer "yes" was awarded 1 point, while "no" or "unable to determine" correlates with 0 point with an exception of the last item. Primitive item 27 was modified to a binary answer system in which 1 point was assigned if statistical power or sample size calculation was present, thus producing a maximum score of 28.

Data Extraction

A meta-analysis database was built with extracted data as follows: study identification incorporating author, year of publication, title and journal; study design

and level of evidence; characteristics of study population including country, sample size, male/female ratio, patient age and responsible segment; surgical method and instrument; length of follow-up and patients lost to follow-up; and outcomes of clinical success, complications and reoperation.

Two researchers independently conducted inclusion of eligible studies, methodological quality assessment, and data extraction. Disagreement was settled by consultation with a third senior professor to reach a consensus.

Statistical Analysis

Statistical analysis was performed using Comprehensive Meta Analysis 2.2 (Biostat, Englewood, NJ). The studies were weighted in the meta-analysis by the inverse of the variance, which included both within and between-study errors. Since clinical results to be assessed were extracted as dichotomous data, prevalence point estimates and 95% confidence intervals (CI) were calculated and forest plots of the pooled results based on logit event rate (LER) were reported. Heterogeneity was evaluated using Cochran Q test and Higgins I^2 statistic. Representing the percentage of error due to between-study variation, $I^2 < 25\%$ generally indicated consistent results and homogeneous studies, whereas $I^2 > 50\%$ was used as a threshold to indicate significant heterogeneity and a random-effects model was preferred. Comparisons between the groups were conducted using t test, with *P*-value of 0.05 set for significance. Sensitivity analysis was performed by eliminating single studies and determining whether pooled results were impacted distinctly. To assess publication bias, the *P*-value for Egger intercept was computed and the funnel plot of effect size versus standard error was inspected.

Results

Search Results

The initial literature search resulted in 56 articles in Pubmed, 53 studies in EMBASE, 118 articles in Web of Science. Among these articles, 149 duplicates were identified and then 32 articles were excluded by browsing titles and abstracts. The remaining 46 studies were subjected to full-text screening process, during which 20 studies were further eliminated based on the inclusion and exclusion criteria. Finally, 26 studies were included in this meta-analysis (11,12,16-22,27-43) (Fig.1).

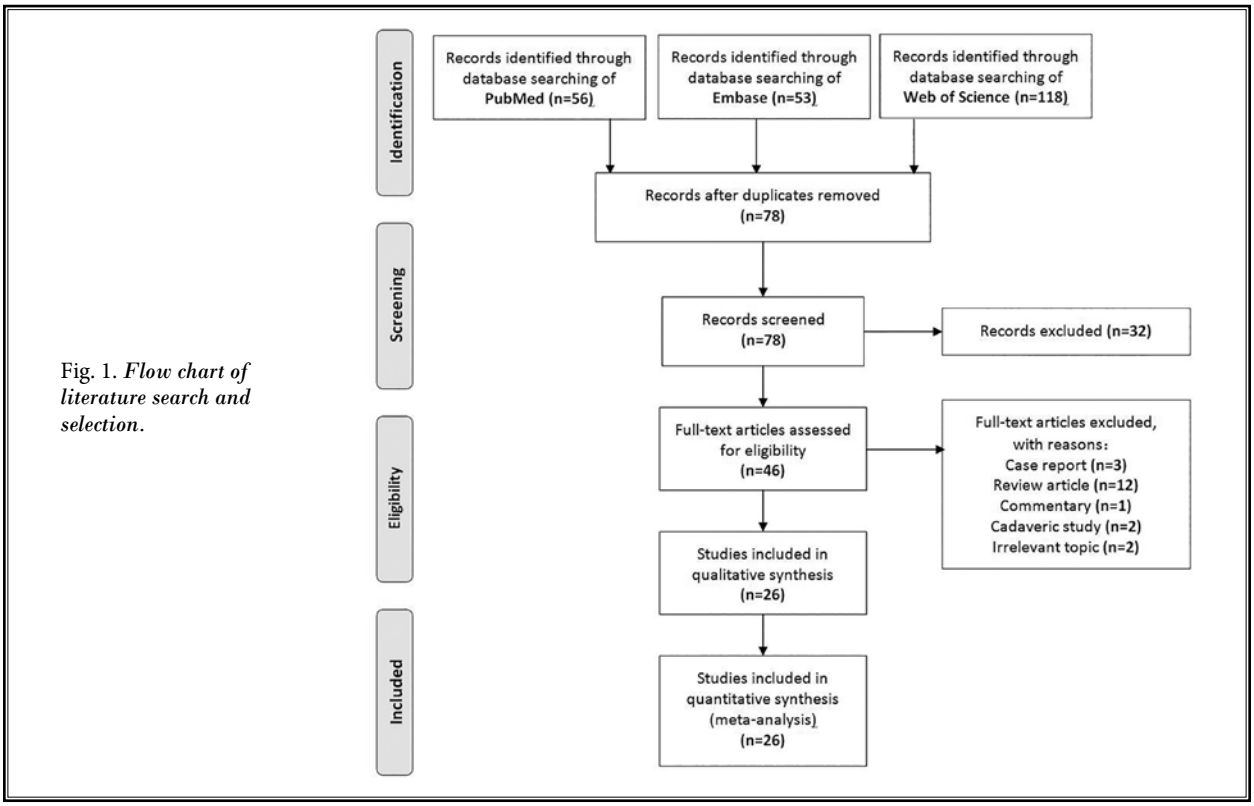

Fig. 1. *Flow chart of literature search and selection.*

Quality Assessment of Included Studies

There were 2 randomized controlled trials (RCT), 2 prospective cohort studies (PCS), 7 retrospective cohort studies (RCS) and 15 retrospective case series (CS). Levels of evidence of the majority studies were III (n = 9) and IV (n = 15). The quality index score ranged from 13 to 20, with an average score of 16.5 and a standard deviation of 1.9. We defined a higher quality study as 19 to 20, a moderate quality study as 16 to 18, and a poor quality study as 13 to 15. (14) There were 5 higher quality studies, 15 moderate quality studies, and 6 poor quality studies. Methodological assessment for individual study, as well as demographic information, was given in Table 1.

Summary of Basic Characteristics

In total, this meta-analysis incorporated 2,003 patients, with 377 in the FE group and 1,626 in the MI group. Direct comparison of FE-PCF and MI-PCF was inclusively conducted in 1 RCS by Kim et al (19), whereas single arms of either technique were extracted from the other studies. South Korea (n = 10), USA (n = 7) and Germany (n = 6) were the top 3 countries where studies were conducted. Concerning overall characteristics of patients, the average male/female ratio was 1.6 (FE group, 1.0; MI group, 1.6) and the average age was 49.9 years (FE group, 46.2; MI group, 50.5). Operations were mainly performed on single segment from C4 to T1, and the featured instruments were Vertebris system (Richard Wolf GmbH, Knittlingen, Germany) for FE-PCF and METRx system (Medtronic Sofamor Danek, Memphis, TN) for MI-PCF. The mean follow-up period was 36.9 months (FE group, 23.7; MI group, 40.2) and patients lost to final follow-up were reported in 4 studies (12,16,17,40)(Table 1).

Meta-Analysis Results

Clinical Success

Adequate outcomes of clinical success were reported in 6 studies of FE-PCF and 12 studies of MI-PCF. The pooled clinical success rate was 93.6% (CI: 90.0%~95.9%) for the FE group and 89.9% (CI: 86.6%~92.5%) for the MI group. The difference was not statistically significant between the 2 groups (P = 0.908). The studies showed minimal heterogeneity in the FE group (Q = 4.9, I^2 = 0), but moderate heterogeneity in the MI group (Q = 21.5, I^2 = 48.9%) (Fig. 2, Table 2, Table 3).

Complications

Overall complication rates were covered in all studies with 1 exception in the FE group. Complications occurred in 16 cases of 331 patients undergoing FE-PCF, with the pooled complication rate of 6.1% (CI: 3.2%~11.3%). Meanwhile, there were 47 cases of complications of 1,626 patients in the MI group, resulting in the pooled complication rate of 3.5% (CI: 2.7%~4.6%). No statistical significance was revealed between the 2 groups (P = 0.128). There was moderate heterogeneity in the FE group (Q = 10.1, I^2 = 40.9%), however, minimal heterogeneity in the MI group (Q = 15.9, I^2 = 0) (Fig. 3, Table 2, Table 3).

Reoperation

Incidence of revision surgery was involved in 8 studies of FE-PCF and 16 studies of MI-PCF. The pooled reoperation rate was 4.8% (CI: 2.9%~7.8%) for the FE group and 5.3% (CI: 3.4%~8.2%) for the MI group. There was no significant difference between the 2 groups (P = 0.741). Studies in the FE group demonstrated minimal heterogeneity (Q = 3.4, I^2 = 0), whereas studies in the MI group indicated moderate heterogeneity (Q = 34.8, I^2 = 56.9%) (Fig. 4, Table 2, Table 3).

Sensitivity Analysis and Publication Bias

Single elimination of each study had no significant influence on the overall results of the meta-analysis. All funnel plots were symmetric regarding the mean effect, indicating an absence of evident publication bias within the studies. Funnel plots of complication rate taken for example, were presented in Fig. 5. The Egger test results were -1.32 (P = 0.52) and -0.04 (P = 0.94) for the complication rate of the FE group and the MI group. This again demonstrated a lack of substantial evidence testifying to publication bias.

Discussion

The surgical treatment of cervical radiculopathy is still controversial. Typical of anterior techniques, ACDF has been favored as a "golden standard" by many surgeons, while CDR has been considered as an effective alternative with appropriate, but restricted indications. PCF can refrain from anterior-approach related complications and reduce adjacent segment diseases to a certain degree (44). When combined with minimally invasive techniques, severe blood loss and muscle injury in traditional PCF should be lessened. FE and MI techniques have been widely applied in minimally invasive spine surgeries, especially in a large spectrum of lumbar diseases (45-47). Recently a network meta-analysis by Feng et al (48) suggested that for lumbar

disc herniation FE technique had higher success rates, lower complication rates, and higher reoperation rates, in contrast to MI. As for cervical radiculopathy, this is the first meta-analysis that compared clinical outcomes of FE-PCF versus MI-PCF.

We found no statistical evidence of differences in clinical success, complications, and reoperation results between the 2 groups. Outcomes of clinical success were extracted from individual studies based on a broad definition — complete remission of

Table 1. *Basic characteristics of included studies.*

Study	Country	Study Design	Level of Evidence	Quality Score	Surgical Method	Sample Size	M/F Ratio	Mean Age	No. of Segment	Segment	Mean FU Duration	Operating Device
Ruetten.2007 (12)	Germany	CS	IV	19	FE	100	39/61	44	1	C4-T1	24	Vertebris
Ruetten.2008 (16)	Germany	RCT	II	20	FE	100	NR	NR	1	C4-T1	24	Vertebris
Yang.2014 (17)	China	RCS	III	17	FE	42	28/14	40.5	1	C3-C7	18	NR
Kim.2014 (18)	Korea	CS	IV	16	FE	32	22/10	49	1	C4-T1	30	Vertebris
Kim.2015 (19)	Korea	RCS	III	19	FE	22	15/7	44.7	1	C4-T1	24	Vertebris
Won.2017 (20)	Korea	RCS	IV	16	FE	46	30/16	49.3	1	C4-T1	25.8	Vertebris
Park.2017 (21)	Korea	CS	IV	13	FE	13	5/8	47.1	1	C4-C7	14.8	Arthrex
Youn.2017 (22)	Korea	CS	IV	15	FE	22	13/9	56	2	C4-T1	24	TESSYS
Adamson.2001 (11)	USA	CS	IV	16	MI	100	63/37	46.6	1	C4-T1	14.8	NR
Fessler.2002 (27)	USA	PCS	III	17	MI	25	20/5	49.6	1-2	C3-T2	16	METRx
Korinth.2006 (28)	Germany	RCS	III	18	MI	168	98/70	46.9	1	C3-T1	72.1	NR
Holly.2007 (29)	USA	CS	IV	14	MI	21	13/8	51	2	C2-T1	23	METRx
Hilton.2007 (30)	USA	CS	IV	16	MI	222	141/81	49	NR	NR	26	METRx
Caglar.2007 (31)	Turkey	CS	IV	16	MI	84	49/35	49	1-2	C5-C7	94	NR
Jagannathan.2009 (32)	USA	CS	IV	17	MI	162	94/68	48.4	1	C3-C7	78.4	NR
Kim.2009 (33)	Korea	RCT	II	20	MI	22	14/8	54.4	1-2	C4-T1	33.1	METRx
Lidar.2011 (34)	Israel	CS	IV	15	MI	32	19/13	46	NR	NR	39	METRx
Winder.2011 (35)	Canada	RCS	III	18	MI	42	28/14	49.8	NR	C3-T1	NR	NR
Ahn.2012 (36)	Korea	RCS	III	16	MI	47	30/17	52.7*	NR	C4-T1	30*	NR
Lawton.2014 (37)	USA	CS	IV	16	MI	38	25/13	49.5	1-3	C4-T1	24.5	NR
Skovrlj.2014 (38)	USA	PCS	III	19	MI	70	42/28	50.5	1-3	C3-T1	32.1	NR
Kwon.2014 (39)	Korea	CS	IV	16	MI	33	21/12	50.8	1	C4-C7	32.7	NR
Jeon.2015 (40)	Korea	CS	IV	13	MI	12	8/4	53	1-2	C5-C7	33.3	NR
Kim.2015 (19)	Korea	RCS	III	19	MI	22	16/6	56.3	1	C4-T1	24	NR
Branch.2015 (41)	Germany	CS	IV	16	MI	463	272/191	53.7	1-2	C4-T1	27.1	NR
Burkhardt.2016 (42)	Germany	RCS	III	14	MI	20	12/8	53.7	1-2	C5-T1	27.1	EasyGO
Oertel.2016 (43)	Germany	CS	IV	17	MI	43	27/16	55	1-3	C3-T2	28.8	EasyGO

RCT indicates randomized controlled trial; PCS, prospective cohort study; RCS, retrospective cohort study; CS, case series; FE, full-endoscopic; MI, microendoscopic; M/F, male/female; FU, follow-up; NR, not reported.

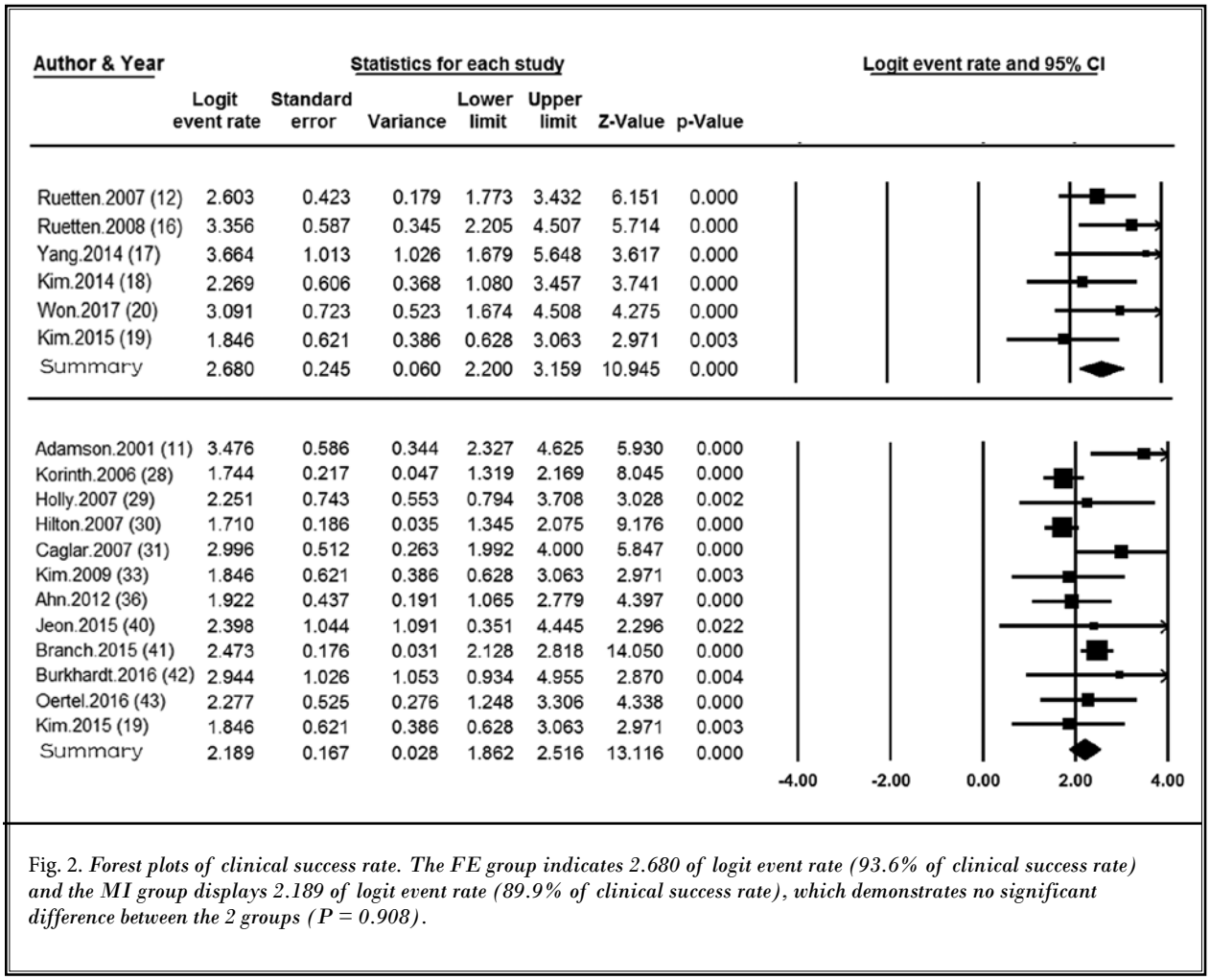

Fig. 2. *Forest plots of clinical success rate. The FE group indicates 2.680 of logit event rate (93.6% of clinical success rate) and the MI group displays 2.189 of logit event rate (89.9% of clinical success rate), which demonstrates no significant difference between the 2 groups (P = 0.908).*

Table 2. *Clinical outcomes of studies included in the FE group.*

Study	Clinical Success		Complications		Reoperation	
	No of patients	Incidence	No of patients	Incidence	No of patients	Incidence
Ruetten.2007 (12)	81	93.1%	3	3.0%	5	5.7%
Ruetten.2008 (16)	86	96.6%	3	3.0%	6	6.7%
Yang.2014 (17)	39	97.5%	1	2.4%	1	2.5%
Kim.2014 (18)	29	90.6%	3	9.4%	0	0
Kim.2015 (19)	19	86.4%	2	9.1%	0	0
Won.2017 (20)	44	95.7%	NR	NR	1	2.2%
Park.2017 (21)	NR	NR	0	0	0	0
Youn.2017 (22)	NR	NR	4	18.2%	0	0
Total	298	93.6% (CI: 90.0%~95.9%)	16	6.1% (CI: 3.2%~11.3%)	13	4.8% (CI: 2.9%~7.8%)

NR indicates not reported.

Table 3. *Clinical outcomes of studies included in the MI group.*

Study	Clinical success		Complications		Reoperation	
	No of patients	Incidence	No of patients	Incidence	No of patients	Incidence
Adamson.2001 (11)	97	97.0%	3	3.0%	3	3.0%
Fessler.2002 (27)	NR	NR	2	8.0%	0	0
Korinth.2006 (28)	143	85.1%	3	1.8%	12	7.1%
Holly.2007 (29)	19	90.5%	0	0	2	9.5%
Hilton.2007 (30)	188	84.7%	4	1.8%	3	1.4%
Caglar.2007 (31)	80	95.2%	1	1.2%	0	0
Jagannathan.2009 (32)	NR	NR	8	4.9%	7	4.3%
Kim.2009 (33)	19	86.4%	0	0	NR	NR
Lidar.2011 (34)	NR	NR	2	6.3%	NR	NR
Winder.2011 (35)	NR	NR	3	7.1%	NR	NR
Ahn.2012 (36)	41	87.2%	4	8.5%	0	0
Lawton.2014 (37)	NR	NR	1	2.6%	1	2.6%
Skovrlj.2014 (38)	NR	NR	3	4.3%	5	7.1%
Kwon.2014 (39)	NR	NR	0	0	0	0
Jeon.2015 (40)	11	91.7%	0	0	1	8.3%
Kim.2015 (19)	19	86.4%	1	4.5%	1	4.5%
Branch.2015 (41)	415	92.2%	10	2.2%	11	4.6%
Burkhardt.2016 (42)	19	95.0%	0	0	4	20.0%
Oertel.2016 (43)	39	90.7%	2	4.7%	8	18.6%
Total	1090	89.9% (86.6%~92.5%)	47	3.5% (2.7%~4.6%)	58	5.3% (3.4%~8.2%)

NR indicates not reported.

symptoms (29-31,41), excellent/good grade by Odom criteria (11,28,33,40,42,43), Hilibrand criteria (12,16), or MacNab criteria (17,18), as well as the minimum clinically important difference (MCID) of arm-VAS (49) which was more than 4.3 in the study by Kim et al (19). Nevertheless, no significant heterogeneity was disclosed and examiniations of the sensitivity analysis and publication bias further validated the reliability of the pooled results. Moreover, 2 recent systematic reviews (13,15) summarized the clinical success rate with similar definitions for minimally invasive PCF, including both FE and MI procedures. The pooled results were 94.9% by McAnany et al (13) and 92.7% by Song et al (15). Hence, the pooled clinical success rates of 93.6% for FE-PCF and 89.9% for MI-PCF in our studies were basically consistent with previous findings.

Although overall incidence of complications between the 2 groups manifested no significant difference, the specific constituents showed apparent disparity, with transient nerve root palsy in the FE group (12/16, 75.0%) and dural tear in the MI group (20/47, 42.6%) being the most commonly reported (Table 4). Transient nerve root palsy, featured by newly emerging or aggravating dermatome-related hypesthesia and/or muscle weakness, was hypothesized to be caused by thermal injury (18,19), and virtually all cases achieved complete alleviation from conservative therapy in 3 months. Dural tear, often accompanied by short-term cerebrospinal fluid leakage, was not dealt with distinctively other than observation, and no further sequela such as intracranial infection was incurred. Wound hematoma and superficial infection were relatively infrequent in the 2 groups. Noticeably, partial injury of the cervical spinal cord was observed in 1 case of each group, which deserved profound contemplation, despite the fact that both cases recovered gradually (17,28). Other rare complications include hemianopsia (30), neck pain (34), meningitis and vertebral artery occlusion postoperatively without obvious causes (41), and 1 adverse event of intraoperative extubation (41) as well as 3 cases with no detailed information (35) were also incorporated in Table 4. On the whole, no severe or

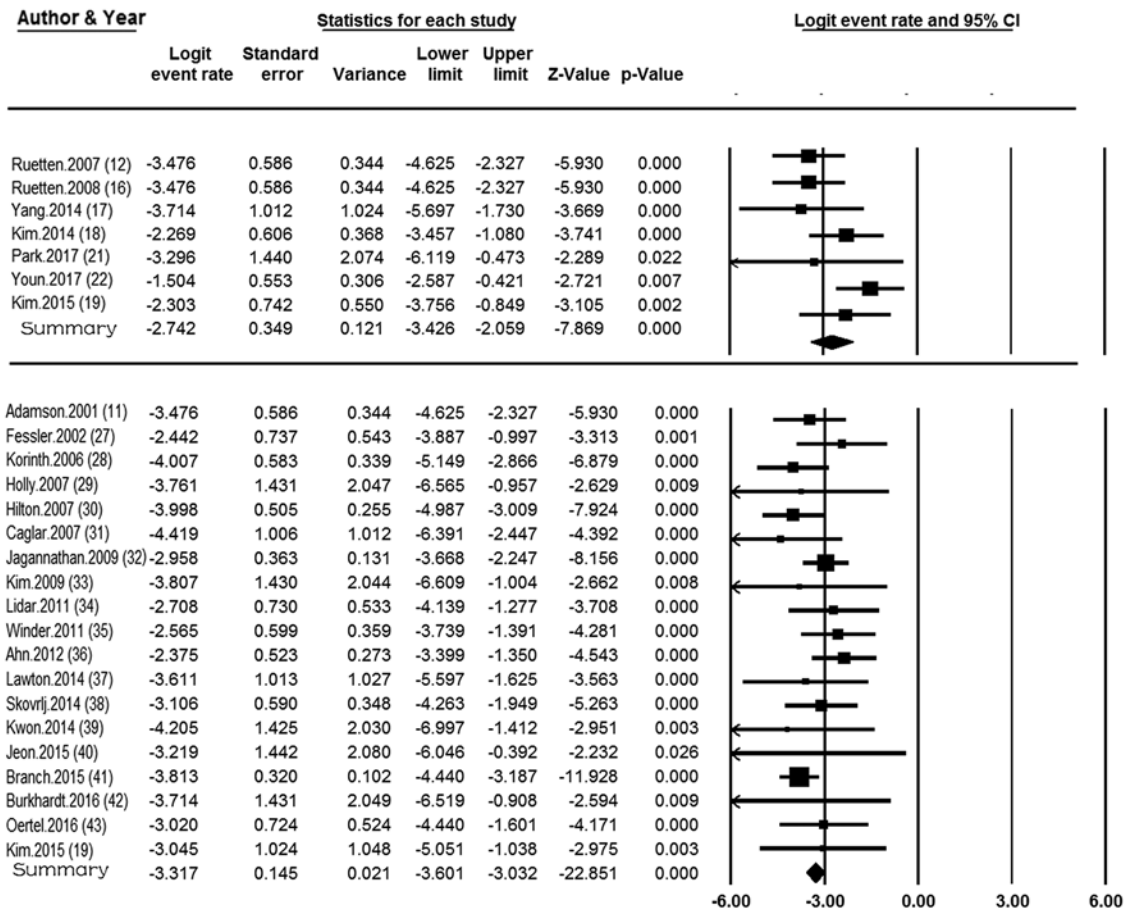

Fig. 3. *Forest plots of complication rate. The FE group indicates -2.742 of logit event rate (6.1% of complication rate) and the MI group displays -3.317 of logit event rate (3.5% of complication rate), which demonstrates no significant difference between the 2 groups (P = 0.128).*

permanent adverse events after either FE-PCF or MI-PCF had been reported. However, there is a paucity of articles focused on postoperative imaging changes of the cervical lordosis, segmental mobility, and intervertebral height. Therefore, complications of cervical kyphosis, segmental instability, and other degenerative diseases in the long term remain to be determined.

Our data found that FE procedures had similar overall incidence of reoperation as MI procedures. Reoperation might be owing to debridement of infection or hematoma, management of sustaining or aggravating symptoms, treatment of adjacent segment degeneration, but were most commonly due to recurrence at the identical level, thus reoperation and recurrence rates were roughly equivalent. The intervals of reop-

Table 4. *Categories of complications in the FE and MI group.*

Complications	FE	MI
Dural Tear	1 (6.2%)	20 (42.6%)
Transient Nerve Root Palsy	12 (75.0%)	10 (21.3%)
Superficial Wound Infection	2 (12.6%)	5 (10.6%)
Wound Hematoma	0	3 (6.4%)
Partial Injury of spinal cord	1 (6.2%)	1 (2.1%)
Others	0	8 (17.0%)
Total	16	47

FE indicates full-endoscopic; MI, microendoscopic.

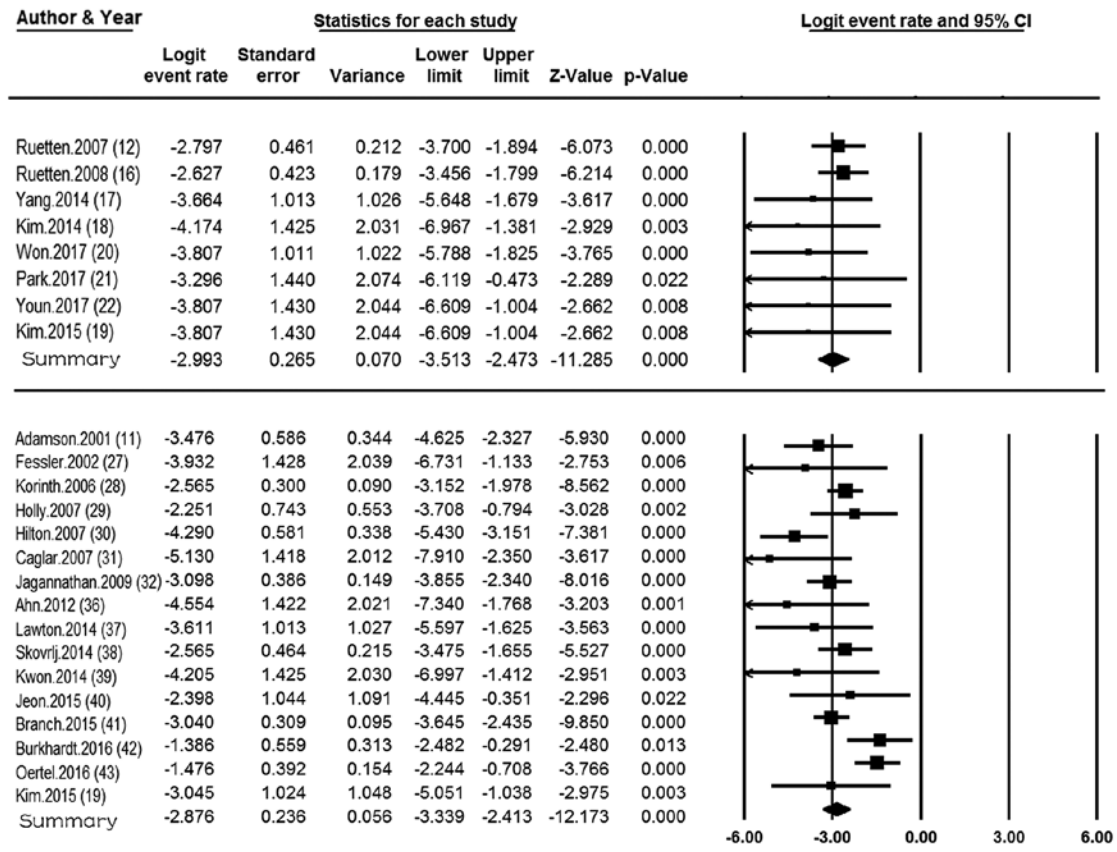

Fig. 4. *Forest plots of reoperation rate. The FE group indicates -2.993 of logit event rate (4.8% of reoperation rate) and the MI group displays -2.876 of logit event rate (5.3% of reoperation rate), which demonstrates no significant difference between the 2 groups (P = 0.741).*

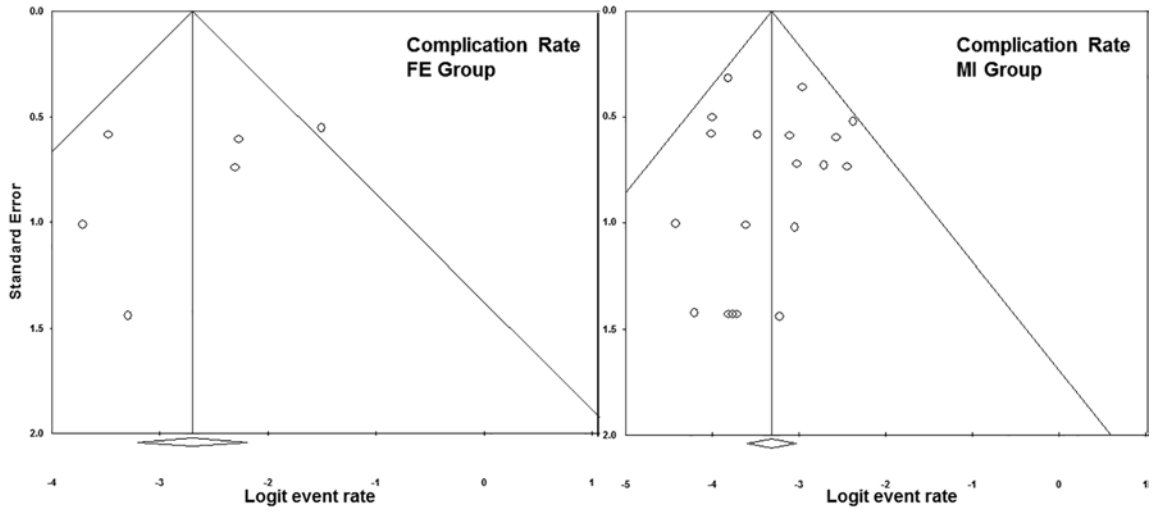

Fig. 5. *Funnel plots of standard error by logit event rate of complication rate. Both plots are symmetric about the mean effect, which indicates an absence of substantial publication bias.*

eration showed considerable discrepancy. In regard to MI-PCF, Oertel et al (43) concluded that mean periods to reoperation at index level and at adjacent level were 4.6 months and 9.7 months, respectively, whereas Skovrlj et al (38) reported 2 distinguishing number of 55.0 months and 47.0 months. Only Won et al (20) described the intermittence to recurrence after FE-PCF, postoperative 24 and 36 months in 2 cases without specification of the affected level. For recurrence verified by imaging, repeated FE-PCF or MI-PCF, together with ACDF was usually given priority, and satisfactory relief was obtained.

Limitations

There are several limitations of our study. First, the lack of high-quality randomized trials or cohort studies restricted this meta-analysis to incorporate single arms from separate studies or case series. The process of unadjusted, indirect comparison eroded the reliability of results inevitably, although more and more scholars approved of the inclusion of case series (50-52), especially regarding clinical decisions that encountered rigid ethic principles. Second, we were unable to conduct a comprehensive analysis for other relevant variables such as surgical time, blood loss, NDI, and VAS because of reporting deficiencies in these studies. Lastly, inherent heterogeneity among included studies limited the strength of our conclusions. Such factors as races and regions of patients, surgical centers and instruments, operating experience, and grasp of indications of surgeons can induce significant variations in clinical outcomes. Though, this study can provide evidence-based guidance to some extent for surgeons performing FE-PCF and MI-PCF.

Conclusion

Both FE-PCF and MI-PCF can offer an effective and relatively secure treatment for cervical radiculopathy. Nevertheless, there was no significant difference in clinical success rate, complication rates, and reoperation rate between the 2 surgical methods. So far, the most commonly reported complications were transient nerve root palsy in the FE group and dural tear in the MI group.

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