Lumbar microdiscectomy complication rates: a systematic review and meta-analysis

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OBJECT Lumbar microdiscectomy and its various minimally invasive surgical techniques are seeing increasing popularity, but a systematic review of their associated complications has yet to be performed. The authors sought to identify all prospective clinical studies reporting complications associated with lumbar open microdiscectomy, microendoscopic discectomy (MED), and percutaneous microdiscectomy.

METHODS The authors conducted MEDLINE, Scopus, Web of Science, and Embase database searches for randomized controlled trials and prospective cohort studies reporting complications associated with open, microendoscopic, or percutaneous lumbar microdiscectomy. Studies with fewer than 10 patients and published before 1990 were excluded. Overall and interstudy median complication rates were calculated for each surgical technique. The authors also performed a meta-analysis of the reported complications to assess statistical significance across the various surgical techniques.

RESULTS Of 9504 articles retrieved from the databases, 42 met inclusion criteria. Most studies screened were retrospective case series, limiting the number of studies that could be included. A total of 9 complication types were identified in the included studies, and these were analyzed across each of the surgical techniques. The rates of any complication across the included studies were 12.5%, 13.3%, and 10.8% for open, MED, and percutaneous microdiscectomy, respectively. New or worsening neurological deficit arose in 1.3%, 3.0%, and 1.6% of patients, while direct nerve root injury occurred at rates of 2.6%, 0.9%, and 1.1%, respectively. Hematoma was reported at rates of 0.5%, 1.2%, and 0.6%, respectively. Wound complications (infection, dehiscence, or seroma) occurred at rates of 2.1%, 1.2%, and 0.5%, respectively. The rates of recurrent disc complications were 4.4%, 3.1%, and 3.9%, while reoperation was indicated in 7.1%, 3.7%, and 10.2% of operations, respectively. Meta-analysis calculations revealed a statistically significant higher rate of intraoperative nerve root injury following percutaneous procedures relative to MED. No other significant differences were found.

CONCLUSIONS This review highlights complication rates among various microdiscectomy techniques, which likely reflect real-world practice and conceptualization of complications among physicians. This investigation sets the framework for further discussions regarding microdiscectomy options and their associated complications during the informed consent process.

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KEY WORDS lumbar microdiscectomy; microendoscopic discectomy; percutaneous discectomy; complications; systematic review; meta-analysis

ABBREVIATIONS IQR = interquartile range; MED = microendoscopic discectomy; MIS = minimally invasive surgical; PCS = prospective cohort study; PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses; RCT = randomized controlled trial.

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WHILE the traditional open microdiscectomy technique provides excellent outcomes, it carries the risk of complications such as postoperative CSF leak, nerve root injury, and postoperative pain.^{24,55,63,64} Because minimally invasive surgical (MIS) techniques, such as microendoscopic discectomy (MED) and percutaneous microdiscectomy, minimize the manipulation of surrounding tissue, they have been purported to decrease complication rates and reduce postoperative pain in addition to improving function.^{15,20} However, outcome studies have yet to verify the claims that MIS techniques for lumbar microdiscectomy are better than conventional methods.³⁴

Complications related to lumbar microdiscectomy are typically analyzed from an institutional or individual surgeon perspective.^{4,5,31} A systematic review and meta-analysis of complications following the various surgical techniques to perform lumbar microdiscectomy has not been previously performed. Accurate knowledge of complication rates following conventional open, MED, and percutaneous approaches can be used to help educate patients and surgeons during the informed consent process. We sought to identify differences in complication rates among open, MED, and percutaneous microdiscectomy by performing a systematic review and meta-analysis of all complications reported in clinical studies.

Methods

Study Search

The systematic review was conducted following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).³⁹ We conducted MEDLINE, Scopus, Web of Science, and Embase database searches with the search algorithm: (“Lumbar Discectomy Complication(s)”) OR (“Lumbar Discectomy Complication(s) and Outcome(s)”) OR (“Lumbar” and “Discectomy” or “Microdiscectomy”) AND (“Complications” or “Outcomes”). The search returned 9504 citations. We searched for articles published between January 1, 1990, and December 27, 2014.

Inclusion and Exclusion Criteria

Articles published prior to 1990 were excluded to avoid a historical bias and because MIS techniques were not yet widely used.⁵⁹ To create a more homogenous patient cohort, studies involving the following procedures were excluded: interbody fusion, transperitoneal lumbar microdiscectomy, corpectomy, revision surgery, and lumbar microdiscectomy spanning more than one vertebral level. We included studies in which lumbar microdiscectomy was performed for degenerative indications and excluded those in which lumbar discectomy was performed to treat infection and tumor pathological processes. We imposed no restrictions on publication status. Animal, in vitro, biomechanical, and non-English language studies were excluded. We also excluded those concerning large administrative data sets because different surgical techniques were not separated and many complications are frequently underreported in coded data. We included prospective cohort studies (PCSs) and randomized controlled trials (RCTs; experimental or control arms). We excluded all

retrospective chart reviews since many complications are underreported in retrospective studies. For clinical studies using duplicate data, only the study with the most recent results was included.

Data Collection

Three reviewers (M.F.S., J.J.X., and E.Y.T.) independently conducted data extraction from the 42 included articles. The extracted data sets were compared to confirm accuracy. Level of evidence for each of the included articles was assessed using the Oxford Centre for Evidence Based Medicine Level of Evidence 2 classification system (<http://www.cebm.net/ocebml-levels-of-evidence/>). From the eligible articles, we recorded the publication year, follow-up period (months), number of patients, complications, and collection method. The included studies reported the following complications: nerve root injury, new or worsening neurological deficit, medical complications, surgical errors, durotomy, hematoma, wound complications, recurrent disc complications at the primary surgical site, and reoperation. Criteria and definitions for each complication are summarized in Table 1. Nerve root injuries were recorded separately from new or worsening neurological deficit because some studies reported intraoperative puncture, displacement, or direct injury to the nerve root but did not correlate it to postoperative neurological deficit development. Additionally, surgical errors consisted of exploration started at the wrong vertebral level and surgical instrument breakage during the operative procedure.

Open lumbar microdiscectomy surgeries use a longitudinal midline incision over the area of the herniated disc and employ a microscope for visualization.^{2,3,9,17–19,21,25,26,28,33,36,41–43,45,49,52–54,56–58,61} MED techniques employ a longitudinal paramedian incision through which a tubular retractor is placed and visualization is achieved through an endoscope.^{2,6,10,13,19,24,25,29,36,46,51,53,57,60,62,64} Percutaneous discectomy entails placing a sheath directly into the disc space via a transforaminal approach, extraforaminal approach, or interlaminar approach and then using a suction/debrider or chemical injection to remove the disc.^{1,11,12,23,30,37,44,50}

To assess the risk of bias for each study, 3 reviewers (M.F.S., J.J.X., and E.Y.T.) independently investigated the individual studies and used The Cochrane Collaboration's tool for assessing risk of bias.²² Bias risk assessment was performed at the study level. Inconsistencies in bias risk assessment were reconciled through discussion.

Statistical Analysis

Unweighted overall mean complication rates were calculated by the summation of total complication events divided by the overall number of patients included in the studies reporting that specific complication. If a study reported zero events for a particular complication, the study's cohort was included in the denominator. To assess the variation in the rate of a specific complication across studies, an interstudy median and interquartile range (IQR), which ranged from the first to the third quartile (Q1–Q3), were calculated to demonstrate variations in specific cross-study complication rates.

We also analyzed complication data using a random-

TABLE 1. Criteria and definitions for complications reported among included studies

Complication	Criteria
Nerve root injury*	Defined as any intraop nerve root puncture or direct nerve root injury & nerve root displacement
New or worsening neurological deficit	Included increased motor or sensory deficit or new postop radiculopathy
Medical complications	Included deep vein thrombosis, pulmonary embolism, myocardial infarction, urinary tract infection, acute kidney or lung disorders, & respiratory distress or failure
Surgical errors	Consisted of exploration started at wrong vertebral level & surgical instrument breakage during the procedure
Durotomy	Recorded for any incidental intraop injury to dura or postop CSF leak
Hematoma	Included wound & perineural hematoma
Wound complications	Included cellulitis, discitis, spondylodiscitis, skin infection, superficial wound infection, suture granuloma, dehiscence, & seroma
Recurrent disc complications	Included any persistent or relapsing disc herniation or prolapse
Reoperation	Included any reop during the postop period, regardless of indication

* Studies reporting intraoperative nerve root injury without subsequent correlation to postoperative neurological deficit.

effects model with inverse variance weighting. Calculations for the meta-analysis and construction of forest plots were completed using an established spreadsheet by Neyeloff et al.⁴⁰ The principal summary measures were the effect summary values and 95% CIs. The presence of zero complication events in some studies did not permit calculations. To allow for inclusion of these studies, we substituted a value of 0.1 complication events per study and calculations were performed using this value. Because of the lack of consistent control groups across all included studies, we were unable to calculate relative risk ratios. We compared results among studies with 95% CIs and forest plots.

To assess heterogeneity between individual studies, a Q statistic and I² value were calculated within each complication's meta-analysis. Delong et al.¹⁴ established an I² less than 25% as low heterogeneity, 25%–75% as moderate heterogeneity, and greater than 75% as severe heterogeneity. These same values were used to assess heterogeneity in our meta-analysis.

Results

Study Selection

After removing 6870 duplicates, the titles and abstracts of 2634 publications were screened (Figs. 1 and 2, Table 2).³⁹ The full text was assessed in the resulting 402 articles for eligibility criteria. Full-text assessment resulted in 42 eligible articles (0.4%) to be included in the final analysis. Twenty-four studies reported utilization of the open microdiscectomy technique, while 16 and 8 studies reported the use of MED and percutaneous approaches, respectively.

Bias risk assessment of the included studies identified a marked difference between RCTs and PCSs, with RCTs demonstrating significantly less bias among sequence generation, allocation concealment, and blinding of participants, personnel, and outcome assessors (Table 3).²² No studies demonstrated a high risk of incomplete outcome data or selective reporting of outcomes.²²

Neurological Injuries

Intraoperative nerve root injury was identified by 19 studies (Table 4, Figs. 3 and 4). Studies performing open, MED, and percutaneous techniques resulted in unweighted means of 2.6% (median 0.0%), 0.9% (median 0.7%), and 1.1% (median 0.7%), respectively. Meta-analysis calculations revealed a statistically significant higher rate of intraoperative nerve root injury following percutaneous procedures relative to MED. A new or worsening neurological deficit was reported in 15 studies. Studies involving open microdiscectomy, MED, and percutaneous microdiscectomy resulted in unweighted means of 1.3% (median 1.2%), 3.0% (median 2.8%), and 1.6% (median 5.0%), respectively. Meta-analysis calculations indicated no statistically significant difference between the surgical techniques.

General Complications

Medical complications were reported in 10 studies but not in any studies performing percutaneous microdiscectomy (Table 4, Figs. 3 and 4). Open microdiscectomy and MED resulted in rates of medical complications of 2.6% (median 2.6%) and 2.6% (median 0.0%), respectively. Surgical errors were reported only in studies that involved open microdiscectomy and MED at rates of 3.1% (median 3.1%) and 1.0% (median 1.0%), respectively. No statistically significant differences were found among the different approaches.

Durotomy-Related Complications

Durotomy was identified in 29 studies (Table 4, Figs. 3 and 4). Open and MED techniques resulted in unweighted means of 3.9% (median 4.9%) and 4.5% (median 4.8%), respectively. Postoperative CSF leakage was reported by 1 study for open (1.3%) and MED (0.6%) approaches.² Meta-analysis calculations, of durotomy rates, indicated no statistically significant difference among the surgical techniques.

FIG. 1. PRISMA flow diagram.

Wound Complications

Nine total studies reported the development of a wound hematoma (Table 4, Figs. 3 and 4). Open, MED, and percutaneous microdiscectomy studies reported rates of 0.5% (median 0.6%), 1.2% (median 1.2%), and 0.6% (median 0.8%), respectively. Wound complications were identified in 33 studies. Open, MED, and percutaneous microdiscectomy techniques resulted in rates of 2.1% (median 2.2%), 1.2% (median 0.8%), and 0.5% (median 0.2%), respectively. There was no statically significant difference in reported hematoma or wound complication rates in the meta-analysis.

Recurrent Complications

Recurrent disc complications were reported by 29

studies and occurred in 4.4% (median 4.8%), 3.1% (median 3.3%), and 3.9% (median 5.4%) of patients undergoing open, MED, and percutaneous microdiscectomy, respectively (Table 4, Figs. 3 and 4). Reoperation occurred at rates of 7.1% (median 7.1%), 3.7% (median 3.3%), and 10.2% (median 7.9%) for open, MED, and percutaneous techniques, respectively. Meta-analysis calculations indicated no statistically significant difference between the surgical techniques.

Discussion

This study represents the most comprehensive systematic literature review and meta-analysis of complication rates associated with the various surgical techniques of

FIG. 2. Included studies according to year of publication.

lumbar microdiscectomy to date. While the 42 included studies represent a small sample of the 2634 total studies screened during our systematic review, we solely evaluated prospective studies because of bias and underreported complication rates outlined in retrospective studies. We analyzed reported complication rates and elucidated differences among open, MED, and percutaneous microdiscectomy procedures.

Open Microdiscectomy and MED

In our review and meta-analysis, we identified a number of complications following conventional open microdiscectomy and MED. While there were differences in unweighted mean complication rates following both surgical techniques, none reached statistical significance (Fig. 4). The conventional open procedure potentially requires more extensive muscle and soft-tissue dissection, and with its reliance on a microscope, it offers a restricted view during the operation.⁵¹ MED, on the other hand, achieves resection of the herniated disc by access through a smaller incision and uses a tubular retractor and endoscope.⁵¹ Prior studies evaluating MED have reported a reduction in postoperative complications.^{16,35,38,51} Authors performing the MED technique have purported better visualization with the endoscope, facilitating enhanced identification and manipulation of anatomical structures such as the nerve root and dural sac.^{7,8,51} These conclusions suggest that fewer complications should be observed when using MED relative to the conventional open technique. This, however, was not the case in our review. While the MED approach is less invasive for disc resection, we found no significant difference in complication rates compared with open microdiscectomy. We did not evaluate rates of improved neurological outcomes following these procedures because the literature was inconsistent in its reporting.

Garg et al.¹⁹ have reported that MED results in less paravertebral muscle trauma, fibrosis, and morbidity, along with reduced hospital length of stay, ultimately increasing overall patient satisfaction. Therefore, while MED is indeed associated with a learning curve during initial implementation, the lack of significant differences in complication rates advocates for MED as a potential alternative to traditional open microdiscectomy.

Open Microdiscectomy and Percutaneous Discectomy

While there were differences in complication rates between open and percutaneous microdiscectomy techniques, none reached statistical significance (Fig. 4). An advantage associated with percutaneous discectomy, over that seen with open conventional discectomy, is the elimination of the need for facet resection because the disc interspace is accessed through the triangle of Kambin, which decreases the risk for spine destabilization.^{27,48} In addition, a percutaneous approach requires less damage to muscular and ligamentous structures than open microdiscectomy. However, the evaluation of complication rates showed no statistical significance in our meta-analysis. Nonetheless, it is worth noting that there were fewer contributing studies for percutaneous discectomy than for MED and open microdiscectomy. The lack of significant difference in complication rates and advantages in terms of shorter operating time, shorter hospital stay, and disc height preservation suggests that percutaneous discectomy is a potential alternative for minimally invasive surgery.^{32,47} Further prospective or randomized controlled studies are required to more objectively evaluate the outcomes of the 2 techniques.

Limitations

Most abstracts and studies screened for complication

TABLE 2. Included studies identified by systematic literature review

Authors & Year	Follow-Up (mos)	No. of Patients	Type of Op	Collection Method
Galarza et al., 2014	24	47	Open	P
Hussein et al., 2014	96	Open: 90, MED: 95	Open, MED	P, PR
Tsutsumimoto et al., 2014	6	555	MED	P
Choi et al., 2013	24	89	Percutaneous	P, PR
Yoshimoto et al., 2013	12	26	MED	P, chart
Hirano et al., 2012	3	37	Percutaneous	P
Kaushal et al., 2012	24	300	MED	P
Lønne et al., 2012	12	91	Open	PR, IO
Martín-Láez et al., 2012	24	Open: 101, MED: 37	Open, MED	P
Righesso et al., 2012	24	149	Open	P
Wang et al., 2012	120	151	MED	P, PR
Casal-Moro et al., 2011	60	120	MED	PR, IO
Celik et al., 2011	83	64	Open	P, chart
Chen et al., 2011	12	123	MED	Not defined
Choi et al., 2011	24	52	Percutaneous	PR
Chumanvej et al., 2011	23	60	MED	P
Garg et al., 2011	12	Open: 57, MED: 55	Open, MED	IO
Aronsohn et al., 2010	2	50	Percutaneous	Not defined
Kaner et al., 2010	41	40	Open	Chart
Nicassio et al., 2010	30	262	Open	Not defined
Teli et al., 2010	29	Open: 72, MED: 70	Open, MED	Chart
Arts et al., 2009	12	Open: 159, MED: 166	Open, MED	IO
Franke et al., 2009	12	48	Open	P, PR
Harrington et al., 2008	3	35	Open	Research nurse, chart
Parikh et al., 2008	9	141	MED	P, PR, chart
Peul et al., 2008	24	180	Open	Research nurse
Ruetten et al., 2008	24	Open: 100, MED: 100	Open, MED	PR, IO
Ryang et al., 2008	26	30	Open	PR, IO
Righesso et al., 2007	24	21	MED	Not defined
Ivanic et al., 2006	6	31	Open	IO, PR
Osterman et al., 2006	24	28	Open	PR
Tassi, 2006	36	500	Open	PR
Thomé et al., 2005	18	42	Open	PR
Türeyen, 2003	12	63	Open	PR
Aydin et al., 2002	32.4	200	Open	PR
Huang et al., 2001	12	11	MED	Not defined
Krugluger et al., 2000	24	10	Percutaneous	Not defined
Nygaard et al., 2000	12	39	Open	IO
Nygaard et al., 1999	12	98	Open	IO
Mayer et al., 1993	48	20	Percutaneous	IO
Revel et al., 1993	6	69	Percutaneous	P, PR
Onik et al., 1990	12	506	Percutaneous	IO

IO = independent observer; P = physician; PR = patient-reported.

rates in this review were retrospective case series, which limited the number of included studies. As a result, a small number of studies were analyzed, which somewhat restricted our ability to compare surgical techniques. Because of this limitation and concomitant lack of studies with direct

comparisons or a consistent control group, we were unable to calculate relative risk values among the procedures. In addition, while stratification of complication rates by age and anatomical levels would decrease heterogeneity and reveal inherent differences associated with these factors,

TABLE 3. Bias risk assessment for all 42 included studies identified by systematic review

Authors & Year	Study Type	Sequence Generation	Allocation Concealment	Blinding of Participants, Personnel, & Outcome Assessors	Incomplete Outcome Data	Select Outcome Reporting	Other Sources of Bias
Galarza et al., 2014	PCS	Low	Unclear	Low	Low	Low	Low
Hussein et al., 2014	RCT	Low	Low	Unclear	Low	Low	Low
Tsutsumimoto et al., 2014	PCS	Low	Unclear	High	Unclear	Low	Low
Choi et al., 2013	PCS	Low	Unclear	Low	Low	Low	Low
Yoshimoto et al., 2013	PCS	Low	Unclear	Low	Low	Low	High
Hirano et al., 2012	PCS	Low	Unclear	Unclear	Low	High	High
Kaushal et al., 2012	PCS	Low	Unclear	Low	Low	Low	High
Lønne et al., 2012	PCS	Low	Unclear	Unclear	Low	High	Low
Martín-Láez et al., 2012	PCS	Low	Low	High	Low	Low	Low
Righesso et al., 2012	PCS	Low	Low	Unclear	Low	Low	Low
Wang et al., 2012	PCS	Low	Unclear	Low	Low	Low	Low
Casal-Moro et al., 2011	PCS	Low	Low	High	Low	Low	High
Celik et al., 2011	RCT	Low	Unclear	Low	Low	Low	Low
Chen et al., 2011	PCS	Unclear	Low	High	Low	Low	Low
Choi et al., 2011	PCS	Low	Unclear	Unclear	Low	Low	Unclear
Chumnanvej et al., 2011	PCS	Low	Unclear	Unclear	Low	Low	Low
Garg et al., 2011	PCS	Low	Low	Low	Low	Low	Low
Aronsohn et al., 2010	RCT	Low	Low	Low	Low	Low	Low
Kaner et al., 2010	PCS	Low	Low	Unclear	Low	Low	Low
Nicassio et al., 2010	PCS	Unclear	High	High	Low	Low	High
Teli et al., 2010	RCT	Low	Low	Low	Low	Low	Low
Arts et al., 2009	RCT	Low	Low	Low	Low	Low	Low
Franke et al., 2009	RCT	Low	Low	Low	Low	Low	Unclear
Harrington et al., 2008	PCS	Unclear	Unclear	Low	Low	Unclear	Low
Parikh et al., 2008	PCS	Unclear	Unclear	Unclear	Low	Low	Unclear
Peul et al., 2008	RCT	Low	Low	Low	Low	Low	Low
Ruetten et al., 2008	RCT	Low	Low	Low	Low	Low	Low
Ryang et al., 2008	RCT	Low	Low	Low	Low	Low	Low
Righesso et al., 2007	RCT	Low	Low	Low	Low	Low	Low
Ivanic et al., 2006	RCT	Low	Unclear	Low	Low	Low	Low
Osterman et al., 2006	RCT	Low	Unclear	Low	Low	Low	Low
Tassi, 2006	PCS	Low	Unclear	High	Low	Low	Low
Thomé et al., 2005	PCS	Low	Low	Unclear	Low	Low	Low
Türeyen, 2003	PCS	Low	Unclear	Unclear	Low	Low	Low
Aydin et al., 2002	PCS	Low	Low	Low	Low	Low	Low
Huang et al., 2001	PCS	Low	Unclear	Low	Low	Low	Low
Krugluger et al., 2000	RCT	Low	Unclear	Unclear	Low	Low	Unclear
Nygaard et al., 2000	PCS	Low	Unclear	High	Low	Low	Low
Nygaard et al., 1999	PCS	Low	High	Low	Low	Low	Low
Mayer et al., 1993	RCT	Low	Low	Low	Low	Low	Low
Revel et al., 1993	RCT	Low	Low	Low	Low	Low	Low
Onik et al., 1990	PCS	Low	Low	Unclear	Unclear	Low	Low

TABLE 4. Complication rates for open, MED, and percutaneous microdiscectomy

Neurological Injuries	Contributing Studies	No. of Patients	Overall Rate*	Interstudy Median Rate (IQR)†
Nerve root injury				
Open	7	618	2.6%	0.0% (0.0%–0.9%)
MED	10	1065	0.9%	0.7% (0.0%–1.6%)
Percutaneous	2	89	1.1%	0.7% (0.4%–1.1%)
New or worsening neurological deficit				
Open	6	1069	1.3%	1.2% (0.5%–1.7%)
MED	7	573	3.0%	2.8% (0.0%–3.1%)
Percutaneous	2	62	1.6%	5.0% (2.5%–7.5%)
General complications				
Medical complications				
Open	5	384	2.6%	2.6% (2.5%–3.6%)
MED	5	587	2.6%	0.0% (0.0%–0.8%)
Percutaneous	—	—	—	—
Surgical errors				
Open	1	159	3.1%	3.1%
MED	2	286	1.0%	1.0% (0.9%–1.1%)
Percutaneous	—	—	—	—
Durotomy complications				
Durotomy				
Open	14	1479	3.9%	4.9% (1.5%–6.0%)
MED	15	2019	4.5%	4.8% (1.2%–7.4%)
Percutaneous	—	—	—	—
Wound complications				
Hematoma				
Open	4	930	0.5%	0.6% (0.5%–0.7%)
MED	1	166	1.2%	1.2%
Percutaneous	4	716	0.6%	0.8% (0.1%–1.6%)
Wound complications				
Open	16	2016	2.1%	2.2% (0.9%–3.4%)
MED	13	1378	1.2%	0.8% (0.0%–2.0%)
Percutaneous	4	628	0.5%	0.2% (0.0%–0.8%)
Recurrent complications				
Recurrent disc complications				
Open	14	1192	4.4%	4.8% (2.7%–6.1%)
MED	12	1599	3.1%	3.3% (1.8%–5.1%)
Percutaneous	3	178	3.9%	5.4% (3.8%–5.6%)
Reoperation				
Open	16	1631	7.1%	7.1% (4.8%–10.1%)
MED	14	1719	3.7%	3.3% (2.1%–6.2%)
Percutaneous	6	714	10.2%	7.9% (5.5%–11.4%)

* Overall rate = number of patients affected/total number of patients screened.

† IQR = interquartile range from Quartile 1 to Quartile 3.

the primary literature is varied and does not routinely discuss these factors in reporting complications. Finally, this meta-analysis solely investigated complications associated with single-level lumbar microdiscectomy. Further research should be performed to explore complication rates across all forms of lumbar surgery, allowing for comparative effectiveness investigation.

Conclusions

This work presents a systematic review of complications

reported in 42 studies published between 1990 and 2014, comparing the differences in complication rates among open microdiscectomy, MED, and percutaneous discectomy. Previous clinical studies have purported reduced complications when utilizing MIS techniques, but our analysis of complication rates following open microdiscectomy and MED showed no statistically significant differences. Furthermore, differences in complication rates between open microdiscectomy and percutaneous discectomy were not statistically significant. The resultant list of complications should serve as a framework to provide an educated and reasonably comprehensive informed consent discussion

FIG. 3. Combined bar graph for the overall rates of various complications across open, microendoscopic, and percutaneous lumbar microdiscectomy.

FIG. 4. Meta-analysis effect summary values and 95% CIs for identified complications following each surgical technique.

between the surgeon and the patient regarding potential expectations as well as alternative surgical techniques.

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Conception and design: Shriver, Xie, Rosenbaum, Kshetty. Acquisition of data: Shriver, Xie, Tye. Analysis and interpretation of data: Shriver, Xie, Tye. Drafting the article: Shriver, Xie, Critically revising the article: Shriver, Xie, Rosenbaum, Kshetty, Benzel, Mroz. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Shriver. Statistical analysis: Xie, Tye.

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