Review Article

Complications associated with lumbar discectomy surgical techniques: a systematic review

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Background: Open discectomy (OD) and microdiscectomy (MD) are routine procedures for the treatment of lumbar disc herniation. Minimally invasive surgery (MIS), such as micro-endoscopic discectomy (MED) and full endoscopic discectomy (FED), offers potential advantages (less pain, less bleeding, shorter hospitalisation and earlier return to work), but their complications have not yet been fully evaluated. The aim of this paper was to identify the frequency of these complications with a focus on MIS in comparison to OD/MD.

Methods: The authors conducted a Medline database search for randomised controlled and prospective cohort studies reporting complications associated with MIS and MD/OD from 1997 to February 2020. Included studies were assessed for bias using the Newcastle-Ottawa Quality assessment form. Mean complication rates for each technique were calculated by dividing the total number of each complication by the total number of patients included in the studies which reported that specific complication.

Results: Of the 1,095 articles retrieved from Medline, 35 met the inclusion criteria. OD, MD, MED and FED were associated with: recurrent lumbar disc hernias in 4.1%, 5.1%, 3.9% and 3.5% respectively; re-operations in 5.2%, 7.5%, 4.9% and 4% respectively; wound complications in 3.5%, 3.5%, 1.2% and 2% respectively; durotomy in 6.6%, 2.3%, 4.4% and 1.1% respectively; neurological complications in 1.8%, 2.8%, 4.5% and 4.9% respectively. Nerve root injury was reported in 0.3% for MD, 0.8% for MED and 1.2% for FED.

Discussion: This up-to-date systematic review of complications after various techniques of lumbar discectomy (including a large pool of patients who had MIS) confirms previous findings of low and comparable rates. However variable levels of bias were reported amongst included studies, which reported complications with varying levels of clinical detail.

Keywords: Lumbar microdiscectomy; microendoscopic discectomy; percutaneous discectomy; complications; systematic review

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Introduction

Lower limb radiculopathy caused by lumbar disc herniation has varied management pathways. Conservative treatment is aimed at pain reduction, either by analgesics or by reducing pressure on the nerve root (1). Discectomy is considered a valid treatment once symptoms become unresponsive to conservative care after 6–12 weeks (2,3). Several surgical techniques are utilized for lumbar discectomy (see *Table 1*). They are categorised into open discectomy (OD) and minimally invasive surgery (MIS). Open lumbar discectomy, first performed by Mixter and Barr in 1934, was the mainstay of surgery with few technical changes until 1977 when an operating microscope was added, thus introducing micro-discectomy (MD) (3,4). MD allows for smaller incisions compared to standard OD granting improved operating times, shortened hospital stay and a faster return to work (5,6), altogether contributing to making it the most widespread procedure. However, whilst MD/OD provide comparable outcomes, they carry the risk of complications such as bleeding, dural tears, postoperative pain and nerve root injury (7).

Advances in technology have allowed the introduction of modern MIS techniques. In 1993, Mayer and Brock, and in 1997 Smith and Foley described techniques using tubular retractors micro-endoscopic discectomy (MED) and video-assisted endoscopes full endoscopic discectomy (FED) to access the intervertebral space and allow less soft-tissue damage (8-10). MIS is claimed to reduce complications whilst improving operating time, hospital stay and reducing recovery time (11,12). Controversy remains surrounding MIS procedures' utilization in practice, as there is a significant learning curve associated with adopting these procedures, potentially affecting patient safety and outcomes (13,14). Furthermore, comparative studies have demonstrated that clinical outcomes between MIS and OD/MS are still similar (10,15).

There are few reviews comparing the complications associated with the various surgical techniques. The most recent systematic review was published in 2015, includes studies with significant limitations (few patients, short follow-up time), and has few studies on MIS techniques with a small pool of patients undergoing FED. With the emergence of new prospective studies and randomised trials, this systematic review has the objective of identifying complications after OD, MD and MIS techniques and calculating rates for each procedure. Accurate knowledge of complication rates can be used to help inform patients and surgeons throughout the consent procedure. This study will aim to perform a systematic review of current literature by using explicit, systematic methods to collate and synthesise findings of studies to calculate complication rates associated with lumbar discectomy techniques. This systematic review will be performed in accordance with the PRISMA 2020 checklist, which provides an evidence-based framework for reporting on systematic reviews (16). No statistical analysis of results will be performed to conduct a meta-analysis on the findings of this review. We present the following article in accordance with the PRISMA reporting checklist (available at https://jss.amegroups.com/article/view/10.21037/jss-21-59/rc).

Methods

Study search

A Medline database search was performed in February 2020, from 1997 to date, using the following search algorithm: ("Lumbar Discectomy Complication(s)") OR ("Lumbar Discectomy Complication(s) and Outcome(s)") OR (("Lumbar" and "Discectomy" or "Microdiscectomy" or "Minimally Invasive Discectomy" or "Endoscopic Discectomy") AND ("Complications" or "Outcomes")). Other sources included the Cochrane database, systematic reviews and recent literature reviews. The search was conducted by a single reviewer. After screening by title and by abstract, full text articles were assessed for inclusion.

Inclusion and exclusion criteria

The search for this review (see *Table 2* with inclusion and exclusion criteria) was restricted to studies published in the English language. Inclusion criteria of the selected studies were both male and female adults, diagnosed with a single level lumbar disc herniation which hadn't responded to conservative treatment. Both intraoperative and postoperative complications were included. Only studies with lumbar discectomy performed for degenerative disc pathologies were considered, excluding those performed to treat malignancies and infection. Moreover, studies involving the presence of herniated disc spanning one or more anatomical level, revision surgery, spinal stenosis, spondylolisthesis and interbody fusion were excluded, in order to produce a more homogenous cohort. Studies published before 1997 were excluded as MIS techniques were not yet widely used (3) and to avoid historical bias. Studies with less than 100 patients were excluded as

Table 1 Lumbar discectomy operations assessed (with abbreviations and description) (3)

Surgical technique	Description
Open (standard) discectomy (OD)	5 cm approach
Micro-discectomy (MD)	3 cm approach, microscope or loupe for magnification
Full endoscopic discectomy (FED)	Percutaneous endoscopic lumbar discectomy performing dissection with extra/ transforaminal/interlaminar approach
Micro-endoscopic discectomy (MED)	Video-assisted technique using a tubular work canal or speculum with a 2-cm incision on a transmuscular approach without multifidus release

Table 2 summary of inclusion and exclusion criteria

Inclusion	Exclusion
Published in the English language	Studies published before 1997
Randomized controlled trials and prospective cohort studies	All retrospective studies, meta-analysis and systematic reviews
Male/female adults diagnosed with single level disc herniation which hadn't responded to conservative treatment	Studies with fewer than 100 patients
Lumbar discectomy for degenerative indications only	Lumbar discectomy performed for infectious and malignancy indications
Studies discussing intraoperative and postoperative complications	Studies involving more than a single level disc herniation, spinal stenosis and spondylolisthesis
	Studies involving procedures such as revision surgery, interbody fusion, laser discectomy and chemonucleolysis

complications following lumbar discectomy are infrequent. Retrospective studies were also excluded since complications often go underreported.

Data collection

This was performed by a single reviewer. From selected papers the following was recorded in a database: article reference, publication year, type of study (cohort, case control, randomized control trial (RCT)), type of operation (see *Table 1*), number of patients, follow-up period, complications (as detailed in *Table 3*). 'Nerve root injury' is recorded separately from 'Neurological complications' because they are often described as 'asymptomatic'. 'Recurrent discopathy' is recorded separately from 'Re-operation' because some recurrences do not undergo repeat surgery and some re-operations are due to a different indication (other than recurrence). Studies reporting on patients who have annular closure devices (ACD) are also noted (as the presence of a foreign body may affect the infection rate).

Data analysis

Mean complication rates were calculated by using the total number of each complication for each operation as the 'numerator'. This was divided by the total number of patients included in the studies which reported that specific complication as the 'denominator'. If a study reported a rate of 'zero' for a specific complication, the study's cohort was included in the denominator.

Bias risk assessment

A risk of bias assessment was conducted using the Newcastle-Ottawa Quality assessment form. This form was developed to assess the quality of non-randomised studies with its design, content and ease of use for the purpose of facilitating the assessment and interpretation of meta-analysis (17). Strengths and weaknesses of this tool have been assessed (18) and it is considered one of the most used worldwide for this purpose.

Table 3 Classification of complications of lumbar discectomy by category

Complication	Criteria
Durotomy	Any intraoperative injury to the dura plus postoperative CSF leak and meningocele
Nerve root injury	Any intraoperative nerve root injury or displacement
Neurological complications	Worsening of pre-existing motor or sensory symptoms and new postoperative symptoms (including symptomatic nerve root injury)
Wound complications	Superficial wound infections (including cellulitis) and deep wound infections (including spondylodiscitis), wound haematoma, poor wound healing and dehiscence.
Recurrent discopathy	Relapsing disc herniation
Re-operation	Any re-operation regardless of indication during the postoperative period
Other	Surgical errors* and medical complications**

*, surgical errors: exploration of wrong vertebral level, surgical equipment failure and iatrogenic vessel injury; **, medical complications: thrombotic events, bleeding requiring blood transfusion, urinary tract infections and urinary retention. CSF; cerebrospinal fluid.

Results

Medline search

After a Medline search, 1,095 titles were obtained after duplicates were removed with 18 further titles identified using other sources (see PRISMA chart in *Figure 1*). After screening titles, abstracts and full text articles, 35 studies were included for analysis (see *Table 4*). They include a total of 7,354 patients, of which 227 in 3 studies had OD, 3,540 in 16 studies had MD (using loupe or microscope magnification), 1,526 in 13 studies had MED and 2,061 in 14 studies had FED.

Risk of bias assessment

Using the Newcastle-Ottawa Quality assessment form, 16 studies were classified as 'good' with a low risk of bias (see *Table 5*), for a total of 3,802 patients (52% of included patients). Randomized controlled studies (n=15) were all classified as having a low risk of bias. Outcome assessment was conducted using a variety of methods (see *Table 5*), with only 9 studies conducting an independent assessment.

Recurrent lumbar disc hernia and re-operations

Data in relation to recurrent lumbar disc herniation at the same site was obtained from all 3 studies on OD (227 patients), 13 of 16 studies on MD (3,092 patients), 12 of 13 studies on MED (1,392 patients) and 12 of 14 studies on FED (1,679 patients). The mean incidence was similar for all techniques under investigation at 4.8%, 5.1% (after excluding 2 studies involving patients with large disc hernias), 3.9% and 3.5% (after excluding 1 study involving patients with large disc hernias) respectively (see *Table 6*). Details are shown in Table S1.

Data in relation to re-operations was obtained from all 3 studies on OD (227 patients), 14 of 16 studies on MD (3,162 patients), 12 of 13 studies on MED (1,392 patients) and 11 of 14 studies on FED discectomy (1,495 patients). The mean incidence was similar for all techniques under investigation at 5.2%, 7.5% (after excluding 2 studies involving patients with large disc hernias), 4.9% and 4% respectively (see *Table 6*). Details are shown in Table S2.

The number of re-operations with indication (when provided) was:

(I) OD (12 re-operations): recurrent disc hernia (11/12) and meningocele (1/12);
(II) MD (280 re-operations): recurrent disc hernia (135/280), meningocele (1/280), residual disc hernia (9/280) and CSF leak (3/280). No reason was given for 132 re-operations (47%);
(III) MED (69 re-operations): recurrent disc hernia (52/69), residual disc hernia (7/69), discitis (1/69), stenosis (2/69) and fibrosis (6/69). No reason was given for 1 re-operation (1.4%);
(IV) FED (61 re-operations): recurrent disc hernia 53/61 and residual disc hernia (7/61). No reason was given for 1 re-operation (1.6%).

Wound complications

The rate of wound complications, including superficial

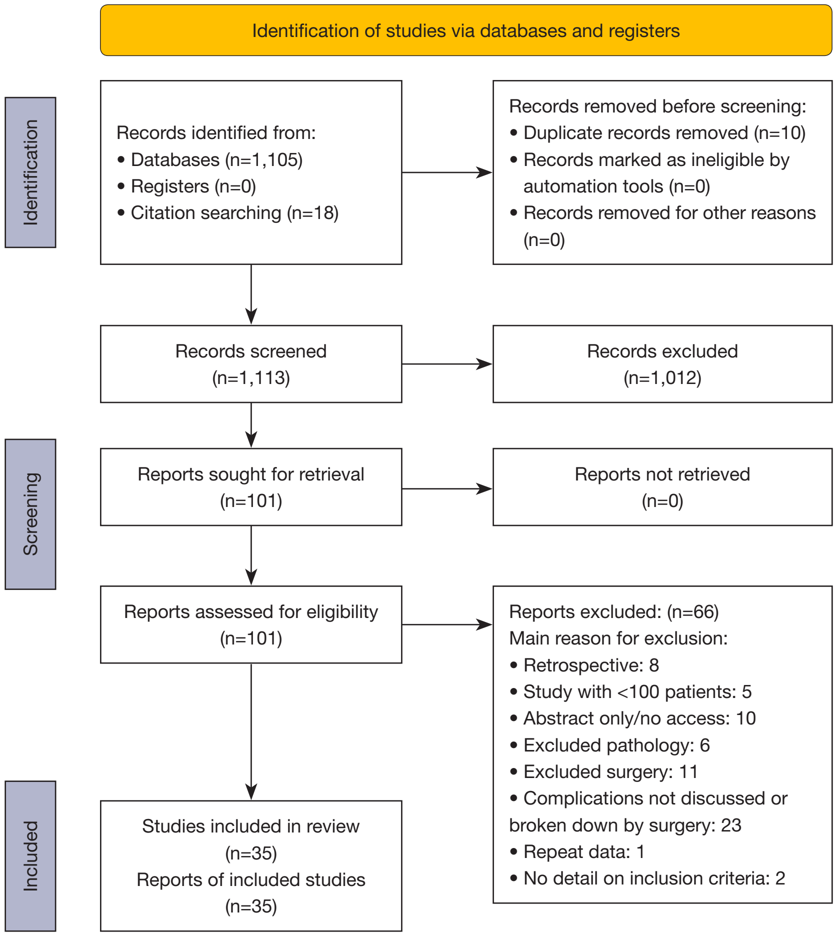

Figure 1 PRISMA flow chart.

infections, deep infections (discitis), and others (mostly poor healing but also wound haematoma) is shown in *Table 6*.

The frequency of these complications was similar amongst all groups: 3.5% for OD, 1.8% for MD, 1.2% for MED and 2% for FED. Details about the relative frequency of superficial and deep infections and other wound complications (such as haematoma and delayed wound healing) are shown in Table S3.

Durotomy

Durotomy-related complications were identified by all 3 studies on OD (227 patients), 13/16 studies on MD (2,730 patients), 11/14 studies on FED (1,519 patients), and 12/13 studies on MED (1,526 patients). The frequency of these complications was: 6.6% for OD, 2.3% for MD, 1.1% for FED and 4.4% for MED (see *Table 6*). Post-operative CSF leakage was reported by 2 studies for MD citing a frequency of 1.1%. Meningocele was reported by 2 studies for OD (1.8%) and 1 study for MD (1.4%).

Nerve root injury

Intra-operative nerve root injury was reported in 7 of 16 studies on Micro-discectomy (1,777 patients), 10 of 14 studies on Full-endoscopic discectomy (1,361 patients) and 10 of 13 studies on Micro-endoscopic discectomy (1,241 patients). The frequency of this complication was none reported for OD, 0.3% for MD, 1.2% for FED and 0.8% for MED as shown in *Table 6*. The proportion of studies disclosing symptomatic nerve root lesions (or where there was a clear correlation between lesion and new symptoms) was 2/7 for MD, 5/10 for FED and 4/10 for MED.

Table 4 List of included studies

Authors & year	Type of study	Follow-up (months)	Number of patients	Type of surgery, number of patients/surgery
Carragee *et al.*, 1999 (19)	Cohort	56 m	152	MD
Singhal *et al.*, 2002 (20)	Cohort	1 m	116	MD
Weinstein *et al.*, 2006 (21)	Cohort	24 m	528	MD
Weinstein *et al.*, 2006 (22)	RCT	24 m	243	MD
Ranjan *et al.*, 2006 (23)	Cohort	Not stated	107	MED
Hoogland *et al.*, 2008 (24)	RCT	24 m	272	FED
Peul *et al.*, 2008 (25)	RCT	24 m	187	MD
Ruetten *et al.*, 2008 (26)	RCT	24 m	178	MD 87, FED 91
Parikh *et al.*, 2008 (27)	Cohort	12 m	141	MED
Arts *et al.*, 2009 (28)	RCT	12 m	328	MD 161, MED 167
Jhala *et al.*, 2010 (29)	Cohort	12 m	100	MED
Teli *et al.*, 2010 (30)	RCT	24 m	212	OD 70, MD 72, MED 70
Nicassio *et al.*, 2010 (31)	Cohort	11 m	262	MD
Chen *et al.*, 2011 (32)	Case control	12 m	123	FED
Casal Moro *et al.*, 2011 (33)	Cohort	60 m	120	MED
Garg *et al.*, 2011 (34)	RCT	12 m	112	OD 57, MED 55
Kaushal *et al.*, 2012 (35)	Cohort	24 m	300	FED
Martín-Láez *et al.*, 2012 (36)	Case control	12 m	138	MD 101, MED 37
Hussein *et al.*, 2014 (37)	RCT	102 m	200	OD 100, MED 100
Mummaneni *et al.*, 2014 (38)	Cohort	12 m	148	MD
Gadjradj *et al.*, 2016 (39)	Cohort	12 m	158	FED
Gotecha *et al.*, 2016 (40)	Cohort	6 m	112	FED
Gibson *et al.*, 2017 (41)	RCT	24 m	140	MD 70, FED 70
Song *et al.*, 2017 (42)	Cohort	27 m	126	FED
Debono *et al.*, 2017 (43)	Cohort	6 m	201	MD
Bono *et al.*, 2017 (44)	RCT	12 m	108	MD
Thomé *et al.*, 2018 (45)	RCT	24 m	550	MD
Patil *et al.*, 2018 (46)	Cohort	6 m	300	MED
Chen *et al.*, 2018 (47)	RCT	12 m	153	MED 73, FED 80
Abdurexiti *et al.*, 2018 (48)	Case control	18 m	216	MED 134, FED 82
Ahn *et al.*, 2018 (49)	Cohort	60 m	204	FED
van den Brink *et al.*, 2019 (50)	RCT	12 m	554	MD
Chen *et al.*, 2020 (51)	RCT	24 m	241	MED 122, FED 119
Liu *et al.*, 2019 (52)	RCT	46 m	184	FED
Wu *et al.*, 2019 (53)	Case control	24 m	140	FED

RCT, randomized controlled trial; MD, microscopic discectomy; MED, micro-endoscopic discectomy; OD, open discectomy; FED, full endoscopic discectomy.

Table 5 Newcastle-Ottawa Quality Assessment Form

Authors & year	Rating	Outcome assessment
Carragee *et al.*, 1999	Poor	1,3
Shingal *et al.*, 2002	Poor	2
Weinstein *et al.*, 2006	Poor	2,3
Weinstein *et al.*, 2006	Good	2,3
Ranjan *et al.*, 2006	Poor	2
Hoogland *et al.*, 2008	Good	2,3
Peul *et al.*, 2008	Good	2
Ruetten *et al.*, 2008	Good	1,3
Parikh *et al.*, 2008	Poor	2
Arts *et al.*, 2009	Good	1,3
Jhala *et al.*, 2010	Poor	2
Teli *et al.*, 2010	Good	1,3
Nicassio *et al.*, 2010	Poor	2
Chen *et al.*, 2011	Poor	2
Casal Moro *et al.*, 2011	Poor	1
Garg *et al.*, 2011	Good	1,3
Kaushal *et al.*, 2012	Poor	2
Martín-Láez *et al.*, 2012	Poor	4
Hussein *et al.*, 2014	Good	1,3
Mummaneni *et al.*, 2014	Poor	2
Gadjradj *et al.*, 2016	Poor	2,3
Gotecha *et al.*, 2016	Poor	2
Gibson *et al.*, 2017	Good	2,3
Song *et al.*, 2017	Poor	2,3
Debono *et al.*, 2017	Poor	2,3
Bono *et al.*, 2017	Good	2,3
Thomé *et al.*, 2018	Good	1,2,3
Patil *et al.*, 2018	Poor	2,3
Chen *et al.*, 2018	Good	1,3
Abdurexiti *et al.*, 2018	Poor	2
Ahn *et al.*, 2018	Poor	2,3
van den Brink *et al.*, 2019	Good	2,3
Chen *et al.*, 2019	Good	2,3
Liu *et al.*, 2019	Good	2
Wu *et al.*, 2019	Good	2,3

quality rated as 'good', 'fair' or 'poor' and outcome assessment method (1: independent, 2: clinician, 3: patient questionnaire, 4: not stated).

Table 6 Complications rates for lumbar discectomy procedures

Complications	Contributing studies	No. of patients	Overall rate (%)
Durotomy			
OD	3	227	6.6
MD	13	2,730	2.3
FED	11	1,519	1.1
MED	12	1,526	4.4
Nerve root injury			
OD	–	–	–
MD	7	1,777	0.3
FED	10	1,361	1.2
MED	10	1,241	0.8
Neurological complications			
OD	3	227	1.8
MD	12	2,399	2.8
FED	14	1,931	4.9
MED	12	1,319	4.5
Wound complications			
OD	3	227	3.5
MD	16	2,942	3.5
FED	9	1,337	2
MED	13	1,526	1.2
Recurrent discopathy			
OD	3	227	4.1
MD	13	3,092	5.1
FED	12	1,679	3.5
MED	12	1,392	3.9

OD, open discectomy; MD, micro-discectomy; FED, full-endoscopic discectomy; MED, micro-endoscopic discectomy.

Neurological complications

Data in relation to neurological complications arising from residual symptoms, new symptoms and positioning lesions was obtained from all 3 studies on Open discectomy (227 patients), 12 of 16 studies on Micro-discectomy (2,399 patients), all 14 studies on Full-endoscopic discectomy (1,931 patients) and 12 of 13 studies on Micro-endoscopic discectomy (1,319 patients). The net frequency of all neurological complications was varied, ranging between*:* 1.8% for OD, 2.8% for MD, 4.9% for FED and 4.5% for MED as detailed in *Table 6*. Residual symptoms were reported in 7 studies for MD (2.3%), 4 studies for FED (4.3%) and 3 studies for MED (1.7%).

New symptoms were presented as changes in sensory and motor deficits. Sensory deficits were reported in 1 study for OD (3%) with all deficits being cited as 'dysesthesia'. 4 studies for MD (2%) reported sensory deficits with 'new pain' accounting for 0.7%, 'dysesthesia' for 0.6% and 'unspecified' for 0.7% of mean incidence. 10 studies for FED (4.3%) reported sensory deficits with 'leg pain' accounting for 0.1%, 'dysesthesia' for 4.2% and 'sciatica' for 0.1% of mean incidence. 8 studies for MED (3.8%) reported sensory deficits with 'new pain' accounting for 0.2%, 'regional anesthesia' for 0.1%, 'dysesthesia' for 2.5% and 'unspecified' for 1% of mean incidence. Motor deficits were reported in 2 studies for OD (0.7%) with 'foot drop' accounting for all mean incidence of motor deficits. 7 studies for MD (1.1%) reported motor deficits with 'foot drop' accounting for 0.2%, 'bilateral L5-S1 nerve palsy' for 0.1% and 'unspecified' for 0.8% of mean incidence. 3 studies for FED (0.8%) reported motor deficits, with 'transient paralysis' accounting for 0.4%, 'knee extension weakness' for 0.2% and 'unspecified' for 0.2% of mean incidence. Four studies for MED (1.4%) reported motor deficits, with 'foot drop' accounting for 1% and 'unspecified' for 0.4%.

Moreover 1 study for MD reported positioning lesions (1 ulnar and 1 suprascapular) and transient Cauda equina syndrome, representing 0.08% and 0.04% of neurological complications for the MD approach.

Other

Surgical errors were reported in only 2/16 studies on MD (affecting 1.5% of a total of 395 patients) and in 2/13 studies on MED (affecting 0.7% of a total of 287 patients). Surgical errors given were 'wrong level of exploration' (5/161 for MD and 1/167 for MED), 'iatrogenic vessel injury' (1/234 for MD) and 'equipment breakage' (1/120 rongeur rupture for MED). No surgical errors were reported in studies on OD and FED.

Data in relation to medical complications was obtained in 2/3 studies on Open discectomy (157 patients), 11/16 studies on Micro-discectomy (2,801 patients) and 5/13 studies on Micro-endoscopic discectomy (446 patients). The reported frequency of medical complications was 6.4% for OD, 1% for MD and 2% for MED. No medical complications were reported for FED. Medical complications reported were 'bleeding', 'thrombosis' (deep vein thrombosis), 'urinary tract infections' (UTIs) and 'urinary retention'. 'Bleeding' was reported for 11/2,163 MD patients, with none being reported for OD, FED and MED. 'Thrombosis' was reported for 1/101 MD patients, 1/120 MED patients and none for OD and FED patients. 'UTIs' were reported for 3/57 OD patients, 3/161 MD patients and none for FED and MED patients. 'Urinary retention' was reported for 7/157 OD patients, 13/825 MD patients, 8/155 MED patients with none reported for FED. Furthermore, unspecified 'other' complications were reported in 3 MD studies (12/520 patients), 1 FED study (1/126 patients) and 2 MED studies (17/287 patients).

Discussion

This study represents the most up-to-date systematic review of complication rates associated with the various surgical techniques of lumbar discectomy. Despite having only 35 of the 1,095 total studies being eligible for analysis, all of these were prospective studies which keeps levels of bias and underreporting of complications lower than those outlined in retrospective studies. From these studies, complication rates were calculated and compared amongst the various discectomy techniques.

This review confirms that the complication rate of all types of discectomy is low and similar in all groups, although subtle differences might exist with regards to the type of complication within each category (e.g., the rate of superficial wound infection was 3.5% for OD, 1.3% for MD, 0.2% for MED and zero for FED, perhaps reflecting differences in the size of the incision). All surgical techniques had a similar number of contributing studies, except OD which only had three contributing studies and a total patient cohort of 227, which makes it less suitable for comparison than the other techniques. Small differences in nerve root injury and neurological complication rates were seen, with a lower mean incidence for MD as compared to other procedures (although it is not known whether this is statistically different). MED utilizes tubular retractors which avoids the need for muscle stripping, whilst using a smaller incision to access the herniated disc (14,54,55). Similarly FED minimises facet resection, avoids dissection of paraspinous muscles and is less damaging to muscular and ligamentous structures when accessing the herniated disc (56). Both MED/FED techniques offer better visualisation with endoscopes, and altogether these advantages over OD techniques suggest that fewer complications should be observed (11,12). That wasn't the case for nerve root injury and neurological complication rates, with MD resulting in lower complication rates than MED/FED. However this could be a product of the learning curve associated with initially adopting these techniques (13,14), in addition to MD being the cornerstone of lumbar discectomy techniques which offers reliable results. Meanwhile, by contrast MED/FED resulted in less wound complications, reoperation and recurrent discopathy than MD. Whilst the learning curve associated with MIS may have influenced neurological complication rates, the differences were small, and together with improved operating times, hospital stay and recovery time (11,12), MED/FED could be a viable alternative to MD. There was no significant difference in complications rates between MED and FED, and further randomised controlled trials and prospective studies are needed to establish the outcomes of the techniques.

This study has similar inclusion criteria and many elements in common with a review published by Shriver *et al.* (57) which also aimed at establishing the rate of complications following discectomy. It covers a different time-period to reflect current practice (see Table S4). The 2 reviews share only 12 papers. The remaining papers used by Shriver *et al.* (30/42) were not included because they had less than 100 patients, covered a different time period (before 1997), were found to be retrospective (rather than prospective), focused only on a single complication (e.g., durotomy), or were found only in abstract form. The findings of both reviews are comparable in all categories of complications (see Table S5), with the current review including a larger number of patients, particularly in relation to FED (where the number of patients is much higher reflecting a trend in current practice).

The papers included in this review have variable quality with regards to the risk of bias. When using the Newcastle-Ottawa Quality Assessment form, only half (16/35) were classified as 'good' (unlikely to have significant bias). Only 15/35 were randomized controlled studies (offering the highest level of evidence). Only 9/35 studies outcome assessment and the reporting of complications was truly independent (not conducted by the clinician). Moreover, as the Newcastle-Ottawa tool only assesses bias in non-randomised studies, no formal risk of bias assessment was completed for RCTs. Bias therefore may have affected the results of this review.

Furthermore, the amount of clinical detail in most papers regarding complications was generally disappointing. Nerve root lesions were reported by 16 papers but only half (8/16) provided clinical details. Equally new neurological symptoms (such as motor deficits and dysesthesia) and the clinical effects of durotomies are generally reported with scarce clinical information. This perhaps reflects a general focus on outcomes rather than complications, which are generally seen as 'infrequent', less relevant and often not investigated as a 'primary' or even 'secondary' outcome measure. It is therefore not clear whether complications have a significant impact on patient's recovery and quality of life.

Numerous tools are available for the assessment of surgical outcomes after spine surgery, including disability scores and pain scores (58), which provide valuable 'patient-centred' information at fixed periods of time (before and after surgery). However, they are not designed to focus on complications, provide clinical details and report on the impact complications can have during the recovery period. In addition to the complications reported in the studies selected for this review, other complications can occur which often go under-reported. Some are probably deemed to be 'non-specific' and likely to occur after any surgical procedure (anaesthetic problems, medical and respiratory problems, thrombosis, etc). Others are rare (e.g., epidural haematomas, vascular and abdominal injuries) and despite the inclusion of 7,354 patients in this review, only one of these were reported in the selected studies. Rare complications are in fact more likely to be described as 'case reports'. Similarly, missed pathology and surgical errors (e.g., wrong level exploration) are also likely to go under-reported (these infrequent events are even less likely to occur during clinical trials, when surgery is performed by experts in centres of excellence). The ideal tools for the reporting of complications are National Specialty Registries. The British Association of Spine Surgeons (BASS) has set up a registry in 2012 with the aim to improve patient safety and monitor the results of spinal surgery. Only once widespread implementation of a registry is achieved, will accurate reporting of complications and their impact become common practice, enabling better feedback for surgeons and patients to help guide clinical decisions.

Informing patients of the possible risk of complications is an important part of the decision-making process and patients need access to all relevant information. The findings of this review corroborate the findings found in previous reviews, providing an update with the most recent literature, increasing the validity of the information already given to patients.

Limitations

Several limitations are relevant when considering the findings of this review. Only 35 full-text articles met the inclusion criteria, with the vast majority of studies being excluded for being retrospective or for not discussing complications. As a result, the number of studies being analysed was small, which hindered the ability to compare surgical techniques, especially for OD which was limited to 3 contributing studies. Additionally, the absence of statistical analysis restricts the ability to make a robust comparison between the various techniques.

Only one database (Medline) was searched for this review, which means evidence selection bias will be present as studies published in other databases will not have been included. Publication bias could be present as only studies published in the English language were included, with unpublished studies being unaccounted for. No risk of bias assessment for RCTs included within this review could mean that bias influences the reliability of the results. Studies in general lacked clinical detail and focus on complications, thus hindering the ability to extract useful information.

Despite these limitations, this review has several key strengths. As compared to previous studies, this review is based on a larger number of prospective studies with a greater pool of patients and longer follow-up periods. It reflects current practice by including a much larger number of patients undergoing FED procedures.

Future research on complications should benefit from the widespread use of National Registries where data is entered for all cases in adequate detail and infrequent complications can be better counted and understood.

Conclusions

This systematic review of complications after lumbar discectomy, based on 35 studies published between 1997 and 2020, shows low and similar complication rates for the various surgical techniques and is consistent with the previous literature. It reinforces current knowledge and trends in modern practice by including a large pool of patients who underwent FED. The resulting information can be used to strengthen the process of informed consent prior to surgery.

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Footnote

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