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A meta-analysis of interlaminar minimally invasive discectomy compared to conventional microdiscectomy for lumbar disk herniation

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ABSTRACT

A meta-analysis was conducted to evaluate the evidence that compared the safety and efficacy of interlaminar minimally invasive discectomy (ILMI) and conventional microdiscectomy (MD) for treating lumbar disk herniation (LDH) patients and to develop GRADE based recommendations for using the procedures to treat LDH. Eleven studies, encompassing 1012 patients, met the inclusion criteria. Overall, the results of the meta-analysis indicated that there were significant differences between the two groups in blood loss (SMD = −0.93, 95% CI −1.84, −0.02; $p = 0.05$), and the number of days stays in hospital (SMD = −0.79, 95% CI −1.55, −0.04; $p = 0.04$). However, there were no significant differences in the short-term back visual analog scale (VAS) scores (SMD = −0.34, 95% CI −0.81, 0.14; $p = 0.16$), the long-term back VAS scores (SMD = 0.13, 95% CI −0.04, 0.30; $p = 0.14$), the short-term leg VAS scores (SMD = 0.14, 95% CI −0.01, 0.29; $p = 0.07$), the long-term leg VAS scores (SMD = 0.12, 95% CI −0.05, 0.30; $p = 0.17$), the short-term Oswestry disability index (ODI) scores (SMD = 0.01, 95% CI −0.14, 0.15; $p = 0.92$), the long-term ODI scores (SMD = 0.11, 95% CI −0.03, 0.25; $p = 0.14$), and the incidence of complications (RR = 1.22, 95% CI 0.88, 1.69; $p = 0.24$). The results of this meta-analysis demonstrate that ILMI and MD are both safe and effective surgical procedures for treating LDH. Compared with MD, ILMI can shorten days in hospital, decrease the mounts of blood loss during surgery. However, the overall GRADE evidence quality was very low. Therefore, further validation is required, and medical institutions should conduct high-quality studies.

1. Introduction

Sciatica or lumbosacral radicular syndrome affects millions of individuals worldwide and is typically caused by lumbar disk herniation (LDH) [1]. It is responsible for considerable personal and societal costs. The natural course is usually favorable. Patients with disk-related sciatica may need treatment conservatively or via surgery when conservative treatment fails or complaints worsen over time [2–4]. The goal of surgical intervention is to remove disk material to decompress the nerve root. Since the first successful lumbar disk operation, described by Mixter and Barr in 1934, a variety of minimally invasive (MI) techniques have been developed. With the introduction of the microscope, the original laminectomy was refined into open microdiscectomy (MD), which is now the most common procedure [5].

Furthermore, advances in surgical technique and technology have seen an increase in MI techniques whereby access to the disk is gained via a tube, using a microscope or endoscope for visualization. In 1997, Foley and co-workers [6] firstly introduced the minimally invasive technique of transmuscular tubular discectomy. Currently, tubular retraction systems and endoscopic systems enable simultaneous visualization and removal of disk material via one MI working portal. MI techniques are contrasted with MD, which requires a larger incision and hypothetically a greater degree of muscle trauma. Patients are expected to have reduced postoperative pain, thus allowing quicker mobilization and contributing to shorter hospitalization and faster resumption daily activities. In spite of the above advantages, safety of the MI approach has been questioned due to the small working channel and compromised visualization. The minimal working space might lead to the damage of dural and neural tissue. Therefore, assessing the efficacy of MI

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techniques compared with MD is important because an estimated 300,000 discectomies are performed annually in the US alone [7]. Moreover, there is an interest in minimally invasive spine surgery in the lay community [8].

There are several routes by which the surgeons perform MI surgery. Recently, several randomized controlled trials (RCTs) compared the effects and efficiency of interlaminar minimally invasive discectomy (ILMI) and MD in treating LDH. Potential benefits to ILMI may include decreased pain, less muscle damage, and better functional recovery after surgery. While RCTs provide high-quality evidence, different studies investigating a similar question do not reach the same conclusions occasionally.

At present, there was a controversy over whether ILMI is superior to MD for patients with sciatica due to LDH. Thus, a meta-analysis of relevant studies is necessary to establish the current state of evidence. The purpose of the present meta-analysis is to evaluate the evidence from RCTs that compared the safety and efficacy of ILMI and MD for treating LDH patients and to develop GRADE (Grading of Recommendations, Assessment, Development, and Evaluation) based recommendations for using the procedures to treat LDH [9,10].

2. Materials and methods

2.1. Search strategy

To assemble all the relevant literatures, PRISMA compliant searches of Medline, Embase, Science Direct, OVID, and the Cochrane CENTRAL database were performed on all peer-reviewed studies through May 2014 for randomized control trials (RCTs) comparing ILMI versus MD in patients with LDH. The following search terms were adopted for the database research: Minimally invasive, Diskectomy, Endoscopy, Sciatica, lumbar disk herniation.

Secondary searches of unpublished literature were conducted by searching the WHO International Clinical Trials Registry Platform, UK National Research Register Archive, Current Controlled Trials from their inception to May 1, 2014.

2.2. Inclusion criteria

Studies were considered eligible for inclusion if they met the following criteria:

Study design: RCT.
Population: Patients with sciatica caused by one level LDH.
Intervention: ILMI.
Comparator: MD.
Outcomes: Reported at least one of the following: Operation time, blood loss, stay in hospital time, subjective pain perception, functional recovery, incidence of complications.

2.3. Exclusive criteria

Patients were excluded from the meta-analysis if they had a neoplastic etiology (i.e., metastasis or myeloma), infection, traumatic fracture and spinal stenosis. Other exclusion criteria were cauda equina syndrome, previous spinal surgery at the same disk level, spondylolisthesis, central canal stenosis, severe somatic or psychiatric diseases.

2.4. Study selection

Two reviewers independently screened the title and abstract related to the eligibility criteria. Then, full-text intensive reading was performed when those studies might meet the inclusion criteria, and the literature was reviewed to determine the final inclusion. We resolved disagreements by discussion to reach a consensus.

2.5. Date extraction

Two authors independently extracted the following data. The data extracted from the studies include the following: study characteristics, types of interventions, symptoms duration and outcomes parameters. The extracted data were rechecked by RFS.

2.6. Outcomes

The clinical outcomes included the back or leg visual analog scale (VAS), the Oswestry disability index (ODI), operative time, number of days in hospital, blood loss, and incidence of complication. In addition, we defined the short-term time point as no more than one month and the long-term time point as more than one year. We used the time point closest to the time for pooling, if there was no report at the same time point.

2.7. Assessment of methodological quality

According to the Cochrane Handbook for Systematic Reviews of Interventions 5.0, the risk of bias included studies was assessed by two authors (XSW and XMN) independently. A third author (QJ) was the adjudicator when no consensus was achieved. We applied the "assessing the risk of bias" table, which includes the following key domains: adequate sequence generation, allocation of concealment, blinding, incomplete outcome data, free of selective reporting and free of other biases.

2.8. Data analysis

We performed all of the meta-analyses with the Review Manager software (RevMan Version 5.1; The Nordic Cochrane Center, The Cochrane Collaboration, Copenhagen, Denmark). For continuous outcomes, such as ODI and VAS, the means and standard deviations were pooled to a standardized mean differences (SMD) and its 95% confidence interval (CI). Risk ratios (RRs) and 95% confidence intervals (CIs) were used to evaluate the dichotomous outcomes, such as the incidence of complications. The inverse variance and Mantel-Haenszel techniques were used to combine separate statistics. A p-value <0.05 was considered statistically significant.

Statistical heterogeneity was assessed using Q statistics. A fixed-effects (inverse variance) model was used when the effects were assumed to be homogenous ($p > 0.05$). $p < 0.05$ implied statistical heterogeneity, and a random effects model was used in those circumstances. The sensitivity analysis was performed by rejecting the studies with higher statistical heterogeneity.

2.9. Evidence synthesis

The evidence grade was determined using the guidelines of the GRADE (Grading of Recommendations, Assessment, Development, and Evaluation) working group [9]. The GRADE system uses a sequential assessment of the evidence quality that is followed by an assessment of the risk-benefit balance and a subsequent judgment on the strength of the recommendations. The evidence grades are divided into the following categories: (1) high, which indicates that further research is unlikely to alter confidence in the effect estimate; (2) moderate, which indicates that further research is likely to significantly alter confidence in the effect estimate and may change the estimate; (3) low, which indicates that further