European Spine Journal (2019) 28:55–60
https://doi.org/10.1007/s00586-018-5716-8

ORIGINAL ARTICLE

Minimally invasive spinal decompression surgery in diabetic patients: perioperative risks, complications and clinical outcomes compared with non-diabetic patients' cohort

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Received: 12 December 2017 / Revised: 15 April 2018 / Accepted: 4 August 2018 / Published online: 11 August 2018
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Abstract

Background Prior studies have documented an increased complication rate in diabetic patients undergoing spinal surgery. However, the impact of diabetes on the risk of postoperative complications and clinical outcome following minimally invasive spinal (MIS) decompression is not well understood.

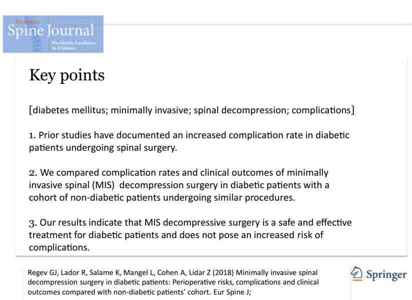
Objectives To compare complication rates and outcomes of MIS decompression in diabetic patients with a cohort of non-diabetic patients undergoing similar procedures.

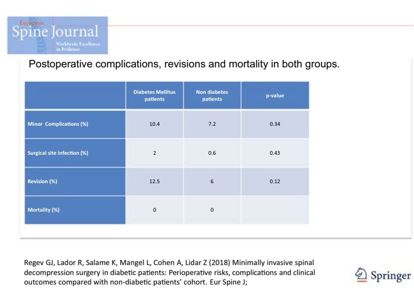
Methods Medical records of 48 patients with diabetes and 151 control patients that underwent minimally invasive lumbar decompression between April 2009 and July 2014 at our institute were reviewed and compared. Past medical history, the American Society of Anesthesiologists score, perioperative mortality, complication and revision surgeries rates were analyzed. Patient outcomes included: the visual analog scale and the EQ-5D scores.

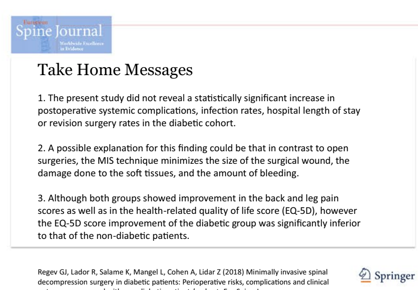
Results The mean age was 68.58 ± 11 years in the diabetic group and 51.7 ± 17.7 years in the control group. No major postoperative complications were recorded in either group. Both groups were statistically equivalent in their postoperative length of stay, minor complications and revision rates. Both groups showed significant improvement in their outcome scores following surgery.

Conclusions Our results indicate that minimally invasive decompressive surgery is a safe and effective treatment for diabetic patients and does not pose an increased risk of complications. Future prospective studies are necessary to validate the specific advantages of the minimally invasive techniques in the diabetic population.

Graphical abstract These slides can be retrieved under Electronic Supplementary Material.







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Electronic supplementary material The online version of this article (https://doi.org/10.1007/s00586-018-5716-8) contains supplementary material, which is available to authorized users.

Extended author information available on the last page of the article

Keywords Diabetes mellitus · Minimally invasive · Spinal decompression · Complications

Introduction

Diabetes mellitus (DM) is a systemic disease that has been recognized as an independent risk factor for complications following spinal surgery [1]. As the prevalence of DM increases in the western world and among the general population, its impact on the outcome of patients undergoing spinal surgery for the treatment of spinal stenosis or disk herniation intensifies.

Prior studies have found that diabetic patients are at higher risk of intraoperative bleeding, perioperative wound infection, systemic infections and even death [2, 3]. Moreover, these studies have identified that diabetic patients suffer from prolong postoperative hospitalization, increased rates of revision surgeries and worsened functional outcomes [4, 5].

Minimally invasive surgery (MIS) of the spine has gained increased popularity in recent years. This approach significantly reduces soft tissue injury and intraoperative bleeding [6]. As a result, patients experience less postoperative pain and can usually be mobilized and discharged earlier [7]. Previous studies have shown comparable long-term outcomes of MIS and traditional open spinal decompression procedures [8].

Therefore, the aim of the present study is to further examine and clarify the perioperative risk and outcomes of diabetic patients undergoing MIS decompression. We hypothesize that MIS decompression would be particularly beneficial to the diabetic patients by decreasing their higher risk of complication.

Methods

Following study approval by our local institutional review board, medical records of patients who underwent one or two levels minimally invasive lumbar decompression surgery between April 2009 and December 2014 were reviewed. Inclusion criteria included patients with a previous diagnosis of diabetes and a control group of non-diabetic patients undergoing similar surgeries. Exclusion criteria included patients undergoing surgeries of more than two spinal levels and procedures that involved spinal instrumentation, fusion, resection of tumor, spinal infection or revision surgery.

The study cohort included a total of 199 patients, 48 diabetic patients and 151 patients in the control group. Demographic data and preoperative data, including past medical history, medical comorbidities, and the American Society of Anesthesiologists (ASA) score [9], were used for analysis. To simplify the presentation of the medical history data, we classified patients' comorbidities into six categories: cardiovascular, hypertension, cerebrovascular disease, dyslipidemia, peripheral vascular disease and renal. Operative data included: type of surgery (discectomy, lamino-foraminotomy or both), operated spinal level and incidence of intraoperative complications.

Measured clinical outcomes included: hospital length of stay (LOS), early postsurgical complications, revision surgery and mortality. Patient-reported outcomes were obtained only for a sub-group of 39 patients (81%) of the DM group and 64 patients (42%) of the non-DM group using telephone interviews. Reported outcomes in these sub-groups included: the health-related quality of life EQ-5D-3L instrument [10] and the visual analogue scale (VAS) for back and leg pain scores, before surgery and post operatively, and at the time of data collection. The EQ-5D questionnaire consists of five dimensions including mobility, self-care, usual activities, pain and anxiety/depression. Each domain is rated according to three levels of severity: no problems (1 point), some or moderate problems (2 points), and severe problems (3 points).

MIS surgical technique

All procedures were performed in a single medical center by two senior spinal surgeons who are well experienced in MIS surgeries. MIS decompression procedures were done routinely under general anesthesia using an 18- or 20-mm tubular retractor system (METRx; Medtronic Sofamor Danek, Memphis, TN) and a surgical microscope. Surgery was performed using a unilateral approach, with either an ipsilateral or bilateral canal decompression as previously described [11].

Statistical analysis

All data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 23.0 (SPSS Inc, Chicago, Illinois).

Continuous variables are expressed as mean ± standard deviation, and categorical data are shown as absolute and relative frequencies. Normality of distribution was assessed by means of the Kolmogorov–Smirnov test.

Independent samples *t* tests were used to test numeric variables, and the Chi-squared test and Fisher's exact test were used to investigate categorical variables. Preoperative to postoperative EQ-5D changes within each group were analyzed using the paired *t* tests. A two-sided $p < 0.05$ was considered to be significant.

Results

A total of 199 patients were analyzed, 48 suffered from DM. The average age in the DM group was 68.58 ± 11 years and 51.7 ± 17.7 years in the non-DM group ($p = 0.01$). The male/female ratio was similar in both groups ($p = 0.168$), and the follow-up period was 31.19 ± 12.85 months for the DM group and 32.15 ± 11.12 for the non-DM group ($p = 0.45$). The average ASA score in the DM group (2.65 ± 0.82) was significantly higher than in the non-DM group (1.48 ± 0.48) ($p = 0.036$) (Table 1).

Of the 48 patients in the DM group, 30 patients (62.5%) were diagnosed with spinal canal and foraminal stenosis and thus underwent a MIS bilateral spinal canal decompression (laminectomy). The remaining 18 patients (37.5%) were diagnosed with lumbar disk herniation and underwent a MIS discectomy. Of the 151 non-DM patients, 48 (31.7%) were diagnosed with spinal canal and foraminal stenosis and thus underwent MIS bilateral spinal canal decompression (laminectomy), and 103 (68.3%) were diagnosed with lumbar disk herniation and underwent MIS discectomy. Motor weakness in one or more of the lower limbs muscles was present in 27 patients (56%) in the DM group and in 115 patients (76%) in the non-DM group.

Medical comorbidities were divided into six categories as specified in the methods. Significant differences were recorded between the groups in all categories including hypertension (HTN), cardiovascular disease (IHD) and previous cerebrovascular disease (CVA/TIA) (Table 2). Only 8.3% of the patients in the DM group did not present any additional concomitant diseases prior to admission, compared to 41% of the patients in the non-DM group.

Sixty-three percent of patients in the DM group were diagnosed with HTN, 35.4% with IHD, and 18.7% had prior CVA/TIA. Other common comorbidities included 35.42% dyslipidemia, 4.2% chronic renal failure and 4.2% peripheral vascular disease. In the non-DM group, the most prevalent comorbidity was HTN (25.8%) followed by dyslipidemia (11.2%) and IHD (6.6%) (Table 2).

The mean hospital LOS was not significantly different between the DM and non-DM groups, 4.38 versus 3.36, respectively ($p = 0.101$). Minor complications (incidental durotomies and superficial wound infection) occurred in 10.4% of the DM group compared to 7.2% in the non-DM group ($p = 0.34$). Surgical site infection was recorded in one patient in the DM group (2%) and in one patient in the non-DM group (0.6%) ($p = 0.425$). No major postoperative infection, pulmonary or cerebrovascular complications were recorded in neither group (Table 3).

No statistically significant difference was observed in the surgical revision rate between the groups, 12.5 versus 6% of revision in the DM and non-DM groups, respectively ($p = 0.121$). Indications for revision surgery included: recurrent disk herniation, insufficient decompression during the primary surgery, re-stenosis at the operated level or adjacent level stenosis. Additionally, no instrumented fusion was performed as part of the revision surgery in either group.

A total of 103 patients were surveyed for long-term outcomes, 39 from the DM group and 64 from the non-DM group. Overall, VAS and EQ-5D-3L scores significantly improved in both groups after surgery. VAS for back pain improved from 6.56 ± 3.51 to 3.15 ± 3.3 in the DM group ($p = 0.003$) and from 8.35 ± 7.79 to 3.83 ± 3.3 ($p = 0.002$) in the non-DM group with no significant difference in the improvement between groups ($p = 0.186$). VAS for leg pain improved from 6.3 ± 3.9 to 2.88 ± 4.1 in the DM group and from 7.53 ± 3.47 to 3 ± 3.5 in the non-DM group ($p = 0.354$). The EQ-5D-3L scores improved significantly in both groups, in the DM group from 7.41 ± 3.5 to 6.19 ± 3.3, and from 9.73 ± 1.7 to 7.27 ± 2.2 in the non-DM group ($p < 0.05$ for both groups). However, this improvement was found to be significantly greater in the non-DM group ($p = 0.028$).

Table 1 Demographic data and basic health status in both groups

	DM ($n = 48$)	Control ($n = 151$)	p value
Age (years)*	68.58 ± 10	51.7 ± 17	0.01
Male/female (%)	58/42	49/51	0.168
ASA score*	2.65 ± 0.82	1.48 ± 0.41	< 0.036
Follow-up (months)*	31.19 ± 12.85	32.15 ± 11.12	0.452

*Values are expressed as mean ± SD

Table 2 Comorbidities distribution in the two groups

Categories (%)	DM	Control	p value
Cardiovascular	35.4	6.6	< 0.001
Hypertension	63	25.8	< 0.001
Cerebrovascular disease	18.7	4.6	< 0.01
Peripheral vascular disease	4.2	0.67	< 0.001
Dyslipidemia	35.4	11.2	< 0.001
Chronic renal failure	4.2	0.67	< 0.001

Table 3 Postoperative complications, revisions and mortality in both groups

	DM	Control	p value
Minor complications (%)	10.4	7.2	0.34
Surgical site infection (%)	2	0.6	0.43
Revision (%)	12.5	6	0.12
Mortality (%)	0	0	

Discussion

Diabetes mellitus has become a common morbidity in the western world. Its prevalence increases with age and as the elderly population increases in number, so will the number of persons with diabetes [12, 13]. It has been suggested that DM may be a predisposing factor for the development of spinal stenosis [14, 15].

Diabetic patients undergoing spinal surgery possess unique challenges that may influence their clinical outcomes. Diagnosing the specific origin of their neurologic symptoms may be difficult as many of them present with coexisting degree of peripheral diabetic neuropathy that may simulate the compressive lumbar spinal condition, causing pain or dysesthesia. Moreover, the prevalence of peripheral vascular arterial disease in diabetic patients is higher, causing at times vascular claudication that might coexist with the neurogenic type of claudication caused by spinal stenosis.

Higher risk of perioperative complications in diabetic patients has been a consistent finding in many studies [1, 2, 4, 5, 16].

Simpson et al. [17] have reported high rates of postoperative infection and prolonged hospitalization in diabetic patients who underwent posterior decompressive procedures. Glassman et al. made a similar observation in a case–control retrospective study of patients who underwent posterior lumbar fusion procedures. The incident of both minor and major complications in the diabetic group was found to be two- to threefold higher compared to the one in the non-diabetic group with total complication rates reaching 53 and 56% for non-insulin-dependent and insulin-dependent patients, respectively [16]. Furthermore, Browne et al. have examined diabetic patient's morbidity and mortality following spine fusion surgery using the Nationwide Inpatient Sample (NIS) database. They reported that diabetes was associated with higher risks of postoperative infection, need for blood transfusion, pneumonia, and non-routine discharge [18].

The present study compares a retrospective cohort of diabetic and non-diabetic patients that were operated in our medical center. Significant differences were found between these two groups as the DM patients group consisted of older patients with significantly higher number of comorbidities and overall increased surgical risk. Moreover, approximately two-thirds of the DM group were treated for spinal stenosis compared to only one-third of the non-DM group, requiring a relatively more extensive and longer procedure to achieve a bilateral decompression of the canal.

Despite all the above-mentioned risks, our study did not reveal a statistically significant increase in postoperative systemic complications, infection rate, LOS or revision surgery rate in the DM cohort.

A possible explanation for this finding could be that in contrast to open surgeries, the MIS technique minimizes the size of the surgical wound, the damage done to the soft tissues and the amount of bleeding [19, 20]. This finding of a relatively low rate of postoperative infections following minimally invasive procedures has been previously reported in several studies. O'Toole et al. [21] reported an infection rate of 0.22% following MIS decompression surgery in a cohort of 1274 patients. In a Cochrane systematic review comparing minimally invasive to standard discectomy, the authors found that the potential advantages of minimal invasive discectomy are lower risk of surgical site infection and other infections [22].

Moreover, hospital LOS for both groups was found to be shorter than the average hospitalization length following open spine surgeries as reported in previous studies [8, 23, 24]. In our department, patients were treated with non-opioid analgesics and encouraged to mobilize as soon as possible, usually during the same day of surgery in order to decrease the risks associated with prolong bed rest. Intra-venous catheters were promptly removed the next day following surgery, and urinary catheters were not used routinely. Patients were usually discharged from the hospital within 1–2 days.

Although both groups showed improvement in the back and leg pain scores as well as in the health-related quality of life score, the mean EQ-5D score of the DM group was significantly inferior to that of the non-DM patients. This finding is further intensified by the higher percentage of preoperative neurological deficits in the control group. These results are consistent with previous reports. Armaghani et al. analyzed patients self-reported outcomes one- and two-year following surgery. They found that although patients with diabetes improved compared to their baseline values, when compared to non-diabetic, they exhibited lower improvement of their SF-12 physical, EQ-5D and ODI scores [25].

The present study has several limitations. This is a level 3 retrospective case–control study that uses a small to medium sample size cohorts. It is possible that with a larger sample groups the trend toward higher complication rate and longer hospital stay of the DM group would have reached statistical significance. However, it is important to note that the complication and infection rates found in the DM group are lower compared to similarly reported case series.

Although a sub-analysis comparing the complications of the DM patients group to a smaller, aged-matched and procedure-matched control group was possible, it is reasonable to think that this sub-analysis would have led to similar results. This selection bias in fact strengthens our findings regarding the low operative risk in the DM group. As such, we opted to use the larger-sized group consisting of younger, healthier patients.

In addition, we were unable to record the hemoglobin A1c (HbA1c) levels of the diabetic patients prior to surgery. High levels of HbA1c indicates high and poorly controlled glucose serum levels and were found to correlates with higher risk of surgical complications. Cancienne et al. [26] determined that a perioperative HbA1c above 7.5 mg/dL could serve as a threshold for a significantly increased risk of deep postoperative infection following lumbar decompression.

Future studies using prospective collected data are needed in order to determine whether the same HbA1c threshold is applicable for DM patients undergoing MIS decompression.

We conclude that MIS decompressive surgery is a safe and effective treatment for diabetic patients. Our data suggest that the risk for complications and poor outcome following spinal surgery in this group might be reduced by the use of minimally invasive techniques. Future prospective studies using larger and more homogenous control cohorts are necessary to validate the specific advantages of these techniques in the diabetic population.

Compliance with ethical standards

Conflict of interest All authors declared that they have no conflict of interest.

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