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Research Article

Medium-Term Results of Minimally Invasive Surgery Vs. Open Surgery for the Treatment of Lumbar Degenerative Discopathy

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Abstract

Background: Currently, lumbar pathology has the option of being surgically treated in an open way (OPEN) or a minimally invasive way (MIS), a treatment that is presented as an alternative that promises the same results but with less soft tissue injury and a speedy recovery. The objective of this study is to analyse the perioperative and postoperative results of patients undergoing open posterolateral or circumferential arthrodesis in comparison with minimally invasive surgery in lumbar degenerative pathology.

Material and methods: A retrospective comparative study was carried out on 83 patients operated on using the OPEN technique and 36 patients using the MIS technique. Both diagnosed with lumbar degenerative disc disease, without previous interventions, with no central canal stenosis and symptoms of low back pain and radiculopathy. To assess the results, we carried out a preoperative and postoperative clinical follow-up at 3, 6 and 12 months. Among other items, the lumbar and radicular VAS, the patient's functional and occupational status, as well as the appearance of complications during follow-up and the need for reoperation were compared.

Results: Lumbar and radicular VAS improved in both groups during follow-up. However, this improvement was noticeably better in the open surgery group during the first year. Regarding functional recovery, it was shown that at 3 months more than 62.2% of the open group had totally or partially recovered their activity compared to 51.4% of the MIS group and at 6 months more than 95.2% of the open group had partially or fully recovered vs. 69.7% of the MIS group. A statistically significant difference was found in both cases ($p<0.05$). Only after a year do the results become equal. Regarding the appearance of complications, a rate of 41.7% of complications of some kind was found during the first year in the MIS group, especially in the first 3 months after surgery, compared to 18.1% in those operated openly. This being a statistically significant difference. The reoperation rate was 11% vs 2.4%, respectively, throughout the follow-up.

Conclusions: Open and percutaneous surgery are two very different techniques that aim to achieve the same results. However, in light of our study we have been able to see that functional recovery and pain improvement, although after one year it is equal in both groups, it is plausibly better in those operated on openly. In summary, we can conclude that minimally invasive surgery is currently unable to improve the results of open surgery in patients suffering from degenerative disc disease, which could open a debate on its current indications.

Keywords: Degenerative; Minimally invasive; Open surgery; TLIF, Lumbar; Spine

Introduction

Minimally Invasive Surgery (MIS) in spinal surgery, with Transforaminal Lumbar Interbody Fusion (TLIF) was developed with the concept of minimizing soft tissue and paravertebral muscle injury that is commonly produced by the classic open approach (OPEN) [1,2]. In some articles, it has been determined that the pressure exerted by the separators on the muscles in OPEN surgery, as well as the duration of the operation, cause injuries to the paraspinal muscles, negatively affecting muscle strength [3-5]. Likewise, apart from the local effect, it is argued that this intervention results in less blood loss, less postoperative pain, fewer days in hospital, less recovery time and a lower rate of infection compared to open surgery [6-9].

However, in the current literature, comparative studies focus mainly on fracture management, screw positioning, or physiological changes or general complications. But there are few comparative studies between both techniques in purely degenerative pathology, by experienced surgeons and large cohorts [10-14]. The objective of this study is to analyse the medium term perioperative and postoperative results of patients undergoing open posterolateral or circumferential arthrodesis in comparison with minimally invasive surgery on one or two-level lumbar degenerative pathology.

Materials and Methods

A retrospective cohort study is carried out, with patients operated on in a single medical institution, using the MIS technique or the OPEN technique. All underwent surgery between 2016 and 2019, with a minimum follow-up of 12 months. The patients were consecutively selected based on the primary diagnosis of lumbar degenerative disc disease, spondylolisthesis, or 1- or 2-level disc herniation. All with symptoms of radiculopathy and/or lumbago. They were separated into 2 groups depending on the type of intervention: open (OPEN) or closed (MIS) posterior arthrodesis. It is recorded if during the intervention only posterolateral arthrodesis is performed (only screws with or without graft) or 360º with placement of the TLIF interbody cage. Patients with a diagnosis of fracture, canal stenosis or a history of previous interventions of any type at the lumbar level were excluded. The objective was to achieve two groups with pathologies that could be addressed by both surgical options and without anatomical alterations of iatrogenic origin, such as post-surgical fibrosis.

Surgical Technique

The surgical interventions have been performed by a team of six spine surgeons with extensive experience in both open and minimally invasive approaches, excluding those interventions performed before completing at least a 5-year learning curve [15-17]. We classified the groups according to two techniques: traditional open with midline incision and posterolateral or circumferential arthrodesis through transforaminal lumbar interbody fusion (TLIF) or minimally invasive with Wiltse and TLIF approach. The techniques were complemented with facetectomies, foraminotomies, and hemilaminectomies at the surgeon's discretion. A variety of instrumentation was used, as well as interbody devices, including PEEK, titanium and expandable cages.

Traditional Open Surgery

A posterior midline incision is made over the lumbar spine. The detachment of the paravertebral muscles from the spinous processes, the lamina, facet capsule and transverse processes is carried out. Facetectomy of the levels to be arthrodesed is performed bilaterally, instrumentation with pedicle screws and placement (except for those cases that for anatomical reasons prevented it) of interbody cages. Autologous graft extracted from local release is deposited in the crushed and/or intertransverse contralateral space mixed with demineralized bone matrix.

Minimally Invasive Surgery

Bilateral Wiltse approaches are performed, with paramedial incision 3 cm laterally to the midline and in depth up to the lumbar dorsal fascia. The deep incision is made between the multifidus and longissimus muscles on the side on which the TLIF device is to be released and placed. On the non-released side, the opening is reduced to the essential minimum for the introduction of needle guides and subsequently of the pedicle screws. The preparation of the disc space and placement of the cage is carried out using serial dilators and the use of a tubular separator. In all cases, unilateral complete facetectomy and fixation with percutaneous pedicle screws on guide needles is performed after TLIF.

Measurements

In both groups, descriptive data such as gender, relevant personal history such as chronic diseases, age at the time of surgery, preoperative symptoms, preoperative diagnosis and total follow-up time were collected, counting the cases of loss during follow-up. The perioperative factors evaluated were: duration of the intervention in minutes, intraoperative complications of any type, blood loss, need for transfusion, days of hospitalisation and immediate postoperative complications, understood as those complications that occurred within the first 30 days (mainly surgical wound infection, screw/implant malposition, poorly controlled pain that requires surgical review or other). The evolution of both radicular and lumbar pain is monitored, measured by the Visual Analogue Scale (VAS). Likewise, both the living and working situation are evaluated through a simple survey in which the patient

places their status in 3 possible situations: 1. The patient does not work, is on sick leave or unable to perform daily activities; 2. The patient works adequately in the workplace or has partially limited autonomy and 3. Works and/or lives normally. Finally, a survey of dichotomous variables is carried out in which the patient is asked if he or she reports improvement with respect to the preoperative state. Measurements are performed at the preoperative level and postoperative follow-up at 3, 6, 12 months.

Postoperative complications were recorded throughout the follow-up from 30 days after surgery. Specifying the period of their appearance between 1 and 3 months postoperatively, between 3 and 6 months, between 6 and 12 months and those that appeared after the year of follow-up. The type of complication is specified: periradicular fibrosis, adjacent disc syndrome, mobilization or loosening of the instrumentation, implant malposition, pseudoarthrosis, fracture, late infection, pain without an objective cause (failed back syndrome), etc., in addition to whether it required surgical treatment or conservative type (rehabilitation, infiltrations or other interventional techniques, chronic mediation, etc.).

Statistical Analysis

Statistical analysis is performed using the SPSS statistical program (IBM). Differences between the OPEN and MIS patient groups were assessed using non-parametric tests with Chi-square tests, cross-tables, Man-Whitney test, and Wilcoxon signed-rank test. In all analyses, significance was defined as $p<0.05$

Results

119 patients were recruited for the study: 36 patients within the MIS group and 83 for the OPEN group. Both diagnosed with lumbar disc degenerative pathology of 1 or 2 levels or spondylolisthesis as the main diagnosis.

Descriptive data for both groups are shown in Table 1.

	MIS (n=36)	OPEN (n=83)
Gender: Male Female	 9 (25%) 27 (75%)	 34 (41%) 49 (59%)
Average age at the time of the intervention	50 (35-82)	53 (32-85)
Preoperative clinic: Low back pain and radiculopathy Isolated radiculopathy Isolated low back pain Claudication Loss of strength	 32 (88.9%) 2 (5.6%) 1 (2.8%) 0 (0%) 1 (2.8%)	 70 (84.3%) 0 (0%) 8 (9.6%) 5 (6%) 0 (0%)
Preoperative diagnosis: L3-L4 degenerative disc disease L4-L5 degenerative disc disease L5-S1 degenerative disc disease L4-L5-S1 degenerative disc disease Spondylolisthesis L4-L5 grade I-II Spondylolisthesis L5-S1 grade I-II	 1 (2.8%) 8 (22.2%) 17 (47.2%) 7 (19.4%) 1 (2.8%) 2 (5.6%)	 1 (1.2%) 12 (14.5%) 27 (32.5%) 18 (21.7%) 12 (14.5%) 13 (15.7%)
Preoperative VAS scale: Lumbar VAS Radicular VAS	 7.61 7.61	 8.39 7.62
Follow-up (months):	20.5 (6-46)	22.7 (3-66)
Lost to follow up:	3 (8.3%)	6 (7.2%)

Table 1: Descriptive summary of both groups.

There were no significant differences in terms of age, sex, clinical symptoms, diagnosis and preoperative VAS between both groups. Low back pain and concomitant radiculopathy were the most frequent symptoms, representing 88.9% of patients in the MIS group and 84% in the OPEN group.

Perioperative Measurements

All arthrodeses have been of 1 level (29 (80.6%) MIS vs 60 (72.3%) OPEN) or 2 levels (7 (19.4%) MIS vs 23 (27.7%) OPEN). In all cases of MIS surgery, circumferential arthrodesis was performed, in the case of the OPEN group, posterolateral arthrodesis was performed in 12 cases (14.5%) with autologous graft contribution and circumferential in 71 cases (85.5%). The average operation time was 130.56 minutes in the MIS group (range 90-215 minutes) and 139.39 (range 55-240 minutes) in the OPEN

group, with no statistically significant differences found after performing the t-test (p= 0.820). Only one case of intraoperative complication has been recorded in a patient from the MIS group, a case of cerebrospinal fluid leakage that was sealed in situ without repercussions in the postoperative period. Average blood loss and days of hospitalisation were lower in the MIS group (Hb loss of 2 points vs. 2.8 and average hospitalisation of 4.61 vs. 6.56 days), with no statistical significance found in both parameters (p=0.380). There were 4 cases of need for transfusion of blood products, 2 in the MIS group (5.6%) and 2 in the OPEN group (2.4%). Regarding the rate of complications in the immediate postoperative period (understood as the first 30 postoperative days), 5 cases were described in the MIS group (13.9%) vs. 6 cases in the OPEN group (7.2%). No statistical significance was found (p=0.127). The type of complication and need for reoperation is described in Table 2.

	MIS (n=36)	OPEN (n=83)
Poorly controlled pain that requires surgical revision	3 (8.3%)	0 (0%)
Surgical wound infection	0 (0%)	2 (2.4%)
Screw/implant malposition	2 (5.6%)	1 (1.2%)
Other non-surgical complications:	0 (0%)	4 (3.6%)

Table 2: Complications within the first 30 days postoperatively.

Postoperative Measurements

As for radicular and lumbar pain recorded using the VAS scale, a progressive decrease was seen in both groups throughout the first year. In all the periods studied, there was a significant improvement compared to the preoperative period, regardless of the type of intervention (p<0.005), as can be seen in Figure 1.

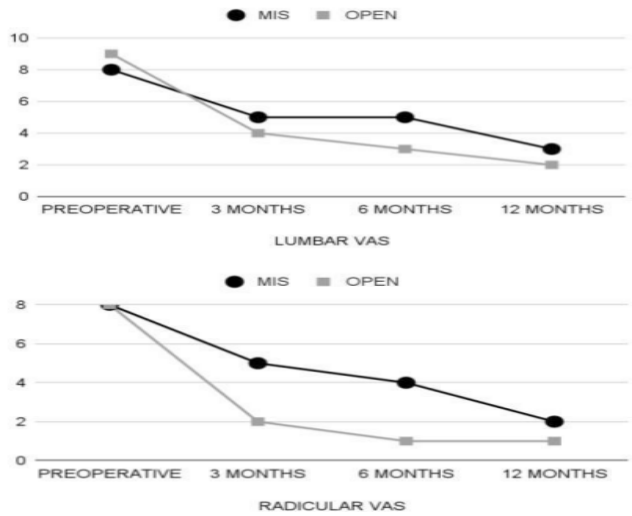

Figure 1: Lumbar and radicular VAS evolution during follow-up.

Comparatively, the decrease in lumbar VAS was greater in the OPEN group (-2.5 MIS vs -5 OPEN points at 3 months, -3 vs -6 points at 6 months, -3.5 vs -6 points at 12 months), this decrease being significant in all study periods (p<0.005). As for radicular VAS, the differences increase in the first 6 months (-2.5 MIS vs -5 OPEN points at 3 months, -3 vs -7 points at 6 months, -4 vs -6 points at 12 months) with p <0.005 except at 12 months (p = 0.373). Regarding the evolution of functional status in relation to the survey carried out, an improvement was also found in both groups in all periods (p<0.05). However, the improvement at 3 months was considerably better in the OPEN group (where 62.2% of the patients have returned to work with job adaptation or have recovered part of their autonomy vs. 45.7% of the MIS patients), with statistically significant differences being found (p<0.05). At this point in the study, only 5.7% of the patients who underwent minimally invasive surgery had a normal life or had returned to

their usual work without restrictions. Statistically significant differences were also found in favour of the OPEN group at 6 months (it was seen that 95.2% of the patients had a normal life or had partially recovered their autonomy and work vs. 69.7% of the OPEN group, where still a third of the group remained on sick leave or unable to carry out daily activities) ($p<0.05$). It is around a year when the results become comparable ($p=0.454$), in both groups the percentage of partial or total recovery is above 90%.

Surveys were also carried out at 24 months postoperatively with reproducible results for the OPEN group, but since in our hospital the follow-up period in the absence of complications is 12 months, at which time the patient is discharged, the results obtained may be biased by the remaining sample, in general, more complex patients with complications. The broken down results can be seen in Figure 2.

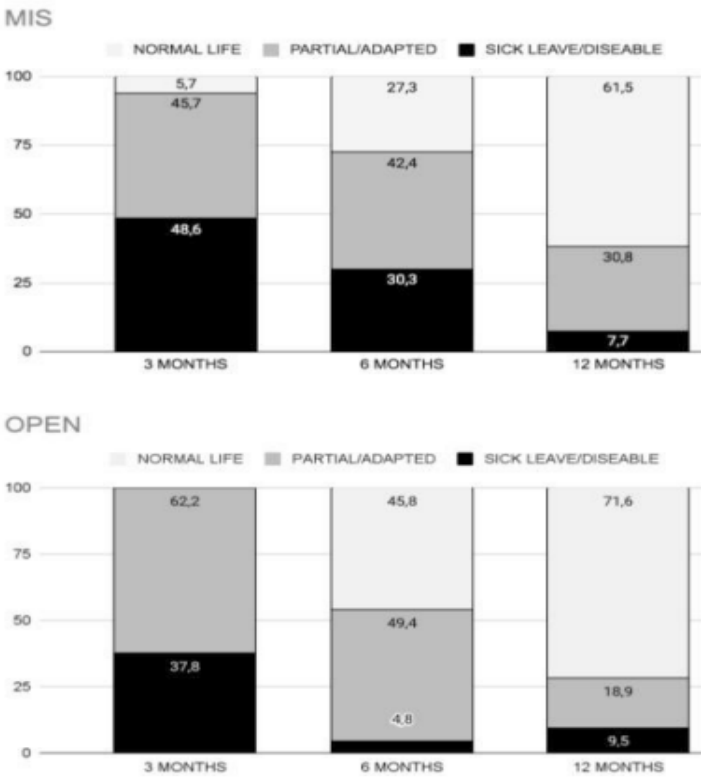

Figure 2: Results of the survey carried out on patients with 3 possible answers: 1. Remains on leave, does not work or is unable to perform daily tasks (Sick leave/disabled), 2. They have returned to work with job adaptation or have recovered part of their autonomy (Partial/adapted), 3. Works and/or leads a normal life (Normal life).

Complications

Within the first 12 months, 15 patients (41.7%) with some type of adverse event were found in the MIS group vs. 15 patients (18.1%) in the OPEN group. ($p=0.249$). Table 3.

	MIS (n=36)	OPEN (n=83)
Low back/sciatica episodes	9	8
Pseudarthrosis	4	3
Implant malposition	1	0
Haematogenous infection	1	0
Adjacent disc syndrome	0	4
Total	15 (41,7%)	15(18.1%)

Table 3: Postoperative complications throughout the follow-up period.

However, differences were found when broken down by time periods of the onset of symptoms from the time of surgery (Table 4). Within the first 3 months postoperatively, 6 cases of complications were found in the MIS group, mainly related to implant malposition or pain without objective cause, compared to 0 cases in the OPEN group ($p<0.05$).

	MIS (n=36)	OPEN (n=83)
1-3 months	6 (40%)	0 (0%)
3-6 months	5 (33.3%)	6 (22.2%)
6-12 months	4 (26.7%)	9 (33.3%)
>12 months	0 (0%)	12 (44.4%)
Total	15 (100%)	27 (100%)

Table 4: Periods of onset of complications during the postoperative period.

The reoperation rate during the entire follow-up period was 11% in the MIS group and 2.4% in the OPEN group, corresponding to 4 and 2 patients. No statistically significant differences were found throughout the follow-up period ($p=0.431$). The rest of the patients were managed conservatively.

Discussion

In the current literature, the evidence regarding the benefits of the MIS approach is inconsistent, as we will see below. In light

of the results of our study, we can see that, although the result at 12 months is the same in both groups, the path to that result has been very different, with a positive result for the OPEN group. Wong et al described a significantly lower rate of reinterventions in those operated on using the MIS approach (8.3% vs 20.4%) [18]. Phan et at in their meta-analysis, among other authors, show that, in addition to the high trend of reoperation in the open group, there is additional evidence that MIS-TLIF can produce significantly lower infection rates (1.2% vs 4.6%) [19-20]. In the comparative analysis of Ge et al, a significantly lower rate of complications and readmissions was found in the MIS group. However, no differences were found in terms of reoperations, although with a higher trend in the MIS approach (8% vs 4%) [21]. On the other hand, reoperation and complication rates between MIS and OPEN surgeries have been shown to be not statistically different in several systematic reviews and meta-analyses [9,22-26].

The results of the present study correspond to this literature because no statistically significant difference was shown in complications and reinterventions throughout the follow-up period. We did find differences in the rate of complications in the follow-up broken down by periods, being significantly higher in the MIS group in the first 3 months and a greater trend of reintervention in congruence with what was explained by Ge and Qu Jin-Tao et al [21,25]. Regarding clinical evolution, both techniques have satisfactory and relevant results. However, the speed of pain improvement both at lumbar and radicular level is objectively greater in the OPEN group in the medium term. In their comparative meta-analysis between both techniques in cases of fractures and degenerative pathology, Phan et al conclude that there is an improvement in the VAS scale and immediate postoperative ODI of the minimally invasive techniques, but, at the same time, they highlight the heterogeneity of the results between studies and the lack of significance in the analysis by subgroups [19,27]. On the other hand, Seng et al demonstrate significantly worse pain outcomes in the MIS group [28].

Conclusions

In summary, the present study shows that both open and minimally invasive surgery have good results, comparable in terms of length of hospital stay, blood loss, or intra-and perioperative complications. However, pain management and functional recovery are markedly better and faster in the open group. Also highlighting the lower rate of adverse events and reoperation rate during the first year of follow-up.

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