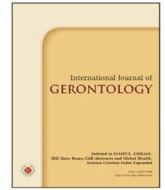




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## Original Article

# Evaluation of the Clinical Outcomes of Lumbar Microdiscectomy in Both Gender of Geriatric Patients Aged $\geq 65$ Years

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## SUMMARY

**Background:** Lumbar microdiscectomy is considered the gold standard in the surgical treatment of patients with lumbar disc herniation. This study evaluated the clinical outcomes of lumbar microdiscectomy in geriatric patients who underwent surgery in our clinic and determined whether there was a significant difference in clinical outcomes between the two genders in this population.

**Methods:** This study included 60 geriatric patients aged  $\geq 65$  years who underwent lumbar microdiscectomy between April 2015 and May 2019 for lumbar disc herniation. Preoperative and postoperative visual analog scale and Oswestry Disability Index scores were calculated and compared separately for both genders. Statistical analyses were performed using statistical package for the social sciences version 22.0 software.

**Results:** The mean age of the patients was  $72.22 \pm 6.06$  years and the mean length of stay in the operating room and hospital were  $172.83 \pm 37.19$  min and  $1643.18 \pm 647.05$  min, respectively. Although there was a significant decrease in postoperative visual analog scale and Oswestry Disability Index scores compared to preoperative scores, no significant difference was observed between the genders. The success rate for excellent or good results according to the modified Macnab criteria was 91.66% in all groups.

**Conclusion:** In the surgical treatment of geriatric patients with lumbar disc herniation, lumbar microdiscectomy is an effective and safe method since it is associated with low complication rates and high success rates. No significant difference was found between genders in terms of clinical outcomes in this age group.

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## 1. Introduction

Low back pain is one of the leading causes of hospital admission among geriatric patients. Approximately 70%–80% of the population suffers from low back pain at least once in their lives. It is an important public health concern due to its economic burden. Low back pain is more common among patients aged between 40 and 80 years and it equally affects males and females. The muscles, nerves, and bones are primarily affected. Surgical treatment is not required in all low back and leg pain cases; however, it is recommended if there is unresponsive pain or neurological deficit despite conservative treatment for  $> 6$  weeks.<sup>1</sup>

Approximately 5% (1%–10%) of patients who undergo discectomy for lumbar disc herniation (LDH) have been reported to be elderly patients. Neurosurgeons perform back surgery more frequently in geriatric patients than in other populations. LDH occurs at any adult age, but is less common in the elderly. Especially in developed countries, the aging population is increasing. Accordingly, the number of LDH surgery is increasing. Possible causes of this include prolonged life expectancy and the availability of advanced radiological examinations such as magnetic resonance imaging (MRI).<sup>2</sup>

There are many surgical options for LDH treatment, but minimally invasive surgical techniques have recently grown popular.<sup>3</sup> Lumbar microdiscectomy (LMD) is the most popular method for the surgical treatment of LDH. In this procedure, the degenerated part of a herniated disc that is compressing the nerve root is surgically removed under a microscope. The experience of neurosurgeons in LMD has increased in recent years. Satisfactory results have been obtained in 60%–80% of patients undergoing LMD.<sup>4</sup>

Some studies have reported the clinical results of LMD in patients with LDH. There are publications in the literature showing that female patients after spinal surgery are clinically worse than male patients. However, the number of studies conducted on the geriatric population is limited. Moreover, studies comparing the differences between the genders of geriatric patients are rare. This study evaluated the clinical outcomes of LMD in patients aged  $\geq 65$  years and analyzed whether there are differences between the clinical outcomes of both genders.

## 2. Materials and methods

### 2.1. Study design

Patients aged  $\geq 65$  years who underwent LMD by a single surgeon in a single center between April 2015 and May 2019 were

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retrospectively analyzed. All data were collected from patient files. All patients were diagnosed with LDH using preoperative lumbar MRI (Figure 1). The surgical technique was preoperatively explained in detail and informed consent of the patients was obtained. This retrospective study was approved by the Ethics Committee of the Istanbul Rumeli University (Approval No: 2588, dated 18/12/2019).

## 2.2. Inclusion and exclusion criteria

The study included geriatric patients aged  $\geq 65$  years who were diagnosed with single or multiple LDHs, leg pain, or a neurological deficit that was unresponsive to medical treatment for the last 6 months, whose informed consent was obtained and who underwent LMD.

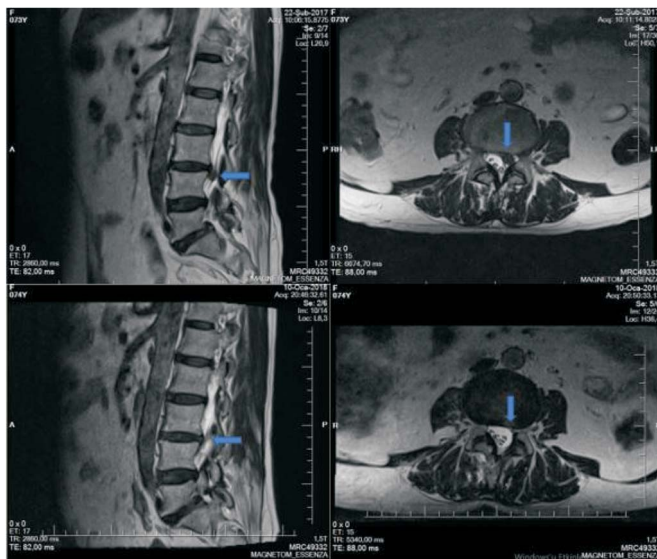
Patients aged  $< 65$  years with spondylolisthesis, spinal fracture, spine tumors, severe scoliosis with a Cobb's angle of  $> 40^\circ$ , or spinal and disc infections other than LDH at the surgical site during the preoperative period were excluded from the study.

## 2.3. Surgical technique

The surgeries were performed by a single neurosurgeon under a microscope at a single center. All patients were administered preoperative antibiotic prophylaxis. The preferred surgical technique was LMD. The operations were performed under general or spinal anesthesia with the patients in the prone position. The operation level was determined using C-arm fluoroscopy. An incision of 1.5–3 cm was made for a single level depending on the amount of adipose tissue and the distance between the lamina and skin surface. The interlaminar approach was preferred and a conventional procedure consisting of hemilaminectomy and microdiscectomy, followed by foraminotomy was performed. After the nerve root was released and hemostasis was secured, the tissues were closed according to anatomy using absorbable sutures and the skin was closed using sterile strips. We did not use non-absorbable sutures that require removal later.

## 2.4. Evaluation criteria

The postoperative clinical outcomes of all the patients were



**Figure 1.** Preoperative sagittal and axial lumbar MRI images (upper figures) and early postoperative sagittal and axial lumbar MRI images (lower figures) of a 73-year-old female patient. Appearance of extruded disc fragment before and after LMD (blue arrows).

divided in 4 categories according to the modified Macnab criteria. The visual analog scale (VAS) and Oswestry Disability Index (ODI) scores of all patients were preoperatively and postoperatively (10<sup>th</sup> day, 1<sup>st</sup> month, and 6<sup>th</sup> month) recorded.

## 2.5. Statistical analysis

This study examined the preoperative and postoperative (10<sup>th</sup> day, 1<sup>st</sup> month, and 6<sup>th</sup> month) VAS and ODI values and the differences in these values according to gender. The data were analyzed using statistical and visual analyses. Repeated measures analysis of variance (ANOVA) was used to analyze the changes in VAS and ODI scores over time. Statistical analysis was performed using statistical package for the social sciences (SPSS) version 22.0 software. A p-value of  $< 0.05$  was considered statistically significant.

## 3. Results

### 3.1. Patients' characteristics

Surgery was performed on a total of 60 geriatric patients and 71 vertebra levels; 24 patients were male and 36 were female (2:3). The ages of the patients were in the range of 65–88 years ( $72.22 \pm 6.06$  years) and there was no significant difference between male and female patients ( $71.67 \pm 6.90$  and  $72.58 \pm 5.50$  years, respectively). All patients had at least one neurological deficit (progressive muscle weakness, hypoesthesia, decrease in deep tendon reflex) or leg pain unresponsive to nonsurgical treatment for 6 weeks preoperatively.

Of the 71 LDH levels treated with LMD, 4 (5.63%) were L1-2, 6 (8.45%) were L2-3, 15 (21.13%) were L3-4, 33 (46.48%) were L4-5, and 13 (18.31%) were L5-S1 (Table 1). Regarding the levels, 50 (83.33%) were single-level, 9 (15.00%) were two-level and 1 (1.67%) was three-level. A total of 31 (43.66%), 35 (49.30%), and five (7.04%) patients underwent surgery for left, right, and bilateral LDH, respectively. The mean time interval between entering and leaving the operating room was calculated to be  $172.83 \pm 37.19$  min. The mean length of hospital stay was  $1643.18 \pm 647.05$  min ( $1.14 \pm 0.45$  days).

### 3.2. Postoperative health status analysis

The preoperative and 6<sup>th</sup>-month postoperative VAS scores of male patients were  $9.00 \pm 0.59$  and  $1.80 \pm 0.45$ , respectively; whereas, the preoperative and 6<sup>th</sup>-month postoperative ODI (%) scores were  $85.42 \pm 5.85$  and  $16.40 \pm 4.98$ , respectively ( $p < 0.001$ ). Preoperative and 6<sup>th</sup>-month postoperative VAS scores of female patients were  $9.03 \pm 0.56$  and  $2.00 \pm 1.27$ , respectively; whereas, the preoperative and 6<sup>th</sup>-month postoperative ODI (%) scores were

**Table 1**  
Demographic data of the patients and levels operated on.

Total number of patients (n)	60
Number of male patients	24
Number of female patients	36
Mean age of the study population (65–88 years)	$72.22 \pm 6.06$
Mean age of male patients	$71.67 \pm 6.90$
Mean age of female patients	$72.58 \pm 5.50$
Levels operated n (%)	
L1-2	4 (5.63%)
L2-3	6 (8.45%)
L3-4	15 (21.13%)
L4-5	33 (46.48%)
L5-S1	13 (18.31%)

85.94 ± 6.49 and 20.60 ± 12.55, respectively (p < 0.001). No statistically significant difference was observed in the VAS and ODI (%) scores of the two genders.

According to the modified Macnab criteria, the 6-month LMD outcomes of geriatric patients were excellent in 73.33% (n = 44), good in 18.33% (n = 11), fair in 6.67% (n = 4), and poor in 1.67% (n = 1). The outcome was successful in 91.66% of the geriatric group. According to these criteria, the outcome was successful for 95.83% of males and 88.89% of females. Although the success rate was slightly higher in men, there was no significant difference between the genders.

Table 2 shows the independent-samples t-test results for the comparison of VAS and ODI preoperative and postoperative values by gender. Analysis showed no significant difference between preoperative and postoperative measurements in VAS and ODI values (p < 0.05).

Figure 2 shows the visual analysis of the changes in VAS values for each gender. The graph shows that there was a decrease in VAS values until the 1<sup>st</sup> postoperative month; subsequently, the values became stable.

As a result of the variance analysis, a significant difference was observed in preoperative and postoperative VAS scores ( $F_{(3,42)} = 339.167$ , p < 0.01, partial  $\eta^2 = 0.96$ ); however, there was no significant difference in the scores of the two genders ( $F_{(3,42)} = 0.429$ , p > 0.05, partial  $\eta^2 = 0.03$ ). While there is a significant difference between preoperative and postoperative results, this difference did not change according to gender. Intergroup comparisons were examined with Bonferroni corrections and the analysis showed a significant difference between the preoperative and postoperative (10<sup>th</sup> day and 1<sup>st</sup>-month) VAS scores; however, no significant difference was observed between these and the postoperative 6<sup>th</sup>-month score. In other words, VAS scores were stable after the 1<sup>st</sup>-month postoperatively.

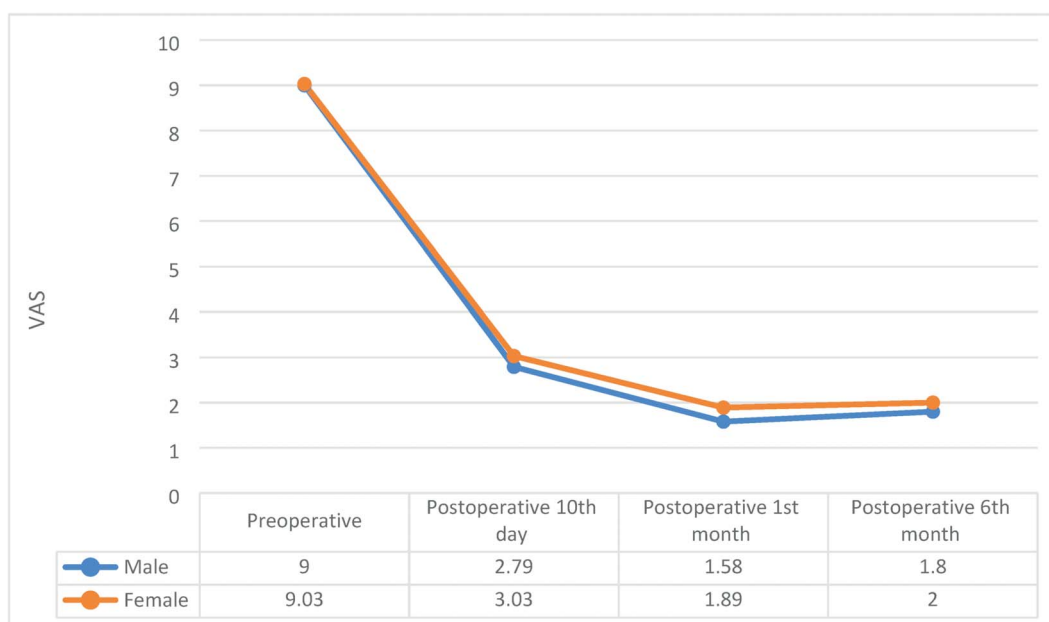
Figure 3 shows a visual analysis of the changes in ODI scores of each gender. The graph shows that there was a decrease in ODI (%) until the 1<sup>st</sup> postoperative month; subsequently, the values became stable.

As a result of the variance analysis, a significant difference was observed in preoperative and postoperative ODI (%) scores ( $F_{(3,39)} =$

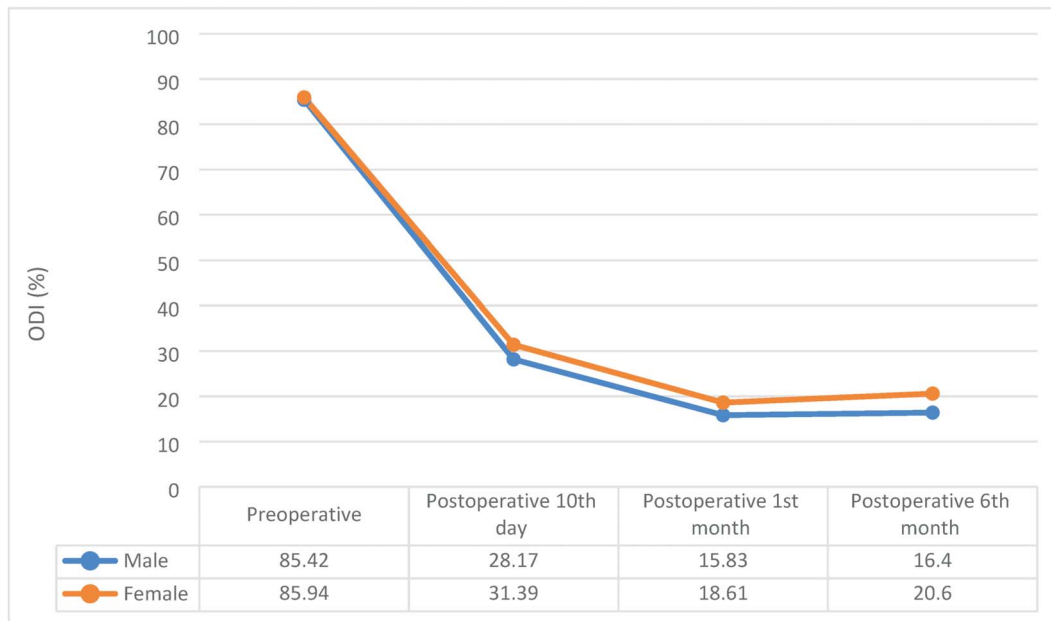
283.811, p < 0.01, partial  $\eta^2 = 0.97$ ), but there was no significant difference between the scores of the two genders ( $F_{(3,39)} = 0.881$ , p > 0.05, partial  $\eta^2 = 0.06$ ). In other words, while there is a significant difference between preoperative and postoperative results, this difference does not change according to gender. Intergroup comparisons were examined with Bonferroni corrections to determine the point of difference between the scores. The analysis showed that there was a significant difference between preoperative and postoperative 10<sup>th</sup> day and between preoperative and postoperative 1<sup>st</sup> month ODI (%); whereas, no significant difference was observed between these scores and that of the 6<sup>th</sup>-month postoperative score. A significant decrease was observed in the preoperative

**Table 2**  
Independent-samples t-test results for the comparison of VAS and ODI preoperative and postoperative values by gender.

Male (n): 24 Female (n): 36	Mean	SD	t	p
Preoperative VAS				
Male	9.00	.59		
Female	9.03	.56		
Postoperative VAS 10th day				
Male	2.79	1.10		
Female	3.03	1.52		
Postoperative VAS 1st month				
Male	1.58	.65		
Female	1.89	1.28		
Postoperative VAS 6th month				
Male	1.80	.45		
Female	2.00	1.27		
Preoperative ODI (%)				
Male	85.42	5.85		
Female	85.94	6.49		
Postoperative ODI(%) 10th day				
Male	28.17	12.27		
Female	31.39	14.81		
Postoperative ODI (%) 1st month				
Male	15.83	8.04		
Female	18.61	13.27		
Post ODI (%) 6th month				
Male	16.40	4.98		
Female	20.60	12.55		



**Figure 2.** Mean preoperative and postoperative VAS scores by gender.



**Figure 3.** Mean preoperative and postoperative ODI (%) scores by gender.

ODI (%) until the 1<sup>st</sup> month postoperatively, whereas ODI (%) became stable after that.

**3.3. Complications**

Of the 60 geriatric patients undergoing LMD, one (1.67%) developed recurrent LDH, one (1.67%) developed a postoperative spinal infection, and one (1.67%) developed (cerebrospinal fluid) CSF leakage and a dural defect. The complication rate was 5.00% and no surgery-related death occurred (Table 3).

The patient who developed recurrent LDH was a 73-year-old male patient in whom LDH was detected during a follow-up check two years postoperatively. The patient had no neurological deficiency. There was only left leg pain. For this reason, medical treatment was applied for 6 weeks and bed rest was recommended. At the end of this period, his complaints passed and therefore no surgical intervention was made. The patient with CSF leakage and dural defect was a 77-year-old female patient. During surgery, muscle and adipose tissues were used to repair the dural defect and no further surgical intervention was required. No CSF collection was observed. The patient who developed a spinal infection was a 68-year-old female. No growth was observed in the two wound cultures performed; however, the discharge stopped with two months of antibiotic treatment.

**4. Discussion**

Neurosurgeons encounter older patients more frequently, particularly for LDH surgery, because of the increasing average life expectancy that exceeds 80 years throughout the world. An article published in 2016 reported the results of minimally invasive surgery performed in the lumbar region of 26 elderly patients, 12 males, and 14 females aged 65–86 years (mean age, 72 years). The surgery was most frequently performed at the L4-5 level (40.7%). The length of hospital stay was reported to be 1.65 days. The authors reported that the clinical outcomes of such surgical procedures were successful in patients aged ≥ 65 years.<sup>5</sup> The mean age and age ranges, spinal level at which surgery was most frequently performed, length of hospital stay, and success rate of outcomes of this study were

**Table 3**

Distribution of complications in geriatric patients undergoing LMD.

Complications	Number of patients (n)	Rate (%)
Recurrent LDH	1	1.67
CSF leakage and dura defect	1	1.67
Spinal infection	1	1.67
Total	3	5.00

similar to our study. However, our study differed in that the total number of patients and the ratio of female patients to male patients were higher.

In another study published in 2019, 16 patients (7 male and 9 female) (mean age, 71.00 ± 6.24 years) underwent cementoplasty and percutaneous lumbar discectomy. The rate of excellent and good outcomes according to the Macnab criteria in the 6<sup>th</sup> postoperative month was 87.5%.<sup>6</sup> The follow-up duration and mean age in this study were very similar to our study. The outcomes of our study were slightly enhanced according to the Macnab criteria, but the values were very similar.

A study published in 2016, reported the preoperative and postoperative VAS and ODI scores of 68 patients aged ≥ 65 years (mean age, 71.46 ± 3.87 years) who underwent LMD; a significant improvement was reported in VAS and ODI scores in the 6<sup>th</sup> month postoperatively.<sup>7</sup> These findings were similar to the present study.

A recent study (2019) included a total of 65 patients aged ≥ 65 years who underwent transforaminal endoscopic surgery for lateral recess stenosis. Dyesthesia developed in the nerve root dermatome as a complication in two patients. The complication rate was reported to be 3.1%.<sup>8</sup> Another study reported the complications of endoscopic spinal surgery that was performed for 53 geriatric patients (mean age, 76 ± 4 years). Five patients (9.4%) developed recurrent disc herniation and one patient (1.9%) developed hematoma causing motor weakness. The overall complication rate was 11.3%.<sup>9</sup> Notably, different complications develop at different rates in minimally invasive spinal surgeries other than LMD, which are endoscopically performed. In the present study, the complication rate was 5%, which was consistent with the complication rates of other studies.

In a study of 367 patients aged > 65 years who underwent

lumbar spinal stenosis surgery, no difference was observed between the groups in terms of surgical parameters including complications. However, gender difference was identified as a factor affecting the satisfaction rate, which was not associated with surgical intervention; female patients were found to be less satisfied with the operation.<sup>10</sup> In the present study, positive results were obtained for the VAS and ODI scores; however, there were no significant differences between the genders in terms of the clinical results. The number of studies comparing the genders in minimally invasive spinal surgeries, particularly LMD, in the geriatric population is limited. Further studies discussing these outcomes are required.

In a study published in 2019, LMD was compared as the length of hospital stay in patients receiving general anesthesia and spinal anesthesia. The average length of hospital stay was about 1.5 days and 1 day, respectively.<sup>11</sup> In another study with an average age of 52, LMD was applied to a total of 271 LDH patients. The hospital stay was found to be 1.14 days.<sup>12</sup> In our study, the hospital stay was  $1.14 \pm 0.45$  days. Similar results were obtained in terms of length of hospital stay with these two studies.

Regarding the time taken for surgery, a study of minimally invasive lumbar decompression reported the outcomes of 244 elderly patients with a (mean age,  $83.1 \pm 3$  years). The mean operation time was  $89.7 \pm 34.7$  min.<sup>13</sup> In the present study, the total time spent in the operating room, including that taken for anesthesia, positioning, and awakening was measured rather than only the operation time; it was  $172.83 \pm 37.19$  min. If we assume that approximately half of the time spent in the operating room was the operation time, similar results would be achieved. However, we could not make a one-to-one comparison because there are no studies on the geriatric population that have reported the total time spent in the operating room.

In a study published in 2016, 61 patients > 75 years and 69 patients < 45 years were compared in terms of minimally invasive spinal surgery performed for spinal stenosis or LDH. The mortality rate, complications, and revision surgery rates were analyzed. No complications or deaths were reported in either group and a significant improvement was found in both groups. The only difference between the groups was in the surgical revision rate. The study advocated that minimally invasive decompressive surgery is safe and effective method for the treatment of elderly patients. It has been further reported that the risk of complications does not increase.<sup>14</sup>

It is stated that lumbar discectomy performed after 6th month may be associated with worse clinical results in patients without neurological deficits.<sup>15</sup> In another study, the authors stressed that this waiting period should be 14–22 weeks.<sup>16</sup> We preferred to follow patients without neurological deficits for 6 weeks without surgery.

According to an article in 2018, the authors compared genders for all age groups in response to the information that female patients were worse than male patients after spinal surgery. In this study, although women reported more severe symptoms, the degree of improvement was not different from men.<sup>17</sup> In our study, the geriatric age group was studied and in the long term, there was no statistically significant difference between the VAS and ODI scores between the two genders.

In an article published in 2017, recurrent LDH rate after LMD was found to be 4.5%. In our study, this rate is 1.67%.<sup>18</sup> However, since our study is only for the geriatric age group, our follow-up time is shorter. Successful results in patients undergoing LMD are also related to surgeons' experience.

In an article published in 2019, the safety and effectiveness of short-stay elective degenerative lumbar spine surgery in geriatric patients over 65 years of age was investigated. There was no significant difference in the elderly in terms of clinical and complica-

tions. Hospital stay and operation time were longer.<sup>19</sup> We think that the age group in our study gave similar results with patients over 65 years old in this article. Although the elderly population was included in our study, the complication rates were not very different from those that have been reported.

In this study, we have discussed the postoperative outcomes for patients aged  $\geq 65$  years who underwent LMD for LDH considering the available literature. People over the age of 65 have been identified as 'elderly' by the World Health Organization (WHO).<sup>20</sup> This definition was adopted in Turkey. That's why we chose the cutoff of 65 years. This allowed us to look at the better defined older adult group.

Our results and complication rates are compatible with those of previous studies. The number of studies presenting the clinical outcomes of LMD in the geriatric patient population and those comparing clinical outcomes between genders are limited. Similarly, the total time spent in the operating room for geriatric patients has not been previously studied.

## 5. Conclusions

LMD is an effective treatment method for geriatric patients with LDH. No significant difference was observed between the two genders in terms of clinical outcomes in this age group. Lumbar microdiscectomy remains to be the gold standard because the length of hospital stay time taken in the operating room are short, clinically successful outcomes can be achieved, and the complication rates are low.

## Conflicts of interest

All authors declare no potential financial and non-financial conflicts of interest.

## References

1. Singh R, Zeng Xin G, Hirachan MP, et al. Outcome of percutaneous transforaminal endoscopic lumbar surgery in > 60-year-old patients with low back pain. *Asian Spine J.* 2018;12:511–517.
2. Silvers HR, Lewis PJ, Asch HL, et al. Lumbar microdiscectomy in the elderly patient. *Br J Neurosurg.* 1997;11:16–24.
3. Zhu Y, Zhao Y, Fan G, et al. Comparison of the effects of local anesthesia and epidural anesthesia for percutaneous transforaminal endoscopic discectomy in elderly patients over 65 years old. *Int J Surg.* 2017;48:260–263.
4. Gelalis ID, Papanastasiou EI, Pakos EE, et al. Clinical outcomes after lumbar spine microdiscectomy: a 5-year follow-up prospective study in 100 patients. *Eur J Orthop Surg Traumatol.* 2019;29:321–327.
5. Avila MJ, Walter CM, Baaj AA. Outcomes and complications of minimally invasive surgery of the lumbar spine in the elderly. *Cureus.* 2016;8:e519.
6. Tian QH, Liu ZJ, Liu HF, et al. Safety and efficacy of percutaneous lumbar discectomy and percutaneous disc cementoplasty for painful lumbar disc herniation in patients over 60 years. *J Vasc Interv Radiol.* 2019;30:894–899.
7. Yeo CG, Jeon I, Kim SW, et al. Three-years outcome of microdiscectomy via paramedian approach for lumbar foraminal or extraforaminal disc herniations in elderly patients over 65 years old. *Korean J Spine.* 2016; 13:107–113.
8. Kapetanakis S, Gkantsinikoudis N, Thomaidis T, et al. The role of percutaneous transforaminal endoscopic surgery in lateral recess stenosis in elderly patients. *Asian Spine J.* 2019;13:638–647.
9. Kim JH, Kim HS, Kapoor A, et al. Feasibility of full endoscopic spine surgery in patients over the age of 70 years with degenerative lumbar spine disease. *Neurospine.* 2018;15:131–137.
10. Shabat S, Folman Y, Arinzon Z, et al. Gender differences as an influence on patients' satisfaction rates in spinal surgery of elderly patients. *Eur Spine J.* 2005;14:1027–1032.

11. Kilic ET, Naderi S. Effects of anesthesia protocol on perioperative outcomes and costs of lumbar microdiscectomies. *Turk Neurosurg.* 2019;29:843–850.
12. Ozger O, Kaplan N. Evaluation of clinical outcomes of 271 patients undergoing lumbar microdiscectomy in the light of literature. *Ann Med Res.* 2020;27:664–669.
13. Gerhardt J, Bette S, Janssen I, et al. Is eighty the new sixty? Outcomes and complications after lumbar decompression surgery in elderly patients over 80 years of age. *World Neurosurg.* 2018;112:e555–e560.
14. Khashan M, Lidar Z, Salame K, et al. Minimally invasive spinal decompression in patients older than 75 years of age: perioperative risks, complications, and clinical outcomes compared with patients younger than 45 years of age. *World Neurosurg.* 2016;89:337–342.
15. Siccoli A, Staartjes VE, de Wispelaere MP, et al. Association of time to surgery with leg pain after lumbar discectomy: is delayed surgery detrimental? *J Neurosurg Spine.* 2019;32:160–167.
16. Siccoli A, de Wispelaere MP, Schröder ML, et al. Timing of surgery in tubular microdiscectomy for lumbar disc herniation and its effect on functional impairment outcomes. *Neurospine.* 2020;17:204–212.
17. Siccoli A, Staartjes VE, de Wispelaere MP, et al. Gender differences in degenerative spine surgery: do female patients really fare worse? *Eur Spine J.* 2018;27:2427–2435.
18. Staartjes VE, de Wispelaere MP, Miedema J, et al. Recurrent lumbar disc herniation after tubular microdiscectomy: analysis of learning curve progression. *World Neurosurg.* 2017;107:28–34.
19. Siccoli A, Staartjes VE, de Wispelaere MP, et al. Is elective degenerative lumbar spine surgery in older adults safe in a short-stay clinic? Data from an institutional registry. *Eur Geriatr Med.* 2019;10:79–88.
20. Macchini M, Chiaravalli M, Zanon S, et al. Chemotherapy in elderly patients with pancreatic cancer: efficacy, feasibility and future perspectives. *Cancer Treat Rev.* 2019;72:1–6.