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Original Research Article

Association between Postoperative Low Back Pain and Change in Multifidus Muscle Mass of Patients undergoing Elective Single-Level Unilateral Lumbar Microdiscectomy: A Single-Centre Prospective Study

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Abstract: ***Objective:*** To assess the change in postoperative multifidus muscle mass (MMM) and its impact on postoperative low back pain (LBP) and disability .***Study Design:*** Prospective observational cohort study. Study Setting and Duration: Aga Khan University Hospital, Karachi from November 2023 to September 2025. ***Methodology:*** In this prospective study of twenty patients undergoing elective single-level unilateral microdiscectomy, LBP and disability were measured using the Numeric Rating Scale (NRS) for pain and Oswestry Disability Index (ODI) preoperatively, and one day and one month after surgery. MMM, measured via ultrasound, was assessed before surgery and at four weeks after surgery. Associations between changes in muscle mass and clinical outcomes were analysed using paired t-tests and Pearson's correlation**.** ***Results:*** Mean NRS scores significantly decreased one month postoperatively (from 5.10 ± 1.76 to 0.33 (IQR=2), $p < 0.001$), as did ODI scores (from 46.96 ± 16.74% to 17.89 (IQR=19.08) %, $p < 0.001$). The mean percentage change in ipsilateral multifidus CSA was +4.10 ± 33.38%. Significant association was found between percentage change in mean ipsilateral CSA and one-month ODI scores (Spearman's ρ = 0.573, p = 0.008). However, there was no significant correlation percentage change in muscle NRS (r = 0.198, p = 0.403) or ODI scores (Spearman's ρ = 0.397, p = 0.083. ***Conclusion:*** Unilateral lumbar microdiscectomy was associated with reduced postoperative LBP and disability, reflected in decreased NRS and ODI scores. Changes in multifidus muscle mass measured by ultrasound showed a significant association with postoperative disability but not with LBP. The slight postoperative increase in muscle size may reflect oedema or fatty infiltration rather than true recovery.

Keywords: Lumbar Vertebrae; Intervertebral Disc; Low Back Pain; Ultrasonography; Diskectomy

INTRODUCTION

Low back pain (LBP) is a common musculoskeletal condition affecting approximately 70% to 85% of the individuals worldwide (1). It is largely related to the stability of the back provided by anatomical musculature, especially the paraspinal muscles. Of the paraspinal muscle group, the multifidus muscle plays a significant role in spine stability (2,3).

Microdiscectomy is a standard surgical intervention for lumbar disc herniation that relieves nerve compression and improves overall function(4,5). However, spine surgery can damage these muscle groups due to long incisions, muscle detachment, and prolonged retraction that causes denervation and ischemia of paraspinal muscles (4,5). Thus, postoperative patients have been shown to have functionally abnormal paraspinal muscles due to denervation, scar remodelling and healing (4). These changes may contribute to spinal instability, delayed recovery, and 'failed back syndrome' (FBS) (4), which is defined as chronic back pain following spinal surgery (6). The lumbar multifidus has a large cross-sectional area (CSA) and shorter fibres compared to other lumbar muscles (7,8). Hence, it is vulnerable to such damage, which may cause instability manifesting as back pain, especially in earlier stages. Some imaging techniques have highlighted the atrophy of the multifidus muscles in patients with LBP (9). Sihvonen et al. reported that paraspinal muscle atrophy is more widespread in patients experiencing persistent post-surgical LBP and in patients with failed back surgery and attributed it to the disuse of paraspinal muscles. Surprisingly, paraspinal muscle atrophy was also found beyond the level of surgery (4). Moreover, a study by Liu et al. highlighted that fatty infiltration in multifidus muscles yields poor outcomes (10). Comparing two imaging modalities (ultrasound versus magnetic resonance imaging (MRI)) for measuring the CSA of the lumbar multifidus, they found no discrepancy between them (11). Although multifidus atrophy is a recognized outcome of spinal surgery, the relation between its loss and postoperative back pain is still underexplored. We hypothesized that postoperative back pain can be correlated with a reduction in multifidus muscle mass (MMM), and hence unsatisfactory patient outcomes. This study aims to assess the change in postoperative MMM and its impact on postoperative back pain measured using the Numeric Rating Scale (NRS) and Oswestry Disability Index (ODI).

Materials and Methods

Ethical Statement: This study was conducted in compliance with the principles of the Declaration of Helsinki. Ethical approval for the study was obtained from institutional ethics review committee (ERC#2023-8749-26259). For all patients, written informed consent in English or the local language was obtained prior to inclusion. The study followed the guidelines specified by Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) for cohort studies (12).

We prospectively conducted an observational study from November 2023 to September 2025 by enrolling a cohort of consenting adult patients using non-probability convenience sampling, set to undergo elective single-level unilateral microdiscectomy of the lumbar spine at our hospital. Patients were excluded if they had a history of conditions affecting the spine (trauma, tuberculosis, congenital deformity, malignant tumour, infection, prior surgery) or significant neurological disorders (cerebrovascular accident, myelopathy, neurodegeneration).
An initial sample size of 30 was targeted, anticipating 25% attrition. This targeted 80% power to detect ≥30% change in mean muscle mass and pain scores (13,14) with a ≤40% coefficient of variation at a two-sided 5% significance level. Sample size was calculated using $n = 8(CV^2 [1+(1–PC)^2]) / (PC)^2$. Final analysis included 20 patients, with 8 lost to follow-up.

Every patient underwent a preoperative ultrasound to document the ipsilateral and contralateral MMM CSA (cm^2) at the operated level by 2 radiologists blinded to measured patient characteristics. Data, including demographics, self-reported back pain and functional disability, were collected just prior to surgery using a structured proforma. Patients were followed up 30 days postoperatively to measure multifidus muscle mass via ultrasound. Pain and disability were reassessed one day and 30 days following surgery via a phone call or in person at the time of ultrasound. The Numeric Rating Scale (NRS) (15) and Oswestry Disability Index (ODI) (16) were used to measure pain and pain-related disability, respectively. NRS rates pain from 0 (no pain) to 10 (worst pain), using the mean of current, best, and worst pain scores over 24 hours (15). ODI is a 10-item patient-reported questionnaire scored 0–5, measuring disability resulting from pain (16). An ODI score of ≥20, or an NRS score ≥3, was considered significant back pain.

Statistical analysis was conducted using SPSS Inc. Version 27.0. Continuous variables are assessed for normality using the Shapiro-Wilk test. Normally distributed variables are expressed as mean ± standard deviation, while non-normally distributed variables are reported as median with interquartile range (IQR). Categorical variables are expressed as frequencies and percentages.

For comparisons of preoperative and postoperative CSA, paired t-tests were used for

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normally distributed variables, and Wilcoxon signed-rank test was applied when normality was not met. Changes in NRS and ODI scores across the three timepoints (preoperative, immediate postoperative day one, and one-month postoperative) were analyzed using paired t-tests or Wilcoxon tests based on distribution characteristics.

The percentage change in ipsilateral muscle CSA from preoperative to postoperative was calculated for each patient. Spearman's rank correlation assessed associations with one-month postoperative NRS and ODI scores. A p-value of <0.05 was considered statistically significant.

RESULTS

Out of a total of 28 patients recruited, 8 (28.6%) were lost to follow-up, leaving 20 patients for final analysis. Patient characteristics are summarized in Table I. Mean age was 37.45 ± 11.63 years, and mean body mass index (BMI) was 27.10 ± 5.98 kg/m^2. Regarding comorbidities, two patients (10%) had diabetes mellitus, two patients (10%) were smokers, and two patients (10%) had hypertension. None of the patients had a history of cerebrovascular accidents, while 14 patients (70%) had other comorbidities. In case of presenting symptoms, 3 patients (15%) reported leg pain only, 1 (5%) reported back pain only, and 14 (70%) experienced both leg and back pain. Two patients (10%) experienced painless motor symptoms.

Table I. Baseline characteristics

Measure	Value
Age (years)	37.45± 11.63
BMI[a] (kg/m^2)	27.10 ± 5.98
Comorbidities	
• Diabetes mellitus	2 (10%)
• Smoking	2 (10%)
• Hypertension (HTN)	2 (10%)
• Others	14 (70%)
Pain Type	
• Painless motor symptoms	2 (10%)
• Leg pain only	3 (15%)
• Back pain only	1 (5%)
• Leg pain and back pain	14 (70%)

a) BMI: Body Mass Index

As presented in Table II, the mean ipsilateral preoperative muscle cross-sectional area (CSA) (normally distributed) was 4.74 ± 1.28 cm² compared to the mean contralateral muscle CSA which showed a non-normal distribution (Shapiro–Wilk test, p = 0.006) and was reported as median (IQR): 4.00 (IQR=1.50) cm².

Wilcoxon signed-rank test revealed no significant difference between the muscles of the two sides (Z = –0.224, p = 0.823). One month after the surgical intervention, the mean ipsilateral CSA measured 4.78 ± 1.46 cm² versus 4.82 ± 1.59 cm² on the contralateral side. The paired sample t-test indicated no significant difference between them (t (19) = –0.210, p = 0.836). Across all patients, the mean percentage increase in ipsilateral CSA was calculated to be +4.10 ± 33.38%.

Table II. Muscle Cross-Sectional Area

Comparison	Mean ± SD[a] (cm²) Ipsilateral CSA[b]	Mean ± SD / Median (IQR[c]) (cm²) Contralateral CSA	t(df) / Z	p
Preoperative	4.74 ± 1.28	4.00 (IQR=1.50)	-0.224	0.823 ns
Postoperative	4.78 ± 1.46	4.82 ± 1.59	-0.210 (19)	0.836 ns
% Change in Ipsilateral CSA	+ 4.10 ± 33.38 %		—	—

a) SD: Standard Deviation
b) CSA: Cross-Sectional Area
c) IQR: Interquartile Range

Pain intensity (NRS) declined significantly over time (Table III). Preoperative and one day NRS scores were normally distributed so were reported as mean ± SD and paired sample t-test was used for comparison. NRS score decreased from 5.10 ± 1.76 preoperatively to 3.08 ± 2.15 on day one (t(19)=3.938, p<0.001). Because one-month postoperative NRS scores were not normally distributed (Shapiro–Wilk test, p < 0.001), these

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values were reported as median (IQR), and Wilcoxon test was used for such comparisons. The mean NRS score at one month was 0.33 (IQR=2) and was compared with preoperative score (Z= -3.703, p<0.001) and day-one score (Z= 3.101, p=0.002).

Functional disability (ODI) also improved significantly over time. Preoperative and one day ODI values were normally distributed and were presented as mean ± SD and paired sample t-test was used. ODI decreased from 46.96 ± 16.74% preoperatively to 31.16 ± 18.16% at day one (t(19)=4.020, p<0.001). Because one-month postoperative ODI values were not normal (Shapiro–Wilk test, p = 0.010), they are reported as median (IQR) and Wilcoxon test was applied. The median ODI at one month was 17.89 (IQR=19.08) % and was compared with preoperative scores (Z=3.696, p<0.001) and day one scores (Z=2.315, p=0.021).

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d) SD: Standard Deviation
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f) IQR: Interquartile Range

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Table III. Pain and Disability over Time

Outcome	Preop	Day One Postop	One Month Postop	Paired Comparisons [t(df), p] / (Z, p)
NRS[a] Pain Score	5.10 ± 1.76	3.08 ± 2.15	0.33 (IQR[c]=2)	Preop vs Day 1 Postop: 3.9 (19), <.001 Preop vs 1 Month Postop: -3.7, <.001 Day 1 vs 1 Month Postop: 3.1, .002
ODI[b] (%)	46.96 ± 16.74	31.16 ± 18.16	17.89 (IQR=19.08)	Pre vs Day 1 Postop: 4.0 (19), <.001 Pre vs 1 Month Postop: 3.7, <.001 Day 1 vs 1 Month Postop: 2.3, .021

a) Numeric Rating Scale for pain
b) Oswestry Disability Index
c) Interquartile Range

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The correlation analysis showed a significant association between percentage change in mean ipsilateral CSA and one-month ODI scores (Spearman’s $\rho = 0.573$, $p = 0.008$, $n = 20$), indicating that more increase in CSA was associated with higher levels of postoperative disability. However, the association between the percentage change in mean ipsilateral CSA and one-month NRS scores was not statistically significant (Spearman’s $\rho = 0.397$, $p = 0.083$, $n = 20$).

DISCUSSION

The association between post-discectomy changes in multifidus muscle mass and morphology and postoperative lower back pain has not been thoroughly investigated to allow the establishment of definitive conclusions. In a recent systematic review and meta-analysis, Lu et al. identified only 6 studies investigating the association between back muscle CSA and postoperative pain, 3 of which specifically assessed the role of the multifidus muscle in the aforementioned association (17). Our study serves as an addition to the limited literature addressing this gap in clinical neuroscience.

Our study participants had a mean age of 37.45 years, which is consistent with the general trend of mechanical lower back pain occurring in the young to middle-aged population and was also similar to the mean ages reported by other studies investigating the association between MMM and post-discectomy pain (17,18). The average BMI of our study patients was also similar to the average BMI reported by similar prior studies (17). Our study did not find a significant difference in side-to-side MMM cross-sectional areas (CSA) pre- or postoperatively. However, our study also found a 4.10% increase in ipsilateral muscle mass postoperatively, which might explain the absence of any significant difference in side-to-side muscle mass postoperatively. This increase in size can be attributable to postoperative inflammatory changes and fat infiltration of the ipsilateral multifidus muscle, causing an artefactual increase in CSA when, in fact, the true muscle mass might have been reduced. Of the three studies specifically assessing MMM association with post-discectomy pain, one of the studies reported a slight increase in postoperative CSA, while the other two reported a slight decrease; none of these changes reached statistical significance (17).

Our study indicates that there is a significant decrease in pain intensity and functional disability following the single-level unilateral microdiscectomy. They are represented by NRS and ODI scores, respectively. The ODI scores showed a significant improvement over time, demonstrating an improvement in pain intensity and thus shorter hospital stays and better and quicker recovery of patients (19). Similarly, NRS scores showed a significant decline immediately after the surgery when compared to the preoperative levels, as well as at one month postoperatively. Our findings are also consistent with the literature, which shows that pain and disability can be reduced with lumbar discectomy, enhancing functional recovery in most patients (20).

This study is limited to a single tertiary health care centre in a developing country, limiting the generalizability of our findings to a wider population worldwide. Moreover, since different interventions are expected to be associated with different amounts of change, responsiveness characteristics for an outcome measure may not be stable across different interventions. Future research could overcome methodological weaknesses in our study by controlling confounders. Also, multifidus muscle biopsy could be performed to further analyse histological findings, check for fat infiltration and fibre-type transformation, to check CSA findings.

Conclusions

Patients undergoing single-level unilateral lumbar microdiscectomy showed significant improvements in postoperative back pain and disability. Changes in multifidus muscle CSA were significantly correlated with disability but not with back pain. The slight postoperative increase in muscle size may reflect oedema or fatty infiltration rather than true recovery.

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The authors declare no conflicts of interest.
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