Medical Journal of Bakırköy

Med J Bakirkoy 2025;21:55-61
DOI: 10.4274/BMJ.galenos.2025.2024.12-6

Research

Comparison of Post-Operative Long-Term Surgical Fibrosis in the Multifidus Muscle Between Microdiscectomy and Microendoscopic Discectomy

Mikrodiskektomi ve Mikroendoskopik Diskektomi Sonrası Multifidus Kasındaki Uzun Dönem Cerrahi Fibrozisin Karşılaştırılması

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ABSTRACT

Objective: The aim of this study is to compare long-term post-operative surgical fibrosis in the multifidus muscle between microdiscectomy (MD) and microendoscopic discectomy (MED) procedures.

Methods: The study included 70 patients with post-operative surgical fibrosis in the multifidus muscle. Various types of MED were analyzed, including percutaneous endoscopic lumbar discectomy (PELD), percutaneous endoscopic interlaminar discectomy (PEID), and unilateral biportal endoscopic discectomy (UBED). Creatine phosphokinase (CPK) and C-reactive protein (CRP) levels were measured pre-and post-operatively. Hospital stay duration and operative time were also recorded.

Results: The MD group demonstrated significantly higher post-operative CPK levels compared to the other groups ($p<0.05$). Similarly, CRP levels were highest in the MD group ($p<0.01$), while lower levels were observed in the PEID and PELD groups. The UBED group exhibited a larger cross-sectional area compared to each of the PEID and PELD groups ($p<0.01$). Additionally, the PELD group had the shortest hospital stay and operative time ($p<0.01$).

Conclusion: This study underscores significant variations in outcomes based on surgical approaches used for spinal conditions, particularly regarding post-operative fibrosis in the multifidus muscle. MD was associated with higher CPK and CRP levels, suggesting increased muscle injury and inflammatory response compared to PELD and PEID techniques.

Keywords: Surgical fibrosis, multifidus muscle, microdiscectomy, microendoscopic discectomy, creatine phosphokinase

ÖZ

Amaç: Bu çalışmanın amacı, mikrodiskektomi (MD) ve mikroendoskopik diskektomi (MED) işlemleri sonrası multifidus kasında oluşan uzun dönem cerrahi fibrozisi karşılaştırmaktır.

Gereç ve Yöntem: Çalışmaya, multifidus kasında cerrahi fibrozis gelişen 70 hasta dahil edilmiştir. MED'in farklı türleri incelenmiştir: Perkütan endoskopik lomber diskektomi (PELD), perkütan endoskopik interlaminar diskektomi (PEID) ve tek taraflı biportal endoskopik diskektomi (UBED). Kreatin fosfokinaz (CPK) ve C-reaktif protein (CRP) seviyeleri, ameliyat öncesi ve sonrası ölçülmüştür. Ayrıca, hastanede kalış süresi ve ameliyat süresi kaydedilmiştir.

Bulgular: MD grubunda ameliyat sonrası CPK seviyeleri, diğer gruplarla karşılaştırıldığında, istatistiksel olarak anlamlı derecede daha yüksek bulundu ($p<0,05$). Aynı şekilde, CRP seviyeleri de MD grubunda en yüksek düzeydeydi ($p<0,01$). PEID ve PELD gruplarında ise CRP seviyeleri daha düşüktü. UBED grubunun kesitsel alanı, PEID ve PELD gruplarına göre daha genişti ($p<0,01$). PELD grubu, en kısa hastanede kalış süresi ve operasyon süresi ile öne çıktı ($p<0,01$).

Sonuç: MD, daha yüksek CPK ve CRP seviyeleriyle ilişkili olduğu ve bu durumun ameliyat sonrası kas hasarı ve enflamatvuar yanıtın daha fazla olduğunu gösterdiği saptanmıştır.

Anahtar Kelimeler: Cerrahi fibrozis, multifidus kası, mikrodiskektomi, mikroendoskopik diskektomi, kreatin fosfokinaz

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Cite as: Bozyiğit B, Kına H. Comparison of post-operative long-term surgical fibrosis in the multifidus muscle between microdiscectomy and microendoscopic discectomy. Med J Bakirkoy. 2025;21:55-61

Received: 03.01.2025
Accepted: 11.02.2025
Publication Date: 25.03.2025

INTRODUCTION

Chronic low back pain is a major cause of disability worldwide and remains the leading non-cancerous reason for opioid prescriptions. Biomechanically, the multifidus and surrounding paraspinal muscles are vital for stabilizing the spine, ensuring correct posture, and limiting excessive vertebral movement. Various spinal disorders, such as scoliosis, spinal stenosis, and disc herniation, have been linked to paraspinal muscle fibrosis, atrophy, and fatty infiltration in clinical practice (1). The development of surgical fibrosis in the multifidus muscle during postoperative recovery is a critical factor influencing spinal stability (2). Microdiscectomy (MD) and microendoscopic discectomy (MED) are two widely used techniques for treating lumbar disc herniation, both designed to minimize tissue trauma (3). As the multifidus muscle plays a vital role in maintaining spinal balance and controlling movement, its damage during surgery can lead to significant pain and functional impairments. Postoperative fibrosis refers to the formation of scar tissue following spinal surgeries, such as MD and MED. This fibrosis results from tissue stress induced by surgical techniques, the body's inflammatory response, or surgical trauma (4). Fibrosis in the multifidus muscle can contribute to chronic pain, impaired muscle function, and decreased spinal stability (5). Postoperative fibrosis in the multifidus muscle is a recognized complication, particularly following lumbar disc surgeries such as MD and MED. However, there is limited research on the long-term effects of this fibrosis and its impact on surgical outcomes, leaving questions about the influence of these procedures on muscle tissue unanswered. For the treatment of lumbar disc herniation, interlaminar endoscopic lumbar discectomy is regarded as a less invasive alternative to microscopic lumbar discectomy. Nevertheless, studies investigating radiologic changes in the multifidus muscle following these procedures remain limited. Enhancing the volume and function of the multifidus muscle may contribute to better long-term surgical outcomes (6). This study aims to compare the long-term effects of MD and MED on the multifidus muscle, with the goal of refining surgical techniques and improving patient outcomes.

METHODS

This study was planned as a retrospective comparative analysis, involving 70 patients who underwent one of four surgical methods for lumbar disc herniation. The surgeries were performed by two experienced spine surgeons, each with over seven years of expertise in both open and endoscopic procedures. Eligible patients had disc herniation causing nerve root compression, which manifested as leg symptoms consistent with sciatica and back pain, persisting for at least six weeks despite conservative treatment. All patients underwent lumbar spine radiography, magnetic resonance imaging (MRI), and computed tomography for diagnosis.

Exclusion criteria included patients with foraminal or extraforaminal disc herniation, multilayer disc herniation, spinal stenosis, spondylolisthesis, scoliosis, prior lumbar surgery, spinal infections, tumors, or hip or knee arthritis. Demographic data (age, gender), along with laboratory markers including creatine phosphokinase (CPK) and C-reactive protein (CRP), were recorded during the first seven days post-surgery. Pain levels were evaluated on postoperative days (POD) 1, 3, 5, and 30. Additionally, the presence of fibrosis in the multifidus muscle was assessed via MRI (Figure 1). The Oswestry disability index (ODI), length of hospital stay, and surgery duration were also documented.

Ethical approval was granted by the İstinye University Human Research Ethics Committee (date: 01.08.2024, protocol no: 24-154), and all participants provided written informed consent.

Statistical Analysis

Statistical analyses were performed using SPSS (Version 22.0, IBM Corp., Armonk, NY), with data distribution normality assessed using the Shapiro-Wilk test. Descriptive statistics are presented as mean ± standard deviation or median (range) depending on the data distribution. Intergroup differences were evaluated using the Kruskal-Wallis test, and a p-value of less than 0.05 was considered statistically significant.

Surgical Procedures

Microdiscectomy

The patient was positioned prone, and a 3-cm midline incision was made. The paravertebral muscles were dissected using monopolar cautery, and the ligamentum flavum was excised during partial laminectomy and medial facetectomy under microscopic observation. The fractured disc fragment, extruded disc material, intra-annular fragments, and partial nucleus pulposus were carefully removed, preserving the endplate.

Percutaneous Endoscopic Lumbar Discectomy

This procedure was performed under local anesthesia with the patient in the prone position. A skin entry point, 10-13 cm from the midline, was identified. An 18-gauge spinal needle was inserted under fluoroscopic guidance, and

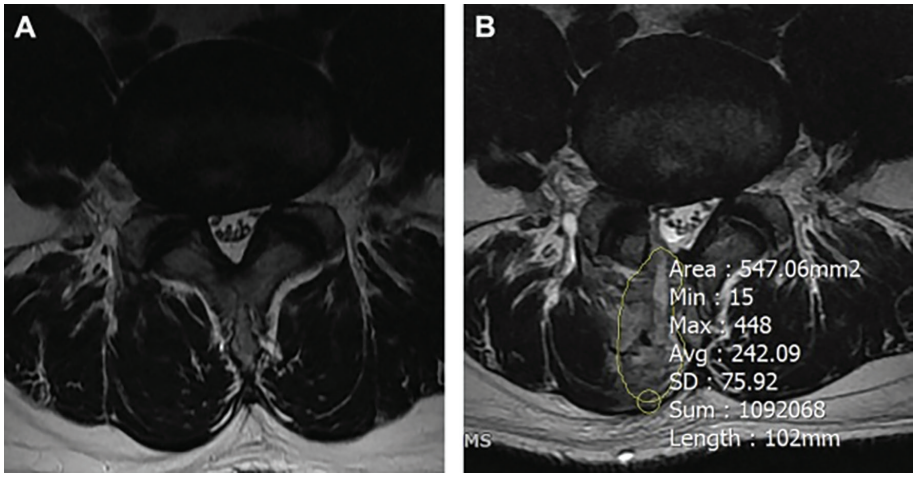

Figure 1. Comparison of the cross-sectional area (mm²) of high-intensity regions in the paraspinal muscle at the surgical site. Images from preoperative axial T2-weighted magnetic resonance imaging (MRI) (A) and postoperative MRI (B) are shown

after confirming the location of the nerve root, discography was performed using a contrast medium and indigo carmine. A guidewire was introduced, followed by a cannulated obturator, and a working cannula was inserted into the disc (7).

Percutaneous Endoscopic Interlaminar Discectomy

Under spinal anesthesia, the entry site was positioned at the lateral interlaminar space of the affected side. A small skin incision was made, and a dilator was placed into the interlaminar space. A working channel was inserted, with the final position confirmed by fluoroscopy. After the endoscope was introduced, soft tissue was cleared to expose the ligamentum flavum (8).

Unilateral Biportal Endoscopic Discectomy

Performed under epidural anesthesia, this technique involved cranial and caudal entry points placed 1 cm above and below the target lesion. The cranial site served as the primary endoscopic portal, while the caudal site was used as the functional portal. After fascia opening and muscle-splitting dissection, successive dilators were introduced, followed by insertion of an arthroscope into the endoscopic portal (9).

RESULTS

A total of 70 patients were included in the study to compare long-term post-operative surgical fibrosis in the multifidus muscle between the MD and MED techniques. Seventeen patients underwent percutaneous endoscopic interlaminar discectomy (PEID) and MD, while 18 patients underwent percutaneous endoscopic lumbar discectomy (PELD) and unilateral biportal endoscopic discectomy (UBED) (Table 1).

The mean age of the patients was 44.09 years in the MD group, compared to 42.91, 46.01, and 47.44 years in the PELD, PEID, and UBED groups, respectively. The average operation times were 56.44±15.75 minutes for PELD, 80.84±17.56 minutes for MD, 85.53±17.78 minutes for PEID, and 96.14±16.96 minutes for UBED. Hospital stays were 1.45±0.47 days for PELD, 2.87±0.66 days for PEID, 2.97±0.36 days for UBED, and 3.05±1.25 days for MD. Both operation time and hospital stay were shorter in the PELD group ($p<0.01$). In terms of high-intensity lesions (HIL), the cross-sectional area (CSA) was 97.64±109.83 mm² in the PELD group, 149.20±110.58 mm² in the PEID group, 481.16±233.39 mm² in the UBED group, and 629.94±208.67 mm² in the MD group ($p<0.01$) (Figure 1). The MD group showed the highest CSA, while the UBED group had a larger CSA than the PEID and PELD groups. ODI scores were 28.97±9.42 for MD, 30.47±9.24 for PELD, 28.57±11.66 for PEID, and 31.60±8.12 for UBED. ODI scores improved significantly by POD-30, with values of 13.95±7.05 for MD, 11.01±3.77 for PELD, 10.37±4.5 for PEID, and 10.33±5.4 for UBED, although the differences among groups were not statistically significant (Table 2).

The MD group had higher visual analog scale (VAS) scores for back pain on both POD-1 and POD-3. Specifically, VAS scores for leg pain and back pain were lowest in the PELD group at all time points ($p<0.05$) (Figure 2). CPK levels showed a pattern of increase and subsequent decrease. CPK levels peaked on POD-1 in 61 patients (88%), with the MD group showing the highest CPK-1 and CPK-3 levels ($p<0.05$). Significant differences were observed in CPK values at POD-5 and POD-7 across all groups (Figure 3). The CPK ratio was 1.67±0.55 in the MD group, compared to 1.21±0.48 in the

PELD group, 1.26±1.12 in the PEID group, and 1.34±0.55 in the UBED group (p=0.037). For CRP, significant outcomes were noted at POD-1, POD-3, POD-5, and POD-7 across all groups (Figure 4). CRP levels also peaked on POD-1 and POD-3, with the MD group exhibiting higher CRP-1, CRP-3, CRP-5, and CRP-57 levels compared to the other groups (p<0.05).

DISCUSSION

This study compared postoperative long-term surgical fibrosis in the multifidus muscle following MD and MED. A total of 70 patients with surgical fibrosis in the multifidus muscle were included, and levels of CPK and CRP were assessed both before and after surgery. The study also examined the length of hospital stays and the duration of the surgeries. The findings indicated that the MD group exhibited the highest CPK levels following surgery. MD surgery minimizes the size of skin incisions and improves visibility; however, muscle contraction and separation are still required. Minimally invasive spinal surgery procedures are becoming increasingly popular. Endoscopic surgeries provide several benefits, including minimal blood loss, reduced hospital stays, and faster recovery times (10). On the other hand, the MD group exhibited the highest CRP levels. CRP, an acute-phase protein produced by the liver, increases in response to inflammation, tissue damage, or infection. Post-surgery, CRP levels typically peak rapidly and normalize within five days. The extent of CRP elevation depends on the type and duration of the surgical procedure, with instrumented surgeries leading to higher peak levels compared to single-level decompression procedures. In the MD technique, the paraspinal muscle is detached from the lamina and facet joints using a muscle-stripping method. Excessive dissection, retraction, and muscle stripping during surgery may result in segmental instability, which contributes to severe low back pain (11).

Table 1. Operative levels

Level	MD	UBED	PELD	PEID
L1-L2	-	-	1	-
L2-L3	-	-	1	1
L3-L4	1	2	3	2
L4-L5	10	11	11	11
L5-S1	6	5	2	3
Total	17	18	18	17

MD: Microdiscectomy, UBED: Unilateral biportal endoscopic discectomy, PELD: Percutaneous endoscopic lumbar discectomy, PEID: Percutaneous endoscopic interlaminar discectomy

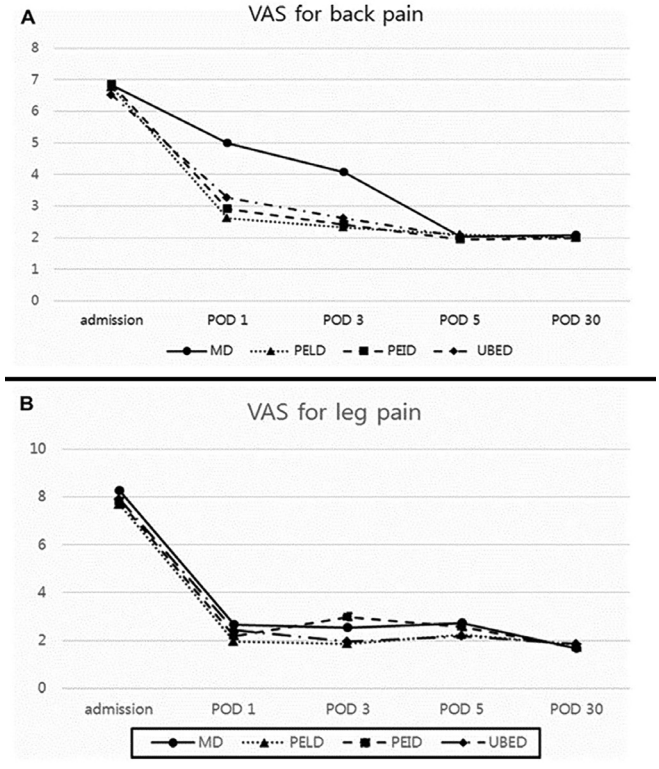

Figure 2. Variations in visual analog scale (VAS) scores among all groups: (A) for back pain and (B) for leg pain
MD: Microdiscectomy, UBED: Unilateral biportal endoscopic discectomy, PELD: Percutaneous endoscopic lumbar discectomy, PEID: Percutaneous endoscopic interlaminar discectomy

Table 2. Laboratory and clinical results of all techniques

	MD	PELD	PEID	UBED	p-value
Age	44.09 (11.34)	42.91 (6.52)	46.01 (8.92)	47.44 (12.22)	p>0.05
Sex (M:F)	6:11	11:7	6:11	8:10	p>0.05
OT, minutes	80.84 (17.56)	56.44 (15.75)	85.53 (17.78)	89.14 (18.98)	0.01
HS, days	9.05 (3.25)	4.15 (3.83)	6.47 (2.16)	6.53 (2.36)	0.02
CSA of HIL, mm^2	629.97 (208.67)	97.64 (109.83)	149.11 (110.58)	481.16 (233.37)	0.01
ODI, Adm	28.96 (9.43)	30.47 (9.24)	28.57 (11.66)	31.71 (8.14)	p>0.05
ODI, POD-30	13.95 (7.05)	11.01 (3.77)	10.37 (4.5)	10.33 (5.4)	p>0.05

MD: Microdiscectomy, PEID: Percutaneous endoscopic interlaminar discectomy, PELD: Percutaneous endoscopic lumbar discectomy, UBED: Unilateral biportal endoscopic discectomy, OT: Operation time, CSA: Cross sectional area, HIL: High intensity lesion, ODI: Oswestry disability index, POD: Postoperative days

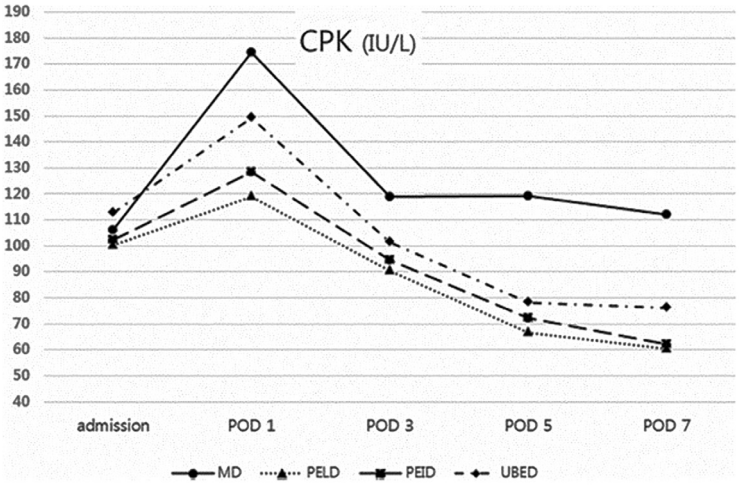

Figure 3. Fluctuations in creatine phosphokinase (CPK) levels across all study groups
MD: Microdiscectomy, UBED: Unilateral biportal endoscopic discectomy, PELD: Percutaneous endoscopic lumbar discectomy, PEID: Percutaneous endoscopic interlaminar discectomy

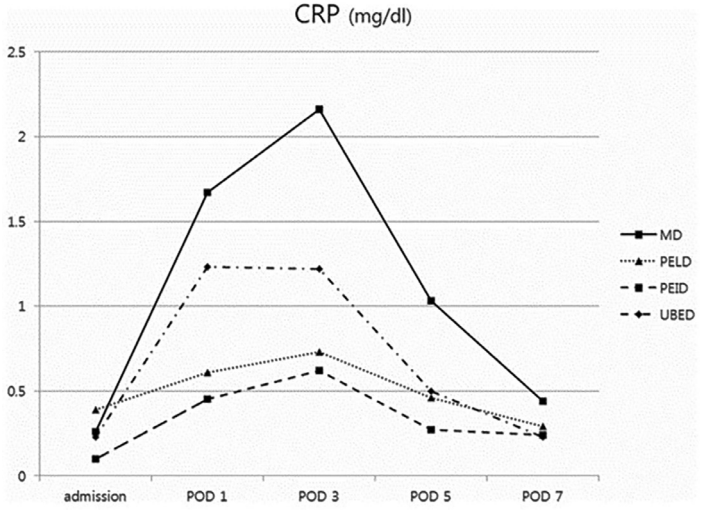

Figure 4. Alterations in C-reactive protein (CRP) levels observed in all groups
MD: Microdiscectomy, UBED: Unilateral biportal endoscopic discectomy, PELD: Percutaneous endoscopic lumbar discectomy, PEID: Percutaneous endoscopic interlaminar discectomy

In contrast, the PEID and PELD groups demonstrated significantly lower CRP levels. Among the groups, the PELD group showed the lowest CRP levels in the HIL of the paraspinal muscle, compared to UBED and MD. Full endoscopic procedures resulted in shorter hospital stays, fewer postoperative back pain, and fewer muscle injury. Similar results were observed for PEID and PELD. The UBED system, which uses two ports-one for the endoscope and one for surgical instruments-allows clear vision without the need for constant saline irrigation or muscle retraction. Surgical instruments can be used without restriction. According to our research, surgical invasiveness has an early effect on postoperative back discomfort and length of hospital stay (12). Furthermore, it was found that the UBED group had a larger CSA compared to the PEID and PELD groups. PEID and PELD employ muscle-splitting techniques using blunt obturators and successive dilators to preserve the paraspinal muscle. PEID requires partial facet joint and lamina removal, along with the cauterization of surrounding muscles and soft tissues to reach the epidural area, while PELD allows direct access to the disc fragment without the need for a barrier. The UBED technique integrates muscle-splitting and, to a lesser extent, muscle-stripping techniques (13). The comparison of postoperative long-term surgical fibrosis in the multifidus muscle following MD and MED offers significant

implications for clinical practice. The study's findings are crucial for clinical practitioners, particularly spine surgeons, as they provide valuable insights into how different surgical techniques impact the multifidus muscle. This knowledge can help guide decisions on whether to perform a MD or a MED, based on the potential effects on the multifidus muscle. These implications extend to surgical practice patterns, influencing how neurosurgeons and orthopedic surgeons approach spinal surgery. By understanding the long-term effects of these procedures on the multifidus muscle, surgeons may adjust their strategies to optimize patient outcomes. Such findings could also inform medical education programs, ensuring that practitioners are aware of the postoperative consequences of various procedures. The study also highlights the importance of patient education and informed decision-making. A thorough understanding of the long-term consequences of MD and MED on the multifidus muscle allows patients to make more informed choices regarding their treatment options. This patient-centered approach encourages active patient involvement in decision-making, helping them understand the potential risks and benefits of each surgical option.

Study Limitations

The study has two main limitations: the small sample size and the focus on long-term outcomes. Additionally, the level of CPK-MM in skeletal muscle was not measured, so it remains unclear whether the HIL observed in the paraspinal muscles reflect actual muscle damage. Follow-up MRI scans would be helpful to determine if these lesions are associated with muscle atrophy. Since the study is based on data from a specific cohort, the findings may not be applicable to other healthcare settings or populations. Further research should involve diverse cohorts to improve the generalizability of the results. The focus on fibrosis and its long-term effects on outcomes is also limited, leaving gaps in understanding how surgical procedures impact muscle tissue. Several factors may significantly influence these outcomes, but it is not feasible to address all variables within a single study.

CONCLUSION

The study found that the MD group exhibited the highest levels of CPK and CRP following surgery. These results suggest that MD surgery may have a more significant impact on muscle stress, as reflected by these biomarkers. In contrast, the PEID and PELD groups displayed lower CRP levels, indicating less inflammation. Additionally, the UBED group had a significantly larger CSA compared to the PEID and PELD groups. The PELD group also had shorter hospital stays and shorter operating times, suggesting a more efficient recovery process. While MD showed more substantial biomarker responses, PELD demonstrated the most favorable outcomes in terms of recovery time and hospital stay. Additional studies are required to validate these results and investigate the prolonged impacts of these surgical methods on muscle structure and the overall healing process.

ETHICS

Ethics Committee Approval: Ethical approval was granted by the İstinye University Human Research Ethics Committee (date: 01.08.2024, protocol no: 24-154).

Informed Consent: All participants provided written informed consent.

FOOTNOTES

Authorship Contributions

Surgical and Medical Practices: B.B., H.K., Concept: B.B., H.K., Design: B.B., H.K., Data Collection or Processing: B.B., H.K., Analysis or Interpretation: B.B., H.K., Literature Search: B.B., H.K., Writing: B.B., H.K.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declare that this study received no financial support.

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