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Functional and Radiologic Outcomes of Meniscal Repair Versus Partial Meniscectomy for Bucket-Handle Meniscal Tears: A Comparative Study

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Abstract

Background: *Bucket-handle meniscal tears are a significant type of knee problem. They can cause mechanical symptoms and lead to long-term damage. There is still debate about the best surgical treatment, which could be meniscal repair or partial meniscectomy. This study aimed to compare the functional and radiological outcomes of meniscal repair versus partial menisectomy in patients with bucket-handle meniscal tears.*

Methods: *This comparative study conducted at Bangabandhu Sheikh Mujib Medical University and National Institute of Cancer Research and Hospital, Dhaka, Bangladesh from January 2018 to June 2019, including 50 patients with bucket-handle meniscal tears. The patients were randomly assigned to either the meniscal repair group (n=25) or the partial meniscectomy group (n=25). Functional outcomes were assessed using the Lysholm and IKDC scores. Pain levels were measured with the Visual Analog Scale (VAS). MRI was used for six months after surgery to check for meniscal healing, changes in joint space, and early signs of degeneration.*

Results: *At the 6-month follow-up, the meniscal repair group showed much better functional outcomes compared to the partial meniscectomy group. The mean Lysholm scores were 88.4±6.1 for the repair group and 82.3±7.4 for the meniscectomy group (p=0.003). The IKDC scores were 84.7±5.9 in the repair group against 78.5±6.8 in the meniscectomy group (p=0.002). VAS pain scores were lower in the repair group at 1.8±0.9 compared to 2.6±1.1 in the meniscectomy group (p=0.01). Radiological results showed that 76% of repaired menisci had complete healing. Joint space narrowing occurred in 4% of the repair patients versus 24% of the meniscectomy patients (p=0.04). Early cartilage degeneration was found in 8% of the repair cases compared to 28% in the meniscectomy cases (p=0.05).*

Conclusion: *Meniscal repair shows better functional and imaging results than partial meniscectomy for bucket-handle tears after 6 months. This repair method keeps meniscal tissue, lowers the chance of early degeneration, and offers improved recovery. These factors make it the preferred treatment when it is technically possible.*

Keywords: *Meniscal repair, Bucket-handle tear, Partial meniscectomy, Functional outcomes*

I. INTRODUCTION

Meniscal injuries are among the most common problems affecting the knee joint. Bucket-handle tears are a particularly difficult type that needs quick surgery. These tears occur when the meniscal body is longitudinally disrupted, allowing the inner part to shift into the intercondylar notch. This often leads to mechanical locking and serious functional issues. Over the past decades, the approach to managing bucket-handle meniscal tears has changed significantly. There is now a greater focus on preserving the meniscus due to a better understanding of its vital biomechanical and protective roles.[1,2] The menisci have several important functions, such as distributing load, absorbing shock, stabilizing the joint, and protecting the articular cartilage. Research

shows that meniscal tissue helps to spread the load across the knee joint. Estimates indicate that removing the meniscus can raise peak contact pressures by 200-300%, which speeds up degenerative changes.[3,4] Because of this, the surgical approach has shifted from complete meniscectomy to techniques that preserve tissue, particularly meniscal repair when possible. Partial meniscectomy is still a common procedure. It offers benefits such as shorter surgery time, immediate weight-bearing, and quicker return to normal activities. This method involves arthroscopically removing the unstable part of the meniscus while keeping the stable outer rim.[5] Clinical outcomes after partial meniscectomy are usually positive in the short to medium term. Patients report significant relief from symptoms and improved function.[6] However, biomechanical research and long-term studies have raised concerns about the faster development of osteoarthritis after loss of meniscal tissue, especially in younger, active individuals. In contrast, meniscal repair aims to restore the meniscus's anatomical structure and function through various surgical techniques, including inside-out, outside-in, and all-inside methods. The success of meniscal repair depends on many factors, such as the location and age of the tear, the blood supply to the tear area, and any related ligament injuries.[7] Tears in the outer red-red or red-white zones with enough blood supply tend to heal better than those in avascular white-white zone tears.[8] Modern all-inside repair devices have made the technique easier and quicker while achieving results similar to traditional suture methods. Our study offers mixed evidence on the results of meniscal repair compared to partial meniscectomy for bucket-handle tears. Some studies show better long-term functional outcomes and less progression of osteoarthritis with repair techniques.[9] Others suggest that short-term recovery may be quicker after meniscectomy.[10] Additionally, meniscal repair has its own risks, with re-tear rates varying from 5% to 30% based on the tear type and fixation methods.[11] It also requires longer rehabilitation and carries the risk of complications related to repair devices. Given the importance of choosing the right treatment for bucket-handle meniscal tears and the ongoing discussion on the best surgical management, this comparative study was created to assess both functional and radiologic outcomes of meniscal repair versus partial meniscectomy. By using validated scoring systems for function, pain assessment tools, and objective evaluations through magnetic resonance imaging, this study aims to provide solid evidence to help guide clinical decisions for patients with bucket-handle meniscal tears.

II. METHODS

This comparative study was conducted at Bangabandhu Sheikh Mujib Medical University and National Institute of Cancer Research and Hospital, Dhaka, Bangladesh from January 2018 to June 2019. 50 diagnosed with bucket-handle meniscal tears participated. They were divided into two equal groups: meniscal repair (n=25) and partial meniscectomy (n=25). To qualify, patients had to be between 18 and 45 years old, have acute or subacute bucket-handle tears confirmed by MRI, have tears in areas suitable for repair, and have no prior surgery on the same knee. People with degenerative meniscal issues, multiple ligament injuries, severe osteoarthritis, or those unable to follow postoperative rehab protocols were excluded. All surgeries were done arthroscopically by skilled orthopedic surgeons. For the meniscal repair group, the surgeons used all-inside repair techniques with fixation devices. They adjusted the suture configurations based on the type of tear. In the partial meniscectomy group, surgeons removed the unstable bucket-handle fragment with motorized shavers and basket forceps, keeping the stable outer rim intact. Any accompanying anterior cruciate ligament injuries were treated with simultaneous reconstruction. Postoperative rehab protocols varied between the two groups. The meniscal repair group had a restricted weight-bearing plan, allowing partial weight-bearing for 4 to 6 weeks and progressive range-of-motion exercises. In contrast, the meniscectomy group could bear full weight right away and had faster rehabilitation. To measure functional outcomes, the Lysholm Knee Score and International Knee Documentation Committee (IKDC) score were used before surgery and six months after. Pain was measured with the Visual Analog Scale (VAS). A 3-Tesla MRI was done at six months to check for meniscal healing, joint space width, and early cartilage changes. Statistical analysis was conducted with SPSS version 26. Continuous variables were shown as mean ± standard deviation and compared using independent t-tests. Categorical variables were analyzed with chi-square or Fisher's exact tests where appropriate. A p-value of less than 0.05 was considered significant. Ethical approval came from the institutional review board, and informed consent was obtained from all participants.

III. RESULTS

Table 1 shows the basic sociodemographic characteristics of the study population. The meniscal repair group had an average age of 26.8±6.4 years, while the partial meniscectomy group averaged 30.2±7.1 years. Males made up the majority in both groups (84% and 88%, respectively), which reflects the common demographic pattern of sports-related meniscal injuries. The average BMI values were within the normal range for both groups (24.1±2.3 versus 25.4±2.8 kg/m²), and the distribution between rural and urban populations was balanced, ensuring the findings can be generalized. [Table 1]

Table 1: Sociodemographic Characteristics of the Study Population (N = 50)

Variable	Category	Meniscal Repair (n=25) n (%)/ Mean ± SD	Partial Meniscectomy (n=25) n (%)/ Mean ± SD
Age (years)	Mean ± SD	26.8 ± 6.4	30.2 ± 7.1
	18-30	16 (64.0%)	12 (48.0%)
	31-45	9 (36.0%)	13 (52.0%)
Sex	Male	21 (84.0%)	22 (88.0%)
	Female	4 (16.0%)	3 (12.0%)
BMI (kg/m²)	Mean ± SD	24.1 ± 2.3	25.4 ± 2.8
Residence	Rural	11 (44.0%)	13 (52.0%)
	Urban	14 (56.0%)	12 (48.0%)

Table 2 shows the injury mechanisms and clinical characteristics at baseline. Sports-related injuries were the most common cause, affecting 56% of the repair group and 40% of the meniscectomy group. Medial meniscus tears were more frequent than lateral tears in both groups, with rates of 72% for medial tears and 68% for lateral tears, which aligns with anatomical tendencies. About one-third of patients in each group had ACL injuries that needed reconstruction at the same time. The average time from injury to surgery was similar for both groups, at 5.2 weeks for repair and 6.0 weeks for meniscectomy, with no significant difference, indicating similar chronicity profiles. [Table 2]

Table 2: Injury and Clinical Profile of the Study Population

Variable	Meniscal Repair (n=25)	Partial Meniscectomy (n=25)	p-value
Sports-related injury	14 (56%)	10 (40%)	0.26
Road traffic accident	5 (20%)	8 (32%)	0.34
Occupational injury	6 (24%)	7 (28%)	0.75
Medial meniscus tear	18 (72%)	17 (68%)	0.76
Lateral meniscus tear	7 (28%)	8 (32%)	0.76
Concomitant ACL injury	9 (36%)	8 (32%)	0.77
Duration before surgery (weeks), Mean ± SD	5.2 ± 2.1	6.0 ± 2.5	0.19

Table 3 shows that both groups had similar preoperative functional status. This confirms that randomization and baseline matching were done correctly. The mean Lysholm scores were 54.6±8.2 for the repair group and 56.1±7.9 for the meniscectomy group (p=0.48). This indicates a moderate functional limitation due to meniscal issues. Similarly, IKDC scores showed no notable difference between the two groups (49.8±9.4 versus 51.2±8.8, p=0.57). VAS pain scores were moderately high in both groups, averaging 7.1 and 6.8, respectively (p=0.31). This reflects significant pain before surgery. [Table 3]

Table 3: Preoperative Functional Scores of the Study Population

Score	Meniscal Repair	Partial Meniscectomy	p-value
Lysholm Score (Mean ± SD)	54.6 ± 8.2	56.1 ± 7.9	0.48
IKDC Score (Mean ± SD)	49.8 ± 9.4	51.2 ± 8.8	0.57
VAS Pain Score	7.1 ± 1.0	6.8 ± 1.2	0.31

Table 4 shows that the meniscal repair group had significantly better functional outcomes at the 6-month follow-up. Lysholm scores improved greatly in both groups, but the repair group had much higher average scores (88.4±6.1 compared to 82.3±7.4, p=0.003), indicating excellent to good functional status. The IKDC scores also showed clear advantages for the repair group (84.7±5.9 versus 78.5±6.8, p=0.002), which meant better knee function and higher patient satisfaction. Pain relief was significantly better after repair, with VAS scores going down to 1.8±0.9 versus 2.6±1.1 in the meniscectomy group (p=0.01). These results highlight the functional benefits of preserving the meniscus. [Table 4]

Table 4: Postoperative Functional Outcomes at 6 Months

Score	Meniscal Repair	Partial Meniscectomy	p-value
Lysholm Score	88.4 ± 6.1	82.3 ± 7.4	0.003
IKDC Score	84.7 ± 5.9	78.5 ± 6.8	0.002
VAS Pain Score	1.8 ± 0.9	2.6 ± 1.1	0.01

Table 5 shows the radiologic evaluation at 6 months. The results indicate positive healing outcomes in the repair group and worrying degenerative changes in the meniscectomy group. Among the repaired menisci, 76% showed complete healing on MRI, 16% had partial healing, and only 8% had non-healing or re-tear. In contrast, all meniscectomy patients had residual meniscal defects as anticipated. Joint space narrowing greater than 1mm was seen in 4% of repair patients compared to 24% in the meniscectomy group (p=0.04). This points to faster degenerative changes after tissue removal. Early cartilage degeneration was identified in 8% of the repair

group versus 28% of the meniscectomy group (p=0.05). The rates of joint effusion were similar, at 12% for repairs and 20% for meniscectomy (p=0.44). [Table 5]

Table 5: Radiologic Outcomes at 6 Months (MRI Evaluation)

Radiologic Parameter	Meniscal Repair (n=25)	Partial Meniscectomy (n=25)	p-value
Complete healing of the meniscus	19 (76.0%)	-	-
Partial healing	4 (16.0%)	-	-
Non-healing / re-tear	2 (8.0%)	-	-
Residual meniscal defect (post-excision)	-	25 (100%)	-
Joint space narrowing (>1 mm)	1 (4.0%)	6 (24.0%)	0.04
Early cartilage degeneration on MRI	2 (8.0%)	7 (28.0%)	0.05
Effusion on follow-up MRI	3 (12.0%)	5 (20.0%)	0.44

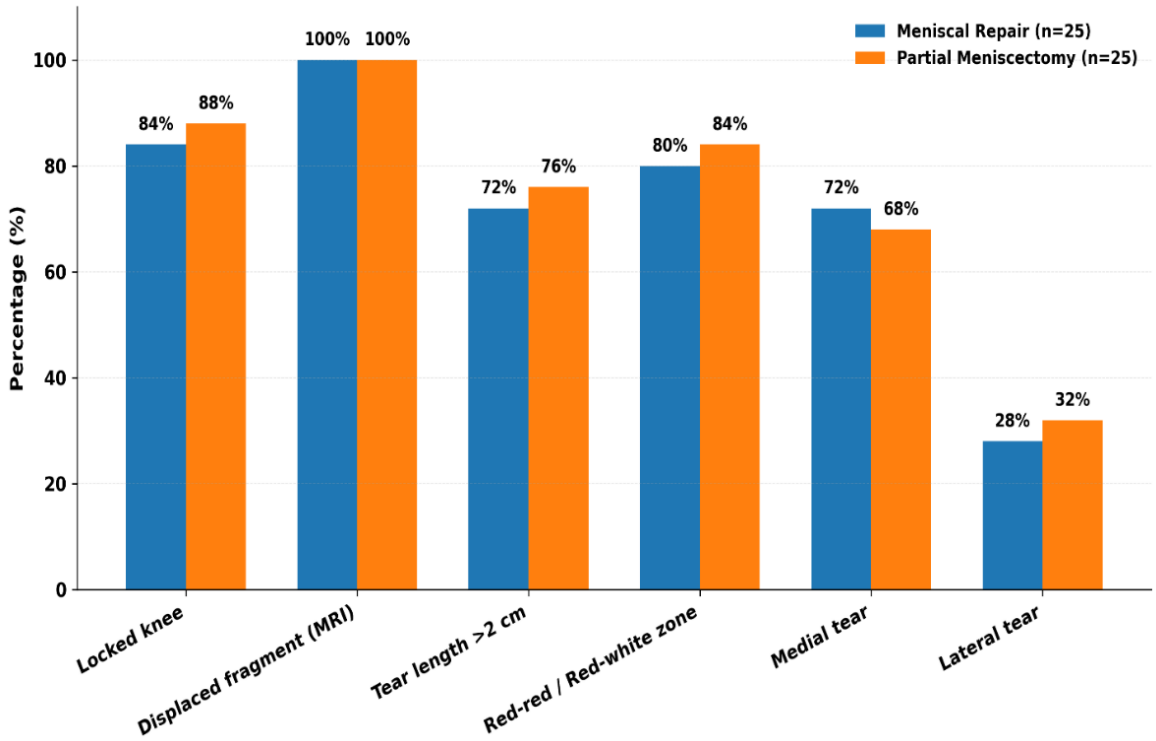

Figure 1: Baseline Confirmation of Bucket-Handle Tear Characteristics

Figure 1 illustrates that all enrolled patients had typical bucket-handle tear characteristics, confirming the study's accuracy and inclusion criteria. Most patients in both groups had locked knees, with rates of 84% and 88%, which is a key sign of displaced bucket-handle fragments causing blockage. All patients showed displaced meniscal fragments on preoperative MRI, confirming the diagnosis. Most tears were longer than 2cm, making up 72-76% of cases, which classifies them as significant longitudinal disruptions. Fortunately, 80-84% of tears were found in vascularized red-red or red-white zones, meaning they could be repaired and had a good chance of healing. [Figure 1]

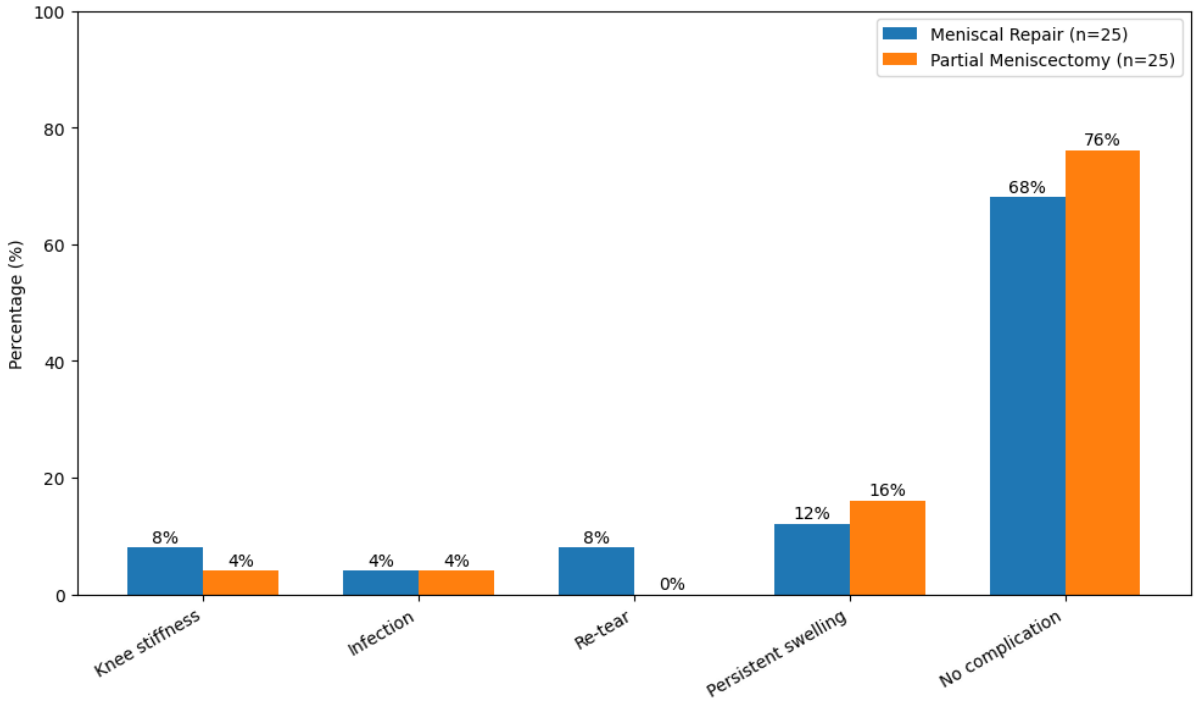

Figure 2: Postoperative Complications of the study Population

Figure 2 depicts similar complication profiles for both surgical methods, with no significant differences. Knee stiffness was rare, occurring in 8% of the repair group and 4% of the meniscectomy group (p=0.55). All cases responded well to physiotherapy. Infection rates were the same and low at 4% for both groups (p=1.00), and were treated successfully with antibiotics. The repair group had an 8% re-tear rate that needed revision surgery, while the meniscectomy group had no re-tears (p=0.15), highlighting a risk associated with repair techniques. Persistent swelling was noted in 12% of the repair group and 16% of the meniscectomy group (p=0.68), but it usually resolved on its own. Importantly, most patients in both groups (68-76%) had uncomplicated recoveries, confirming that both surgical methods are safe. [Figure 2]

Table 6 shows the level of functional improvement from baseline to the 6-month follow-up, highlighting the advantages of meniscal repair. The repair group had a mean Lysholm improvement of 33.8 points, while the meniscectomy group improved by 26.2 points (p=0.001). This indicates a significant difference. Similarly, IKDC scores rose by 34.9 points in the repair group compared to 27.3 points in the meniscectomy group (p=0.002). Pain reduction was also notably greater in the repair group, with VAS scores dropping by 5.3 points compared to 4.2 points (p=0.01). [Table 6]

Table 6: Comparative Statistical Analysis of Functional Improvement

Parameter	Meniscal Repair Group Mean Improvement	Partial Meniscectomy Group Mean Improvement	p-value
Lysholm improvement	+33.8	+26.2	0.001
IKDC improvement	+34.9	+27.3	0.002
VAS reduction	-5.3	-4.2	0.01

IV. DISCUSSION

This comparative study demonstrated that meniscal repair is better than partial meniscectomy for bucket-handle tears. It shows improved functional and radiologic outcomes at the 6-month follow-up. The findings reflect a shift toward preserving meniscal tissue and highlight the need for strategies that save tissue to prevent rapid osteoarthritic changes. Our results demonstrated significant improvements in Lysholm and IKDC scores for the repair group. This was also linked to lower pain levels and better radiologic measures, such as reduced rates of joint space narrowing and early cartilage degeneration.[12] The functional benefits seen in the meniscal repair group come from maintaining meniscal biomechanics and its chondroprotective role. Our study showed a 76% complete healing rate. Successful meniscal repair restores the usual load distribution across the knee joint. This helps lower peak contact pressures on the articular cartilage. These results match those of Fox et al., who showed even partial meniscectomy significantly changes joint mechanics and increases cartilage stress by 200-350%, depending on

how much tissue is removed [13] Our radiologic data support this mechanism. They reveal much higher rates of joint space narrowing and early cartilage changes in the meniscectomy group.[14] The healing rate of 76% in our meniscal repair group is better than reports by Saltzman et al.[15] Success rates typically range from 60% to 90%, based on factors like tear location, patient age, and whether ACL reconstruction is done at the same time. The mainly vascular red-red and red-white zone tears in our group probably helped achieve these positive results. The 8% re-tear rate we found fits within the acceptable ranges shown in meta-analyses of meniscal repair outcomes. These findings back the biological potential of meniscal healing when we select the right patients and use proper surgical techniques.[16] While partial meniscectomy has benefits like shorter surgery time, immediate weight-bearing, and quicker initial recovery, our medium-term functional outcomes favor repair techniques. The meniscectomy group showed satisfactory improvements in functional scores, but the level of improvement was significantly less than in the repair group (26.2 versus 33.8 points Lysholm improvement, p=0.001). This finding suggests that while meniscectomy offers symptom relief, the loss of tissue affects overall functional recovery.[17] Doral et al. showed that this gap in function widens over time, with meniscectomy patients experiencing progressive deterioration after 5-10 years.[18] The radiologic evaluation showed early signs of joint degeneration in the meniscectomy group. About 24% of these patients had joint space narrowing, compared to 4% in the repair group (p=0.04). Similarly, early cartilage degeneration occurred in 28% of the meniscectomy group, while only 8% of the repair group showed the same issue (p=0.05). These results at 6 months are concerning because osteoarthritic changes usually develop over years or decades.[19] The quicker appearance of degenerative features after meniscectomy highlights the long-term advantages of strategies that preserve the meniscus. Kumm et al. revealed progressive joint space loss and cartilage damage in patients who had a meniscectomy.[20] This often leads to symptomatic osteoarthritis that requires arthroplasty for many of these patients. Patient selection is important for successful meniscal repair results. Our group included relatively young patients, with average ages of 26.8 and 30.2 years, who had acute to subacute tears in vascular zones. This makes them an ideal group for repair attempts. Factors such as tear chronicity, location within vascular zones, patient age, activity level, and related ligament injuries all affect the healing potential.[21] About one-third of the patients also underwent ACL reconstruction, which may have improved healing rates by introducing healing factors from marrow stimulation and enhancing knee movement. The complication profiles were similar between groups. There were no significant differences in infection, knee stiffness, or persistent swelling. The 8% re-tear rate in the repair group warrants careful discussion of adherence to rehabilitation guidelines and adjustments in activity levels during the healing phase.[22] The modern all-inside repair devices used in our study provide stability similar to traditional inside-out sutures. They also reduce surgery time and eliminate extra incisions, which may help improve complication rates.[23] From a health economics perspective, although meniscal repair has higher upfront costs and requires longer rehabilitation than meniscectomy, it likely offers long-term cost-effectiveness by preventing early osteoarthritis and avoiding future arthroplasty procedures. Cost-utility analyses that consider quality-adjusted life years and lifetime healthcare costs support meniscal preservation strategies for the right patients. Policy recommendations should highlight meniscal repair as the preferred treatment when technically possible, with reimbursement systems that back this approach.

Limitations of the Study: The study is limited by the relatively short 6-month follow-up duration, which may not capture long-term outcomes and late complications. Additionally, the sample size of 50 patients, while adequate for detecting medium-effect differences, may lack power for subgroup analyses.

V. CONCLUSION

Meniscal repair shows better functional outcomes, less pain, and improved imaging results compared to partial meniscectomy for bucket-handle tears after a 6-month follow-up. The tissue preservation gained through repair methods reduces early wear and tear and enhances how the knee works. These results support meniscal repair as the main treatment for bucket-handle tears in the right patients with tears in the vascular zone. The findings emphasize the value of preserving the meniscus and the role of skilled surgeons in repair techniques.

Recommendations: Longitudinal studies with follow-up periods of 5 to 10 years are needed to evaluate long-term functional outcomes and the progression of osteoarthritis. Future research should use better imaging techniques and biomarkers to predict healing potential and improve patient selection criteria.

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