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SHORT-TERM CLINICAL AND FUNCTIONAL OUTCOMES FOLLOWING ARTHROSCOPIC DEBRIDEMENT AND LAVAGE IN EARLY TO MODERATE KNEE OSTEOARTHRITIS: A PROSPECTIVE LONGITUDINAL STUDY

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ABSTRACT

A common disease affecting degenerative joints that reduces mobility and quality of life is knee osteoarthritis (OA). Although its effectiveness is still up for discussion, arthroscopic debridement and lavage have been suggested as an intermediate surgical option for patients with early to moderate OA who are suffering persistent mechanical symptoms that are not improving with conservative treatment. To assess the immediate clinical, functional, and radiological outcomes of arthroscopic debridement and lavage in patients with Kellgren-Lawrence Grade I–III knee OA who are not responding to non-operative therapy. Over 18 months, prospective longitudinal research was carried out at a tertiary care facility. Lavage and arthroscopic debridement were performed on 35 individuals. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), the Visual Analog Scale (VAS), and the Knee Society Score (KSS) were used to evaluate clinical results. Radiological alterations in osteophytes and joint space were assessed. Wilcoxon signed-rank tests and paired t-tests were used in the statistical analysis; $p < 0.05$ was deemed significant. Postoperative improvements in VAS (6.4 to 2.8), KSS (58 to 82), and WOMAC (74 to 48) ratings were substantial ($p < 0.001$). Radiographs showed reduced osteophyte and increased joint space, especially in KL Grade I–II patients. Only modest, self-limiting occurrences were observed, and the risk of complications was minimal, for certain individuals with early to moderate knee OA and mechanical symptoms, arthroscopic debridement and lavage provide safe, efficient temporary pain alleviation and enhanced

functionality. In KL Grades I–II, the operation is most helpful, and in properly selected patients, it should be viewed as a bridge measure before arthroplasty.

Keywords: Knee osteoarthritis, Arthroscopy, Debridement, Lavage, Kellgren-Lawrence, WOMAC, KSS, Visual Analog Scale

1. INTRODUCTION

A gradual, degenerative joint disease, globally, OA is the primary cause of musculoskeletal impairment. Weight-bearing joints are disproportionately affected, with the knee being the most often affected anatomical location (Langworthy et al., 2024). Because of sedentary lifestyles, rising obesity rates, and longer life expectancies, the worldwide burden of OA is growing (Singh et al., 2022). Lack of access to early diagnosis and appropriate intervention contributes to the illness load in countries with low and medium incomes like India, leading to delayed care and longer disability-adjusted life years. The illness is linked to a decline in productivity and quality of life and poses a significant personal, financial, and healthcare burden on middle-aged and older populations. Progressive articular cartilage degradation, subchondral bone remodelling, and osteophyte formation, often with variable degrees of synovial inflammation, characterise knee OA. These pathophysiological changes result in narrowing of the joint space, altered load distribution, and ultimately biomechanical compromise of the joint as the disease progresses (Palazzo et al., 2016). Patients present clinically with joint pain that is activity-related and relieved by rest, early morning stiffness less than 30 minutes, crepitus, limited range of motion, and episodes of joint effusion. Additionally, patients frequently have mechanical symptoms like locking or seizing, which are suggestive of intraarticular loose bodies, meniscal degeneration, or osteophyte impingement. Patients' mobility, day-to-day functioning, and psychological well-being are significantly impacted by these symptoms, particularly in the early and intermediate phases of the illness (Litwic et al., 2013).

Knee OA is managed in a variety of ways. In the early stages, treatment is primarily conservative. Analgesics (NSAIDs) are examples of frequently utilized pharmaceutical interventions (Rodríguez-Merchán, 2022). Physical therapy, lifestyle changes including losing weight, and the use of orthotic supports are all included in early treatment. Although longer-term effectiveness is still being studied, more modern biological treatments as hyaluronic acid Visco supplementation and PRP injections, have shown promise in symptom regulation (Pavone et al., 2021). A significant portion of patients do not have sufficient symptomatic relief even with these conservative approaches, particularly when mechanical symptoms are the predominant complaint. The last therapy for severe instances of structural joint damage is total knee arthroplasty (TKA). However, because of its invasive nature, expense, and perioperative hazards, TKA is usually reserved for patients with severe illness (Kellgren–Lawrence Grade IV) and considerable functional restriction (Kon et al., 2020). Patients with mildly to intermediate OA (KL Grades I–III) who have not responded to medical therapy but are not yet eligible for joint replacement have a therapeutic gap as a result.

The development of arthroscopic lavage and debridement as intermediate surgical techniques aimed at treating intraarticular disease and alleviating symptoms stems from this context. Mechanical removal of degenerated cartilage fragments, inflamed synovium, osteophytes, and other loose bodies restores joint mechanics and decreases synovial irritation through arthroscopy. In addition, the technique permits visual assessment of the joint surfaces, synovium, and menisci, which allows for diagnostic clarity and therapeutic opportunity in a single procedure. Debridement and lavage are most effective in patients with preserved joint space, stable alignment, and localized symptoms. Without requiring the patient to use a prosthetic joint, arthroscopy may offer significant short-term pain and function relief in some specific situations.

It is debatable, nevertheless, whether arthroscopic operations are effective for knee OA. Moseley et al. (2002) carried out a controlled, randomized study, which is one of numerous high-impact studies that have questioned its long-term advantage over placebo. These discoveries have led to a revaluation of surgical reasons and recommendations in various international contexts (Sancheti et al., 2017).

Subsequent studies have suggested that favourable results in terms of pain alleviation and functional enhancement may be achieved with cautious patient selection (excluding patients with severe degenerative changes and including those with mechanical symptoms). Given this context, there is a compelling argument for evaluating the role of arthroscopy in early-stage OA, especially in regional populations whose demographics, health-seeking patterns, and treatment accessibility differ significantly from those of Western cohorts. In India, where occupational pressures and a lack of conservative care often cause OA to advance more quickly and manifest at a younger age, prompt surgical intervention may slow the disease's course and enhance quality of life (Krych et al., 2013). Although arthroscopy has grown in popularity in India's tertiary care facilities, there are few prospective longitudinal studies assessing the procedure's immediate effects. Furthermore, available data is limited by the variety in follow-up techniques, outcome evaluation, and patient selection (Piuzzi et al., 2016). The majority of published data focuses on long-term arthroplasty requirements or radiological advancement, paying little attention to early clinical outcomes, such as pain management, functional improvement, and radiological stability in the first few months after surgery. In the first six to eighteen months, patients may be interested in clinically significant short-term advantages (symptomatic alleviation and functional improvement), which should be thoroughly assessed (Malempati et al., 2017).

In this study, the short-term clinical, functional, and radiological outcomes of arthroscopic debridement and lavage are evaluated in patients with early to moderate osteoarthritis of the knee, particularly those who are classified as KL Grades I through III. The goal is to evaluate how well this minimally invasive procedure works to reduce mechanical symptoms, including catching, locking, and recurring effusion symptoms that are frequently recalcitrant to conservative therapy. The study uses conventional evaluation measures, such as the WOMAC, the VAS, and the KSS, to gauge gains in joint function, pain alleviation, and patient-reported quality of life.

2. MATERIALS AND METHODS

2.1 Study Design

The purpose of this Well-crafted potential longitudinal research was to evaluate the short-term outcomes for patients with osteoarthritis of the knee following arthroscopic debridement and lavage in terms of clinical, functional, and radiological aspects. Data were collected at several postoperative intervals, including six weeks, twelve weeks, six months, a year, and eleven and a half years, to ensure a trustworthy temporal assessment of changes in symptoms and joint function.

2.2 Study Setting

The study was conducted at the Nil Ratan Sircar (N.R.S.) Medical College and Hospital's Department of Orthopaedics in Kolkata. Serving a diverse urban and periurban population, the institution is a tertiary care facility under the jurisdiction of the West Bengal government. Under stringent institutional norms, this centre was utilized for all diagnostic evaluations, surgical operations, follow-ups, and data gathering activities.

2.3 Study Duration

The research lasted eighteen months, from January 2023 to June 2024. The timeframe was broken up into four distinct phases. During the four-month preliminary phase, baseline data collection, patient screening, and ethical clearance were completed. Organized follow-up evaluations and surgical procedures (Operative and Observational Phase, 8 months). The Analysis Phase was 4 months of statistical review and explanation of the results.

2.4 Study Population and Sample Size

Patients with symptomatic knee osteoarthritis requiring surgery who were seen at the outpatient orthopaedics department of N.R.S. Medical College were included in the target population. Purposive

sampling was used to enrol 35 patients in total. The sample size was calculated using the formula below:

$$n = \frac{Z^2 \times \sigma^2}{d^2}$$

Where:
- Z=1.96Z = 1.96Z=1.96 (for 95% confidence level),
- σ=14.7\sigma = 14.7σ=14.7 (standard deviation based on previous studies),
- d=5d = 5d=5 (precision level)

2.5 Inclusion and Exclusion Criteria

Participants have to be 18 years of age or older, have radiologically verified knee osteoarthritis (Kellgren-Lawrence Grades I–III), and have ongoing mechanical complaints that won't go away with conservative treatment. Only participants who agreed to follow up and give informed consent were accepted. The following cases were excluded: advanced OA (Grade IV), significant deformities (>10° varus/valgus or instability), fixed flexion >15°, active joint infection, or systemic disorders that exclude surgery, such as immunosuppression or poorly managed diabetes.

2.6 Data Collection Tools and Techniques

Function, discomfort, and stiffness were assessed clinically using the VAS, WOMAC, and KSS. Whereas MRI and orthoscanograms were specifically utilized to analyse cartilage, synovium, and alignment, radiographs were utilized to evaluate joint space and osteophytes. Standard ports were used to do arthroscopic surgeries while under spinal anaesthesia. Chondral and osteophytic pieces were lavaged, synovected, and debrided, with microfracture used as needed. Both before and after surgery, standard arthroscopy equipment and goniometric records were employed.

Under sterile settings, the patient is placed in a supine posture with the injured knee flexed and draped. A Stryker camera system is employed for joint viewing, and standard arthroscopic portals are set up. As seen in Figure 1, the various surgical lines, irrigation tubing, and video monitor connections show the standard operating field configurations during arthroscopic debridement and lavage.

Figure 1: Patient Positioning & Setup for arthroscopic debridement

An arthroscopic picture displaying synovial congestion, fibrillated articular cartilage, and intraarticular debris. The mechanical symptoms of locking and catching are exacerbated by these

diseased features. As seen in Figure 2, inflammatory tissue and osteochondral fragments cause the joint cavity to look hazy and asymmetrical.

Figure 2: Pre-debridement Arthroscopic View of the suprapatellar pouch

After debridement and lavage, Figure 3 displays a smoother and cleaner intraarticular surface. The inflammatory synovium and degraded cartilage have been removed. Better visualization signifies that mechanical irritants have been effectively removed and joint congruity has been restored.

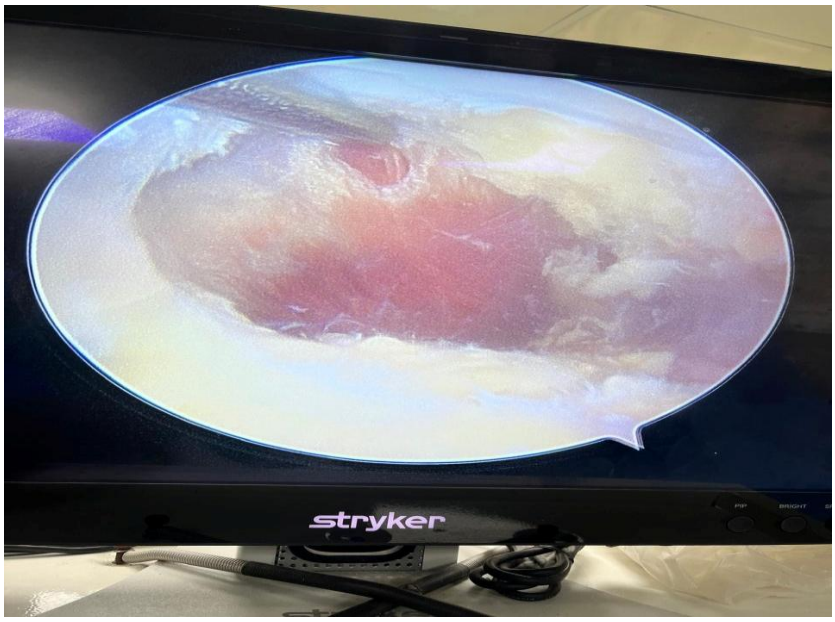

Figure 3: Post-debridement Arthroscopic View Demonstrating pathologic synovium is cleared out completely

3. RESULTS

3.1 Baseline Characteristics of the Study Population

This prospective longitudinal study included 35 people with osteoarthritis in their knees. Members of the group varied in age from 45 to 65, with an average age of 50.8 years. Out of all research participants, 17 were female (48.6%) and 18 were male (51.4%). Over 42.8% of participants were categorized as overweight, with an average BMI of 24.5 ± 2.6 kg/m², indicating that obesity can be a risk element. According to the Kellgren-Lawrence (KL) classification for radiographic scores, 37%

of the patients in this research were classified as Grade III, 40% as Grade II, and 23% as Grade I. The clinical and demographic characteristics of patients receiving arthroscopic debridement and lavage are described in Table 1.

Table 1. Baseline Characteristics of the Study Population

Variable	Value
Age (years)	50.8 ± 6.2
Sex (M/F)	18 / 17
BMI (kg/m²)	24.5 ± 2.6
KL Grade I	23%
KL Grade II	40%
KL Grade III	37%

The distribution of genders among 35 individuals with knee osteoarthritis is shown in Figure 4. There were 17 (48.6%) females and 18 (51.4%) males among them. Both the absolute count and the percentage contribution of each gender are shown by the dual bars.

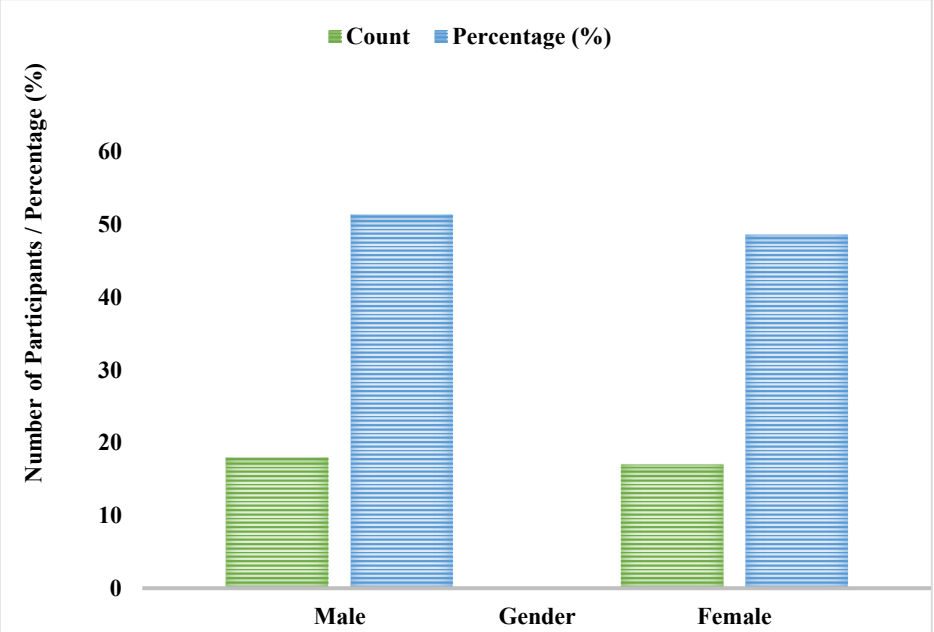

Figure 4: Gender Distribution of Study Participants

The distribution of participants by osteoarthritis severity as determined by the Kellgren–Lawrence (KL) classification is displayed in Figure 5. The most common grade was II (40%), followed by III (37%), and I (23%). The number of participants in each category is shown along with the associated percentage.

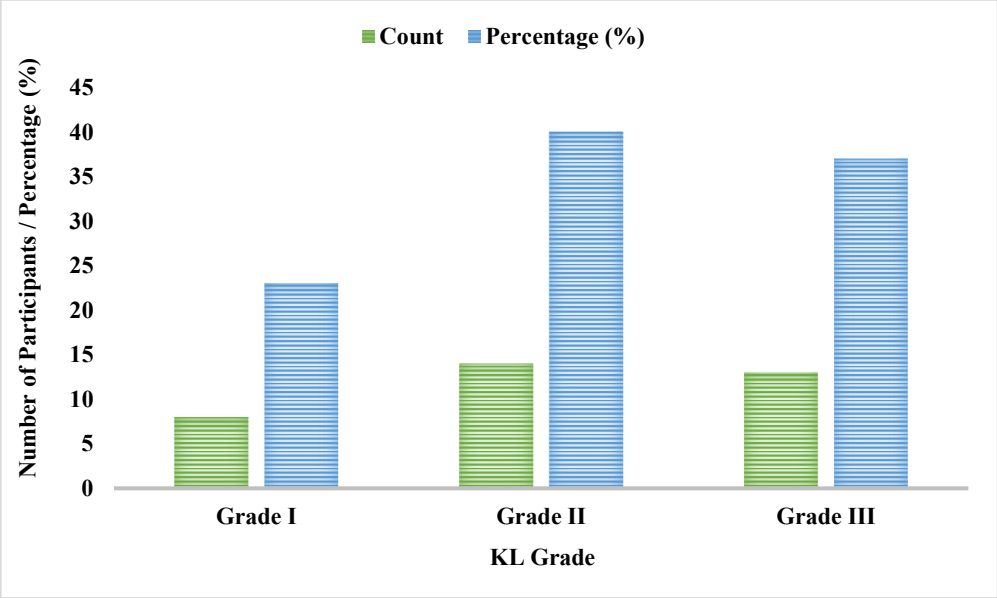

Figure 5: Radiographic KL Grading Classification

3.2 Clinical Outcomes: Pain, Stiffness, and Alignment

The VAS, which measures pain, showed a notable decline over time. At the 6-month postoperative check-up, the patients' average VAS score dropped from 6.4 before surgery to 2.8 ($p < 0.001$). This advancement clarifies why arthroscopy is effective in providing pain alleviation because of joint debris, inflammatory synovium, and osteophytes. There was a noticeable decrease over time in the VAS, which is used to quantify discomfort. This development explains why osteophytes, inflammatory synovium, and joint debris make arthroscopy an effective pain reliever. Table 2 shows postoperative improvements in validated outcome ratings that are statistically significant.

Table 2: Clinical Outcome Scores (VAS, KSS, WOMAC)

Parameter	Preoperative Mean ± SD	Postoperative Mean ± SD	p-value
VAS Score	6.4 ± 1.2	2.8 ± 0.9	<0.001
KSS	58 ± 8.5	82 ± 6.4	<0.001
WOMAC	74 ± 10.3	48 ± 9.6	<0.001

The mean ± standard deviation of the clinical outcome measures, WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index), KSS (Knee Society Score), and VAS (Visual Analogue Scale), before and after surgery is shown in figure 6 While KSS ratings indicate a notable rise, indicating improved joint performance following therapy, VAS and WOMAC levels significantly decrease postoperatively, showing pain alleviation and functional improvement.

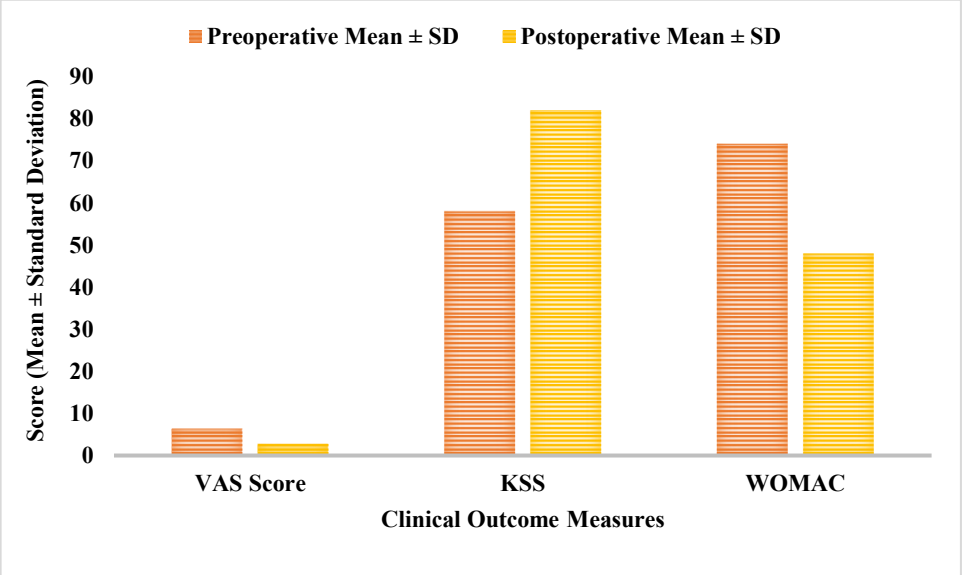

Figure 6: Comparison of Preoperative and Postoperative Clinical Outcome Scores

3.3 Radiological Outcomes: Joint Space and Osteophyte Analysis

Radiographic evaluations were conducted with lateral and anteroposterior knee X-rays. MRI was used in a few instances to evaluate meniscal degeneration, synovial enlargement, and cartilage integrity. 40 % of the patients had substantial constriction of the joint space before surgery. Particularly in those with KL Grades I and II, 65% of these patients had radiological transition to mild or moderate constriction at follow-up. Patients in KL Grade III, however, showed less noticeable alterations. 50% of instances had osteophyte reduction after surgery, which lends credence to the intervention's mechanical debridement component. Patients with KL Grades I and II showed the greatest radiological and clinical improvements, particularly joint space widening and osteophyte reduction Table 3.

Table 3: Radiological and Clinical Improvements

Parameter	Improvement Observed
Joint Space Improvement	65%
Osteophyte Reduction	50%
Malalignment Correction	65%
Synovial Swelling Reduction	Observed in the majority of post-synovectomy

3.4 Functional Outcomes: KSS and WOMAC Scores

For functional evaluation, the WOMAC and the KSS were employed. Both devices showed notable postoperative improvements. Six months after surgery, the mean KSS improved to 82 ± 6.4 from the preoperative mean of 58 ± 8.5 ($p < 0.001$). Mobility, stability, and pain alleviation all improved. The mean WOMAC score dropped from 74 ± 10.3 before surgery to 48 ± 9.6 after surgery ($p < 0.001$), indicating a reduction in physical restriction, stiffness, and subjective pain. This information is consistent with worldwide statistics and demonstrates that arthroscopic intervention yields significant functional recovery in a subset of individuals. The functional recovery seen in individuals receiving arthroscopic procedures for osteoarthritis in the knee is summarized in Figure 7. At six months after surgery, the KSS and WOMAC scores both showed statistically significant improvements, which is in line with worldwide trends in arthroscopic results.

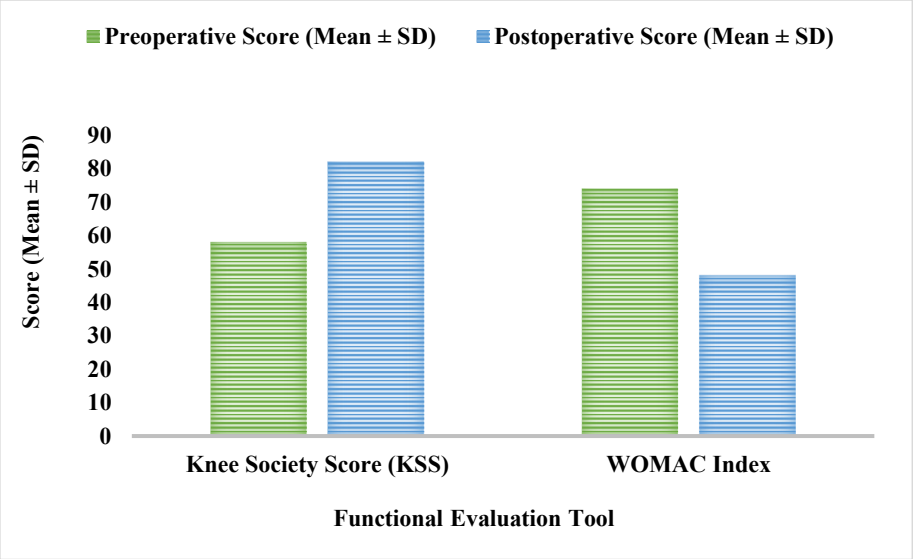

Figure 7: Postoperative Improvement in Functional Scores Following Arthroscopic Knee Surgery

3.5 Adverse Events and Postoperative Complications

The operation was safe since the overall problems were few. Two patients (5.7%) experienced temporary joint swelling, while one patient (2.8%) experienced minor hemarthrosis. Within two weeks, all issues were treated conservatively, avoiding the need for a lengthy hospital stay or surgical revision. There was no deep vein thrombosis, neurovascular damage, or deep infection. The lack of significant problems can be explained by standardized surgical procedures, skilled operating teams, and strict aseptic precautions. None of the patients required conversion to more invasive procedures during the study period, which highlights the feasibility of arthroscopic intervention as a stand-alone modality in selected OA cases. As seen in Table 4, postoperative problems were minor and self-limiting.

Table 4: Postoperative Complications

Complication	Incidence (%)
Joint Swelling	5.7%
Hemarthrosis	2.8%
Deep Infection	0%
Neurovascular Injury	0%

5.6 Statistical Analysis of Outcomes

Knee function and discomfort were significantly improved in the short term with arthroscopic debridement and lavage. A decrease in discomfort was shown by the mean VAS score, which went from 6.4 ± 1.2 to 2.8 ± 0.9 ($p < 0.001$). Better physical function and less stiffness were indicated by the WOMAC score falling from 74 ± 10.3 to 48 ± 9.6 ($p < 0.001$) and the Knee Society Score (KSS) improving from 58 ± 8.5 to 82 ± 6.4 ($p < 0.001$). Kellgren-Lawrence Grade I and II patients showed radiological improvements in osteophyte development and joint space, while Grade III patients did not ($p > 0.05$), indicating limited structural response in advanced osteoarthritis. Figure 8 depicts these postoperative alterations in WOMAC, VAS, and KSS ratings.

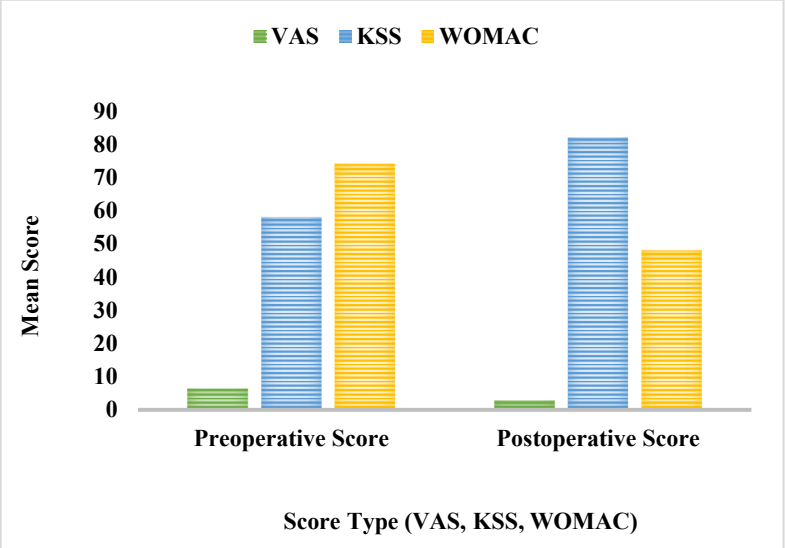

Figure 8: Comparison of Preoperative and Postoperative Scores

4. DISCUSSION

A prospective longitudinal study was carried out to assess the short-term radiological, functional, and clinical outcomes of arthroscopic debridement and lavage of osteoarthritis in individuals with early to intermediate osteoarthritis of the knee, particularly in those with mechanical symptoms that conservative treatment is unable to alleviate. The goal of the trial was to ascertain if this minimally invasive procedure might successfully lower pain, enhance joint function, and improve quality of life in a subset of patients with Kellgren-Lawrence (KL) Grades I–III OA. All clinical outcome markers showed considerable improvements after surgery, according to the research. At six months, the mean VAS score decreased from 6.4 ± 1.2 to 2.8 ± 0.9, demonstrating significant pain alleviation (Marsh et al., 2016). In terms of functional outcomes, the WOMAC score dropped from 74 ± 10.3 to 48 ± 9.6, indicating better joint function and decreased stiffness, while the KSS increased from 58 ± 8.5 to 82 ± 6.4. Patients with KL Grades I and II showed the greatest improvements, highlighting the significance of joint structural integrity in forecasting positive results (Buchbinder et al., 2014). Furthermore, according to Arthroscopic debridement can alleviate functional joint abnormalities but not structural ones, as evidenced by the postoperative improvement observed in 65% of patients with clinical malalignment (Aaron et al., 2006).

These results are consistent with earlier research supporting arthroscopy in properly chosen individuals. Even though it might not alter the course of the disease, arthroscopy provides short-term symptom relief for individuals with mild to moderate OA who have mechanical complaints (Amin et al., 2017). In instances that have been properly screened, this confirms the current study's findings of symptomatic benefit. Conversely, high-impact studies (Piuzzi et al., 2016) did not discover any lasting distinctions between arthroscopy and placebo treatments. Since patients with severe degenerative alterations who are less responsive to minimally invasive procedures were included in the Moseley trial, the discrepancy most likely results from patient selection (Moseley et al., 2002). Moreover, the results from this investigation are consistent. With those who found that mechanical debridement of intraarticular irritants improved functional outcomes in early instances of OA (Brignardello-Petersen et al., 2017). Therefore, the existence of mechanical symptoms, radiographic grading, and baseline OA severity may be the key factors influencing the variation in results across studies.

Among individuals with early to intermediate knee OA who have been carefully chosen, the evidence indicates that arthroscopic debridement and lavage are a short-term, safe, and effective intervention. In settings with limited resources or for patients who are not candidates for complete knee arthroplasty, this surgery is very useful as a way to postpone more invasive procedures (Kon et al., 2020). Pain can be significantly reduced, and mobility and quality of life can be improved, provided the operation is carried out in a standardized surgical setting with proper patient selection and

postoperative rehabilitation (Collins et al., 2014; Koster et al., 2023). Structured physical treatment, which included range-of-motion exercises and quadriceps strengthening, was probably the cause of the long-lasting improvements in functional ratings (den Hertog et al., 2012; Rucinski et al., 2019). A thorough and multifaceted evaluation of recovery was provided by utilizing outcome measures that have been validated (VAS, KSS, and WOMAC) (Moreira et al., 2024). Crucially, the low rate of complications (only temporary joint swelling and one mild instance of hemarthrosis) shows that arthroscopy, when out by skilled teams in aseptic settings, is a safe procedure (Rai et al., 2021).

The study has limits, even if it has positives. Although it reduces the statistical ability to do subgroup assessments, the sample size is sufficient for exploratory research. Lastly, the absence of a control group creates possible interpretive bias and prevents causal inference (e.g., conservative treatment or sham arthroscopy). The study was conducted in a government tertiary hospital and had a single-centre design, which restricts its generalizability to larger and more varied populations. Moreover, the 6–18-month follow-up period is insufficient to evaluate the sustainability of clinical improvement or long-term structural advancement. As a result, the results might not be able to forecast the chance of future joint replacement or illness progression.

Multicenter randomized controlled trials with bigger and more varied patient populations should be a part of future research to bolster the body of data. By including matched control groups, it would be possible to draw firmer findings on the effectiveness of arthroscopy in comparison to nonoperative treatment or newly developed biologic medicines. Extended follow-up beyond two years is required to ascertain if early symptomatic improvements result in a postponed requirement for joint arthroplasty or slowed OA development. Research evaluating the relative benefits of intra-articular biologic treatments, such as stem cell therapies or platelet-rich plasma, against arthroscopy has been reported. Might improve clinical decision-making even further. Moreover, standardized post-operative care pathways might be developed using a formal study of rehabilitation compliance and its connection to functional outcomes as a reference. These integrated methods might have a better therapeutic effect on arthroscopy and offer long-term symptom management in the early stages of OA treatment.

5. CONCLUSION

This prospective longitudinal trial provides strong evidence that, in individuals who are carefully chosen, arthroscopic debridement and lavage are a safe and successful treatment for early to moderate osteoarthritis (OA) of the knee. Particularly for individuals with KL Grades I and II, there was a considerable short-term improvement in pain reduction, joint function, and patient-reported outcomes. The greatest improvements were reported by patients with mechanical symptoms (locking, catching, recurring effusions) who had not responded to conservative therapy but whose joint architecture was intact without permanent abnormalities or instability. The significant decrease in VAS scores and the improvement in KSS and WOMAC scores demonstrate the effectiveness of arthroscopy in reducing intraarticular causes of pain and dysfunction. Following surgery, further radiological and clinical measures demonstrated improvements, especially in joint space visibility and discomfort associated with osteophyte. When carried out using standardized approaches in a controlled surgical setting, the minimal rates of complications confirmed the procedural safety. However, as this technique becomes less and less effective in joints with structural defects, patients with advanced OA (KL Grade III and higher) did not benefit much from it. The importance of radiographic grading and thorough clinical examination in patient selection is stressed to maximize results. Additionally, postoperative therapy played a significant role in sustaining functional improvements throughout the group. Lastly, treating early to intermediate knee OA with mechanical symptoms should involve arthroscopic debridement and lavage. More invasive surgical procedures, such as joint arthroplasty, may not be necessary since they offer significant short-term comfort and functional improvement.

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