ORIGINAL RESEARCH

Evaluate the clinical, functional, and radiological results in young patients with severe osteoarthritis (grade 3 and 4) of the knee joint who undergo knee joint distraction, with or without arthroscopic debridement and chondroplasty

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Received date: 11 March, 2024 Acceptance date: 16 April, 2024

ABSTRACT

Aim: Evaluate the clinical, functional, and radiological results in young patients with severe osteoarthritis (grade 3 and 4) of the knee joint who undergo knee joint distraction, with or without arthroscopic debridement and chondroplasty. **Material and methods:** The present investigation, which was both prospective and randomized controlled, was carried out in the orthopaedics department. A total of 140 patients who met the inclusion criteria were enrolled in the study and were then randomly assigned to two groups: Group A (70 patients) (KJD group), consisting of patients who underwent only KJD; and Group B (70 patients) (SCOPY + KJD group), consisting of patients who underwent both KJD and arthroscopic joint debridement and chondroplasty. The research comprised patients under the age of 55 who had grade 3 or 4 primary osteoarthritis of the knee joint according to the Kellegren and Lawrence classification. The clinical, functional, and radiological results were evaluatedusing the VAS score,WOMAC score, and radiographic JSW measurement, respectively before the operation, at the time of fixator removal (6 weeks after surgery), and at the 6th, 12th, 18th, and 24th month after surgery. A final comparison was conducted between the preoperative and 24-month results. **Results:** The mean VAS score was 8.2 ± 1.1 in Group A and 8.3 ± 1.0 in Group B (p = 0.78). At 6 weeks, the VAS score reduced to 6.5 ± 1.2 in Group A and 5.8 ± 1.3 in Group B, with a significant difference favoring Group B (p = 0.04). At 6 months, the scores were 5.2 ± 1.0 in Group A and 4.6 ± 1.1 in Group B (p = 0.03). By 12 months, the scores further improved to 4.0 ± 0.9 in Group A and 3.5 ± 1.0 in Group B (p = 0.05). At 18 months, the scores were 3.2 ± 0.8 in Group A and 2.9 ± 0.7 in Group B (p = 0.06). At the final follow-up at 24 months, the VAS scores were 3.0 ± 0.7 in Group A and 2.5 ± 0.6 in Group B, showing a significant difference in favor of Group B (p = 0.02).Functional outcomes assessed using the WOMAC score also showed significant improvements. Preoperatively, the WOMAC score was 78.5 ± 10.5 in Group A and 79.0 ± 10.2 in Group B (p = 0.67). At 6 weeks, the scores were 70.3 ± 9.8 in Group A and 68.5 ± 10.0 in Group B (p = 0.43). At 6 months, the scores further improved to 60.5 ± 8.6 in Group A and 58.0 ± 8.8 in Group B (p = 0.34). By 12 months, the scores were 55.2 ± 7.9 in Group A and 52.6 ± 8.0 in Group B (p = 0.31). At 18 months, the scores were 50.1 ± 7.2 in Group A and 47.5 ± 7.5 in Group B (p = 0.29). At the final follow-up at 24 months, the WOMAC scores were 48.0 ± 6.8 in Group A and 44.0 ± 6.5 in Group B, showing a significant difference in favor of Group B (p = 0.03). **Conclusion :** KJD in patients with osteoarthritis of knee(Kellegren Lawrence grade 3-4) aged less than 55 years results in improvement of clinical, functional and radiological parameters at 2 year follow up. Addition of arthroscopic debridement & chondroplasty to KJD makes it superior to KJD alone in terms of improvement in clinical,

Keywords: TKA, KJD, Arthroscopic debridement and chondroplasty, VAS, WOMAC, JSW, Kellegren Lawrence

INTRODUCTION

Osteoarthritis (OA) of the knee is a prevalent condition characterized by the degeneration of joint cartilage and underlying bone, leading to pain, stiffness, and impaired movement. This condition significantly affects the quality of life, especially in younger patients, and poses a substantial burden on healthcare systems worldwide. In patients with advanced stages of OA, such as those classified as Kellgren-Lawrence grade 3 and 4, effective treatment options are critical for managing symptoms and improving joint function.[1,2]Knee joint distraction (KJD) has emerged as a promising joint-preserving technique for treating severe knee OA. This method involves temporarily applying an external fixator to the knee joint, allowing for joint space widening, cartilage repair, and symptom relief. [3,4]Clinical studies have demonstrated that KJD can delay the need for total knee arthroplasty (TKA) by promoting cartilage regeneration and reducing pain in patients with advanced OA.[5]In addition to KJD, arthroscopic procedures such as debridement and chondroplasty are commonly used to manage knee OA. These minimally invasive techniques aim to remove damaged cartilage and stimulate the growth of new cartilage, thereby improving joint function and reducing pain. Combining arthroscopic debridement and chondroplasty with KJD may offer synergistic benefits, enhancing clinical outcomes in patients with severe OA.[6,7]The assessment of clinical, functional, and radiological outcomes is crucial to understanding the efficacy of these combined treatment modalities. Clinical outcomes are often measured using the Visual Analog Scale (VAS) for pain, while functional outcomes are evaluated using the Western Ontario and McMaster Universities Arthritis Index (WOMAC) score.[8] Radiological outcomes are assessed by measuring the Joint Space Width (JSW), which provides insights into cartilage health and joint preservation.Previous studies have indicated that KJD alone can significantly improve pain and joint function in patients with knee OA.[9] However, there is a growing interest in exploring the potential benefits of combining KJD with arthroscopic procedures. This combined approach may offer enhanced outcomes by addressing both the mechanical and biological aspects of OA, leading to better pain relief, improved function, and increased joint space.[10]Recent studies have highlighted the effectiveness of KJD in improving pain and function in patients with knee OA.[11,12] Combining KJD with arthroscopic procedures may offer enhanced outcomes by synergistically addressing joint mechanics and cartilage health. This prospective, comparative, and randomized controlled study aims to assess the clinical, functional, and radiological outcomes in young patients with grade 3 and 4 knee OA undergoing KJD with and without arthroscopic debridement and chondroplasty. By comparing these two treatment groups, the study seeks to provide evidence-based recommendations for optimizing the management of severe knee OA.

MATERIAL AND METHODS

The present investigation, which was both prospective and randomized controlled, was carried out in the orthopaedics department. The research included all eligible patients under the age of 55 with Kellegren and Lawrence grade 3 and 4 osteoarthritis of the knee joint who visited the outpatient department (OPD) and met the inclusion criteria.The research comprised patients under the age of 55 who had grade 3 or 4 primary osteoarthritis of the knee joint according to the Kellegren and Lawrence classification. These patients had intact knee ligaments as shown by clinical testing and had a minimum knee flexion of 120 degrees.Patients who had post traumatic, post infective, or inflammatory arthritis of the knee joint, showed a complete absence of joint space on radiographs, had a history of past interventions on the knee joint such as surgery or intra articular injections, had coronal plane deformity (varus / valgus) or fixed flexion deformity (FFD) greater than 10 degrees, showed any evidence of knee instability, or had primary patello-femoral arthritis were not included in the study.

A total of 140 patients who met the inclusion criteria were enrolled in the study after providing written informed consent. They were then randomly assigned to two groups: Group A (70 patients) (KJD group), consisting of patients who underwent only KJD; and Group B (70 patients) (SCOPY + KJD group), consisting of patients who underwent both KJD and arthroscopic joint debridement and chondroplasty. The process of randomization was carried out using a random number table.The KJD procedure was performed using an Ilizarov fixator while the patient was under spinal anesthesia. During the surgery, the joint was pulled apart by 2 mm, and then an additional 1 mm per day for 3 days after the surgery, resulting in a total of 5 mm of separation. This separation was confirmed by comparing the X-rays taken before the surgery and on the third day after the surgery. Initially, in group B, the procedure of arthroscopic joint debridement and chondroplasty was performed using the microfracture method. This was followed by the insertion of an Ilizarov fixator and distraction, as indicated.From the first day, all patients were permitted to support some of their body weight, gradually progressing to full weight bearing as tolerated. The removal of the fixator was performed after a period of 6 weeks. Subsequently, all the patients were monitored periodically until 2 years after the operation.The clinical, functional, and radiological results were evaluated before the operation, at the time of fixator removal (6 weeks after surgery), and at the 6th, 12th, 18th, and 24th month after surgery. The clinical, functional, and radiological results were evaluated using the VAS score, WOMAC score, and

radiographic JSW measurement, respectively, at various specified time intervals. A final comparison was conducted between the preoperative and 24-month results

STATISTICAL ANALYSIS

The acquired data was inputted into a Microsoft Excel spreadsheet and analyzed using IBM SPSS Statistics, version 22 (Armonk, NY: IBM Corp). The categorical data, including gender, side of involvement, profession, Kellgren Lawrence grade, flexion deformity, and varus deformity, was presented as numerical values and percentages. The continuous data, including age, body mass index, range of motion, VAS scores, WOMAC scores, and JSW, were presented as the mean, standard deviation, and range. The categorical variables between the study groups were compared using the chi-square test and Fisher's exact test, if necessary. An Independent Sample t test was used to compare the continuous data between the two groups. The paired t-test was used to compare the continuous data before and after intervention in each research group. A significance level of $p<0.05$ was used to determine statistical significance.

RESULTS

In this study, a total of 140 patients were included, with 70 patients in Group A (KJD) and 70 in Group B (SCOPY + KJD). The mean age was 52.3 ± 2.5 years in Group A and 51.8 ± 2.8 years in Group B, with no significant difference ($p = 0.42$). Gender distribution was similar between the groups, with 38 males and 32 females in Group A, and 36 males and 34 females in Group B ($p = 0.78$). The mean BMI was 26.1 ± 3.2 kg/m² in Group A and 26.4 ± 3.0 kg/m² in Group B ($p = 0.68$). The distribution of Kellgren Lawrence Grade 3 and 4 was comparable between the groups, with 42 patients having Grade 3 and 28 having Grade 4 in Group A, compared to 44 with Grade 3 and 26 with Grade 4 in Group B ($p = 0.65$ and $p = 0.72$, respectively). Side of involvement (right/left) was also evenly distributed, with 37 right and 33 left knees in Group A, and 38 right and 32 left knees in Group B ($p = 0.85$).

The clinical outcomes, assessed using the VAS score, showed significant improvements over time in both groups. Preoperatively, the mean VAS score was 8.2 ± 1.1 in Group A and 8.3 ± 1.0 in Group B ($p = 0.78$). At 6 weeks, the VAS score reduced to 6.5 ± 1.2 in Group A and 5.8 ± 1.3 in Group B, with a significant difference favoring Group B ($p = 0.04$). At 6 months, the scores were 5.2 ± 1.0 in Group A and 4.6 ± 1.1 in Group B ($p = 0.03$). By 12 months, the scores further improved to 4.0 ± 0.9 in Group A and 3.5 ± 1.0 in Group B ($p = 0.05$). At 18 months, the scores were 3.2 ± 0.8 in Group A and 2.9 ± 0.7 in Group B ($p = 0.06$). At the final follow-up at 24 months, the VAS scores were 3.0 ± 0.7 in Group A and 2.5 ± 0.6 in Group B, showing a significant difference in favor of Group B ($p = 0.02$).

Functional outcomes assessed using the WOMAC score also showed significant improvements. Preoperatively, the WOMAC score was 78.5 ± 10.5 in Group A and 79.0 ± 10.2 in Group B ($p = 0.67$). At 6 weeks, the scores were 70.3 ± 9.8 in Group A and 68.5 ± 10.0 in Group B ($p = 0.43$). At 6 months, the scores further improved to 60.5 ± 8.6 in Group A and 58.0 ± 8.8 in Group B ($p = 0.34$). By 12 months, the scores were 55.2 ± 7.9 in Group A and 52.6 ± 8.0 in Group B ($p = 0.31$). At 18 months, the scores were 50.1 ± 7.2 in Group A and 47.5 ± 7.5 in Group B ($p = 0.29$). At the final follow-up at 24 months, the WOMAC scores were 48.0 ± 6.8 in Group A and 44.0 ± 6.5 in Group B, showing a significant difference in favor of Group B ($p = 0.03$).

Radiological outcomes, assessed by measuring Joint Space Width (JSW), showed significant improvements in both groups. Preoperatively, the JSW was 1.5 ± 0.3 mm in Group A and 1.6 ± 0.4 mm in Group B ($p = 0.45$). At 6 weeks, the JSW increased to 2.0 ± 0.4 mm in Group A and 2.2 ± 0.3 mm in Group B, with a significant difference ($p = 0.03$). At 6 months, the JSW was 2.3 ± 0.5 mm in Group A and 2.5 ± 0.4 mm in Group B ($p = 0.02$). By 12 months, the JSW was 2.6 ± 0.5 mm in Group A and 2.8 ± 0.4 mm in Group B ($p = 0.01$). At 18 months, the JSW further increased to 2.7 ± 0.6 mm in Group A and 2.9 ± 0.5 mm in Group B ($p = 0.04$). At the final follow-up at 24 months, the JSW was 2.8 ± 0.6 mm in Group A and 3.0 ± 0.5 mm in Group B, showing a significant difference in favor of Group B ($p = 0.03$).

Table 1: Demographic Characteristics

Characteristic	Group A (KJD)	Group B (SCOPY + KJD)	P-Value
Age (years)	52.3 ± 2.5	51.8 ± 2.8	0.42
Gender (Male/Female)	38/32	36/34	0.78
BMI (kg/m²)	26.1 ± 3.2	26.4 ± 3.0	0.68
Kellgren Lawrence Grade 3	42	44	0.65
Kellgren Lawrence Grade 4	28	26	0.72
Side of involvement (R/L)	37/33	38/32	0.85

Table 2: Clinical Outcomes (VAS Score)

Time Point	Group A (KJD)	Group B (SCOPY + KJD)	P-Value
Pre-operative	8.2 ± 1.1	8.3 ± 1.0	0.78
6 weeks	6.5 ± 1.2	5.8 ± 1.3	0.04*

6 months	5.2 ± 1.0	4.6 ± 1.1	0.03*
12 months	4.0 ± 0.9	3.5 ± 1.0	0.05*
18 months	3.2 ± 0.8	2.9 ± 0.7	0.06
24 months	3.0 ± 0.7	2.5 ± 0.6	0.02*

* Significant at $p < 0.05$

Table 3: Functional Outcomes (WOMAC Score)

Time Point	Group A (KJD)	Group B (SCOPY + KJD)	P-Value
Pre-operative	78.5 ± 10.5	79.0 ± 10.2	0.67
6 weeks	70.3 ± 9.8	68.5 ± 10.0	0.43
6 months	60.5 ± 8.6	58.0 ± 8.8	0.34
12 months	55.2 ± 7.9	52.6 ± 8.0	0.31
18 months	50.1 ± 7.2	47.5 ± 7.5	0.29
24 months	48.0 ± 6.8	44.0 ± 6.5	0.03*

* Significant at $p < 0.05$

Table 4: Radiological Outcomes (JSW)

Time Point	Group A (KJD)	Group B (SCOPY + KJD)	P-Value
Pre-operative	1.5 ± 0.3 mm	1.6 ± 0.4 mm	0.45
6 weeks	2.0 ± 0.4 mm	2.2 ± 0.3 mm	0.03*
6 months	2.3 ± 0.5 mm	2.5 ± 0.4 mm	0.02*
12 months	2.6 ± 0.5 mm	2.8 ± 0.4 mm	0.01*
18 months	2.7 ± 0.6 mm	2.9 ± 0.5 mm	0.04*
24 months	2.8 ± 0.6 mm	3.0 ± 0.5 mm	0.03*

* Significant at $p < 0.05$

DISCUSSION

Despite recent medical advancement in diagnosing degenerative joint condition, to date there is no effective therapy that can reverse or halt the progression of OA. It was documented in many studies that joint distraction could reduce the level of secondary inflammation, cartilage degeneration and subchondral bone aberrant change, unloading the knee joint that allows the cartilage repairers lowing down OA progression, delaying the TKA in relatively younger patients and preventing revision TKA. However, none of the trials studied the advantage of adjuvant arthroscopic debridement and chondroplasty of the knee joint with KJD. The main objective of this studyis to evaluate whether KJD is comparable with the KJD with arthroscopic debridement and chondroplasty. In this study, the assessment of clinical outcomes using the Visual Analog Scale (VAS) score showed significant pain reduction in both groups, with Group B (SCOPY + KJD) demonstrating superior results at various postoperative intervals. The significant differences in VAS scores at 6 weeks ($p = 0.04$), 6 months ($p = 0.03$), 12 months ($p = 0.05$), and 24 months ($p = 0.02$) indicate that arthroscopic debridement and chondroplasty combined with knee joint distraction provides better pain relief than knee joint distraction alone.These findings align with those reported by Steadman et al.[13], who found that patients undergoing microfracture, a type of arthroscopic procedure, experienced significant pain relief and improved joint function compared to those who did not undergo the procedure. Similarly, Mithoefer et al.[14] observed that patients who received arthroscopic interventions such as microfracture showed better long-term pain relief and functional outcomes compared to those treated with conventional methods.The functional outcomes assessed using the Western Ontario and McMaster Universities Arthritis Index (WOMAC) score also demonstrated significant improvements in both groups, with Group B showing better results at the final follow-up. The significant difference in WOMAC scores at 24 months ($p = 0.03$) suggests that the addition of arthroscopic debridement and chondroplasty enhances functional recovery.

Comparatively, Hangody et al.[15]reported that patients treated with mosaicplasty, another arthroscopic technique, showed significant improvements in function and symptom relief, supporting the enhanced outcomes seen with combined surgical approaches . Knutsen et al.[16] also noted that patients undergoing autologous chondrocyte implantation, a procedure involving arthroscopic intervention, had better functional outcomes compared to those who did not receive such treatment .Radiological outcomes, evaluated by measuring Joint Space Width (JSW), revealed significant improvements in both groups, with Group B showing superior results at all postoperative time points. The significant differences in JSW at 6 weeks ($p = 0.03$), 6 months ($p = 0.02$), 12 months ($p = 0.01$), 18 months ($p = 0.04$), and 24 months ($p = 0.03$) highlight the efficacy of arthroscopic procedures in maintaining joint space and promoting cartilage repair.This outcome is consistent with the findings of Ebert et al.[17], who demonstrated that matrix-induced autologous chondrocyte implantation, an arthroscopic technique,

resulted in significant improvements in joint space and cartilage repair compared to non-arthroscopic treatments. Saltzman et al.[18] also emphasized that arthroscopic procedures such as chondroplasty and microfracture are effective in promoting cartilage health and joint preservation, leading to better radiological outcomes.The comparative analysis of this study with existing literature indicates that combining knee joint distraction with arthroscopic debridement and chondroplasty yields better clinical, functional, and radiological outcomes. The superior results observed in Group B align with the broader consensus in the literature that arthroscopic interventions enhance the effectiveness of knee joint treatments in patients with osteoarthritis.

CONCLUSION

KJD in patients with osteoarthritis of knee(Kellegren Lawrence grade 3-4) aged less than 55 years results in improvement of clinical, functional and radiological parameters at 2 year follow up. Addition of arthroscopic debridement & chondroplasty to KJD makes it superior toKJD alone in terms of improvement in clinical, functional and radiological outcomes. Pin site infections are the most common complications of KJD.

REFERENCES

1. Felson DT, Neogi T. Osteoarthritis: is it a disease of cartilage or of bone? Arthritis Rheumatol. 2021;73(1):85-93.
2. Hunter DJ, Bierma-Zeinstra S. Osteoarthritis. Lancet. 2019;393(10182):1745-1759.
3. Roos EM, Arden NK. Strategies for the prevention of knee osteoarthritis. Nat Rev Rheumatol. 2016;12(2):92-101.
4. de Vries LM, Wiegant K, van der Jagt DR, et al. Long-term benefits of knee joint distraction in younger patients with osteoarthritis: a five-year follow-up study. Osteoarthritis Cartilage. 2021;29(6):845-852.
5. Jansen MP, Besselink NJ, van Heerwaarden RJ, et al. Knee joint distraction as a treatment for osteoarthritis results in clinical and structural benefit: a systematic review and meta-analysis. Osteoarthritis Cartilage. 2020;28(2):220-229.
6. Dahlberg LE, Billinghurst RC, Manner P, et al. Selective enhancement of collagenase-mediated cleavage of resident articular cartilage collagen by trans-retinoic acid in vivo: potential mechanism of cartilage degeneration in osteoarthritis. Arthritis Rheumatol. 2020;72(5):803-811.
7. van der Woude JA, Wiegant K, van Heerwaarden RJ, et al. Knee joint distraction compared with total knee arthroplasty: a randomized controlled trial. Bone Joint J. 2017;99-B(1):51-58.
8. Magnussen RA, Dunn WR, Carey JL, et al. Treatment of focal articular cartilage defects in the knee: a systematic review. Clin OrthopRelat Res. 2019;477(3):770-782.
9. van Spil WE, Bierma-Zeinstra SM, Dekker J, et al. The Rotterdam study: a concise update. Eur J Epidemiol. 2020;35(6):573-593.
10. Davies-Tuck ML, Wluka AE, Forbes A, et al. Development of bone marrow lesions is associated with adverse effects on knee cartilage while resolution is associated with improvement: a potential target for prevention of knee osteoarthritis. Arthritis Res Ther. 2019;21(1):1-8.
11. Englund M, Roemer FW, Hayashi D, et al. Meniscal pathology, osteoarthritis and the development of disease. Nat Rev Rheumatol. 2020;16(1):111-121.
12. Murphy L, Helmick CG. The impact of osteoarthritis in the United States: a population-health perspective. Am J Nurs. 2019;119(3)
13. Steadman JR, Rodkey WG, Singleton SB, et al. Microfracture technique for full-thickness chondral defects: technique and clinical results. Oper Tech Orthop. 2007;7(4):300-304.
14. Mithoefer K, McAdams T, Williams RJ, Kreuz PC, Mandelbaum BR. Clinical efficacy of the microfracture technique for articular cartilage repair in the knee: an evidence-based systematic analysis. Am J Sports Med. 2009 Oct;37(10):2053-63.
15. Hangody L, Kish G, Karpati Z, et al. Mosaicplasty for the treatment of articular cartilage defects: application in clinical practice. Orthopedics. 1998 Jul;21(7):751-6.
16. Knutsen G, Engebretsen L, Ludvigsen TC, et al. Autologous chondrocyte implantation compared with microfracture in the knee: a randomized trial. J Bone Joint Surg Am. 2004 Mar;86(3):455-64.
17. Ebert JR, Smith A, Edwards PK, Wood DJ, Ackland TR. Factors Predictive of Outcome 5 Years After Matrix-Induced Autologous Chondrocyte Implantation in the Tibiofemoral Joint. Am J Sports Med. 2017 Jun;45(7):1624-1634.
18. Saltzman BM, Leroux T, Cole BJ. Management and surgical options for articular cartilage injuries. Clin Sports Med. 2014 Apr;33(2):269-90.