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Case Series

Modified fourth generation autologous cartilage transplantation for grade 2-3 knee osteoarthritis

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ABSTRACT

Osteoarthritis (OA) of the knee poses a significant burden on physical mobility and quality of life, especially in middle-aged adults. This study evaluates the outcomes of a modified fourth-generation autologous cartilage transplantation technique developed to overcome limitations of traditional cartilage repair strategies. The major learning curve observed during this study was that patient preferred a minimally invasive and a shorter hospital stay technique over traditional TKR. The case series involves a cohort of 15 patients with Grade 2-3 knee OA, the case series showed significant improvements in pain relief, knee function, early mobilization, and patient satisfaction with no reported adverse events. Some patients had follow-up data extending up to 5 years, with results consistent with 6-month outcomes. Improved patient mobility score and improved patient satisfaction score noted. This technique offers a cost-effective, single-stage, arthroscopic alternative with promising short- and mid-term outcomes. Thus, this technique caters to the population at early osteoarthritis stage preventing an Early replacement.

Keywords: Knee osteoarthritis, Cartilage transplantation, NPRS, Autologous cartilage, Fourth-generation ACI, PRP, Arthroscopic surgery

INTRODUCTION

Osteoarthritis (OA) of the knee is a progressive degenerative condition affecting nearly one-third of the Indian adult population. As the prevalence of OA continues to rise with increasing age, obesity, and lifestyle-related factors, the demand for effective cartilage-preserving interventions has grown significantly. For patients with Grade 2-3 OA, who often fall into the therapeutic gray zone—not advanced enough for joint replacement but significantly symptomatic—traditional management options can be unsatisfactory. Autologous Chondrocyte Implantation (ACI), particularly its fourth-generation variant, has emerged as a gold standard for focal cartilage repair.[3] However, this procedure involves multiple stages—cartilage biopsy, in vitro cell culture, and delayed reimplantation—along with extended postoperative immobilization and high costs.[3] These challenges often limit its accessibility, especially in low-resource settings. To address these gaps, we developed a modified technique involving a single-stage, arthroscopic transplantation of autologous cartilage, harvested and processed intraoperatively without the need for lab culture or staged surgeries. This study aims to evaluate the outcomes, safety, and feasibility of this approach.

Objectives

The objectives of the study were to assess the clinical effectiveness of a novel autologous cartilage transplantation technique for treating Grade 2-3 knee OA; to evaluate postoperative pain, functional recovery, and patient satisfaction over short and mid-term follow-up; to compare the feasibility and cost with traditional ACI and

microfracture techniques; to document the procedural technique and outcomes for future scalability.[2,3]

CASE SERIES

Study design and sample

An observational single group prospective interventional clinical study. To enhance patient outcomes by evaluating recovery, mobility, and overall satisfaction with the new technique involving 15 patients diagnosed with Grade 2-3 OA of the knee. Data was collected from patient records and follow-up evaluations, with some patients being monitored for up to 5 years postoperatively.

Inclusion criteria

Age ≥18 years; radiologically confirmed Grade 2-3 OA (Kellgren-Lawrence classification); Cartilage defect in MRI were included.

Exclusion criteria

Deformities or advanced OA; requirement of concomitant open or extensive reconstructive surgery (e.g., ORIF/CRIF) were excluded.

Surgical technique

The procedure is performed under spinal or general anesthesia. Standard anterolateral and anteromedial portals are created for arthroscopic access. Healthy cartilage is harvested from non-articular surfaces of the femoral condyle- intercondylar notch using an arthroscopic shaver.[1] An autologous tissue collector system is employed to collect and filter the cartilage fragments. PRP is prepared intraoperatively using autologous thrombin system and mixed with the harvested cartilage to form a fibrin matrix. The mixture is loaded into an 18G syringe and injected into the cartilage defect site under direct visualization. The joint is kept in position for 2-3 minutes to allow matrix setting.[9] A similar technique is used to treat cartilage defects in Talar bone.[7]

Postoperative care

Mobilization is initiated on same day for patients undergoing procedure under general anesthesia, mobilization initiated on post operative day 1 if procedure was done under spinal anesthesia. Weight-bearing as tolerated. Physiotherapy begins immediately post-surgery to preserve joint motion and muscle strength.

Demographics

Mean age: Mean ± SD: 50.20±11.76years

Gender: 53.3% female, 46.7% male

20% had concomitant procedures (chondroplasty or lateral release) (Table 1).

Pain (NPRS)

Statistically significant reduction of pain from pre-op to 6 months (Wilcoxon signed-rank test, P<0.001). The majority (86.7%) of patients transitioned from moderate to minimal/no pain category (Figure 1).

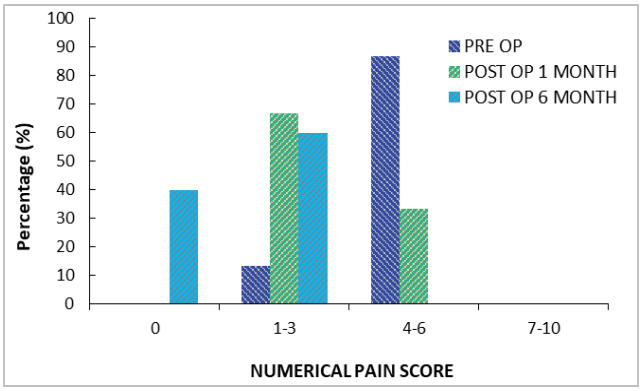

Figure 1: (P<0.001, significant, paired proportion test, change at 86.7%).

Functional outcome (oxford knee score) (figure 2)

Patients after undergoing procedure had better knee mobility and the quality of life significantly improved. Improvement was statistically significant (paired t-test, P <0.001).

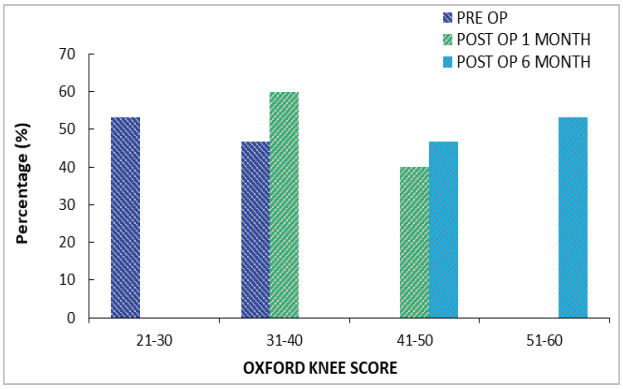

Figure 2: Oxford knee score- assessment at different time points of patients studied (p<0.001, significant, paired proportion test, change of 53.3%).

Hospital stay and analgesics

Most patients underwent procedure in day care basis were discharged on the same day. Patients undergoing the procedure under spinal anesthesia were discharged on Day 1. No patients required extended postoperative IV analgesics, no adverse events recorded.

Table 1: Numerical pain score (NPRS)- assessment at different time points of patients studied.

	Pain score			Patient satisfaction score		
Numerical pain score	**Pre OP**	**Post OP 1 month**	**Post OP 6 month**	**Post OP 6 month**	**No. of patients**	**%**
0	0 (0%)	0 (0%)	6 (40%)	1	0	0.0
1-3	2 (13.3%)	10 (66.7%)	9 (60%)	2	0	0.0
4-6	13 (86.7%)	5 (33.3%)	0 (0%)	3	0	0.0
7-10	0 (0%)	0 (0%)	0 (0%)	4	4	26.7
Total	15 (100%)	15 (100%)	15 (100%)	5	11	73.3

Patient satisfaction score

Patient satisfaction score was measured using a questionnaire (5 questions, each of the question was given one score if patient felt satisfied regarding the procedure, maximum score was 5). It was recorded in immediate post-operative period and was followed up at 6 months. Overall patient satisfaction score with regards to procedure and recovery was very good (Table 2).

Table 2: Patient satisfaction score post OP 6 month.

Patient satisfaction score post OP 6 month	No. of patients	%
1	0	0.0
2	0	0.0
3	0	0.0
4	4	26.7
5	11	73.3
Total	15	100.0

Long-term follow-up

Among patients followed up to 5 years, outcomes remained consistent with 6-month trends—no symptom recurrence, stable function, and no radiographic worsening of OA. X-rays showed no deterioration, although MRI was not performed.

DISCUSSION

The findings demonstrate that this modified cartilage transplantation technique is not only feasible but also effective in significantly improving pain and function in patients with early OA.[6] The advantages—single-stage procedure, minimal hospitalization, early mobilization, and high patient satisfaction—make it especially suitable for real-world clinical practice in resource-limited settings.

Comparison with ACI and microfracture

Traditional ACI, while effective, requires multiple surgeries and cell expansion, often delaying recovery.[1-3] Microfracture, on the other hand, relies on bone marrow stimulation and may not provide durable hyaline-like cartilage.[2] Our method bridges these two by offering matrix-based hyaline-like cartilage repair without the downsides of extended immobilization or costly cell culture.[10]

Cost-effectiveness

The overall cost of this procedure is comparable to diagnostic arthroscopy with PRP—far more affordable than ACI.[3,4] This accessibility widens treatment options for middle-income populations.

Surgical innovation

Use of devices like autologous tissue collector and autologous thrombin system streamlines the process, making the technique replicable and safe.[4] Eliminating the biopsy step further reduces morbidity and procedure time.[8]

Safety and patient experience

No intraoperative or postoperative complications were reported. Early mobilization likely contributes to improved functional recovery, reduced stiffness, and enhanced patient confidence.

Limitations

Small sample size; can be done only for two compartments; lack of MRI follow-up or re-arthroscopy for cartilage quality assessment; single-centre, non-comparative design; cannot be done for cases with tricompartmental or large cartilage defects. Future studies should involve randomized designs and multicenter collaborations to confirm reproducibility.

CONCLUSION

The modified fourth-generation autologous cartilage transplantation technique is a promising intervention for Grade 2-3 knee OA. It demonstrates excellent short- and mid-term results in pain relief, functional recovery, and patient satisfaction, with favorable safety and cost profiles. The biggest advantage of this technique being the same day discharge and same day mobilization. Patients undergoing this treatment are usually allowed to resume contact sports after 3 months of surgery. This technique holds the potential to fill the treatment gap between conservative therapy and joint replacement, especially in younger, active patients.

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