

Original Research Article

Clinical evaluation of core decompression with bone marrow aspirate concentrate in early-stage avascular necrosis of the hip: a prospective observational study

G. V. S. Rawi Babu*, Raviteja Ukkisala

Department of Orthopaedics, Gemcare Kamineni Hospital, Kurnool, India

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***Correspondence:**

Dr. G. V. S. Rawi Babu,

E-mail: gvsrawibabu@gmail.com

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ABSTRACT

Background: To evaluate the efficacy of core decompression (CD) combined with bone marrow aspirate concentrate (BMAC) in early-stage avascular necrosis (AVN) of the hip by assessing pain, stiffness, functional impairment and quality of life (QOL).

Methods: This prospective observational study was conducted at Gemcare Kamineni Hospital, Kurnool, on 46 patients with early-stage AVN (ARCO I–III). Patients underwent CD with BMAC. Outcomes were assessed pre- and post-operatively using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scale. Data were analyzed using paired t-test.

Results: Mean pain severity score decreased from 4.18 ± 0.90 pre-operatively to 2.50 ± 0.86 post-operatively ($p < 0.05$). Joint stiffness improved from 3.31 ± 0.76 to 2.15 ± 0.76 ($p < 0.05$). Physical functioning score improved from 3.68 ± 0.86 to 2.38 ± 0.78 ($p < 0.05$). Total WOMAC score reduced significantly from 3.75 ± 0.90 to 2.38 ± 0.80 ($p < 0.05$).

Conclusions: Core decompression combined with BMAC provides significant pain relief, improves hip function and enhances quality of life in early-stage AVN, delaying disease progression and the need for total hip arthroplasty.

Keywords: Avascular necrosis, Bone marrow aspirate concentrate, Core decompression, Hip preservation, Quality of life, WOMAC scale

INTRODUCTION

Avascular necrosis (AVN) of the femoral head is a progressive disease characterized by ischemia-induced bone death leading to structural collapse and joint dysfunction.¹ It typically affects young adults and if untreated, progresses to end-stage arthritis requiring total hip arthroplasty (THA). Early intervention is critical for preserving the native joint.²

Core decompression (CD) is a widely accepted joint-preserving technique in early AVN. Bone marrow aspirate concentrate (BMAC), rich in mesenchymal stem cells and growth factors, enhances osteogenesis and revascularization when used adjunctively with CD.³ This

study evaluates the clinical efficacy of CD combined with BMAC in improving pain, function and quality of life in early-stage hip AVN.

CD+Bone marrow aspirate concentrate (BMAC) is an increasingly used regenerative strategy for early-stage AVN of the femoral head. Benefits of CD+BMAC in Hip AVN.

Enhanced bone regeneration

BMAC is rich in mesenchymal stem cells (MSCs), growth factors and cytokines. When injected into the decompressed area, these cells stimulate osteogenesis, supporting the repair of necrotic bone.⁴

Better clinical outcomes

Improved pain relief and hip function in patients treated with CD+BMAC. Delayed or reduced need for total hip replacement (THR), especially in young patients.⁵

Disease progression delay

CD+BMAC actively promotes tissue healing. CD+BMAC lowers the rate of femoral head collapse in early AVN.⁶

Minimally invasive and safe

BMAC is autologous (from the patient's own iliac crest), minimizing rejection risk. Procedure with low complication rates when done properly.⁷

Cost-effective in early stages

Though there's an upfront cost for BMAC processing, it may prevent or delay THR reducing long-term disability and cost.⁸

Aim

To evaluate the efficacy and outcomes of CD combined with BMAC injection in the management of avascular necrosis.

Objectives

To assess the improvement in pain, joint stiffness and physical function using the WOMAC scale pre- and post-operatively. To determine the osteogenic and vascular regenerative effects of BMAC when injected into the decompressed femoral head. To evaluate the role of CD+BMAC in delaying or preventing the progression of femoral head collapse. To assess the need for future joint replacement surgery THA in patients undergoing CD+BMAC treatment. To analyse the overall improvement in QOL post-treatment.

Need of the study

To understand the impact of early joint preserving intervention (CD+BMAC) during early stages of AVN of the hip on rapid progression to femoral head collapse which often require total hip replacement at a young age.

To understand the effectiveness of combining CD with BMAC as a minimally invasive treatment to reduce pain, improve joint function and delay or prevent the need for hip arthroplasty.

METHODS

Study design

This study was a prospective observational study.

Study place

The study was conducted at Gemcare Kamineni Hospital, Kurnool from January 2024 to September 2024

Sample size

46 patients diagnosed with hip AVN (ARCO stages I–III).

Inclusion criteria

Patients with radiographically confirmed AVN, eligible for CD+BMAC and willing to provide informed consent were included.

Exclusion criteria

ARCO stage IV, obstetric patients and unwilling participants were excluded.

Procedure

Patients underwent CD followed by injection of autologous bone marrow aspirate concentrate harvested from the iliac crest.

Outcome assessment

Pain, stiffness and physical function were assessed using the WOMAC scale pre- and post-operatively.

Statistical analysis

Data were analysed using paired t-test. A p value < 0.05 was considered statistically significant.

RESULTS

Distribution of patients based on gender

A total of 46 patients were included in this study. Out of them 29 were males (63%) 17 were females (36%).

Distribution of patients based on age

According to age wise categorization, about 1 (2%) patient were in the age group of 11–20, 13 (28%) patients were in the age group of 21–30, 19 (41%) patients were in the age group of 31–40, 10 (21%) patients were in the group of 41–50 and 3 (6%) patients were in the age group of 51–60.

Distribution of patients based on comorbidities

Among the total 35 patients included in the study, the most common comorbidity observed was COVID-19, affecting 16 patients (45.7%). Alcohol use was reported in 9 patients (25.7%), while diabetes mellitus with hypertension (DM, HTN) was seen in 5 patients (14.3%). Obesity was the least common comorbidity, noted in 2 patients (5.7%). Overall,

comorbidities were present in a significant proportion of the study population, with COVID-19 being the predominant condition.

Distribution of patients based on unilateral staging

Out of a total of 20 unilateral cases, 10 were right-sided and 10 were left-sided. Among the right-sided cases, 5 (50%) were Stage II and 5 (50%) were Stage III. Similarly, on the left side, 3 cases (30%) were Stage II and 7 cases (70%) were Stage III. Overall, Stage III disease was more commonly observed (12 cases, 60%) compared to Stage II (8 cases, 40%), with an equal distribution between right and left sides.

Distribution of patients based on bilateral staging

Among the 26 patients with bilateral involvement, the most common staging pattern observed was Stage III on both sides (III–III), seen in 15 patients (57.7%). Stage II–III involvement (right–left) was noted in 6 patients (23.1%), while Stage III–II involvement (right–left) was observed in 5 patients (19.2%). Overall, Stage III disease predominated in bilateral cases, indicating a higher proportion of advanced-stage involvement on both sides.

Quality outcomes of CD+BMAC in hip AVN

Based on the WOMAC scale assessment, a significant improvement was observed in all evaluated parameters following the CD+ BMAC procedure. The mean pain severity score decreased from 4.18±0.90 (severe) preoperatively to 2.50±0.86 (moderate) postoperatively (p<0.05). Similarly, joint stiffness improved from 3.31±0.76 (moderate) to 2.15±0.76 (mild) (p<0.05).

Physical functioning impairment showed marked improvement, with mean scores reducing from 3.68±0.86 (severe) to 2.38±0.78 (moderate) (p<0.05). The total WOMAC score also demonstrated significant enhancement, declining from 3.75±0.90 (severe) preoperatively to 2.38±0.80 (moderate) postoperatively (p<0.05). These findings indicate that CD+BMAC treatment resulted in statistically significant improvement in pain, stiffness and physical function among patients.

Paired t-test

Mild (1–2.33), moderate (2.34–3.67) and severe (3.68–5).

Table 1: Distribution of patients based on gender.

S. no.	Gender	No. of patients	%
1	Male	29	63
2	Female	17	37

Table 2: Distribution of patients based on age.

S. no.	Age group	No. of patients	%
1	11–20	1	2
2	21–30	13	28
3	31–40	19	41
4	41–50	10	22
5	51–60	3	7
	Total	46	100

Table 3: Distribution of patients based on comorbidities.

Comorbidity	No. of patients
COVID-19	16
Alcohol	9
Obesity	2
DM, HTN	5
Total	35

Table 4: Distribution of patients based on unilateral staging.

Staging	Unilateral	
	Right	Left
II	5	3
III	5	7
Total	10	10

Table 5: Distribution of patients based on bilateral staging.

Staging	Bilateral
Right-Left	No. of Patients
II-III	6
III-II	5
III-III	15
Total	26

Table 6: Quality outcomes based on WOMAC scale.

S. no.	Variables CD+BMAC (WOMAC) scale	Pre-operative M+-SD	Status level	Post-operative M+-SD	Status level	P value
1	Pain severity	4.18±0.90	Severe	2.5±0.86	Moderate	<0.05
2	Joint stiffness	3.31±0.76	Moderate	2.15±0.76	Mild	<0.05
3	Physical functioning impairment	3.68±0.86	Severe	2.38±0.78	Moderate	<0.05
4	Total WOMAC scale	3.75±0.90	Severe	2.38±0.80	Moderate	<0.05

DISCUSSION

The present study evaluated the clinical efficacy of CD combined with BMAC in patients with early-stage AVN of the femoral head using the WOMAC scale as an outcome measure. The findings demonstrated a statistically significant improvement in pain, stiffness and functional parameters following the procedure, supporting the therapeutic potential of CD+BMAC as a joint-preserving intervention in the early stages of AVN.

In the current study, the majority of patients were male (63%), consistent with previous reports indicating a higher prevalence of AVN in males, often attributed to lifestyle and occupational factors. The peak incidence occurred in the 31-40 years age group (41%), highlighting the disease’s predominance among younger adults who are most affected by the long-term disability associated with hip collapse. Notably, a significant proportion of patients (34%) had a history of COVID-19 infection, emphasizing the emerging association between steroid use during COVID-19 management and the development of osteonecrosis, as previously described by Assad et al, (2022).^{9,10} Other contributing comorbidities included alcohol intake, diabetes, hypertension and obesity, all of which are known to compromise bone vascularity and regeneration. Core decompression remains a well-established procedure for early AVN, as it alleviates intraosseous pressure, restores venous outflow and facilitates revascularization. The adjunctive use of autologous BMAC, which is rich in mesenchymal stem cells and osteogenic growth factors, further augments bone repair through enhanced osteogenesis and angiogenesis. In this study, mean pain severity decreased from 4.18±0.90 to 2.50±0.86 and joint stiffness improved from 3.31±0.76 to 2.15±0.76. Physical functioning scores improved from 3.68±0.86 to 2.38±0.78 and the total WOMAC score

reduced significantly from 3.75±0.90 to 2.38±0.80 (p<0.05). These results collectively indicate significant symptomatic relief and functional recovery post-procedure. Importantly, only three patients required total hip arthroplasty (THA) during follow-up, suggesting that CD+BMAC can effectively delay or prevent the need for joint replacement, particularly in early-stage disease.

The findings of this study are in agreement with earlier literature supporting the combined use of CD and BMAC. Tabatabaee et al and Wang et al reported that patients receiving CD with concentrated bone marrow stem cells showed improved outcomes and delayed progression compared to those treated with CD alone.^{11,12} Similarly, Hernigou et al observed long-term joint preservation and decreased rates of femoral head collapse with autologous bone marrow grafting. These comparative results reinforce the concept that the biological augmentation of CD with stem-cell-rich aspirates provides superior outcomes over decompression alone. Despite these promising findings, the present study has certain limitations. The sample size was relatively small (n=46) and the follow-up duration was limited to six weeks, which may not capture long-term disease progression or radiological changes. Furthermore, the absence of a control group (CD alone) restricts direct comparison of therapeutic efficacy. Future studies with larger, multicentric cohorts and extended follow-up are warranted to validate these findings and evaluate the durability of outcomes. Incorporating imaging-based assessments such as MRI and ARCO stage progression could also provide more objective evidence of bone regeneration.

CONCLUSION

CD combined with BMAC injection for the management of early-stage AVN of the hip. BMAC was harvested and injected into the decompressed femoral head to enhance

osteogenic potential and promote vascular regeneration. This combined approach aims to delay or prevent femoral head collapse and may reduce the need for future joint replacement surgery. CD+BMAC is a safe, effective and joint preserving for early stage AVN of hip. In our study efficiency of CD+BMAC and quality outcomes are measured by using WOMAC scale obtained before the surgery is compared with score obtained after 6 weeks of surgery. In regard of quality outcome, authors have studied severity of pain, joint stiffness, impairment of physical functioning by using WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index) scale. pre-operative WOMAC scale score had shown pain, stiffness and physical functioning were severely impaired and post-operative score has shown improvement has the severity improved to moderate.

This improvement was found to be statistically significant ($p < 0.05$). By performing this study, we can conclude that the CD (Core decompression) combined with BMAC significantly helps in reducing the pain & regaining the functional impairment of hip and delay the need for THA (total hip arthroplasty) as that of pre-operative performance and also improves the patient QOL significantly.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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