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BENEFICIAL EFFECTS OF PERCUTANEOUS CORE DECOMPRESSION WITH BONE MARROW ASPIRATE CONCENTRATE IN THE CLINICAL MANAGEMENT OF AVASCULAR NECROSIS FROM STAGE III TO II: A 28 MONTHS FOLLOW-UP STUDY

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ABSTRACT

Background and Clinical Significance: Avascular necrosis (AVN) of the femoral head is a progressive and debilitating condition resulting from compromised blood supply, leading to bone ischemia, structural collapse, and eventual joint degeneration. Delayed intervention frequently necessitates total hip arthroplasty (THA). Early-stage management using minimally invasive and regenerative approaches aims to preserve the native joint, alleviate symptoms, and prevent disease progression. **Case Presentation:** A 40-year-old male presented with left hip pain and was diagnosed with AVN of the femoral head, classified as Ficat–Arlet Stage III. Magnetic resonance imaging (MRI) revealed STIR hyperintensity involving the left femoral head, neck, and intertrochanteric region, with additional acetabular involvement and minimal joint effusion. The patient underwent a minimally invasive intervention consisting of percutaneous core decompression

(PCD) augmented with autologous Bone Marrow Aspirate Concentrate (BMAC) and Platelet-Rich Plasma (PRP), delivered into the necrotic zone under fluoroscopic guidance. At 28-month follow-up, the patient demonstrated marked clinical and functional improvement. Pain, assessed using the Numeric Pain Rating Scale (NPRS), decreased from 6/10 preoperatively to 1–2/10. Functional outcomes showed significant gains in range of motion (ROM): hip flexion improved from 80° (painful) to 130° on the affected side, while extension increased from 10° to 15°. Internal rotation improved from 10° to 30°, and abduction from 15° to 35°. Muscle strength improved across all groups, with most reaching 5/5 on the Oxford MMT scale. Follow-up MRI demonstrated radiological regression from Stage III to Stage II AVN. **Conclusion:** This case highlights the potential of orthobiologic augmentation using BMAC and PRP in conjunction with core decompression as an effective joint-preserving strategy in AVN. The observed clinical, functional, and radiological improvements suggest that this combined approach may promote osteogenesis and angiogenesis, potentially reversing disease progression and delaying or avoiding the need for total hip arthroplasty in younger patients.

KEYWORDS: Avascular necrosis, Bone Marrow Aspirate Concentrate, Platelet Rich Plasma, Regenerative Orthopaedics, Femoral Head.

INTRODUCTION AND CLINICAL SIGNIFICANCE

Avascular necrosis (AVN) of the femoral head is a progressive and debilitating orthopaedic disorder characterized by compromised blood supply to the subchondral bone, resulting in osteocyte death, structural collapse, and eventual joint degeneration. The condition predominantly affects young and middle-aged adults and often progresses to femoral head collapse, ultimately necessitating total hip arthroplasty (THA) if left untreated. Recent literature identifies AVN as a significant contributor to disability, with considerable socioeconomic burden due to early functional impairment and reduced productivity.[1]

The etiology of AVN is multifactorial, with commonly implicated risk factors including prolonged corticosteroid use, chronic alcohol consumption, trauma, and idiopathic causes. The underlying pathophysiology involves disruption of microvascular circulation, impaired angiogenesis, and increased intraosseous pressure, leading to ischemic bone necrosis and progressive structural failure.[2] Conventional treatment strategies are largely stage-dependent and include pharmacological management, core decompression, and bone grafting procedures aimed at reducing intraosseous pressure and delaying disease progression. However, these

approaches are often limited in their capacity to regenerate necrotic bone or restore vascularity, particularly in more advanced stages of the disease.[3]

In recent years, regenerative orthopaedic therapies have emerged as promising disease-modifying strategies. Among these, bone marrow aspirate concentrate (BMAC) and platelet-rich plasma (PRP) have gained increasing attention due to their biological potential. BMAC contains mesenchymal stem cells with osteogenic differentiation capacity, while PRP is enriched with growth factors such as platelet-derived growth factor (PDGF) and vascular endothelial growth factor (VEGF), which promote angiogenesis, modulate inflammation, and enhance tissue repair.[4-6] Recent systematic reviews and clinical studies have demonstrated encouraging outcomes with these biologic therapies, particularly in early-stage AVN. Evidence suggests that BMAC and PRP, when used as adjuncts to percutaneous core decompression, can improve clinical outcomes, delay disease progression, and reduce the risk of femoral head collapse and increase the angiogenic potential.[7–9]

In this context, the present case report describes the successful management of femoral head AVN using a combination of BMAC and PRP, highlighting its potential as a minimally invasive regenerative approach for disease modification and possible stage reversal.

CASE PRESENTATION

Patient Information

A 40-year-old male patient was diagnosed with AVN of left hip joint from 6 months. There was no significant past medical history or known co-morbid conditions reported at the time of presentation.

Medical History

The patient reported a Pain in left Hip joint and difficulty in walking, squatting and accessing stairs with insidious onset of pain in left hip joint from 6 months and symptoms aggravated in past few weeks. On clinical examination, Ectomorphic, Antalgic pain – sway towards right and on Palpation Tenderness (Grade – II) over anterior hip and groin region was noted. Imaging studies of left hips dated 20/10/2023 revealed AVN of left femoral heads, classified as Stage III.

Family History

No significant family history was reported.

Psychosocial History

Persistent hip pain significantly limited the patient's mobility and contributed to psychological stress. However, no formal psychiatric consultation was sought.

Genetic Information

No relevant genetic testing was performed.

Relevant Past Interventions

Insidious onset of pain in left hip joint from 6 months and symptoms aggravated in past few weeks, imaging confirmed left hip AVN.

Clinical Findings

The patient presented with left hip AVN from 6 months, with progressive worsening of pain, particularly in the left hip over the past few weeks.

Diagnostic Assessment

Clinical examination revealed mild tenderness (Grade II) on deep palpation over the anterior hip and groin region of the left hip joint. The Numeric Pain Rating Scale (NPRS) score was 6/10. Range of motion (ROM) assessment demonstrated significant restriction on the affected side: hip flexion was 140° on the right and 80° on the left (painful), extension was 20° on the right and 10° on the left, internal rotation was 35° on the right and 10° on the left, and abduction was 40° on the right and 15° on the left.

Muscle strength, assessed using the Oxford Manual Muscle Testing (MMT) scale, showed a reduction power in the affected limb: hip flexors were graded 5/5 on the right and 3/5 on the left, hip extensors 5/5 on the right and 4/5 on the left, hip abductors 5/5 on the right and 3/5 on the left, and rotators 5/5 on the right and 4/5 on the left.

Magnetic resonance imaging (MRI) of the hips (dated 20/10/2023) revealed findings consistent with avascular necrosis of the left femoral head, classified as Ficat–Arlet Stage III.

Therapeutic Intervention

The patient was admitted for management of left hip AVN. Under spinal anaesthesia, the hip region was prepared and draped under sterile conditions. Under fluoroscopic and PCD guidance BMAC augmented with PRP was performed using a decompression needle power drive.[5,6] The patient was discharged in stable condition after 24 hours of hospitalization.

Follow-up and Outcomes

Clinical outcomes were assessed at baseline (day of intervention) and at 28 months post-procedure using the Numeric Pain Rating Scale (NPRS), hip range of motion (ROM), and muscle strength evaluated by the Oxford Manual Muscle Testing (MMT) scale.

A marked reduction in pain was observed, with the NPRS score improving from 6/10 at baseline to 1/10 at 28 months, indicating substantial symptomatic relief. Hip range of motion demonstrated significant functional improvement over the follow-up period. At baseline, hip flexion was 140° in the right hip and 80° (painful) in the left hip, which improved to 140° (right) and 130° (left) at 28 months. Hip extension improved from 20° (right) and 10° (left) to 20° (right) and 15° (left). Internal rotation increased from 35° (right) and 10° (left) at baseline to 35° (right) and 30° (left) at follow-up. Similarly, hip abduction improved from 40° (right) and 15° (left) to 40° (right) and 35° (left) (Table 1).

Muscle strength assessment using the Oxford MMT scale revealed progressive improvement across all muscle groups. Hip flexor strength improved from 5/5 (right) and 3/5 (left) at baseline to 5/5 (right) and 4/5 (left) at 28 months. Hip extensor strength increased from 5/5 (right) and 4/5 (left) to 5/5 bilaterally. Hip abductor strength improved from 5/5 (right) and 3/5 (left) to 5/5 bilaterally. Similarly, rotator muscle strength improved from 5/5 (right) and 4/5 (left) at baseline to 5/5 bilaterally at follow-up (Table 2). Magnetic resonance imaging (MRI) performed at baseline in October 2023 demonstrated Stage III avascular necrosis of the left femoral head. Follow-up imaging at 28 months showed radiological improvement with regression to Stage II, suggesting partial structural recovery.

Overall, these findings indicate significant improvements in pain, joint mobility, muscle strength, and radiological status over the 28-month follow-up period.

Table 1: Time line Range of Motion.

Time Line	Hip Flexors		Extension		Internal Rotation		Abduction	
	Right	Left	Right	Left	Right	Left	Right	Left
0 Day – Day of Treatment	140^o	80^o	20^o	10^o	35^o	10^o	40^o	15^o
28 Months	140^o	130^o	20^o	15^o	35^o	30^o	40^o	35^o

Table 2: Muscle Power (Oxford MMT Scale).

Time Line	Hip Flexors		Hip Extensors		Hip Abductor		Rotators	
	Right	Left	Right	Left	Right	Left	Right	Left
0 Day – Day of Treatment	5/5	3/5	5/5	4/5	5/5	3/5	5/5	4/5
28 Months	5/5	4/5	5/5	5/5	5/5	5/5	5/5	5/5

MRI Findings Left Hip at base line: October 2023 (image not Given).

- STIR hypersensitivity involving left femur head and neck intertrochanteric region.
- Geographical T2 hypo intensity noted involving the superior aspect of head of the head of the femur.
- Evidence of STIR hyperintensity involving the acetabulum with minimal joint effusion.
- Above features are suggestive of avascular necrosis stage III.

MRI Findings Left Hip at post procedure: February 2026 (image not Given).

- Left femoral head shows geographical defect – Left grade -II AVN changes (Ficat arlet) with secondary osteoarthritis
- Kerboul angle -200^{o} (Moderate).
- Nishi – Type B on left side (2/3rd of weight bearing area)
- Mild left hip joint effusion shows grade II AVN.

DISCUSSION

AVN of the femoral head continues to represent a significant therapeutic challenge, particularly in young and middle-aged individuals where joint-preserving interventions are preferred over arthroplasty. The disease is characterized by a complex and multifactorial pathophysiology involving vascular insufficiency, impaired osteogenic potential, increased intraosseous pressure, and progressive subchondral bone collapse. Contemporary evidence emphasizes that early intervention is critical, as structural deterioration beyond the pre-collapse stage markedly reduces the success of conservative and regenerative strategies.[2]

Traditional approaches such as core decompression aim to reduce intraosseous pressure and improve local blood flow; however, their regenerative capacity remains limited, particularly in the absence of biologic augmentation.[3] This limitation has led to growing interest in orthobiologic therapies that target the underlying pathophysiological mechanisms, including impaired angiogenesis and deficient bone remodelling.[10]

Bone marrow aspirate concentrate (BMAC) has emerged as a promising regenerative modality due to its rich cellular composition, including mesenchymal stromal cells (MSCs), hematopoietic progenitors, and cytokines that facilitate osteogenesis and neovascularization. Recent systematic reviews and meta-analyses have demonstrated that BMAC augmentation, particularly when combined with core decompression, is associated with improved clinical outcomes, reduced pain scores, and delayed radiographic progression compared to conventional treatment alone.[11-13] These benefits are attributed to the ability of MSCs to differentiate into osteogenic lineages and enhance local repair processes within the necrotic femoral head.

Platelet-rich plasma (PRP) provides complementary biological effects through its high concentration of growth factors such as platelet-derived growth factor, transforming growth factor-β, and vascular endothelial growth factor. These mediators play a crucial role in angiogenesis, extracellular matrix synthesis, and modulation of inflammation.[14] Recent studies suggest that PRP not only enhances tissue repair but also improves the microenvironment for stem cell survival and function, thereby potentiating the therapeutic efficacy of cell-based interventions.[15]

The combined use of BMAC and PRP has gained increasing attention as a synergistic regenerative strategy. Emerging clinical evidence indicates that this combination therapy may result in superior pain relief, improved functional outcomes, and a reduced rate of femoral head collapse compared to monotherapy approaches.[16-17] In the present case, the patient demonstrated substantial improvement in pain, hip mobility, and muscle strength over a 28-month follow-up period, along with radiological stabilization. These findings are consistent with recent literature supporting the concept that combined orthobiologic therapy enhances the reparative capacity of necrotic bone through both cellular and growth factor–mediated mechanisms.

Despite these encouraging outcomes, variability in clinical response remains a significant concern. Factors such as stage of disease, lesion size and location, patient-specific risk factors, and variability in biologic preparation protocols may influence treatment efficacy.[12] Furthermore, the lack of standardized protocols for BMAC and PRP preparation and administration continues to limit comparability across studies. Therefore, while the present case adds to the growing body of supportive evidence, larger prospective randomized trials

with standardized methodologies are required to establish definitive clinical guidelines and long-term efficacy.

CONCLUSION

This case demonstrates that combined BMAC and PRP therapy, when used alongside percutaneous core decompression, may serve as an effective joint-preserving strategy in AVN of the femoral head. The observed improvements in pain, function, and radiological status highlight the potential of regenerative orthopaedics in modifying disease progression. Further large-scale, well-designed studies are required to standardize protocols, optimize patient selection, and confirm long-term efficacy.

Author Contributions

Vijayalakshmi Venkatesan: Worked on the manuscript and expertise in regenerative/Orthobiologics for cell transplantation.

Venkatesh Movva: Principal clinician to diagnose the disease pertaining to the Musculoskeletal diseases (MSDs) and sports injuries and an interventional therapist using the Orthobiologics (BMAC & PRP) and post follow up of the patients.

Anand Alluri: Clinician working with the patients suffering from MSDs and sports injuries as well as to treat the patients using the Orthobiologics (BMAC & PRP) and post follow up of the patients.

Syed Khaleel: Expertise in physiotherapy and rehabilitation of the patients receiving the therapy.

Sunitha Manne Mudhu: Participated in the preparation of Manuscript.

Informed Consent Statement: Written informed consent has been obtained from the patient to publish this paper.

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