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ORIGINAL ARTICLE

Augmentation of Autologous Platelet-Rich Plasma in Hip Salvage in Stages I and II of Avascular Necrosis: Randomized Blinded Trial Comparing 3 Surgical Techniques in 82 Patients

Nishit Palo[1] · Binayak Ray[2] · Mahima Lakhanpal[3] · Naveen Jeyaraman[4] · Abhishek Shukla[5] · Abhishek Malik[6]

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Abstract

Introduction Avascular necrosis of the femoral head is common in routine orthopedic clinics. The challenge arises in managing early stages (I and II) without obvious radiological evidence. Authors explore this naïve research area by comparing surgical procedures in early AVN patients.

Materials and Methods A prospective multicentric study was performed from November 2020 to February 2023 on 82 patients treated with surgical decompression and adjuvants, concerning the defined inclusion and exclusion criteria. Radiopacity and intraosseous edema resolution and THA conversion rates were assessed. Hip pain VAS, groin/thigh pain, difficulty in sitting cross-legged incidence, pain-free walking distance, Harris hip scores, 30-s chair test, and complications were noted.

Results Among 82 patients, the mean age was 28.46 years. Male:female ratio of 3.9:1. 8.5% had bilateral affection and 48.78% had a positive family history. 93.90% presented with groin pain and difficulty in sitting cross-legged, restricted hip movements in 85.3%, and thigh pain in 54.87%. Harris hip scored worst in Group 3 followed by Group 2 and Group 1. 63.41% and 36.58% of patients had Grades 1 and 2 AVN, respectively. At 1 week post-operatively, 96.3% and 93.9% of patients were relieved from groin and thigh pain, respectively ($p < 0.001$); the trend being Group 3 > Group 2 > Group 1. Hip pain VAS followed a similar trend. At 4 weeks, Harris hip scores improved in Group 3 > Group 2 > Group 1. At 6 months, the trend was Group 2 > Group 3 > Group 1. Group 3 had better 30-s chair test results, pain-free walking distance, and longer cross-legged sitting time. Complication rate of 3.6%. 6.09% of patients underwent THA later. Sclerotic patch and marrow edema resolution early in Group 3, i.e., 46 and 31 days respectively, followed by Group 2 and Group 1.

Conclusion In Stages I and II AVN, biplanar core decompression (double) and intraosseous PRP injection is a promising salvage option; patients have better early hip scores (4 weeks), and early groin and thigh pain recovery. Patients treated early have better clinical and radiological recovery.

Keywords Hip salvage · Decompression · Avascular necrosis · Platelet-rich plasma

✉ Nishit Palo
nishit_palo@yahoo.com

Binayak Ray
binayakray09@gmail.com

Mahima Lakhanpal
mahimalakhanpal@yahoo.com

Naveen Jeyaraman
naveenjeyaraman@yahoo.com

Abhishek Shukla
abhishekshukla4@gmail.com

Abhishek Malik
abhishek.malik.16@gmail.com

[1] Department of Orthopaedics, Sharda Medical College & Hospital, Greater Noida, Uttar Pradesh, India

[2] Department of Orthopaedics, All India Institute of Medical Sciences, Kalyani, Kolkata, India

[3] Department of Anaesthesiology, Santosh Medical College & Hospital, Ghaziabad, Uttar Pradesh, India

[4] Department of Orthopaedics, ACS Medical College & Hospital, Dr MGR Educational and Research Institute, Chennai, Tamil Nadu, India

[5] Department of Orthopedics, Holy Family Hospital, New Delhi, India

[6] Department of Orthopaedics, Santosh Medical College & Hospital, Ghaziabad, Uttar Pradesh, India

Introduction

Hip arthritis following femoral head degeneration or collapse is a common musculoskeletal condition in the routine orthopedic clinic. Mostly attributed to avascular necrosis (AVN), the etiology remains unknown in most cases. In early stages (I, II, and early III) with the articular cartilage viability, salvage appears to be a viable option [1]; whereas in the later stages (late III and IV), owing to femoral head distortion, subchondral bone collapse or acetabulum involvement demands replacement of diseased joint [2]. The challenge arises in managing the early stages (I and II) where patients complain of hip pain or groin pain, without obvious radiological evidence supporting a diagnosis of AVN.

Core decompression is a commonly performed and safe salvage procedure for AVN of the femoral head [3]. Performed alone or in combination with fibula strut graft, orthobiologics like platelet-rich plasma (PRP), bone marrow aspirate concentrate (BMAC), bone morphogenic protein (BMP), mesenchymal stem cells (MSC), or intraosseous bisphosphonates like ibandronate constitute the spectrum of hip salvage procedures for AVN of the femoral head [4–6]. BMAC and PRP act synergistically with core decompression to reverse the ongoing osteonecrosis process, thus preventing femoral head collapse [7].

AVN of the hip is often bilateral, with a presentation lag between either hip joint varying from 2 to 5 months. The natural progressive intraosseous pathology goes unnoticed in early stages or is maltreated especially in rural areas [8], thereby limiting the patient's functional abilities as the disease progresses [9]. These patients present later to specialized centers with subchondral collapse and head deformation or acetabular involvement; with limited treatment options to explore, hip replacement seems to be the only viable option [10–12].

Therefore, arriving at a diagnosis of AVN in its early stages is purely clinical. The clinicians ought to have strong suspicion, especially in the absence of strong radiology evidence. Authors explore this naïve research area by comparing a few surgical procedures with clinical and surgical assessment in patients with hip or groin pain, suspected of having early AVN of the femoral head.

Materials and Methods

A prospective multicentric study was performed at 2 centers from November 2020 to February 2023 on 82 patients with early AVN of the femoral head treated with surgical decompression and adjuvants. Patients were randomized into 3 groups; randomization was done by computer-generated numbers.

Inclusion Criteria

Patients of both sexes aged between 17 and 52 years, patients with hip/groin pain with restricted hip rotations, patients with MRI diagnosed Ficat and Arlet stages 1 and 2 AVN, any etiology, and patients who are willing to participate in our study were included in the study.

Exclusion Criteria

Patients of both sexes aged less than 17 and more than 52 years, patients with MRI diagnosed Ficat and Arlet stages 3 and 4 AVN, patients who refused consent to the study protocol, and patients who lost to follow-up were excluded from the study.

Surgical Technique

Patients were placed on a radiolucent table in the supine position. The affected hip was elevated using a radiolucent drape sheet bolster. Ultrasound-guided regional blocks were performed by experienced anesthetists depending on the bone involved (fascia iliaca and fascia lata block for hip and adductor canal and sciatic-popliteal block for leg). Surgical parts were painted and draped as usual. A fibula graft was harvested from the contralateral leg. First, under aseptic precautions, surgical soft tissue dissection was performed, and fibula graft was harvested by a minimally invasive approach. Guide wires were placed under fluoroscopy guidance, and the femoral (core) channel was drilled with a 10-mm reamer till sub-chondral bone. Platelet-rich plasma was prepared and injected into the core. The fibula graft was immediately inserted post-PRP injection to avoid spillage. Bone wax was used to seal the core in patients where fibula graft was not used.

PRP Preparation Protocol

Platelet-rich plasma (PRP) was prepared using Arthrex ACP Syringe under sterile conditions. The syringe was loaded with 2-ml ACD-A anticoagulant, and 13-ml blood was drawn into the ACP Syringe from the cubital vein using a scalp vein set (18G). This syringe was centrifuged at 3000 rpm for 7 min. The inner plunger was pulled to draw prepared PRP into the inner syringe. PRP harvest is approximately 6 ml from 30 ml of blood. The PRP was injected into the femoral head using a spinal needle (18G), site was confirmed under fluoroscopy. Immediately following PRP injection, the slot was filled with fibula graft, and

the step was performed under fluoroscopy control. Bone wax was used to seal the drilled slot where fibula graft was not used.

Surgical procedure performed across the 3 groups were as follows.

(a) Group 1: Core Decompression (Single) + Fibula Graft + PRP (Intra-osseous) (Fig. 1),
(b) Group 2: Core Decompression (Single) + PRP (Intraosseous + Intra-articular) (Fig. 2), and
(c) Group 3: Core Decompression (Double) + PRP (Intraosseous) (Fig. 3).

Randomization and Blinding Protocol

Patients were randomized into 3 groups. Surgical steps were the same for all patients, groups differed in core decompression slots and adjuvant used. Surgeons performing the surgery were unaware of patient grouping or ongoing study. Doctors performing follow-up assessments were unaware of patient grouping and procedures performed.

Parameters Assessed

Resolution of radiopacity (assessed on radiographs), integration of fibula graft (assessed on CT scan), reversal of intraosseous edema/necrotic changes (assessed on MRI), and conversion to THA rates.

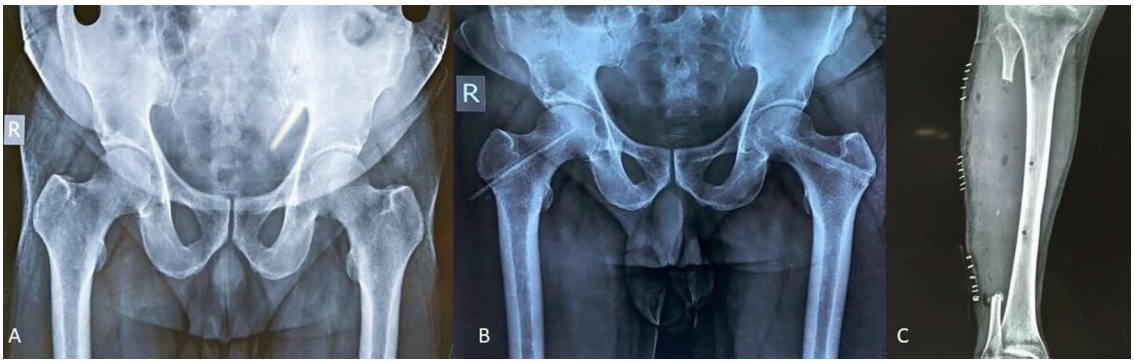


Fig. 1 **A** Bilateral AVN of the femoral head (Ficat and Arlet-1); **B** core decompression (single slot) performed with intraosseous PRP injection + fibula graft placement; **C** fibula graft harvested by minimally invasive approach

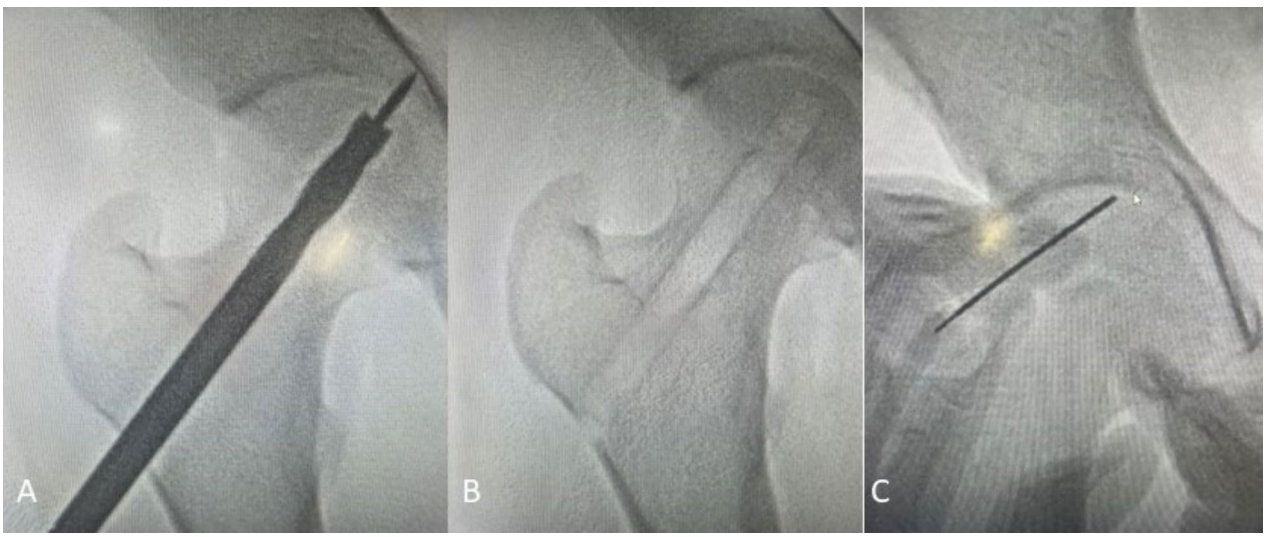


Fig. 2 **A** AVN of the right femoral head (Ficat and Arlet-1)—reamer advanced over guidewire for core preparation; **B** single slot core decompression and intraosseous PRP; **C** intra-articular PRP after hip aspiration trial

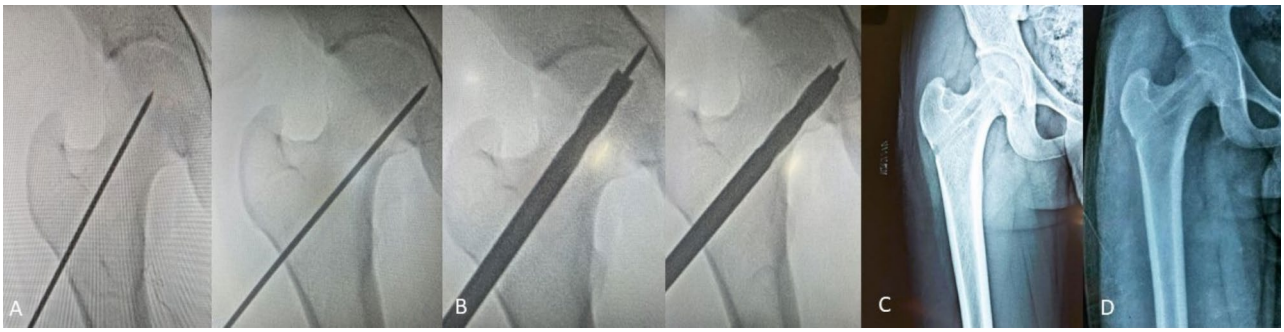


Fig. 3 **A** Guidewire placement for bi-planar core preparation; **B** reamer advanced over guidewires for core preparation; **C**, **D** post-operative radiograph (PoD1) and (6 weeks) respectively

Clinical Evaluation

Hip pain VAS, groin/thigh pain status, difficulty in sitting cross-legged incidence, pain-free walking distance, modified Harris hip scores, 30-s chair test, surgical scar condition, time to suture removal, and complications.

Radiological Evaluation

Radiology was assessed by 2 radiologists unaware of the study and the mean of the readings was taken. Radiographs were performed weekly from 4 to 8 weeks to evaluate the resolution of the sclerotic patch. MRI scans were performed weekly from 4 to 8 weeks to evaluate bone edema or geographic defect resolution. CT scans were performed weekly from 6 to 8 weeks to evaluate and confirm union at the fibula graft and graft site interface.

Rehabilitation

Non-weight-bearing walking was allowed on PoD1 with bed rest for 7 days (bilateral cases). Sitting by hanging leg on the bed and chair was allowed on PoD1. Active hip, knee, and ankle exercises were allowed on the bed. Weight-bearing was allowed after 7 days.

Follow-Up

Patients were discharged the next day after surgery and were followed up in person at PoD5, PoD10, and PoD15 for dressing and suture removal and then at 2-week intervals till 12 weeks; at 4-week intervals till 1 year.

Statistical Analysis

SPSS version 25.0, IBM Corp, Chicago, Illinois, USA was used. Pre- and post-operative outcomes were compared by paired sample t-test. To compare clinical results between the groups, an independent two-sample t-test and Chi-Square test were used; a p value < 0.001 was considered significant.

Results

Initially, 86 patients were enrolled; 4 patients were lost to follow-up around 6 weeks post-operatively. Therefore, data from 82 patients with early AVN who completed 1-year follow-up comprised the study group. They were treated surgically with core decompression, PRP injection, and fibula grafting in 3 combinations. Group 1 (core decompression [single] + fibula grafting + intraosseous PRP injection) had 28 patients, Group 2 (core decompression [single] + intraosseous and intraarticular PRP Injection) had 27 patients, and Group 3 (core decompression [double] + intraosseous PRP injection) had 27 patients.

The mean age of patients was 28.46 years (S.D-4.86). Male:female ratio was 3.9:1 with 59 males (80.48%) and 15 females (18.29%) being a part of the study group. 7 patients (8.5%) presented with bilateral affection and procedure on both sides was done in the same sitting. Patients in Group 2 had the longest duration of symptoms of 9.30 weeks (S.D-4.2) followed by Group 1 and Group 3.

On presentation, along with hip features; 13/82 (15.85%) patients had lumbar prolapsed disc features, which was treated conservatively. Rheumatoid or inflammatory arthritis was the most common comorbidity seen in 22 patients (26.82%) followed by immunosuppression seen in 13 patients (15.85%). 40 patients (48.78%) reported a similar incidence in the family and 55 (67.07%) patients were treated previously with medications with 51 (62.19%) patients being dependent on analgesic medications (Table 1).

Majority of patients, 77/82 (93.90%), presented with groin pain and difficulty in sitting cross-legged followed by restricted hip movements in 70/82 (85.3%) and thigh pain in 45/82 (54.87%). Modified Harris hip score was worst in Group 3 followed by Group 2 and Group 1.

Table 1 Demographic and pre-operative patient data

Characteristics	Group 1 [Single Core + Fibula Graft + PRP (IO)] (*n*-28)	Group 2 [Single Core + PRP (IO + IA)] (*n*-27)	Group 3 [Dual Core + PRP (IO)] (*n*-27)	*p* value
Age (years)	28.40 ± 5.10	26.58 ± 4.20	30.40 ± 5.28	0.22
Sex (male: female)	21 (75.0): 6 (21.4)	23 (85.1): 4 (14.8)	22 (81.4): 5 (18.5)	0.14
Symptom duration (weeks)	8.20 ± 2.45	9.30 ± 4.20	8 ± 2.60	0.45
Hip involved (unilateral: bilateral)	26 (92.8): 2 (7.1)	24 (88.8): 3 (11.1)	25 (92.6): 2 (7.4)	< 0.001
Spine Involvement	4 (14.2)	4 (14.8)	5 (18.5)	0.21
Co-morbidities				
Diabetes	3 (10.7)	4 (14.8)	4 (14.8)	
Ankylosing spondylitis	4 (14.2)	3 (11.1)	3 (11.1)	
Immune suppression (steroids)	5 (17.8)	3 (11.1)	5 (18.5)	
Rheumatoid/inflammatory arthritis	8 (28.5)	7 (25.9)	7 (25.9)	
Family history (AVN)	10 (35.7)	8 (29.6)	12 (44.4)	0.48
Previously treated	16 (57.1)	20 (74.1)	19 (70.3)	0.22
Daily analgesic requirement	15 (53.5)	18 (66.6)	18 (66.6)	0.23

Values are presented as mean ± standard deviation or number (%)

VAS Visual Analog Scale, *IO* intra-osseous, *IA* intra-articular

Table 2 Clinico-radiological parameters assessment (pre-operative)

Characteristics	Group 1 [Single Core + Fibula Graft + PRP (IO)] (*n*-28)	Group 2 [Single Core + PRP (IO + IA)] (*n*-27)	Group 3 [Dual Core + PRP (IO)] (*n*-27)	*p* value
Groin pain	26 (92.8)	25 (92.5)	26 (96.2)	< 0.001
Thigh pain	15 (53.5)	13 (48.1)	17 (62.9)	0.44
Restricted hip movements	24 (85.7)	22 (81.4)	24 (88.8)	0.36
Pain on sitting cross-legged	26 (92.8)	26 (96.2)	25 (92.5)	< 0.001
Hip pain (VAS)	5 ± 1.5	4 ± 1	5 ± 1	0.15
Modified Harris hip score (baseline)	54 ± 3	52 ± 2	49 ± 2	0.32
Pain-free walk (meters)	40 ± 8	40 ± 6	44 ± 5	0.54
30-s chair test	5 ± 1	5 ± 1	5 ± 2.5	0.33
Pain while sitting cross-legged (mins)	5 ± 2	7 ± 2	5 ± 3.5	0.42
Radiographs (Lucency/Sclerosis)	12 (42.8)	14 (51.8)	12 (44.4)	0.22
AVN Grade 1 (Ficat and Arlet)	19 (67.8)	17 (62.9)	16 (59.2)	
AVN Grade 2 (Ficat and Arlet)	9 (32.1)	10 (37.0)	11 (40.7)	

Values are presented as mean ± standard deviation or number (%)

VAS Visual Analog Scale, *IO* intra-osseous, *IA* intra-articular

Pain-free walking distance, sitting cross-legged time, and 30-s chair test were lower and comparable across the 3 groups (Table 2).

The radiographic assessment was performed by 3 radiologists, mean of 3 reading was obtained for all groups. On radiographs, signs suggesting avascular necrosis (radiolucency or sclerosis) were seen only in seen in 27/82 (39.92%) patients. According to Ficat and Arlet grading, 52/82 (63.41%) patients had Grade 1, and 30/82 (36.58%) patients had Grade 2 AVN of the femoral head.

At 1 week post-operatively, 79/82 (96.3%) and 77/82 (93.9%) patients were relieved from groin pain and thigh pain, respectively, and both values were statistically significant. Patients in Group 3 were most relieved followed by Group 2 and Group 1. Hip Pain VAS was better and followed a similar trend, with patients being most benefitted in Group 3. In Group 1, 4/28 (14.25%) patients complained of leg pain at the fibula graft harvest site, all patients from the group were relieved at 2 months post-operatively. Surgeries were faster in Group 2, followed by Group 3 and Group

Table 3 Clinical parameters assessment (post-operative)

Characteristics	Group 1 [Single Core + Fibula Graft + PRP (IO)] (*n*-28)	Group 2 [Single Core + PRP (IO + IA)] (*n*-27)	Group 3 [Dual Core + PRP (IO)] (*n*-27)	*p* value
Groin pain (1 week)	2 (7.1)	1 (3.7)	–	< 0.001
Thigh pain (1 week)	3 (10.7)	1 (3.7)	1 (3.7)	< 0.001
Hip pain (VAS)				
PoD1	7 (25.0)	6 (22.2)	7 (25.9)	0.45
1 week	2 (7.1)	2 (7.4)	1 (3.7)	< 0.001
1 month	–	–	–	0.44
6 months	1 (3.5)	–	–	< 0.001
Leg pain (VAS)				
PoD-1	8 (28.5)	–	–	
1 week	4 (14.2)	–	–	
1 month	3 (10.7)	–	–	
6 months	–	–	–	
Surgical time (min)	64 ± 8	42 ± 4	48 ± 3	0.32
Suture removal time (days)	15 ± 2	14 ± 1	14 ± 2	0.54
Modified Harris hip score (4 weeks)	89 ± 2.5	91 ± 1.5	92 ± 3	< 0.001
Modified Harris hip score (24 weeks)	93 ± 1.5	96 ± 2	94 ± 2.5	0.14
30-s chair test (4 weeks)	7 ± 2	8 ± 2	9 ± 2	0.33
Pain-free walk (meters) (4 weeks)	1500 ± 300	1800 ± 200	1850 ± 200	< 0.001
Pain while sitting cross-legged (mins) (4 weeks)	26 ± 6	28 ± 4	29 ± 4	< 0.001
Complications	2 (7.1)	–	1 (3.7)	
Conversion to THA in 1 year	3 (10.7)	1 (3.7)	1 (3.7)	

Values are presented as mean ± standard deviation or number (%)

VAS Visual Analog Scale, *IO* intra-osseous, *IA* intra-articular, *THA* total hip arthroplasty

1. Suture removal time was comparable across all groups around 14.3 days (Table 3).

At 4 weeks post-operatively, the modified Harris hip scores improved significantly across all groups. Most improved scores were seen in Group 3, followed by Group 2 and Group 1. At 6 months, this trend changed to Group 2 > Group 3 > Group 1, patients being benefitted most in Group 2. At 4 weeks, patients in Group 3 performed well, they had better 30-s chair test results, pain-free walking distance, and sat cross-legged comfortably for a longer time compared to patients in Group 2 and Group 1, the latter 2 values being statistically significant. Authors report a complication incidence of 3/82 and a rate of 3.6%. 2 patients in Group 1 had fibula graft fracture and 1 patient in Group 3 had a surgical site infection, all were managed conservatively, to improve later. 5/82 (6.09%) patients underwent a THA within 1 year and the trend was Group 1 > Group 2 = Group 3 (Table 3).

All patients were relieved from groin pain on the 9th day post-surgery ($p < 0.001$) and thigh pain on the 11th day post-surgery. In Group 1, leg pain from the graft harvest site was relieved on the 62th day post-surgery. Group 3 patients left analgesics on the 9th day post-surgery followed by Group 2 (13 days) and Group 1 (16 days). Patients in Group 1 walked 1500 m painlessly first in Group 3 (12 days), followed by Group 2 (14 days) and Group 1 (21 days). A similar trend was seen for cross-legged sitting (> 20 min); patients in Group 1 could sit comfortably 23 days after surgery followed by Group 2 (25 days) and Group 1 (42 days).

Radiologically, patients in Group 3 achieved resolution of sclerotic patch earliest (46 days) followed by Group 2 (49 days) and Group 1 (56 days). Earliest seen at 38 days post-surgery in Group 3. On MRI resolution of marrow edema was first seen in Group 3 (31 days) post-surgery. The trend was Group 3 > Group 2 > Group 1. On CT scans on the 54th day post-surgery all patients in Group 1 achieved graft parent bone union (Table 4).

Discussion

Orthobiologics have revolutionized the treatment of AVN, especially in the early stages of AVN of the femoral head. The use of core decompression and regenerative techniques in combination provides significant improvement in terms of survivorship and clinical results when compared to cord

Table 4 Clinico-radiological outcome timeline (post-operative)

Characteristics	Group 1 [Single Core + Fibula Graft + PRP (IO)] (*n*-28)	Group 2 [Single Core + PRP (IO + IA)] (*n*-27)	Group 3 [Dual Core + PRP (IO)] (*n*-27)	*p*-value
Relief from groin pain (days)	5 (3–9)	4 (2–9)	3 (1–4)	< 0.001
Relief from thigh pain (days)	9 (5–11)	6 (3–10)	4 (2–8)	0.22
Relief from leg pain (days)	48 (44–62)			
Time to no analgesic required (daily)	14 (10–16)	11 (9–13)	9 (7–9)	0.43
Time to painless walk (> 1500 m)—days	18 (15–21)	12 (7–14)	11 (9–12)	< 0.001
Time to comfortable cross-legged sitting (20 min)—days	32 (28–42)	22 (19–25)	19 (17–23)	< 0.001
Sclerotic patch resolution (radiograph)—weeks[a]	7.6 (6–8)	6.8 (6–8)	6.2 (5–7)	0.33
Edema/Geographic defect resolution (MRI)—weeks[a]	6.8 (6–8)	6.2 (6–8)	5.2 (5–7)	0.24
Graft-parent bone union (CT)—weeks[a]	7.4 (6–8)	–	–	

PRP platelet-rich plasma, *IO* intra-osseous, *IA* intra-articular, *MRI* magnetic resonance imaging, *CT* computerized tomography

[a]The outcomes were observed by 2 radiologists, values are presented as mean (range)

decompression alone [13]. The regenerative therapies include vascularized or free bone graft, PRP, BMAC, and MSCs. MSC differentiate into various cells including osteoblasts, enhances overall osteoblastic and osteoclastic activity, and their role is well documented in treating osteoporosis and bone repair. Augments act synergistically to reverse ongoing necrotic changes, owing to special properties like osteogenesis, osteo-induction, and immune response modulating effects [7, 14, 15].

Preferred surgical options for early stages are core-decompression with adjuvants; it relieves the intraosseous pressure and leads to new vessel formation thereby enhancing the local blood flow and thus halting the ongoing necrotic process. Reversal rates range from 77 to 97% depending on the extent of the area involved and the adjuvant used [5]. Patients report significant pain relief in groin and thigh with this procedure.

Additional fibula graft provides strength and enhances bony repair post-core removal in late stages (III and IV). Total hip arthroplasty is reserved for later stages (III and IV) when hip arthritis sets in, and salvage seems impractical. Few authors report favorable results with offloading osteotomies (trans-trochanteric rotational or varus/valgus osteotomies) but their application seems declining with the advent of more predictable arthroplasties [16].

A recent in vivo trial by Ismail et al. [17] reported a favorable response of vascularized osteogenic constructs to revitalize necrotic bone of AVN in rat models. In its manufacturing, thrombin activated PRP is a suitable substitute for fetal bovine serum in generating vascularized, osteogenic grafts from human stromal vascular fraction cells. The author suggests the use of this strategy in the treatment of bone loss and AVN. Ibrahim et al. [18], from their research, reported the superiority of PRP as a non-surgical treatment of early AVN of the femoral head.

Rocchi et al. [19] reported the promising results of bone grafting and PRP in 52 patients for early AVN of the femoral head (ARCO 1 and 2) with a small necrotic area and articular surface collapse within 2 mm. They observed high graft failure rates in advanced grades. Nandeesh et al. [20] from their study on 48 AVN patients reported promising cartilage regeneration (3–10 mm), high motor activity, and patient satisfaction with a combination of stem cells and activated PRP-derived growth factor concentrate therapy for early and late AVN patients.

Authors observed that patients with biplanar core decompression (double) and PRP application had early relief from groin and thigh pain, they had better clinical recovery as compared to other patients, probably due to the wider area being decompressed (Fig. 4) and PRP being delivered over a larger affected area. Extensive revascularization owing to the wider area being decompressed could be the reason for early resolution of sclerosis and marrow edema reversal on MRI. As there was no graft involved here, patients did not experience leg pain or incidences of graft fracture.

Hip aspiration and intraarticular injection of PRP should be reserved for traumatic cases where MRI reports a hip joint effusion, aspiration before injecting PRP helps decompress the hip joint. Patients report a significant improvement in hip joint pain and range of movements. This is evident by better modified Harris hip scores at 6 months as compared to patients in other groups.

Patients with core decompression (single) and PRP did better than patients with additional fibula graft insertion both clinically and had earlier resolution of AVN features on radiographs and MRI as compared to fibula graft group patients. Harvesting a fibula graft even through a minimally invasive approach can lead to donor site pain and morbidity. Patients experience leg pain and sometimes limp for up to 8 weeks. This additional procedure adds to surgical time

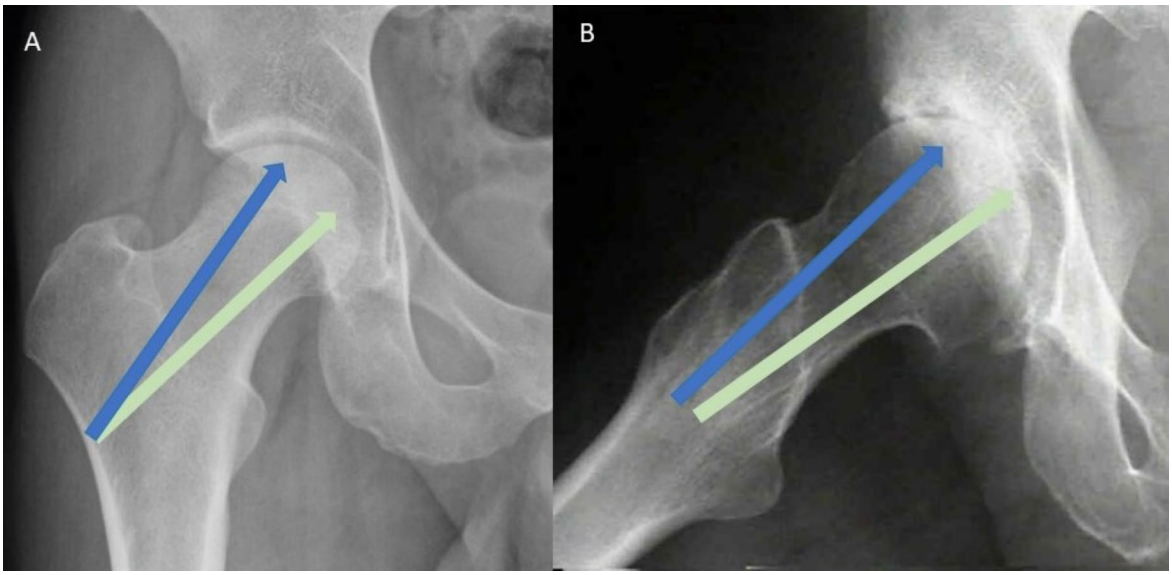


Fig. 4 Scheme of biplanar core decompression (double)—2 separate cores in 2 planes (AP and Lateral): **A** anteroposterior and **B** lateral view

as well but does not seem to have a significant contribution to early AVN features reversal or clinical improvement in early stages (Ficat and Arlet 1 and 2) when compared to patients not receiving the fibula graft. Authors observed fibula graft fracture in 2 instances, this can be attributed to force generated due to early hip movements and rehabilitation. 5 patients required THA in 1 year, seen across all 3 groups but more in the fibula graft group authors believe that this is due to the progression of the disease process.

The strengths of our study were its prospective nature and comparison of 3 treatment modalities in relatively lesser treated stages of hip AVN (Grades 1 and 2), result supported by radiological data. Although authors got favorable results, authors feel that the limitations of the study were shorter study group and follow-up. Further studies on larger study groups across the subcontinent and a larger follow-up may further provide crucial data and outcomes.

Conclusion

A high degree of clinical suspicion is required to diagnose early stages (1 and 2) AVN of the femoral head. Patients treated early have better clinical and radiological recovery. Salvage is a promising therapeutic approach with biplanar core decompression (double) and intraosseous PRP injection having better early hip scores (4 weeks), clinical performance with early groin and thigh pain recovery. Additionally, hip aspiration and intraarticular PRP injection can be reserved for MRI-proven hip effusion (traumatic) cases; it helps relieve hip pain and improve the range of movements.

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Author Contributions NJ, BR formulated the study design and methodology. AS enrolled patients for the study. NP and ML constituted the surgical team. NJ, BR tabulated results and performed statistical analysis. AM performed clinical follow-up. ML prepared figures and tables. ML prepared an initial manuscript draft. NP edited the manuscript.

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Data availability De-identified data may be requested with reasonable justification from the authors (e-mail to the corresponding author) and shall be shared after approval as per the authors' institution policy.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval The work was done at Manas Hospital, Noida, and Rudra Fracture Hospital, NCR, India. Ethical committee clearance was obtained before enrolling patients for the study [MSH-2020/8-12] and [RFH-6.2020-03].

Informed Consent Written informed consents were obtained from all participants before the start of the study.

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