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Original Research Article

Functional outcomes of core decompression and autologous cancellous bone grafting with and without platelet rich plasma in early avascular necrosis of head of femur

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ABSTRACT

Background: Early diagnosis and management of avascular necrosis (AVN) is of paramount importance in order to preserve the femoral head. Early intervention, if implemented at the pre-collapse stage, has favourable impact on the prognosis of disease. This study was conducted to compare the functional outcome of core decompression and autologous cancellous bone grafting with and without platelet rich plasma in early avascular necrosis of head of femur and to evaluate the complications associated with the procedure.
Methods: It was a comparative, and prospective study. After obtaining ethics committee approval, total 30 hips (19 patients) divided randomly into two groups for treatment, as per inclusion and exclusion criteria. Group A (core decompression with autologous cancellous bone grafting with PRP), and group B (core decompression with autologous cancellous bone grafting without PRP). Assessment of the results, was based on the Harris hip score (HHS) and visual analogue scale (VAS) at preoperative, 2 weeks, 4 weeks, 6 weeks and 3, 6, and 9 months post-operatively.
Results: There was no statistical difference seen between two groups in terms of distribution of cases based on age, gender, side, duration of symptoms, etiology, Ficat-Arlet grade, and surgical time. Mean HHS and mean VAS was found to be comparable in two groups postoperatively at all follow ups. Excellent to good results were obtained on functional assessment by HHS grading at final follow up of 9 months in patient treated under group A while patients treated under group B showed good to fair results. Both groups showed statistically significant improvement in HHS grade at 9 months as compared to preoperative HHS. In both groups, there was a statistically significant improvement in mean VAS at 9 months as compared to preoperative VAS.
Conclusions: When combined with core decompression and bone grafting, PRP produces better HHS/functional outcomes as compared to core decompression and bone grafting alone for the treatment of early avascular necrosis of head of femur.

Keywords: Avascular necrosis, FICAT-ARLET grade, Harris hip score, VAS

INTRODUCTION

Avascular necrosis (AVN) of femoral head is aseptic necrosis or ischemic bone necrosis due to disruption of blood supply to the proximal femur resulting in the death of osteocytes and the collapse of the articular surface, finally leading to degenerative arthritis.[1] As it is a progressive condition, it should be detected with a high index of suspicion at an early stage, especially in patients with unilateral symptoms due to the high likelihood of developing AVN in the opposite side. The exact prevalence of AVN is not known. In US about 15,000-20,000 cases are estimated to be diagnosed each year. Men are more commonly affected than women, with ratios from 3:1 to 5:1.[2,3] The mean age affected is 34.71 years (range 14-70 years). Most common aetiology is non traumatic

like medications/steroids followed by traumatic as fractures following road traffic accidents.[4]

The management of AVN of the femoral head ranges from conservative to operative and depends on stage of disease. The aim of treatment is to preserve rather than replace femoral head and cartilage particularly in young patients with present at an early stage. A variety of head/joint preserving treatment options are available but none has proved its worth in terms of curing the disease permanently. With recent advance in surgical techniques, better implant survival, increased familiarity with the procedure and government schemes providing free of cost surgeries there is ever increasing temptation to prefer replacement surgery as first line or only treatment option, even in early AVN. however, it is not indicated in young patients presenting with early stages of AVN. Early diagnosis and management of AVN is of paramount importance in order to preserve the femoral head. Early intervention, if implemented at the pre-collapse stage, has favourable impact on the prognosis of disease. It may progress to subchondral fractures within only 2 to 3 years, if not intervened.[5]

Use of core decompression, autologous cancellous bone graft with or without platelet-rich plasma (PRP) is early AVN should be encouraged due to its promising results and multiple advantages. It preserves the natural anatomy of femoral head and normal biomechanics of hip which is lost in fibular grafting and osteotomies and hence an easier conversion to total hip replacement (THR) is possible. There is minimum surgical morbidity owing to smaller incision with minimum blood loss, lesser duration of surgery with a short hospital stay. Surgeries with muscle pedicle bone graft and vascularized fibula graft are cumbersome and have significant surgical morbidity. No immunologic reactions are possible as autologous graft and PRP are being used. PRP in addition provides various growth factors like vascular endothelial growth factor (VEGF), platelet-derived growth factor (PDGF), and fibroblast growth factor (FGF), which increase the vascularity of necrotic area.

With this background/rationale, we underwent this study to compare the functional outcomes of core decompression and autologous cancellous bone grafting with and without PRP in early avascular necrosis of head of femur and to evaluate the complications associated with the procedure.

METHODS

This study was conducted at Department of Orthopaedics, P. D. U. Medical College and D. B. Hospital, Churu, Rajasthan, from December 2022 to January 2024. It included 30 hips (19 patients) who presented to the outpatient department (OPD) with AVN of femoral head. It was a prospective, comparative and interventional study. Patients presented to the OPD with history of pain over hip were examined clinically and AVN of femoral head was confirmed with plain radiographs and MRI of the affected hip, Ficat and Arlet grading was done and patient were included in the study after informed written consent as per the Institutional Ethical committee guidelines.

Inclusion criteria

Patients with age 18-60 years, Ficat-Arlet stage I, II AVN, and unilateral or bilateral disease were included.

Exclusion criteria

Patients with Ficat-Arlet stage III and IV AVN, sickle cell anemia, infective/autoimmune conditions, with neuromuscular or neurodegenerative disorders, pregnancy and renal compromised patients were excluded.

The selected patients who satisfied the above inclusion criteria were then registered, history and clinical details were recorded as per the proforma. Prior to surgery, all patients were counselled in their own language in detail about the nature of the disease, anesthesia and the operative procedure and its possible complications and informed written consent was taken. They were informed that they were free to opt out of the study at any point of time without affecting the further management.

All patients included in study were randomized based on procedure to be done into: group A (core decompression with autologous cancellous bone grafting with PRP), and group B (core decompression with autologous cancellous bone grafting without PRP).

The randomization of treatment modality was done by quasi randomization. First case was selected by lottery and subsequent cases were selected alternatively.

Pre-operative preparation

Detailed history to look for possible cause of AVN, clinical examination to look for hip function, X rays both hips AP and lateral views, MRI both hips, sickling test (to rule out SCA), VAS scores, Harris hip score, Informed written consents, PAC investigations and fitness for surgery.

Surgical technique

PRP preparation

One hour prior to surgery, 30 ml of autologous blood was withdrawn by venous puncture in acid citrate dextrose (ACD) tubes. The ACD vial containing blood was taken to the blood bank for centrifugation. 1st stage centrifugation: its aim is to separate the erythrocytes and is done by centrifuging the sample at 2400 rpm for a period of 10 minutes. After the above step the obtained PRP containing platelets was poured into other sterile tube (without anticoagulant). 2nd stage centrifugation: its aim is to concentrate the platelets and is done by centrifuging the

sample at 3600 rpm for a period of 15 minutes. 5 ml of platelet rich plasma was prepared.

Core decompression

Using a 2.5 mm guide wire multiple percutaneous drill holes were made in the involved areas of femoral head by entering through the lateral wall, below greater trochanter under fluoroscopic guidance.

Bone graft harvesting

A 3 cm transverse incision was given 2-3 cm proximal to ASIS along outer lip of iliac crest. Dissection done and retractors were used to expose the iliac crest. 8 mm hollow mill along with trocar was used to harvest the bone graft.

PRP and bone graft insertion

The exact location of necrotic segment of femoral head on MRI was noted and 2.5 mm guide wire was passed through the lateral wall, below greater trochanter into the segment and was confirmed under C-arm guidance in AP and lateral view. A 1.5 cm longitudinal incision was given along the entry of guide wire. 8 mm ACL reamer was used to the drill and decompress the tract up to the subchondral area. 5 ml of PRP was loaded aseptically in a syringe from the ACD vial. Fracture table was tilted to opposite side. Using a 16 G spinal needle, PRP was inserted into the necrotic area through the decompressed channel. Immediately after PRP insertion, the trocar which was already filled with autologous cancellous bone graft was passed through the drilled area.

Using a trocar and plunger, graft was punched into the necrotic area and it was confirmed under C-arm and was evident by radiodensity occupying the radiolucent area in the necrotic segment. Thorough wash, suturing and dressing done. Table was tilted back to normal. Patient was taken out of OT.

Postoperative protocol

Partial weight bearing was started on day 2 in unilateral cases patient was kept non weight bearing for 1 month in bilateral cases allowing only activities of daily living. Dynamic quadriceps and knee range of motion exercises were started on POD 2. Suture removal was done at 2 weeks. Full weight bearing started at 6 weeks. DVT prophylaxis was given postoperatively in high-risk cases.

Follow-up protocol

All patients were followed up at 2 weeks, 4 weeks, 6 weeks, 3 months, 6 months and 9 months thereafter. Harris Hip scoring system (HHS) and VAS score was used for evaluation of functional outcome and radiological outcome was assessed by x-ray of the affected hips and the two groups were compared. Minimum follow up in our study was 9 months.

Statistical analysis

Online statistical software GraphPad and EpiInfo were used for calculating p values. Descriptive statistics was presented in the form of numbers and percentages. Comparison of means between two groups was done using unpaired t test and association between two non-parametric variables was done using Pearson Chi square test. P value of <0.05 was taken statistically significant.

RESULTS

In the present study, the mean age in the group A was 31.00±11.49 years and in the group B was 28.90±4.12 years. The difference was found to be statistically not significant (p=0.595), showing that the mean age was comparable between the two groups. Similarly, the associations between certain other factors [gender, involved side of hip joint, etiology, Ficat Arlet grade of the disease (Figure 1), duration of symptoms, and surgical time] and the groups were found to be statistically not significant (p value >0.05), showing that the groups are independent of the all these factors of the patients.

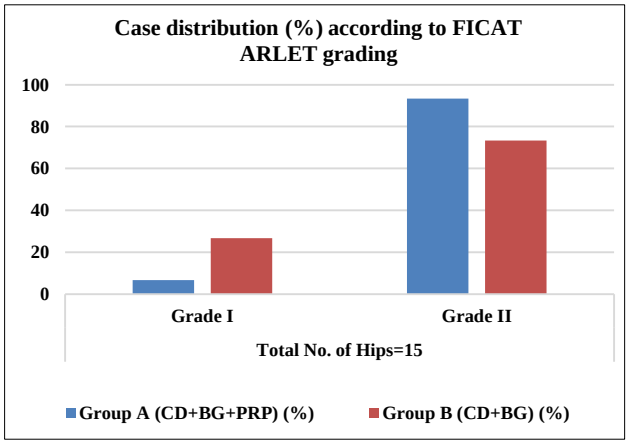

Figure 1: Case distribution according to FICAT ARLET grade of AVN.

Other results of our study, represented here in tabulated form (Tables 1-4) and in figures (Figures 1 and 2).

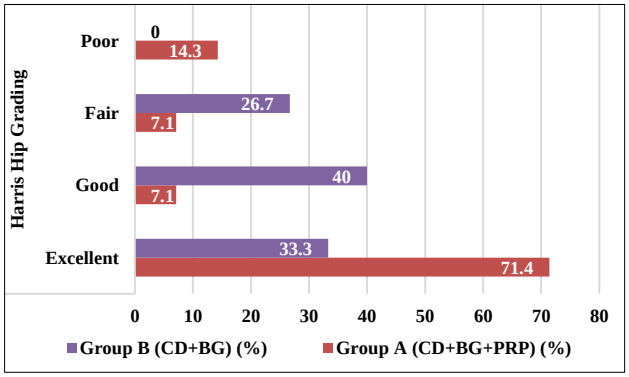

Figure 2: Comparison of Harris hip grading at 9 months between the two groups.

Table 1: Comparison of Harris hip score at different time intervals between the two groups.

Time interval and groups	No. of hips	Mean±SD	P value
Pre-HHS			
Group-A (CD+BG+PRP)	14	7.71±0.47	0.396, NS
Group-B (CD+BG)	15	7.53±0.64	
3 months			
Group-A (CD+BG+PRP)	14	3.29±0.99	0.697, NS
Group-B (CD+BG)	15	3.40±0.51	
6 months			
Group-A (CD+BG+PRP)	14	2.71±1.59	0.793, NS
Group-B (CD+BG)	15	2.60±0.51	
9 months			
Group-A (CD+BG+PRP)	14	2.79±1.63	0.721, NS
Group-B (CD+BG)	15	2.60±1.12	

P value <0.05 was taken as statistically significant; NS=not significant

Table 2: Comparison of VAS at different time intervals between the two groups.

Time interval and groups	No. of hips	Mean±SD	P value
Pre-VAS			
Group-A (CD+BG+PRP)	14	7.71±0.47	0.396, NS
Group-B (CD+BG)	15	7.53±0.64	
3 months			
Group-A (CD+BG+PRP)	14	3.29±0.99	0.697, NS
Group-B (CD+BG)	15	3.40±0.51	
6 months			
Group-A (CD+BG+PRP)	14	2.71±1.59	0.793, NS
Group-B (CD+BG)	15	2.60±0.51	
9 months			
Group-A (CD+BG+PRP)	14	2.79±1.63	0.721, NS
Group-B (CD+BG)	15	2.60±1.12	

P value <0.05 was taken as statistically significant; NS=not significant

Complications

In our study in the group A, 1 (6.7%) patient had infection, while no complications were seen in group B. There was no statistically significant association seen between complications and the groups (p=0.309), showing that the groups are independent of the complications.

Table 3: Comparison of mean HHS preoperatively and at 9 months follow-up.

Groups	Pre-HHS (mean±SD)	Post-HHS (9 months) (mean±SD)	P value
Group A (CD+BG+ PRP)	31.74±6.35	84.41±18.03	0.001 *
Group B (CD+BG)	37.36±9.17	85.07±4.71	0.001 *

P value <0.05 was taken as statistically significant

Table 4: Comparison of mean VAS preoperatively and at 9 months follow-up.

Groups	Pre-VAS (mean±SD)	Post-VAS (9 months) (mean±SD)	P value
Group A (CD+BG+ PRP)	7.71±0.47	2.77±1.63	0.001 *
Group B (CD+BG)	7.53±0.64	2.87±0.92	0.001 *

P value <0.05 was taken as statistically significant

DISCUSSION

In our study, 19 cases comprising 30 hips with early stage AVN (Ficat-Arlet grade 1 and 2) were divided into two groups based on the procedure to be performed. In group A (core decompression with autologous cancellous bone grafting with PRP) and group B (core decompression with autologous cancellous bone grafting without PRP) was done.

In the present study, the mean age in the group A was 31.00±11.49 years and in group B was 28.90±4.12 years. The difference was found to be statistically not significant (p=0.595), showing that the mean age was comparable between the two groups. The maximum age was 59 years and minimum 18 years. About 94.7% affected cases were below 40 years of age. In similar study results observed by Soni et al.[6] In another study conducted by Rochhi et al, younger patients with hip pain were more commonly diagnosed with AVN.[7] This is could be due to multifactorial etiology and risk factors like alcohol intake, steroid abuse, immunological diseases, congenital conditions and trauma being more prevalent at younger age and also due to development of diagnostic modalities like MRI, bone scan which can identify disease at an early stage.

In group A, male predominance is seen as 7 (77.8%) patients were males and 2 (22.2%) patients were females while in group B also male predominance is seen as 3 (30.0%) patients were females and 7 (70.0%) patients were males. The association between sex and the groups was found to be statistically not significant (p=0.701), showing that the groups are independent of the sex of the patients.

Male dominance was also seen in similar studies done by Rochhi et al, which is comparable to our study.[7] Thus, we concluded that males were more frequently affected than females with a male: female ratio of 2.8:1. This could be due to intake of alcohol, steroids and trauma/accidents being more frequent in male population.

In both groups, 7 (46.7%) had left side involvement and 8 (53.3%) had right sided involvement. There was no statistically significant association seen between side involved and groups (p=1.000), showing that the groups are independent of the side involved. There were 11 patients with bilateral involvement and 8 with unilateral involvement. Similar study results obtained by Rochhi et al and Tushar et al.[7,8] We can conclude that bilateral presentation is more common than unilateral and most unilateral cases invariably lead to involvement of opposite hip also.

In the group A, 14 (93.3%) were in grade II while in the group B were in 11 (73.3%) were in grade II but this comparison was found to be statistically not significant (P=0.142), showing that groups are independent of Ficat Arlet grade. Stage III and IV were not included in the study. Soni et al conducted a similar study in which out of 38 hips, according to Ficat and Arlet, 28 (73.7%) hips had stage II (sclerosis and cysts) and 10 hips (26.3%) had stage I (normal radiologically), which is comparable with our study.[6] In Indian scenario where due to low socioeconomic status and less awareness patients do not present to hospital for treatment of mild symptoms. Thus, most patients present with higher grades as compared to stage I which can drastically affect the treatment options and prognosis. In some studies, stage I is reported to be more common than stage 2 at time of presentation which is probably due to higher level of literacy among population and a more developed medical system.

Duration of symptoms was less than 6 months in 9 (60%) in the group A while in group B, 10 (66.7%) had duration of symptoms of less than 6. There was no statistically significant association seen between duration of symptoms and groups (p=0.705), showing that the groups are independent of duration of symptoms. Most patients presented within 6 months of onset of symptoms suggesting the rapidly progressive nature of disease and hence early diagnosis in early stages (pre collapse stage) and intervention is required to halt the disease process at an early stage and prevent progression to stage of arthritis.

In our study, there was no statistically significant association seen between etiology and the groups (p=0.331), showing that the groups are independent of etiology. In most cases, no definitive cause could be identified (idiopathic). In others, alcohol was most common etiology followed by medication. Similar results observed in the studies conducted by Soni et al and Shah et al.[6,9]

The mean duration of surgery in group A was 36.41±3.11 minutes and in group B was 35.40±2.26 minutes, showing a slightly longer duration of surgery in the group A. Maintaining the sterility of PRP while loading into syringe from vial and then pushing it through the trocar was associated with increase in duration in group A.

In our study, there was no statistically significant association seen between complications and the groups (p=0.309), showing that the groups are independent of the complications. Only one complication (infection) was seen that too in the group A. In another study using PRP conducted by Soni et al, there was one case of deep-seated infection.[6] Thus, PRP is associated with risk of infection which can lead to complications like septic arthritis and hip subluxation following which patient will land up in THR at an early age than may be required with normal progression of disease.

The difference in mean Harris hip score was found to be statistically not significant and was comparable between the two groups at all the time intervals (preoperative, 3 months, 6 months, and 9 months). In reference to evaluation criteria of HHS, in group A-15 (100%) had a poor score preoperatively. At 9 months follow-up 10 (71.4%) had excellent Harris hip grade, 1 (7.1%) had good grade, 1 (7.1%) had fair grade and 2 (14.3%) had poor grade, while, in group B- 5 (33.3%) had excellent Harris hip grade at 9 months, 6 (40.0%) had good grade and 4 (26.7%) had fair grade. There was a statistically significant association seen between Harris hip grade at 9 months and the groups (p=0.029), showing that the groups are dependent on the Harris hip grades. Thus, better outcome was seen in group A in comparison to group B in terms of Harris hip grade at final follow up. All these findings are comparable with the studies conducted by Soni et al and Tushar et al.[6,8]

Similarly, the mean VAS was comparable between the two groups at all the time intervals (preoperative, 3 months, 6 months, and 9 months). The difference in mean VAS was found to be statistically not significant and was comparable between the two groups at all the time intervals. It can be concluded that both treatment modalities are equally successful in providing pain relief at 9 months follow up. Similar results observed in the study conducted by Martina et al.[7]

Radiological outcome was assessed based on X-rays at 9 months follow up which showed progression of disease in all cases of both groups. In cases of AVN, X-rays may not correlate with the functional status of the patients. Therefore, both radiological and functional assessment should be done together. The progression could not be quantified or graded as MRI was not done at final follow up.

PRP should not be administered as a stand-alone therapy for AVN. It should always be used in conjunction with other treatment options such as bone grafting and core

decompression. As AVN is characterized by osteocyte apoptosis as a result of the interruption of the blood supply, the most important steps for treating AVN are facilitating osteogenesis and angiogenesis, as well as restoring bone formation to reconstruct the support at the joint surface. Han et al did a study in which they concluded that PRP must be administered in conjunction with core decompression with stem cells and bone grafts (autologous or allogeneic) in early stage AVN to generate osteogenic activity and promote stem cell differentiation.[10]

Both the treatment modalities in our study showed improved functional outcome and relief of pain at 9 months follow up. In group A, individuals showed better improvement of functional outcome at final follow up compared to group B but was associated with complication (infection) in one case in which cement antibiotic spacer was done and is planned for THR and had 2 poor Harris hip grades at 9 months which converted to THR at 10 and 12 months of surgery after duration of study.

Limitations

Small size of study sample and short duration of follow ups are certain limiting factors in our present study. After 9 months of follow up, few patients still complained of persistent pain in both groups. AVN being a progressive disease, larger sample size with further long duration follow ups are required to look for how long the THR can be delayed due to its use.

CONCLUSION

It can be concluded with the present study that when combined with core decompression and bone grafting, PRP produces better HHS/functional outcomes as compared to core decompression and bone grafting alone. Addition of PRP has associated risk of infection which can lead to serious complications, hence maintaining its sterility is of paramount importance. PRP should not be used alone as a treatment method, but rather in conjunction with other modalities such as core decompression and bone grafting to improve results and its efficacy. AVN being a progressive disease, require long term follow ups and further comparative studies to assess the improvement of scores, functional outcome and efficacy of these different procedures in delaying the THR.

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

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