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Comparative Study of Core Decompression with Autologous Iliac Crest Bone Graft Versus Bone Marrow Infiltration in Osteonecrosis of Femoral Head

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Abstract

Background: We intend to determine the difference in outcome of core decompression with autologous iliac crest bone graft versus bone marrow infiltration in avascular necrosis (AVN) of femoral head.

Materials and Methods: Stage II, III of Ficat and Arlet of AVN of femoral head evaluated clinically and radiologically before getting included into this study. A minimum of 20 cases were studied after clearance from the Ethics committee.

Results: In our study, the mean HHS were statistically significant differences between the groups at 3 months and 6 months ($P < 0.05$). At 3 months, the mean Visual Analog Scale (VAS) was 5.7 in Group A and 4.3 in Group B. At the end of the study (6 months), the mean VAS was 4.9 in group A and 2.7 in Group B. However, there were statistically significant differences between the groups at 3 months and 6 months ($P < 0.05$). Stage III X-ray finding was most common in Group a (63.6%) at pre-operative, and Stage II was most common in Group B (63.6%) at pre-operative. A similar finding was found at 6 months post-operative. Stage III magnetic resonance imaging (MRI) finding was most common in Group a (63.6%) at pre-operative and Stage II was most common in Group B (63.6%) at pre-operative. There was no significant difference ($P > 0.05$) in MRI and X-ray findings at pre-operative and 6 months between the groups.

Conclusion: We conclude that core decompression with bone marrow infiltration is better to iliac crest bone graft because of better HHS and VAS at 6 months in Stage II, III of Ficat and Arlet of AVN of femoral head.

Keywords: Osteonecrosis of femoral head, Core decompression, Autologous iliac crest bone graft, Bone marrow infiltration, Harris Hip Score

Introduction

Osteonecrosis of the femoral head (ONFH) is a disorder defined by the aseptic ischemic necrosis of osseous tissue in the femoral head [1]. This degenerative ailment results from impaired microcirculation beneath the cartilage, resulting in bone necrosis. In the US, the annual incidence of ONFH is expected to range from 20,000 to 30,000 cases per year. It predominantly impacts younger, active adults between the ages of 20 and 50, causing considerable functional impairment and frequently resulting in secondary osteoarthritis. Numerous theories have been suggested concerning the etiology of ONFH, encompassing ischemia from diverse sources, direct cellular toxicity. Core decompression is employed in the initial phases of avascular necrosis (AVN) of the femoral head before structural collapse. The approach, initially devised by Ficat et al. in 1985 for the purpose of obtaining biopsy samples for diagnostic purposes, continues to be a prevalent way for addressing pre-collapse lesions [2, 3]. Core decompression is

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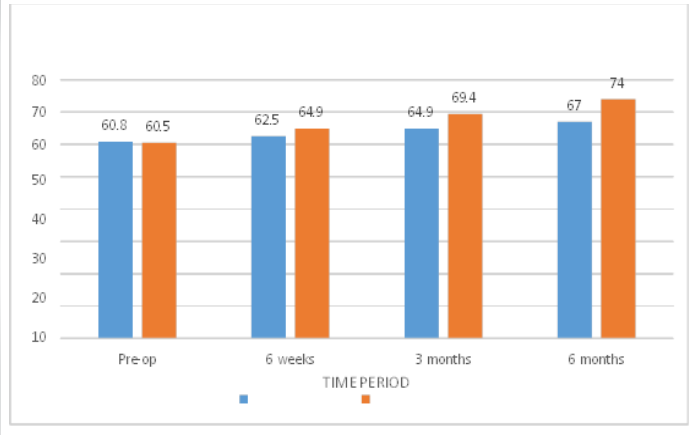

Figure 1: Comparison of Harris hip score.

believed to alleviate intraosseous pressure and reinstate blood circulation to the femoral head. This surgery has been integrated with additional treatments, including bone grafting, bone marrow infiltrates, osteotomy, and muscle pedicle grafts [4, 5]. Our study seeks to evaluate the clinical and radiological effects of core decompression utilizing autologous iliac crest bone graft compared to bone marrow infiltration in the management of ONFH AVN.

Materials and Methods

All of the patients having Stage II, III of Ficat and Arlet of AVN of femoral head evaluated clinically and radiologically before getting included into this prospective and interventional randomized comparative study.

Sample size

A minimum of 20 cases were studied after clearance from the Ethics committee.

Study period

This study includes patients from 2018 to 2020 minimum 6 month fallow-up.

Participants

Inclusion criteria

- Both gender
- Age between 18 years and 50 years
- Stage II, III of Ficat and Arlet4 and Association research circulation osseous classification.

Exclusion criteria

- AVN of femoral head with implant in situ
- Age <18 year
- History of major hip trauma
- History of blood dyscrasias.

Allocation and implementation

Table 1: Comparison of harris hip score

Time period	Group A (n=11)	Group B (n=11)	P-value1
Pre-operative	60.8	60.5	0.81
6 weeks	62.5	64.9	0.3
3 months	64.9	69.4	0.005
6 months	67	74	0.04

VAS: Visual Analog Scale

After obtaining consent for study, every patient has to do a pre-intervention investigation profile and Magnetic resonance imaging (MRI) to identify the AVN Grade.

Interventions

Patients randomized in two groups using a simple random number table method.

Group A: Core decompression 5–8 mm with autologous iliac crest bone graft will be used. Group B: Multiple small 3.2 core decompression with bone marrow infiltration will be done.

Objectives

To study the use of Limb reconstruction system external fixation for definitive facture management from injury to soft-tissue coverage and fracture Healing.

Outcome

To compare the outcome of core decompression with autologous iliac crest bone graft versus bone marrow infiltrate in terms of

- Functional outcome by Harris Hip Score (HHS) and Visual Analog Scale (VAS) score
- Radiological out come by MRI scan and X-ray.

Statistical analysis

Categorical variables will be displayed as counts and percentages, while continuous variables will be presented as mean ± standard deviation and median. The Kolmogorov-Smirnov test will be employed to assess the normality of the data. If normality is rejected, a non-parametric test will be employed. Statistical testing will be implemented as outlined below- 1. Quantitative variables will be analyzed using the Unpaired t-test or Mann-Whitney Test (where the data sets are not normally distributed) comparing the two groups. Qualitative variables will be analyzed using the Chi-Square test or Fisher's exact test. A $P < 0.05$ will be deemed statistically significant.

Observations and Results

The mean age of patients in Group A was 38.12 ± 9.44 years,

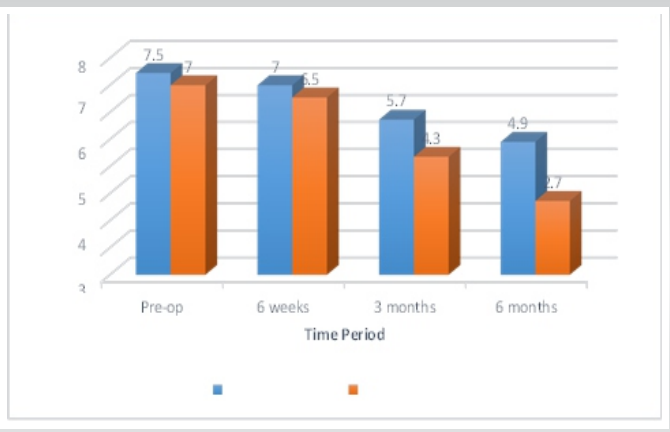

Figure 2: Comparison of Visual Analog Scale.

while in Group B it was 33.57 ± 6.16 years. The predominant gender among patients in Group A was male (87.5%), while Group B consisted entirely of male patients (100%). Fifty percent of patients in Group A and 42.9 percent of patients in Group B got bilateral hip surgery. Furthermore, over fifty percent of the patients in Group A (54.5%) and 63.6% of those in Group B underwent surgery on their left hip.

Comparison of HHS

No significant change (P > 0.05) in the HHS was seen from pre-operative to 6 weeks post-operative in either group across all time intervals. The average HHS pre-operatively was 60.8 in Group A and 60.5 in Group B. At 6 weeks post-operation, the average HHS rose to 62.5 in Group A and 64 in Group B. At 3 months, the average HHS was 64.9 in Group A and 69.4 in Group B. At the conclusion of the trial (6 months), the average HHS was 67 in Group A and 74 in Group B. Statistically significant differences were noted between the two groups at both 3 months and 6 months (P < 0.05). (Table 1) (Fig. 1)

Comparison of VAS

No significant change (P > 0.05) in the VAS was seen from pre-operative to 6 weeks post-operative in either group across all

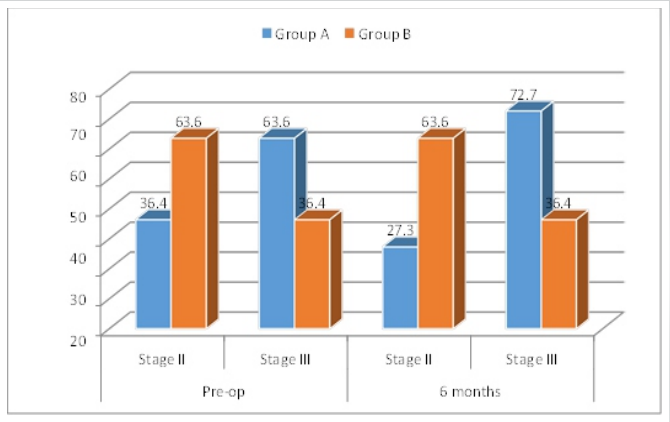

Figure 3: Comparison of X-ray findings.

Table 2: Comparison of VAS

Time period	Group A (*n*=11)	Group B (*n*=11)	*P*-value1
Pre-operative	7.5	7	0.122
6 weeks	7	6.5	0.162
3 months	5.7	4.3	0.021
6 months	4.9	2.7	0.039

VAS: Visual Analog Scale

time intervals. The average VAS preoperatively was 7.5 in Group A and 7 in Group B. At 6 weeks post-operation, the average VAS was 7 in Group A and 6.5 in Group B. At 3 months, the average VAS was 5.7 in Group A and 4.3 in Group B. At the conclusion of the trial (6 months), the average VAS was 4.9 in Group A and 2.7 in Group B. Statistically significant differences were seen between the two groups at both 3 months and 6 months (P < 0.05). (Table 2) (Fig. 2)

Comparison of X-ray findings

Based on X-ray findings, one of our patients showed radiological deterioration from stage II to stage III over a period of 6 months to 1 year. Clinically, the patient experienced increased pain (not relieved by medication) and restricted range of motion (ROM), ultimately requiring a total hip replacement (THR). Stage III X-ray findings were most common in Group A (63.6%) pre-operatively, while Stage II was most common in Group B (63.6%) pre-operatively. Similar findings were observed at 6 months post-operatively. There were no significant (P > 0.05) differences in X-ray findings between the groups at 6 months. (Table 3) (Fig. 3)

Comparison of MRI findings

Stage III MRI finding was most common in Group a (63.6%) at pre-operative and Stage II was most common in Group B (63.6%) at pre-operative. There was no significant difference (P > 0.05) in MRI findings at pre-operative and 6 months between the groups. (Table 4) (Fig. 4)

Table 3: Comparison of X-ray findings

Time period/ X-ray findings	Group A (*n*=11)		Group B (*n*=11)		*P*-value1
	No.	%	No.	%	
Pre-operative					
Stage II	4	36.4	7	63.6	
Stage III	7	63.6	4	36.4	
6 months					
Stage II	3	27.3	7	63.6	0.08
Stage III	8	72.7	4	36.4	

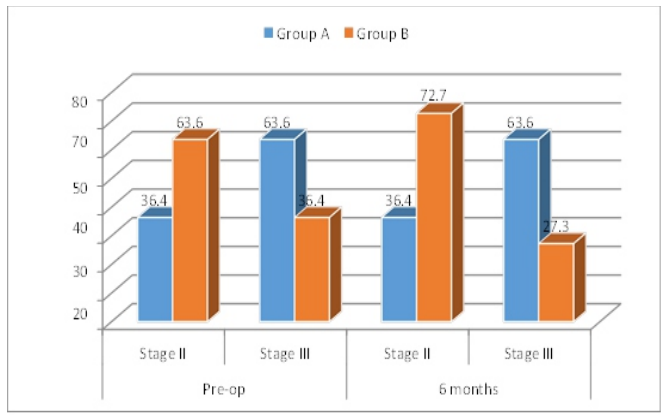

Figure 4: Comparison of magnetic resonance imaging findings.

Discussion

Mont et al. [6] delineated the pathophysiology of AVN by categorizing the femoral head into three zones: Necrotic, mended, and normal. Their conclusion indicated that during the initial phases of osteonecrosis, the body's reparative ability is adequate to reverse the disease progression. Nevertheless, inadequate repair capacity, stemming from diminished proliferation of progenitor cells in osteonecrosis patients, is a primary factor contributing to the ongoing progression of the illness [7, 8].

Our investigation revealed no statistically significant difference ($P > 0.05$) in the HHS between the groups from pre-operative to 6 weeks across all time intervals. Nonetheless, a substantial mean alteration in HHS was observed in Group B from pre-operative to 3 months and from pre-operative to 6 months ($P < 0.05$). The average change in HHS was more advantageous in Group B compared to Group A. In the investigation by Sen et al. [9], which compared core decompression (Group A) to autologous bone marrow mononuclear cell instillation subsequent to core decompression (Group B) for the treatment of osteonecrosis, the mean HHS pre-operatively was 65.72 ± 15.24 in the core decompression group and 66.19 ± 13.04 in the autologous bone marrow mononuclear cell instillation group, indicating no statistically significant difference ($P > 0.05$). At 12 and 24 months, the mean HHS in Group A was 76.68 ± 13.86 and 77.39 ± 16.98, while Group B reported 83.65 ± 8.04 and 82.42 ± 9.63, respectively.

Statistically significant differences ($P < 0.05$) in the VAS were seen between the groups from pre-operative to 6 weeks across all intervals. However, a significant mean change in VAS was noted in Group B from pre-operative to 3 months ($P < 0.02$) and from pre-operative to 6 months ($P < 0.039$). In alignment with our findings, studies by Sen et al. [9] and Shukla et al. [10] also revealed substantial differences in pain levels between patients in the core decompression group (Group A) and those receiving autologous bone marrow mononuclear cell instillation into the core tract post-core decompression (Group B) during the postoperative phase in osteonecrosis management.

Table 4: Comparison of MRI findings

Time period/MRI findings on Ficat Arlet staging	Group A (n=11)		Group B (n=11)		P-value1
	No.	%	No.	%	
Pre-operative					
Stage II	4	36.4	7	63.6	0.2
Stage III	7	63.6	4	36.4	
6 months					
Stage II	4	36.4	8	72.7	0.08
Stage III	7	63.6	3	27.3	

MRI: Magnetic resonance imaging

Radiographic findings in this study indicated that Stage III X-ray findings were predominant in Group A (63.6%) pre-operatively, whereas Stage II was predominant in Group B (63.6%) pre-operatively. Comparable results were noted after 6 months following the operation. No significant differences ($P > 0.05$) in X-ray findings were seen between the groups at 6 months. Sen et al. [9] indicated that radiographic alterations did not substantially influence clinical outcomes in either group at the 12-month ($P = 0.209$) and 24-month ($P = 0.538$) follow-ups for the treatment of osteonecrosis. Ito et al. [11] and Stroie and Vu [12] highlighted that radiographic characteristics, including the double line sign accompanied by bone marrow edema, serve as unfavorable prognostic indications for AVN.

In this investigation, Stage III MRI findings were predominant in Group A (63.6%) pre-operatively, whereas Stage II was predominant in Group B (63.6%) pre-operatively. No significant differences ($P > 0.05$) in MRI results were seen between the groups at both pre-operative and 6-month follow-up assessments. Sen et al. [9] similarly observed no significant difference in the overall enhancement of MRI characteristics between the two groups. In the research conducted by Karimi et al. [13] and Shiravani Brojeni et al. [14], at the 3-month follow-up, two hips in the core decompression cohort advanced from Ficat stage I to stage II, whereas six hips in stage II moved to stages III/IV. Conversely, in the cohort that underwent core decompression accompanied by bone marrow cell implantation, merely two hips exhibited deterioration post-treatment.

No notable problems were noted during the surgery, postoperative period, or follow-up in our investigation. Nonetheless, one patient, who advanced from stage II to stage III, had radiological decline during a duration of 6 months to 1 year. The patient exhibited exacerbated pain unresponsive to medicine and limited ROM, necessitating THR.

Limitations

Limitations include a single-center design, 24-week follow-up

period precludes conclusions about long-term durability or late recurrence. The study's reliance solely on VAS for pain assessment is noted as a limitation, and we recommend the use of validated functional outcome scores (e.g., Constant–Murley, Disabilities of the Arm, Shoulder and Hand, American Shoulder and Elbow Surgeons) in future studies. We have clarified that neither patient nor assessor blinding was performed, which may introduce detection bias. Furthermore, we now state that the lack of standardized post-injection physiotherapy protocols, absence of platelet concentration or growth factor quantification, and no imaging follow-up for structural healing limit reproducibility and mechanistic understanding. Sample size constraints preventing meaningful subgroup analyses and the potential placebo/mechanical effect of saline injections have also been acknowledged. Finally, we recommend future studies to include cost-effectiveness analysis to balance the clinical benefits of PRP against its economic implications.

Conclusion

Core decompression utilizing iliac crest bone graft increases the likelihood of head sphericity loss due to the application of a broad-bore drill, which compromises head support by excising subchondral bone. Core decompression with bone marrow infiltration yields a statistically significant enhancement in clinical outcomes, as evidenced by mean HHS and VAS scores. We also infer that multiple core decompressions with bone marrow infiltration would positively impact the patient's radiological and clinical outcomes.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

Conflict of Interest: NIL; **Source of Support:** NIL

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