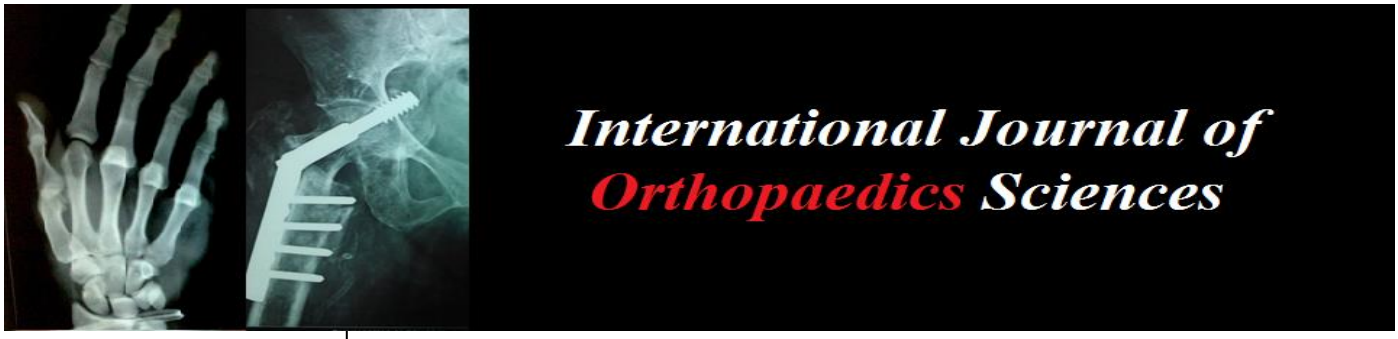

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Role of core decompression and bone marrow grafting in treatment of early avascular necrosis of femoral head

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Abstract
This study describes the role of core decompression and bone marrow grafting in the treatment of early AVN of femoral head. We performed core decompression using multiple drill holes and then the bone marrow graft is taken from iliac crest and inserted into track created by drilling into the femoral head and neck .We included 50 patients, 62 hips of both sex, in the age group between 18-50 years without any comorbidities and followed these cases for 1 year.

Keywords: Core decompression, bone marrow graft, harris hip score, avascular necrosis, osteoprogenitor cell

Introduction
Osteonecrosis [1] of hip is painful condition that occurs when blood supply to head of femur is disrupted [2]. Most ideal lesions treated with core decompression belongs to FICAT ARLET stage I, IIa/b (early AVN) also called Pre collapse stage [3]. Core decompression has been used successfully in treatment of early AVN. These procedures are typically performed with drilling and removal of cylindrical core from the osteonecrotic lesion. Another commonly used technique involves multiple drilling.
Core decompression [4] is most widespread and accepted techniques for treatment of early AVN of femoral head. Good results have been reported when performed in the initial or pre collapse phases (Ficat and Arlet stage 0 through 2) [5]; however ,less than desirable results have been reported when performed in advanced stages(Ficat stages III or IV).It has been suggested that one reason for poor healing in some patients is that there might be insufficient osteoprogenitor cells in the femoral head to support the repair the necrotic bone .Therefore, bone marrow aspirate (BMA) therapy has been proposed as an adjuvant therapy to core decompression. Several studies have reported better results when core decompression is combined with BMA [6], as compared alone.

Patient is evaluated preoperatively by
Preoperative x ray Hip AP and Lateral view.
MRI [7] is diagnostic gold standard.
Preoperative Harris Hip Score

Ficat and Arlet [5, 8] Stage

Stage	Symptoms	Radiography	Bone scan	Pathological findings	Biopsy
0	None	Normal	Decreased uptake?		
1	None/mild	Normal	Cold spot on femoral head	Infarction of weight-bearing portion of femoral head	Abundant dead marrow cells, osteoblasts, osteogenic cells
2	Mild	Density change in femoral head	Increased uptake	Spontaneous repair of infarcted area	New bone deposited between necrotic trabeculae
2A		Sclerosis or cysts, normal joint line, normal head contour	Increased uptake		
2B		Flattening (crescent sign)			
3	Mild to moderate	Loss of sphericity, collapse	Increased uptake	Subchondral fracture, collapse, compaction, and fragmentation of necrotic segment	Dead bone trabeculae and marrow cells on both sides of fracture line
4	Moderate to severe	Joint space narrowing, acetabular changes	Increased uptake	Osteoarthritic changes	Degenerative changes in acetabular cartilage

- Here for grade 1 and 2 AVN, we are performing core decompression with bone marrow grafting.
- Whereas for grade 3 and 4,THR [9] is suitable option.

1) Hip ambulation activities were recorded using the hip and function sub score using Harris hip score [10] preoperatively and post operatively

Harris Hip Score

Hip ID:

Study Hip: ☐ Left ☐ Right

Examination Date (MM/DD/YY): / /

Subject Initials: |___|___|___|

Medical Record Number:

Interval: _____

Harris Hip Score

Pain *(check one)*

- ☐ None or ignores it (44)
- ☐ Slight, occasional, no compromise in activities (40)
- ☐ Mild pain, no effect on average activities, rarely moderate pain with unusual activity; may take aspirin (30)
- ☐ Moderate Pain, tolerable but makes concession to pain. Some limitation of ordinary activity or work. May require Occasional pain medication stronger than aspirin (20)
- ☐ Marked pain, serious limitation of activities (10)
- ☐ Totally disabled, crippled, pain in bed, bedridden (0)

Limp

- ☐ None (11)
- ☐ Slight (8)
- ☐ Moderate (5)
- ☐ Severe (0)

Support

- ☐ None (11)
- ☐ Cane for long walks (7)
- ☐ Cane most of time (5)
- ☐ One crutch (3)
- ☐ Two canes (2)
- ☐ Two crutches or not able to walk (0)

Distance Walked

- ☐ Unlimited (11)
- ☐ Six blocks (8)
- ☐ Two or three blocks (5)
- ☐ Indoors only (2)
- ☐ Bed and chair only (0)

Sitting

- ☐ Comfortably in ordinary chair for one hour (5)
- ☐ On a high chair for 30 minutes (3)
- ☐ Unable to sit comfortably in any chair (0)

Enter public transportation

- ☐ Yes (1)
- ☐ No (0)

Stairs

- ☐ Normally without using a railing (4)
- ☐ Normally using a railing (2)
- ☐ In any manner (1)
- ☐ Unable to do stairs (0)

Put on Shoes and Socks

- ☐ With ease (4)
- ☐ With difficulty (2)
- ☐ Unable (0)

Absence of Deformity (All yes = 4; Less than 4 =0)

- Less than 30° fixed flexion contracture ☐ Yes ☐ No
- Less than 10° fixed abduction ☐ Yes ☐ No
- Less than 10° fixed internal rotation in extension ☐ Yes ☐ No
- Limb length discrepancy less than 3.2 cm ☐ Yes ☐ No

Range of Motion (**indicates normal*)

- Flexion (*140°) _____
- Abduction (*40°) _____
- Adduction (*40°) _____
- External Rotation (*40°) _____
- Internal Rotation (*40°) _____

Range of Motion Scale

211° - 300° (5)	61° - 100 (2)
161° - 210° (4)	31° - 60° (1)
101° - 160° (3)	0° - 30° (0)

Range of Motion Score _____

Total Harris Hip Score _____

Grading of results based on harris hip score

Category	HSS
Excellent	90-100
Good	80-89
Fair	70-79
Poor	< 70

Preoperative and postoperative weight-bearing and whole lower extremity radiographs were obtained in all patients.

Data collection and assessment were performed by two independent observers who were not involved in the surgery.

Technique of core decompression [11]

Patient positioning :

The patient is positioned supine on a fracture table.

It is necessary to ensure that AP and lateral views can be taken with a fluoroscope before preparing the patient. Draping should be performed in a sterile manner that provides exposure of the anterosuperior iliac spine proximally and continues below the knee distally .

The C-arm is used to locate the starting point , which will provide landmarks for the lateral skin marking. This should be at the lateral cortex at the location of the lesser trochanter or proximal to it.

A 3-4 cm skin incision is then performed at the corresponding entry point over the lateral aspect of the femur, just below the vastus ridge of the trochanter. The starting point is maintained proximal to the level of the lesser trochanter and distal to the vastus ridge. When the ideal starting point has been obtained, the Steinmann ‘s pin or drill bit is advanced from lateral to medial under fluoroscopy and same procedure is repeated to create 3-4(multiple drilling hole) [12] drilling hole. This must be performed under the AP and lateral views, with the surgeon making sure the Steinmann ‘s pin or drill bit location matches the area of AVN .(fig 1,2,3)

Fig 1, 2, 3: Bone marrow aspiration and injection

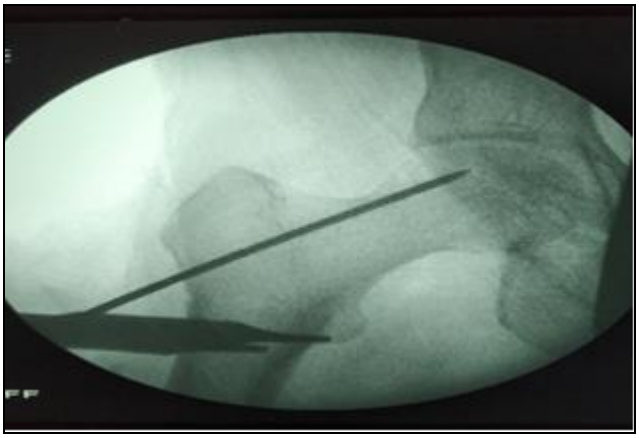

Fig 4: C arm image showing placement of Steinman pin

Bone marrow graft

Bone marrow graft [13, 14, 15] contains mesenchymal stem cells having osteogenic and osteoinductive properties. These properties are used in treatment of early avascular necrosis of femoral head and augments the healing.

Marrow is aspirated from the iliac crests. After deep insertion of a bevelled needle 16 guage needle or spinal needle , the marrow was aspirated into a 20-mL plastic syringe. The needle was moved toward the surface through the same insertion site and successive aspirations were begun again, always turning the needle 45 degree after each aspiration. Using the same skin opening, several perforations were made into the iliac crest.

After aspirations , bone marrow graft is inserted[14] into hip at core decompression site and plug it with bone wax.

Patient adviced non weight bearing for 1 month and then followed at 3 ,6 ,12 months.

Patient advised non weight bearing on crutches with crutches. Weight bearing started after 4 weeks.

Follow up

Patients were followed up by OPD visits and interviews.

Functional assessment was done using HHS and VAS.

Follow up done at TSR, 3 month, 6 month, and 1 year.

Fig 5: 55 yr male having bilateral AVN grade II(B) on right side and grade II (A) on left side. Posterative x ray at 12 month follow up

Discussion

Table 1: Demographic characteristics of study population.

Age				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Below 45 years	32	64.0	64.0	64.0
Above 45 years	18	36.0	36.0	100.0
Mean ± SD	37.35 ± 11.49			
Gender				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Female	10	20.0	20.0	20.0
Male	40	80.0	80.0	100.0
Type of Affection				
Bilateral	12	24.0	24.0	24.0
Left Side	20	40.0	40.0	64.0
Right Side	18	36.0	36.0	100.0
Stage (62 hips)				
I	20	32.2	32.2	30.0
IIA	30	48.3	48.3	80.5
IIB	12	19.5	19.5	100.0

Table 1 depicted the demographic characteristics of study population. The frequency of age was found to be high in cases below 45 years with a percentage of 64.0% and the cases above 45 years is found to have a low frequency with percentage of 36.0% and mean of age of study group was found 37.35 years (SD±11.49). In this study the percentage of male was found to be higher (80.0%) than the female cases (20.0%).

Table 2: Mean VAS pain score during pre-operative, after 6 months and after 12 months of the surgery.

	VAS pain score		
	Pre-operative	**After 6 months**	**After 12 months**
Mean	5.25	3.76	2.45

Table 2 suggests that the mean of VAS pain score was found to be high during the pre-operative period (5.25), whereas the mean slowly decreased after 6 months (3.76) and reached a value of 2.45 after a year.

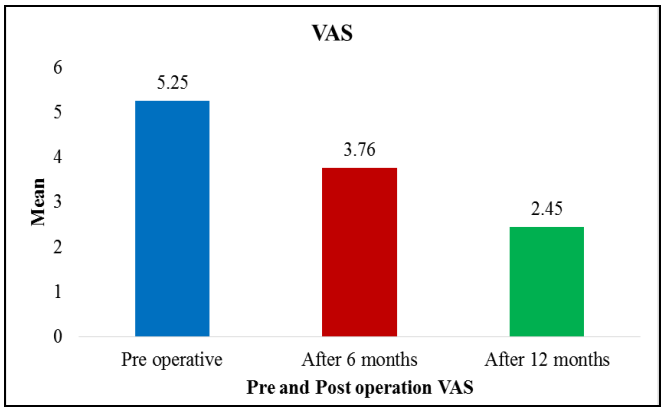

Fig 6: Figure representing the mean of VAS pain score during pre-operative, after 6 months and after 12 months of the surgery.

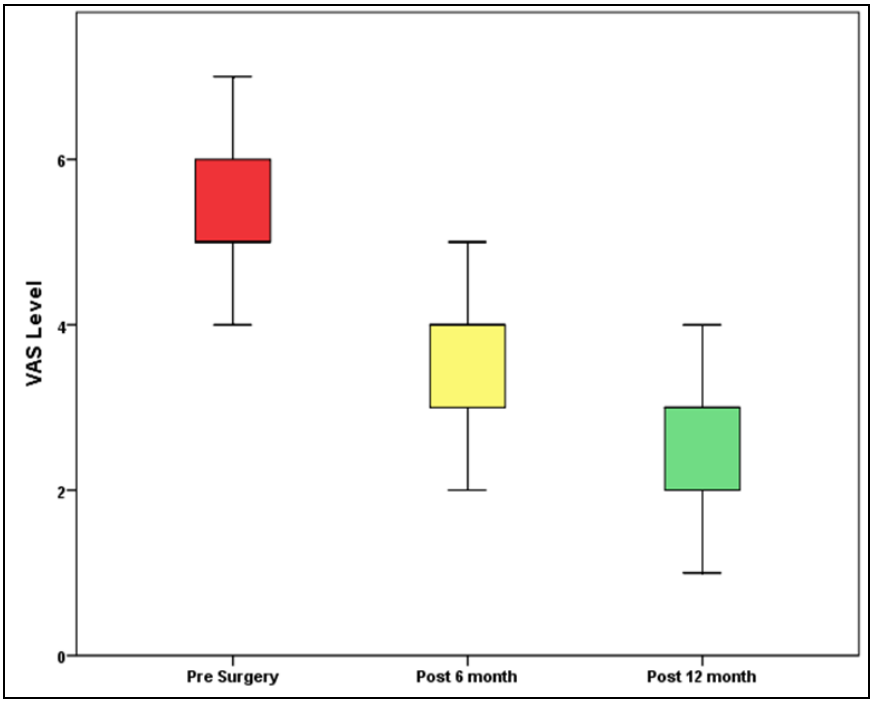

Fig 7: Figure representing the VAS pain score during pre-operation and post operation

Table 3: Table representing the mean of the Harris Hip Score (HHS) during pre and post-surgery.

	Harris Hip Score (HHS) during pre and post-surgery				
	Pre-operative	After 1 months	After 3 months	After 6 months	After 12 months
Mean	60.15	64.1	67.35	70.8	80.4

From the Table 3, we observe that the mean of Harris Hip Score (HHS) was found to be very less during the pre-operative period (60.15), and gradually increased during the post-operative period. However, a statistically significant change was noted after 1 month in which the mean was found to be 64.1, and after 3 months of follow-up the mean value was 67.35, which then improved after 6 months it was noticed to be 70.8 and finally after a year the mean of HHS was found to be 80.4. The functional improvement is directly correlated with the length of follow-up.

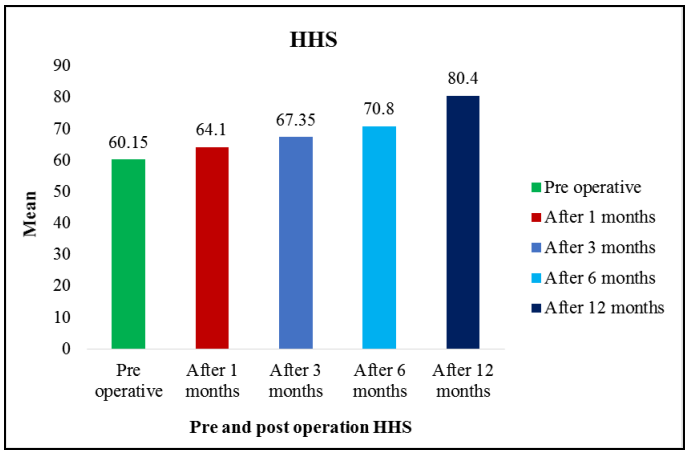

Fig 8: Figure representing the mean of the Harris Hip Score (HHS) during pre and post-surgery.

Table 4: Table representing the stage and the status of the disease.

Stage * Status of disease					
			Status of disease		Total
			Exist	Remission	
Stage	I	Count	0	20	20
		% within Stage	0.0%	100.0%	100.0%
	IIA	Count	15	15	30
		% within Stage	50%	50%	100.0%
	IIB	Count	7	5	12
		% within Stage	58.3%	41.7%	100.0%
Total		Count	22	40	62
		% within Stage	35.5%	64.5%	100.0%

From Table 4 we observe that out of 50 cases ,62 hips, 20 cases which belong to Stage I samples had a chance of remission of 100.0% after the surgery, whereas Stage IIA had totally 30 cases, out of which 15 samples had an existence of the disease after surgery (50%) and 15 samples had a possibility of remission (50%). Moreover, the Stage IIB had 12 samples, in which 7 was found to have the existence of the disease (58.3%) and 5 had a risk of remission of the disease even after the surgery was successful (41.7%). In the overall analysis, out of 50 sample 17 cases had an existence of the disease, were the percentage was found to be 34.0% and the rate of remission was found to be high in 33 cases with a percentage of 66.0% in all the three stages after the operation. In 62 Hips, 22 hips had a existence of disease ,where the percentage was found to be 35.5% and rate of remission was found to be high in 40 cases with a percentage of 64.5 % in all three stages after operation.

Conclusion

The core decompression with bone marrow grafting is a viable option for treatment of early stage (stage I and II A/B) or pre collapse AVN of femoral head, in terms of improvement in ability to perform daily activities and delaying or halting the process of necrosis of the femoral head. This procedure helps in preserving the natural joint in 64.5 % cases which is the goal in younger individuals as replacing the joint at the young age will need a subsequent revision because the implants itself have their shelf-life.

The present study concludes that, adding bone marrow graft to the conventional core decompression which showed fair to good results in literature, gives additional good to excellent results at a short-term follow-up in pre-collapse stage of osteonecrosis of hip but long-term follow-up is awaited.

Further comparative studies are required to assess the improvement scores of the above procedure and the procedures mentioned in the literature.

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