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ORIGINAL RESEARCH

Functional and radiological outcome of quadratus femoris muscle pedicle grafting (meyer's procedure) in early stage of osteonecrosis of femoral head

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ABSTRACT

Background: Avascular necrosis of the femoral head is a complex, progressive disease with variable outcomes, primarily affecting young individuals between 30-50 years. While often idiopathic, it can also result from alcohol, steroid use, and femoral neck fractures, particularly in the elderly.

Objective: This study evaluated the clinicoradiological outcomes of Quadratus femoris muscle pedicle grafting in patients with osteonecrosis of the femoral head (ONFH), FICAT-Arlet Stage I and II.

Methods: The study included 20 patients with ONFH, treated at the Department of Orthopedics, Rajindra Hospital & Government Medical College, Patiala, Punjab. All patients underwent Quadratus femoris muscle pedicle grafting and were followed up clinically using Harris Hip Scores (HHS) at 1 year and radiologically using post-operative radiographs and MRIs at 3 months.

Results: After an average follow-up of 1 year:

- One patient's hip regressed from Stage II to Stage I.
- One patient progressed to Stage III and underwent arthroplasty.
- HHS significantly improved in all patients post-surgery ($P < 0.05$).
- Radiographs and MRIs showed no femoral head collapse.
- MRI revealed decreased edema signals.

Conclusion: Quadratus femoris muscle pedicle grafting is a straightforward surgical technique with:

- Low complication rates
- Short surgical duration
- Relatively short post-operative hospital stay

Given its benefits, this technique is recommended for patients with early-stage osteonecrosis (FICAT Stage I and II), provided it is performed meticulously. **Recommendations:** Further studies with larger sample sizes and longer follow-up periods are warranted to confirm these findings and establish Quadratus femoris muscle pedicle grafting as a reliable treatment option for ONFH.

Keywords: ONFH, Meyers procedure, muscle pedicle bone grafting, AVN

INTRODUCTION

Avascular necrosis (AVN) of the femoral head is a complex condition that predominantly affects younger individuals, particularly those aged 30 to 50. The multifactorial nature of AVN means that while many cases arise without a known cause, various risk factors—including alcohol consumption, steroid use, and prior femoral neck fractures—can contribute to its onset.In the early stages, AVN may not cause significant pain; however, as the condition advances, it can lead to restricted hip movement and considerable discomfort. The condition is more common in males and is often associated with other health issues such as cancer, autoimmune diseases,

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and radiation exposure, highlighting the diverse causes involved.

The classification of AVN into stages, as outlined by Ficat and further refined by Steinberg, aids in understanding the disease's progression and informs treatment decisions. The social and economic repercussions of AVN are substantial, as the condition can severely hinder a patient's ability to engage in daily activities, often resulting in multiple surgical interventions and, ultimately, the necessity for hip replacement.

Early intervention using hip preservation techniques, such as muscle pedicle grafting, has shown promise, especially in patients diagnosed with early-stage AVN. Research by Meyers MH indicates that those in the earlier stages of the disease tend to experience better outcomes compared to individuals with more advanced stages.

In summary, managing AVN requires a thorough evaluation of the disease stage, along with consideration of the patient's age and activity level, to optimize treatment outcomes and potentially delay or prevent the need for joint replacement surgery.

Inclusion criteria

Individuals who are symptomatic and diagnosed with osteonecrosis in the early stages (Ficat stages I or II) are eligible for consideration. This demographic generally consists of those aged between 18 and 50 years.

Exclusion Criteria

The following criteria will exclude certain patients from this consideration:

- Osteonecrosis resulting from steroid use
- Any previous hip surgeries
- History of hip joint fractures or dislocations
- Patients with contraindications for MRI, which include:
- Having an internal cardiac pacemaker
- Possessing an implantable cardiac defibrillator

This structured approach ensures that only suitable candidates are evaluated for potential treatment options.

Here’s a rephrased version of the text that maintains the original meaning while ensuring originality:

After completing the patient history and conducting a comprehensive examination, which includes necessary imaging such as MRI and regional X-rays, a treatment strategy is formulated. A functional assessment is conducted prior to surgery. Following the operation, patients are monitored through radiological evaluations. The assessment of radiological progress is carried out according to the Ficat-Arlet staging system, which includes:

- Stage I – Normal
- Stage II – Sclerosis, cyst formation, and flattening

Radiographic evaluations are performed to identify any signs of osteoarthritis. Positive findings indicate either cartilage healing or no change, while negative findings suggest a progression towards osteoarthritis, potentially leading to total hip replacement. The clinical outcomes are assessed using the Harris hip scoring system.

Surgical technique

Following the administration of spinal or general anesthesia, the patient was placed in a true lateral position with the affected leg elevated. The greater trochanter was located through palpation, and a standard incision measuring 10-12 cm in a curvilinear fashion was made, centered on the tip of the greater trochanter. The upper part of the incision was extended 5-6 cm toward the posterior superior iliac spine (PSIS), while the lower part was extended 5-6 cm downward along the mid-shaft of the femur.

To access the vastus lateralis, the fascia lata on the lateral side of the femur was incised, and the fibers of the gluteus maximus muscle were separated using blunt dissection. The hip joint was internally rotated to enhance the visibility of the short external rotator muscles and to move the surgical field away from the sciatic nerve.

A bone graft from the Quadratus Femoris muscle pedicle was obtained from the posterior aspect of the proximal femur, measuring approximately 4.0 cm x 1.5 cm x 1.5 cm. This was achieved by creating multiple drill holes that were then connected using fine osteotomes. A capsulotomy was performed to expose the femoral neck and the junction between the head and neck. A trough measuring 2.5 cm x 1.5 cm was created in the center of the femoral neck.

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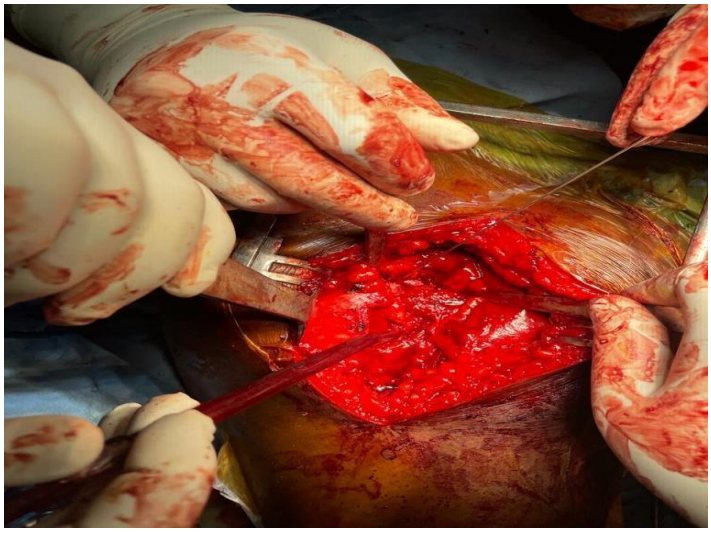

Fig 1- Quadratus femoris muscle pedicle graft Harvesting

The surgical procedure involved creating a channel near the junction of the femoral head and neck. A segment of bone was then extracted from the Quadratus femoris muscle and transplanted into the femoral head through a strategically created opening. For stabilization, one or two 3.5 mm cortical screws were inserted without a washer. Finally, the wound was meticulously closed in layers, accompanied by the placement of a suction drain and sterile dressing.

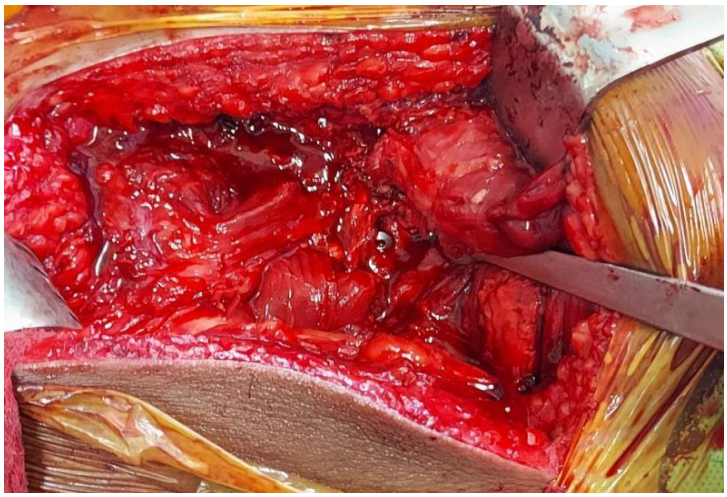

Fig 2- Fixation of muscle pedicle graft to femoral head neck junction with 3.5 mm cortical screw

After surgery, all patients received routine postoperative care. They were permitted to move around with assistance, adhering to non-weight-bearing protocols for the operated limb for a period of three months.

Staging of disease

Three months post-operatively, follow-up imaging studies, including radiographs and hip MRI, were conducted. These images were utilized to assess and classify the disease progression using established staging systems: Ficat classification and Mitchell classification.

RESULTS

1. Gender distribution

Table 1: Gender distribution of patients in our study to gender.

Sex	Stage I	Stage II
	Patients	Patients
Female	1	2
Male	11	6
Total	12	8
X^2	1.23	
p value	0.267 (NS)	

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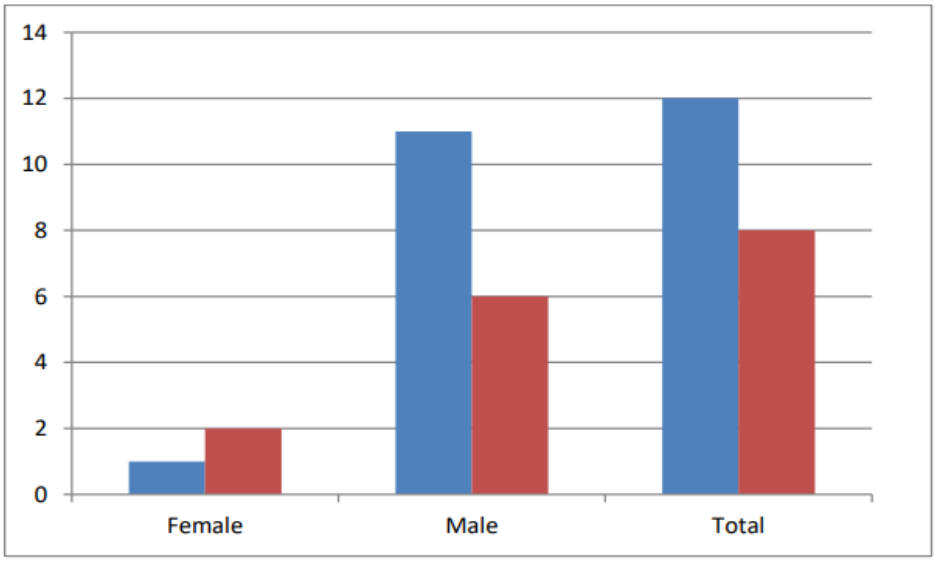

Figure 3 Shows the distribution of cases according to gender.

As shown in table 1 and figure 3 majority of patients in both the stages of AVN (stage I and II) were males, being 11 in Stage I group and 6 in Stage II group. The difference in gender distribution in both the groups was statistically found to be **non-significant.** (p-value=0.267i.e. >0.05).

2. Age Distribution

Table 2 Shows the different age groups with respect to stages of AVN

Age (Years)	Stage I	Stage II
	Patients	Patients
19-28 Years	0	1
29-38 Years	8	3
39-48 Years	4	4
Total	12	8
Mean±SD	35.08±6.16	38.25±8.61
Median	35.00	38.50
Range	31-45	19-48
t-test	0.593	
p value	0.559 (NS)	

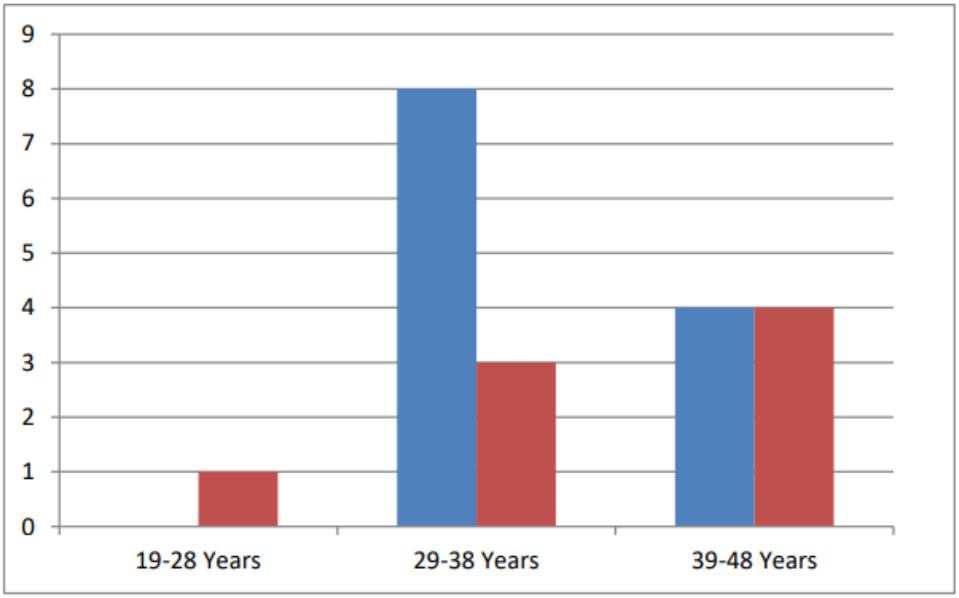

Figure 4- Different age groups with respect to stages of AVN

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As shown in Table 1 and Figure 10, majority of the patients of AVN (both stage I and stage II) in our study were in the 29-38 years age group.The difference in **Age Distribution** in both the groups of Stage I and Stage II was statistically be found to be **non-significant.** (p-value=0.559 i.e.
>0.05)

3. Causes

Table 3- Causes of Avascular necrosis in our study

Cause	Stage I Patients	Stage II Patients
Alcohol	6	5
Idiopathic	3	3
Smoking	2	1
Total	11	9
X^2	0.424	
p value	0.808 (NS)	

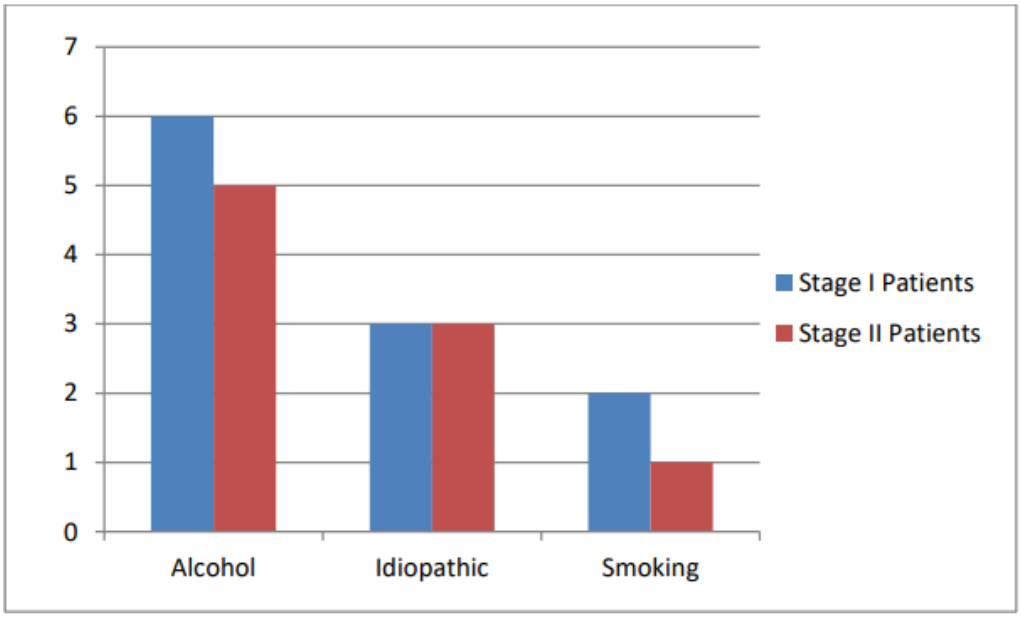

Figure 5- Percentage of various causes of Avascular necrosis in our study.

As shown in table 3 and figure 5 ,11 out of 20 patients in our study were having Alcohol as the root cause of avascular necrosis in them , while 6 patients suffered avascular necrosis of idiopathic origin and 3 patients were having smoking as the root cause of avascular necrosis in them.The difference in both the Stages I and II was statistically found to be non-significant. (p- value=0.808 i.e. >0.05).

FUNCTIONAL OUTCOMES OF PROCEDURE HARRIS HIP SCORE

1. Harris Hip Score

Table 4 - Pre-operative and post-operative values of Harris Hip Score

Harris Hip Score	Stage I	Stage II
No. of Patients	12	8
Pre OP	63±4.59	45±4.97
Post OP	90±3.81	82±6.65
Paired t-test	13.43	7.31
p value	<0.05 (HS)	<0.05 (HS)

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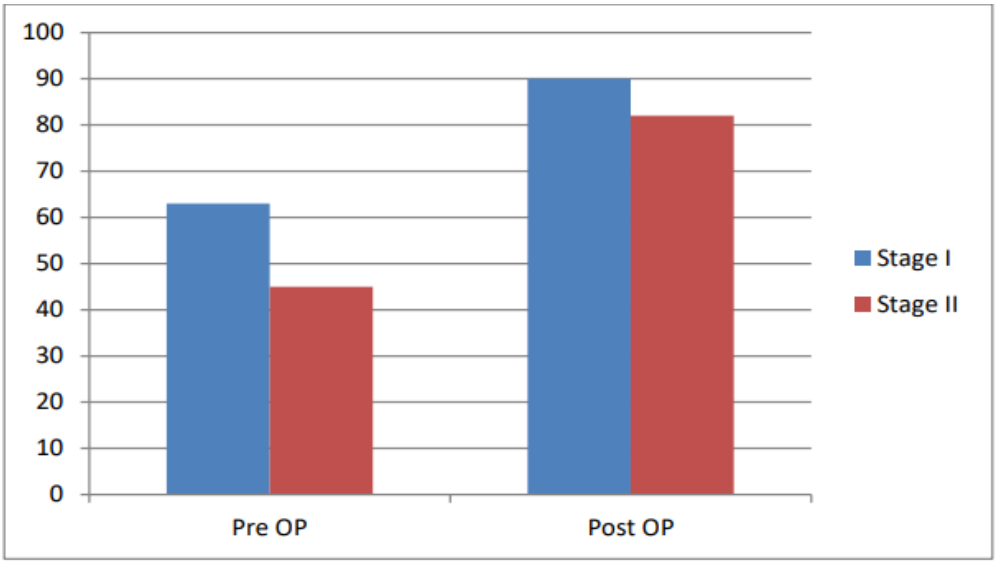

Figure 6- Pre-operative and post-operative values of Harris Hip Score.

As shown in Table 4 and Figure 6 there was significant improvement in the Post-operative Harris Hip Score. Scores improved from 63±4.59 to 90±3.81 in Stage I of osteonecrosis of head of the femur and scores improved from 45±4.97 to 82±6.65in Stage II of osteonecrosis of head of the femur and this was found to be statistically significant .(p-value=0.001).

Table 5- Post Operative Harris Hip Score according to the stage of AVN

Stage	Harris Hip Score Post OP				Total
	90-100 (Excellent)	80-89 (Good)	70-79 (Fair)	<70 (Poor)	
Stage I	8	5	0	0	13
Stage II	2	2	3	0	7
$X^2 = 10.41$; df = 3; p value = 0.015 (S)					

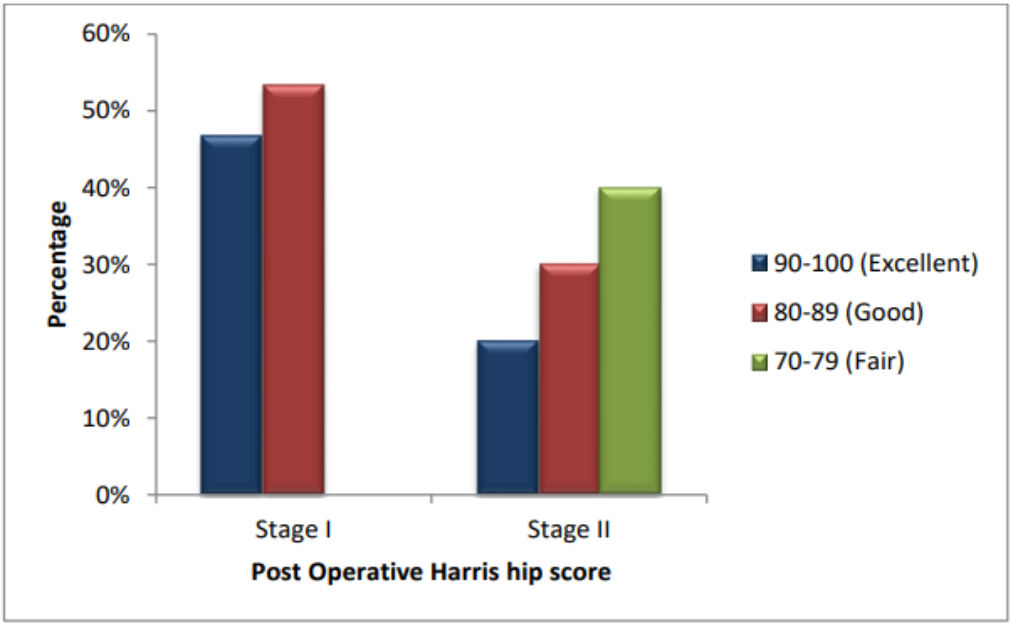

Figure 7- Post operative Harris Hip Score according to the stages of AVN hip.

As shown in Table 5 and Figure 7, all of the cases of stage I AVN hip (13 cases) achieved good to excellent Harris Hip Score post-operatively while in case of stage II osteonecrosis, out of total 7 cases only 2 cases reported an excellent outcome , 2 cases reported good outcome and 3 cases recorded a fair outcome. Considering total 20 cases in this study , majority of the cases reported good to excellent outcome and this

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was found to be statistically significant (p-value=0.015)

RADIOLOGICAL OUTCOMES OF THE PROCEDURE

1. FICAT ARLET STAGING

All 20 patients who underwent Quadratus femoris muscle pedicle grafting were followed up, MRI and radiographs were taken 3 months postoperatively. These radiographs were compared with preoperative radiographs and MRI. There were 11 patients with stage 1 Avascular necrosis preoperatively, postoperatively 1 patient had improved radiologically from stage 2 and total patient in stage 1 were 12.
p value of the changes was 0.001(HS)

Table 6- Pre op and post op FICAT Arlet Grading on X-Ray

X-Ray	Pre OP	Post OP
Stage I	11 (56%)	12 (60%)
Stage II	9 (44%)	8 (36%)
Total	20 (100%)	20 (100%)
X^2	53.41	
p value	<0.05(HS)	

2. Mitchell Classification

Follow up MRIs were also conducted in patients in postoperative period after 3 months . 1 Patients had improved from Stage B to Stage A of mitchell staging

Table 7- Pre op and post op stages of patients according to Mitchell staging

Mitchell Classification	Pre OP	Post OP
Stage A	11	12
Stage B	9	8
Stage C	0	0
Total	20	20
X^2	53.41	
p value	<0.05(HS)	

As shown in Table 7 pre-operatively there were 11 cases of Stage A and 9 cases of Stage B. After intervention i.e. post operatively there were 12 cases of Stage A, 8 cases of Stage B. This comparison of Pre-operative and Post-operative Mitchell Classification based Staging was found to be statistically highly significant with p-value=0.001 (HS)

DISCUSSION

Age distribution

The current study's demographic analysis revealed a mean age of 35.08 ± 6.16 years for FICAT Stage I and 38.25 ± 8.61 years for FICAT Stage II patients, falling within the 18-50 years inclusion criteria.These results are consistent with previous research, such as Popere et al.'s study [10], which reported a mean age of 37 years.

Our findings highlight the propensity for osteonecrosis to affect younger individuals, with 69.69% of ONFH cases occurring below 30 years, as reported by Bhargava [13]. This trend suggests a multifactorial etiology and emphasizes the importance of early diagnosis and intervention.

Gender distribution

In the present study (Table 2) it was observed that majority of the patients were males(22) .

STUDY	MALE/FEMALE
Vaishya et al (2016) [14]	32/8
Popere S et al (2020) [10]	38/22
Our Study	17/3

Thus male to female distribution in our study was in coherence with the other studies suggesting greater number of males are affected as compared to females.

Causes of osteonecrosis

The primary etiology of osteonecrosis in our cohort was alcoholism (55%, 11/20 cases), followed by idiopathic causes (30%, 6/20 cases). This finding is consistent with previous research, where alcoholism has been identified as a major risk factor.

For instance, Vaishya et al. [14] reported alcoholism as the leading cause of osteonecrosis. Similarly, Bhargava [13] found that alcoholism accounted for 30.30% of cases, highlighting its significant role in the development of osteonecrosis.

Our study's results align with existing literature, underscoring the importance of addressing alcoholism

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as a key risk factor for osteonecrosis

Harris Hip Score

Our study demonstrated significant improvements in Harris hip scores for patients with osteonecrosis of the femoral head, particularly in:

- Stage I: 63 ± 4.59 to 90 ± 3.81
- Stage II: 45 ± 4.97 to 82 ± 6.65

These findings are consistent with previous research. For instance, Popere et al. [10] reported a notable improvement in Harris hip scores from 54.1 to 85.5 at 12 months post-operatively. Similarly, Bhargava [13] observed a significant enhancement in Harris hip scores, from a pre- operative mean of 59.08 to 66.50 post-operatively.

Our results suggest that Quadratus femoris muscle pedicle bone grafting leads to substantial functional improvement in patients with osteonecrosis of the femoral head, particularly in early stages.

Author	Pre-operative Harris hip score	Post-operative Harris hip score
Bhargava[13]	59.08	66.50
Popere et al.[10]	54.1	85.5
Our study		
Stage-I	63±4.59	90±3.81
Stage-II	45±4.97	82±6.65

STAGE OF DISEASE

Our investigation revealed that the majority of patients presented with early-stage osteonecrosis, with 60% (12/20) classified as FICAT Stage I and 40% (8/20) as Stage II. This differs from previous studies, such as Steinberg et al. [6], which reported a higher proportion of patients in Stage II-A.

A similar disparity was observed in Popere et al.'s research [10], where Stage II-A was the most common presentation (53.3%), followed by Stage II-B (30%) and Stage I (16.67%). In our study, postoperative Ficat's staging remained unchanged for 19 patients, while one patient demonstrated significant improvement, transitioning from Stage II to Stage I.

Notably, our findings mirror those of Lee et al. [15], who reported successful radiological outcomes in 70% (7/10) of patients undergoing Quadratus femoris muscle pedicle bone grafting, with the remaining 30% exhibiting disease progression characterized by the 'crescent sign' or femoral head collapse.

CONCLUSION

This research undertook a comprehensive evaluation of the clinical efficacy, functional recovery, and radiographic changes following Quadratus femoris muscle pedicle bone grafting in hip surgery patients. Although the study's scope was limited, the findings provided robust evidence of favorable outcomes, characterized by significant improvements in Harris hip scores over time.

The procedure's technical simplicity, minimal complications, and reduced hospital stay make it a promising treatment option. Based on these results, the researcher suggests that Quadratus femoris muscle pedicle bone grafting, when executed with precision, may be a viable treatment strategy for patients with early-stage osteonecrosis (Ficat's stages I and II), warranting further investigation.

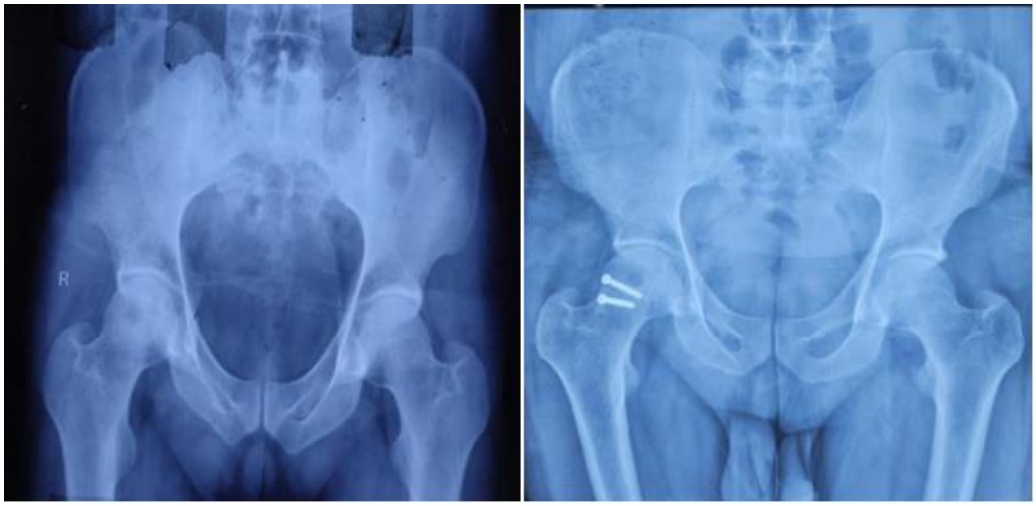

FIGURE 8, 9 Preoperative and postoperative radiographs respectively

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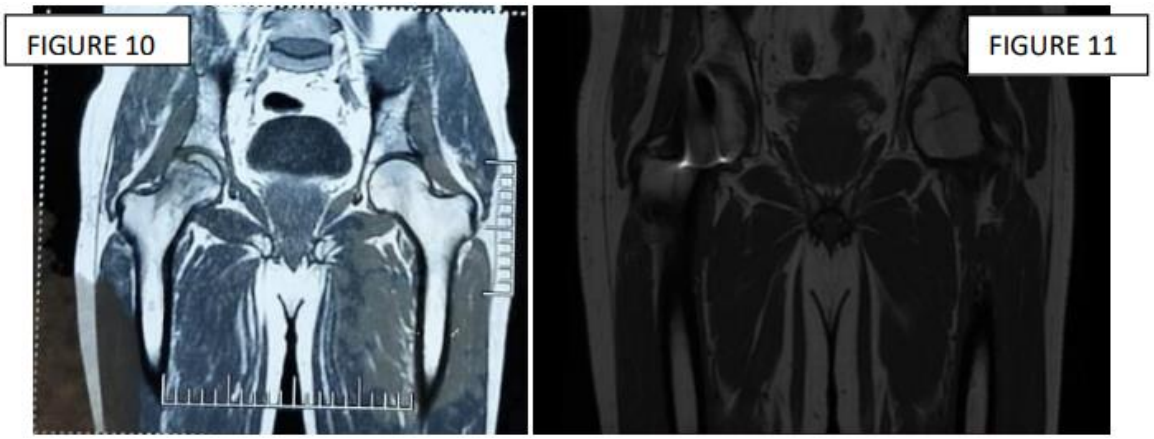

FIGURE 10, 11 Preoperative and postoperative MRIs

FIGURE 12,13 shows Postoperative range of motion in the patient

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