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Clinicoradiological Outcome of Quadratus Femoris Muscle Pedicle Grafting in Osteonecrosis of Femoral Head

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ABSTRACT
Avascular necrosis of the femoral head is a progressive, multifactorial, complex and debilitating disease with variable outcomes. It mostly affects young people between the ages of third and fifth decade. Although the cause is usually idiopathic, it can also occur due to alcohol, steroid use and femoral neck fracture, mostly in the elderly. In this study we evaluated the clinicoradiological outcomes of Quadratus femoris muscle pedicle grafting in osteonecrosis of femoral head. The study was conducted in patients with osteonecrosis of femoral head(Ficat-Arlet Stage I and II) at the Department of Orthopedics, Rajindra Hospital and Government Medical College, Patiala, Punjab for a period of 1 year. 25 patients with osteonecrosis of femoral head were taken for study. All these patients underwent quadratus femoris muscle pedicle grafting. These patients were clinically followed up by Harris hip score at 1 year. Radiological outcomes were done by post operative radiograph and Mris at 3 months. All patients were followed for an average 1.5 years . One hip regressed from stage 2 to stage 1 hip in study, one progressed into stage 3 and patient underwent arthroplasty . The HHSS significantly increased in all patients after surgery ($P<0.05$). X-ray and MRI showed that the femoral head did not progress to collapse after operation . In addition, MRI showed that the edema signals decreased. Quadratus femoris muscle pedicle grafting is simple surgical technique, low incidence of complications, short duration of surgery and relatively shorter length of post-operative hospital stay, it is the researcher's view that this technique if done meticulously, can be recommended in patients with early stages of osteonecrosis (Ficat's stage I and II).

INTRODUCTION

Avascular necrosis (AVN) of the femoral head is a progressive, multifactorial, complex and debilitating disease with variable outcomes. It mostly affects young people between the ages of third and fifth decade. Although the cause is usually idiopathic, it can also occur due to alcohol, steroid use and femoral neck fracture, mostly in the elderly. Early symptoms of avascular necrosis of the femoral head may not be painful., However, the end result is restriction of hip movements[1]. Mostly men are affected more than females. Other causes of AVN include cancer, radiation exposure, medications, deep-sea divers and Autoimmune diseases. The "avascular" state of necrotic bone is the result of loss of circulation which can be due to the a number of factors. When symptomatic, the disease often causes degeneration of the femoral head and eventual deterioration of the hip joint. Ficat defines a four-stage (I to IV) classification for AVN based on radiographic patterns[2]. Steinberg et al further revised the Ficat system by classifying stage III lesions in the hip with or without femoral head collapse or acetabular involvement[3]. This disease has a major social and economic impact as it hampers patients' capabilities to do daily work and day to day activities. This problem may increase as multiple surgeries may be required and there may be discomfort without any definitive improvement in patient's condition. Many patients in this young group eventually require joint replacement surgery. (Mont 2015)[4] Although many patients with advanced AVN eventually undergo hip replacement, some patients diagnosed early can be managed with native hip preservation surgeries[5]. Meyers MH (1978) first reported the use of muscle pedicle grafting to treat 23 patients with femoral head necrosis. After 6 months to 2 years of follow-up, all 8 patients with Ficat stage I or II disease had good results, but only 5 of 15 patients with Ficat stage III or IV had good results[6]. Given the life expectancy of arthroplasty implants and survival time of up to 10 years, revision surgery seem inevitable. Therefore, choosing femoral head preserving surgery at a young age will delay the entire hip replacement or even avoid it altogether[7]. Many other studies have evaluated the effectiveness of quadratus femoris pedicle grafting in the treatment of osteonecrosis of femur head[8-10].

MATERIALS AND METHODS

Inclusion Criteria: Symptomatic patients suffering from osteonecrosis in pre-collapse stage of Ficat's classification (stage I or II).
Age group between 18-50 years.

Exclusion Criteria: Steroid induced osteonecrosis
Prior hip surgery.
Prior fracture or dislocation of hip joint.
Patients with contraindications to MRI.

- Internal cardiac pacemaker.
- Implantable cardiac defibrillator.
- MR incompatible metallic implants.
- Intraocular foreign body.
- Renal failure.

Once the history is completed and a thorough examination is performed with appropriate examinations, including MRI and regional X-rays, a treatment plan is prepared. A preoperative functional assessment was done. Postoperatively, patients were followed up with radiological procedures. Radiological progress is evaluated as described below by Ficat-Arlet staging.
Stage I-Normal.
Stage II-Sclerosis, cysts, flattening.
Radiographic examination for signs of osteoarthritis., Positive results mean cartilage healing or No change, negative results mean progression to osteoarthritis and conversion to total hip replacement. Clinical outcomes were evaluated using the Harris hip scoring system.

Surgical Technique: After spinal or general anesthesia, the patient was positioned in the true lateral position, with the affected limb up. The greater trochanter was palpated, and a standard 10-12 cm curvilinear incision was made centred on the tip of greater trochanter. The proximal limb of the incision was extended 5-6 cm in line towards PSIS and the distal limb 5-6 cm down along the middle of the shaft of the femur. To expose the vastus lateralis, the fascia lata on the lateral surface of the femur was incised and the gluteus maximus muscle fibres were divided by blunt dissection. The hip was internally rotated to stretch the short external rotator muscles (making them more visible) and draw the operating field away from the sciatic nerve. The Quadratus Femoris muscle pedicle bone graft was harvested from posterior aspect of proximal femur of approximate size 4.0 cm x 1.5 cm x 1.5 cm using multiple drill holes connected with fine osteotomes and mobilized. Capsulotomy was performed to uncover the femoral neck and head-neck junction. A trough was made in the center of the femoral neck of size 2.5 cm x 1.5 cm.

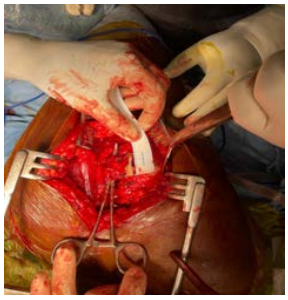

Fig. 1: Quadratus femoris muscle pedicle graft with its dimensions as per our surgical technique

This trough is extended towards the femoral head underneath the head neck junction. The Quadratus femoris muscle pedicle bone graft was harvested and placed into the femoral head through the bone window. For fixation, one or two cortical screw (3.5 mm) without washer were utilized. Wound was closed in layers over a suction drain and aseptic dressing was done.

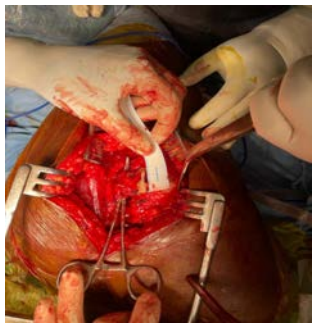

Fig. 2: Fixation of muscle pedicle graft to femoral head neck junction with 3.5 mm cortical screw

Post-Operative Care: Following the operative procedure, all the patients received standard postoperative care. They were allowed to ambulate with the help of a without bearing weight on the operated limb for the first 3 months.

Staging of Disease: A follow-up radiograph and magnetic resonance imaging (MRI) of the hip was done at 3 months post-operatively which was further used to evaluate and stage the progression of the disease using Ficat classification11 and Mitchell classification12

RESULTS AND DISCUSSIONS

Gender Distribution:

Table 1: Gender Distribution Of Patients In Our Study

Sex	Stage I		Stage II	
	Patients	Percentage	Patients	Percentage
Female	1	6.67%	2	20%
Male	14	93.33%	8	80%
Total	15	100%	10	100%
$X^{[2]}$	0.938			
p value	0.626 (NS)			

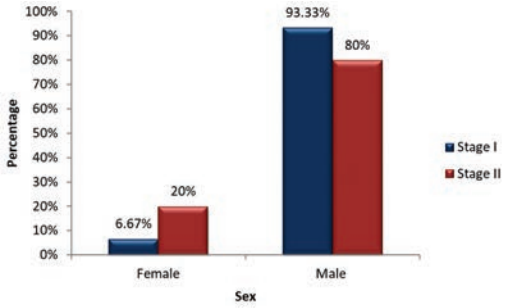

Fig. 3: Shows the distribution of cases according to gender.

As shown in (Table 1) and figure 3 majority of patients in both the stages of AVN (stage I and II) were males, being 93.33% in Stage I group and 70% in Stage II group. The difference in gender distribution in both the groups was statistically found to be non-significant. (p-value=0.626 i.e. >0.05).

Age Distribution:

Table 2: Shows the Different Age Groups with Respect to Stages of AVN

Age (Years)	Stage I		Stage II	
	Patients	Percentage	Patients	Percentage
19-28 Years	0	0%	1	10%
29-38 Years	10	66.67%	4	40%
39-48 Years	5	33.33%	5	50%
Total	15	100%	10	100%
Mean±SD	36.47	38.00		
	±4.12	±8.72		
Median	35.00	38.50		
Range	31-45	19-48		
t-test	0.593			
p value	0.559			
	(NS)			

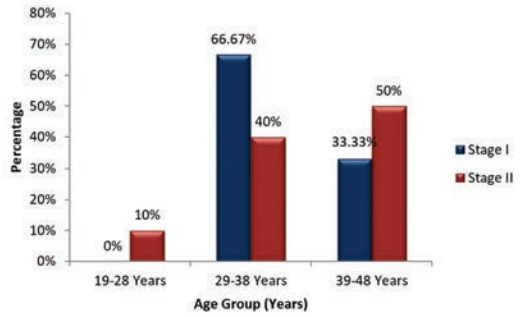

Fig. 4: Different age groups with respect to stages of AVN

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).

Causes:

Table 3: Causes of Avascular Necrosis in our Study

Cause	Stage I		Stage II	
	Patients	Percentage	Patients	Percentage
Alcohol	8	53.33%	5	50%
Idiopathic	4	26.67%	4	40%
Smoking	3	20%	1	10%
Total	15	100%	10	100%
$X^{[2]}$	1.562			
p value	0.995 (NS)			

As shown in (Table 3) and figure 5 ,13 out of 25 patients in our study were having Alcohol as the root cause of avascular necrosis in them , while 8 patients suffered avascular necrosis of idiopathic origin and 4 patients were having smoking as the root cause of

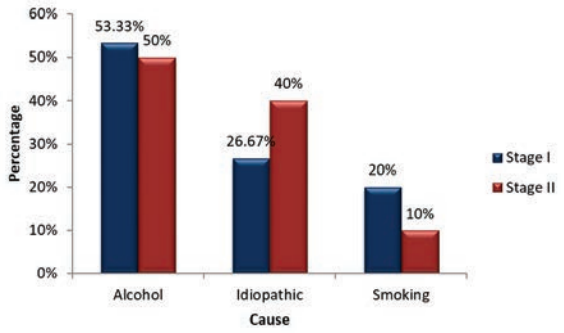

Fig. 5: Percentage of various causes of Avascular necrosis in our study

avascular necrosis in them.The difference in both the Stages I and II was statistically found to be non-significant. (p-value=0.995 i.e. >0.05).

Functional Outcomes of Procedure Harris hip score: 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	15	10
Pre OP	58.07±6.58	44.50±4.30
Post OP	87.67±5.95	79.00±9.20
Paired t-test	18.569	10.379
p value	0.001 (HS)	0.001 (HS)

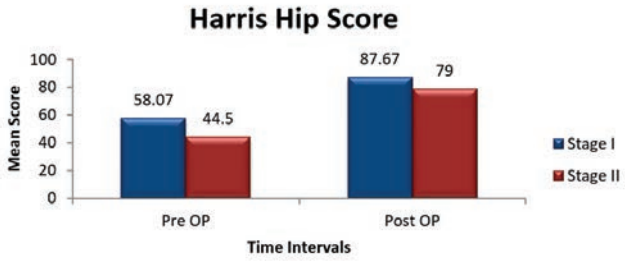

Fig. 6: Pre-operative and post-operative values of Harris Hip Score

As shown in (Table 4) and Figure 6 there was significant improvement in the Post-operative Harris Hip Score. Scores improved from 58.07±6.58to 87.67±5.95 in Stage I of osteonecrosis of head of the femur and scores improved from 44.50±4.30 to 79.00±9.20 in Stage II of osteonecrosis of head of the femur and this was found to be statistically significant. (p-value=0.001).

As shown in (Table 5) and Figure 7, all of the cases of stage I AVN hip (15 cases) achieved good to excellent Harris Hip Score post-operatively while in case of stage II osteonecrosis, out of total 10 cases only 2 cases

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	7 (46.67%)	8 (53.33%)	0 (0%)	0 (0%)	15 (100%)
Stage II	2 (20%)	3 (30%)	4 (40%)	1 (10%)	10 (100%)

X2 = 12.321; df = 3., p value = 0.015 (S)

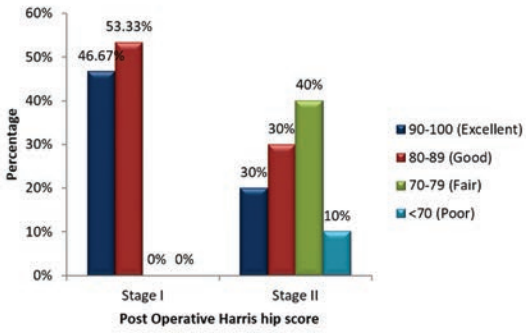

Fig. 7: Post operative Harris Hip Score according to the stages of AVN hip

reported an excellent outcome , 3 cases reported good outcome and 4 cases recorded a fair outcome while one case reported poor outcome as well. Considering total 25 cases in this study , majority of the cases reported good to excellent outcome and this was found to be statistically significant (p-value=0.015).

Radiological Outcomes of the Procedure:

Ficat Arlet Staging:

All 25 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 14 patients with stage 1 Avascular necrosis preoperatively, postoperatively 1 patient had improved radiologically from stage 2 and total patient in stage 1 were 15.

Of 11 stage 2 AVN patients, 1 patient had deteriorated to stage 3 of Avascular necrosis. 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	14 (56%)	15 (60%)
Stage II	11 (44%)	9 (36%)
Stage III	0 (0%)	1 (4%)
Total	25 (100%)	25 (100%)
$X^{[2]}$		21.212
p value		0.001 (HS)

Mitchell Classification:

Follow up MRIs were also conducted in patients in postoperative period after 3 months . 2 Patients had improved from Stage B to Stage A of mitchell staging, however 1 patient had deteriorated to stage C.

As shown in Table 7 and Figure 9, pre-operatively there were 44% cases of Stage A and 56% cases of Stage B. After intervention i.e. post operatively there were 52% cases of Stage A, 44% cases of Stage B and 4% cases of Stage C. This comparison of Pre-operative and Post-operative Mitchell Classification based Staging

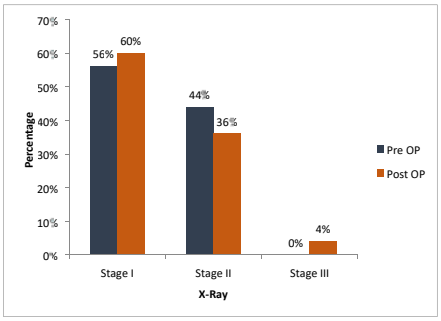

Fig. 8: The preoperative and postoperative Ficat and Arlet staging in patients

Table 7: Pre Op and Post Op Stages of Patients According to Mitchell Staging

Mitchell Classification	Pre OP	Post OP
Stage A	11 (44%)	13 (52%)
Stage B	14 (56%)	11 (44%)
Stage C	0 (0%)	1 (4%)
Total	25 (100%)	25 (100%)
$X^{[2]}$	18.132	
p value	0.001 (HS)	

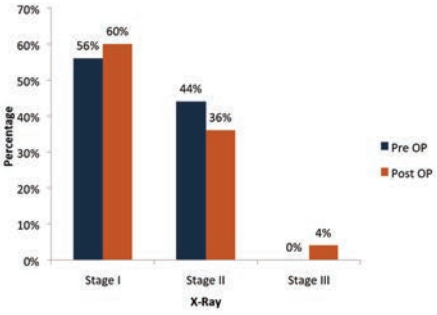

Fig. 9: Pre-operative and Post-operative Mitchell Classification based Staging comparison

was found to be statistically highly significant with p-value=0.001 i.e. >0.05.

Gender Distribution: Patients between the age of 18-50 years were included in the study. However, the mean age observed was 36.47±4.12 years for FICAT Stage I and 38.00±8.72 years for FICAT stage II.
It was similar to the study by Popere[10] where mean age was 37 years. Thus, we concluded that osteonecrosis is prevalent in the younger populations which could be attributed to multifactorial causes.
In a study by Bhargava[13] >69.69% cases of ONFH were below the age of 30 years.

Age Distribution: In the present study (Table 2) it was observed that majority of the patients were males being 88% (22) .

Table 8: Study and Gender Distribution

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

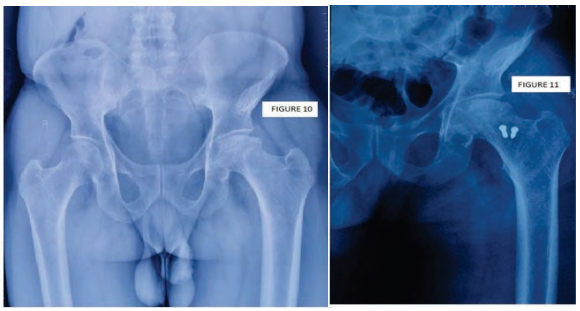

Fig. 10,11: Preoperative and postoperative radiographs respectively

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 main underlying cause of osteonecrosis in our study was alcoholism(13 cases) ,followed by idiopathic causes(8 cases).
In a study done by Vaishya[14], alcoholism was found to be the major cause of osteonecrosis.
Similarly in a study by Bhargava[13S] ,alcoholism was found to be one of the major causes (30.30%).

Harris Hip Score: Scores improved from 58.07±6.58to 87.67±5.95 in Stage I of osteonecrosis of head of the femur and scores improved from 44.50±4.30-79.00±9.20 in Stage II of osteonecrosis of head of the femur .
In the study by Popere[10], Harris hip score was noted at the end of 12 months and scores improved from 54.1 -85.5 post operatively.
In a study by Bhargava[13] Harris hip score improved from a mean value of 59.08 pre-operatively to 66.50 post-operatively.

Table 9: Pre-Operative Harris Hip Score and Post-Operative Harris Hip Score

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	58.07	87.67
Stage-II	44.50	79.00

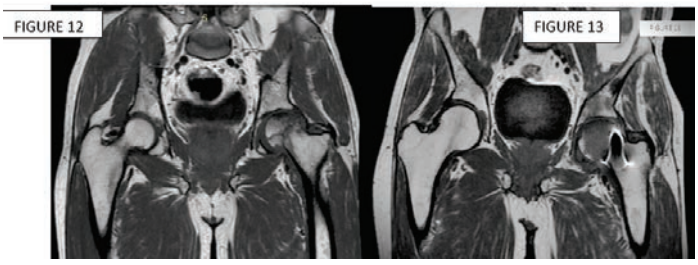

Fig. 12,13: Preoperative and postoperative MRIS

Our results for osteonecrosis are quite comparable with the results of the Western series as well as Indian series.

Stage of Disease: In our study, we found out that most common stage of osteonecrosis at presentation was stage I according to FICAT's classification. 56% of patients included in this study presented in stage I whereas 44% of patients were in stage II.

Steinberg[6] found in their study of 312 hips in 208 patients that maximum patients were in stage II-A according to Ficat and Arlet classification. In the study conducted by Popere[10] 53.3% of patients were in stage II-A at the time of presentation according to Ficat and Arlet classification whereas 30% of hips in stage II-B and 16.67% in stage I.

In our study, 92% of patients didn't show any difference in Ficat's staging postoperatively. One patient improved from Stage II to Stage I and in one patient there was a progression of disease radiologically.

A similar observation was noted in the study by Lee[15] where 10 patients of osteonecrosis were operated by Quadratus femoris muscle pedicle bone grafting and 7 of them had radiological signs of healing whereas the rest 3 patients evidenced further progression of the disease indicated by "crescent sign"/ femoral head collapse.

CONCLUSION

The present study was planned to scientifically evaluate the clinical and functional outcome as well as the radiological changes observed at the operated hips following Quadratus femoris muscle pedicle bone grafting. Though it is a small study within a specific time limit, yet it has generated statistically significant data to support the view that the functional outcome of this procedure is mostly good to excellent. There is progressive increase of Harris hip score during the follow-up period. With longer follow-up, it can be ascertained whether the procedure halts the progression of the disease or not. However, because of its simple surgical technique, low incidence of complications, short duration of surgery and relatively shorter length of post-operative hospital stay, it is the researcher's view that this technique if done meticulously, can be recommended in patients with early stages of osteonecrosis (Ficat's stage I and II).

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