

# Cheilectomy, Drilling, Curettage and TFL Muscle Pedicle Bone Grafting in Post Traumatic Osteonecrosis of The Femoral Head

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## Abstract

**Background:** Osteonecrosis of the femoral head is a common entity in developing countries. It is generally progressive inspite of treatment, resulting in collapse of the femoral head and painful secondary osteoarthritis of the hip joint.

**Aims and objectives:** This is a retrospective and prospective study to evaluate the treatment by cheilectomy, drilling, curettage and TFL muscle pedicle bone grafting in post traumatic osteonecrosis of the femoral head.

**Material and method:** The study was conducted at IPGME&R & SSKM Hospital, Kolkata from January 2005 to March 2009 on 20 subjects between the age of 25 yrs to 60 yrs with good range of movement in at least one direction particularly flexion of 90° in Ficat Arlet stages II and III of posttraumatic osteonecrosis of the femoral head.

**Results:** Results were analysed on the basis of reduction in pain and increase in the range of movement, status of preservation of the contour and congruity of the articular surface and reduction in the rate of progressive collapse of the femoral head and degeneration and effectiveness in postponing a head sacrificing surgery in pre and post collapse stages respectively. Final evaluation was done clinically by modified Harris Hip Score and Baksi's radiological criterion. Overall clinical improvement having excellent and good results were obtained in 9 out of 10 stage II (90%), 8 of 10 stage III (80%) patients whereas radiological improvement was noted in 8 (80%) patients of stage II and 6 (60%) patients of stage III disease. Chi Square  $=\chi^2 = 1.25$  for clinical evaluation and is significant at 0.05 level of significance.

**Conclusion:** In patients especially young with a predegenerative and early degenerative stage of osteonecrosis of the femoral head this can be the treatment protocol.

**Keywords:** Femoral head, Muscle pedicle bone grafting, Osteonecrosis, TFL

## INTRODUCTION

Osteonecrosis of the femoral head is associated with trauma and other etiologies like corticosteroids intake, alcoholism, hemoglobinopathy (sickle cell disease and coagulopathies), hepatorenal and skin disorders and commonly affects young patients around the age of 20-40 years. Idiopathic osteonecrosis is also a common entity in developing countries like ours. It is generally progressive inspite of treatment, resulting in subchondral fracture, collapse and painful secondary osteoarthritis of the hip joint. Early diagnosis and management may prevent the subsequent collapse of the femoral head and development of a painful and stiff hip joint.

Untreated osteonecrosis of the femoral head ultimately leads to collapse and disintegration of hip joint. The predegenerative stages of osteonecrosis especially when seen in young adults, should be treated by a femoral head preservation operation with the objective to delay and possibly to avert the above consequences. Previously head preserving surgeries were not in vogue so total hip replacement was the only viable option.

Femoral head preservation operation produce good result in the early stages of osteonecrosis but most of their results were inconsistent and have deteriorated markedly in longer follow up, as seen in following different

osteotomies,<sup>1-5</sup> core decompression<sup>6-8</sup> and non vascular strut grafting with the tibia or fibula.<sup>9</sup> Cancellous bone grafting after the curettage of the necrotic bones fails to relieve pain or prevent progressive collapse of the femoral head.<sup>10,11</sup>

Recently, different vascularised bone grafts like free vascularised fibular graft with free iliac chip graft<sup>12-15</sup> and vascular pedicle iliac crest grafting,<sup>16-18</sup> provided encouraging results, especially in early stages of necrosis. The use of quadratus femoris muscle pedicle bone grafting combined with free cancellous graft provide good results in early stages of osteonecrosis but poor results in advanced stages.<sup>19</sup> However even in advanced stages of osteonecrosis, subcutaneous adductor tenotomy, cheilectomy, drilling and muscle pedicle bone grafting provided symptomatic relief irrespective of femoral head deformity.<sup>20</sup>

The results of the use of different MPBGs alone using of Q-F, Sartorius, Gluteus medius or the tensor fascia lata (TFL) in the different stages of osteonecrosis of the femoral head was reported by Baksi.<sup>20,21</sup>

## AIMS AND OBJECTIVES

This study was undertaken in a retrospective and prospective basis to analyse the results of cheilectomy, drilling, curettage and TFL muscle pedicle bone grafting in post traumatic osteonecrosis of the femoral head. Initially the study was intended to include cheilectomy in all cases but due to the paucity of cases in the advanced stages the same was done in cases where applicable. The aims and objectives of the study were –

- a. In the pre collapse stage:-
  1. To analyse whether the procedure reduces pain.
  2. To analyse whether the contour and congruity of the articular surface is preserved.
  3. To analyse whether the procedure reduces the rate of natural progression of the disease into collapse of the femoral head and subsequent degeneration.
- b. In the post collapse stage:-
  1. To analyse whether the procedure relieves pain, increases the range of movement and daily functional activities.
  2. To analyse whether the method is an effective salvage procedure for the already deformed head and whether it postpones a head sacrificing surgery.

Null Hypothesis: There is no improvement in the clinical condition of the patient after the surgery (Both Grade- II & grade III) cases on the modified Harris hip scoring.

## MATERIALS AND METHODS

This study was conducted in the Department of Orthopaedics, I.P.G.M.E & R and S.S.K.M Hospital, Kolkata-20, in a retrospective and prospective basis from January 2005 to March 2009.

In this study 20 patients were taken into consideration after taking proper written consent and explaining the nature and possible complications of the procedures. 13 were men and 7 were females. 8 of the male patients were manual labourers. 4 males and 1 female were government office employees. 4 were housewives and 2 young females were unemployed. 1 male patient was a driver.

Osteonecrosis was diagnosed by clinical and radiological studies in all cases. Magnetic resonance imaging (MRI) and computerised tomography (CT) scanning were done in selected cases. The diagnosis was confirmed by histopathological examination of the subarticular bone obtained from the femoral head during the operation in all cases. Clinical evaluation pre and postoperatively was done using the Harris hip score (modified).

Preoperative radiological staging of osteonecrosis was done according to Ficat and Arlet. Accordingly, among the 20 cases 10 were in stage II and 10 were in stage III necrosis. However, badly damaged femoral heads with a collapse of 5 mm or more were not included here. Postoperative radiological assessment of the cases was carried out on the basis of radiological criteria of healing. 14 (70%) osteonecrotic femoral heads were due to united post fracture femoral necks and 6 (30%) were due to traumatic hip dislocations. 12 had right hip and 8 had left hip involvement.

### Inclusion criteria

Age - 25-60 years.

Post traumatic osteonecrosis of femoral head without any other etiologies of osteonecrosis were taken into consideration, eg: Cases after cannulated hip screw fixation for fracture femoral neck which have united, traumatic dislocation of the hip joint etc.

Osteonecrosis Ficat Arlet stages II and III.

Good range of movement at least in one direction particularly flexion of 90°.

Collapse of femoral head of 1-2 mm; maximum upto 5 mm.

### Exclusion Criteria

Age: Less than 25 yrs, more than 60 yrs.

Osteonecrosis Ficat Arlet stage I, IV disease.

Gross restriction of movements especially flexion less than 90°.

Collapse of femoral head more than 5 mm.

Other etiologies like longterm corticosteroids consumption, alcohol abuse, hemoglobinopathy (sickle cell disease and coagulopathies), certain renal, hepatic, skin disorders, gout, hip dysplasias were not taken into consideration.

Associated comorbid conditions like uncontrolled diabetes, psychiatric illness and anaesthetically unfit patients were not included.

Previous history of two or more surgeries of the hip joint.

Uncooperative patients who are not willing to follow strict postoperative regime including three months non-ambulation.

### Preliminary Management

On admission to the ward a detailed history of the case was taken and age, sex, occupation, socioeconomic status, mode of injury, any concurrent medical illness, relevant past illness and previous surgery were recorded.

A detailed and thorough clinical examination of major systems and affected part was done.

The patient was counselled and encouraged to start hip and knee exercises.

Routine preoperative investigations were done and standard surgical protocols were followed in all cases.

### Methods

Majority of the cases with posttraumatic osteonecrosis of femoral head in Ficat & Arlet stages II and III were treated with cheilectomy, drilling, curettage and TFL muscle pedicle bone grafting. The indication of surgery was pain and discomfort around the hip during walking, sitting cross-legged, and even at rest and limitation of movement of the hip. The presence of a good range of movement at least in one direction, particularly flexion of at least 90° was considered important for this head preserving operation.

### Technique of tensor fascia lata muscle-pedicle bone graft (Figures 1-3)<sup>20,21</sup>

With the patient in the supine position and a small sandbag behind the buttock of the affected side, an incision is made from a point about 7.5 cm behind the anterior superior iliac spine, along the outer lip of the iliac crest. It curves downwards, with its concavity directed posteriorly, to the level of the base of the greater trochanter.

The groove between sartorius and TFL is identified and the deep fascia overlying TFL is raised. An incision is then made in the muscle fibres of the TFL, in their direction, 2.5 cm behind the anterior edge of the muscle. The isolated anterior fibres of TFL are elevated and its deeper fibres, found intermingled with those of the underlying gluteus minimus, are sectioned. A segment of the iliac crest 2.5 cm long and 2.5 cm broad is osteotomised and retracted down, keeping its attachment to the anterior fibres of the TFL intact. The muscle-pedicle bone graft so prepared gets its blood supply from the superior gluteal artery and the ascending branch of the lateral circumflex femoral artery. Bleeding from the raw surface of the muscle pedicle bone graft is observed.

The exposed gluteus minimus muscle is erased from the outer surface of the ilium and retracted down, and the straight and reflected heads of rectus femoris are sectioned. Next, the anterior capsule of the hip is opened, using an inverted T-shaped incision. Marginal osteophytes are trimmed from the femoral head and, in advanced stages of necrosis, cheilectomy of the femoral head in its superior, anterior & anterior inferior part is performed medial to the limit of the acetabular margin. This improves the range of abduction and rotation of the hip.

The articular surface of the femoral head is examined for alteration of its colour and contour, for erosion and for softening. A pit with undermined edges is made in the anterosuperior subarticular surface of the femoral head close to the neck. Through this pit multiple drilled holes into the femoral head are made. Usually the necrotic area is sclerotic but in some it is friable. A small notch is cut at the margin of the pit to accommodate the muscle belly of the pedicle and to prevent it being stripped off the graft during impaction. Splitting the inferiorly retracted gluteus minimus muscle belly facilitates easy placement of the TFL graft into the necrotic bed without tension. The bony portion of the MPBG is shaved according to the contour of the slot. One drill hole is made on either side of the slot over the femoral head and also along the axial length of the MPBG for the passage of one Vicryl thread or one 4 mm cannulated screw as and when necessary. The MPBG is impacted inside the slot and anchored with the overlying fascial sleeve.

The cut margins of the capsule and the gluteus minimus muscle are then repaired to secure the graft. The wound is closed in layers over a suction drain (Figure 6). If needed, subcutaneous adductor tenotomy is done at the end of the operation. The foot is fitted with a well padded boot with an anti-rotation bar.

### Aftercare<sup>20,21</sup>

Assisted hip movements are encouraged early in the postoperative period. Vigorous hip movements are started at four weeks with the patient still in bed. Crutch walking, non-weight-bearing on the affected leg, is allowed from five to six weeks. Full weight-bearing does not begin before four to five months after the operation. The cases with significant pre operative limitation of movement of the hip in advanced stages are treated with 7.5 lbs to 10 lbs skin traction of the operated limb for 2-3 weeks accompanied by intermittent hip motion. Postoperative check x-ray of pelvis including both hip joints in anteroposterior view and lateral view of the affected hip is done in every cases before discharge.

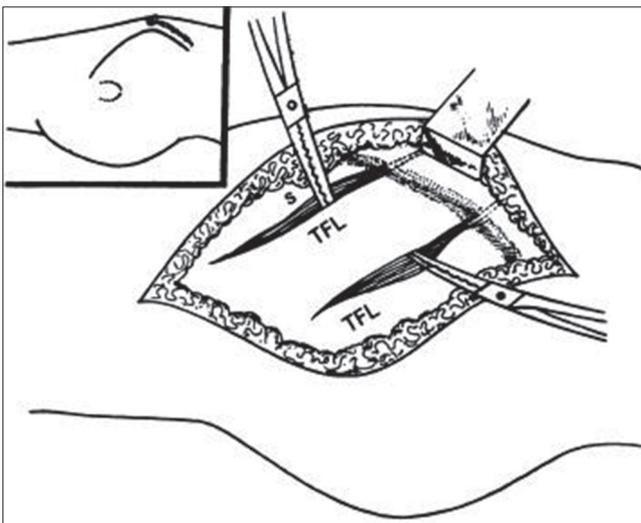


Figure 1: Skin incision (inset) and method of isolation of the tensor fascia lata (TFL) muscle fibres

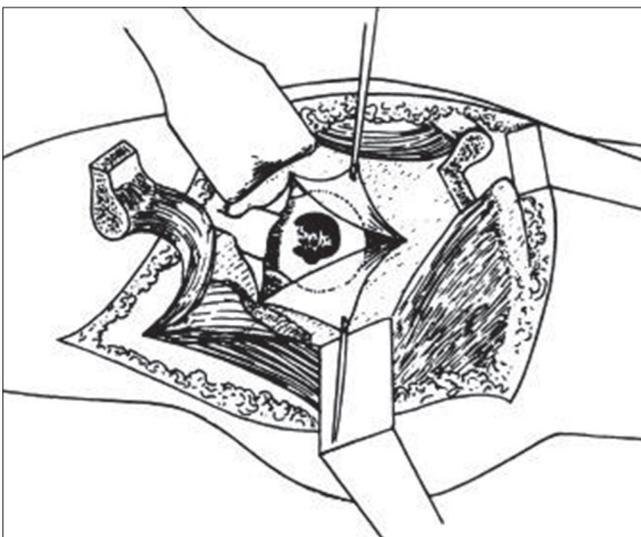


Figure 2: Diagram to show the prepared TFL muscle pedicle bone graft and a pit cut in the antero superior surface of the femoral head and neck. Multiple drill holes are made into the femoral head through the pit

### Evaluation

Evaluation of operation was based on functional results, radiological findings and complications. There is no universally acceptable hip score for every society. So different authors have used different hip scales of scoring for their society. In this study Harris Hip Evaluation system (modified) was used to assess the functional outcome of cheilectomy, drilling, curettage and TFL muscle pedicle bone grafting in posttraumatic osteonecrosis of femoral head.

Final clinical evaluation was done by modified Harris Hip Score and patients' satisfaction was graded by the following way:-

- Excellent: Hip score: 91-100, Patient is very satisfied.
- Good: Hip score: 81-90, Patient is satisfied.
- Fair: Hip score: 71-80, Patient is satisfied, but not up to the mark.
- Poor: Hip score is less than 70, patient is not satisfied.

The results were analysed by the Chi square test and tested for significance at 0.05.

### Radiological criteria of improvement (Baksi's)<sup>20,21</sup>

- The diminution of density of the necrotic portion of the femoral head.
- Return to normal density of the preoperative rarefied areas, restoration of the normal trabecular pattern.
- Disappearance of the crescent sign.
- Healing of the cystic areas and of the fracture line



Figure 3: Diagram to show the line of cheilectomy on a deformed femoral head and the pit prepared for grafting

within the necrotic area or between it and the healthy bone.

- Improvement in the contour of the femoral head, particularly after cheilectomy and improvement of the radiological joint space.

The results were analysed by the Chi square test and tested for significance at 0.05.

## RESULTS AND ANALYSIS

Clinical improvement was considered according to modified Harris hip score and radiological improvement was judged by Baksi's radiological criteria of healing. The duration of follow-up was of a minimum of six months and maximum of four years and eight months (average 31 months) The average operative time in our study was 1.5 hours.

Overall clinical improvement having excellent and good results were obtained in 9 out of 10 stage II (90%), 8 of 10 stage III (80%) whereas radiological improvement was noted in 8 (80%) patients of stage II and 6 (60%) patients of stage III disease (Figures 4 and 5). There was no case of death. No cases were lost to follow up and all cases were followed up at regular intervals.

The average age in our study was 43 years, ranging from 29 years to 57 years. Among them, 13 cases were males and 7 cases were females. 12 cases had right hip and 8 cases had left hip involvement.

### Harris Hip Score

Preoperative Harris hip score was evaluated in all the cases. The average score was 50.

#### Harris Hip Score

HHS 21-30	0
HHS 31-40	2
HHS 41-50	9
HHS 51-60	8
HHS 61-70	1

#### Harris Hip Score – at 3 months post operative

HHS 0-40	0
HHS 41-50	3
HHS 51-60	6
HHS 61-70	9
HHS 71-80	2
HHS 81-90	0
HHS 91-100	0

\*The average was 65

#### Harris Hip Score – at 6 months post operative

HHS 0-40	0
HHS 41-50	1
HHS 51-60	1
HHS 61-70	4
HHS 71-80	5
HHS 81-90	8
HHS 91-100	1

\*The average was 86

#### Harris Hip Score – at 12 months post operative

HHS 0-40	0
HHS 41-50	0
HHS 51-60	1
HHS 61-70	1
HHS 71-80	3
HHS 81-90	6
HHS 91-100	9

\*The average was 95

### Statistical Analysis

Chi-Square test on the effectiveness of the surgery based on Clinical Evaluation done by Modified Harris Hip score.

#### Results of clinical examination

Result of test →	Satisfactory	Dissatisfactory	Total
Type of test ↓			
Grade II	9	1	10
Grade III	7	3	10
Total	16	4	20

Calculation of expected frequencies (f<sub>e</sub>):-

$$\text{Row 1:- } \frac{(16 \times 10)}{20} = 8, \frac{(4 \times 10)}{20} = 2$$

$$\text{Row 2:- } \frac{(16 \times 10)}{20} = 8, \frac{(4 \times 10)}{20} = 2$$

$$\therefore \text{ Chi Square } = \chi^2 = \sum \left[ \frac{(f_o - f_e)^2}{f_e} \right] \text{ Where } f_o = \text{ Observed}$$

frequencies & f<sub>e</sub> = Expected frequencies

$$= \frac{(9-8)^2}{8} + \frac{(1-2)^2}{2} + \frac{(7-8)^2}{8} + \frac{(3-2)^2}{2} =$$

$$\frac{(1)^2}{8} + \frac{(-1)^2}{2} + \frac{(-1)^2}{8} + \frac{(1)^2}{2}$$

$$= 0.125 + 0.5 + 0.125 + 0.5 = 1.25$$

$$\therefore \chi^2 = 1.25$$

$$\text{Degree of Freedom} = df = (r-1)(c-1) = (2-1)(2-1) = 1 \times 1 = 1.$$

∴ Chi Square =  $\chi^2 = 1.25$ , Degree of Freedom =  $df = 1$ .

The  $\chi^2$  critical value for 1 df is 0.455 at 0.05 level of significance and the obtained value is 1.25, greater than the table value. This indicates that there is a positive relationship in between the type of tests and the results of clinical evaluation.

Thus the Null Hypothesis that there is no improvement in the clinical condition of the patient after the surgery (Both Grade-II & grade III) based on the modified Harris hip scoring is rejected and the alternative hypothesis that there is a significant improvement after the surgery (Both Grade-II & grade III) is accepted at 0.05 level of significance.

### Chi-Square Test on the Effectiveness of Radiological Examination

Results of radiological examination			
Result of test →	Satisfactory	Unsatisfactory	Total
Type of test ↓			
Grade II	7	3	10
Grade III	6	4	10
Total	13	7	20

Calculation of expected frequencies (f):-

$$\text{Row 1:- } \frac{(13 \times 10)}{20} = 6.5, \frac{(7 \times 10)}{20} = 3.5$$

$$\text{Row 2:- } \frac{(13 \times 10)}{20} = 6.5, \frac{(7 \times 10)}{20} = 3.5$$

$$\therefore \text{ Chi Square} = \chi^2 = \sum \left[ \frac{(f_o - f_e)^2}{f_e} \right] \text{ Where } f_o = \text{Observed}$$

frequencies &  $f_e$  = Expected frequencies

$$= \frac{(7 - 6.5)^2}{6.5} + \frac{(3 - 3.5)^2}{3.5} + \frac{(6 - 6.5)^2}{6.5} + \frac{(4 - 3.5)^2}{3.5} =$$

$$\frac{(0.5)^2}{6.5} + \frac{(-0.5)^2}{3.5} + \frac{(-0.5)^2}{6.5} + \frac{(0.5)^2}{3.5}$$

$$= 0.384 + 0.071 + 0.038 + 0.071 = 0.218$$

$$\therefore \chi^2 = 0.218$$

$$\text{Degree of Freedom} = df = (r-1)(c-1) = (2-1)(2-1) = 1 \times 1 = 1.$$

$$\therefore \text{ Chi Square} = \chi^2 = 0.218, \text{ Degree of Freedom} = df = 1.$$

There is no significant relationship in between the type of test and the results of radiological examination. Thus the radiological examination shows no significant improvement

after the surgery (Both Grade-II & grade III) at 0.05 level of significance.

Hence, after the statistical analysis it can be concluded that the Clinical Examination shows comparatively more significant results than the Radiological Examination after surgery (Both Grade-II & grade III).

### COMPLICATIONS

There was no case of any neurovascular compromise, haemorrhage, heterotopic ossification, thromboembolism, periprosthetic fractures or deep infection in our study. Only 2 cases of superficial wound infection were found in our series. Both were treated with a change of antibiotic, according to the wound swab culture and sensitivity report. Only 2 cases had a terminal restriction of hip movements with persistence of pain less limp in another 3 cases. Slippage of the graft occurred in 1 case which was fixed with Vicryl suture. This prompted us to use a 4 mm cannulated cancellous screw to fix the MPBG in the latter part of our series.

### ILLUSTRATING PHOTOGRAPHS

#### Pre Operative Skiagrams

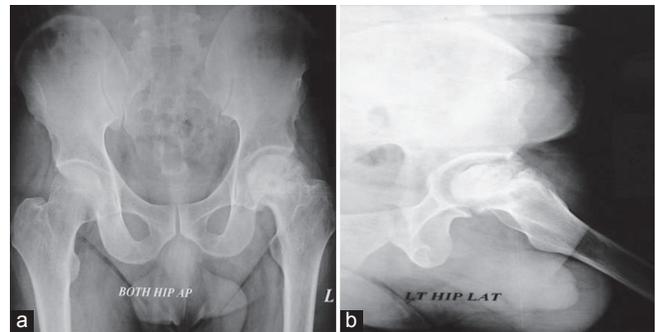


Figure 4: Ficat Arlet stage III osteonecrosis of the left femoral head

#### Post Operative Skiagrams

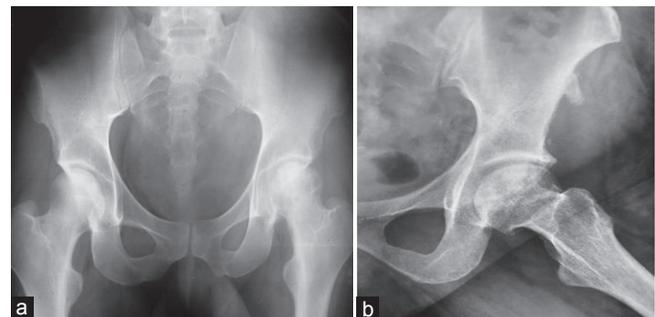
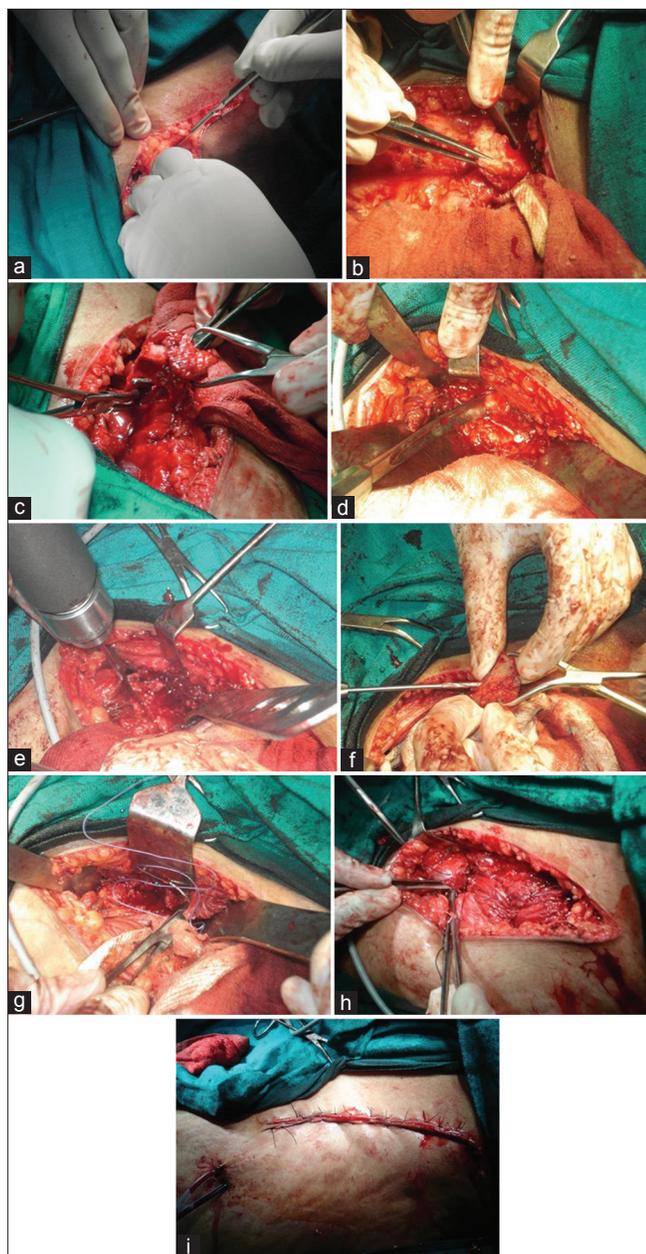


Figure 5: Ficat Arlet stage III osteonecrosis of the left femoral head in the above case without any radiological improvement

## Per Operative Photographs



**Figure 6: (a) Incision, (b) Separation of TFL MPBG, (c) TFL MPBG Secured, (d) Cheilectomy, (e) Decompression, (f) Slot Made in the Graft for Fixation, (g) Fixation of the graft, (h) Closure in layers, (i) Wound closed**

## DISCUSSION

Majority of femoral head retaining operations are extraarticular which does not address the intracapsular pathology and hence do not provide satisfactory long term functional outcome. Our study with cheilectomy, drilling, curettage and TFL MPBG addresses the pathology

with a single treatment modality unlike others like only decompression or decompression with cheilectomy.

Posttraumatic osteonecrosis of the femoral head is on the rise in developing countries like India due to the high incidence of road traffic accidents. This modality of treatment is especially beneficial in the younger population with modern lifestyle in whom the results of total hip replacement (THR) are unpredictable with high failure and revision rates. Pain relief in osteonecrosis were mainly due to decrease in subarticular venous pressure and intracystic pressure achieved due to decompression and cheilectomy where applicable.

Revascularisation occurs due to the ingrowth of granulation tissue from MPBG and better clinical outcome were evident with preoperative collapse of femoral head of 2-3 mm. In precollapse stage TFL MPBG gives better strut effects than Q-F<sup>19</sup> or gluteus medius<sup>21</sup> MPBG which contain spongy bones.<sup>20</sup> The gluteus medius MPBG is also comparatively short to reach the anterosuperior necrotic part of femoral head.

Our study showed favourable results also in most cases with limited preoperative collapse but some had persistent pain with restricted range of motion due to ongoing necrosis and secondary osteoarthritis which can be taken care of by future total hip replacement.

The vascularised fibular bone grafting combined with free iliac bone chip provided 86% survivorship compared to 30% using non-vascular fibular grafting in seven years follow up only in the early stages of necrosis<sup>13</sup> whereas they showed only 69.6% survivorship in five years when performed among combined early and stage III necrosis.<sup>15</sup> The vascular pedicle iliac crest grafting provided 40%<sup>18</sup> to 52%<sup>17</sup> good results for stage II and early stage III necrosis during four to fourteen years follow-up and provided a survival rate of 85% in five years and 61% in 10 years, mostly amongst stage II cases.<sup>16</sup> The procedures showed over 80% survivorship in all of the predegenerative stages of necrosis at 15 years follow up. The confidence band is also narrow indicating that the estimates have variability.

Vascularised grafts needs technical expertise and also has the chances of losing viability as it is based on a single vascular pedicle which may undergo torsion as compared to TFL MPBG which is technically simpler and the multiple vascular channels are well protected in the muscular bed.

Since this method gives satisfactory outcome even in predegenerative stages and significant functional outcome with better congruity of the femoral head, this

treatment protocol can be given in young patients with a predegenerative stage of osteonecrosis of the femoral head. In the context of its long term failure, total hip replacement can always be carried out in later period of life.<sup>20-22</sup>

## CONCLUSION

Osteonecrosis has become a subject of interest amongst orthopaedic surgeons predominantly during the last four to five decades. Etiologies include idiopathic, traumatic, steroid intake, alcoholism, smoking, Caissons disease, Gauchers disease, gout, haemoglobinopathies among others with different pathogenesis in each cases.

Diagnosis of osteonecrosis of femoral head is done clinically by pain in the groin, gradual restriction of motions, radiographic criteria and staging of Ficat and Arlet and ARCO. Radionuclide Scintigraphy (<sup>99</sup>mTc Di-phosphonate) can be done especially for diagnosis in the early stages of osteonecrosis without any significant radiological changes. CT also can detect the early bone changes. MRI shows very early marrow necrosis not detectable by CT and this has significantly improved the outlook of outcome with the advent of stem cell therapy. Tests for haemodynamic functions (intramedullary pressure measurements and venography) for vascular stasis also helps in early diagnosis.

Pain in hip in early stages is due to subarticular increased intravenous pressure, marrow oedema, necrosis and also due to increased intracystic pressure associated with secondary degenerative changes of hip in advanced stages of necrosis. In advanced stages, there may be collapse of femoral head, cheilus formation, adhesions around the periphery of femoral head and associated capsular contracture causing pain due to its stretching effect over the peripheral cheilus. These may produce mechanical limitation of hip motions.

Conservative management has no role in the final outcome of osteonecrosis and collapse occurs in 75% - 100% cases. Treatment depends on age of the patient, stage of the disease, etiology, lifestyle and associated morbidity among others. In our country where squatting and sitting crosslegged is customary every effort should be made to preserve a biological femoral head as long as possible.

Post traumatic osteonecrosis of femoral head treated in our study by curettage of the necrotic area in the anterosuperior aspect of the femoral head followed by multiple drilling and TFL MPBG helped in revascularisation of the necrotic bone by absorption of the dead bone and ingrowth of vascular granulation tissue. Advanced cases were treated in addition with cheilectomy and adductor tenotomy. Results

produced pain relief, improvement in range of motion, prevention of collapse and improvement in articular incongruity especially in early stages.

The clinical results did not always correlate with this radiological alterations of the femoral head, since some patients achieved satisfactory clinical scoring even in long term follow up despite the lack of radiological improvement. Clinical improvement was considered according to modified Harris hip score and radiological improvement was judged by Baksi's<sup>20,21</sup> radiological criteria of healing. The duration of follow-up was of a minimum of six months and maximum of four years and eight months.

Overall clinical improvement having excellent and good results were obtained in 9 of 10 (90%) stage II, 8 of 10 (80%) stage III disease whereas radiological improvement was noted in 8 (80%) patients of stage II and 6 (60%) patients of stage III disease. Only 2 cases had a terminal restriction of hip movements with persistence of pain less limp in another 3 cases.

While THR is the treatment of choice for older patients and with advanced degenerative changes; younger patients undergoing femoral head preserving surgery showed good results both immediate post surgery and also on long term follow up. Hence when the compression is less than 5 mm or the femoral head is not badly compromised beyond repair, decompression of femoral head and TFL muscle pedicle bone grafting is preferred in early and also in some advanced stages of the disease especially as the Indian population in general requires to squat. TFL muscle pedicle bone grafting is a relatively simpler procedure technically than other vascular bone grafting procedures for treatment of osteonecrosis which is commonly encountered in India.<sup>22</sup>

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