Original Research Article

A Functional and Radiological outcome analysis of Hip Forage procedure, done for early stages(Ficat and Arlet Grade 1 and 2A) of Avascular Necrosis of Head of Femur

ABSTRACT

Background and objectives: Avascular necrosis of the femoral head is a severe disease and causes osteoarthritis of the hip joint in young adults. Early diagnosis leads to better prognosis and therapeutic success. This study was conducted to assess the feasibility of the use of the forage procedure in Avascular necrosis of the femoral head patients and to collect information on its effect on pain, functional and radiological outcome.
Aim: To study pain, radiological outcome & functional outcome post hip forage procedure in patients of avascular necrosis of head of femur (Ficat and Arlet grade 1 and grade 2A).
Study Design: This was a prospective observational study.
Place and duration of Study: Conducted in the Department of Orthopaedics, Dr. D.Y. Patil Medical College, Hospital and Research Centre, Nerul, Navi Mumbai over a period of 2 years from 2015 to 2017
Methodology: We included 50 patients (39 males, 11 females) with Avascular necrosis of unilateral or bilateral head of femur (Grade 1 and Grade 2A), clinical, radiological and functional(with the help of Harris hip score) examination was done at 6 months and 12 months follow up post operatively.
Results: Out of the 50 patients, Pre-operatively, 60% reported moderate pain, 20% mild pain and 20% marked pains. At follow-up, 36% patients reported slight pain, 26% mild pain, 26% moderate pain, 8% marked pain, and no pain was reported by 4% patients. Pre-operatively, no limp was seen in 34% patients, moderate limp in 34% patients, and slight limp in 16% patients. At follow-up, slight limp was seen in 58% patients, moderate limp in 12% patients, and no limp in 30% patients. Before surgery, support (cane use) was required by 6% patients, while at follow-up, support was noted by 12% patients. Preoperative mean Harris Hip Score was 63.6 ± 8.94, while that at follow-up it was 74.74 ± 14.69. Radiological worsening of the disease occurred only in 38% of the patients which suggests that disease progression was delayed in most patients(62%). 2% patients had a complication of foot drop.
Conclusion: Avascular necrosis of femoral head is more common in young males. Core decompression by multiple drilling and/or core decompression with fibular strut grafting are equally effective in pre collapse stages (stage 1 and stage 2A) with better functional and radiological outcomes and hence these procedures can play a vital role in delaying the disease progression

Keywords: -Osteonecrosis, Avascular necrosis, Forage procedure, Core decompression, Fibular strut graft , Ficat and Arlet classification.

Abbreviations: AVN- avascular necrosis, ANFH- Avascular necrosis of the femoral head, HHS- Harris Hip Score, SCFE- slipped capital femoral epiphysis, ONFH- osteonecrosis of femoral head, THR- Total Hip Replacement,

1. INTRODUCTION

Osteonecrosis or avascular necrosis (AVN) is a pathological process which occurs due to a critical reduction in blood supply to the bone along with elevated intraosseous pressure [1]. AVN can be local or systemic. Local AVN occurs mostly due to trauma or microtrauma e.g. primary osteonecrosis of the medial condyle, vertebral osteonecrosis, necrosis after meniscectomy, and osteonecrosis of the mandible or small bones. Systemic AVN however manifests itself as epiphyseal necrosis or bone infarction, which is multifocal in nature [2]. AVN is a severe disease and usually causes osteoarthritis of the hip joint in young adults. It is most prevalent among middle-aged patients with approximately 75% of patients between 30 to 60 years of age, hence it has a considerable economic burden and impact on workforce as these are productive years of people [3]. Also, 30%-70% of patients show involvement of both the hips [4]. The classical manifestation of ANFH occurs in the form of bone cell death, which results in impaired repair processes of the microfractures occurring in the femoral head [3]. Eventually femoral head ischemia causes death of bone marrow and osteocytes and finally leads to the collapse of the necrotic segment [1]. It has been reported that 75% of cases with AVN suffered collapse of the femoral head within three years of presentation; and 80% suffered collapse within four years from onset of hip pain due to AVN [5]. The exact cause of AVN remains yet to be understood [2]. The involvement of vascular abnormalities in the development of ANFH was propounded by *Phemister* as early as 1934; he postulated that thrombosis and embolism occurring due to vascular abnormalities can lead to the development of ANFH. A study by *Jones CL and colleagues* among osteonecrosis patients found a high incidence of thrombophilic and hypofibrinolytic coagulation abnormalities [6]. Postulated mechanisms include intraluminal obliteration of blood vessels due to microscopic fat emboli, sickle cells, nitrogen bubbles (caisson disease), or focal clotting as a result of procoagulant abnormalities. Extraluminal obliteration can also occur as a result of elevated marrow pressure or increased marrow fat. Certain cytotoxic and genetic factors have also been suggested to be involved in AVN [2]. AVN can also result as a complication of slipped capital femoral epiphysis (SCFE), which leads to considerable pain, femoral head deformity and increased disability [7]. It is most likely a multifactorial disease with postulated causes ranging from Gaucher's disease, ionizing radiation, steroid therapy, alcohol overdose, hyperuricemia, pancreatitis and pregnancy [4]. The failure of arterial supply, obstruction of venous drainage, intraluminal capillary obstruction, and compression of capillaries in the bone marrow leads to osseous necrosis [4].The present

models explaining the pathophysiology suggest that recurrent ischaemic attacks on bone are preceded by an increase in the intraosseous pressure, most likely as a result of oedema. This cause damage to the intraosseous venules and capillaries restarting a vicious circle similar to the compartment syndrome of the extremities [4]. Magnetic resonance imaging (MRI) can be used to assess with high degree of precision the initial size and location of the necrotic segment; this is of importance as the risk of collapse is mostly dependent on it [2].It has been clearly shown that early diagnosis of AVN leads to better prognosis and therapeutic success. If osteonecrosis of femoral head (ONFH) remains untreated, it progresses to secondary hip arthritis in about 70%-80% of patients. It is vital that early diagnosis and treatment is performed to ensure that the hip joint is preserved [8]. Treatments have been recommended based on the symptoms along with the Ficat and ARCO classification by many researchers [4]. The aim of any therapeutic modality is to preserve the range of motion of the hip and to prevent the collapse of the femoral head.[7] If treatment begins early on in the disease then non-operative or joint preserving techniques can improve outcomes [8].In patients with early stages of AVN (i.e., Ficat and Arlet stage I and II), treatment can be in the form of joint-preserving methods such as core decompression, avascular or vascularized bone grafting, and various femoral osteotomies as the structural integrity of the subchondral plate is still preserved. Hip preservation protocols become ineffective once the femoral head collapses (>2 mm) or if there is secondary degeneration, and arthroplasty becomes the only viable treatment. In the more developed stage of the disease (Ficat and Arlet stage III and IV) THR becomes the only effective treatment modality [1,8].Determining the Ficat and Arlet stage is of importance as the treatment to be provided and its efficacy will depend on it; this is seen especially in the fact that aside from the treatments mentioned earlier, surface replacement and THR is recommended only to treat patients with stage III lesions [4].However due to the paucity of data on the outcome of treatment modalities of ANFH in an Indian setting, we planned a study to help fill this lacuna. This study was planned with an aim to assess the feasibility of the use of FORAGE procedure (minimally invasive drilling procedure or fibula strut grafting) in ANFH patients and to collect information on its effect of pain, functional and radiological outcome. The data generated from this study will help clinicians in future to determine the best course of action.

2. MATERIAL AND METHODS

The study was initiated after obtaining approval from the Institutional Ethics Committee.The purpose and rationale of the study as well as their role as participants was explained to all the patients in the study. Written informed consent was obtained from all the patients prior to enrolling them in the study. This was a prospective observational study of 50 patients, conducted in the Department of Orthopaedics, Dr. D.Y. Patil Medical College, Hospital and Research Centre, Nerul, Navi Mumbai over a period of 2 years from 2015 to 2017. This

study was conducted in patients of either gender with avascular necrosis head of femur grade 1 and grade 2a fulfilling the eligibility criteria of the study.

2.1 Study Selection Criteria: Inclusion Criteria:- Patients with avascular necrosis of head of femur grade1 and grade 2A according to Ficat and Arlet classification and patients of either sex older than 18 years and below 50 years of age. Exclusion Criteria: - Patients with avascular necrosis of head of femur grade 2B, grade 3 and grade 4 according to Ficat and Arlet classification and Patients not willing to give written consent were excluded .

2.2 Study procedure: During the study the patients were called for follow up at 6 months and 12 months post-operatively. At every visit, thorough clinical and radiological examinations were performed. During the first visit at 6 months period post-operatively, X-ray of pelvis with both hips and MRI of Hip was done.Then MRI hip was done after the initial six months' period post-operatively. A standardized questionnaire was completed for each patient to evaluate subjective factors such as pain, functional limitations, and occupational considerations (using Harris Hip score). Objective examination included inspection of the hip joint for deformity, tenderness, abnormal mobility, and measurement of range of movements. The radiographic evaluation was done to monitor the healing of avascular necrosis of femur head in form of X-ray of pelvis with both hip and MRI of hip. Hip range of movements, Abduction and adduction, Flexion and extension, Internal rotation and external rotation, Ability to do day-to-day activities were used to assess the functional outcome.

2.3 Operative procedures: *Core decompression with multiple drill holes*- patient positioned supine on fracture table with affected leg in slight internal rotation and contralateral leg in abduction. Image intensifier was used to confirm visualization of femoral head and neck in anteroposterior and lateral. 5 cm incision (tip of greater trochanter to lesser trochanter), Vastus lateralis asplit to expose femur, Diseased area of femur head drilled using 4.5 mm drill bit under image guidance. Decompression of necrotic bone by multiple drill bits under image guidance

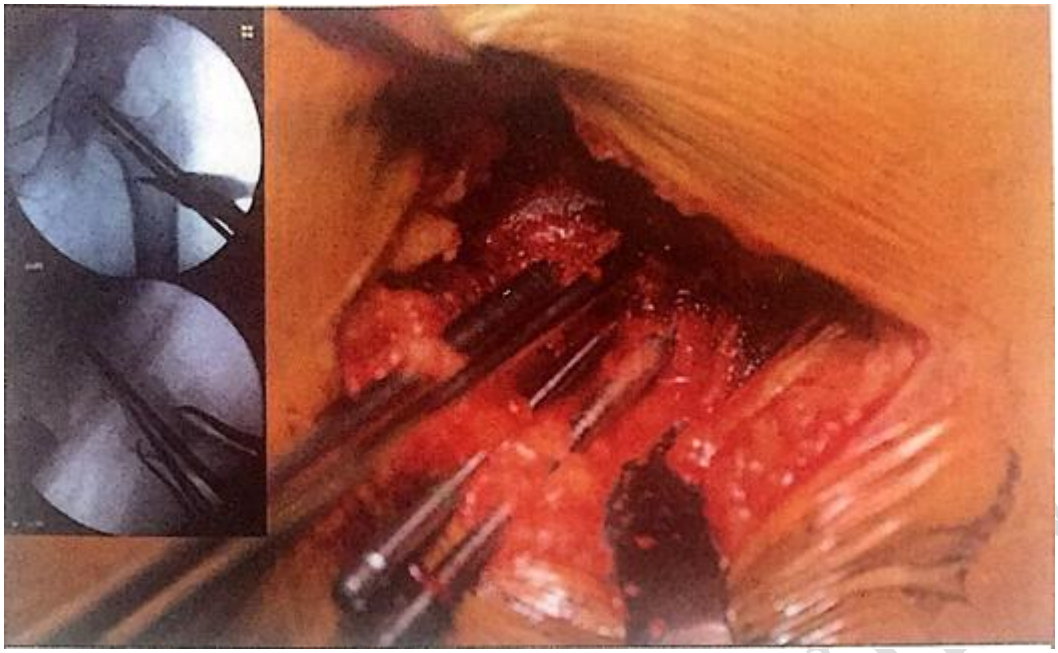

Fig. 1. Shows Decompression of necrotic bone by multiple drill bits under image guidance

Core decompression and Fibula strut grafting Patient positioned supine on fracture table with affected leg in slight internal rotation and contralateral leg in abduction. 12 cm incision taken over lateral aspect of leg, Fibular graft harvested, Graft measurement done . Following the similar above approach, Core decompression is done and femoral neck is prepared for femoral strut with a reamer , femoral strut graft is placed in the prepared tract.

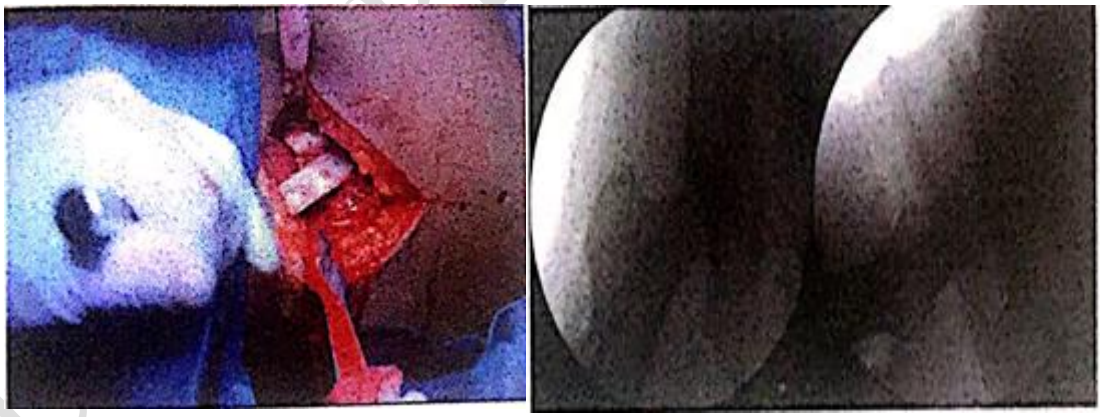

Fig. 2. Shows Placement of femoral strut graft in the prepared tract

3. RESULTS

Chi-square test was used to analyze categorical data. Pearson correlation test was used for parametric correlation analysis while Spearman correlation test was used to analyze non-parametric correlation.

Table 1 Compares the various Risk factors

Risk factor	**No.**	**%**
Idiopathic	30	60
Trauma	6	12
Smoking	3	6
Alcohol	8	16
Steroids	3	6

We observed idiopathic risk factors in most of our study patients (60%; 30/50), followed by alcohol (16%; 8/50) patients, trauma (12%; 6/50), and smoking and steroids in 6% (3/50) patients each.

Mean Age: In the present study, the mean age of our study patients was 35.12 ± 7.60 years.

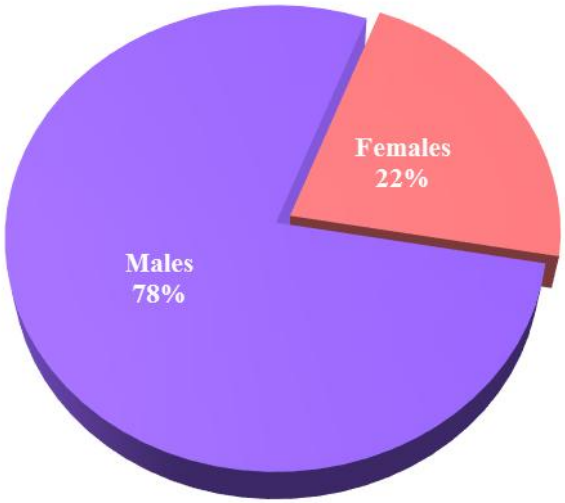

Fig. 3. Shows male predominance.

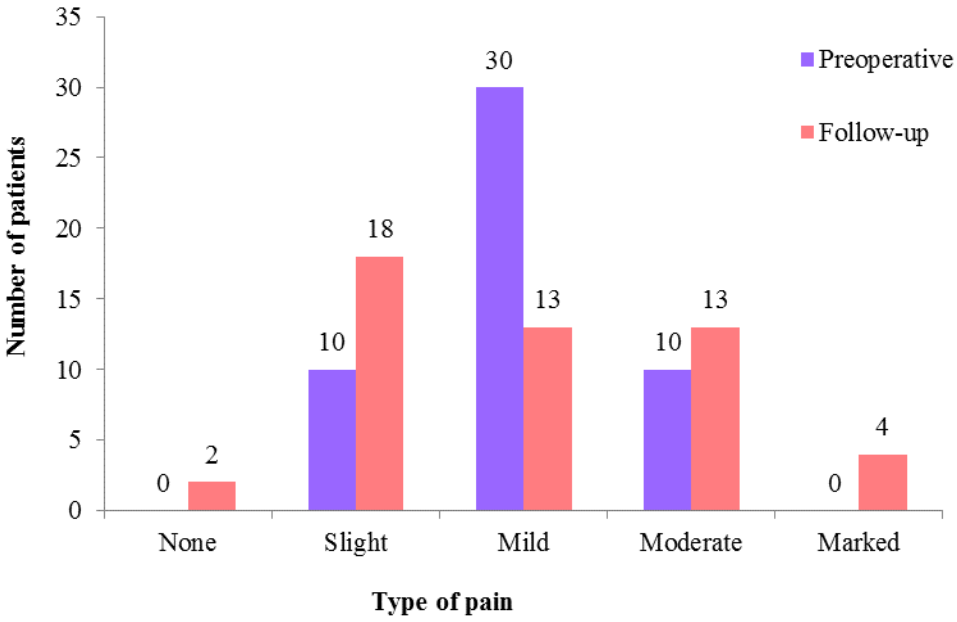

Fig. 4. Shows comparison between preoperative and follow-up pain

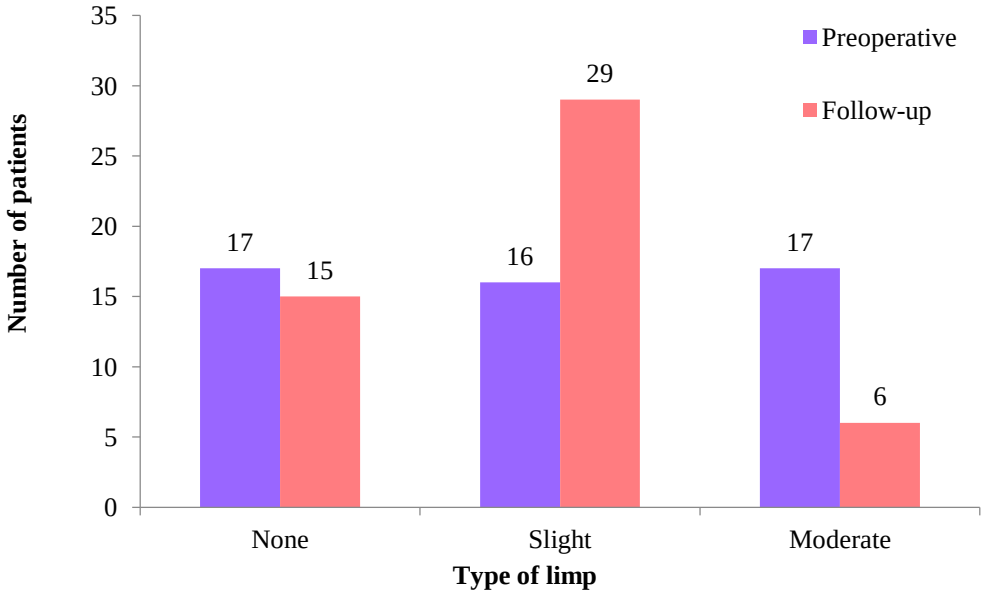

Fig. 5. Shows comparison between preoperative and follow-up limp

Preoperative and follow-up limp was compared using the chi-square test. We observed a statistically significant improvement (*P*= .01) between preoperative and follow-up limp among our patients.

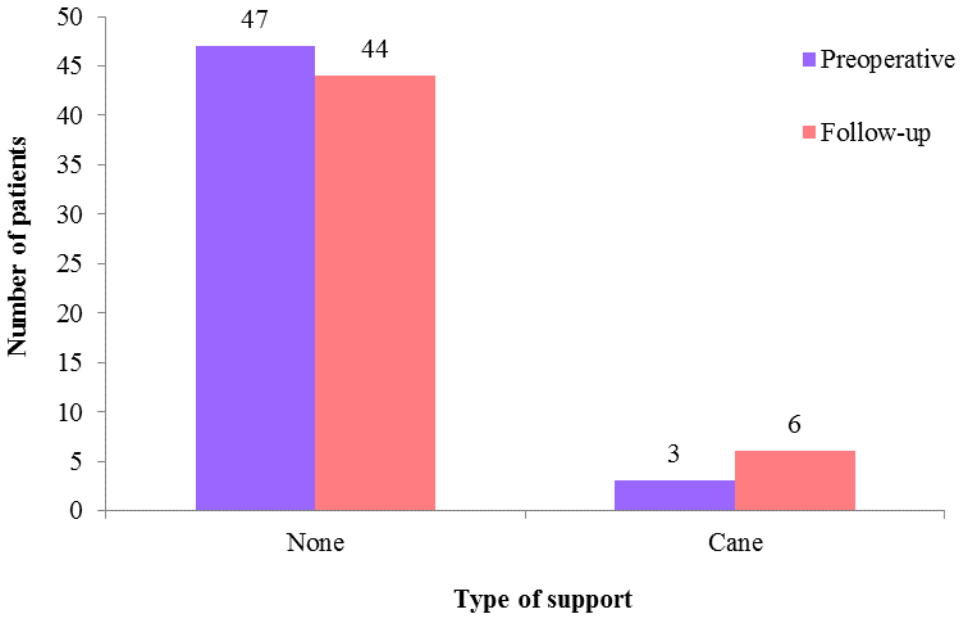

Fig. 6. Shows comparison between preoperative and follow-up support

Preoperative and follow-up support was compared using the chi-square test. No statistically significant difference (*P* = .29) was observed between preoperative and follow-up support among our patients.

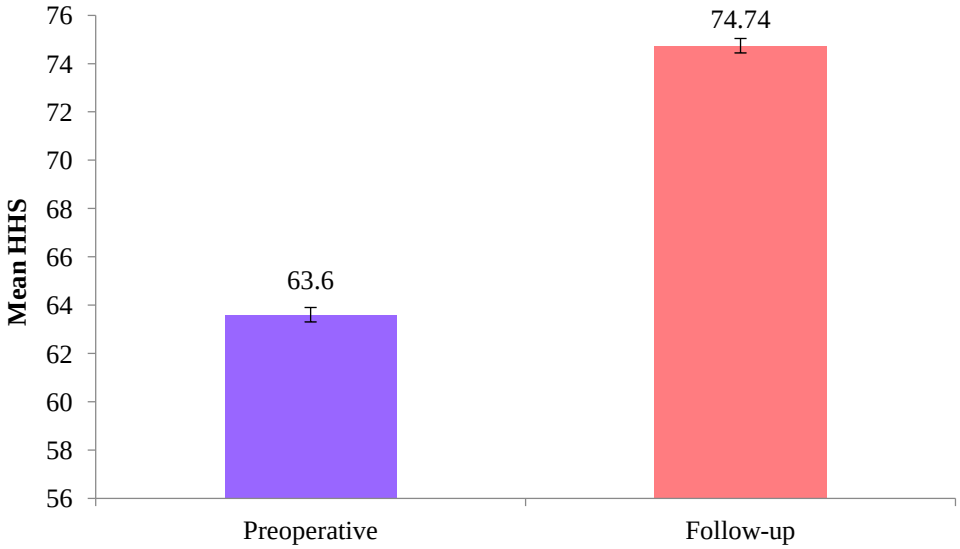

Fig. 7. Shows comparison between preoperative and follow-up mean HHS

The above figure shows an overall increase in the Harris Hip score which is indicative of a better functional outcome post decompression. Preoperative and follow-up mean HHS was compared using the t-test. A statistically significant difference (*P*= .0001) was observed between the mean preoperative and follow-up HHS scores among our patients.

Table 2. Comparison between preoperative and follow-up radiologic score				
Radiologic score	**Preoperative**		**Follow-up**	
	Right	**Left**	**Right**	**Left**
1	10	13	4	7
2A	23	27	23	18
2B	0	0	5	9
3	0	0	1	4
Nil	17	10	17	12

Above table shows that radiological worsening of the disease occurred only in 38% of the patients which suggests that disease progression was delayed in most patients(62%).

4. DISCUSSION

Avascular necrosis of the femoral head is a chronic, potentially debilitating condition with a comprehensive array of etiologies and a poorly understood pathogenesis. A consensus concerning the ideal algorithm to treat patients at different stages of the condition is lacking. During the early stages, joint preserving procedures like percutaneous drilling or core decompression might increase blood flow to the necrotic area by decreasing the intraosseous pressure, consequently relieving pain and enhancing function [9].
The Ficat and Arlet system was the first classification system for ANFH [10]. In patients with early stages of AVN (i.e ficat and arlet stage 1 and 2A), treatment can be in the form of joint-preserving methods since the structural integrity of the subchondral plate is still preserved [11]. Seeking a safe, minimally invasive and effective treatment for ANFH, the use of multiple small drilling for core decompression was proposed in 2003, with findings of a lower rate of collapse (14.3 %) compared with traditional core decompression methods (45 %) 3 years after surgery [12]. The present study was designed to evaluate the feasibility of forage procedure (use of minimally invasive drilling procedure or fibular strut grafting) in ANFH patients and to collect information on its effect of pain, functional and radiological outcome.
We observed idiopathic risk factors in most of our study patients (60%; 30/50), followed by alcohol (16%; 8/50) patients, trauma (12%; 6/50), and smoking and steroids in 6% (3/50) patients each.Majority (12/20) of the patients evaluated by *Shah SN et al* were alcoholics, 1

patient had AVN after long-term steroid use, 1 had HIV infection and no cause could be identified in 6/20 patients [13].

Similar risk factors were identified by *Yoon TK et al*: alcoholism (20/31 patients), steroid overdose (10/31 patients) and idiopathic (9/31 patients) [14]. The distribution of similar risk factors leading to AVN reported by *Maniwa S et al* were: idiopathic (8/19), steroid related (7/19), alcohol (1/19), trauma (1/19) among others [15]. Alcohol abuse and corticosteroid usage have been frequently cited as risk factors in various studies, as reviewed by *Marker DR et al* [11].

In the present study, pre-operatively, most patients (60%; 30/50) reported moderate pain, while 20% (10/50) patients each reported mild and marked pains. At follow-up, 36% (18/50) patients reported slight pain, 26% (13/50) patients each reported mild and moderate pains, 8% (4/50) reported marked pain, while no pain was reported by 4% (2/50) patients.

Out of 28 hips treated by *Shah SN et al*, 15 of the 20 patients presented within 6 months of the onset of pain; 26 hips reported relief in pain instantaneously post-surgery. At 3 months follow-up, 22 hips had complete pain relief with no pain in 19 hips at 6 months and final follow-up [13].

The preoperative mean HHS among our study patients was 63.6 ± 8.94, while that at follow-up was 74.74 ± 14.69; a statistically significant difference ($p<0.0001$) was observed between the mean preoperative and follow-up HHS among our patients, indicating a significant improvement. *Kim et al reported* the average preoperative and last HHS as 86.7 to 73.7 in the core decompression group as compared to 87.0 and 74.6 in the multiple drilling group [12]. *Shah SN et al* found that, of the 20 hips that improved, the average preoperative HHS was 71.18 which increased to 88.23 at final follow-up. Whereas for the remaining 8 hips that did not show improvement the average preoperative HHS was 58.03 that reduced to 47.68 at final follow-up, indicating deterioration [13].

In the present study, among the patients with right hip involvement: radiologic score of 1 was seen in 10 patients preoperatively and in 4 patients at follow-up; radiologic score of 2A was seen in 23 patients preoperatively which remained the same at follow-up; radiologic score of 2B was not seen in any patients preoperatively but in 5 patients at follow-up; radiologic score of 3 was not seen in any patients preoperatively but in 1 patient at follow-up; nil radiologic score was seen in 17 patients preoperatively as well as at follow-up. Among those patients with left hip involvement: radiologic score of 1 was seen in 13 patients preoperatively and in 7 patients at follow-up; radiologic score of 2A was seen in 27 patients preoperatively and in 18 patients at follow-up; radiologic score of 2B was not seen in any patients preoperatively but in 9 patients at follow-up; radiologic score of 3 was not seen in any patients preoperatively but in 4 patients at follow-up; nil radiologic score was seen in 10 patients preoperatively and in 12 patients at follow-up.In the study by *Shah SN et al*, grading was done as per the Ficat & Arlet grading system: there were 13 hips (46.42%) of grade I, 11 hips (39.28%) of grade IIA and 4 hips (14.28%) were grade IIB [13]. In the study by *Maniwa*

et al, 10/26 hips had stage I while 16 had stage II of the disease. Using the Ficat criteria, they observed that 65.4% hips had very good or good results [15]. *Yoon TK et al* observed 17/39 hips with Ficat grade I, 14/39 hips with Ficat grade 2 and 8/39 hips with Ficat grade 3 [14].

5. CONCLUSION

Avascular necrosis of femoral head is more common in young males. If done in early stages of disease(stage 1 and stage 2A), core decompression by multiple drilling or core decompression with fibular strut grafting is equally effective in reducing the pain and improving the ability of the patient to do his/her day-to-day activity. It was also observed that the radiological outcomes improved in few patients following the procedure which shows that these early interventions can have some potential of delaying the progression of the disease and the need for Replacement surgeries.

CONSENT AND ETHICAL APPROVAL

As per international standard or university standard guideline patient's consent and ethical approval has been collected and preserved by the authors.

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