RESEARCH ARTICLE

Treatment of Femoral Head Osteonecrosis (Stages 2B, 3 Ficat) Through Open Direct Core Decompression by Allograft Impaction and Light Bulb Technique

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Abstract

Background: Femoral head avascular necrosis is the cause of paralyzing status of youth population. Initial diagnosis is the main element in treating the disease. Bone grafting and core decompression are the approved cures at the early steps of the disease. Hip replacement in a total manner is the common cure in the final stages. The optimal treatment in the intermediate stages is partially disputable. We investigated several patients with femoral head osteonecrosis cured with impacted cancellous allograft and open core decompression using the lightbulb technique.

Methods: A total of 46 patients (58 hips) suffering from femoral head osteonecrosis were evaluated in this cross-sectional study. Patients were classified into two groups: A (stage 2B Ficat) and B (stage 3 Ficat) to be treated with the impaction of cancellous allograft and by open core decompression. Radiographic results, demographic data, and range of hip joint motions were recorded. The patients were assessed through employing the Harris hip score (HHS) and visual analogue scale (VAS) index prior to operation and over five years following surgery. We also studied radiographic alterations of femoral head.

Results: The means of HHS and VAS were developed following the operation. Radiographic outcomes promoted in both groups, however, it was better in group A. 12 (40%) and six (22%) hips (40%) in groups A and B, respectively displayed developed stages following the operation. The hip ROM was enhanced with the mean of 15-20 degrees (*P<0.005*).

Conclusion: Open core decompression combined with allograft impaction sounds to be influential in the developing steps of femoral head necrosis and leads to joint discomfort and diminished pain improving ROM of the hip joint and meanwhile procrastinating the worsening of the disease.

Level of evidence: IV

Keywords: Allograft, Cancellous bone, Femur head necrosis, Osteonecrosis, Surgical decompression

Introduction

Femoral head osteonecrosis is a paralyzed status that affects young patients aging around 20-40 years and is linked with several etiological causes like smoking, alcohol addiction, sickle cell occlusion, coagulation disorders, corticosteroid use, myeloproliferative disorders, and HIV infection. Alcohol use and corticosteroid consumption are the most prominent sources of non-idiopathic AVN of femoral head

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(1-3). It is frequently specified by merciless development in spite of treatment leading to collapse and secondary osteoarthritis as well as a subchondral fracture (2, 4). Early diagnosis and hereby the treatment of patients of osteonecrosis is crucial to preclude secondary annihilation of the hip joint and femoral head collapse (5). The prevalence of the illness is hard to estimate. Five to 18% of patients who underwent complete hip replacement in the US were reported to have developed osteonecrosis with secondary osteoarthritis (6, 7). Patients suffering from femoral head osteonecrosis due to alcohol consumption and corticosteroid were younger and more probably had bilateral illness and were found to have faster progress and femoral head collapse (8, 9).

Practical constraints, serious pain, and concession state of life in the current population of patients may be the outcome of necrosis in the formal head (10). The announced occurrence of bilateral ONFH ranges from 6% to 72% (11). In spite of the great occurrence of bilateral ONFH, merely around 15% of patients were reported to have bilateral symptoms on primary demonstration (1). Due to the asymptomatic condition in the initial steps, there is hardship in measuring the predominance of osteonecrosis (11). Hitherto, the normal record of femoral head osteonecrosis prior to the expansion of crescent sign or the femoral head collapse has rarely been well identified. The possibility of progression to higher stages is assumed to enhance following the advancement of abnormality which can be observed on a plain radiograph (1). It is commonly acknowledged that operation had better outcomes than non-operative treatment and symptomatic hip can proceed to femoral head collapse and higher stages of disease when the treatment is nonoperative (12). To evade the above-mentioned medical intricacies and to prevent original total hip arthroplasty in young patients, there are numerous operational processes to save the femoral head (12, 13).

Ficat and Arlet, in 1962, introduced core decompression as a competent method to treat the initial steps of femoral head necrosis. Core decompression would diminish femoral head pressure (14). Core decompression has a clinically successful rate of 53-71% (15). The head-salvage procedure of core decompression along with any type of bone grafting surely yields excellent or good outcomes in the initial stages of osteonecrosis. In spite of numerous written accounts on the efficacy diverse operational methods, no single operation can consistently arrest the illness or prevent the collapse of the femoral head completely. Autograft in combination with core decompression would procure better results compared to mere core decompression. Combined, these two procedures result in a significant improvement of Harris hip score and visual analog score (VAS) after one year follow up as observed in patients undergoing core decompression with bone grafting once compared to core decompression alone (16). The procedure of providing the vascular fibula with microanastomosis to the beneficiary site is the requirement for the promising usage of free vascularized bone grafts. In this study, we examined and reported several patients of femoral head osteonecrosis in the advanced stages of AVN (stages 2B, 3 Ficat) that was cured by affected cancellous bone allograft and open core decompression. We think the impaction of the graft may prevent or retard femoral head collapse.

Materials and Methods

Clinical data

We studied a big group of patients suffering from osteonecrosis of the femoral head in a military hospital of the Islamic Republic of Iran. Patients with Ficat stages 2B and 3 between ages 20-50 years were included in this study. Patients older than 50 and younger than 20 years old, with history of any previous hip surgery, Ficat stages 1,2A and 4 with underlying illnesses like systemic lupus erythematosus, rheumatoid arthritis, and diabetes mellitus, current use of steroids and immunosuppressive therapy were excluded from this study. A total of 46 patients with ONFH (58 hips), were classified into two groups. Group A (n=26) included 30 hips with the mean age of 31.6 years with preoperative HHS of 55±11.9 and Ficat stage 2A and group B (n=20) had 28 hips with the average age of 26.7 years, preoperative HHS of 48± 10.9 and Ficat stage 3 [Table 1]. Most of the patients had a record of consumption of high-doses of corticosteroids, anabolic steroids, or bodybuilding drugs and opioids. The patients were evaluated with AP pelvis view, AP and lateral view of involved hip, false profile view in cases of CAM type FAI. CT scan was used for determining the subchondral fracture and differentiating between 2A and 2B stages. The amount of head involvement was assessed with MRI (STIR sequence or T2WI fat-suppressed, T2WI and 1.5T T1WI).

Typing and staging

All patients were ranked and categorized based on the Ficat classification scheme. Group A consisted of patients with stage 2B Ficat while group B consisted of patients with stage 3 Ficat. Patients with stages 1, 2A, and 4 Ficat classification of ONFH were not included in this study.

*Assessment of efficacy(7) **

According to the Harris hip score (HHS), the clinical

Table 1. Demographic data. Abbreviation: VAS, visual analogue scale; HHS, Harris hip score

Group	A		B	
number	26		20	
hip	30		28	
Age(mean)	31.6		26.7	
sex	16m	10f	14m	6f
Mean follow up	60 mounts		60 mounts	
Hamp	9		11	
Corticosteroid consumption	20		14	
VAS first	7.9±1.8		8.5±1.2	
HHS first	55±11.9		48±10.9	

effectiveness was measured. Harris hip scores over 90, 80–89, 70–79, and under 70 were respectively described by excellent, good, fair and poor outcomes. The radiological assessment was conducted and classified according to the cross-table lateral radiographs and anteroposterior, namely as total roundness of the femoral head, cyst and subchondral fracture, CAM and PINCER pathology, gentle collapse with the mismatch between the femoral head and the acetabulum from mild to serious collapse.

The procedure of surgery

The process was conducted with the patient in supine position. In order to locate the anatomical situation of the necrotic lesion, fluoroscopy was employed. For an anterolateral approach (Watson-Jones approach), a cut of roughly 5-cm was created to the hip over the larger trochanter to conserve blood supply to the femoral head. The fascia lata was split longitudinally and with the preservation of the gluteus medius, the initial joint capsule was exposed and opened with standard z–shaped incision. In most cases, the articular capsule was thicker than normal. Capsular and retinacular vessels especially at the superolateral portion of the head were preserved during the surgery. After exposing the head neck junction and the anterior part of the femoral neck at the femoral head-neck junction, a window (length and width of 1.5 cm) was made using a drill and thin osteotomes. Under C-arm fluoroscopy, a 2.5 mm pin was sent into the necrotic part of the head. All the dead bone until reaching to bleeding region was completely removed utilizing a curette and a great-speed drill, yielding remaining of at least 5 mm subchondral bone. Sclerotic bone was pierced in numerous sites with drill bits. In the cases of subchondral depression and articular cartilage collapse, the site of collapse was elevated and the defect was filled with impacted allograft chips. A bougie was used for better impaction of the grafts. The originally removed cortical bone was capped with the bone window. At this point, if there was primary or secondary cam type FAI due to femoral head collapse, osteochondroplasty of the junction of head neck and the head was done and ROM of hip joint especially interior and outward rotation, flexion, and adduction was checked to ascertain that there was no impingement in the anterosuperior, anterolateral and superolateral part of the femoral head. Finally, trimming of the anterior and lateral parts of the articular capsule was done and the articular capsule was sutured loosely.

Post-operative treatment

The patients were asked to walk with touch-down weight bearing during the first 6 weeks after the operation. Complete weight bearing began during the next six weeks PWB and thereafter. Higher load-bearing activities (such as running) began 1 year postoperatively. Alendronate sodium 70 mg weekly was prescribed for 12 months. Following the operation, a surgeon clinically examined all patients every three and six months over the first upcoming year. This analytical follow-up comprised of the measurement of preoperative and postoperative Harris hip scores and VAS every 3 months in the first year, every 6 months during the second year, and yearly. AP, cross-table lateral radiographs were obtained at 3, 6, and12 months and then annually for the radiographic follow-up. An MRI test was repeated after six months and later. The results were judged according to Harris hip score and VAS and classified as poor, fair, good, or excellent.

Statistical method

By utilizing SPSS version 24 statistical software, the data were scrutinized. Analytical investigation of the data was performed employing Fisher's exact test and Chi-square. P values smaller than 0.05 were recognized as statistically important.

Results

Clinical results

We observed all the patients for 4 to 6 years (average of 5 years). Good and great results were obtained in 6 and 10 hips, respectively, which justified 53% of the hip joints in group A. Six hips (20%) had favorable and 8 hips (26.6%) had poor results. In the last follow-up, the mean post-operative HHS score of all the hips was 88±13.4 points. As for the patients in group B (3 Ficat), the coming effective outcomes were achieved as "excellent" and "good", respectively in 3 and 7 hips (35% of the hips); favorable in 6 hips (21%); and "poor" in 12 hips (42%). The mean post-operative HHS score was 79.3±11.2 points. Osteochondroplasty was done for 9 patients in group A and all had excellent or good Harris hip score and also for 11 patients in group B and 6 of them had an excellent or good score. Hip function (hip score) improved significantly in both groups (*P=0.001*) and was better in group A compared to group B (*P=0.04*). The mean VAS for group A and group B was 7.9±1.8 and 8.5±1.2, respectively (*P=0.13*). After treatment, there was a significant decrease in the mean VAS and pain in both groups (*P=0.001*); meanwhile, no noticeable discrepancy was observed between the two genders (*P=0.1*) [Table 2; 3].

Radiological results

The results of clinical assessment were identical to radiological outcomes. In group A (2B Ficat), the comprehensive improvement and the roundness of the femoral head were seen in 18 out of 30 hips with "great" results. In 6 patients with ONFH (stage 2B), the femoral head was not round and had poor outcomes. Of the 28 hips with ONFH (3 Ficat), thorough improvement and the roundness of the femoral head were seen in 10, and 12 hips had poor outcomes after the first year of follow-up period. Among 12 hips with "poor" results, higher than 4 mm femoral head collapse, fracture of subchondral bone (by CT), mismatch of the joint, unsymmetrical alterations in the articular space and bone marrow edema (by MRI) were observed. In 5 years, remarkable disparity was observed between the head survival rate of 12/30 (40%) in group A, and 6/28 (21%) in group B (P=0.04). Of these mentioned patients, 8 were male and 4 females in group A and 2 males and 4 females in group B. No notable discrepancy was observed between two genders with regard to femoral head survival time [Figures 1; 2].

Table 2. No significant complications were observed during the operation and in first trimester after operation except one patient that had fallen down and subsequent femoral neck fracture that underwent total hip arthroplasty. However, the postoperative complications included worsening of disease and progression to higher stages were seen in 6 patients (6 hips) in group A and 10 patients (12 hips) in group B. The amount of hip abduction in group A increased from 15 degrees (mean abduction) to 35 degrees and in group B from 10 degrees to 25 degrees and was significantly valuable in each group (*P<0.05*), and in comparison, together was better in group A than group B (*P<0.05*). Those patients that underwent osteochondroplasty had significantly increased hip abduction in both groups in comparison with those that underwent core decompression and impacted grafting without osteochondroplasty (*P<0.05*). Similar to abduction of hip, the excellent and good HHS was seen in 8 patients in group A and 6 patients in group B in whom osteochondroplasty was carried out. Abbreviation: VAS, visual analogue scale; HHS, Harris hip score.

Patient Groups	A			B		
	Average	Male	Female	average	Male	Female
VAS primary	7.9±1.8	7.3±1.5	8.2±1.1	8.5±1.2	8.6±1.3	8.1±8
VAS 5 years latter	2.6±1.1	2.9±1.4	2.6±1.3	3.2±1.4	3±1.1	2.9±1.4
Primary HHS	55±11.9	54±9	58±11	48±10.9	51±8	46±11
HHS 12 mounts latter	88±13.4	86±8	84±9	79.3±11.2	77±10	79±11
Primary HIP abduction	15	-	-	10	-	-
HIP abduction 1 years latter	35	-	-	25	-	-

Table 3. Number of patients with different degrees of abduction of hip joints

Abduction	Group A			Group B		
	Before	Mounts 3	Last follow up	Before	Mounts 3	Last follow up
0-10	0	0	0	01	3	2
11-20	9	3	6	51	11	7
21-30	91	9	3	3	8	12
31-40	2	16	17	0	6	7
41-50	0	2	4	0	0	0

Figure 1. 30-year-old male with FHON grade 3 Ficat. Abbreviation: FHON, femoral head osteonecrosis.

Figure 2. Three years after the operation.

At the end of the fifth year of the pursuing period, eight patients (10 hips) in group A and nine patients (12 hips) in group B developed severe osteoarthritis that underwent a total hip replacement.

Discussion

Young male patients are commonly affected by femoral head necrosis which is a painful illness whose innate period tends to be continuous while secondary osteoarthritis is the outcome (8). In late-stage osteonecrosis (Ficat 4), currently, total hip arthroplasty seems to be the best treatment with a good functional hip score. Nonetheless, the presently anticipated long life of primitive total hip replacement is shorter than the patient's young age and his predicted life duration. Initial realization of osteonecrosis and recently recognized less invasive healing procedures have opened modern prospects to cure this illness (13). Saving the femoral head roundness and sphericity produces a better outcome and finally delays the progression of the disease and evading THA (17). Core decompression procedure is among these operations and the previous findings show it is higher than non-operative remedy (18). It was found that core decompression results in crucial post-operative pain lessening in primitive stages of FHON, but, in the postoperative evaluations, it might be displayed that no important amendment procedure in FHN necrotic area could be gained only with decompression, causing it to be a challenging activity demanding extra alternative cure choices (18, 19). There is a lack of research assessing pain and operational benefit following core decompression; meanwhile, making a prompt comparison with these studies is a challenging problem. Ali *et al*. conducted an analytical study of fifteen total studies assessing core decompression of femoral head necrosis and its impact on operation and pain of the hip, at least, in a period of 5 years in postoperative manner (20). Following the core decompression process, the findings of their research displayed a volatile achievement of function. Three studies have demonstrated significant results in vascularized fibular graft and 2 of them demonstrated superiority in the free vascularized fibular graft. Some studies have noted no significant superiority. The stage of the osteonecrosis affects the long-term results of this process with the best prognosis for stages 1 and 2A Ficat. The outcome of stage 2B and 3 Ficat is still under discussion. Therefore, we only included Ficat 2B and 3 hips in the present work.

The results of FHN as presented by Wei *et al* appear to be developed by the impaction of the graft into the osteonecrosis (15). For cooperative patients with ONFH without severe comorbidity, impacted bone grafting and the core decompression would attain optimal results. Rosenwasser originally presented this procedure and attained the survival rate of the femoral head of up to 81% in 15 patients who had non-traumatic ONFH and a mean follow-up period of 12 years (17). On the other hand, core decompression in combination with the graft impacted at the site of necrosis was developed that permitted intra-operative filling of the area of FHN leading to better remodeling and reconstruction of head shape and sphericity. Wei *et al*. (2014) reported this treatment option in 72 hips, which represents an observable development in the head survival rate in comparison with previous findings with merely core decompression (15). Ultimately, Liberman *et al*. revealed no superiority of curing pre-collapse stage of femoral head necrosis utilizing allograft or vascularized autograft and pointed that the degree of involvement of weight bearing area and femoral head are the most important factors that influence the outcome (6). Bulent Atilla *et al.* stated that the announced results of core decompression are disputable in various aspects. The age, location, necrosis size, stage, and etiology of the ONFH as well as the technique of operation are among the different variables that have not been standardized. They have shown that the outcomes were improved in patients with younger age, smaller (less than 15% of femoral head), and medially located lesions (13).

This study aimed to evaluate the efficacy and safety of the open core decompression via a window in the femoral neck in association with the influence of a cancellous bone allograft. Based on our experience, the impaction of the graft is more important than its source and viability. In particular, no more excessive complications were observed at the harvesting side. One of the significant components that affects the outcome of hip salvage surgery is the circulation of the femoral head; however, it may result in damage to the femoral vasculature and worsening of the ANFH if the surgeon is not familiar with the procedure. Fukui *et al.* cited that other causes of hip pain must be considered in patients with idiopathic ONFH with the pain in hip. They reported a case of idiopathic ONFH with cam lesion that was treated with arthroscopic correction of head neck junction lesion (21). In many patients, there was cam pathology and impingement that affected the pre- and post-operative findings. The existence of cam pathology can be primary as it is seen in asymptomatic individuals of the general population or secondary to periphery collapse or head neck junction of the femoral head. During the operation, femoral head osteochondroplasty and junction of the head neck was done if needed. Femoral head osteochondroplasty junction of the head neck, reshaping of femoral head removing the osteophytes, in combination with removal of thick synovium and trimming of thick anterior and hip joint lateral capsule may explain decreased hip pain and increased range of internal rotation, flexion of hip joint, and abduction seen in our patients. The evaluation of the effect of the impaction of the graft into the femoral head was done by the assessment of radiological and clinical results. We found that pain ease and practical development might be obtained in both groups at the end of the first year after operation. Yildiz *et al* in treating 28 hips with lightbulb technique with ONFH of stages 4a or earlier according to Steinburg classification, obtained 75% excellent to good outcomes and fair to poor outcomes in 25% of hips. 5 hips in the later group subsequently required total hip arthroplasty. Although their results were better than our study, however, they operated patients at the earlier stages of osteonecrosis (22).

Open core decompression with graft impaction the at the

necrosis site seems to be useful and effective in managing femoral head osteonecrosis before joint destruction and osteoarthritis. Mild degrees of the collapse of femoral head can be treated effectively with head preserving open core decompression with impaction of allograft and this operation results in better hip function, decreased hip pain, improved quality of life, and more importantly, delays joint destruction.

Disclosure: The authors state no conflict of interest in terms of methods and materials utilized in the study nor the results.

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