Non Traumatic Hip Osteonecrosis Treated By Non Vascularised Bone Graft Versus Core Decompression

*Dhary F. hassan; ** Ghadeer H. Majeed, *Abed Falih Al-Sudani

ABSTRACT
Background: Avascular necrosis (AVN) is defined as cellular death of bone components due to interruption of the blood supply; the bone structures then collapse, resulting in bone destruction, pain, and loss of joint function. AVN is associated with numerous conditions and usually involves the epiphysis of long bones, such as the femoral head. In clinical practice, AVN is most commonly encountered in the hip. Early diagnosis and appropriate intervention can delay the need for joint replacement. However, most patients present late in the disease course. Without treatment, the process is almost always progressive, leading to joint destruction within 5 years. Treatment of a vascular necrosis depends mainly on early diagnosis which mainly based on clinical findings, x-ray finding & MRI. A variety of non vascularized bone grafting techniques have been proposed with varying degrees of success as treatment alternatives for osteonecrosis of the femoral head. The success of these procedures may be enhanced using ancillary growth and differentiation factors.

Objectives: To treat non traumatic hip osteonecrosis by non vascularized bone graft versus core decompression.

Type of the study: A retrospective study.

Methods: We retrospectively reviewed 72 patients (88 hips) with osteonecrosis of the femoral head between May 2009, and March 2014, divided into two groups. Group A include 34 patients (44 hips) with osteonecrosis of the femoral head who had non vascularized bone grafting procedures done for them. Minimum follow up was 12 months. We compared the outcomes in this cohort to similar hip number (44 hips) in 40 patients treated with core decompression only (group B). We used Phemister technique to make a window at the posterior aspect of greater trochanter to remove necrotic bone and packed the excavated area with autogenous cancellous bone graft taken from ipsilateral iliac crest or leave it without bone graft (decompression only).

Results: We report the result of treatment for femoral head avascular necrosis depending on Ficat classification stage I, II, & III. The minimum follow up was 12 months (12m-36m). The success percentage of hips in our cohort of patients with non vascularized bone grafting group A are 86% (38 of 44 hips), which is higher than group B 63% (28 of 44 hips) with core decompression alone.

Conclusions: These procedures core decompression and autogenous cancellous bone graft may defer joint arthroplasty in selected patients & it is more effective than core decompression alone in treating early stages of femoral head osteonecrosis.

Keywords: femoral head, osteonecrosis, core decompression and bone graft

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Osteonecrosis of the femoral head is a devastating disease that often leads to destruction of the hip and the need for total hip arthroplasty [1]. Haenisch (1925) and Freind (1926) were among the first to report ischemic necrosis of the femoral head [2, 3].

In early stages of the disease, head-preserving treatment modalities such as core decompression, osteotomy, and vascularized or nonvascularized bone grafting are often utilized to defer head-replacing options such as total hip arthroplasty [1, 4]. The rationale for the use of nonvascularized bone grafting is to remove necrotic bone and replace it with cancellous and cortical autografts that support the subchondral bone and articular cartilage of the femoral head and may stimulate bone formation [5]. Three different surgical techniques have been popularized for nonvascularized bone grafting: (1) grafting through a core decompression tract (Phemister technique) [6, 7, 8,9]; (2) grafting through a window or trapdoor in the articular cartilage [10], and (3) grafting through a window made in the femoral neck or femoral head-neck junction [11]. Each of these techniques has its advantages and its limitations. While earlier studies of non vascularized bone grafting through a core tract or cartilage window reported promising clinical results [6,8,12].

In our study, we used Phemister surgical techniques for core decompression of the femoral head with non vascularized bone grafting through a window made at the base of greater trochanter (Fig. 1) [13]. We asked whether this technique effectively and similarly deferred further surgical treatment options when compared to those reported in studies not use bone graft in treatment.
The diagnosis of osteonecrosis of the femoral head does not depend on a single finding. The diagnosis should be considered as established if any of the followings are found: pathognomonic radiographic changes (collapse of femoral head, anterolateral sequestrum or crescent sign)\(^{[1,14]}\), a double line on T2-weighted MRI\(^{[16]}\), increased uptake surrounding a photopenic area (so called cold hot) on radionuclide scintigraphy surrounding an area of femoral head necrosis using fluoroscopic guidance within approximately 5 mm of the subchondral plate, a window is opened at the base of greater trochanter by about 1-2 inch and 8-mm bone drill was used to de brie necrotic bone in the femoral head using the trapdoor as an entrance point. Accidental head penetration with the burr was avoided. The cavity was filled with cancellous bone chips taken from ipsilateral iliac bone crest. The graft was inserted to the hole using a syringe of 2 mm after cutting its head, the graft should be fill the hole. Finally, various bone grafted procedures done for them after core decompression, Group B include 40 patients (44 hips) with osteonecrosis of the femoral head who had non vascularized bone grafting procedures done for them.

## Operative treatment
Under guidance of image intensification with the patient in supine position. A limited skin incision was made over the lateral aspect of the proximal femur end at the tip of greater trochanter and carried out to a point just 3 cm below the greater trochanter parallel the femoral shaft, dissection was curried down to the bone after dividing the fascia latae and split the vastus lateralis muscle. A guide wire was placed along the femoral neck into the area of femoral head necrosis using fluoroscopic guidance.

### Materials and Methods
We retrospectively reviewed 72 patients (88 hips) with osteonecrosis of the femoral head between May 2009, and March 2014 in Al Kindy teaching hospital. We divided into two groups. Group A include 34 patients (44 hips) with osteonecrosis of the femoral head who had non vascularized bone grafting procedures done for them after core decompression, Group B include 40 patients (44 hips) with osteonecrosis of the femoral head who

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**Table 1**: Scheme of Ficat classification (1985)\(^{[15]}\)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Radiographic signs</th>
<th>Clinical features</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Inconspicuous/normal findings</td>
<td>0 (&quot;silent hip&quot;)</td>
</tr>
<tr>
<td>I</td>
<td>Inconspicuous findings or minor changes (slight patchy osteoporosis, blurring of trabecular pattern, subtle loss of clarity)</td>
<td>+</td>
</tr>
<tr>
<td>II A</td>
<td>Diffuse/ focal radiological changes (osteoporosis, sclerosis, cysts)</td>
<td>+</td>
</tr>
<tr>
<td>II B</td>
<td>Subchondral fracture (&quot;crescent sign&quot;) segmental flattening of femoral head (&quot;out-of-round appearance&quot;)</td>
<td>+</td>
</tr>
<tr>
<td>III</td>
<td>Broken contour of femoral head, bone sequestrum, joint space normal</td>
<td>++</td>
</tr>
<tr>
<td>IV</td>
<td>Flattened contour of femoral head, decreased joint space collapse of femoral head, acetabular osteoarthritic changes</td>
<td>+++</td>
</tr>
</tbody>
</table>

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had performed core decompression alone. Indications for the procedure were Ficat and Arlet Stage I, II or III lesions. Minimum follow-up was 12 months (12-32 months). After obtaining institutional review board approval, a prospective database was used to collect relevant surgical, clinical, and radiographic data. We identified the following risk factors and associated conditions with osteonecrosis of the femoral head: corticosteroid usage (defined as a dose greater than 2 g prednisone or its equivalent per month for 3 months minimum), alcohol abuse (defined as alcohol consumption of more than 400 mill per week, tobacco abuse (defined as 20 cigarettes or more per day).

Some patients had more than one associated risk factor. I assessed patients using Hip d’Aubigne system. A score of 15 or more points was considered a successful outcome. Anteroposterior and lateral radiographs were made preoperatively and postoperatively at 6 months & 1 year. Thereafter, we determined Ficat and Arlet stage, combined presence or absence of new bone formation, location of the lesion, and disease progression. In vague cases in which the lesion was not clearly demarcated on plain radiographs, MRI and computed tomography evaluations were used to assist in the evaluation of lesion size.

All patients were maintained at toe-touch weight bearing with two crutches or a walker for 5 to 6 weeks post operatively. For the next 5 to 6 weeks, patients were advanced to approximately 50% weight bearing using a cane or crutch in the opposite hand. Patients were then advised to start full weight bearing as tolerated at 12 weeks postoperatively. Participation in sports and higher impact loading activities such as running were not recommended for the first 10 months postoperatively.

To assess how the results of the procedures for our cohort compared other core decompressed procedures group B in similarly aged patients at a similar technique & a same length of follow up. Our result being the use of non vascularised bone graft is better than the decompression only in long life of femoral head to defer arthroplasty.

**Results:** For both groups the mean age of 32 years (range 18-46 years). For group(A) there were 18 men 55% (24 hips), and 16 women 45% (20 hips) , while for group(B) there were 22 men 59% (26 hips) and 18 women 41% (18 hips).

Regarding the risk factors we find the steroid abuse in 30 patients (38 hips) 40.6%, alcohol abuse 28 patients (30 hips) 37.8%, tobacco abuse 6 patients (8 hips) 8.1%, and 10 patients (12 hips) 13.5% had no apparent associated risk factors and were deemed idiopathic osteonecrosis. Some patients had more than one associated risk factor.

Of the 44 hips group (A), 12 hips were classified as Ficat and Arlet stage I, 18 hips were classified as stage II & 14 hips were classified as stage III preoperatively, while for group(B) of the 44 hips, 10 hips were classified as Ficat and Arlet stage I, 22 hips were classified as stage II & 12 hips were classified as stage III preoperatively.

Overall, 38 of the hips survived out of the 44 hips treated (86%) had avoided further surgery from group A. When clinical satisfied for all patients in stage I, 16 of the 18 hips with stage II disease did not undergo further surgery. Stage III hips were less successful with 10 of 14 hips surviving. (Table 2). While in group B, 28 of the hips survived out of the 44 hips treated (63%) had avoided further surgery. In stage I, 8 of the 10 hips did not undergo further surgery while in stage II disease 16 of 22 hips did not undergo further surgery. Stage III hips were less successful with 8 of 12 hips surviving. (Table 3).

**Table 2. Correlation between Ficat and Arlet stage, and incidence of collapse in group A**

<table>
<thead>
<tr>
<th>Ficat and Arlet Stage</th>
<th>No. of hip</th>
<th>No. of collapse</th>
<th>Incidence of collapse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage I</td>
<td>12</td>
<td>not applicable</td>
<td>0%</td>
</tr>
<tr>
<td>Stage II</td>
<td>18</td>
<td>2</td>
<td>11.1%</td>
</tr>
<tr>
<td>Stage III</td>
<td>14</td>
<td>4</td>
<td>28.6%</td>
</tr>
</tbody>
</table>

**Table 3. Correlation between Ficat and Arlet stage, and incidence of collapse in group B**

<table>
<thead>
<tr>
<th>Ficat and Arlet Stage</th>
<th>No. of hip</th>
<th>No. of collapse</th>
<th>Incidence of collapse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage I</td>
<td>10</td>
<td>2</td>
<td>20%</td>
</tr>
<tr>
<td>Stage II</td>
<td>22</td>
<td>6</td>
<td>27.3%</td>
</tr>
<tr>
<td>Stage III</td>
<td>12</td>
<td>8</td>
<td>66.7%</td>
</tr>
</tbody>
</table>

There were no perioperative complications documented. There were no medical complications or surgical complication.

The overall early clinical success (fig 3) (defined as not later undergoing total hip arthroplasty) rate of 86% (38 of 44 hips) for group A in which bone graft added, while for group B the early clinical success rate of 63% (28 of 44 hips) for core decompression alone .Table 4

**Table 4: clinical & radiological outcome of core decompression + B.G & core decompression.**

<table>
<thead>
<tr>
<th>Group</th>
<th>Stage</th>
<th>N. of hips</th>
<th>Clinical success (%)</th>
<th>Radiologic success (%)</th>
<th>Combined success (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core decompression</td>
<td>I</td>
<td>12</td>
<td>12 (100%)</td>
<td>12(100%)</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>18</td>
<td>16 (88.9%)</td>
<td>14 (77.8%)</td>
<td>82%</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>14</td>
<td>12 (71%)</td>
<td>10 (71%)</td>
<td>78%</td>
</tr>
</tbody>
</table>
Discussion: Nonvascularized bone grafting techniques for the treatment of osteonecrosis of the femoral head were popularized in the 1950s and 1960s [7, 21]. The literature reports a wide range of success rates with these techniques and this may be a result of the various surgical techniques and/or reflect the problem of choosing the appropriate treatment modality for the various disease stages. We evaluated our experience with non vascularized bone grafting. The primary questions were whether this technique effectively deferred further surgical treatment when compared to those reported in studies using core decompression treatment only. In addition, we questioned whether the outcomes in this study were comparable to other studies of non vascularized bone grafts. Our study has several shortcomings including the small number of patients and the short-term follow up. Nevertheless, the early results encourage the continued use and further study of this procedure. A larger series with longer follow up will further help assess positive and negative predictors of outcome. Saito et al. [22] reported various treatment modalities for idiopathic necrosis of the femoral head. The success percentage of hips in our cohort of patients with non vascularized bone grafting group A are 86% (38 of 44 hips) and were similar to other study at similar mean follow up (range, 12-36 months) (Table 5), while for group B the success percentage of hips are 63% (28 of 44 hips) for core decompression alone and compared similarly to other decompression procedures performed at similar mean follow up (range, 12-36 months) for comparison (58%).(Table 6).

Table 5: Literature review of non vascularised bone grafting technique

<table>
<thead>
<tr>
<th>Study (Phemister technique)</th>
<th>Year</th>
<th>hips</th>
<th>Follow up Months</th>
<th>Clinical success(%)</th>
<th>Radiological success(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonfiglio and Voke [7]</td>
<td>1968</td>
<td>1</td>
<td>6</td>
<td>78 (24-204)</td>
<td>NA</td>
</tr>
<tr>
<td>Boettcher et al [6]</td>
<td>1970</td>
<td>3</td>
<td>8</td>
<td>79 (24-204)</td>
<td>76</td>
</tr>
<tr>
<td>Marcus et al [8]</td>
<td>1973</td>
<td>1</td>
<td>1</td>
<td>91</td>
<td>91</td>
</tr>
<tr>
<td>Dunn &amp; Grow [23]</td>
<td>1977</td>
<td>2</td>
<td>3</td>
<td>74 (27-98)</td>
<td>30</td>
</tr>
<tr>
<td>McBeath &amp; Oeljen [24]</td>
<td>1977</td>
<td>6</td>
<td>NA</td>
<td>83</td>
<td>0</td>
</tr>
<tr>
<td>Smith et al [25]</td>
<td>1980</td>
<td>5</td>
<td>6</td>
<td>57 (24-332)</td>
<td>NA</td>
</tr>
<tr>
<td>Steinberg et al [26]</td>
<td>1984</td>
<td>1</td>
<td>9</td>
<td>&gt;6</td>
<td>82 (24-228)</td>
</tr>
<tr>
<td>Buckley et al [12]</td>
<td>1991</td>
<td>2</td>
<td>0</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Nelson &amp; Clark [26]</td>
<td>1993</td>
<td>5</td>
<td>2</td>
<td>NA (24-144)</td>
<td>77 (23-146)</td>
</tr>
<tr>
<td>Steinberg et al [27]</td>
<td>2001</td>
<td>3</td>
<td>1</td>
<td>64 (48-55)</td>
<td>61</td>
</tr>
<tr>
<td>Mont et al [27]</td>
<td>2003</td>
<td>2</td>
<td>1</td>
<td>86 (60-96)</td>
<td>76</td>
</tr>
<tr>
<td>Plakseychunk et al [28]</td>
<td>2003</td>
<td>5</td>
<td>0</td>
<td>36 (50-24)</td>
<td>28</td>
</tr>
<tr>
<td>Rijken et al [29]</td>
<td>2004</td>
<td>2</td>
<td>1</td>
<td>71 (50-13)</td>
<td>57</td>
</tr>
</tbody>
</table>
Despite the limitations of the study, we are encouraged by these early results using cancellous bone chips as a non vascularized bone grafting technique for the treatment of Stage I, II and III osteonecrosis of the femoral head. The decreased progression of symptoms at a mean of 36 months suggests the natural progression of the disease and subsequent hip arthroplasty surgery has been delayed. This technique is straightforward, has low donor site morbidity, and demonstrates a high degree of efficacy for early Stage and small to medium sized lesions.

Conclusion:
1 - Core decompression appears to be an acceptable treatment and a reasonable initial surgical intervention for early stages of disease (stage I, IIA sclerotic).
2 - Nonvascularised bone graft is very useful method in treating early stages of femoral head osteonecrosis.
3 - There is no role for core decompression after the disease has progressed to stage IIA (cystic), only for temporal relief of the pain, so another type of treatment should be considered, unless the patient is not candidates for more extensive operative procedures.
4 - Early detection of the disease is the key to get good results.
5 - Patients treated with core decompression should be observed carefully for disease progression. If progression is seen other methods such as bone grafting can be done.
6 - MRI seems to be the most sensitive imaging for detection of early stages of the disease, and can be used preoperatively to help in predicting the percentage of femoral head collapse post operatively.
7 - The procedure provides decompression of the femoral head, removal of necrotic bone, and structural support and scaffolding to allow repair and remodeling of subchondral bone.
8 - The goals in the treatment of osteonecrosis are to relieve pain and preserve the femoral head for as long as possible.

References:
5. Ganz R, Buchler U. Overview of attempts to revitalize the dead head in aseptic necrosis of the femoral head osteotomy and revascularization. Hip. 1983;296-305.


