Non Vascularized Bone Graft versus Core Decompression in Treatment of Early Stages of Non Traumatic Hip Osteonecrosis

Dr. Mohammed Sh. Al-Edanny F.I.C.M.S.

*Al-Kidney collage of medicine/University of Baghdad.

Abstract

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.

Patients & Methods: We retrospectively reviewed 37 patients (44 hips) with osteonecrosis of the femoral head between May 2007, and March 2011, divided into two groups. Group A include 17 patients (22 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 (22 hips) in 20 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% (19 of 22 hips), which is higher than group B 63% (14 of 22 hips) with core decompression alone.

Conclusion: These procedures (core decompression and autogenous cancellous bone graft) effectively reduce donor site morbidity and may defer joint arthroplasty in selected patients & it is more effective than core decompression alone in treating early stages of femoral head osteonecrosis.

Introduction

Osteonecrosis of the femoral head is a devastating disease that often leads to destruction of the hip and the need for total hip arthroplasty [1,2]. Haenisch (1925) and Frelnd (1926) were among the first to report ischemic necrosis of the femoral head [3, 4] The diagnosis of osteonecrosis accounts for between 2.8% to 6% of all primary total hip arthroplasties performed [5, 6, 7]. 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 [1,8]. 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 [9, 10]. Three different surgical techniques have been popularized for nonvascularized bone grafting: (1) grafting through a core decompression tract (Phemister technique) [11, 12, 13, 10, 14]; (2) grafting through a window or trapdoor in the articular cartilage [15, 16,17]; and (3) grafting through a window made in the femoral neck or femoral head-neck junction [18, 19]. 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 [11, 20, 13, 21, 19].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) [22]. 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.

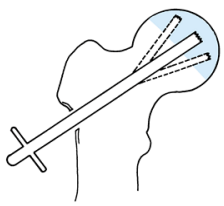

Fig. 1 Technique for performing core decompression. (From Steinberg ME, Brighton CT, Corces A, et al. Osteonecrosis of the Femoral Head. Results of Core Decompression and Grafting. Clin Orthop 1989; 249:199, with permission.) [22]Whereas there are multiple etiologies for the disease, unclear pathogenesis, the pathological condition is remarkably similar in all patients [1]. Irreversible osteonecrosis occur after a minimum of 2 hours of complete ischemia with total anoxia and can be detected by light microscopy after 24 hours of ischemia. Once osteonecrosis develops in the subchondral area of the femoral head, it is thought to follow a defined course[23] Bonenecrosis has no specific radiographic appearance and a normal radiograph does not necessarily mean a normal hip. When radiographic changes do appear, they are due to the reaction of living tissue to the ischemia [24]. The classic radiographic sign ofosteonecrosis is increased bone density, (fig. 2). [1, 25].

Fig. 2: Stage II osteonecrosis showing areas of sclerosis and radiolucency within the femoral head [22].Plain radiographs alone are often inadequate for the evaluation of the extent of osteonecrosis of the hip because of inter observer variability in grading. Before the advent of magnetic resonance imaging (MRI), the size of the lesion was estimated with use of outlines of the lesion on anteroposterior and lateral radiograph as described by Kerboul et al [1, 26].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) [1,26], a double line on T2 — weighted MRI[27], increased uptake surrounding a photopenic area (so called cold in-hot) on radionuclide scintinography [1,23,25]or a positive finding on bone biopsy.Several staging for femoral head osteonecrosis arise include : Ficat and Arle't [1,25] , Steinberg et al staging system[1,4], The International staging system [1],The Japanese Modification [1], Shimizu classify-cation [25]. We depend on Ficat and Arle't staging system, (Table 1) and is based on standard radiographs. The system was applied to symptomatic patients. [1, 25]

Table 1: Scheme of Ficat classification (1985) [24]

Stage	**Radiographic signs**	**Clinical features**
0	Inconspicious/normal findings	0("silent hip")
I	Inconspicious findings or minor changes (slight patchy osteoporosis, blurring of trabecular pattern, subtle loss of clarity)	+
II A	Diffuse/ focal radiological changes (osteoporosis, sclerosis, cysts)	+
II B	Subchondral fracture ("crescent sign") segmental flattening of femoral head ("out-of-round appearance")	+
III	Broken contour of femoral head, bone sequestrum, joint space normal	++
IV	Flattened contour of femoral head, decreased joint space collapse of femoral head, acetabular osteoarthrotic changes	+++

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 3cm 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 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 mushroom-tipped burr was used to de´bride 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, vastus muscle and fascia latae were repaired with interrupted sutures. The procedure had a mean operative time of 20-30 minutes. Wound was thoroughly irrigated and closed primarily [3]

Materials and Methods

We retrospectively reviewed 37 patients (44 hips) with osteonecrosis of the femoral head between May 2007, and March 2011, divided into two groups . Group A include 17 patients (22 hips) with osteonecrosis of the femoral head who had non vascularized bone grafting proce-dures done for them after core

decompression, Group B include 2o patients (22 hips) with osteonecrosis of the femoral head who 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 [28], alcohol abuse (defined as alcohol consumption of more than 400 mill per week [29], tobacco abuse (defined as 20 cigarettes or more per day [29]. Some patients had more than one associated risk factor. I assessed patients using Hip d'Aubigne system. [30] 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 [24], 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. Of the 22 hips, 8 hips were classified as Ficat and Arlet Stage I, 9 hips were classified as Stage II & 5 hips were classified as Stage III preoperatively. The assessment of lesions size using the Kerboul technique revealed seven small lesions, 9 medium lesions, and 6 large lesions. The technique [19, 31] 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 10 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 femora head to defer arthroplasty.

Results

For both groups the mean age of 32 years (range 18-46 years). For group(A) there were 9 men 55% (12 hips), and 8 women 45% (10 hips) , while for group(B) there were11 men 59% (13 hips) and 9 women 41% (9 hips). Regarding the risk factors we find the steroid abuse in 15 patients (19 hips) 40.6%, alcohol abuse 14 patients (15 hips) 37.8%, tobacco abuse 3 patients (4 hips) 8.1%, and 5 patients (6 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 22 hips group (A) , 6 hips were classified as Ficat and Arlet stage I , 9 hips were classified as stage II & 7 hips were classified as stage III preoperatively, while for group(B) ;of the 22 hips ,5 hips were classified as Ficat and Arlet stage I ,11 hips were classified as stage II & 6 hips were classified as stage III preoperatively. Overall, 19 of the hips survived out of

the 22 hips treated (86%) had avoided further surgery from group A. When clinical satisfied for all patients in stage I, 8 of the 9 hips with stage II disease did not undergo further surgery. Stage III hips were less successful with 5 of 7 hips surviving. (Table 2). While in group B, 14 of the hips survived out of the 22 hips treated (63%) had avoided further surgery. In stage I, 4 of the 5 hips did not undergo further surgery while in stage II disease 8 of 11 hips did not undergo further surgery. Stage III hips were less successful with 4 of 6 hips surviving. (Table 3).

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

Ficat and Arlet Stage	No. of hip	No. of collapse	Incidence of collapse
Stage I	6	not applicable	0 %
Stage II	9	1	11.1 %
Stage III	7	2	28.6 %

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

Ficat and Arlet Stage	No. of hip	No. of collapse	Incidence of collapse
Stage I	5	1	20 %
Stage II	11	3	27.3 %
Stage III	6	4	66.7 %

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% (19 of 22 hips) for group A in which bone graft added, while for group B the early clinical success rate of 63% (14 of 22 hips) for core decompression alone .table 4

Discussion

Nonvascularized bone grafting techniques for the treatment of osteonecrosis of the femoral head were popularized in the 1950s and 1960s [10, 12, 32]. 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.

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

Group	Stages	No. of hips	Clinical success (%)	Radiological success (%)	Combined success (%)
Core decompression + B.G	I	6	6 (100 %)	6(100%)	100%
	II	9	8 (88.9 %)	7(77.8%)	82%
	III	7	6 (85.7 %)	5 (71 %)	78%
	Total	22	20 (90.1 %)	18 (81.8 %)	85%
core decompression	I	5	4 (80 %)	4 (80 %)	80%
	II	11	8 (72.7 %)	7 (63.6 %)	67%
	III	6	2(33%)	1 (16.7 %)	24%
	Total	22	14 (63.6 %)	12 (54.5 %)	58%

A

B

Fig 3: A: stage II AVN B: result after 1year

Saito et al. [33] 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% (19 of 22 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% (14 of 22 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).

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 straight forward, has low donor site morbidity, and demonstrates a high degree of efficacy for early Stage and small to medium sized lesions.

Conclusion

1- The treatment of non-traumatic osteonecrosis of femoral head remains a difficult decision for orthopedist.
2- Core decompression appears to be an acceptable treatment and a reasonable initial surgical intervention for early stages of disease (stage 0, I, IIA sclerotic).

3- Nonvascularised bone graft is very useful method in treating early stages of femoral head osteonecrosis & defers need of arthroplasty.
4- 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.

5- Early detection of the disease (pre symptomatic or pre radiological) is the key to get good results.

6- 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.

7- MRI seems to be is 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.

8- Periodic screening to delineate the natural history of asymptomatic hips in all patients with high risk (eg, SLE) to diagnose osteonecrosis as early as possible is mandatory to get good results of treatment.

9- Careful screening in apparent stage II disease should be done using tomograms or CT to check for any evidence of collapse before contemplating treatment with core decompression.

10- 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.

11- The goals in the treatment of osteonecrosis are to relieve pain and preserve the femoral head for as long as possible.

Table 5: Literature review of non vascularised bone grafting technique

Study (Phemister technique)	Year	hips	Follow up Months	Clinical success(%)	Radiological Success(%)
Bonfiglio and Voke [12]	1968	116	67(24-204)	78	NA
Boettcher et al [11]	1970	38	72(24-204)	79	76
Marcus et al [13]	1973	11	NA	90	91
Dunn &Grow [34]	1977	23	40(27-98)	74	30
McBeath &Oeljen [35]	1977	6	NA	83	0
Smith et al [14]	1980	56	144(24-332)	57	NA
Steinberg et al [36]	1984	19	>6	82	36
Buckley et al [20]	1991	20	24-228	90	90
Nelson &Clark [37]	1993	52	NA(24-144)	77	13
Steinberg et al [38]	2001	312	63(23-146)	64	61
Mont et al [18]	2003	21	48(36-55)	86	76
Plakseychunk et al [39]	2003	50	60(36-96)	36	28
Rijnen et al [40]	2003	28	50(24-119)	71	57
Lieberman et al [41]	2004	17	53(26-94)	82	82
Kim et al [42]	2005	30	50(36-67)	78	80
Israelite et al [43]	2005	276	NA(24-145)	62	NA
Wang et al [44]	2005	28	26(24-39)	68	64
Keizer et al [45]	2006	80	84(36-NA)	46	43

NA: data not available

Table 6. Literature review of decompression treatment outcomes

Study	Year	No. of patients	Follow up Months	Successful rate %
Musso et al. [46]	1986	50	30	32
Steinberg et al. [22]	1989	55	21 (6-120)	16
Churchill and Spencer [47]	1991	18	60	50
Stulberg et al. [48]	1991	22	27	9
Robinson and Springer [49]	1992	16	39 (24-36)	56
Bradway and Morrey [50]	1993	15	23 (3-66)	13
Jergesen and Khan [51]	1997	19	111 (51-81)	42
Lai et al. [52]	2005	25	24	32
Hernigou et al [53]	2006	121	168 (120-240)	25
Neumayr et al [54]	2006	21	63	86
Morse et al. [55]	2007	67	23 (17-23)	70

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