Core Decompression and Fibular Graft in Treatment Of Precollapsed Stages of Non Traumatic Hip Osteonecrosis

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Abstracts

Background
Osteonecrosis of the femoral head is a multifactorial disease that can result in significant clinical morbidity and affects patients of any age, including young, active patients. Late sequelae of femoral head osteo-necrosis include femoral head collapse and subsequent degeneration of the hip joint. A variety of non-vascularized bone grafting techniques have been proposed with varying degrees of success as treatment alternatives for osteonecrosis (ON) of the femoral head.

Patients & Methods
A prospectively reviewed 14 patients with ON of the femoral head between May 2010, and March 2012, with ON of the femoral head in precollapsed stage and they had treated with core decompression and non vascularized fibular bone grafting procedure. 8 men, 6 women, five cases with **Ficate** and **Arlet** and **Steinberg** modification stage were II and 9 cases with stage IIIA. Average follow-up was 15.8 months (10-20) months.

Results
Fourteen patients with ON femoral head according to Ficat classification stage II in 5 cases, stage IIIA in 9 cases. Average follow up was 15.8months (10 m- 20m).Ten patients presented with excellent /good results and four with fair/poor results due to head collapse and limited range of motion. **Conclusion:** Core decompression and non vascularized fibular bone graft in selected patients is more effective than core decompression alone in treating patients with early stages of femoral head osteonecrosis.

Key wards
Core Decompression, Fibular Graft, Hip Osteonecrosis.

Introduction

Avascular necrosis of the femoral head commonly affects patients in the second, third and fourth decades of life. Prosthetic replacement of the hip in this group is complicated by the relatively long expected life span of the patient and finite life expectancy of the prosthesis.[1–3] optimal treatment requires preservation of the femoral head or at least to delay its collapse or the onset of degenerative changes. Avascular necrosis accounts for between 5% and 12% of total hip replacements.[4] Both traumatic or a traumatic causes have been associated with a vascular necrosis.[5] subchondral fractures leading to collapse and osteoarthritis.[6–7]. Many options for treatment femoral head AVN including core decompression, vascularised and non-vascularised bone grafting and various osteotomies.[4] Ficat described a four stage (I through IV) classification system, which is based on standard radiographs.[8] In Stage I the radiographs are normal. In Stage II the contour of the femoral head is normal but the radiographs show evidence of bone remodeling including cystic and sclerotic areas. Stage III involves flattening of the femoral head. In Stage IV, there is joint space narrowing with secondary degenerative changes in the acetabulum. Steinberg[9] expanded the Ficat system by dividing Stage III lesions into femoral heads with and without collapse or hips with acetabular involvement. Using MRI to detect location and size of the lesions.[10] (Table I).

The use of a non-vascularised graft is more appealing than that of a vascularised graft because it is less technically demanding and may reduce donor-site morbidity. The procedure provides decompression of a vascular lesion and removal of the necrotic bone in order to interrupt the cycle of ischemia and interosseous hypertension. Grafting of the defect with fresh cancellous bone and placement of a cortical strut support the subchondral surface and introduce a scaffold for repair and remodeling of subchondral bone. Patients with advanced AVN usually end up with hip arthroplasty; patients with early diagnosis

of the lesion (at pre-collapse stage) have been managed with hip salvage surgery. Cortical bone strut grafts have been advocated in an effort primarily to provide structural support to the subchondral bone and articular cartilage to prevent collapse during the repair process. The procedures can vary from addition of autogenous or allograft cancellous bone to a core decompression, osteochondral grafts, muscle-pedicle bone grafts, free cortical grafts and free vascularized bone grafts with iliac or fibular bone. Three different surgical techniques have been popularized for nonvascularized bone grafting: (1) grafting through a core decompression tract (Phemister technique) [11-14]; (2) grafting through a window or trapdoor in the articular cartilage [15-17] and (3) grafting through a window made in the femoral neck or femoral head neck junction [18, 19].

Table I: Ficat and Arlet staging system for osteonecrosis of the femoral head [8]

Stage	radiological appearance of femoral head
I	Normal
II	Cystic or osteosclerotic lesions, or both, normal contour of Femoral head, no subchondral fracture
III	Crescent sign or subchondral collapse
IV	Joint-space narrowing, secondary acetabular changes (cysts, Marginal osteophytes and destruction of the cartilage)

Surgical technique:

After anaesthesia and under C-arm 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 carried 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. The cavity was cureeted to remove any necrotic bone. Cancellous bone graft was harvested from the greater trochanter and was carefully packed into the femoral head. The fibular graft taken from ipsilateral leg using the middle third fibula was inserted to the hole and gently hammered to reach the subchondral bone in the desired area .Finally, vastus muscle and fascia latae were repaired with interrupted sutures. Wound was thoroughly irrigated and closed in layers .[20]

Patients and Methods

A prospective study 14 patients with osteonecrosis of the femoral head between May 2010, and March 2012, 8 male patients and 6 female patients with osteonecrosis of the femoral head who had core decompression and non vascularized fibular bone grafting procedures. Indications for the procedure were **Ficat** and **Arlet** [8] and **Steinberg**[9] Stage II, IIIA, average follow-up was 15.8months (10 -20ms).The following risk factors and associated conditions with osteonecrosis of the femoral head were present as corticosteroid usage (defined as a dose greater than 2 g prednisone or its equivalent per month for 3 months minimum in 3 patients 21.4%, tobacco abuse (defined as 20 cigarettes or more per day in 4 patients 28.6% .Hip modified **Merle d'Aubigne** system[21] score of 15 or more points was considered a successful outcome as pain range from 2-6 points, walking points 1-6, range of motion points 1-6, clinical grade excellent with 18 points, good results 15-17 points, fair results 13-14 points and fair results less than 13 points.Anteroposterior and lateral radiographs were made preoperatively and postoperatively at 6 months& 1 year, determined **Ficat** and**Arlet**[8] 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 was used to assist in the evaluation of lesion size. Of the 14 hips, 5 hips 35.7% were classified as **Ficat** and **Arlet** Stage II, Stage IIIA and **Steinberg**[9] in 9 hips 64.2%. The assessment of lesions size using the **Kerboul** technique[22] revealed 5 small lesions, 9 medium lesions. (Table 2).

Postoperative follow-up:

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, running were not recommended for the first 10 months postoperatively.

Table 2: Patient data

Case	Age	Sex	Side	stage	Risk factor	Kerboul technique	Follow-up months	Merled' Aubigne score	Results
1	36	Male	Right	II		Small lesion	14	18	Excellent
2	40	Male	Left	IIIA	Steroid	Medium lesion	12	17	Good
3	44	Female	Left	IIIA		Medium lesion	13	12	Poor
4	28	Male	Right	II	Tobacco	Small lesion	16	16	Good
5	32	Male	Left	IIIA	Steroid	Medium lesion	10	15	Good
6	40	Male	Left	II	Steroid	Small lesion	18	11	Poor
7	41	Male	Left	IIIA	Tobacco	Medium lesion	17	14	Fair
8	44	Female	Right	IIIA		Medium lesion	20	18	Excellent
9	36	Female	Left	IIIA		Small lesion	19	15	Good
10	37	Female	Right	II		Medium lesion	20	18	Excellent
11	29	Male	Right	IIIA		Medium lesion	17	12	Poor
12	35	Female	Left	II	Tobacco	Small lesion	15	16	Good
13	38	Male	Left	IIIA		Medium lesion	14	17	Good
14	41	Female	Right	IIIA	Tobacco	Medium lesion	16	18	Excellent
Average	35.1						15.8 m		

Results

The average age of 14 patients 35 years (range 28-44years). There were 8 men57%, and6 women 43%. Regarding the risk factors, steroid abuse in 3patients 21.4%, tobacco abuse 4 patients28.6%, seven patients.

50% had no apparent associated risk factors and was deemed idiopathic osteonecrosis. Of the 14 hips, five hips 35.7% were classified as **Ficat** and **Arlet** and **Steinberg**[9]**,** stage II, 9 hips 64.2% were classified as stage IIIA. Clinical satisfied for all patients in stageII, 8 of the 9 hips with stage IIIA.There were no medical complications or surgical complication. The overall early clinical success (defined as not later undergoing total hip arthroplasty) rate of 78.6 % (11 of 14 hips). One case 7.1% in stage II, two cases 14.2% in stage IIIA. These three 21.3% cases presented with head collapse and need further hip arthroplasty later on. One patient 7.1% with fair results due to limited range of motion. (Table 3).

Case 1 presented figure (1) with excellent results.

Figure 1: case no14

(a, b) Anteroposterior, lateral; (c) MRI picture and (d, e) postoperative radiographs with excellent results

Table 3: Correlation between stage, incidence of collapse

Result	Stage II	Number	Stage IIIA	Number	Complication
Excellent		2		2	
Good		2		4	
Fair		-		1	Limited ROM
Poor		1		2	Head collapse

Statistical analysis:

The following statistical methods were used for analysis of results of the present study. Data were checked, entered and analyzed using SPSS version 19(SPSS Inc., Chicago, IL) used in Windows 7 for data processing and statistic. Analysis of the results of this study illustrated in the tables (4-11) and figure (2).

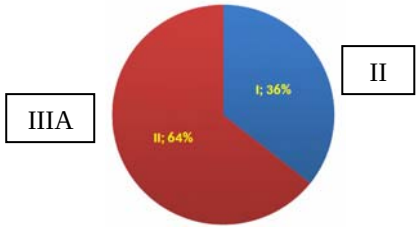

Figure 2: Ficate stage in studied group. Stage II, 36%, Stage IIIA, 64%

Table 4: association between mean ages and ficate stage

Ficate stage	*Age(years) No.=14*	*T*	*p.value*
	Mean ±SD		
II	*35.2±4.4*	*-1.137*	*0.278*
IIIA	*38.3±5.2*		

Table 5: association between mean Follow-up /months and ficate stage

Ficate stage	Follow-up /months *(No.=14)*	*T*	*p.value*
	Mean ±SD		
II	*16.6±2.4*	*0.746*	*0.47*
*III*A	*15.3±3.3*		

Table 6: association between mean Merled'Aubigne Score and ficate stage

Ficate stage	**Merled'Aubigne score (No.=14)**	*T*	*p.value*
	Mean ±SD		
II	*15.8±2.9*	*0.331*	*0.747*
*III*A	*15.3±2.3*		

Table 7: association between sex and *ficate stage*

Ficate stage	*Sex*				*Total (no.=14)*	*X2*	*p.value*
	Male (no.=8)		*Female (no.=6)*				
	No.	*%*	*No.*	*%*			
II	*3*	*37.5*	*2*	*33.3*	*5(35.7)*	*0.03*	*0.872*
IIIA	*5*	*62.5*	*4*	66.7	*9(64.3)*		

Table 8: association between side and ficate stage

Ficate stage	*Side*				*X2*	*p.value*
	Right (no.=6)		*Left (no.=8)*			
	No.	*%*	*No.*	*%*		
II	*3*	*50.0*	*2*	*25.0*	*0.93*	*0.334*
*III*A	*3*	*50.0*	*6*	*75.0*		

Table 9: association between risk factors and ficate stage

Ficate stage	*Risk factor*				*X2*	*p.value*
	Steroid (no.=3)		*Tobacco (no.=4)*			
	No.	*%*	*No.*	*%*		
II	*1*	*33.3*	*2*	*50.0*	*0.19*	*0.659*
IIAI	*2*	*66.7*	*2*	*50.0*		

Table 10: association between Kerboul Technique and ficate stage

Ficate stage	*Kerboul technique*				*X2*	*p.value*
	Small lesion (no.=5)		*Medium lesion (no.=9)*			
	No.	*%*	*No.*	*%*		
II	*4*	*80.0*	*1*	*11.1*	*6.64*	*0.009⁄*
*III*A	*1*	*20.0*	*8*	*88.9*		

Table 11: association between results and ficate stage

Results	*Ficate stage*				*X2*	*p.value*
	II (no.=5)		*IIIA (no.=9)*			
	No.	*%*	*No.*	*%*		
Poor	*1*	*20.0*	*2*	*22.2*	*0.93*	*0.817*
Fair	*0*	*0.0*	*1*	*11.1*		
Good	*2*	*40.0*	*4*	*44.4*		
Excellent	*2*	*40.0*	*2*	*22.2*		

Discussion

Bone grafting has been added to the core decompression in an effort to provide structural support, or to act as scaffolding for repair and allow remodelling of subchondral bone. Three distinct approaches can be used to insert a cortical strut graft into the femoral head: 1) a core track; 2) a window in the femoral neck (a 'light-bulb' procedure); or 3) a trapdoor made through the articular cartilage in the femoral head. For the past 15 years we have used the strut-grafting procedure through a core track, as first described by Phemister,[23] since it is a relatively simple, extra-articular, reproducible procedure.Monte[24] reported

a new technique for core decompression involving multiple small drilled holes and a 3-mm Steinman pin. In the study, 32 of the 45 hips (71%; 35patients) demonstrated successful clinical results following a mean follow-up of two years (range, 20-39months). In total, 24 of the 30 stage I hips (80%; 23 patients) had successful outcomes compared with eight of the 15 stage II hips (57%; 12 patients), with no surgical complications. This technique may be effective for delaying the need for total hip arthroplasty in young patients with early (precollapse) stages of ONFH.Core decompression remains the leading surgical treatment for ONFH (early-and mid-stage), and the efficacy of any new treatments should be compared with core decompression. Marker[25] collected data from 1,268 hips following decompression and revealed a clinical success rate of 70% after 63months, without the need for additional surgery. Certain studies reported core decompression combined with other treatments produces an improved effect for ONFH.Core decompression is a commonly used prophylactic surgery used in pre-collapse osteonecrosis (prior to Ficat and ARCO stage II, Steinberg stage IIIa), in which necrotic cancellous bone in the femoral head is drilled and removed from a lateral femoral cortical entry point[26]. This is often stabilized with structural allograft or with autograft by harvesting cancellous bone from the greater trochanter and proximal femur. This cancellous graft contains osteoprogenitor cells that aid in healing. The results for core decompression alone generally deteriorate with more advanced lesions[27] Augmentation of the core decompression can be achieved with the addition of bone morphogenic proteins, electromagnetic stimulation, or demineralized bone matrix[28]. Although core decompression for Steinberg stage I disease was successful as a definitive procedure in > 80% of patients, Steinberg stage II and III osteonecrosis treated with decompression required further surgical reconstructive intervention in 37% and 71% of patients, respectively[29].The vascularised bone grafting is characterized by a prolonged operation, complicated techniques, major trauma and a significant number of complications; therefore, many researchers began to introduce non-vascularised bone grafting .[30-32] Vascularised bone grafting (such as pedicled iliac bone block with gluteus medius muscle, quadratus femoris or sartorius), which has inconsistent long-term success rates, supplies a source of viable bone, improving the healing potential by providing circulating stem cells and growth factors [33-35]. Hasegawa.[36] reported that there was 61% success in stage II patients at ten years; while Baksi.[37] found that there was 100% success in stage I, 92% in stage II and 80.4% in stage III with radiographic success in 81.3% of stage II and 70.1% of stage III at 16 years. At a mean of eight years (2 to 19), Buckley[38] reported excellent results in 18 (90%) of 20 hips in which a Ficat and Arlet stage-I or stage-II lesion had been treated by core decompression combined with tibial auto grafting and fibular grafting (both autogenous and allogenic). Boettcher[39] initially reported success in 27 (71%) of 38 hips six years after the use of cortical tibial strut grafts, long-term study by Smith[40] which included the original 38 patients evaluated by Boettcher[39] 40 (71%) of 56 hips had a poor clinical result after a mean follow-up of 14 years (4 to 27). Later studies showed a high rate of radiological progression even in hips with a pre-collapse stage of avascular necrosis. Free vascularised fibular grafting procedures with complexity of the procedure, its complication rate and the length of the operation have raised questions regarding its efficacy. Results of 103 hips Urbaniak[41] reported that 30% required a subsequent operation at a median of seven years. Survivorship analysis in their series showed a conversion rate to a total hip arthroplasty within five years of 89% for stage II (our study 80%), 77% for stage II (our study 63%), 71% for stage III (our study 54%) and 73% for stage IV (our study 56%). In a more recent study by Marciniak, Furey and Shaffer,[42] 58% of hips required a subsequent operation after eight years. It appears that patients treated by vascularised fibular grafting have a higher complication rate. Vail and Urbaniak[43] found in their study of 247 vascularised fibular grafts, a donor-site morbidity of 35%.

Conclusion

Core decompression and non vascularized fibular bone graft in selected patients is more effective than core decompression alone in treating patients with early stages of femoral head osteonecrosis. Treatment of adult hip ONFH is usually based on the stage of the disease. Nonsurgical treatments are being developed, but exact indications are not yet clear. For those with moderate or large sized lesions without subchondral collapse, core decompression is commonly utilized. Once a crescent sign is observed on radiographs (Steinberg stage III), hip arthroplasty is the most commonly offered treatment modality.Surgical options such as vascularized and nonvascu-larized bone grafting, osteotomy, and fusion may be indicated for certain patients. Techniques and devices for performing total hip arthroplasty continue to im-prove, and as a result, surgeons are considerably less reluctant to recommend this for young patients whoseosteonecrosis has progressed to the point that some type of arthroplasty is required. Treatment algorithms for ONFH continue to evolve, and evidence-based medicine will enhance our understanding of how best to address different stages of this disease.

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