Introduction

Avascular necrosis of the femoral head (AVNFH) is a debilitating disease affecting patients in the fourth and fifth decade [1-4]. It can be idiopathic or secondary; the most common causes include steroid and alcohol intake. Steroid intake is most commonly encountered in patients following renal transplants, lupus erythematosus, asthma, glomerulonephritis, peripheral neuritis, sinusitis, pemphigus, Guillain-Barre syndrome, head injuries and those receiving combination chemotherapy [5]. A number of treatment options are available for this disease. Non-surgical management includes medical treatment, protected weight bearing and electrical stimulation. Surgical management includes core decompression, debridement and grafting and arthroplasty [4]. An understanding of the natural history of AVNFH is important for predicting the fate of the hip, in choosing the appropriate treatment and in evaluating the results of various treatments. The rate at which the femoral head will collapse is related among other things to the cause of disease, the stage and extent of disease at the initial diagnosis and to the size and location of the necrotic lesion. Nevertheless, very small lesions (<15% involvement of the femoral head) may remain minimally symptomatic without any formal treatment. On the other hand, large lesions (>50% involvement of the femoral head) continually progress to collapse and arthrosis in greater than 85% of cases [6]. Numerous reviews of the natural progression in patients who were treated non-surgically with crutches and partial non-weight bearing ambulation document a risk of progression of 85-92% [4]. Core decompression, which is minimally invasive and lacks complexity when compared to another surgical option, is a commonly performed procedure for AVNFH. Typically, this is recommended for early-stage pre-collapsed osteonecrosis with small to medium size lesions.

In this prospective study, we describe the technical aspects and outcome of a modified technique of core decompression and bone graft injection for the treatment of AVNFH.

Methods

We prospectively evaluated the outcome of 26 hips in 20 patients with AVNFH who received

Abstract

Objectives: Avascular necrosis (AVN) of the femoral head is a pathologic process resulting from interruption of blood supply to bone. The aim of this article is to describe the technical aspects and outcome of a modified technique of core decompression and bone graft injection for the treatment of AVNFH.

Methods: Twenty patients (26 femoral head AVN) Ficat stage I to early III were treated using core decompression kit followed by injection with bone graft material. Nine hips were stage III, 16 stages II and 1 stage I. Average operative time was 25 minutes.

Results: At a median follow-up of 48 months, 20 hips (77%) had almost complete pain relief while pain persisted in 6 hips (23%). All patients who demonstrated clinical response exhibited radiological stabilization of disease. The mean Haris hip score for all patients’ prior and following surgery was 41 and 85, respectively (p<0.0001).

Conclusions: Femur head decompression using core decompression kit followed by bone substitute injection can result in long-term pain relief and prevention of progression of AVN in the majority of patients.

Keywords: Femoral; Head; Decompression; Bone graft; Avascular necrosis
treatment at King Hussein Cancer Centre (Amman, Jordan) from January 2009 to August 2013 using a modified technique for core decompression and backfilling with injectable bone graft. All patients signed an informed consent and this study was approved by the Institutional Review Board. Patients were staged by one musculoskeletal radiologist (OMA) utilizing anterior posterior (AP) and frog lateral radiographs and magnetic resonance imaging (MRI). Staging was based on Ficat and Arlet staging system (stage I-IV) [7]. Participants were cancer patients who received corticosteroids as part of their chemotherapy treatment protocol. The median cumulative dose of Dexamethasone was 1,438mg (range; 274mg to 8,389mg).

Decompression was performed for patients with symptomatic stage I, all patients with stage II and patients with stage III with early collapse (crescent sign or early flattening). There were 9 females (14 hips) and 11 males (12 hips); the mean age at time of procedure was 22.1 years (range; 8 to 54 years).

Clinical follow-up was according to the Haris Hip Score (HHS) determined preoperatively and postoperatively. Serial AP and frog lateral radiograph views of the hips were obtained 6 weeks postoperatively and then every 3 months. Failure of treatment was defined as lack of 10 grades increase in HHS after procedure and/or persistence of pain. Paired t-test was used to compare postoperative HHS to preoperative HHS; a p-value of ≤0.05 was considered to indicate a statistically significant difference.

Surgical technique

We utilized a specialized core decompression kit (Wright Medical Technology Inc., Arlington, TN); (Figure 1). In addition, we made use of the X-ream Percutaneous Expandable Reamer (Wright Medical Technology Inc., Arlington, TN), which is a specialized reamer with an expanding tip; (Figure 2A and B).

The following are the steps involved in this procedure:

1. Patient placed at lateral position with operative side up
2. Cleaning and draping of the operative limb with full exposure to the hip and thigh

3. A 1.5cm stab incision is made over the lateral aspect of proximal femur 2cm below the ridge of greater trochanter

4. Dissection till reaching the bone surface

5. A 3.2mm fluted guide wire is advanced under fluoroscopic guidance from an entry site just distal to the greater trochanter up the femoral neck into the necrotic lesion in the femoral head; (Figure 3A and B)

6. A tissue protector is inserted till it touches the bone and then the 9mm cannulated drill is inserted to start decompression of the necrotic region

7. Drilling should be 5mm away from the articular surface; (Figure 4)

8. Removal of the drill and the guide wire and insertion of the working cannula into the track; (Figure 5A and B)

9. A special curette is used to remove all debris which is then sent for histopathological examination

7. The X-Ream Percutaneous Expandable Reamer is inserted to remove a greater volume of the necrotic bone, the blade control knob is turned clockwise until it cannot be turned anymore and the entire reamer is rotated once or twice or three times till the resistance is high the instrument cannot be further rotated

8. The control knob is then turned clockwise again and step 8 is repeated till reaching the full expansion of the reamer and the marker at the control knob is reading number 3; corresponding to the maximum expansion which is 2.1 cm; (Figure 6)

9. AP and lateral radiological control is mandatory all through the reaming procedure to verify the location and extent of the reamer expansion and make sure that no breach of the joint has occurred

10. If there was a concern regarding the penetration into the joint, Angiograffin contrast is to be injected into the track to see if there is spillage of the contrast into the hip joint

11. Turning the blade control knob counter clockwise till full collapse and removal of the X-Ream and curettage again to remove all debris and final irrigation and suction of the track

12. The generated track is ready now for injection of bone graft

13. The core track is now backfilled with graft material; MIIG 115 (Wright Medical Technology Inc., Arlington, TN); (Figure 7)

Following the operation, patients were allowed to start walking full weight bearing as tolerated the first day after surgery.

Results

All patients who received treatment were symptomatic with hip pain; stage I (1 hip), stage II (13 hips) and stage III (12 hips). All patients were reviewed at a median follow up period of 43 months, (range; 10-60 months). No complications related to the procedure were reported.

The median preoperative HHS was 41 (range; 30 to 82), the median postoperative HHS at last follow up was 80 (range; 40 to 96);
indicating a significant difference between scores (p-value <0.0001). There were no significant differences between stages I, II and III in terms of HHS increase following the operation; table 1. In terms of symptomatic response, pain resolved in 20 hips (77%) and persisted in 6 hips (23%).

Radiological evaluation revealed that 14 hips (54%) were radiologically stable at last follow up; table 2. Clinical failure was encountered in 6 hips (23%); 4 of which were converted to hip arthroplasty. Overall, 15% of all hips were converted to arthroplasty; three patients were stage III disease at time of operation and progressed to stage IV, one patient was stage II at time of operation and progressed to stage IV after procedure.

Discussion

The use of this core decompression technique offers a number of advantages over traditional core decompression methods including simplicity of the technique, the minimally invasive approach and the more extensive percutaneous debridement of necrotic lesions [8,9]. By utilizing the X-REAM, we can enhance the area of debridement at the femoral head through the same core width that is created at the femoral neck and lateral femoral cortex. Core decompression alone can increase the risk of femur head collapse. This technique penetrates the body of necrotic lesions and as such, places the head at greater risk of structural collapse compared to the untreated situation [10,11].

Our selection of MIIG 115 (calcium sulphate) was based on our knowledge that this product can provide a maximum compressive strength of 15 MPa, as compared to 4 MPa, the compressive strength of cancellous bone, within 2 hours after injection. Essentially, this enables immediate post-operative weight bearing by the patient. Furthermore, this product is typically completely resorbed in 6-12 weeks; if accidental spillage into the hip joint occurs, it will be resorbed within 4 weeks with no need for arthrotomy to take it out. This is in variance to products that contains calcium phosphates [12-14].

A literature review demonstrates that this technique has a comparable outcome to more complicated procedures such as vascularized bone graft insertion at the femur head and harvesting and preparation of bone marrow aspirate; table 3. These procedures are more time consuming, require longer hospital stay and are associated potential donor site morbidity. The ideal graft material; however, is still a matter of debate that should be further investigated by comparative prospective studies.

References


| Table 1: Pre- and postoperative HSS according to preoperative AVN stage. |  |
| --- | --- | --- | --- | --- |
| Preoperative AVN stage | Number | Average preoperative HSS (minimum, maximum) | Average postoperative HSS (minimum, maximum) | p-value |
| Stage 1 | 1 | 40.0 | 85.0 | <0.0001 |
| Stage 2 | 13 | 44.9 (30.0, 82.0) | 75.8 (40.0, 96.0) |  |
| Stage 3 | 12 | 47.3 (30.0, 80.0) | 73.3 (45.0, 95.0) |  |

| Table 2: Radiological evaluation at the time of follow-up. |  |
| --- | --- | --- | --- | --- |
| Postoperative AVN stage | Number | Preoperative AVN stage | p-value |
| Stage 1 | Stage 2 | Stage 3 |
| Stage 2 | 6 | 1 (100%) | 5 (38.5%) | 0.024 |
| Stage 3 | 16 | 7 (53.8%) | 9 (75.0%) |  |
| Stage 4 | 4 | 1 (7.7%) | 3 (25.0%) |  |

| Table 3: Summery of literature review of previously published similar studies. |  |
| --- | --- | --- | --- | --- |
| Series/year of publication | Number of hips | Material injected | Follow-up (months) | Clinical results | Radiological results |
| Liberman et al. [15] | 17 | Combined allogenic fibular graft recm BMP-2 | NA | 82.4% improved clinically with regards to pain | 14 hips (82.4%) with no further collapse |
| Mont et Al. [16] | 39 | DBM, allograft bone chips with BMP-7 | 48 | 86% improved clinically and with mean HHS increase to 80 | 24 hips (61.5%) with no further collapse |
| Cuervas-Mons et al. [17] | 22 | Concentrated autologous bone marrow aspirate | 19 | 86% improved clinically | No differences in the baseline Ficat stage |
| Martin et al. [18] | 77 | Concentrated bone marrow aspirate and platelet rich plasma | 19 | 86% improved clinically | 61 hips (79.2%) with no further collapse |
| Yoo et al. [19] | 151 | Vascularized fibula graft | Minimum; 120 | Mean HSS improved from 72 to 88 points | 76 hips (61.2%) with no further collapse |
| Current Study | 26 | Standardized Decompression kit/Calcium Sulphate Injectable form | Mean; 48 | Mean HSS improved from 52 to 85 points | 14 hips (54%) with no further collapse |


