

Avascular Necrosis of the Femoral Head in Patients with Hemoglobinopathies: a Case Series and Review of the Literature

Abstract

A retrospective chart review was performed to determine the therapeutic results of core decompression in sickle cell anemia patients with avascular necrosis (AVN) of the femoral head that were followed up at the Orthopedic Surgery Department of King Abdul-Aziz University Hospital between 2001 and 2014. The Ficat classification system was used to classify AVN stage. Ten patients were identified and their records were available for analysis. Of these, 4 patients showed improvement in pain scores in both hips before and after the surgery. Overall, core decompression remains a valid treatment option for temporary pain relief in patients with stage I-III disease.

Keywords: Avascular necrosis; Osteonecrosis; Femoral head; Hemoglobinopathies; Sickle cell anemia

Research Article

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Abbreviations: AVN: Avascular Necrosis; CD: Core Decompression; SCA: Sickle Cell Anemia; VAS: Visual Analog Score; AP: Anteroposterior; DBM: Demineralized Bone Matrix

Introduction

Osteonecrosis or avascular necrosis (AVN) is a pathologic process that results from a critical decrease of blood supply to the bone and elevated intraosseous pressure [1]. While the pathogenic process is not clear, it is believed that osteonecrosis is the final common pathway of traumatic and non-traumatic insults and that it impairs blood circulation to the femoral head. Subsequently, interruption of blood flow to the femoral head leads to the death of bone marrow and osteocytes and usually causes the collapse of the necrotic segment [1].

Avascular necrosis is a well-known complication of sickle cell anemia (SCA); however, the exact underlying mechanism has not been fully explained. Nevertheless, it is thought that microvascular occlusion from hypoxia-induced erythrocyte sickling, in addition to extra-vascular compression of the intra-osseous blood supply due to bone marrow hyperplasia and hypertension, leads to ischemia, which culminates in bone infarction [2]. Several authors have shown that increased hematocrit levels, low hemoglobin F, co-existence of alpha thalassemia trait, and recurrent episodes of vaso-occlusive crisis are positively correlated with AVN [3-5].

To diagnose AVN of the femoral head based on plain radiographs, the well-known and accepted "Ficat" classification system is always used [6]. The treatment of AVN depends on the severity or stage of the disease and the extent of head

involvement. The intervention is more extensive when the disease is more advanced and outcomes are different based on the treatment offered.

Most patients with AVN progress quickly from the early stages of the disease to advanced stages, making it impossible to save the femoral head. In this study, we aimed to determine the therapeutic results of hip core decompression (CD) in SCA patients with AVN of the femoral head.

Methods

Patient selection

Following approval from the Medical Ethics Committee (Reference No. 1275-13), we retrospectively reviewed the medical records of patients with hemoglobinopathies who underwent core decompression surgery for AVN of the femoral head at King Abdula-Aziz University Hospital between 2001 and 2014. We excluded patients with AVN who underwent arthroplasty, and patients who had AVN for another cause such as hip fracture. Ten patients were identified and their records were available for analysis. Radiological evaluation for pre-operative staging was done using the Ficat classification system. During the post-operative and follow-up periods, plain films of the pelvis (Anteroposterior [AP] view) or magnetic resonance imaging (MRI) of the hip or both were used for assessments. The procedures were done by different orthopedic surgeons who used the same technique. A data collection sheet was used to gather information from the patients' medical charts. Multiple variables were available for analysis, including age, gender, co-morbidities, steroid use as a risk factor, type of

hemoglobinopathy, Ficat stage, and side of hip involvement, dates of surgeries, and dates of clinic visits. The recorded follow-up period ranged from 1 to 3 years post procedure. Four of the 10 patients were available for follow-up (Table 1)

Table 1: Demographics of the four patients available for follow-up

Pt no.	Age	Gender	Hemoglobinopathies	Other Co-Morbidities	AVN of Femoral Head	Hip Side
1	18Y	Female	Sickle Cell Anemia	Systemic Lupus Erythematosus-Chronic Renal Failure	Bilateral	LT
						RT
2	36Y	Male	Sickle Cell Anemia	None	Bilateral	LT
						RT
3	23Y	Female	Sickle Cell Anemia	None	Bilateral	LT
						RT
4	21Y	Female	Sickle Cell Anemia	Epilepsy	Unilateral	RT

Surgical technique

Surgery in all cases was performed by different orthopedic surgeons using the same technique. Prophylactic antibiotic was administered to all patients prior to surgery. Under standard anesthesia, patients were placed in the supine position on a traction table. Surgical draping and prepping were done under usual sterile technique, and a lateral approach to the hip was used. Superficial and deep dissections were done. Under the image intensifier, K-wire was guided toward the centre of the femoral head and decompression was performed. The wound was washed and closed in layers. The skin was closed using staplers and dressing was applied. All patients tolerated the procedure and were shifted to the recovery room without any complications.

Post-operative orders were as follows:

- a. Medications: analgesics, antibiotic (Cefazolin).
- b. Laboratory investigations: complete blood count for hemoglobin level.
- c. Radiological imaging: pelvis/hip X-rays (AP) view.
- d. Physiotherapy: no weight-bearing for six weeks.

Post-operative follow-up visits at the clinic were offered after discharge.

Clinical variables

For the four patients who were available for follow-up, we used a visual analog scale (VAS) to evaluate pain before and after the surgery.

Statistical analysis

The data were analyzed using the Statistical Package for the Social Sciences (IBM SPSS, New York, US), version 22. Simple

descriptive statistics were used to define the characteristics of the study variables. Results are described in absolute values and percentages for categorical and nominal variables while continuous variables are presented as means and standard deviations. To determine significant changes in pain score before and after surgery, a paired-samples t-test was used. This test was conducted with the assumption of normal distribution. Lastly, a conventional p-value <0.05 was used to reject the null hypothesis.

Results

The results of 10 patients (total of 16 hip joints) were available for analysis. Patients’ ages ranged from 14 to 36 years (mean [SD], 26 [6.7] years). The male to female ratio was 4:6. All patients were known to have SCA except for one, who had chronic myeloid leukemia; two of the SCA patients had thalassemia as well. History of steroid use was reported in only two patients. Different co-morbidities were identified in our patients, including glucose-6-phosphate dehydrogenase, (10%); systemic lupus erythematosus and chronic renal failure (10%); diabetes mellitus, hypertension and bronchial asthma, (10%); and epilepsy (10%). However, most of the patients (60%) had no other associated medical illness. Six patients (60%) had bilateral involvement of the femoral head and four (40%) had unilateral involvement (two had AVN of the right hip and the remainder had AVN of the left hip).

There was noticeable decrease in pain scores before and after surgery in the four patients who were available for follow up; pain scores decreased in both hips and, more specially, in the right side (Table 2). Four patients had stage IV AVN on at least one hip joint at the time of surgery. In most cases, patients had stage III disease, with two patients having stage III disease on both hip joints prior to surgery. Pre-operative and post-operative details for each hip side are illustrated in Tables 3 & 4. A bone graft (Demineralized bone matrix -DBM-) was applied

in seven joints (Table 3 & 4). The first case was an 18-year old female patient who underwent bilateral core decompression. Her VAS for pain before the operation was 10 for the left hip and 9 for the right side; after the operation, it went to zero for both sides. The second case was a 21-year-old female patient who had CD surgery only on the right side. Following the operation, her VAS went from 10 to 4. The last two cases were a 36-year-old male patient and a 23-year-old female patient. The pain for

the male patient did not improve for the left side and remained at 10 (the same before and after the surgery); however, there was an improvement on the right side, with the VAS reduction from 7 to 5. The female patient's pain improved for both hips, decreasing from 9 to 8 and from 10 to 7 for the left and right sides, respectively. Further analysis showed no significant correlation between the Ficat stage of the disease and the VAS for pain (Table 5).

Table 2: Pain score results of the patients available for Follow-up.

Variables	Total	Pain Score Before Operation	Pain Score After Operation	Mean Difference	p-value
Right hip	4	9.0 ± 1.4	4.0 ± 2.9	5	0.051
Left hip	3	9.7 ± 0.6	6.0 ± 5.3	3.7	0.368

Table 3: Characteristics of Patients with Avascular Necrosis of the Right Hip.

Variables	Range	Mean (Standard Deviation)
Pre-operative details		
Age at surgery	14-32	20.3 (5.7)
Ficat stage at time of surgery	1-4	2.6 (1.2)
Pain history (months)	4-36	16.7 (14.9)
Pain score	7-10	9.0 (1.4)
	Frequency*	Percent
History of Steroid Use		
Yes	1	12.5
No	7	87.5
Associated symptoms		
None	4	50.0
Limping	4	50.0
Post-operative details		
	Range	Mean (Standard Deviation)
Last clinic visit after surgery (months)	1-48	16.1 (21.2)
Pain score	0-7	4.0 (2.9)
	Frequency*	Percent
Pain History		
Partially improved	6	75.0
Improved	2	25.0
Bone Graft		
Yes	4	57.1
No	3	42.9

*The total is < 10 due to missing values.

Table 4: Characteristics of Patients with Avascular Necrosis of the Left Hip.

Variables	Range	Mean (Standard Deviation)
Pre-operative details		
Age at surgery	16-32	23.1 (6.1)
Ficat stage at time of surgery	1-4	3.3 (1.0)
Pain history (months)	3-24	13.9 (8.8)
Pain score	9-10	9.7 (0.6)
	Frequency*	Percent
History of steroid use		
Yes	1	12.5
No	7	87.5
Associated Symptoms		
None	5	62.5
Limping	3	37.5
Post-operative details		
	Range	Mean (Standard Deviation)
Last clinic visit after surgery (months)	1-48	14.5 (16.7)
Pain score	0-10	6.0 (5.3)
	Frequency*	Percent
Pain History		
Partially improved	5	62.5
Improved	3	37.5
Bone Graft		
Yes	3	37.5
No	5	62.5

*The total is < 10 due to missing values.

Table 5: Correlation Pain Score and Ficat Stage.

Correlation	Pain Score for the Right Hip	Pain Score for the Left Hip
Pain Score Right		
r	0.596	
p-value	0.404	
Frequency	4	
Pain Score Left		
r		0.419
p-value		0.725
Frequency		3

Discussion

To assess the therapeutic results of core decompression procedure for AVN of femoral head in patients with hemoglobinopathies, and especially with sickle cell anemia, we retrospectively reviewed medical charts for ten patients. The mean age of our sample was 26 years, with female predominance. Six of them were complaining of both right- and left-side femoral head necrosis. We found a noticeable decrease in visual analog pain scores in both hips and, more specifically, in the right side after the surgery. However, this decrease was not found to be statistically significant, which might be due to the small sample size.

A review of the literature showed that, at present, the gold standard treatment modality for femoral head osteonecrosis is unclear [6]. The effect of different non-surgical treatment modalities, such as pharmacological agents (bisphosphonate, anticoagulant, vasodilator, lipid lowering drugs, etc.), restricted weight-bearing, and biophysical modalities (extracorporeal shock waves and pulsed electromagnetic fields), still need further investigation as there is limited information available in the literature [2,6].

Surgical management depends greatly on patient factors and AVN stage, which influence the decision to either replace or preserve the hip [6]. Ficat described a system based on standard radiographs to stage and diagnose AVN (stages I-IV) [7]. Patients with stage I disease have normal radiographs. In stage II, the contour of the femoral head is normal, but there are signs of bone remodelling (such as cystic and sclerotic areas). The femoral head is flattened in stage III disease and in stage IV AVN the joint space is narrow and there is evidence of secondary degenerative changes in the acetabulum. Before the head collapse in the early stages of the disease, in young patients [6] and in SCA patients, the main goal of the treatment is to alleviate the pain and preserve a mobile joint [8]. Head preservation is done by core decompression with or without the use of bone grafting [6], which has been a predominant modality for approximately three decades [9]. Once the head collapses in [6] stage III, the preferred available option is hip replacement by arthroplasty [6].

Core decompression (CD) was introduced by Ficat and Arlet based on the principle of decreasing intramedullary pressure to allow an increase of blood perfusion to the femoral head [10]. Mont et al. [1] reported a review study that showed AVN hips treated non-operatively had a success rate of only 23% compared with CD, which showed more promising results [2]. A systematic review reported a 63.5% clinical success rate of CD with or without bone grafting [9]. In our study, bone grafting was applied in only seven joints (46.7%).

In a recent review article, the authors summarized that CD achieves better outcomes when performed in the early disease stages, regardless of associated risk factors [2]. As in our patients, different risk factors and associated medical co-morbidities were present, such as diabetes, hypertension, bronchial asthma, epilepsy, chronic renal failure, systemic lupus erythematosus, and glucose-6-phosphatase dehydrogenase, which did not affect the outcomes. While nearly half our joint sample (7 joints) had stage III disease, 4 joints were in the early stages (I or II) of the disease.

The most common presenting symptom is deep pain in the groin that can be referred to same side knee or buttock [6]. Pain was assessed using a visual analog pain scale before and after the surgery to measure its effect on pain. The results indicate a dramatic improvement in patients' pain scores following CD.

The small sample size and poor follow-up rate impose limitations on the study results, as well as the limitations inherent to case series studies. Thus, further testing with a larger sample (i.e., multi-center study) is necessary to draw tangible conclusions regarding this treatment.

Conclusion

Providing treatment options for patients with hemoglobinopathy and AVN of the hip continues to be a challenge, particularly given that patients are young and have active lifestyles. Core decompression remains a valid treatment option for temporary pain relief in patients with stage I-III disease.

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