

# Scientific Reports in Medicine

## Research Article

### Core decompression can still be an effective treatment in femoral head avascular necrosis

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DOI: 10.37609/srinmed.10

#### Abstract

**Objective:** Core decompression is one of the femoral head sparing surgeries that is used in femoral head avascular necrosis. The efficacy of the treatment is inconsistent in the literature. We aimed to contribute to clarifying the controversies about the index treatment by publishing this retrospective paper.

**Methods:** Functional and radiological data of 44 hips of 33 patients who were diagnosed with femoral head avascular necrosis and treated with core decompression were extracted from the hospital database. Presumed risk factors were determined as corticosteroid use, trauma, chemotherapy, sickle cell anemia, alcohol, and pregnancy. Twenty hips were treated with core decompression only, 24 hips were treated with core decompression and avascular bone grafting. All surgeries were performed with a standard technique which is described by Arlet and Ficat, and patients complied with standard follow-up protocol. Functional results were assessed with Harris hip score and radiological findings before and after the operations were evaluated by a single author.

**Results:** The mean follow-up of patients was 89 (17-171) months. Patients had significant improvement in Harris hip score postoperatively regardless of the surgical technique. Sixteen hips (36.3%) underwent total hip arthroplasty (THA) during follow-up and there is no significant difference between treatment groups. Mean interval between the primary surgery and THA was 37.8 months.

**Conclusion:** Core decompression can still be an effective treatment options at an early-stage avascular necrosis of the femoral head.

**Keywords:** Avascular necrosis, core decompression, femoral head

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Received: 2024-07-24

Accepted: 2024-08-30

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## Introduction

Avascular necrosis of the femoral head has been remaining a clinical issue that is difficult to treat and obtain a satisfactory outcome. In literature, it was reported to affect the people between the third and fifth decades of their lives (1). So, it has serious demanding effects on work and leisure activities of highly active groups of population. Untreated cases suffer from early hip degeneration that is irresponsive to salvage procedures and inevitably needs to be treated with hip arthroplasty (2). Besides, treatment options at early periods include various options standing between restriction of activities such as weight bearing combined with nonsteroid anti-inflammatory drugs and salvage procedures such as core decompression with non-vascular grafting or vascular grafting (3). However, the effectiveness of these treatment options is debatable and there is no widely accepted treatment algorithm (4).

Many etiologic factors were blamed for the disease. Excessive alcohol use, corticosteroid use, some metabolic disorders, radiation therapy, and chemotherapeutic agents are presumed as some of the etiological factors but, the mystery of the exact pathophysiological mechanism remains (5). Ficat and Arlet came up with the idea of an increment in the intraosseous pressure which ends up with the deterioration of the perfusion and necrosis of the bone (6). This theory encouraged the orthopedic surgeons to try to diminish the increased intraosseous pressure with invasive approaches including core decompression which is the most famous one.

Core decompression was firstly described by Ficat and Arlet in 1968 (6). They theorized that the removal of the increased pressure may reconstitute the normal blood flow, alleviate the pain of the patients, and stimulate the healing of the necrotic bone. They obtained promising results. Controversial results were reported in following studies but, there is a consensus on the fact that far better results would be obtained if the procedure was applied before the femoral head collapsed (7,8). Different methods of core decompression were defined by different

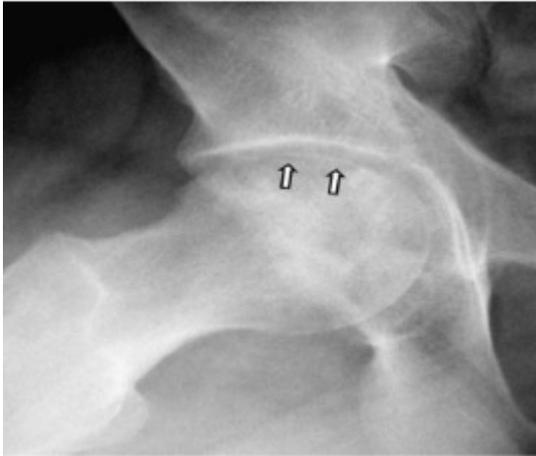
authors, however the success of these methods extended in a distinct perspective according to the affected site of the femoral head, grade and extension of the disease (9,10). In our institute, we used a standard approach of core decompression combined with avascular autografting. In this study, we revealed the functional results and necessity of the secondary arthroplasty following the core decompression.

## Material and Methods

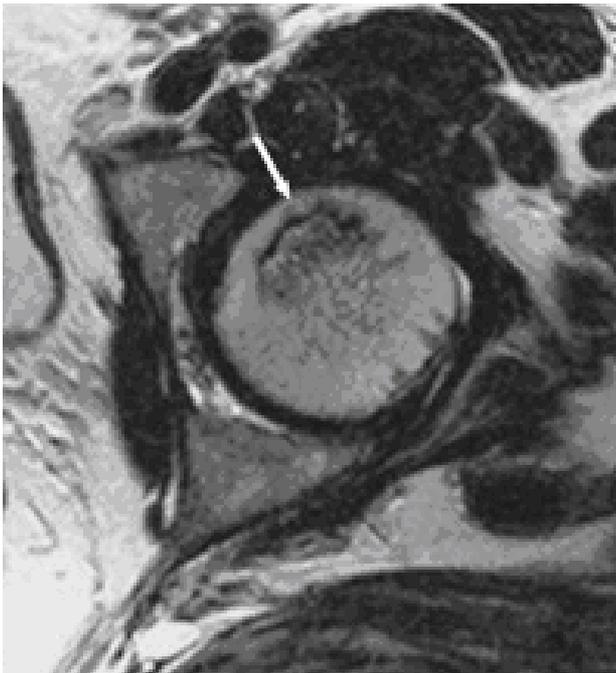
Ethical approval was obtained from Cukurova University ethical committee 09.06.2009/6-15. Patients who were diagnosed as avascular necrosis of the femoral head on radiographs and magnetic resonance imaging, (Figures 1-4) and had regular follow-ups were included in the study. Data of the patients who met the inclusion criteria between 1996 and 2009 was extracted. There were 44 hips of 33 patients were recorded as treated by core decompression or core decompression with bone grafting. Retrospective review showed that all the patients who had the diagnosis of AVN without collapse in the femoral head were defined as candidates for core decompression regardless of the etiology. Autograft was used as bone substitute to enhance the mechanical strength of the subchondral bone. In the presence of large defects after decompression allograft was also added. All interventions were performed by one experienced hip surgeon.



**Figure 1:** Radiograph of Ficat grade 2 hip avascular necrosis



**Figure 2:** Crescent sign (X-ray)



**Figure 3:** Double line sign (MRI – axial view)

## Surgical Technique

Surgery was performed under epidural or general anesthesia. Patients were placed supine on the fracture table. Involved lower extremity was adjusted as 15 degrees of internal rotation to acquire the parallelism of the femoral neck to the ground. Adequate AP and lateral views of the hips were checked. The surgical area was sterilized with

Betadine solution. For the surgical prophylaxis, 1 gram of cephazolin was administered intravenously. Five centimeters length skin incision was made to the distal of the tip of trochanter major. Fibers of tensor fascia lata were separated and 3.2 mm guide wire was sent into the previously determined necrosis area with the help of C-arm fluoroscopy (Figures 5,6). Eight millimeters drill was sent through the drill guide and decompression was made (Figure 7). Subsequently, another 5 centimeters incision was made over the iliac crest, 3 centimeters proximal to the anterior superior iliac spine (ASIS). A cortical window was created and spongiosa bone was harvested. Grafts were embedded with spinal rod through dynamic hip screw holder which was placed into the previously performed drill hole (Figures 8,9). The grafted site was controlled with Fluoroscopy lastly. Then the layers were closed appropriately.



**Figure 4:** Double line sign (MRI - coronal view)



**Figure 5:** 3.2 mm guide wire is sent to the femoral head through the incision.



**Figure 6:** Guide wire position and relation with lesion is checked with C – arm fluoroscopy.



**Figure 7:** Reaming is performed with 8 mm drill, over the guide wire; and decompression is made.



**Figure 8:** Non-vascularized bone graft which is harvested from the iliac crest.



**Figure 9:** Grafts are sent through dynamic hip screw holder which is placed into the previously performed drill hole with spinal rod.

## Postoperative Rehabilitation

Patients received prophylactic antibiotic treatment till the day after the surgery. Wound dressings were renewed and patients were discharged from the hospital. Weight bearing was not allowed until the 6<sup>th</sup> week. Routine follow-up procedure was admonished at 3<sup>rd</sup> week, 6<sup>th</sup> week, 3<sup>rd</sup>, 6<sup>th</sup>, 9<sup>th</sup>, and 12<sup>th</sup> month of the surgery. Radiographs of the hips were obtained in control admission to the outpatient clinic. If the radiographs were failed to demonstrate the condition of the femoral head in a clinically worsening patient, MRI obtained for detailed evaluation. Control examination of the patients includes the routine daily activity level of the patients, crouch use or limping, and Harris Hip scores.

## Results

Twenty-two patients were male and 11 patients were female. The mean age of patients was 34.8 (16-57) years and the mean follow-up duration was 89 (17-171) months (**Table 1**). Presumed risk factors in this study were corticosteroid use in 21 hips, sickle cell anemia in 3, trauma in 3, chemotherapy in 2, and pregnancy in one. No etiologic factor was detected in 14 patients (**Table 2**). Ficat and Arlet classification was used for the grading of the disease. Twelve hips were grade 1, 27 were grade 2, and 5 were grade 3 (**Table 3**). Core decompression and grafting were performed in 20 hips, and core decompression without grafting was performed in 24 hips (**Table 4**). Age, follow-up duration, distribution of the grades of the hips were homogenous between two groups.

Functional results were evaluated according to the Harris hip score system. The preoperative Harris hip score was  $57.9 \pm 14.6$ , and the postoperative score was  $92.9 \pm 8.7$ . Median values of the Harris hip score were significantly higher in the postoperative group (61, 95 respectively) ( $p=0.0001$ ) (**Table 5,6**). Forty-one patients showed excellent or good functional results however 3 patients were assessed as bad functional results (**Table 7**).

**Table 1: Gender and side distribution of the patients.**

		Number	Percentage
Gender	Female	11	33.3 %
	Male	22	66.7 %
<b>Total patients)</b>		<b>33</b>	<b>%100</b>
Side	Right	24	54.5 %
	Left	20	45.5 %
<b>Total (hips)</b>		<b>44</b>	<b>%100</b>

**Table 2: Etiologic factors involved in study.**

Etiology	Number	Percentage
Corticosteroid use	21	47.7 %
Primary	14	31.9 %
Sickle Cell Anemia	3	6.8 %
Trauma	3	6.8 %
Chemoterapy	2	4.5 %
Pregnancy	1	2.3 %

**Table 3: Distribution of the hips according to Ficat – Arlet grading system.**

Ficat – Arlet	Number	Percentage
Grade 1	12	27.3 %
Grade 2	27	61.4 %
Grade 3	5	11.3 %

**Table 4: Distribution of patients according to performed surgical methods.**

Method	Number	Percentage
Core decompression	24	54.4 %
Core decompression + grafting	20	45.5 %

**Table 5: Pre-operative Harris Hip Scores**

Pre-operative HHS	Number (Percentage)
Excellent	0 (0 %)
Good	0 (0 %)
Moderate	35 (79.5 %)
Poor	9 (20.5 %)

**Table 6: Comparison of pre-operative and post-operative Harris Hip Scores**

	Pre-operative HHS	Postoperative HHS	P value
Mean ± SD	57.9 ± 14.6	92.9 ± 8.7	
Median	61.0 (32.0 – 78.0)	95.0 (65.0 – 100.0)	0.0001

Following the operation, 16 hips underwent total hip arthroplasty. The mean time for subsequent THA due to the disease progression and clinical worsening was 37.8 months after the primary surgery (Table 8). Analysis of the grades of these hips before the surgery revealed that one patient was grade 1, 11 patients were grade 2, and 4 patients were grade 3 (Table 9). We found no statistical differences between two treatment groups in terms of total hip arthroplasty necessity. Six of 16 patients were treated with core decompression and bone grafting while 10 patients with core decompression only (Table 10).

**Table 7: Post operative Harris Hip Scores**

Post operative HHS	Number (Percentage)
Excellent	32 (72.7 %)
Good	9 (20.5 %)
Moderate	0
Poor	3 (6.8 %)

**Table 8: Correlation of graft use and hip survival**

	Grafting				P value
	Yes		No		
	Mean ± SD	Median	Mean ± SD	Median	
Hip survival (months)	28,2 ± 21,7	23,0	43,7 ± 26,1	48,0	0.313
		(6.0 – 56.0)		(7.0 – 79.0)	

**Table 9: Follow-up findings**

Grade	Number (Hips)	Additional intervention	Percentage among the grade
1	12	1	8.3 %
2	27	11	40.7 %
3	5	4	80 %

**Table 10: Patient distribution according to grades of AVN and graft use**

	Grade 1 (n)	Grade 2 (n)	Grade 3 (n)
<b>Graft +</b>	4 (33.3 %)	13 (48 %)	3 (%60)
<b>Graft -</b>	8 (66.7 %)	14 (52 %)	2 (40 %)

## Discussion

Core decompression is a femoral head sparing technique for treatment of femoral head avascular necrosis. It is still a widely used procedure and is believed to decrease the intraosseous pressure and restore the blood flow into the necrotic area. Despite a standard technique was described by Arlet, many variations and combinations with supportive techniques were also described by different authors later (6,11-16). The efficacy of the treatment is inconsistent in the literature. We aimed to contribute to clarifying the controversies about the index treatment by publishing this retrospective paper. In this study; patients had significant improvement in Harris hip score postoperatively regardless of the surgical technique. This finding shows that; core decompression can still be an effective treatment options at an early-stage avascular necrosis of the femoral head.

Femoral head avascular necrosis is a progressive disease that leads to collapse and early hip degeneration. It was described that untreated disease leads to early hip degeneration in 70% of the cases so, early detection and treatment of the disease is mandatory to prevent the progression to the irreversible stage (17). Multiple etiologic factors were blamed. The common feature of all these factors is their deterioration of the microcirculatory system which leads to apoptosis of osteocytes and necrosis of the subchondral bone. As a result mechanical failure ends up with the collapse of the femoral head and degeneration of the joint. Hyperlipidemia, chronic alcohol use, and corticosteroids create a hypertrophic fat tissue in the intraosseous space and obstructs the blood flow (18). Hemoglobinopathies could cause sickling of the erythrocytes and obstruction of the blood flow (19). Trauma related to the femoral neck may intervene the anastomoses that provide the blood supply of the femoral head and lead to avascular necrosis (20). Nitrogen bubbles due to the acute decompression could obstruct the micro-vessels (21). Besides, in most of the cases no etiologic factors could be detected and this group is defined as idiopathic. In our study, corticosteroid

was appeared to be the most prevalent causative factor and followed by the idiopathic cases. This finding is consistent with the literature. Sickle cell anemia, trauma, chemotherapy and pregnancy were the other accepted factors.

There are multiple classification systems used for the evaluation of the AVN. Prognostic value of these classification systems remains controversial. The stage and area of the necrotic lesion were defined as the main prognostic factors (22). We used Ficat and Arlet classification for assessing the stage in this study. ARCO classification is based on both stage and the area that is mainly affected. The size and location of the necrosis was ignored in our study. To the best of our knowledge, core decompression was being performed as the only femoral head sparing surgery in our institute and irrespective of the necrosis size; however, it was not performed, if crescent was appeared on the radiograph (**Figure 4**). Additionally, bone grafting was added if necrosis affected a large part of the subchondral bone and weight bearing area. In the literature, stage of the disease is highly related to the treatment outcomes. In a metanalysis included 1206 patient that investigated the effectiveness of core decompression, it was reported that 84% of stage 1 patients and 65% of stage 2 patients had successful results. The survival of stage 3 hips was 47%. Results also pointed out the proportionality of the size of the necrosis and outcomes. The patients who were failed with the treatment had a mean affected area of 45% of the femoral head, and 22% in patients with favorable results. Another study also showed that 87% of untreated stage 3 hips underwent total hip arthroplasty while core decompression reduced this rate to 53%. In our study, we also found that the hips that were stage 3 AVN according to the Ficat and Arlet classification had the worst outcomes (20%) and best results were obtained in stage 1 patients (91.3%).

Decompression of the necrotic site is the main objective in treatment. Regardless of the physiologic contributory effect of the procedure, elimination of the mechanical effect of the increased pressure was

reported as the one relieving factor of the patients' complaints. On the other hand, some authors also reported that the dramatically favorable clinical feedback of the patients could be related to the prevention of the weight bearing of the affected extremity. Since, the collapse of the subchondral bone appears to be the irreversible step of the disease, literature highly recommends the filling of the space that is formed subsequent the core decompression. Avascular grafting and vascular fibular grafting techniques are viable options for now. Mont et al. reviewed the results of the study that investigated the efficacy of the core decompression with avascular grafting (23). Satisfactory results were reported in 63.5% of 1206 hips which were treated with core decompression only. Results were better in patients without femoral head collapse. This rate was detected as 22.7 % in the treated non-operatively in the same study. In contrary, Koo et al. performed a randomized trial that study about the prevention of femoral head collapse following the core decompression (24). They observed that patients acquired a symptomatic relief following the surgery however survival of the femoral head was similar to the hips which were treated non-operatively. There are similar studies that showed low success results related to the core decompression. These controversial results made the core decompression and avascular grafting questionable. Obtaining more promising results especially in early stages shaded the efficacy of the avascular grafting since the natural course of the disease remained unknown for a long time. Indifference success rates with grafting and without grafting groups could be attributed to this theory. The avascular grafting was believed to be insufficient for obtaining viable osteoprogenitor cells. For this reason, vascular fibular bone grafting is described as an attractive alternative method for reconstruction of the decompressed site. Vascular fibula is a cortical bone which is superior to cancellous autograft in terms of mechanical strength and gathers osteoprogenitor cells because of its vascular feature. Cao et al published the results of 27 bilateral AVN patients whose hips were treated with

core decompression and concomitant contralateral vascular fibular grafting (25). They concluded that in the hips treated with vascular fibular grafting, the analysis with SPECT/CT revealed better vascularity, ARCO staging was improved and second operation necessity in the first 36 months was significantly lower in the hips treated with vascular fibular grafting. AVN is accepted as the mesenchymal cell disease of the femoral head. Some authors theorized the pure mononuclear cell extract or bone marrow could provide healthy osteoprogenitor cell to the necrotic region. Tabatabaee et al. published the results of the randomized controlled study that they enrolled 28 hips which were treated with core decompression and concentrated bone marrow aspirate, or core decompression alone. Hips treated with core decompression and bone marrow injection showed better functional and MRI results. In terms of hip joint survival and functional scores, we found consistent results with the similar studies in literature.

Size of the groups and heterogeneity of etiologic factors are weak part of this study. Besides, follow-up duration was enough to predict the natural course of the hips following the treatment.

## Conclusion

Core decompression can be used to prevent femoral head collapse and early necessity of THA.

## Acknowledgement

### Peer-Review

Double blind both externally and Internally Peer Reviewed

### Conflict of Interest

The authors declare that they have no conflict of interest regarding content of this article.

### Financial Support

The Authors report no financial support regarding content of this article.

## Ethical Declaration

Ethical approval was obtained from Çukurova University Research Ethical Committee with date 09/06/2009 and number 6-15, and Helsinki Declaration rules were followed to conduct this study.

## Is Thesis?

This study was prepared by rearrangement of the medical specialty thesis by Mustafa Tekin, entitled as “Femur başı avasküler nekrozlarında kor dekompresyon tedavisinin fonksiyonel sonuçları” in 2011.

## Authorship Contributions

Concept: MT, AM, BK, MB, ÖSB, İT, Design: MT, AM, BK, MB, ÖSB, İT, Supervising: MT, AM, BK, MB, ÖSB, İT, Financing and equipment: MT, AM, BK, MB, ÖSB, İT Data collection and entry: MT, AM, BK, MB, ÖSB, İT Analysis and interpretation: MT, AM, BK, MB, ÖSB, İT Literature search: MT, AM, BK, MB, ÖSB, İT Writing: FİD, Aİ, HMS, TM, FT, HD Critical review: MT, AM, BK, MB, ÖSB, İT

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