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Osseoscopy-assisted core decompression and debridement in the treatment of avascular necrosis of the femoral head

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Abstract

Core decompression of the femoral head is a standard surgical procedure used in the early stages of the femoral head avascular necrosis (AVN) (Steinberg I to III). This study aimed to determine whether the advantages of osseoscopy-assisted core decompression using a standard arthroscopic set up in the early stages of AVN of the femoral head. Twelve hips of 12 patients who underwent osseoscopy-assisted core decompression and debridement with the diagnosis of AVN of the femoral head were reviewed between 2019 and 2021. The etiology was idiopathic in 2 patients; ten had a history of steroid use. The preoperative and postoperative first month Harris Hip Score (HHS) and visual analogue scale (VAS) were recorded. Standard X-rays, computerized tomography, and magnetic resonance imaging (MRI) were noted at preoperatively and sixth month follow-ups. In a 1-year follow-up, X-rays and MRIs were reviewed. All patients significantly improved in the VAS and HHS after the osseoscopy-assisted core decompression ($P = .002$). Two of the 12 patients with an initial stage of Steinberg IIC and IIB and one with Steinberg IA had a progressive femoral collapse and, therefore, had a total hip replacement at the end of the follow-up. Nine patients (75%) had satisfactory functional and radiological results in 1-year of follow-up. However, 3 patients (25%) culminated in total hip arthroplasty in a 1-year follow-up. Using an arthroscopic set up during osseoscopy-assisted core decompression surgery of the femoral head AVN has the benefits of direct visualization and accurate debridement of the involved area. The osseoscopy-assisted core decompression technique avoids excessive debridement of the healthy bone tissue adjacent to the necrotic area.

Abbreviations: AVN = avascular necrosis, HHS = Harris Hip Score, MRI = magnetic resonance imaging, VAS = visual analogue scale.

Keywords: avascular necrosis, core decompression, debridement, Osseoscopy

1. Introduction

Osteonecrosis, also known as avascular necrosis (AVN) or ischemic necrosis of the femoral head, is a pathological process that results from the interruption of blood supply to the bone.[1,2] Although there are lots of risk factors that can cause AVN, such as trauma, alcohol, or genetic factors, the use of corticosteroids is the most common, accounting for almost 10% to 30% of cases.[3] Whatever the cause, this process usually results in the collapse of the femoral head and subsequent osteoarthritis of the hip joint, depending on the severity of the pathology.[4]

Although conservative treatment methods are available, such as limited weight bearing,[5] pharmacological agents, extracorporeal shock-wave therapy, and hyperbaric oxygen therapy at the initial level of progression,[6,7] the success rates are generally reported lower compared to surgical methods.[7] Core decompression is currently the most common surgical procedure in the early stages of osteonecrosis of the femoral head,[2] according to Steinberg classification stages I, II, and III.[8] The aim of core decompression is to reduce intraosseous pressure by removing necrotic bone tissue in the femoral head and restoring normal vascular flow.[9] Before the femoral head collapse, the patient may benefit from bone grafting, intertrochanteric osteotomy, or core decompression. However, the options are usually limited to arthroplasty if the femoral head collapses.[10] Also, the core decompression technique is combined with non-vascular or vascular bone grafts. Most commonly, core decompression is performed under fluoroscopy, and necrotic bone tissue of the femoral head is removed through a tunnel at the lateral subtrochanteric region of the femur.[5]

A limitation of classical core decompression under fluoroscopy is the lack of visualization of the necrotic bone tissue intra-operatively. Therefore, the amount of necrotic tissue debridement is based on the radiological and fluoroscopic findings. Visualization of the osteonecrotic area with the assistance of endovision during the core decompression procedure will

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Level of evidence: Level III, retrospective cohort study.

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result in more accurate debridement. In this study, we aimed to determine whether the use of osseoscopy-assisted core decompression with a standard arthroscopic setup has benefits in the early stages of osteonecrosis of the femoral head.

2. Materials and methods

2.1. Study design

Between 2019 and 2021, 12 patients were treated with osseoscopy-assisted core decompression and grafting procedures and were assessed retrospectively. The ethical approval of this study was taken from the Muş Alparslan University Scientific Research and Publication Ethics Committee (2023-90202/4/71). The study was conducted under the principles of the Declaration of Helsinki. An informed consent form was obtained from all patients.

2.2. Participants

All patients were diagnosed with non-traumatic femoral head osteonecrosis (Steinberg stage I, II, or III) based on clinical presentation and physical and radiological findings, including anteroposterior and frog-leg pelvic radiograph and magnetic resonance imaging (MRI). Patients who had an earlier diagnosis of osteonecrosis of the femoral head and received conservative treatment methods were excluded from the study. All patients were treated with osseoscopy-assisted core decompression procedure.

2.3. Surgical technique

After administering regional or general anesthetics, the patient was placed in a lateral decubitus position with the affected side facing upwards, and the ipsilateral iliac wing was exposed for bone graft harvesting. The ipsilateral leg was prepared to allow free intraoperative movement. The image intensifier was placed to visualize the involved hip properly. A longitudinal incision of approximately 7 cm was made over the greater trochanter. After splitting the iliotibial band and vastus lateralis, the lateral cortex at the subtrochanteric area of the femur was exposed. As a guide wire, a 3.2 mm Steinman pin was inserted toward the femoral head to the necrotic bone tissue under fluoroscopic guidance. After the enlargement of the pin trajectory with a 9 mm trephine drill, the necrotic bone tissue in the femoral head was visualized with the assistance of osseoscopy (Fig. 1). A standard arthroscopic setup with an inflow and outflow cannula was used for endovision. A 30-degree arthroscope and an inlet and outlet cannula were used to evaluate necrotic bone tissue. Firstly, the fluid outflow was allowed after arthroscopic access and irrigation were performed. After irrigation, fluid outflow was blocked to obtain a better image quality. A pump pressure of 50 to 60 mm Hg was used to differentiate between bleeding healthy bone tissue and necrotic bone tissue. Fluid outflow was allowed when bleeding was at a level that would impair imaging quality.[5] Necrotic bone tissue is removed by burr under an image intensifier, and the debridement area is visualized by endovision for confirmation. This process was repeated until the endovision visualized the healthy and bleeding bone tissue (Fig. 2). Then, an incision of 3 cm was made over the iliac wing, and after the exposure of the iliac crest, an approximately 5 cm × 1 cm cortical wedge graft was harvested. The autograft taken from the patient iliac wing was placed through the femoral tunnel into the debridement area. After ensuring the autograft stability, the procedure ended, and layered surgical closure was applied. All patients received low molecular weight heparin for thromboembolism prophylaxis, and a 2nd generation cephalosporine was used for antibiotic prophylaxis. The procedure success was defined as accurate visualization and debridement of the necrotic bone tissue without cartilage breach or cortical fracture.[4,5] All patients were allowed partial weight bearing with crutches after the day following the procedure with the guidance of a specialized physical therapist. After discharge, patients were encouraged to do an isometric hip and knee exercise and partial weight bearing under the supervision of the physical therapist. Nearly 8 to 10 weeks after surgery, full weight bearing was allowed. Passive and active hip, knee, and ankle range of movement were allowed and encouraged during the follow-ups.

2.4. Outcome measures

The preoperative and the first postoperative month Harris Hip Scores (HHS) and visual analogue scales (VAS) were recorded for function and pain. Plain radiographs were reviewed preoperatively, during the first and sixth months, and 1-year follow-ups. The computerized tomography (CT) scans were obtained preoperatively and the sixth month after the surgery. Also, the patients were reviewed for MRIs preoperatively, the sixth month after the surgery, and 1-year follow-up. We used a modified Kerboul angle measurement as proposed to determine the extension of the necrotic area.[11] According to their study, using MRI instead of radiographs to calculate the Kerboul angle is an ideal method to assess future hip collapse with femoral head osteonecrosis. Kerboul angles were calculated with mid-coronal and mid-sagittal MRI images. The sum of the mid-coronal and mid-sagittal angles was used to determine the modified Kerboul angle. Progression of the disease, collapse, and narrowing of joint space was evaluated.

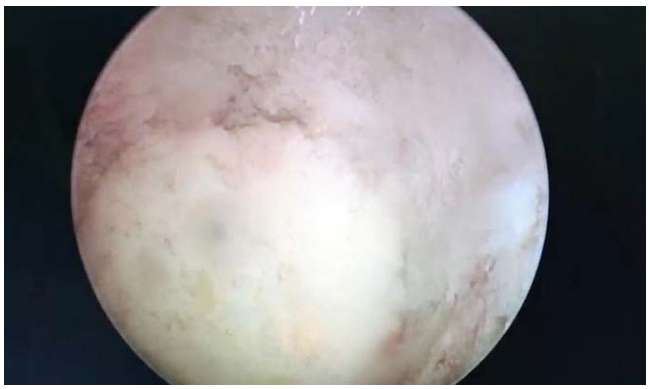

Figure 1. Osseoscopic view of the osteonecrotic and non-bleeding bone tissue around the involved area at the femoral head.

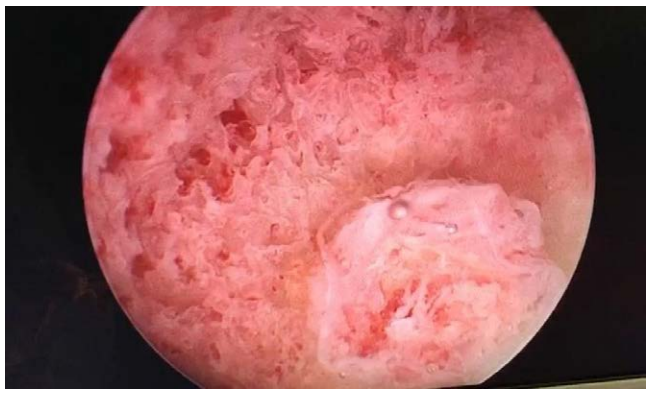

Figure 2. After thorough debridement of the involved area, sufficiently bleeding healthy bone tissue is visible by osseoscopy.

2.5. Statistical analysis

The data were analyzed using the Statistical Package for the Social Sciences software version 25 (IBM Corp., Armonk, NY). Continuous variables were given as mean ± standard deviation or minimum-maximum scores, and categorical variables were presented as frequencies and percentages. To compare the data on pain and function between baseline and 1 month after surgery, paired sample *t*-test for parametric test assumptions and Wilcoxon paired signed test for non-parametric test assumptions were used. Statistical significance was set at $P < .05$.

3. Results

Twelve hips of 12 patients (eight men and 4 women) were reviewed in this study with the diagnosis of osteonecrosis of the femoral head. The mean age at the time of surgery was 37.33 years. The mean follow-up to date was 12.33 months. Four patients were female (33.33%), and 8 were male (66.67%). 83.37% of the patients were right-sided dominancy, and 50% were dominant side affected. Two patients (16.67%) had idiopathic AVN, but the remaining 10 subjects (83.37%) had a history of steroid use. According to Steinberg classification, 3 of the patients (25%) were stage I, 8 (66.67%) were stage II, and 1 (8.33%) was stage III (Table 1).

The mean preoperative VAS score was 9.20, whereas the mean VAS score was 1.20 in the first month of core decompression and was significantly higher when compared to before ($P < .05$). The mean preoperative HHS score was 41.66, whereas the mean HHS score was 86.63 in the first month of core decompression and was significantly higher when compared to before ($P < .05$). The mean Kerboul angle of the patients was 185 degrees. Two patients with Steinberg stage 2C and 3C and one with Steinberg stage IA (Kerboul angles of 210, 260, and 140 degrees, respectively) had a progressive collapse of the femoral head. These patients had total hip replacement surgery at the end of the follow-up period (Table 2).

Sixth month and 1-year follow-up X-rays and MRIs showed no significant issues in patients. None of the patients had complications such as thromboembolism or surgical site infection. There was no intraoperative fracture or chondral injury of the femoral head, and there were no chondral injuries during the osseoscopy-assisted core decompression procedures.

Table 1

Demographic and clinical characteristics of the patients with femoral osteonecrosis.

	Patients with femoral osteonecrosis (n = 12)	
Variables	**Mean (SD)**	
Age (yr)	37.33 (9.55)	
Follow-up (mo)	12.33 (4.01)	
	n (%)	
Gender	Female	Male
	4 (33.33)	8 (66.67)
Dominant side	Right	Left
	10 (83.37)	2 (16.67)
Affected side	Right	Left
	6 (50)	6 (50)
Etiology	Steroid	Idiopathic
	10 (83.33)	2 (16.67)
Steinberg classification	Stage	n (%)
	IA	3 (25)
	IIA	2 (16.67)
	IIB	3 (25)
	IIC	3 (25)
	IIIC	1 (8.33)

SD = standard deviation.

4. Discussion

This study aimed to investigate whether the osseoscopy-assisted core decompression and debridement with a standard arthroscopic setup have benefits in the early stages of osteonecrosis of the femoral head. This study revealed that the osseoscopy-assisted core decompression and debridement have promising results in delaying the progression of the femoral AVN in patients with Steinberg stages I, II, and III. Hip pain and function were improved markedly after the procedure of osseoscopy-assisted core decompression. After the procedure of osseoscopy-assisted core decompression, in 75% of patients, the progression level of osteonecrosis was delayed at a mean of more than 1-year follow-up.

Although core decompression is the most common procedure in treating early-stage osteonecrosis of the femoral head, few randomized trials assess the procedure alone.[1] A study by Zhao et al reported a 10.1% collapse of 59 hips after core decompression plus arthroscopic guidance and a 27.5% collapse of 80 hips after core decompression alone.[12] In a randomized study by Stulberg et al, core decompression alone has a success rate of 70% to 73%, compared to 10% to 20% in the conservative treatment group.[13] The clinical success rates of the core decompression procedure were 93.9% for Ficat stage I hip and 82.3% for stage II hips.[14] Our results with utilizing osseoscopy, in accordance with previous works executing the core decompression, had a 75% success rate of our patient population in 1-year follow-up.

A disadvantage of conventional core decompression is the absence of direct visualization of the debridement area.[5] First described by Ficat,[14] the core decompression technique is traditionally performed under an image intensifier, and the necrotic area of the femoral head is identified and removed radiologically. A study of 13 hips by Brannon emphasized that avascular bone undetected on preoperative MRIs was detected and removed using a flexible endoscope, and thorough debridement of the femoral head was achieved. The authors suggested using endoscopic visualization of the undetected avascular bone as it facilitates thorough debridement of the femoral head.[15] Thorough debridement under endoscopic visualization with bone grafting and stabilization was also reviewed retrospectively by Wells et al.[16] The authors used flexible endoscopes in 16 hips of 13 pediatric (<20 years old) patients and reported successful results for pediatric hips lower than Steinberg grade 3B. Although this seems to be an option for direct visualization, there is a requirement for flexible endoscopic equipment in both studies. In the technique used in this study, direct visualization of the necrotic area by osseoscopy allows for accurate debridement and preserves as much healthy bone as possible. Since the

Table 2

VAS pain and HHS function scores of patients with femoral osteonecrosis before and the first month after osseoscopy-assisted core decompression.

	Patients with femoral osteonecrosis (n = 12)		
	Before the surgery	**After the first-mo of surgery**	***P***
	Mean (SD)	Mean (SD)	
VAS	9.20 (0.35)	1.20 (0.14)	**.002***
HHS	41.66 (6.70)	86.83 (6.57)	**.002***
	Mean (SD)		
Kerboul angle	185 (41.01)		
	n (%)		
Culminating in total hip arthroplasty	3 (25)		

$P < .05$ is highlighted in bold in table.

HHS = harris hip score, SD = standard deviation, VAS = visual analogue scale.

subchondral area of the femoral head is visualized, this technique helped prevent chondral injury of the femoral head. The grafting and debridement processes of the patients were successfully performed thanks to direct visualization and arthroscopic equipment. After a 1-year follow-up period, only 3 patients had collapsed, culminating in total hip arthroplasty.

Reduction of hip pain and function is of great importance in patients with femoral osteonecrosis.[2,16] Previous results showed that core decompression significantly reduces hip pain and improves function in non-traumatic patients at an early stage of femoral osteonecrosis.[2,17] Kunze et al reported that after 14 months of follow-up, the pain level reduced to tolerable, and the patients returned to their everyday lives in the fifth postoperative month.[2] Similarly, Landgraeber et al[17] found that the patients' hip function was increased in the sixth postoperative week and kept at the same level until the 30th postoperative month after the core decompression. Similar to the results of previous studies, the pain and functional levels of the patients improved in the first month after osseoscopy-assisted core decompression in our study.

This is the only study using the assistance of a standard arthroscopic setup for core decompression of the osteonecrosis of the femoral head. A similar surgical technique compared to this study was recently published by Geisert et al.[5] The authors described their surgical procedure using only a standard arthroscopic setup but a wide decompression track (18 mm) to simultaneously operate the camera and curette. The authors also emphasized that if the tunnel is smaller than 18 mm, it is not possible to operate both the camera and curette simultaneously. In contrast to our technique, a wide femoral tunnel does not allow early partial weight bearing due to the risk of proximal femoral fracture. Since they had not published their technique results, we are unaware of the complication rates. In our technique, using only a 9 mm decompression track allows early partial weight bearing and reduces femoral fracture risk.

A standard arthroscopic setup in this study did not affect the surgery cost. Also, this technique does not require a larger diameter decompression tract to be successful. With a 9 mm core decompression tract, osseoscopic visualization of the necrotic tissue and debridement can be easily achieved. Furthermore, we think that direct visualization of necrotic bone tissue could reduce radiation exposure as it reduces the use of fluoroscopy.

Although we had auspicious results with the osseoscopy-assisted core decompression technique for the AVN of the femoral head, this study has some limitations. Firstly, this is a retrospective study with no control group of subjects with the standard technique of core decompression. Also, the number of patients was limited. Further studies with higher patient sizes and control groups may be more definitive in determining the advantages of this technique. Another limitation of this technique is the absence of simultaneous visualization and debridement of the involved area. Because we use a 9 mm decompression tract, the standard arthroscopic setup does not allow equipment other than an endovision cannula. With the advances in surgical equipment, it may be a good option to perform visualization and debridement simultaneously.

5. Conclusions

Osseoscopy-assisted core decompression and debridement for the AVN of the femoral head is applicable and helpful in utilizing accurate debridement and retainment of healthy bone tissue as much as possible. After the osseoscopy-assisted core decompression and debridement, in 75% of patients, the progression level of osteonecrosis was delayed at a mean of more than 1-year follow-up. In addition, the hip pain, which is the main symptom of the patients, was significantly reduced in a 1-year follow-up using osseoscopy-assisted core decompression. With the advances in surgical equipment, there may be a good option for patients with early osteonecrosis to perform visualization and debridement simultaneously.

Author contributions

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Writing – original draft: Müren Mutlu, Hakan Zora, Gökhan Bayrak, Ömer Faruk Bilgen.
Writing – review & editing: Müren Mutlu, Hakan Zora, Gökhan Bayrak, Ömer Faruk Bilgen.

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