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Treatment of femoral head osteonecrosis with core decompression and subsequent hyperbaric oxygen therapy

Femur başı osteonekrozunun kor dekompresyon ve takibinde hiberbarik oksijen uygulaması ile tedavisi

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Abstract

Aim. Regardless the etiologic factor, femoral head avascular necrosis is a process that occurs with femoral head local blood supply deficiency. The purpose of our study was to evaluate the clinical and radiologic outcomes in patients diagnozed with grade 1 and 2 avascular necrosis of the femoral head who were treated with a combination of core decompression and hyperbaric oxygen therapy. **Method.** In our study we have evaluated 21 hips of 16 patients retrospectively, which we have treated with a combination of core decompression and hyperbaric oxygen therapy. We performed clinical and radiological evaluation to the patients. **Result.** VAS and Harris hip scores showed improvement in all of our patients except in short term results. **Conclusion.** Core decompression and subsequent hyperbaric oxygen therapy are accomplishing each other because of their synergistic effects.

Keywords: Femoral head, osteonecrosis, hyperbaric oxygen therapy

Özet

Amaç. Femur başı vasküler nekrozu etyolojik sebep ne olursa olsun femur başı lokal kan akımının azalması ile başlayan bir süreçtir. Çalışmamızın amacı kor dekompresyon sonrası hiperbarik oksijen terapisi ile tedavi edilen evre 1 ve 2 femur başı avasküler nekrozu olgularının klinik ve radyolojik sonuçlarını değerlendirmekti. **Yöntem.** Çalışmamızda kor dekompresyon sonrası hiperbarik oksijen tedavisi uyguladığımız 16 hastanın 21 kalçasını klinik ve radyolojik olarak retrospektif değerlendirdik. **Bulgu.** Kısa dönem sonuçlarımızda 1 hasta hariç tüm hastaların VAS ve Harris kalça skorlarında düzelme tespit ettik. **Sonuç.** Gerek kor dekompresyon gerekse hiperbarik oksijen tedavisi etki mekanizmaları ve sonuçlarına baktığımızda sinerjistik etki göstererek birbirini tamamlayan tedavi yöntemleridir.

Anahtar sözcükler: Femur başı, osteonekroz, hiperbarik, oksijen

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Introduction

Femoral head avascular necrosis (osteonecrosis) is a pathology that is due to the deficiency of the femoral head blood supply which is also called as ischemic necrosis and

aseptic necrosis [1]. In the course of time femoral head avascular necrosis can bring about destruction in the femoral head which can lead to total hip replacement. The incedence of total hip replacement is 10-20% in patients diagnozed with femoral head avascular necrosis. Generally young and middle aged people are affected in an age interval of 25 and 55 [2]. The etiology is multifactorial. It can be idiopathic or can be caused by steroids, excessive usage of alcohol, trauma and vascular injury. The location and size of the lesion, the collapse of the femoral head (crescent sign), the congruity of the femoral head and acetabulum, presence of acetabular changes and degenerative changes in the hip joint determines the grade of the disease. The treatment options vary according to the grade of the avascular necrosis of the femoral head [3].

Early diagnosis and preservation of the femoral head shape are the basic principles of treatment [2, 4]. Conservative teratment protocols such as anti-inflammatory drugs, physical therapy and restriction of weight bearing are generally unsuccessful [2, 3]. Symptomatic hips can be treated surgically but the type of surgery varies according to the grade of the disease. In the early grades of avascular necrosis of the femoral head procedures that preserve the femoral head such as core decompression with non vascularized or vascularized bone grafts, pedicled muscle grafts and derotation osteotomies are preferred [5-10]. In the literature there is strong evidence that, in the early grades of the disease conservative methods like biphosphonates, extracorporeal shock wave therapy (ESWT) and hyperbaric oxygen therapy are considerably effective [11-16]. Although there is not any certain treatment protocol, generally in grade 1-2 avascular necrosis resting and core decompression procedures are carried out. It has been emphasized that when hyperbaric oxygen therapy is administered as an individual treatment in the early stages of avascular necrosis of the femoral head, it has quite satisfactory outcomes [16].

In recent years it has been emphasized that combination of surgical treatment with hyperbaric oxygen therapy provides satisfactory clinical results. Hyperbaric oxygen therapy regulates the tissue oxygene concentration and venous circulation, decreases edema, stimulates angiogenesis, decreases intraosseous pressure and enhances microcirculation at the application field [17]. The purpose of core decompression is to lower intraosseous pressure, decrease edema and stimulate angiogenesis [18, 19]. As a result, core decompression and hyperbaric oxygen therapy have synergistic effects. We have combined core decompression and hyperbaric oxygen therapy which have synergistic effects and applied this protocol to our patients. Clinical and radiologic assessment results were recorded in the follow up controls.

The purpose of our study was to evaluate the clinical and radiologic outcomes in patients diagnozed with grade 1 and 2 avascular necrosis of the femoral head who were treated with a combination of core decompression and hyperbaric oxygen therapy.

Material and methods

Between January 2008 and March 2010, 21 hips with femoral head osteonecrosis of 16 patients who have been treated with core decompression and subsequent hyperbaric oxigen thearpy were retrospectively evaluated. Femoral head avascular necrosis was diagnozed with the help of physical assessment, AP and lateral radiographs of the affected hip and magnetic resonance imaging (MRI) (Figure 1a, b). Sagital and coronal views were evaluated in MRI. The location of the lesion, congruity of the femoral head, cresent sign and degenerative changes in the hip were evaluated with plane radiographs. We also used MRI to assess the changes in the lesion, articular surface of the femoral head and bone marrow edema. We have used the Ficat-Arlet classification system, at the initial assessment 9 hips were rated as grade 1 and 12 hips as grade 2.

Surgical technique

The patients were operated under general or spinal anesthesia and were positioned supine. After preparation of the operation area an anterolateral incision is made to the affected

hip and a modified Watson Jones approach is applied. With the help of MRI and plane radiographs the subchondral necrotic area is localized under fluoroscopy. The hip is internally rotatad 10-15° to neutralize the femoral anteversion. After that, the dynamic hip screw (DHS) k-wire guide is placed to the lateral cortex of the proximal femur and a k-wire which is held parallel to the floor is send into the subchondral necrotic area. The position of the k-wire is controlled under fluoroscopy in both AP and lateral views. Be sure that the k-wire is directly in the necrotic area with an adequate position and then place the canullated DHS drill over the guide k-wire. Drill a tunnel to reach the necrotic area under fluoroscopic control. Remove the necrotic tissue inside the lesion with a curved currete and send the specimen to pathology for confirmation of the diagnosis. The tunnel is filled with spongious allograft and an impactor is used to force the graft to the subchondral area. Ensure that the lesion is fully filled with allograft under fluoroscopic control. Finally, place a hemovac drenage tube and close the wound according to the fashion.

Postoperative management

Abductor strenghtening exercises, active assisted and passive hip range of motion (ROM) exercises are begun in the postoperative first day. The patients were given a pair of crutches and weight bearing was restricted for 6 weeks.

Hyperbaric oxygen therapy

Beginning from the postoperative third week the patients undergone a cure of hyperbaric oxygen therapy. Hyperbaric oxygen therapy was applied under 2, 5 atmospheric pressure. The sessions lasted for 2 hours and a total of 40 sessions were applied to each patient. Each application was made in a pressure chamber with the use of a masked respiratory system providing 100% oxygen to the patient.

Outcome assesment

Evaluations were made by an individual orthopeadic surgeon. Every patient was evaluated preoperatively with VAS and Harris scoring system. Visual Analog Scale (VAS) was used to evaluate pain. The scale ranges from 0 to 10; 0 refers to no pain and 10 refers to severe pain. The patients were asked to grade the pain that they were experiencing. Clinical assessment was made with goniometric measurement of ROM, VAS and Harris hip score. At the last control, the patients were invited and the follow up control data was recorded. At the last control, standart pelvis radiographs, frog leg radiographs of both hips and MRI scans were obtained for radiographic assessment. (Figure 2a, b) The postoperative radiographs and MRI scans were used to evaluate; graft consolidation, congruity of the femoral head, size of the lesion, cresent sign, collaps and collaps progression, bone marrow edema and degenerative changes.

Figure 1a. Preoperative pelvis AP radiograph, subchondral cysts in the left hip, grade 2 avascular necrosis of the femoral head.

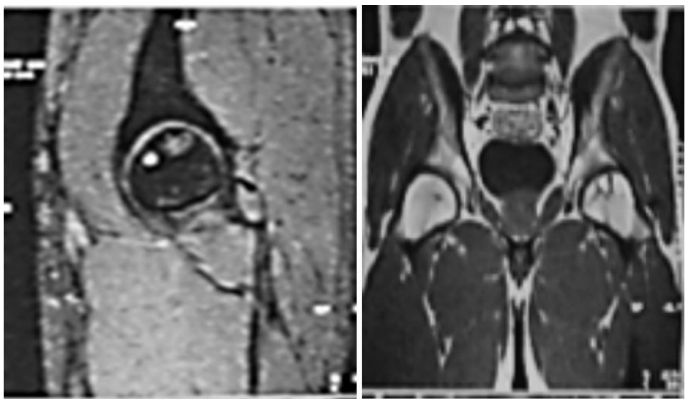

Figure 1b. MRI scans of the same patient (left hip). Subchondral cystic lesions and sclerosis, T1 and T2 weighted scans.

Figure 2a. Cor decompression, grafting and hyperbaric oxygen therapy. Postoperative sixth month AP view of the left hip.

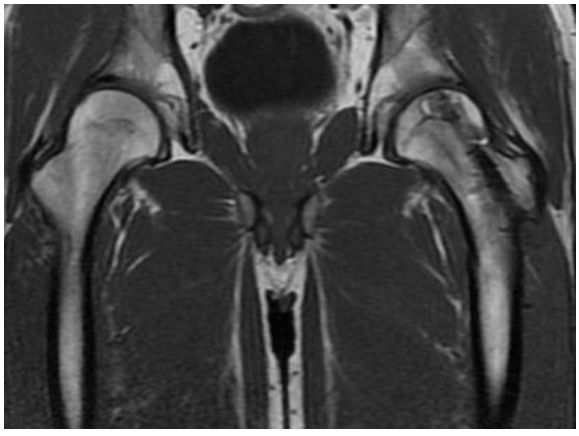

Figure 2b. Postoperative sixth month MRI scan of the left hip. Note that the cyst is fully filled with graft, T1 weighted scan.

Statistical analysis

Statistical analysis was performed using the SPSS version 15. 0 (SPSS, Inc., Chicago, IL). The non-parametric measurements were made using the Wilcoxon and the Mann–Whitney U-test. Statistical significance level was set at $P < 0.05$ for all tests.

Results

Seven male (9 hips) and 9 female (12 hips). The average age at the time of surgery was 35. 8 (23-51) and the average follow up was 24. 2 (22-48) months. All patients had symptoms for a minimum of 5 months before referral. 7 patients (10 hips) had a history steroid usage and 4 patients had a history of excessive alcohol consumption as a predisposing factor. We could not establish any predisposing factors in 5 patients (6 hips) and we considered them as idiopathic.

According to our observations the sympthoms regressed in all of the patients at the last control. Pain, limping and quadriceps atrophy showed a diminution. In 11 patients in whom medullary eduema and subchondral lesions were detected preoperatively in MRI scans. At the last follow-up, medullary eudemas were regressed in T2 weighted scans, but there are findings which were related to the surgerical procedure.

A 32 year old woman had bilateral avascular necrosis due to steroids because of nephritic syndrome. In the postoperative eighth month the reason of her referral was resistant pain and limited motion in both hips. The control plane radiographs and MRI scans showed signs of progression into grade 3 avascular necrosis in both hips. Anti inflammatory medication and rehabilitation was not worthwile and she had undergone bilateral resurfacing arthroplasty.

The VAS score average was 5.7 (3.3-7.5) preoperatively and 8.1 (3.3-9.5) at the last follow-up. The Harris hip score average was 55.2 (32.0-84.0) preoperatively and 75.9 (42.0-92.7) at the last follow-up (Table 1). The patients showed significantly clinical improvement at the last follow-up ($p<0.05$). None of the patients except the one examined above showed signs of progression in their control radiographs. Normal medullary appearance was obvious in MRI scans at the last follow-up.

Table 1. Patient demographics and clinical results.

Factors	Means and Values
Age	35.8 (23-51)
Male/Female	7 (9 hips)/9 (12 hips)
Average length of follow-up (months)	24.2 (22-48)
Average preoperative Harris hip score	55. 2 (32.0-84.0)
Average preoperative VAS score	5.7 (3.3-7.5)
Avarage postoperative Harris Hip Score final follow-up	75.9 (42.0-92.7)
Average postoperative VAS score final follow-up	8.1 (3.3-9.5)
Etiology	
Steroid	7 (10 hips)
İdiopatic	5 (6 hips)
Alchol	4 (6 hips)
Ficat staging (hip count)	
Stage 1	10
Stage 2	12
*VAS: Visual analog scoring	

Discussion

Grade 1 and 2 avascular necrosis of the femoral head is frequently progressive [21). In cases with distinct radiographic changes at the time of diagnosis (grade 2), it has been reported that the risk of femoral head collaps is higher and this may eventually lead to secondary osteoarthritis [22]. The goal in treatment is to prevent femoral head collaps. At

the present day, an absolutely effective treatment method for avascular necrosis of the femoral head is not present. Various treatment modalities including core decompression has been attempted. We have combined core decompression with hyperbaric oxygen therapy in patients with grade 1-2 avascular necrosis of the femoral head and intended to create a synergistic effect. We have evaluated the clinical and radiologic outcomes of combined treatment protocol. The shortcomings of our study is that we do not have a control group and our follow up period is short [23].

Core decompression for the treatment of osteonecrosis of the hip has been a surgical option since the 1960s. Necrotic lesion size <50% had best outcomes with core decompression. Although core decompression may become a standard treatment option to prevent total hip arthroplasty in early stages of osteonecrosis, there are not currently rigorous studies that provide long-term outcome measures [24]. It has been reported that applying core decompression with various grafting techniques gave better clinical and radiographic results than the core decompression procedure alone [25-26]. Core decompresion combined with various methods of nonvascularized bone grafting have been used. Results have varied; however, a 60% to 80% success rate has been achieved at 5- to 10-year follow-up [27].

Hyperbaric oxygen therapy is a method, in which 100% of oxygen at a pressure higher than the atmosphere is intermittently inhaled in a chamber with the use of a mask. Oxygen inhaled at high pressures, increases the amount of dissolution in plasma. When oxygen is inhaled at 2-2.4 atmospheric pressure, the amount of plasma oxygen increases from 0.32% to 4.8-5.76%. Animal models and clinical experiences supports that the marked increase in tissue oxygen concentration is beneficial in chronic osteomyelitis and radiation induced osteonecrosis [23]. As we know, the first evidence in the early stages of avascular necrosis of the femoral head is the disruption of the microcirculation. Osteoclasts have a high level of metabolic activity therefore they require oxygen to eradicate the necrotic bone. Improved oxygen pressures in the hypoxic area enhances collagen synthesis, fibroblast proliferation and angiogenesis [28]. Thus, the oxygen pressure must be at least 40 mmHg. Intraosseous pressure measurements in the affected femoral head denoted that the venous drenage is decreased and venous hypertension is increased. The expeditious effect of hyperbaric oxygen therapy, is to decrease the tissue edema by causing vasoconstriction [17]. Therefore, the intraosseous pressure decreases that restores the venous drenage and accelerates the microcirculation. This effect is similar to core decompression [29].

Levin et al. [15] made an avascular necrosis model on rats and noted that hyperbaric oxygen therapy did not prevent avascular necrosis but had positive effect on healing. Hyperbaric oxygen therapy is usually used as an adjunct treatment. In a study, Reis et al. [16] evaluated MRI scans and observed that when hyperbaric oxygen therapy is used as an individual treatment on grade 1 avascular necrosis, it was considerably effective.

After the core decompression we have implemented hyperbaric oxygen therapy to our patients and evaluated clinically and radiologically the postoperative recovery period. Along with removing the necrotic tissue, core decompression also decreases metaphyseal pressure. Grafting was done to achieve mechanical support which could prevent collaps in the femoral head. Patients have undergone hyperbaric oxygen therapy after core decompression in the aim to decrease the metaphyseal pressure which would enhance microcirculation and ensure angiogenesis. In conclusion, this would eventually accelerate clinic and radiographic healing. Even though in the postoperative period radiologic recovery appears later, with the evaluation of VAS and Harris hip scores we have seen that clinical improvement arises earlier. Short and middle term clinical results support the combination of core decompression and hyperbaric oxygen therapy in grade 1-2 avascular necrosis of the femoral head as a satisfactory treatment protocol.

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