Review Article

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An Overview of Avascular Necrosis of Femoral Head Management

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Abstract

Purpose: The aim of this article is to provide an updated review on most commonly used modalities to treat avscular necrosis of femoral head. A thorough literature search was performed using predetermined criteria.

Recent Findings: Systematic evaluation for decisions about management demonstrated the following:

(1) Though efficacy is vague and controversial non-operative treatments, pharmacological treatments or core decompression can be used in symptomatic medium-sized pre-collapse lesions.

(2) Inspite of known complications to no vascularized bone graft, vascularized bone grafts and osteotomies -medium to larger-sized lesions can be dealt with them.

(3) In post-collapse stages, they should be treated with joint preserving techniques, such as hip surfacing, nonvascularized bone graft, vascularized bone grafts.

(4) If post-collapse and acetabular involvement ensues, arthroplasty is indicated.

(5) Cell-based and biological forms of treatment in form of bone marrow aspirate, stem cells, BMP have shown inconclusive results, and further research is needed to assess their role in the management of this condition.

Methods: Recent articles were searched on search engines like PubMed, Google Scholar and references of different articles were checked.

Summary: There is a need to overview the management options for avascular necrosis of femoral head. This review discusses different management modalities available along with their advantages and disadvantages.

Keywords: AVN femoral head, Non-operative treatment, Biophysical management, Operative treatment

Introduction

Marcus Aurelius Antonius [1] said "Death, like birth, is a secret of nature".In the same way avascular necrosis of femoral head is still a challenging scenario to the biologist, the physicians and surgeons. Though its pathogenesis is partially been explained but its natural history and definitive management is confusing and mysterious.

Avascular necrosis of femoral head can cause severe pain and deformity and can result in marked disability. In the last decades, a variety of management techniques have been described, with pain relief, mobility, and strength as the main goals of treatment. Such procedures include non-operative treatments like pharmacological treatments which includes bisphosphonates, statins, ilioprost, enoxaparin. Non pharmacological treatments include hyperbaric oxygen, extra corporeal shock wave therapy. Operative treatment includes joint preserving techniques such as core decompression, hip non vascularized bone graft, vascularized bone grafts , hemiresurfacing and total hip replacement.

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The aim of this article is to provide an updated, systematic review of management and outcomes of the most commonly used procedures to treat avascular necrosis of femoral head.

In this article, we will evaluate whether there is evidence for current modalities.

Furthermore, we will provide suggestions for future studies that could help us understand differences in outcome for the different procedures and whether there might be new treatment recommendations.

Methods

The terms used in different combinations were "AVN, ON, nonoperative treatment, bisphosphonate, extracorporeal shock wave therapy (ESWT), hyperbaric oxygen, core decompression (CD), stem cell, vascular and non vascular bone-graft, osteotomy, total hip replacement."

Combined searches of the first 3 terms with each of procedures were conducted to identify relevant studies. Additional articles were identified by checking the references. Studies were initially screened for relevance based on title and abstracts. When an article was considered potentially relevant, studies were included if the following criteria were fulfilled:

- The study was a primary study and written in English.
- Pain, physical function, patient global assessment, range of motion,

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or strength was measured as an outcome.

• Only studies with a design classification of levels I to V were included, as classified by Jovell and Navarro-Rubio.

The included studies were scored for design classification, subjective and objective outcomes, and authors findings.

Results

(A) Nonoperative treatment

It includes restricted weight-bearing, with various modalities such as a cane, crutch, walker, or two crutches in view that it will slow the progression of the disease so that ultimately, femoral head-preserving procedures can be performed. It also includes pharmacological agents and biophysical modalities of treatment. The aim of treatment in the pre collapsed stage is to improve clinical and functional outcome of patients.

Non-weight Bearing

In 1996 Mont et al [2] reviewed 21 studies with 819 patients based on restricted weight-bearing and saw satisfactory clinical result in form of no further surgery in 22% patients after 34 months. Radiological advancement was seen in 74% patients. However, this review identified that limiting the patient to a wheelchair or walking frame to reduce weight bearing does not achieve satisfactory clinical benefits.

In modern era of civilization, it is unacceptable as a standard isolated modality of treatment, but can be used as an additive treatment to medical or surgical management.

Bisphosphonates

Agarwala et al in 2011 [3] a recent publication of 53 hips (in 40 patients) at 10 year followup reported a 29% collapse rate in the precollapse-stage of ON (10 of 34 hips) following 3 years of continuous alendronate use at 70 mg weekly. They concluded that the natural history of untreated ON with more than 70% collapse rate was favorably altered with alendronate use.

Outeirino-Fernandez et al [4] reviewed studies on osteonecrosis of the jaw and concluded that alendronate was the bisphosphonate used in the majority of cases, with a mean duration of treatment prior to jaw osteonecrosis of 48.3 months.

In summary, bisphosphonates have revolutionized the treatment of ONFH; however, they carry an increased risk of bisphosphonate-related osteonecrosis of the jaw. Thus, monitoring should be increased in order to prevent the disadvantages associated with these drugs.

Most of the studies on the efficacy of this drug in ONFH are underpowered and without the control group. With the current evidence, alendronate in ONFH patients can be used in a dose of 70 mg weekly for 3 years in Stage-I, II (Ficat Arlet classification).

Anticoagulants, Statins and Other Vasodilators

Glueck et al. [5] recorded outcome of enoxaparin therapy in Ficat Stage-I or II ON hip after 2 years (mean 3 years, range, 2-4 years) of follow up. But they included patients of AVN hip with either hypofibrinolytic or thrombophilic or combined disorders. They observed 95% of hips (19 of 20 hips) with primary ON and 20% (3 of 15 hips) of patients with secondary ON (secondary to corticosteroid use) with no progression of the disease after enoxaparin treatment (60 mg/day for 3 months).

Lipid Lowering Agents

Pritchett et al. [6] reported that after mean follow up of 7.5 years, only 1% of patients taking high-doses of corticosteroids and statin drugs developed ONFH whereas the prevalence was 3-20% in patients receiving high-dose corticosteroids without statins.

Ajmal et al. [7] did not find any significant reduction in ON between patients taking steroid and statin versus steroid without statin (4.4% vs. 7%). Further, large randomized studies are needed to establish its efficacy in ONFH.

Iloprost et al. [8] (a prostacyclin derivative) a vasodilator has also shown benefit after 1-year treatment in patients of osteonecrosis and bone marrow edema.

In 2010 Zaidi M et al. [9], studied adrenocorticotropic hormone for protection against AVNFH induced by steroid. It enhances osteoblastic activity and stimulation of vascular endothelial growth factor that enhance neovascularization in the femoral head.

These modalities are still under trial and need larger and longer follow up studies to consider for main stream modality of management.

Extracorporeal Shock Wave Therapy

Wang et al. [10] reported the long term outcome (mean, 8.5 years; range, 7.7-8.8 years) of the ESWT group (23 patients with 29 hips) to core decompression with nonvascularized fibular grafting (25 patients with 29 hips) group of patients. They reported that patients with ESWT had significantly better clinical outcomes (pain score and HHS, 76% vs. 21% good or fair; $P < 0.001$) and decreased need for THA (24% vs. 64%; P 5.002) compared with the surgery group.

Short follow up and small studies on ESWT are the major limitations for its restricted use.

Pulsed Electromagnetic Therapy [11]

Pulsed electromagnetic therapy is thought to favorably affect early-stage ON through stimulation of osteogenesis and angiogenesis similar to ESWT.

Hyperbaric Oxygen

Camporesi et al. [12] demonstrated that HBO therapy may be a viable treatment modality for Ficat stage II ONFH. In the study, symptoms were relieved following a multi-year follow-up, without hip arthroplasty being required.None of the hyperbaric oxygen group patients needed THA till the time of final follow up -7 years.

Because of limited data, the use of hyperbaric oxygen in ONFH is controversial.

(B) Operative Treatment

Surgical treatment for precollapsed stage ONFH involves hip preserving procedures (Core decompression, nonvascularized bone-graft, vascularized bone-graft) whereas prosthetic hip surgery is reserved for advanced-stage of collapse and arthritic hip.

Core Decompression

Marker et al. [13] collected data from 1,268 hips following core decompression and revealed a clinical success rate of 70% after 63

months, without the need for additional surgery. Core decompression thus is an effective procedure for early AVN mainly in Ficat stage I and II.

Recent technique of Core decompression with multiple drilling of the necrotic lesion of femur head which is an easy, simple and safe procedure with good results.

Mesenchymal stem cells implantation or vascular endothelial growth factor (VEGF) treatment strategies

Hernigou et al. [14] they injected the mononuclear cells fractions of the bone marrow aspirate from the iliac crest and injected into the necrotic area. Nine out of 145 patients with early-stage ONFH (Steinberg stage I or II) and 25 out of 45 patients with advanced ONFH (Steinberg stage III or IV) required THR.

Hang et al [15] evaluated the efficacy of VEGF165 transgenic bone marrow mesenchymal stem cells on the repair of early-stage ONFH in mature mongrel dogs and demonstrated that the treatment enhanced bone reconstruction and blood vessel regeneration.

Mesenchymal stem cells (MSCs) application represents a highly promising option for treatment of AVN in the precollpased stage. But because of limited human research data, the use of these modalities is still controversial.

Porous Tantalum Implant

Varitimidis et al. [16] studied 27 patients who underwent tantalum rod implantation for nontraumatic ONFH. The implant was a porous tantalum rod (10 mm). In total, 13 of the 26 hips remained at the same radiographic stage, while 13 revealed deterioration. The authors concluded that porous tantalum rods were simple to use via a minimally invasive and reproducible method, and may provide functional recovery for patients at pre- and post-collapse stages of hip osteonecrosis.

Thus it resolves pain as well as helps in preventing and curing the collapse of the femoral head due to necrosis at Steinberg classification stages I and II and at stage IIIA with minimal collapse.

Muscle pedicle bone graft, Vascularized fibular graft, Vascularized Iliac crest graft [17]

The results of these procedures are less rewarding and unpredictable. Researchers have shown variable results to these procedures. The major demerits of these techniques is its surgical complexity, longer learning curve, technique dependancy and difficulty in conversion to arthroplasty due to altered anatomy.

Proximal Femoral Osteotomy

Zhao et al. [18] in their study of 73 hips at a mean followup of 12.4 years (range, 5-31 years), reported that 91.8% (67 of 73 hips) of the hips remained intact and did not need conversion to a THA following curved trans-trochanteric varus osteotomy. There was a significant improvement in HHS after surgery, and the mean postoperative intact ratio was 57.2% (range, 27-100%).

The various osteotomy techniques are complex in nature. The technique aren't compared to any other method of treatment and hence it is difficult to establish the superiority of this technique to other methods described. Osteotomies are best suited to patients not being treated with long term steroids, with stage 1, 2 and early 3 of ficat arlet with no loss of joint space or acetabular involvement

Regenerative Medicine

Rittmeister et al. [19] al have used cartilage regenerative technique such as osetochondral graft implantation, mosaicplasty, autologus chondroctes transplantation and acellular matrix application for treatment of ONFH in its advanced-stage (Ficat III and IV).

Gagala et al. [20] recently reported the outcome of autologous osteochondral transfer in ONFH of 20 patients with 21 hips. Seven patients with ARCO IIA and IIB were treated with Osteo Articular Transfer System alone, 13 patients with ARCO IIC, III and IV were treated with OATS and morselized bone allograft. Hip survival in OATS group was 85.71% after 4 years (one conversion to THR) and 61.54% in OATS/allograft group after 3 years (five conversions to THR).

Cartilage regenerative techniques include a surgical dislocation of the hip anteriorly to access the osteochondral defect, thus, it is more invasive and surgically demanding. Very few cases have been reported with the above methods, and it has shown variable results; thus, it is very difficult to comment on the efficacy of these techniques.

Bipolar Arthroplasty

Issa et al. [21], chan et al. [22] concluded that bipolar arthroplasty is no more an acceptable treatment option for AVN hip. Young patients, high incidence of protrusion acetabuli, increased rate of loosening, high revision rates and better THR bearings are major reasons for its unacceptability. Revision rate ranging from 13.9% to 27.6% have been reported with bipolar hemiarthroplasty in ONFH after average followup of more than 5 years.

Total Hip Replacement

Johannson et al. [23] In a systematic review of 67 studies (3277 THR in 2593 patients) reported mean survivorship of 97% at 6 years followup in patients operated after 1990. They observed higher revision rate in sickle cells disease, Gaucher disease and end-stage kidney disease or transplant patients. The revision rate was lower in patients with SLE, idiopathic or after heart transplant.

Chang et al. [24] studied 74 hips in 52 patients who underwent THR for ONFH after kidney transplantation with cementless THRs. They reported 96.6% implant survivorship at a mean follow up of 10.2 years, which is equal to survivorship due to other causes of THR.It shows, the outcomes of THR even in these high-risk patients are improving, potentially due to improved medical and surgical management, as well as the use of modern prosthetic designs, including cementless acetabular and femoral fixation.

Conclusion

Overall, we conclude that at this time total hip replacement is superior to any another in terms of pain,physical function, patient global assessment, range of motion, or strength.

For post collapse,advanced stages of avascular necrosis of femoral head.

Even though the efficacy of bisphosphonates is proven in precollapse stage of avascular necrosis of femoral head, the doses required and duration of therapy is yet be established. Other pharmacological like statins, prostacyclins, enoxaparins and biophysical treatments like ECSW, HBO are still under trial and need larger and longer study for regular use .

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