Exploring the Etiological Evidences at Avascular Necrosis of Femoral Head by Investigative Approaches of Histopathology, Clinical Assessment and Radiology

Kiran Saoji[1], Sandeep Shrivastava[2], Arvind Bhake[3], Aditya Kekatpure[4], Sunil Nikose[5], Aashay Kekatpure[6]

[1]Professor and Head, [2]Director and Professor, Department of Orthopedics, [3]Professor Department of Pathology, [4]Assistant Professor,Department of Orthopedics, [5]Professor, Department of Orthopedics, Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences, Sawangi Wardha, [6]Associate Professor Department of Orthopedics NKP Salve Institute of Medical Science, Nagpur

Abstract

Background- The avascular necrosis of the femoral head includes interference of the blood flow to the femoral head. This ischemia leads to death of the bone cells and bone marrow followed by the collapse of the bone femoral head, which finally leads to the destruction of the bone tissue and arthritis,

Objectives:

1. Histopathological analysis of the tissue obtained after core biopsy or sections of head after head excision while doing Arthroplasty.
2. Correlation between histopathological evidence with clinical and radiological findings.

Methodology: The tissue will be sampled from site of AVN during surgical procedure that is Core decompression or hip arthroplasty. Tissue material obtained will be transfered to regular histological fixative of 10 % formalin. It will be fixed for a day, later to be reprocessed for decalcification. Formalin fixed tissue will be subjected for treatment of running water to remove excess of formalin. Later the tissue will be examined for its gross appearance of any changes of autolysis The process of decalcification adopted for present work is chemical one. The decalcification tissue will be subjected for histokinette cycle. The tissue is now ready for paraffin block. These paraffin blocks will be subjected to microtomy for obtaining 5 micro milimeter sections. These paraffin sections will be stained for H/E and Van. Giesson stain. Histopathological assessment of the tissue will be carried out for the evidence and grading of avascular necrosis.

Expected Results: Correlation between histopathological evidence with clinical and radiological findings.

Conclusion: This study will be helpful in developing Histopathological staging in correlation with clinical, radiological findings.

Keywords: *Avascular necrosis, Head of femur, Histopathology.*

Corresponding Author:
Dr. Aditya Kekatpure
Assistant Professor, Department of Orthopedics,
Jawaharlal Nehru Medical College, Datta Meghe
Institute of Medical Sciences, Sawangi Wardha
Mob No.: 8080426213
e-mail: adityalkekatpure@gmail.com

Introduction

The avascular necrosis of the femoral head includes loss of blood supply to the femoral head. This leads to death of the bone cells and bone marrow followed by the collapse of the femoral head. Which finally leads to the destruction of the bone tissue, arthritis and loss of function[1]. Avascular necrosis of the femoral head is a disease, which affects young adults, in their 3rd, 4th and

5th decade. This disease affects men more frequently as compared to women. ONFH in North Indian patients[2] is a disease of young individuals, male more than females. This disease affects specially young adults, who are socially and professionally active[3]. These patients are initially without symptoms but eventually need hip arthroplasty surgery until their 5th decade [4].

Nowadays, there are more than 16 different classification systems used to classify and describe avascular necrosis of the femoral head[5]. Classification system introduced by Ficat and Arlet is the most commonly used. The Ficat and Arlet classification system consists of five stages (0 to IV): The first three describe the events that occur before the collapse of the femoral head and the last two stages describe the post-collapse changes.

Stage – 0: Only suggestive on symptoms

Stage – 1: Radiograph is normal except minimal osteoporosis, blurring of bony trabecule

Stage – 2: Femoral head contour is maintained but there is sign of bone remodelling such as cystic subchondral lucency beneath articular surface (crescent sign)

Stage – 3: There is subchondral sequential collapse or flattening of femoral head (crescent sign and eventual cortical collapse).

Stage – 4: Joint space is narrowed and secondary degenerative changes seen in acetabulam along with marginal osteophytes formation.

Other classification is international ARCO staging system[6].

Even after collapse occurs, subsequent cessation of collapse can be expected in certain percentage of hips [7].Collapse of femoral head does not necessarily indicate a poor prognosis In such patients use of bisphosphonates[8][9][10] in the treatment of AVN is encouraging. This is relatively new option.[11][12].

Similarly use of Enoxaparincan prevent progression of stage I and II osteonecrosis of the hip [11].

Avascular necrosis of the femoral head is either primary (idiopathic) or secondary may be due to post trauma, alcohol consumption, smoking, steroid induced and following sickle cells disease.

Background/rationale

There is a paucity of histopathological evidence with specific etiopathogenesis in AVN of femoral head. The proposed study is first of its kinds to explore potential of histopathological analysis and attempting to establish it's clinical and radiological correlation.

Objectives:

1. To analyse clinical, radiological and histopathological correlation in avascular necrosis of femoral head"
2. Histopathological analysis of the tissue obtained after core biopsy from different sectors of femoral head while doing core decompression or sections of head after head excision while doing Arthroplasty.
3. Radiological analysis of X-ray and MRI findings
4. Correlation between histopathological evidence with clinical and radiological findings.
5. Secondary objective of the correlation between haematological investigations and histopathological evidence.

Materials and Method

Study plan:

Study design: This will be a Prospective Observational Studyat DMIMS (DU) Jawaharlal Nehru Medical College,Department of Orthopedics, Sawangi Meghe Wardha, during the period from July 2020 to JULY 2022.We will include all patients suffering from non traumatic Avascular necrosis of femoral head. Age group will be from 20 to 60 yrs.

Data Collection: The tissue will be sampled from site of AVN during surgical procedure that is Core decompression or hip arthroplasty. Tissue material obtained will be transferred to regular histological fixative of 10 % formalin. It will be fixed for a day, later to be reprocessed for decalcification. Formalin fixed tissue will be subjected for treatment of running water to remove excess of formalin. Later the tissue will be examined for its gross appearance of any changes of autolysis The process of decalcification adopted for present work is chemical one. The decalcification tissue will be subjected for histokinette cycle. The tissue is now ready for paraffin block. These paraffin blocks will be subjected to microtomy for obtaining 5 micro millimetres sections. These paraffin sections will be stained for H/E

and Van. Giesson stain. Histopathological assessment of the tissue will be carried out for the evidence and grading of avascular necrosis.

Participants: Patients suffering from non traumatic Avascular necrosis of femoral head. Age group will be from 20 to 60 yrs,of both sex

Inclusion Criteria:

1. Patients suffering from non traumatic Avascular necrosis of femoral head attending orthopaedic OPD.
2. Those who are ready to undergo this study with written consent

Exclusion Criteria:

1. **Patients with metabolic disorders:** Variables: Participants who are included in the study having avascular necrosis of femoral head will have a differentetiology like Sickle cell disease,Alcohol induced,Steroid Induced and Idiopathic.

Data sources/measurement: The Histopathological data obtained from this study will be critically analysed according to etiological factors and compared accordingly for each variable of interest.

Data will be collected from the pathologist and tabulated according to findings across various etiological factors. Source of data and details of method of assessment (measurement) will be described Comparability of assessment method will be judged in different groups.

Bias: Measures will be taken to control the selection bias.

Statistics: Raw data processing will be done by using convenient sampling. we will include 10 patients in each group during the study period.

Discussion

Avascular Necrosis of the femoral headis a disease characterized by loss of blood supply to the affected part of the head of the femur which ultimately leads to it's death. Hence it is also called as coronary disease of the hip. Head of femur receives blood supply from 3 main sources-reticular branches from the lateral circumflex femoral artery (supplying majority of the head) which anatomises which branches from medial circumflex femoral artery (supplying area around greater a trochanter) and third source is obturator artery which gives rise to artery of ligamentumteres (supplying small portion of the head.[1] The condition usually involves patients in their early adult hood and middle ages i.e. 30 to 40 years.[2]Every year 10to 20 thousand cases of avascular necrosis of femoral head[3] are diagnosed in the united states, out of which approximately 10%undergo replacement surgeries.[4] The condition is usually unilateral but it gradually progresses to become bilateral. Studies have shown that the etiopathogenesis of avascular necrosis of femoral head is varied and very confusing. Usually the term avascular necrosis refers to the non traumatic, non infective or idiopathic . Broadly the term can be divided into two main groups that is one group with directly identifiable causative factors and other group without any directly identifiable causative [3]factors. Excessive steroid usage for longer duration and chronic alcoholism accounts for approximately more than 80% cases of avascular necrosis of femoral head .exact pathogenesis of this varied aetiologies is not yet established. Various studies are being under taken to establish the exact stapes in the pathogenesis.

Generally following Factors are thought to be associated with the pathogenesis of avascular necrosis of femoral head. End effect all the aetiologies lead to hindrance of blood supply to the femoral head, which in term may be due to occlusion of vessels supplying to the femoral head, stenosis of the blood vessels supplying the femoral head, atherosclerosis involving the arteries supplying femoral head, hyercoagulation, increases intra-osseouspressure, mechanical forces disturbing vascular supply to femoral head (hip dislocations and displaced fracture neck of femur) or various metabolic diseases which hampers blood supply to femoral head.

Due to variability of etiopathogenesis, the clinical, histopathological and radiological pictures also vary. Various staging system[5] have been developed to categorize various patients in groups and then to develops suitable management protocols for the groups. But there has not been single ideal staging system for avascular necrosis of femoral head till date. The diagnosis of avascular necrosis of femoral head is routinely done with the help of detailed history, clinical examination, assessment of the gait, bony palpation of hip and surrounding structures, presence or absence of deformities, limb length discrepancy. Clinical findings start to appear in the patients in late stages of avascular necrosis that is after the collapse[6] of femoral head. After the collapse of the femoral head, the modalities meant

for salvage of femoral head do not work and patient will required total hip arthroplasty.

Radiological staging is based on various radiological modalities like plain radiographs (plain anterioposterior radiograph of pelvis with both hip joints and frog leg or lateral view), CT scan and MRI scans. There are more than 16 various classification[5] and staging system base on radiological modalities out of which two most commonly used are Ficate and Arlet classification and University of Pennsylvania classification. Most of these imaging modalities based staging systems take into account exact site of the lesion, exact size and the extent of the lesion and presence of subchondral fracture or collapse. The exact site of the lesion is best visualised using plain radiograph (cost effective, simple and easily available but not useful in early stages) exact size and extent of the lesion is best visualized with help of MRI scan (high sensitivity and specificity, modality of choice for screening) and subchondral fractures are best studied with the help of CT scan (most sensitive for subchondral fractures). There are various staging systems which consider all these radiological modalities.

There is no staging system which takes into account all the three aspect that is clinical, histopathological and radiological pictures of the patients. Although various studies have shown that histological staging done by taking biopsy from the affected lesion helps in differentiating early stage disease from late and it thus helpful in delaying the replacement surgeries. Histological changes start to developed after few weeks of the starting of the disease. Usually biopsy is done once the disease has been diagnosed. By that time irreversible changes might have occurred in the femoral head. So early biopsy should be promoted. In our study we have tried to correlate histological staging of the patient with clinical and radiological findings. This will help in developing a new staging system which incorporates all the three modalitiesthat is histopathology, clinical and radiology. Thus it will help in developing ideal staging system for the patients suffering from avascular necrosis of the femoral head. It will in terms help in better understanding of the disease, proper categorisation of the patients in various groups and then in determining the ideal treatment modality for those groups.

Various treatment modalities available for treatment of avascular necrosis of femoral head ranges from non surgical modalities like observation and non weight bearing mobilization, various pharmacological agents like bisphosphonates[7][8][9][10] Enoxaparin are shown to be useful in some studies, hyper baric oxygen therapy (all these non surgical modalities are useful in early stages of avascular necrosis of femoral head). Surgical modalities like core decompression with or without additional procedures that is bone grafting, biologicadjutants–Platelet Rich Plasma, stem cells etc. In advance stage of AVN rotational osteotomies or replacement surgeries are indicated. For such a complex disease with varied aetiopathological factors and varied treatment modalities a proper staging system is must. Our study will help in proper staging and thus selecting the appropriate treatment modality for a particular patient especially in cases of early stage of the disease. This will also help in prediction of Prognosis.

Conclusion

This study will be helpful in developing Histopathological staging in correlation with clinical, radiological findings.

Ethical Clearance: Taken from institutional ethics committee.

Source of Funding: Self.

Conflict of Interest: Nil.

References

1. Vardhan H et al. Epidemiological Profile of Femoral Head Osteonecrosis in the North Indian Population. Indian J Orthop. 2018 Mar-Apr:52(2): 140-146.
2. Baig S et al, Osteonecrosis of the Femoral Head: Etiology, Investigations, and Management. Cureus. 2018; 21; 10(8):e3171.
3. Kim Y et al. Contemporary total hip Arthroplasty with and without cement in patients with osteonecrosis of the femoral head:a concise follow-up, at an average of seventeen years, of a previous report. J Bone Joint Surg Am. 2011 05;93(19):1806-10.
4. Choi H, Steinberg M, Cheng E. Osteonecrosis of the femoral head: diagnosis and classification systems. Curr Rev Musculosketel Med. 2015;8(3):210-20.
5. Niimi R, Sudo A, Hasegawa M, Uchida A. Course of avascular necrosis of femoral head without collapse of femoral head at first examination: minimum 8-year follow-up. Orthopedics, 2008; 21(8):755.

6. Agarwala S et al. Ten year followup of Avascular Necrosis of femoral head treated with Alendronate for 3 years Journal of Arthroplasty. 2011; 26(7).
7. Eli P et al. Aldronate preserves femoral head shape and height/length ratio in experimental vat model. Indian Journal of Orthopaedics
8. Agarwala S et al. The use of alendronate in the treatment of avascular necrosis of the femoral head: follow-up to eight years. J Bone Joint Surg Br. 2009;91(8):1013-8.
9. Lai K et al. The use of alendronate to prevent early collapse of the femoral head in patients with nontraumatic osteonecrosis. A randomized clinical study. J Bone Joint Surg Am. 2005;87(10):2155-9.
10. Glueek C et al. Enoxaparin prevents progression of stages I and II osteonecrosis of the hip. Clin. Orthop. Relat. Res. 2005;435:164-70.