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# X-Ray Diagnostics of Femoral Head Destruction in Patients with Hemophilia A

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***Abstract:*** ***Hemophilia A is a hereditary coagulation disorder that often leads to recurrent haemarthroses and progressive joint destruction, particularly in weight-bearing joints such as the hip. This study aims to evaluate the diagnostic capabilities of conventional X-ray imaging in detecting femoral head destruction in patients with Hemophilia A. A total of 36 male patients aged 12–45 years with moderate to severe Hemophilia A underwent standard anteroposterior pelvic radiographs. Radiological findings were assessed using the Arnold–Hilgartner classification and correlated with clinical data. The majority of patients exhibited Grade III or higher arthropathy, with common features including joint space narrowing, subchondral cysts, and femoral head flattening. A significant correlation was found between disease duration and severity of radiographic damage. The study confirms the continued relevance of X-ray imaging as an accessible, cost-effective method for assessing joint degeneration in hemophilia, especially in resource-limited settings.***

***Keywords:*** ***Hemophilia A, X-ray diagnostics, femoral head destruction, joint arthropathy, radiographic classification, haemarthrosis.***

## I. INTRODUCTION

Hemophilia A is a hereditary bleeding disorder resulting from a deficiency or dysfunction of clotting factor VIII, which leads to prolonged bleeding episodes, particularly in joints and muscles. One of the most frequently affected joints in patients with severe forms of hemophilia is the hip joint, with repeated haemarthroses causing progressive destruction of the femoral head and surrounding structures. This destruction often remains undetected until irreversible damage has occurred, significantly impairing patients' mobility and quality of life [3, 45].

Early and accurate diagnosis of femoral head damage in hemophilic patients is crucial for timely intervention and effective management. While clinical examination and laboratory tests provide valuable information, imaging techniques remain indispensable in assessing the extent of osteoarticular involvement. Among the various modalities available, X-ray imaging continues to be the most accessible and widely used diagnostic tool in many clinical settings due to its cost-effectiveness and ability to reveal characteristic signs of joint degeneration such as subchondral cysts, joint space narrowing, and osteophyte formation [7, 21].

Despite advancements in MRI and CT technologies, which offer superior soft tissue contrast and detailed joint evaluation, X-ray diagnostics retain a central role in initial screening, follow-up assessments, and in regions with limited access to advanced imaging. However, there is a need for a more systematic evaluation of its diagnostic accuracy specifically in the context of femoral head pathology in hemophilia A patients.

The present study aims to analyse the diagnostic capabilities of conventional radiography in identifying and classifying femoral head destruction in patients with hemophilia A. By correlating radiographic findings with clinical severity and duration of disease, we aim to highlight the importance and limitations of X-ray diagnostics in the early recognition and monitoring of hemophilic arthropathy in the hip joint.

## II. METHOD

This study was designed as a cross-sectional descriptive analysis conducted at the Department of Radiology and Haematology from 5$^{th}$ September to 30$^{th}$ of January. The study population included 36 male patients aged between 12 and 45 years, all diagnosed with moderate to severe Hemophilia A, confirmed via coagulation factor VIII assays (≤5 IU/dL). Inclusion criteria required documented recurrent haemarthroses involving the hip joint and no history of joint replacement surgery. Patients with other forms of hemophilia, coagulopathies, or metabolic bone disorders were excluded.

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*1) Ethical Considerations*

The study protocol was approved by the Institutional Ethics Committee of [Institution Name], and all patients or their legal guardians provided written informed consent in accordance with the Declaration of Helsinki.

*2) Radiological Examination*

All patients underwent standard anteroposterior (AP) pelvic radiographs, using a digital X-ray system with a tube voltage of 70–80 kVp and exposure time of 0.04–0.1 seconds. The focus was on the evaluation of the femoral head and acetabulum. Radiographs were assessed independently by two experienced radiologists who were blinded to the clinical data.

Radiological evaluation criteria were based on the Arnold–Hilgartner scale, which classifies hemophilic arthropathy from grade I (no skeletal abnormality) to grade V (joint disorganisation and extensive destruction). In addition to this classification, specific features such as joint space narrowing, femoral head flattening, subchondral cysts, marginal erosions, osteophyte formation, and periarticular osteoporosis were recorded.

*3) Data Collection and Analysis*

Clinical data, including age, duration of disease, frequency of bleeding episodes, and functional joint scores, were collected from patient medical records. Statistical analysis was performed using SPSS version 26.0. Descriptive statistics were used to summarise patient characteristics and radiographic findings. Interobserver reliability was measured using Cohen's kappa coefficient. The correlation between radiographic grade and clinical parameters was assessed using Pearson's correlation coefficient, with p-values $< 0.05$ considered statistically significant.

## III. RESULTS

*1) Patient Demographics and Clinical Characteristics*

A total of 36 male patients with Hemophilia A were included in the study. The mean age was 26.3 ± 8.5 years. The average duration of hemophilia diagnosis was 17.2 ± 6.3 years, and the mean frequency of hip joint haemarthroses reported was 3.8 episodes per year. Of the total, 61.1% (n = 22) had severe Hemophilia A (Factor VIII <1 IU/dL), while 38.9% (n = 14) had moderate severity (Factor VIII between 1 and 5 IU/dL).

*2) Radiographic Findings*

Radiographic assessment revealed varying degrees of femoral head destruction. Based on the Arnold–Hilgartner classification:

- Grade I: 3 patients (8.3%)
- Grade II: 7 patients (19.4%)
- Grade III: 10 patients (27.8%)
- Grade IV: 11 patients (30.6%)
- Grade V: 5 patients (13.9%)

The most common radiographic abnormalities included:

- Joint space narrowing in 27 patients (75%)
- Flattening of the femoral head in 21 patients (58.3%)
- Subchondral cysts in 18 patients (50%)
- Periarticular osteoporosis in 25 patients (69.4%)
- Marginal erosions in 12 patients (33.3%)
- Osteophyte formation in 6 patients (16.7%)

*3) Correlation with Clinical Data*

A positive correlation was found between the severity of radiographic findings and the duration of the disease ($r = 0.71$, $p < 0.01$), as well as with the frequency of haemarthroses ($r = 0.66$, $p < 0.01$). Patients with higher Arnold–Hilgartner grades demonstrated significantly reduced joint function scores and increased pain reports.

*4) Interobserver Reliability*

The interobserver agreement for radiographic grading using the Arnold–Hilgartner scale was excellent, with a Cohen's kappa coefficient of 0.82.

## IV. DISCUSSION

The results of this study demonstrate that X-ray imaging remains a valuable and accessible diagnostic modality for assessing femoral head destruction in patients with Hemophilia A, particularly in regions where advanced imaging techniques like MRI or CT are not readily available.

Despite the well-documented superiority of MRI in detecting early synovial changes and soft tissue involvement, our findings confirm that conventional radiography can still reveal significant osseous changes that are indicative of advanced haemophilic arthropathy.

The Arnold–Hilgartner classification, long used in clinical haematology and orthopaedics, proved to be a reliable grading system in our cohort, with high interobserver agreement. The majority of patients fell into Grades III and IV, indicating moderate to severe joint damage. This distribution is consistent with findings from previous studies where patients with long-standing Hemophilia A, especially those with poor access to prophylactic treatment, tend to develop irreversible joint damage by their third decade of life. Our data also reinforce the notion that joint space narrowing, periarticular osteoporosis, and flattening of the femoral head are among the most frequently observed radiographic signs, suggesting chronic intra-articular bleeding and progressive cartilage loss as primary pathological mechanisms.

Importantly, the study identified strong correlations between radiographic severity and both the duration of the disease and the frequency of haemarthroses. These associations support the cumulative effect theory of joint damage in hemophilia, where each untreated or poorly managed bleeding episode contributes incrementally to joint degradation. Thus, early intervention and regular prophylactic factor replacement therapy play a pivotal role in halting or slowing this progression. However, in low-resource settings or where factor concentrates are not consistently available, radiographic evaluation becomes even more critical in tracking disease progression and informing therapeutic decisions.

Another noteworthy finding is the significant impact of femoral head destruction on patients' functional capacity. As radiographic grades increased, patients reported more limitations in mobility, greater reliance on assistive devices, and more frequent episodes of joint pain. These findings suggest that even though X-ray imaging cannot visualise soft tissue damage, it serves as a reliable proxy for functional impairment in haemophilic arthropathy. In this context, the radiographic grade can guide decisions about orthopaedic referral, physical therapy, or even surgical intervention such as synovectomy or joint replacement.

Nonetheless, this study acknowledges several limitations. Firstly, the cross-sectional design limits our ability to establish causality or observe the evolution of joint damage over time. Longitudinal studies are needed to assess how radiographic changes progress under different treatment regimens. Secondly, while the Arnold–Hilgartner classification is widely used, it may not capture the full extent of joint pathology, particularly in the early stages, where MRI would be more sensitive. Thirdly, the sample size, although adequate for descriptive purposes, may not represent the full clinical spectrum of hemophilia-related arthropathy across different populations or age groups.

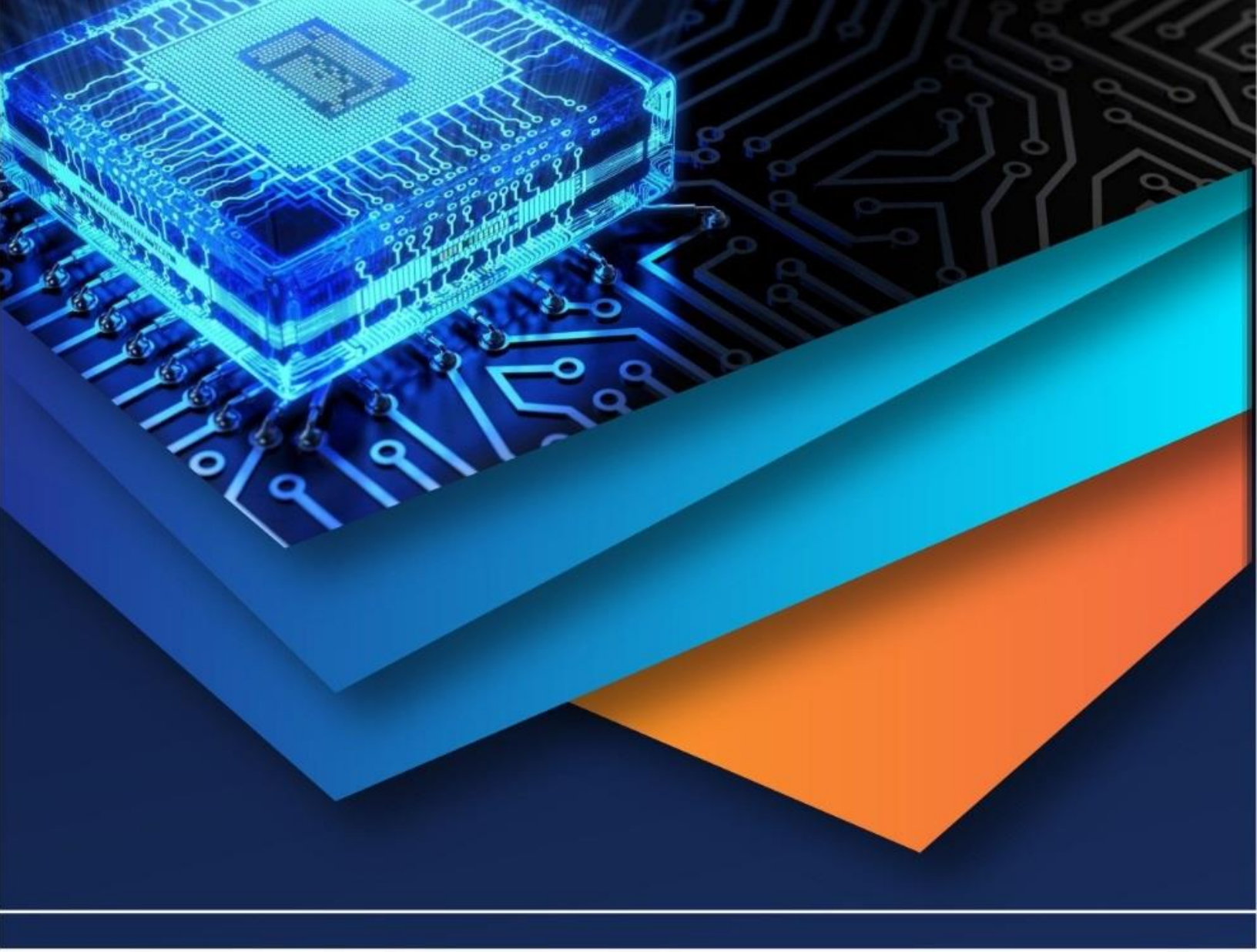
Despite these limitations, the findings have significant clinical relevance. They support the continued use of X-ray imaging in the diagnostic workflow for hemophilia patients, particularly in primary and secondary care settings. They also emphasise the importance of integrating radiological data with clinical findings to form a comprehensive understanding of joint health in these individuals. Moreover, the study highlights the need for national and regional health policies to prioritise access to both prophylactic treatment and routine imaging services for haemophilia patients.

In conclusion, while advanced imaging modalities offer more detailed assessments of early joint changes, X-ray remains an essential and effective tool for evaluating femoral head destruction in Hemophilia A. Its practicality, cost-effectiveness, and diagnostic reliability make it indispensable, particularly in resource-constrained environments. Future research should aim to combine radiographic and clinical data into unified scoring systems that can more accurately predict functional outcomes and guide long-term management strategies for patients living with haemophilia.

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