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2734 17 Avenue SW,  
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# STRESS FRACTURES OF THE FEMORAL NECK IN PHYSICALLY ACTIVE INDIVIDUALS: DIAGNOSTIC CHALLENGES AND MANAGEMENT

**Hanna Markowska** (Corresponding Author, Email: hmarkowska8@gmail.com)

Department of Internal Affairs and Administration Multispecialist Public Healthcare Center in Bydgoszcz, Bydgoszcz, Poland

ORCID ID: 0009-0006-7837-1989

**Natalia Salkowska**

University Clinical Center, Medical University of Warsaw, Warsaw, Poland

ORCID ID: 0009-0005-2518-3493

**Oliwia Borowska**

Prof. W. Orłowski Clinical Hospital, Centre of Postgraduate Medical Education (CMKP), Warsaw, Poland

ORCID ID: 0009-0006-1260-5711

**Jakub Magdziak**

Prof. W. Orłowski Clinical Hospital, Centre of Postgraduate Medical Education (CMKP), Warsaw, Poland

ORCID ID: 0009-0006-0297-7423

**Sara Awad**

Prof. W. Orłowski Clinical Hospital, Centre of Postgraduate Medical Education (CMKP), Warsaw, Poland

ORCID ID: 0009-0004-0942-6240

**Eliza Mędrak**

Nowy Dwór Medical Center, Nowy Dwór Mazowiecki, Poland

ORCID ID: 0009-0001-2830-014X

**Natalia Brzozowska**

Nowy Dwór Medical Center, Nowy Dwór Mazowiecki, Poland

ORCID ID: 0009-0003-6580-1714

**Barbara Wardzyńska**

Independent Public Healthcare Complex in Wyszaków, Wyszaków, Poland

ORCID ID: 0009-0002-4521-8911

**Paulina Zegarska**

Grochowski Hospital named after Dr. Rafał Masztak, Warsaw, Poland

ORCID ID: 0000-0001-6727-8128

**Helena Komosińska**

University Hospital No. 1 named after Dr. Antoni Jurasz, Bydgoszcz, Poland

ORCID ID: 0009-0006-2359-3875

## ABSTRACT

Stress fractures of the femoral neck are rare but potentially serious conditions. They primarily affect physically active individuals. The aim of this study was to summarize the current state of knowledge regarding stress fractures of the femoral neck, with particular emphasis on diagnostic challenges and current treatment methods. An analysis of the available scientific literature was conducted, covering epidemiology, pathophysiology, clinical presentation, diagnosis, and therapeutic management. Stress fractures are relatively rare but are associated with a high risk of complications, especially in cases of delayed diagnosis. Diagnosis of this type of injury is often delayed due to nonspecific symptoms, such as progressive pain in the groin or hip area that worsens during physical activity. Delayed diagnosis is also contributed to by the reduced sensitivity of radiological examinations in the early stages of the condition. Magnetic resonance imaging (MRI) is the method of choice for diagnosis, enabling the detection of lesions at an early stage and the assessment of their severity. Classifying fractures as compression or tension fractures is crucial for selecting the appropriate treatment. Therapy may include both conservative and surgical management. Early diagnosis and appropriate treatment are crucial for a favorable prognosis and return to physical activity. Identifying and modifying risk factors plays an important role in preventing the occurrence and recurrence of fractures.

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## KEYWORDS

Femoral Neck Stress Fracture, Stress Fracture, Overuse Injury, Hip Pain, Athletes, Physically Active Individuals, Magnetic Resonance Imaging, MRI, Diagnostic Imaging, Delayed Diagnosis, Bone Stress Injury, Femoral Neck, Compression Fracture, Tension Fracture, Fracture Classification, Conservative Treatment, Surgical Treatment, Internal Fixation, Risk Factors, Bone Mineral Density, Vitamin D Deficiency, Relative Energy Deficiency In Sport (RED-S), Injury Prevention, Orthopedic Injuries, Sports Medicine

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## Introduction

Stress fractures are bone injuries that develop gradually as a result of repetitive stress exceeding the bone tissue's capacity for regeneration and remodeling (Chen et al., 2020; Bergman and Kaiser, 2025; Fredericson et al., 2006). They most commonly occur in physically active individuals, especially athletes and military recruits, due to intense and regular physical exertion (Yang et al., 2023; Bergman and Kaiser, 2025; Welck et al., 2017).

Stress fractures most commonly occur in the bones of the lower extremities, particularly the metatarsals. Fractures of the femoral neck are less common but are associated with a significantly higher risk of complications (Bergman and Kaiser, 2025; Robertson and Wood, 2017). An untreated injury can lead to fracture displacement, nonunion, or femoral head necrosis (Robertson and Wood, 2017; Koutserimpas et al., 2024).

Symptoms are nonspecific and include progressive pain in the groin or hip area that worsens during physical activity (Biz et al., 2017). In the early stages, radiographic examinations often show no abnormalities, which can lead to a delay in diagnosis (Rizzo et al., 1993).

Magnetic resonance imaging (MRI) is the method of choice for diagnosing stress fractures of the femoral neck, as it allows for the detection of changes at an early stage, even before the appearance of a fracture line (Chen et al., 2020; Robertson and Wood, 2017). Early diagnosis allows for the differentiation of fracture types, classifying them as compression or tension fractures. The treatment of each differs in terms of stability and the risk of complications (Robertson and Wood, 2017; Rohena-Quinquilla et al., 2018).

Stress fractures can be treated conservatively. In such cases, patients are advised to limit weight-bearing and modify their activities. In more severe cases, surgical treatment is necessary (Koutserimpas et al., 2024; Moerenhout et al., 2019). The choice of management depends on many factors, such as the location of the fracture, the patient's level of physical activity, and the risk of disease progression.

### **Study Objective**

The objective of this study is to review the current state of knowledge regarding stress fractures of the femoral neck in physically active individuals, with particular emphasis on diagnostic challenges and treatment methods.

### **Epidemiology**

Stress fractures account for approximately 1–20% of all sports-related injuries (Bergman and Kaiser, 2025; Robertson and Wood, 2017). These types of injuries are particularly common among athletes engaged in long-distance running or triathlon, as well as among military recruits undergoing intense physical training (Yang et al., 2023; Bergman and Kaiser, 2025).

The lower limb bones are primarily affected, particularly the metatarsals, tibia, and fibula (Bergman and Kaiser, 2025; Robertson and Wood, 2017). Fatigue fractures of the femoral neck are observed much less frequently and account for approximately 3–5% of all fatigue fractures (Robertson and Wood, 2017; Koutserimpas et al., 2024).

Although they account for a small percentage of all stress fractures, their clinical significance is high due to the high risk of complications, such as fracture displacement or femoral head necrosis (Robertson and Wood, 2017; Koutserimpas et al., 2024). For this reason, early diagnosis is crucial for the subsequent prognosis.

### **Risk Factors**

The process leading to stress fractures is long-term and multifactorial. It results from an imbalance between mechanical stress and the bone tissue's ability to regenerate (Bergman and Kaiser, 2025). The most important risk factors include both factors related to physical activity and individual patient characteristics.

One of the main risk factors is a sudden increase in the intensity or volume of training, particularly in individuals participating in endurance sports (Yang et al., 2023; Robertson and Wood, 2017; Harris and Chahal, 2015). Repeated stress leads to the accumulation of microtraumas, which, in the absence of sufficient recovery, can result in a stress fracture (Bergman and Kaiser, 2025). When the load exceeds the adaptive capacity of bone tissue, osteoclast activity begins to outweigh osteoblast activity, which promotes the progression of microdamage and ultimately leads to a stress fracture (Bergman and Kaiser, 2025).

Metabolic factors also play a significant role, including disturbances in the body's energy balance, referred to as relative energy deficiency in sport (RED-S) (Yang et al., 2023; Bergman and Kaiser, 2025). Energy deficiency leads to hormonal imbalances and reduced bone mineral density, which increases susceptibility to stress injuries.

Biomechanical factors, such as improper running technique, lower limb alignment disorders, or inappropriate athletic footwear, also play a role (Robertson and Wood, 2017). Additionally, a history of previous stress fractures increases the risk of recurrence.

### **Classification**

Stress fractures of the femoral neck can be classified based on their location relative to the applied mechanical forces. We distinguish between compression-side and tension-side fractures (Robertson and Wood, 2017; Rohena-Quinquilla et al., 2018).

Compression-side fractures occur mainly in the lower part of the medial femoral neck and result from compressive forces. They are associated with a lower risk of progression and displacement due to relative stability (Robertson and Wood, 2017). In cases of early diagnosis, most cases are treated conservatively, with appropriate weight-bearing restrictions.

In contrast, tension-side fractures are located in the upper part of the lateral femoral neck. They are primarily caused by tensile forces (Robertson and Wood, 2017; Rohena-Quinquilla et al., 2018). They are considered unstable and are associated with a high risk of progression to a complete fracture and displacement, which may result in a complication in the form of femoral head necrosis. Therefore, in most cases, they require surgical treatment.

Furthermore, the literature also employs a classification based on the severity of changes observed in imaging studies, particularly magnetic resonance imaging (MRI), which allows for the detection of early stress reactions and the assessment of the extent of bone damage (Rohena-Quinquilla et al., 2018). MRI-based classifications enable a better determination of the risk of progression and the selection of optimal therapeutic management.

### **Clinical Presentation**

The nonspecific clinical presentation of patients often leads to a delay in the diagnosis of a stress fracture of the femoral neck (Biz et al., 2017; Fonte and Rodrigues-Pinto, 2018). Patients most commonly present with pain in the groin area, which gradually worsens with weight-bearing on the limb and often occurs after an increase in training intensity or a change in training conditions, such as the surface or footwear (Shi et al., 2023). These symptoms are often accompanied by a decrease in exercise tolerance and difficulty continuing training, which is of particular importance for athletes (Fonte and Rodrigues-Pinto, 2018). In the early stages of the injury, symptoms occur mainly during physical activity; however, over time, they may also appear during daily activities and even persist at rest, for example upon waking (Shi et al., 2023). Case reports indicate that delayed recognition of early symptoms can lead to progression of the injury and increase the risk of complications, especially in physically active individuals (Tan et al., 2022).

Physical examination primarily reveals tenderness in the hip joint area and limited range of motion, particularly when weight-bearing on the limb (Biz et al., 2017). Pain intensifies during running, jumping, or weight-bearing. The pain may radiate to the thigh or knee, which often leads to misdiagnosis and, consequently, to a delay in initiating appropriate treatment (Moerenhout et al., 2019).

In more advanced cases, there may be a sudden worsening of pain, which may indicate progression to a complete fracture or displacement (Moerenhout et al., 2019; Oudmaijer et al., 2024). In such situations, the patient may be unable to bear weight on the limb, and symptoms become more pronounced.

The nonspecific nature of the symptoms and their gradual onset often lead to a delay in the diagnosis of a stress fracture of the femoral neck, which can consequently worsen the prognosis (Fonte and Rodrigues-Pinto, 2018).

### **Diagnosis**

The diagnosis of stress fractures of the femoral neck involves combining clinical findings with imaging results. Early diagnosis is crucial for preventing disease progression and complications (Robertson and Wood, 2017; Lee and Anderson, 2014; Goldin et al., 2015). Diagnosis is often delayed due to the nonspecific nature of symptoms and the typical absence of abnormalities in initial examinations. Recent case-based studies have shown that some stress fractures of the femoral neck, particularly those located on the extensor side, may initially present with subtle or atypical imaging findings, which may contribute to delayed diagnosis (Oudmaijer et al., 2024).

The doctor will first recommend an X-ray examination. However, it is important to note that the sensitivity of this test is limited when it comes to detecting early changes. In the initial stages, the radiographic image may appear normal, and signs of a fracture do not appear until a more advanced stage (Rizzo et al., 1993; Lee and Anderson, 2014).

In cases of persistent symptoms or their worsening, magnetic resonance imaging (MRI) is the method of choice, even if the X-ray results are normal. MRI offers the highest sensitivity and specificity. It allows for the detection of early-stage changes in the form of bone marrow edema, as well as the assessment of the location and extent of the injury (Chen et al., 2020; Robertson and Wood, 2017; Lee and Anderson, 2014; Goldin et al., 2015).

Computed tomography (CT) can be useful for visualizing fracture lines; however, its diagnostic value for early stress-related changes is lower than that of magnetic resonance imaging (Lee and Anderson, 2014). Bone scintigraphy, despite its high sensitivity, has limited specificity and is currently of lesser diagnostic importance (Rizzo et al., 1993; Lee and Anderson, 2014).

Differential diagnosis is also a key element, encompassing other causes of hip pain, such as damage to joint structures or soft tissue changes caused by overuse. In this context, MRI plays a particularly important role, enabling a comprehensive assessment of the examined area (Goldin et al., 2015).

Early diagnosis of a stress fracture of the femoral neck is crucial for prognosis. Delayed diagnosis increases the risk of progression to a complete fracture and its displacement, which is associated with the possibility of serious complications, such as femoral head necrosis (Robertson and Wood, 2017; Koutserimpas et al., 2024; Lee and Anderson, 2014).

### **Treatment And Return To Activity**

The management of femoral neck stress fractures depends primarily on the fracture location, its stability, and the severity of changes seen on imaging studies. Early diagnosis is crucial, as delayed diagnosis significantly increases the risk of fracture displacement and femoral head necrosis (Robertson and Wood, 2017; Koutserimpas et al., 2024).

#### **Conservative treatment**

Conservative treatment is primarily used for compression fractures, which are considered relatively stable. It mainly involves limiting weight-bearing on the limb and adjusting physical activity. In most cases, it is recommended to limit weight-bearing on the limb for approximately 6–8 weeks, often with the aid of crutches, until the pain subsides (Goldin et al., 2015). Gradual weight-bearing should be based on clinical symptoms and imaging results.

Data from a systematic review indicate that conservative treatment of stable compression fractures leads to union in over 90% of cases, provided there is early diagnosis and appropriate weight-bearing restriction (Goldin et al., 2015). Identifying and modifying risk factors, such as energy imbalance—relative energy deficiency in sport (RED-S), vitamin D deficiency, or training errors—also remains a key element of therapy, as these factors can influence both the healing process and the risk of injury recurrence.

#### **Surgical treatment**

For tension-side fractures, surgical treatment is recommended because these fractures are characterized by a high risk of progression and displacement. This type of treatment is also recommended for unstable fractures or those involving more than 50% of the femoral neck width (Konda et al., 2022; Shah et al., 2023). The most commonly used method is internal stabilization using cannulated screws.

Early surgical intervention significantly reduces the risk of fracture displacement and complications such as femoral head necrosis. In displaced fractures, the incidence of this complication can reach as high as 30–42% (O'Connor et al., 2022). In more severe cases, especially those with displacement, more extensive surgical procedures may be necessary, including hip replacement.

#### **Return to Physical Activity**

The return to physical activity should be gradual and tailored to the patient's individual needs. It should only begin once the pain has completely subsided and the healing process has been confirmed by imaging studies.

According to the literature, the time required to return to full athletic activity is typically 12 to 28 weeks (Goldin et al., 2015). Studies involving athletes have shown that approximately 75–100% of patients return to their previous level of activity; however, these results depend on the type of fracture and the timing of diagnosis. In the case of extensor-side fractures and displaced fractures, the percentage of returns to full activity is lower, and the recovery period is prolonged (Goldin et al., 2015; Shah et al., 2023).

The process of returning to sports should include a gradual increase in training load, simultaneous implementation of strengthening and stabilization training, and correction of biomechanical factors. Monitoring for potential pain recurrence remains critically important. The importance of optimizing energy availability and correcting metabolic disorders, which directly impact healing time and the risk of injury recurrence, is also emphasized (Goldin et al., 2015).

Delayed diagnosis or inappropriate treatment can lead to permanent limitations in physical activity and an increased risk of complications (Robertson and Wood, 2017; Koutserimpas et al., 2024).

### **Discussion**

Stress fractures of the femoral neck are a relatively rare but potentially serious condition, particularly in physically active individuals (Robertson and Wood, 2017; Koutserimpas et al., 2024). Despite growing clinical awareness, their diagnosis is still often delayed, mainly due to nonspecific symptoms and the limited sensitivity of radiographic examinations in the early stages of the disease (Rizzo et al., 1993; Lee and Anderson, 2014).

An analysis of the available literature indicates that magnetic resonance imaging (MRI) plays a key role in diagnosis, as it allows for the detection of stress-related changes even before fracture features appear on X-rays (Chen et al., 2020; Lee and Anderson, 2014). Early use of MRI not only enables diagnosis but also allows for the assessment of the extent of the changes and the risk of their progression (Rohena-Quinquilla et al., 2018).

An essential element of management is the proper classification of the fracture, which determines the choice of treatment method. Compression-side fractures, considered relatively stable, can be effectively treated conservatively, whereas tension-side fractures typically require surgical treatment due to the high risk of displacement and complications (Konda et al., 2022; Shah et al., 2023).

The literature also emphasizes the importance of metabolic factors and training errors in the pathogenesis of stress fractures. Energy supply disorders, vitamin D deficiency, and a sudden increase in training loads are significant risk factors that should be considered in both the diagnostic and therapeutic processes (Yang et al., 2023; Bergman and Kaiser, 2025).

In summary, effective management of stress fractures of the femoral neck requires early diagnosis, proper assessment of the fracture type, and an individualized treatment approach that takes into account both mechanical and metabolic factors. Despite advances in diagnostic imaging and treatment strategies, femoral neck stress fractures remain a clinical challenge, particularly in early-stage detection and differentiation from other causes of hip pain (Fredericson et al., 2006; Oudmajer et al., 2024).

### Conclusions

Fatigue fractures of the femoral neck are a rare but potentially serious condition, particularly in the athletic population. The nonspecific clinical presentation contributes to delayed diagnosis, which increases the risk of complications. Magnetic resonance imaging remains the method of choice for diagnosis, enabling the detection of lesions at an early stage. Classifying the fracture as compression or tension is crucial for selecting the appropriate treatment. Early initiation of appropriate treatment and identification of risk factors increases the chances of a full return to physical activity.

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