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Enhancing The Accuracy And Effectiveness Of Radiological Techniques In Detecting Late-Stage Hip Joint Complications Following Covid-19 Infection

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Abstract The objective of this study is to improve the diagnostic effectiveness of radiological methods in identifying late-stage post-COVID pathologies of the hip joint. This includes defining specific radiological features and patterns that characterize these complications, thereby aiding in early detection, accurate staging, and appropriate management of post-COVID hip joint diseases. Timely and precise diagnosis is essential to prevent progression to severe joint damage and reduce the risk of disability.

Keywords:

Relevance: Coronavirus disease 2019 (COVID-19) is primarily known as a respiratory illness; however, it can also result in a wide range of extrapulmonary manifestations, affecting multiple organ systems. Among the long-term consequences following acute infection is what is commonly referred to as post-COVID syndrome (PCS) or "long COVID." This condition encompasses a variety of symptoms and health issues that persist or appear several months after the initial infection, significantly impacting patients' quality of life. Despite its increasing recognition, a universally accepted definition and standardized nomenclature for PCS have yet to be established. However, in the autumn of 2021, the World Health Organization (WHO) proposed a formal definition of the post-COVID-19 condition, describing it as symptoms that generally develop around three months after the initial illness, persist for at least two months, and are not attributable to alternative diagnoses. These symptoms can affect multiple systems, including respiratory, cardiovascular, neurological, and musculoskeletal. One frequently reported musculoskeletal symptom in PCS is arthralgia (joint pain), observed in approximately 19% of cases (Lopez-Leon et al., 2021). Patients often report persistent joint discomfort, stiffness, and reduced mobility, which can lead to significant functional impairment. Among the joints affected, the hip joint is of particular concern due to its critical role in weight-bearing and mobility. Post-COVID musculoskeletal complications, including osteoarthritis and aseptic necrosis (also known as avascular necrosis), have emerged as notable sequelae that require focused diagnostic attention.

Purpose: The objective of this study is to improve the diagnostic effectiveness of radiological methods in identifying late-stage post-COVID pathologies of the hip joint. This includes defining specific radiological features and patterns that characterize these complications, thereby aiding in early detection, accurate staging, and appropriate management of post-COVID hip joint diseases. Timely and precise diagnosis is essential to prevent progression to severe joint damage and reduce the risk of disability.

Methods and Techniques: The study analyzed clinical and imaging data from 150 individuals. The cohort was divided into two groups: a control group consisting of 50 healthy participants without a history of COVID-19, and a main group of 100 patients with confirmed prior COVID-19 infection and suspected hip joint pathology. Diagnostic evaluations included conventional radiography (X-rays), ultrasound (US), magnetic resonance imaging (MRI), and computed tomography (CT), all conducted at the Radiology Department of the Andijan Regional Hospital of Traumatology and Orthopedics. Each imaging modality was selected based on its strengths and ability to visualize specific aspects of joint pathology. X-rays provided a basic overview of bone structure and joint space but have limited sensitivity in early-stage disease. Ultrasound was used to assess soft tissue structures and blood flow, while MRI offered detailed visualization of cartilage, bone marrow, synovium, and surrounding soft tissues without radiation exposure. CT scans, particularly multidetector CT (MDCT), were used to obtain high-resolution images of bone architecture and identify subtle changes indicative of osteonecrosis.

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Results: In all post-COVID patients examined, pathological changes in the hip joint were identified, highlighting a strong association between prior COVID-19 infection and hip joint complications. Comparative analysis with the control group revealed significant differences in joint condition. MDCT demonstrated several advantages over traditional radiography, notably in detecting early femoral head changes associated with aseptic necrosis, starting from the second stage of the disease. However, a notable disadvantage of CT imaging is the relatively high radiation dose, which limits its frequent use, especially in younger patients or those requiring multiple follow-ups. MRI emerged as a highly valuable tool due to its ability to directly visualize the synovial membrane, articular and fibrocartilage, subchondral bone, bone marrow, and adjacent soft tissues. MRI's superior tissue contrast and ability to employ various imaging sequences allow for detailed morphological assessment and staging of disease processes. It also enables detection of joint effusions and bone marrow edema, which are often invisible on X-rays. Crucially, MRI involves no radiation exposure, making it safer for repeated evaluations. Ultrasound, while non-invasive, safe, and widely accessible, provides real-time assessment of soft tissues, including tendons, ligaments, and joint capsules. Additionally, Doppler ultrasound can evaluate blood flow in the femoral head's feeding vessels, providing indirect information about vascular supply—a key factor in osteonecrosis. Contrast-enhanced ultrasound further enhances visualization. Despite these benefits, ultrasound remains less informative in detecting osteonecrosis due to limited understanding of ultrasound-specific features of necrotic bone and difficulty in grading lesion severity compared to MRI or CT.

Conclusions: The study underscores the importance of integrating multiple imaging modalities, with an emphasis on ultrasound and MRI, for comprehensive assessment of post-COVID osteoarthritic changes and aseptic necrosis of the hip joint. Given the high risk of permanent disability among PCS patients, early and accurate diagnosis is crucial to guiding treatment and rehabilitation strategies. Further research is warranted to refine diagnostic criteria, optimize imaging protocols, and develop contrast-enhanced techniques to enhance lesion detection and characterization. Additionally, establishing clear diagnostic algorithms combining clinical and radiological data will improve patient outcomes. Understanding the full spectrum of post-COVID musculoskeletal complications, including their pathophysiology and natural history, is essential to mitigate long-term consequences and improve quality of life for affected patients.

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