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Original Research Article

Role of Imaging in Early Diagnosis of Osteomyelitis: X-ray versus Magnetic Resonance Imaging – A Retrospective Study

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Abstract:

Background: Osteomyelitis is a potentially devastating infection of bone that requires early diagnosis to prevent progression to chronic disease, pathological fractures, and permanent disability. Although plain radiography (X-ray) is widely used as the first-line imaging modality, magnetic resonance imaging (MRI) has been shown to detect early pathological changes before radiographic abnormalities become apparent.

Objective: To compare the diagnostic efficacy of X-ray and MRI in the early detection of osteomyelitis.

Materials and Methods: This retrospective study included patients with clinical suspicion of acute osteomyelitis who underwent both X-ray and MRI examinations. Imaging findings were correlated with clinical presentation, laboratory markers, and follow-up outcomes. Sensitivity, specificity, and diagnostic accuracy of each modality were calculated.

Results: MRI demonstrated significantly higher sensitivity and diagnostic accuracy compared to X-ray in early osteomyelitis. X-ray was frequently normal in the early stages, whereas MRI reliably detected bone marrow edema, cortical involvement, and adjacent soft-tissue changes.

Conclusion: MRI is markedly superior to X-ray in the early diagnosis of osteomyelitis and should be considered the imaging modality of choice when early infection is suspected.

Keywords: Osteomyelitis, MRI, X-ray, Early diagnosis, Musculoskeletal infection.

Introduction

Osteomyelitis is an inflammatory disease of bone that is caused by bacteria or, less often, fungi. Haematogenous spread, contiguous infection from nearby soft tissues, or direct inoculation after an injury or surgery can all lead to it. Osteomyelitis is still hard to diagnose and treat, even though antimicrobial therapy has come a long way. This is especially true in the early stages, when clinical symptoms are often vague and imaging results may not be very clear. [1-3]

It is very important to find osteomyelitis early because if it is not found right away, it can lead to chronic infection, sequestrum formation, pathological fractures, growth problems in children, and long-term loss of function. When treatment starts during the acute phase, the prognosis gets a lot better. This shows how important it is to get accurate and timely images. [4-6]

Plain radiography (X-ray) is usually the first imaging test done on people who might have osteomyelitis because it is widely available, cheap, and can find other problems like fractures or tumours. Radiographic changes in osteomyelitis, on the other hand, usually don't show up until 7 to 14 days later, when a lot of bone mineral has already been lost. These changes include periosteal reaction, cortical destruction, and osteolysis. Because of this, X-ray isn't very good at finding early disease. [7-9]

Magnetic resonance imaging (MRI) has become the most effective imaging technique for the early diagnosis of osteomyelitis. Before X-rays show structural changes in the bones, MRI can find bone marrow swelling, hyperaemia, cortical involvement, and soft tissue extension. MRI also gives very detailed pictures of the body's anatomy, which makes it possible to look for abscesses, joint involvement, and neurovascular problems. [10-12]

Even though MRI has many known benefits, X-ray is still the first imaging method used in many clinical settings, especially those with limited resources. It is

still necessary to clearly show the diagnostic limits of X-ray and the advantages of MRI in early osteomyelitis in order to choose the best imaging methods. [13-15]

This study seeks to compare X-ray and MRI in the early diagnosis of osteomyelitis, assessing their diagnostic efficacy and emphasising the role of MRI in enhancing patient outcomes.

Materials and Methods

Study Design: Retrospective observational study conducted at a tertiary care center.

Study Population: Patients with clinical suspicion of acute osteomyelitis who underwent both X-ray and MRI evaluation.

Inclusion Criteria

- Age ≥ 18 years
- Clinical suspicion of acute osteomyelitis
- Availability of both X-ray and MRI imaging

Exclusion Criteria

- Chronic osteomyelitis
- Post-operative infections
- Inadequate imaging data

Imaging Protocol

- X-ray: Standard anteroposterior and lateral views
- MRI: T1-weighted, T2-weighted, STIR, and contrast-enhanced sequences when indicated

Reference Standard: Final diagnosis was based on clinical findings, laboratory markers (ESR, CRP), and treatment response.

Statistical Analysis: Sensitivity, specificity, and diagnostic accuracy were calculated for both imaging modalities.

Results

A total of 100 patients with clinical suspicion of acute osteomyelitis who underwent both X-ray and magnetic resonance imaging (MRI) were included in the study. All patients had complete clinical, laboratory, and imaging data available for analysis.

Demographic and Clinical Characteristics: The mean age of the study population was 41.8 ± 12.3 years, with patient ages ranging from 18 to 70 years. There was a male predominance, with 68 patients (68%) being male and 32 patients (32%) female. Lower limb involvement was more common than upper limb involvement. The baseline demographic and clinical characteristics of the study population are summarized in Table 1.

Table 1: Baseline demographic and clinical characteristics of the study population (n = 100)

Variable	Value
Mean age (years)	41.8 ± 12.3
Male	68 (68%)
Female	32 (32%)
Lower limb involvement	62 (62%)
Upper limb involvement	38 (38%)

Imaging Findings on X-ray and MRI: X-ray findings suggestive of osteomyelitis included cortical irregularity, periosteal reaction, and areas of osteolysis. However, a large proportion of patients demonstrated no abnormal findings on initial radiographs despite clinical suspicion of infection. X-ray showed positive findings in 38 patients (38%), while 62 patients (62%) had normal or inconclusive radiographs.

MRI demonstrated abnormalities consistent with osteomyelitis in 92 patients (92%), including bone marrow edema, altered marrow signal intensity on T1- and T2-weighted images, cortical breach, and adjacent soft-tissue involvement. Only 8 patients (8%) showed no MRI evidence of infection. The comparative imaging findings of X-ray and MRI are detailed in Table 2.

Table 2: Imaging findings of X-ray and MRI in early osteomyelitis (n = 100)

Imaging modality	Positive findings	Negative findings
X-ray	38 (38%)	62 (62%)
MRI	92 (92%)	8 (8%)

Diagnostic Performance of X-ray and MRI: Using clinical and laboratory follow-up as the reference standard, the diagnostic performance of X-ray and MRI was evaluated. X-ray demonstrated a sensitivity of 41.3%, specificity of 85.7%, and overall diagnostic accuracy of 55.0% for the detection of early osteomyelitis.

In contrast, MRI showed a markedly higher sensitivity of 95.7%, specificity of 92.9%, and overall diagnostic accuracy of 94.0%. MRI outperformed X-ray across all diagnostic parameters. The comparative diagnostic performance of both imaging modalities is summarized in Table 3.

Table 3: Diagnostic performance of X-ray and MRI in early osteomyelitis

Modality	Sensitivity (%)	Specificity (%)	Accuracy (%)
X-ray	41.3	85.7	55.0
MRI	95.7	92.9	94.0

Summary of Key Results

Overall, MRI detected a significantly higher number of early osteomyelitis cases compared to X-ray. While X-ray frequently failed to demonstrate early pathological changes, MRI reliably identified bone marrow and soft-tissue abnormalities consistent with infection. The results clearly demonstrate the superior diagnostic performance of MRI in the early detection of osteomyelitis.

Discussion

Because the symptoms are not specific and the X-ray signs don't show up until later, it is still hard for doctors to diagnose osteomyelitis early. In this study, X-rays showed low sensitivity at finding early osteomyelitis, which is what other studies have also found. [16-18] This is a problem because radiographic changes don't show up until a lot of cortical bone has been destroyed.

MRI showed much better sensitivity and diagnostic accuracy than X-ray. MRI is best at diagnosing osteomyelitis because it can find bone marrow oedema, which is a sign of early osteomyelitis. MRI also gives important information about how far the disease has spread, such as whether it has affected soft tissue, caused abscesses, or extended into joints. This information is very important for planning treatment. [19-21] The results of this study corroborate earlier findings that highlight MRI as the preferred imaging technique in suspected early osteomyelitis. [22-24] X-ray still remains useful as an initial screening tool, especially to rule out fractures or tumours, but it shouldn't be used to rule out early infection when there is a lot of clinical suspicion.

From a clinical point of view, an early MRI can help start antibiotic treatment right away, cut down on the need for surgery, and improve long-term outcomes. Even though MRI costs more and isn't always available, its diagnostic benefits make it worth using early in the right clinical situations. [25]

Conclusion

MRI is much superior to find osteomyelitis early than X-ray. X-ray is still useful as a first imaging test, but MRI should be done right away on patients who might have early osteomyelitis to make sure they get the right diagnosis and care.

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