Risk Indicators for Osteomyelitis versus Osteitis on MRI

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Introduction/Purpose: Magnetic resonance imaging (MRI) is the most accurate modality for identifying osteomyelitis with prior literature reporting sensitivities and specificities of 90% and 80%, respectively. MRI findings consistent with osteomyelitis include bone marrow edema, hyperintensity on T2-weighted images (T2WI), and confluent signal on T1-weighted images (T1WI). Additional radiographic indicators include superficial ulceration, exposed bone, and cortical erosion. What is unclear is which of these factors, alone or in combination, is most closely associated with a diagnosis of osteomyelitis. The goal of the current study is to determine which clinical risk factors and MRI findings are most predictive of osteomyelitis.

Methods: After IRB approval, clinical records of one hundred five patients who underwent bone biopsy of the foot or ankle between 2015-2017 were retrospectively examined. Patients who did not obtain MRI within 30 days preceding bone biopsy were excluded. A total of 65 patients were included. Diagnosis of osteomyelitis was determined by histology. Blinded radiologic review of MRI was performed to evaluate presence of 4 key indicators of osteomyelitis: hyperintensity on T2WI, confluent signal on T1WI, depth of ulceration, and presence of cortical erosion. Bivariate Poisson regression with robust error variance was used to determine if an association existed between the incidence of osteomyelitis and patient comorbidities and radiographic indicators. A multivariate Poisson regression including patient and radiographic indicators as controls was performed using backwards, stepwise regression until only variables with $p<0.05$ remained.

Results: Of 65 subjects, 41 (63.1%) and 24 (36.9%) had pathologic evidence of osteomyelitis or indeterminate results, respectively. The sensitivity (Se) and specificity (Sp) for osteomyelitis versus osteitis by radiologist heuristic was 51.4% and 77.8%, respectively. The sensitivity and specificity for hyperintensity on T2WI (Se:90.2%; Sp:16.7%), confluent signal on T1WI (Se:43.9%; Sp:83.3%), depth of ulceration (Se:78.0%; Sp:41.7%), and cortical erosion (Se:41.5%; Sp:79.2%) are detailed. Bivariate analysis determined diabetes (Relative risk [RR]=3.2, 95% Confidence Interval [CI]=1.14-8.72, p=0.026) and confluent signal on T1WI (RR=1.5, 95%CI=1.08-2.16, p=0.015) were risk factors for osteomyelitis. An immunocompromised state and presence of cortical erosion were trending towards statistical significance. Multivariate analysis determined an immunocompromised state (RR=1.8, 95%CI=1.32-2.39, p=<0.001) and confluent signal on T1WI (RR=1.6, 95%CI=1.08-2.28, p=0.019) to be independent risk factors for osteomyelitis.

Conclusion: The results of this study demonstrate that confluence of signal on T1WI and an immunocompromised state were independent risk factors for osteomyelitis. Additionally, patients with evidence of cortical erosion or diabetes should be more thoroughly evaluated if clinical concern for osteomyelitis is high. Patients with these comorbidities or radiographic indicators should undergo bone biopsy for definitive diagnosis.

Table 6. Bivariate analysis for osteomyelitis.*

	Rate of Osteomyelitis˅	RR	95% CI	p-value‡
Age (n, years)				
≤ 65	64.1%	Ref.		
> 65	61.5%	1.0	0.65-1.41	0.836
Sex (n)				
Female	55.0%	Ref.		
Male	66.7%	1.2	0.77-1.90	0.403
Body Mass Index (n, kg/m^2)				
Non-obese (BMI < 30)	58.8%	Ref.		
Obese (BMI > 30)	65.2%	1.1	0.73-1.68	0.625
Smoking status (n)				
Non-smoker	61.0%	Ref.		
Smoker	66.7%	1.1	0.75-1.60	0.643
Diabetic				
No	**23.1%**	**Ref.**		
Yes	**73.1%**	**3.2**	**1.14-8.72**	**0.026**
Peripheral Vascular Disease$^\partial$				
No	65.6%	Ref.		
Yes	60.6%	0.9	0.63-1.34	0.678
Immunocompromised$^\beta$				
No	60.3%	Ref.		
Yes	85.7%	1.4	0.98-2.06	0.062
Recent Trauma or Surgery				
No	62.0%	Ref.		
Yes	66.7%	1.1	0.71-1.64	0.736
Depth of Ulcer				
No Ulcer Present or Superficial Fascia	47.4%	Ref.		
Exposed Bone or Tendon/Joint (Within 2mm)	69.6%	1.5	0.88-2.46	0.144
Hyperintense Bone on T2-weighted MRI				
Absent	50.0%	Ref.		
Present	64.9%	1.3	0.63-2.68	0.480
Confluent Bone on T1-weighted MRI				
Absent	**53.5%**	**Ref.**		
Present	**81.8%**	**1.5**	**1.08-2.16**	**0.015**
Cortical Erosion				
Absent	55.8%	Ref.		
Present	77.3%	1.4	0.97-1.97	0.070

*****Boldface** indicates statistical significance.

˅ Percentage of population based on categorical total compared to those with osteitis.

-- Too few occurrences for accurate statistical analysis

$^\partial$ Peripheral arterial and/or venous disease

$^\beta$ Patients were categorized as immunocompromised if they were diagnosed with End Stage Renal Disease (3), Sepsis (2), Kidney Transplant (1), Acquired Immune Deficiency Syndrome (1)

‡ p-value calculated using Poisson regression with robust error variance