

Title: MRI Characteristics to Differentiate Benign versus Malignant Bone Lesions**Authors: Ava Brozovich MD/PhD, MPH,^{1,2} Katelyn Sette BS,^{1,2} Joel Mayerson MD^{1,2}**¹**Department of Orthopedics, The Ohio State University, Wexner Medical Center, Columbus, OH.**²**Department of Orthopedic Oncology, The Ohio State University Comprehensive Cancer Center, James Cancer Center and Solove Research Institute, Columbus, OH.**

Significance & Hypothesis: Bone lesions, whether benign or malignant, present significant diagnostic challenges due to their overlapping imaging characteristics. Identifying which lesions warrant a referral to an Orthopedic Oncologist includes a combination of radiological imaging, clinical findings, and histopathology.¹⁻³ However, there is no standardized criteria to evaluate the likelihood that a bone lesion is benign or malignant based solely on MRI findings. Studies show that malignant lesions often exhibit aggressive features such as ill-defined margins, cortical destruction, and periosteal reaction.^{4,5} This study aims to investigate the specificity and sensitivity of MRI features to accurately differentiate benign from malignant lesions in order to establish a set of criteria that improves diagnostic accuracy and guides clinical decision-making. We hypothesize that developing a scoring system based on imaging will assist surgeons to better determine what lesions necessitate evaluation by an oncologist.

Innovation: This study will develop a set of criteria that assists orthopedic surgeons to predict if a bone lesion is benign or malignant based on specific MRI characteristics.

Approach: A single center retrospective study was performed. Inclusion criteria were new patients evaluated by an Orthopedic Oncologist from January 1st to December 31st, 2015. Exclusion criteria included: no available or viewable MRI imaging, presence of a soft tissue lesion, surveillance patients, no lesion identified on imaging. MRIs were evaluated for: perilesional edema, periosteal reaction, endosteal erosion, cortical breakthrough, soft tissue mass, and size > 4 cm. Chi square, sensitivity, specificity, PPV, NPV, likelihood ratio, and ROC were used to detect differences between malignant and benign lesions. When determining a scoring system, perilesional edema, periosteal reaction, endosteal erosion were given a value of 1, while cortical breakthrough, soft tissue mass, and size > 4 cm were given a value of 2. Significance was determined using a p-value<0.05.

Results: 157 patients were included; 83 (53%) lesions were benign, 74 (47%) were malignant. Malignant lesions were more likely to demonstrate perilesional edema (96% vs 47%), periosteal reaction (86% vs 24%), endosteal erosion (91% vs 31%), cortical breakthrough (77% vs 10%), soft tissue mass (57% vs 14%), and size > 4 cm (80% vs 52%), (p-value <0.0001). Using a scoring system, a score of ≥ 6 was found to best predict if a lesion was malignant (sensitivity 0.73: 95% CI 0.62- 0.82, specificity 0.92: 95% CI 0.84 – 0.96, PPV 0.89: 95% CI 0.78 – 0.94, NPV 0.79: 95% CI 0.70-0.86, LR 8.65); and a ROC curve with area 0.90 (95% CI 0.85-0.94, p-value <0.001).

Discussion & Impact: This study developed a new set of criteria to assist orthopedic surgeons evaluating MRIs to best predict a malignant bone lesion; evaluating for perilesional edema, endosteal erosion, cortical breakthrough, size > 4 cm, and soft tissue mass allows a score to be assigned for each lesion. A score ≥ 6 can be used to know with 90% certainty that a lesion is malignant. This scoring system will assist orthopedic surgeons with concerning MRI findings to more expeditiously be evaluated by an oncologist, while also decreasing unnecessary referrals.

References:

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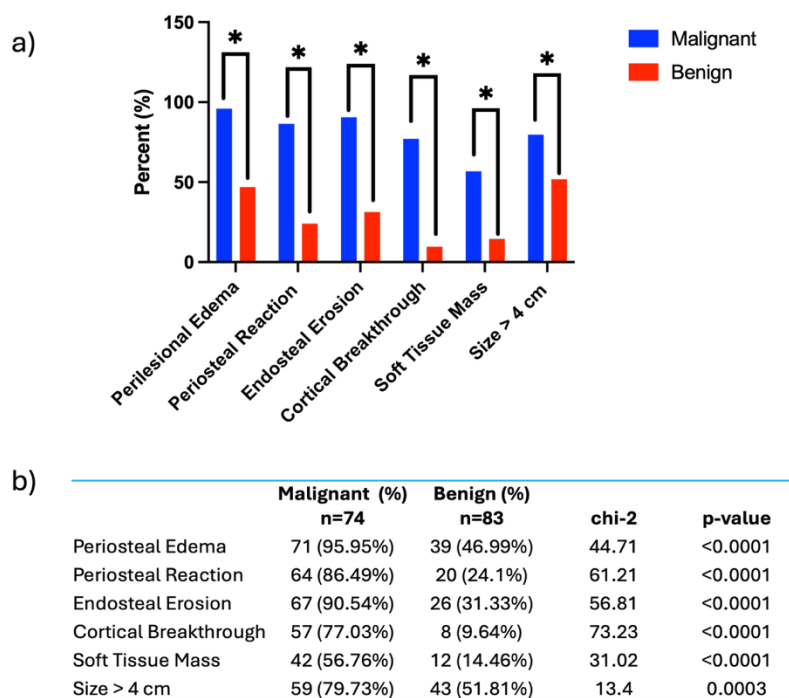


Figure 1: MRI Imaging Characteristics a) MRI imaging characteristics of benign and malignant bone lesions, pvalue < 0.0001; b) Percent of patients with MRI imaging features for benign and malignant lesions.

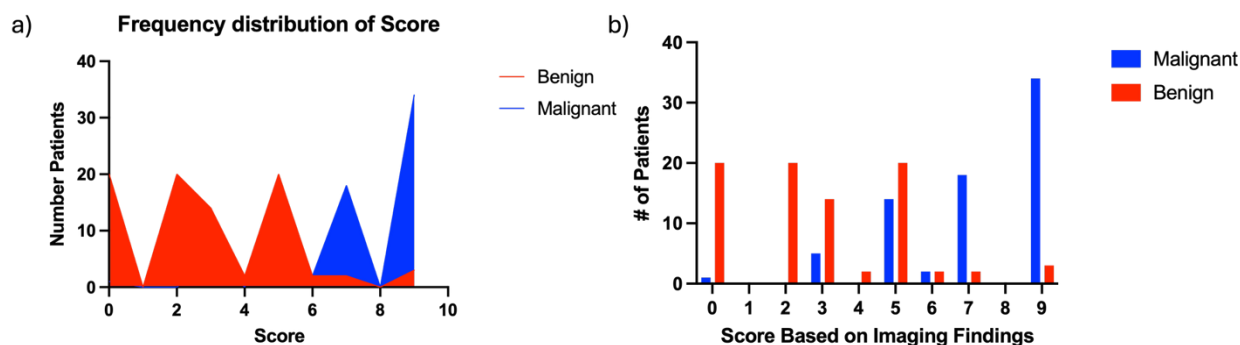


Figure 2: Score Distribution a) Score Distribution for MRI Characteristics for malignant and benign lesions based on scoring system with value of 1 given for perilesional edema, periosteal reaction, endosteal erosion and value of 2 given for cortical breakthrough, soft tissue mass, and size > 4 cm; b) Frequency distribution of malignant and benign lesions based on scoring criteria.

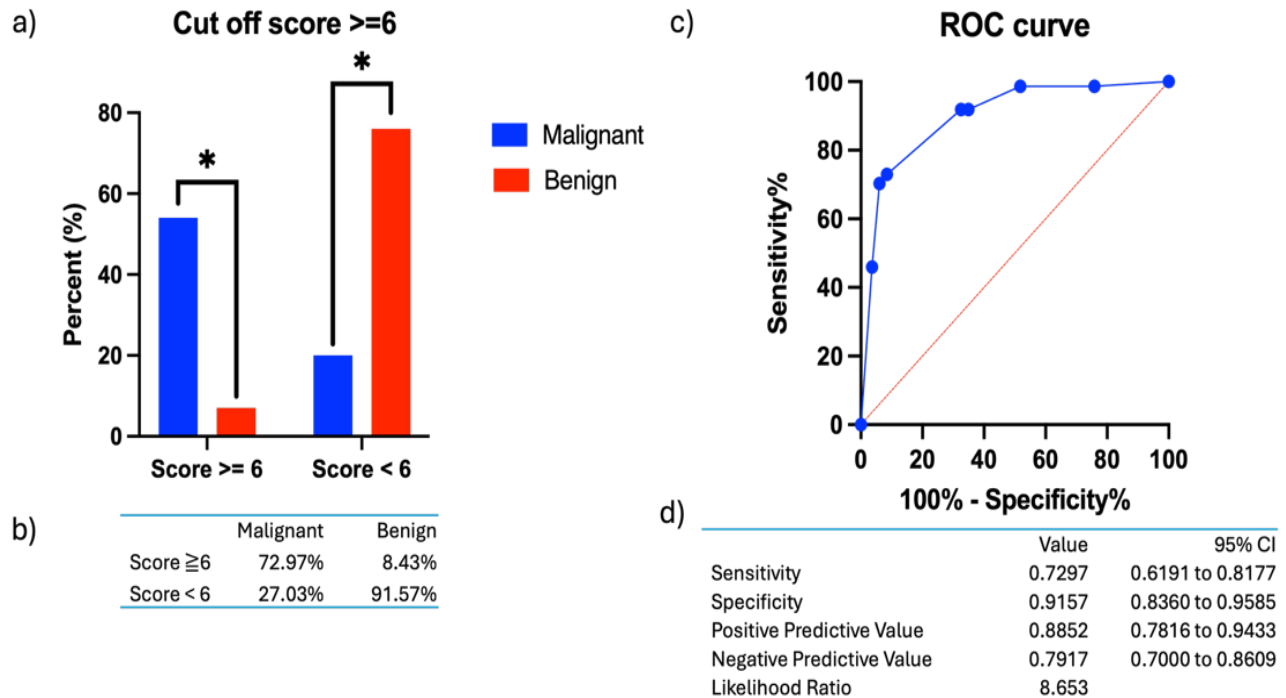


Figure 3: Proposed MRI Scoring System a) MRI Imaging Score for malignant and benign lesions using scoring system with value of 1 for perilesional edema, periosteal reaction, endosteal erosion and value of 2 for cortical breakthrough, soft tissue mass, and size > 4 cm. *pvalue < 0.0001 , b) Percent of patients with scores < 6 or ≥ 6 for malignant and benign lesions; c) Receiving operator characteristics (ROC) curve for malignant or benign lesion based on MRI imaging characteristics using various cutoff of score, AUC= 0.8981, SE= 0.02525, 95% CI 0.8486-0.9476, pvalue < 0.0001 ; d) Sensitivity, specificity, PPV, NPV, and likelihood ratio using a cutoff value of ≥ 6 to predict a lesion is malignant on MRI imaging.