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Prediction Rules for Distinguishing Benign from Malignant Compression Fractures on MRI

John A. Carrino, MD*

Matthew A. Marcus, MD**

* Thomas Jefferson University

** Thomas Jefferson University Hospital

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Prediction Rules for Distinguishing Benign from Malignant Compression Fractures on MRI

In elderly patients, the occurrence of a vertebral fracture with the associated Magnetic Resonance (MR) findings of bone marrow edema (BME) often raises the question of a malignant etiology. Metastases to the vertebrae are found in 5% to 10% of all patients with cancer.[1] Neoplasm induced fractures of the spine occur in approximately 10-15% of patients with skeletal metastasis.[2] However, there are numerous causes of BME patterns (degenerative, infectious, inflammatory, traumatic and neoplastic), and in the elderly, a benign osteoporotic fracture is also a frequent etiology.

Trying to differentiate between benign and malignant compression fractures in the spine is a problem confronting radiologists. MR imaging is often utilized to evaluate the etiology of back pain and is a superbly sensitive method for assessing bone marrow. However, there is a lack of specificity if only signal intensity characteristics are considered. Several MR imaging signs have been described, but the literature is limited on this topic with most investigations performed in convenience samples of fewer than 100 patients. Therefore, because of the variable data, skepticism exists for the imaging criteria. A rapid and accurate technique to differentiate benign from malignant processes has important implications regarding patient treatment and prognosis. In terms of patient management, there are divergent therapies, prognoses and decision trees for the osteoporotic versus malignant causes of BME in the vertebra. The often indeterminate and sometimes misleading appearance of BME on MR imaging has resulted in the frequent need for biopsy and pathological examination.

Prediction rules (also known as clinical decision rules) are logical algorithms that provide estimates of the likelihood for the existence of a particular condition.[3,4] These rules are based on empirical relationships between numerous predictors and possible outcomes, while capitalizing on the different degrees of association among the predictors to formulate the rule. Prediction and decision rules are quite common in other medical fields and when applied to imaging typically address clinical parameters with the goal of determining who should be imaged and how. While there has been an increase in the development and validation of prediction rules in radiology,[5,6] this methodology is not commonly applied to the primary image interpretation tasks.[7] Three steps are involved in the development and testing of a prediction rule: creation of the rule, testing or validating the rule, and assessing the impact of the rule on clinical behavior.

With this in mind, one novel approach is the development of a prediction rule to determine the etiology of vertebral BME from information that is readily obtainable from MR imaging. This project is currently underway in the department of radiology. The types of MR findings that will be evaluated include signal homogeneity, vertebral body morphology, lesion definition, extent of vertebral body abnormality, pedicle involvement, cortical interruption, extraosseous extension, presence of a fracture line, longitudinal ligament attachment, contrast enhancement pattern and number of foci. We are currently accruing a cohort of patients that have undergone spine MR imaging and a subsequent biopsy or follow-up MR imaging showing either disease progression indicating neoplasm or BME resolution indicating a compression fracture.

The dataset derived from this review process will be used as the training set (also known as the derivation set). The prediction rule will be developed using a multivariate regression model.

Evaluation of the prediction rule will be based on several principles including calibration, discrimination, validity, and utility. One method of evaluation is to perform cross-validation of the prediction rule with a new dataset, thus testing the generalizability. This may be done in a prospective manner using an opportunity sample of new patients presenting with compression fractures, or it may be done retrospectively on a different dataset from another institution. If proven useful then the prediction rule may be incorporated in the form of an on-line decision support system.

A predictive algorithm that can consistently discriminate malignant versus benign BME in the context of vertebral compression fractures would be useful in clinical practice and allow for more appropriate allocation of health care resources by expediting therapy rather than furthering the diagnostic work-up. However, it is possible that a sufficiently robust rule cannot be developed based on standard MR imaging and morphological criteria. Accordingly, an additional goal of this project is to identify directions to focus future research in the application of novel MR pulse sequences in a subset of patients with BME patterns, which cannot be sufficiently characterized by morphological criteria.

References

1. Porter BA, Shields AF, Olson DO. Magnetic resonance imaging of bone marrow disorders. Radiol Clin North Am 1986;24:269-289.

2. Sherry HS, Levy RN, Siffert RS. Metastatic disease of bone in orthopedic surgery. Clin Orthop 1982;169:44-48.

3. Randolph AG, Guyatt GH, Calvin JE, Doig G, Richardson WS. Understanding articles describing clinical prediction tools. Crit Care Med 1998;26:1603-12.

4. Laupacis A, Sekar N, Stiell IG. Clinical prediction rules. A review and suggested modifications of methodological standards. JAMA 1997;277:488-94.

5. Hanson JA, Blackmore CC, Mann FA, Wilson AJ. Cervical spine injury: a clinical decision rule to identify high-risk patients for helical CT screening. AJR 2000;174:595.

6. Blackmore CC, Zweibel A, Mann FA. Determining risk of traumatic aortic injury: how to optimize imaging strategy. AJR 2000;174:343-7.

7. Nazarian LN, Schweitzer ME, Mandel S, Rawool NM, Parker L, Fisher AM, Feld RI, Needleman L. Increased soft-tissue blood flow in patients with reflex sympathetic dystrophy of the lower extremity revealed by power doppler sonography. AJR 1998;171:1245-1250.

About the Authors

John A. Carrino, MD, is an Assistant Professor of Radiology at Jefferson Medical College, Thomas Jefferson University. Matthew A. Marcus, MD, is a resident in the Department of Radiology at Thomas Jefferson University Hospital. Please address comments to john.carrino@mail.tju.edu.