Predicting pathological fractures in metastatic humerus lesions

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INTRODUCTION:

The humerus is the second most common site of metastatic disease involving long bones. Humeral lesions can cause significant pain, disability, and pathological fracture. Yet, we still do not understand which patients are at high risk of fracture that may require prophylactic surgical fixation. The Mirel scoring system has been widely used to help predict pathological fractures in long bones, however this system is based on work originally derived from femoral metastases and has only been validated in the lower extremity. The purpose of our study was to assess the validity of the Mirel Score to predict fractures in metastatic lesions of the humerus.

METHODS:

We performed a retrospective electronic chart review of patients with humeral metastases at our institution (2005-2021), with 188 patients meeting the inclusion criteria (n=61 fractures, n=127 no fractures). The humeral metastatic lesion(s) were scored according to the Mirel rating system (location, size, radiographic appearance, and pain) and additional radiographic features collected (cortical breach, diaphyseal location, number lesions). Patients were followed through time to determine if they suffered a pathological fracture. The predictive value of the Mirel score was assessed using sensitivity, specificity, ROC, and logistic regression. Survivorship until fracture was analyzed with Kaplan-Meier curves and the Log Rank test was used to compare survivorship for patients based on Mirel score. Significance was set to $p < 0.01$.

RESULTS:

There were no significant differences in age, gender, side of lesion (left/right) between fracture and non-fracture groups ($p > 0.01$). The Mirel score of 8 points or greater had the best predictive profile with respect to sensitivity 83.6%, specificity 79.5%, and ROC 0.82 (95% CI 0.7 - 0.88), $p < 0.01$ (Table 1). A logistic regression model also demonstrated that a Mirel score of 8 (odds ratio 5.1, 95% CI [1.8 - 13.7], $p < 0.01$) and cortical breach (odds ratio 17.3, 95% CI [5.6 – 53.2], $p < 0.01$) were significant predictors of pathological fracture after controlling for age, gender and side of lesion. Table 2 shows the survivorship profiles for each Mirel Score.

We also performed a subgroup analysis among patients who had pathologic humerus fractures, but no baseline radiograph prior to their fracture (n=119). These patients presented with a pathological fracture to our institution and as such may represent a different stage of progression of the lesion (compared to the cohort with a baseline radiograph of the metastatic lesion who may be earlier in the disease process). This cohort also demonstrated a similar predictive profile: sensitivity 84%, specificity 79.5%, and ROC 0.82 (95% CI 0.76 - 0.87), $p < 0.01$.

DISCUSSION AND CONCLUSION:

In this study, a Mirel score of 8 points or greater had the best predictive profile for predicting fractures in the metastatic humerus. This is distinct to the traditional Mirels' definition of impending pathologic fracture (nine points or greater) that has been shown in the lower extremity. We also demonstrated that the Mirel score had excellent predictive value using radiographs from their index presentation, suggesting its utility even in early disease. Survivorship profiles were also generated to help guide clinical decision making by understanding fracture risk over time.

This study demonstrates that the Mirel rating system is a valid prediction tool for fracture risk in the upper extremity for humeral metastases.