

## Accuracy of pre-operative MRI and radiography in the prediction of intraosseous margins in high-grade bone sarcoma

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**Background:** Limb salvage treatment of long bone sarcoma requires diligent preoperative planning to optimize oncologic and functional outcomes. While obtaining clear surgical margins is of primary importance, minimizing the amount of bone or tissue removed may improve the functional result of the reconstruction. Imaging with MRI and plain radiographs remain the standard for preoperative planning, although there is no clear consensus on which is better for determining resection length and planning the location of the corticotomy. Our goals were to 1) determine the accuracy of MRI and radiography in predicting the final surgical margin, 2) determine if there was a clear pattern of over or underestimation depending on modality, and 3) analyze risk factors for margin prediction errors of > 2 cm.

**Methods:** We performed a retrospective review of all patients with periarticular long bone, high-grade sarcomas who underwent limb salvage surgery between March 2011 and April 2015. We included only those patients with a complete radiographic series and an MRI of the entire tumor performed internally immediately prior to surgery. We recorded patient age, sex, tumor site, and histology. From the pathological report, we recorded the specimen size, tumor size and distance to the bony resection margin. Two independent evaluators recorded the distance from the articular surface to the visible end of the tumor on AP/lateral radiographs and coronal/sagittal MRI using the software provided in our electronic medical record (Philips iSite Enterprise version 3.5.87.0). The margin estimation by imaging was made by subtracting the measured length from the articular surface to the end of visible tumor from the reported specimen size in the pathology report. The statistical analysis was performed using the Student t-test and ANOVA for continuous variables and Fisher's exact test for categorical variables.

**Results:** Nineteen patients with high-grade sarcoma were included. 70% (12/19) were male with a mean age of  $36.5 \pm 21$  years at the time of surgery. The histological type was osteosarcoma in 13 cases, chondrosarcoma in 3, Ewing's sarcoma in 2 and leiomyosarcoma in 1 patient. MRI generally performed better than radiographs, providing a closer estimation in 11/19 patients (58%), but the results did not reach statistical significance ( $p=0.342$ ) (Table 1). Radiographs underestimated margins (i.e. the margin predicted on imaging was larger than the true margin) in 8/19 patients (42%). MRI underestimated margins in 13/19 patients (68%). Predictions more than 2 cm different than the final margins were found in 5/19 patients (26%) on MRI and were more common in osteosarcoma and the humerus or tibia, although no results reached statistical significance (Table 2).

**Conclusions:** In a small series of patients we found that MRI performs slightly better, but statistically equivalent, to plain radiographs in predicting intraosseous margins for limb salvage surgery in long bone sarcoma. Surgeons should be aware that MRI had an error of more than 2 cm in 26% of cases, but no errors were greater than 4 cm. Measurements on preoperative imaging can be used as a guide to aid with corticotomy planning, but are not accurate enough to be the only technique used to determine the location of osseous margins intraoperatively.

Table 1. Mean absolute, minimum, and maximum differences in centimeters by imaging modality and view compared to intraosseous margin reported on final pathology.

	mean absolute difference	minimum difference	maximum difference	range
AP x-ray	1.7	0.1	6.7	-1.8 – 6.7
lateral x-ray	2.1	0.1	7.5	-3.8 – 7.5
combined x-ray	1.8	0.1	7.1	-2.4 – 7.1
coronal MRI	1.2	0	3.9	-3.9 – 1.2
sagittal MRI	1.7	0.1	3.9	-3.8 – 2.7
combined MRI	1.4	0.1	3.8	-3.8 – 2.7

Table 2. Risk factors for an MRI estimate > 2 cm different from the final pathologic margin. SD = standard deviation

	Number ≤ 2 cm	Number > 2 cm	p value
Sex			
Male	8	4	0.603
Female	6	1	
Size in cm (mean [SD])	9.9 (3.6)	11.5 (3.4)	0.391
Histology			
Osteosarcoma	8	5	0.128
Chondrosarcoma	3	0	0.530
Ewing's sarcoma	2	0	1
Bone			
Humerus	4	3	0.305
Femur	6	0	0.128
Tibia	2	2	0.272
Fibula	2	0	1