The Radiologic Aggressiveness Score (RAS) Outperforms Traditional Biopsy in the Preoperative Characterization of Chondrosarcoma of the Extremities for Guidance of Surgical Intervention

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INTRODUCTION: Chondrosarcoma is the second most common primary bone tumor, and its treatment varies largely depending on its grade. Resection-grade tumors (grades 2, 3 or dedifferentiated) are malignant and largely chemo- and radioresistant; therefore, they often require surgical intervention, while resection of low-grade or benign tumors can expose patients to unnecessary risks. Accurate preoperative grading to guide surgical intervention remains a diagnostic challenge. Biopsy has long been the gold-standard for grading chondrosarcoma, but new research has suggested that radiologic methods, such as the Radiologic Aggressiveness Score (RAS), may exceed its accuracy. This study aimed to externally validate the use of RAS compared to biopsy in the preoperative grading of chondrosarcoma.

METHODS: Seventy patients who underwent resection of primary intraosseous chondrosarcoma in long bones from 2000 to 2024 were reviewed in a retrospective analysis. Inclusion required the presence of preoperative X-rays and advanced imaging. Nine radiologic parameters were scored (pathologic fracture, circumferential endosteal scalloping, longitudinal endosteal scalloping, medullary expansion, complete cortical erosion, periosteal reaction, cortical thickening, marrow oedema, and a soft tissue component), with the presence of each parameter earning one point. Resection-grade lesions were defined by a RAS of ≥4/9. Preoperative biopsy grade was also recorded. Final surgical pathology grades were compared to preoperative RAS and biopsy grades to determine each method's accuracy in distinguishing low-grade from resection-grade tumors.

RESULTS: A RAS of ≥4 was significantly more sensitive (92% vs. 57%; $p<0.001$) and accurate (90% vs. 65%; $p=0.002$) in determining resection-grade vs. low grade chondrosarcoma compared to biopsy. Specificity did not differ significantly between groups. Six cases were inaccurately graded by biopsy but correctly by RAS, while none were inaccurately predicted by RAS but correctly by biopsy. Mean RAS scores were 1.6/9 for low-grade and 5.9/9 for resection-grade tumors ($p<0.001$). When controlling for potentially confounding variables, the parameters most associated with prediction of resection-grade histology were complete cortical erosion, periosteal reaction, and soft tissue extension ($p<0.01$).

DISCUSSION AND CONCLUSION: The RAS is a highly sensitive and accurate standardized tool for preoperatively grading long-bone chondrosarcomas. It outperforms biopsy in signaling tumors that are resection-grade, decreasing the potential for malignant tumors to be left untreated. Further studies should evaluate the potential for RAS use in non-long bone chondrosarcomas and whether certain parameters signal worse clinical outcomes.