Patterns and Timing of Local Recurrence in Benign Bone Tumors

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Significance & Hypothesis: Benign bone tumors comprise a heterogeneous group of lesions with variable risks of local recurrence following resection. While recurrence is well recognized, a critical knowledge gap exists regarding when recurrences occur and how they present (symptomatic vs. radiographic) across different histologic subtypes. At present, standardized postoperative surveillance guidelines exist only for giant cell tumor, leaving follow-up for other benign tumors to clinician discretion. This lack of evidence may lead to excessive imaging and cost for some tumors, while delaying detection of clinically silent recurrences in others. We hypothesized that recurrence timing and mode of presentation are dictated by histologic subtype, enabling the development of histology-specific surveillance strategies.

Innovation: This study provides a unique, comparative analysis of local recurrence patterns across eight benign bone tumor histologies within a single institutional cohort. Unlike prior studies that focus on individual tumor types, this work uniquely categorizes recurrence presentation, directly linking recurrence behavior to surveillance utility. By defining histology-specific time-to-recurrence windows, this study offers the first evidence-based framework for de-escalating or intensifying postoperative surveillance based on tumor biology.

Approach (Materials & Methods): We performed a retrospective cohort study of 329 curative-intent procedures for benign bone tumors at a single tertiary academic center from 2010–2024. Included histologies were giant cell tumor (GCT), aneurysmal bone cyst (ABC), unicameral bone cyst (UBC), osteoid osteoma (OO), osteoblastoma (OB), chondroblastoma (CB), non-ossifying fibroma (NOF), and chondromyxoid fibroma (CMF). Local recurrence was defined by histology or characteristic imaging. Recurrences were classified as symptomatic if prompted by new pain or patient concern, and radiographic if detected incidentally on surveillance imaging. Primary outcomes were recurrence presentation and time to recurrence; secondary outcomes included recurrence by filler type in GCT. Statistical analyses included Wilcoxon rank-sum, Fisher's exact, and Spearman correlation tests, with Holm correction for pairwise comparisons ($p<0.05$).

Results: Forty-two local recurrences (12.8%) were identified. Histology was the primary determinant of recurrence presentation ($p=0.001$). OO and OB recurred exclusively symptomatically (100%), while ABC (80%), UBC (78.9%), and GCT (62.5%) recurred predominantly asymptomatically. CB recurred predominantly symptomatically (66.7%, n=2). No recurrences occurred in NOF or CMF. Median time to recurrence was 10.1 months. All OB and 83.3% of OO recurrences occurred within one year. By three years, 100% of OO, ABC, and OB recurrences had occurred; by five years, all tumors except a single late CB recurrence had recurred. In GCT treated with curettage, cement was strongly protective compared with allograft (3.4% vs. 33.3% recurrence, $p=0.007$). Recurrence timing was not associated with age, sex, tumor site, or surgical method.

Discussion & Impact: These findings support a shift toward histology-specific postoperative surveillance. For OO and OB, routine imaging provides limited value, and symptom-based follow-up is sufficient. In contrast, UBC, GCT, and ABC frequently recur silently, justifying structured radiographic surveillance for 3–5 years. Additionally, the marked reduction in GCT recurrence with cement suggests filler choice plays a critical role in local control. Adoption of biology-driven surveillance protocols may reduce unnecessary imaging, improve early detection of silent recurrences, and optimize resource utilization.

Figures:

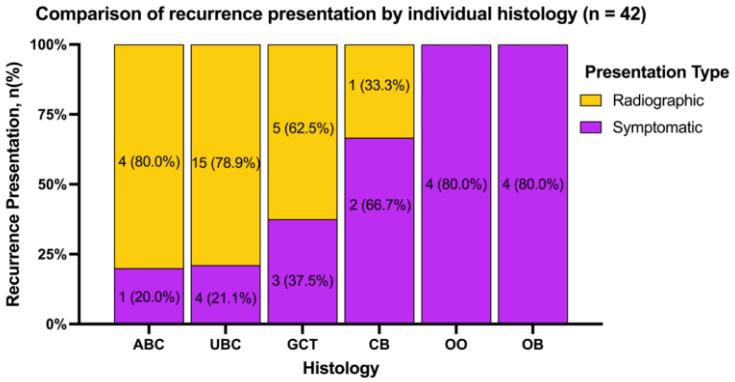

Figure 1. Comparison of recurrence presentation by individual histology (n = 42)

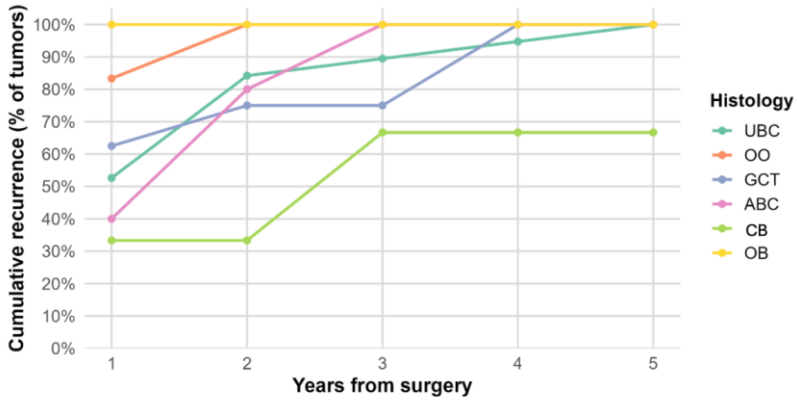

Figure 2. Cumulative tumor recurrence by histology over 5 years after surgery (n = 42)

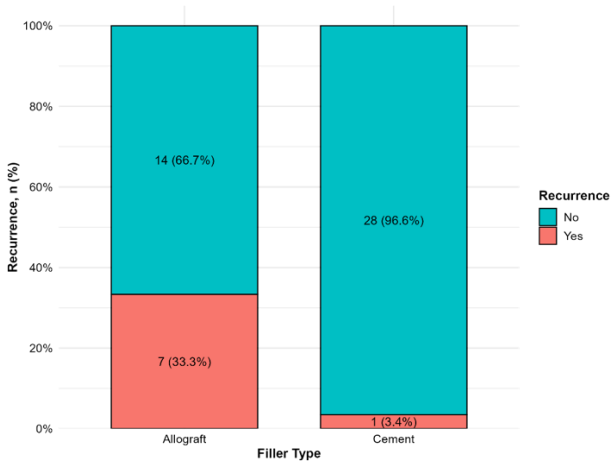

Figure 3. Recurrence rate by filler type in patients with Giant Cell Tumor treated with curettage (n = 50)

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