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CLINICAL RESEARCH

Giant Cell Tumor of Bone

Risk Factors for Recurrence

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Abstract

Background Many surgeons treat giant cell tumor of bone (GCT) with intralesional curettage. Wide resection is reserved for extensive bone destruction where joint preservation is impossible or when expendable sites (eg, fibular head) are affected. Adjuvants such as polymethylmethacrylate and phenol have been recommended to reduce the risk of local recurrence after intralesional surgery. However, the best treatment of these tumors and risk factors for recurrence remain controversial.

Questions/purposes We evaluated the recurrence-free survival after surgical treatment of GCT to determine the influence of the surgical approach, adjuvant treatment, local tumor presentation, and demographic factors on the risk of recurrence.

Methods We retrospectively reviewed 118 patients treated for benign GCT of bone between 1985 and 2005. Recurrence rates, risk factors for recurrence and the development of pulmonary metastases were determined. The minimum followup was 36 months (mean, 108.4 ± 43.7; range, 36–233 months).

Results Wide resection had a lower recurrence rate than intralesional surgery (5% versus 25%). Application of polymethylmethacrylate decreased the risk of local recurrence after intralesional surgery compared with bone grafting; phenol application alone had no effect on the risk of recurrence. Pulmonary metastases occurred in 4%; multidisciplinary treatment including wedge resection, chemotherapy, and radiotherapy achieved disease-free survival or stable disease in all of these patients.

Conclusion We recommend intralesional surgery with polymethylmethacrylate for the majority of primary GCTs. Because pulmonary metastases are rare and aggressive treatment of pulmonary metastases is usually successful, we believe the potential for metastases should not by itself create an indication for wide resection of primary tumors.

Level of Evidence Level III, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

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Introduction

GCT of bone is a rare primary skeletal lesion accounting for approximately 5% of all primary bone tumors in adults. GCT has been described histologically as a benign neoplastic lesion consisting of three cell types: mononuclear histiocytic cells, multinucleated giant cells that resemble osteoclasts, and neoplastic stromal cells that are the main proliferating cell population [52]. On plain radiographs, the tumors appear as lytic lesions without matrix calcification (Fig. 1). Tumors arise in the metaepiphyseal region of long bones, predominantly in the distal femur and the proximal

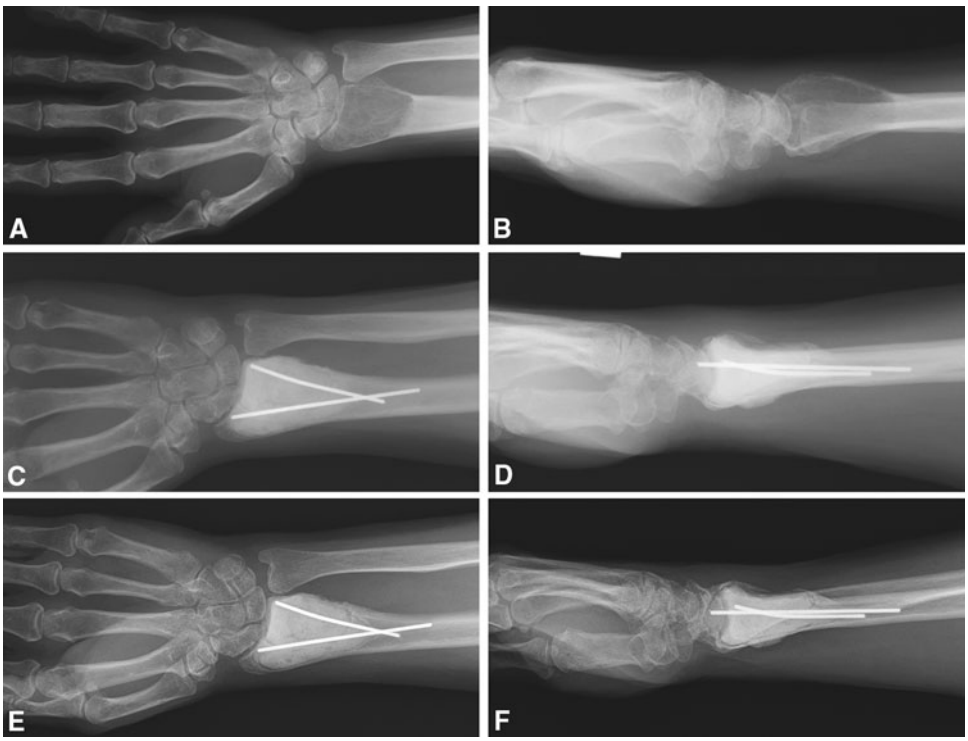

Fig. 1A–F (**A**) AP and (**B**) lateral views are shown of a GCT of the distal radius at diagnosis. (**C**) AP and (**D**) lateral radiographs obtained 6 months after intralesional surgery with polymethylmethacrylate filling are shown. (**E**) AP and (**F**) lateral radiographs obtained at the 3-year followup show no signs of recurrence.

tibia, but they can occur in the entire skeleton [6]. Clinically, GCT presents as a benign but often aggressive lesion with a tendency toward local recurrence. Depending on the type of treatment and the local presentation of the tumor, recurrence rates range from 0% to 65% (Table 1) [1, 3, 5, 6, 15, 20, 25, 26, 29, 31, 37, 38, 40, 43, 50].

Many surgeons treat GCT with intralesional curettage combined with high-speed burring to improve the thoroughness of tumor removal. It is the least invasive surgical option and usually allows preservation of the joint adjacent to the tumor. Intralesional curettage using bone graft as void filler and no additional adjuvants (such as cryotherapy or phenol) has been reported to result in recurrence rates between 12% and 65% [1, 3, 5, 6, 31, 40, 47, 50]. Recent studies indicated polymethylmethacrylate void filling and other adjuvants decrease the risk of local recurrence [1, 3, 22]. However, Blackley et al. [5] and Turcotte et al. [50] reported similar recurrence rates without the use of polymethylmethacrylate or other adjuvants. Wide resection is recommended when sacrificing the affected bone provides superior tumor control with minor functional impairment such as for tumors of the fibular head and the distal ulna [14, 16, 27]. Likewise, tumors with extensive bone destruction and large soft tissue mass or without the possibility to save the adjacent joint as a result of loss of the articular continuity are treated preferentially with wide resection [23, 31, 32, 51]. Various studies suggest wide resection is associated with a decreased risk of local recurrence as compared with intralesional curettage and may increase the recurrence-free survival rate to 84% to 100% [1, 3, 5, 6, 11, 25, 31, 50]. However, wide resection is associated with higher rates of surgical complications [31] and often is accompanied by considerable functional impairment [19, 26, 37]. In long bones, wide resection generally necessitates reconstruction with arthroplasties [22, 31, 46] or massive allografts [46].

In 1986, we reported experience with 146 patients treated surgically for primary GCT [31]. In that report, recurrence rates after wide resection and intralesional excision were 7% and 34%, respectively. The surgical margin was the only factor influencing the risk of local recurrence. None of the patients treated with intralesional curettage had received polymethylmethacrylate void filling. During the last 25 years, treatment strategies have been modified and polymethylmethacrylate has been used increasingly as a substitute for bone grafts.

We first determined the recurrence rates of GCT following wide resection and intralesional surgery and then asked (1) whether adjuvant therapy with polymethylmethacrylate void filling and/or local phenol application after intralesional curettage decreased the risk of local recurrence; (2) if disease-related factors such as tumor extension, pathologic fractures, and tumor localization or patient-related factors such as gender and age contributed to the risk of local recurrence; and (3) whether the development of benign pulmonary metastases was associated with local recurrence.

Table 1. Comparison of studies of GCT

Study	Year	Followup (range)	Patients	Surgical treatment	Recurrences	Lung metastases	Factors influencing recurrence rate
Arbeitsgemeinschaft Knochentumoren [1]	2008	63 months (0–421)	256	Wide resection	2%	NR	Surgical margin
				Curettage	49%		Tumor extension
				Curettage + PMMA	22%		PMMA
				Curettage + PMMA + phenol	27%		
Balke et al. [3]	2008	60 months (8–280)	214	Wide resection	0%	3.3%	Surgical margin
				Curettage	65%		Tumor extension
				Curettage + burr	22%		Location
				Curettage + burr + PMMA	18%		Burr
				Curettage + burr + PMMA + H_2O_2	12%		PMMA H_2O_2
Blackley et al. [5]	1999	80 months (29–132)	59	Curettage + burr	12%	1.7%	NR
Campanacci et al. [6]	1987	2–44 years	280	Wide resection	0%	2.1%	Surgical margin
				Marginal excision	8%		
				Intralesional excision	27%		
Errani et al. [15]	2010	91 months (36–204)	349	Wide resection	12%	4%	Location
				Curettage + burr + phenol	13%		
				Curettage + burr + phenol + PMMA	18%		
Kivioja et al. [22]	2008	5 years (0.2–18)	294	Wide/marginal resection	12%	NR	Surgical margin
				Curettage	51%		PMMA
				Curettage + PMMA	22%		Age
Malek et al. [29]	2006	48 months (18–78)	40	Curettage + burr	33%	NR	None
McDonald et al. [31]	1986	84 months (min. 24)	146	Wide resection	7%	3.2%	Surgical margin
				Intralesion excision ± burr	34%		
O'Donnell et al. [38]	1994	4 years (2–10)	60	Curettage +PMMA	42%	0%	Tumor extension
				Curettage + PMMA + burr	17%		Pathological fracture Location Burr
Prosser et al. [40]	2005	70 months (24–214)	137	Curettage + burring	19%	1.6%	Tumor extension
Saiz et al. [43]	2004	76 months (26–178)	40	Curettage + burr + PMMA + phenol	13%	NR	None
Su et al. [45]	2004	62 months (28–138)	87	Wide resection	3%	1.2%	Surgical margin
				Curettage + burr + phenol	18%		
Trieb et al. [47]	2001	11 years (4–43)	47	Curettage + burr	21%	0%	None
				Curettage + burr + phenol	25%		
Turcotte et al. [50]	2002	60 months (24–192)	156	Wide resection	16%*	NR	None
				Curettage +/− burring +/− PMMA +/− phenol	18%*		
Current study	2010	108 months (36–233)	118	Wide resection	5%	4.2%	Surgical margin
				Curettage + burr	32%		PMMA
				Curettage + burr + phenol	34%		Age
				Curettage + burr + PMMA + phenol	15%		

* Data include patients treated for recurrent GCT; NR = not reported.

Patients and Methods

We retrospectively identified 215 patients diagnosed with histologically confirmed GCT of bone from January 1983 through July 2005. Twenty-six of these patients were referred for consultation only and did not receive any treatment at the Mayo Clinic. Sixty patients had received their initial treatment at an outside hospital and were surgically treated at our institution for local recurrence. To provide a more consistently treated group of patients, we excluded all patients referred to the Mayo Clinic subsequent to primary treatment at another hospital from the study. We therefore reviewed the medical records for all remaining 118 patients primarily treated at the Mayo Clinic. No patients were lost to followup. The patients were not recalled specifically for this study; all data were retrieved from medical records. The minimum followup was 36 months (mean, 108.4 ± 43.7 months; range, 36–233 months).

The lesions were graded according to Campanacci et al. [6] as Grade I, Grade II, or Grade III. Any pathologic fractures were noted. Intracompartmental or extracompartmental tumor growth was identified on the basis of preoperative imaging studies, including CT and MRI and on the basis of intraoperative findings. The compartmental extension was graded T1 or T2 according to the system of Enneking et al. [12, 13] and Wolf and Enneking [53]. All surgical specimens were reviewed by a board certified pathologist specializing in bone and soft tissue pathology and histologically classified as benign GCT.

Intralesional procedures were the most common surgical treatment (n = 95 or 81%) (Table 2). Intralesional procedures included curettage and intralesional excisions, which were performed in the majority of tumors emerging from the spine and the sacrum. For intralesional procedures, a wide cortical window was created to observe the tumor cavity. The tumor tissue was removed with a curette. The borders of the tumor cavity then were ground away with a high-speed burr. The tumor cavity was inspected with a dental mirror or an endoscope to verify the removal of all tumor tissue. Eighty-nine percent phenol was applied in the borders of the cavity with cotton-tipped applicators and then neutralized with alcohol in 40 patients. Finally, the tumor cavity was packed carefully with autologous and/or allogenic bone grafts (n = 54 or 57%) or polymethylmethacrylate (n = 41 or 43%).

Procedures in which polymethylmethacrylate packing was combined with bone grafting were subsumed into polymethylmethacrylate treatment groups. Of the patients treated with intralesional surgery and polymethylmethacrylate void filling, 40 received additional local phenol and alcohol treatment. One patient was treated solely with polymethylmethacrylate and no additional adjuvants. Wide resections were performed in 21 (19%) patients.

Table 2. Descriptive patient demographics and treatment data

Parameter	Mean	SD
Patient age at diagnosis (years)	35.4	15.8
Time to recurrence (months)	16.4	12.3
Followup (months)	108.3	43.8
	Number	Percent
Gender		
Male	53	45.3
Female	65	54.7
Location		
Distal femur	29	24.6
Proximal femur	4	3.4
Distal tibia	6	5.1
Proximal tibia	24	20.3
Proximal fibula	3	2.5
Distal humerus	1	0.8
Proximal humerus	4	3.4
Distal radius	12	10.2
Distal ulna	2	1.7
Proximal ulna	1	0.8
Hand	4	3.4
Scapula	1	0.8
Spine	6	5.1
Sacrum	13	11.0
Pelvis	9	7.6
Grade (Campanacci)		
Grade I	5	4.2
Grade II	46	39.0
Grade III	67	56.8
Tumor extension		
T1	62	52.5
T2	56	47.5
Pathologic fracture	17	14.4
Treatment		
Wide resection	22	18.6
Intralesional surgery	95	80.5
Nonsurgical treatment	1	0.9
Adjuvants		
No adjuvants (bone grafting)	22	23.2
Bone grafting + phenol	32	33.7
PMMA	1	1.1
PMMA + phenol	40	42.2
Recurrences–total	25	21.4
Recurrences–bone	21	17.9
Soft tissue implantations	4	3.4

Reconstructions after wide resections included arthroplasties (n = 7), structural allografts (n = 5), plate/screw reconstructions (n = 4), arthrodesis of the wrist (n = 3),

and osteoarticular allografts (n = 3). In three patients with GCTs of the sacrum, the surgery was combined with external beam radiation, in one patient before surgery and in two patients postoperatively. Amputations were not performed as primary procedures. One patient denying blood transfusion was treated nonsurgically as a result of the high surgical risk and received external beam radiation and tumor embolization instead. Treatment regimes did not differ among patients with different grades of disease. Eleven of 62 T1 tumors (18%) and 11 of 55 T2 tumors (20%) were treated with wide resection; nine of 50 patients (18%) with Grades I/II disease and 13 of 67 patients (19%) with Grade III disease were treated with wide resection.

Patients treated with resection or polymethylmethacrylate reconstructions were allowed to rapidly advance motion and weightbearing as their soft tissue envelopes healed because these reconstructions provided for immediate stability. Those treated with bone grafting procedures were kept none weightbearing with a brace or cast for 6 to 8 weeks followed by a gradual increase in activity as radiographs showed increased graft incorporation.

Routine followups were performed 3 and 6 months after surgery. Subsequently, followups were performed in 6-month intervals until 5 years after surgery. Afterward, checkups were not routinely scheduled. Routine followups included clinical examination and conventional radiographs in two planes. In case of suspicion for local recurrence, additional imaging including MRI and/or CT was performed. If patients were unable to return for followup, a physician in the patient's home community performed a similar examination and the radiographs were sent to our institution for evaluation.

All patients were treated primarily at our institution. Clinical files including operative surgical, radiology, and pathology reports were available for all 118 patients. For 29 patients, preoperative radiographs were taken by outside institutions and were not available. Written reports generated by our radiology department at the time of first consultation were available for these patients. Thus, tumor grading could be performed with available radiographs for 89 of 118 patients. For the other 29 patients, tumor grading was performed on the basis of the written radiology reports. With this approach, there were no missing data for statistical analysis.

Differences in the recurrence-free survival between the surgical procedures were calculated with the Kaplan-Meier survival; the log rank test of equality of survivor function was applied to compare treatment groups. Multivariate Cox regression was used to analyze the risk factors of local tumor recurrence. Test of factor interactions was performed to identify potential confounding variables. Statistical analysis was performed using SPSS Version 16 (SPSS Inc, Chicago, IL, USA).

Results

Twenty-five patients (21%) had a local recurrence. One of the patients treated with wide resection had local recurrence. Twenty-four patients (25%) treated with intralesional surgery experienced local recurrence. The mean interval between surgery and recurrence was 16.3 ± 12.4 months (range, 4–50 months). In four patients treated with intralesional surgery, two or more instances of recurrence were observed. Repeat surgery achieved local control of the disease, as seen at followup in all patients. There was no identified late presentation of malignant transformation of GCT of bone.

Kaplan-Meier survival analysis (Fig. 2; Table 3) showed patients treated with wide resection had better (p = 0.036) recurrence-free survival as compared with the entire collective of patients treated with intralesional surgery (95% versus 75%). Among patients treated with intralesional surgery, those receiving polymethylmethacrylate void filling and local phenol treatment had better (p = 0.044) recurrence-free survival than patients receiving bone grafting with local phenol application (85% versus 66%). Local phenol use did not improve (p = 0.804) the recurrence-free survival for patients treated with bone grafting (66% [bone grafting plus phenol] versus 68% [bone grafting only]).

Analyzing the hazard ratios associated with recurrence, we found intralesional surgery had a greater risk

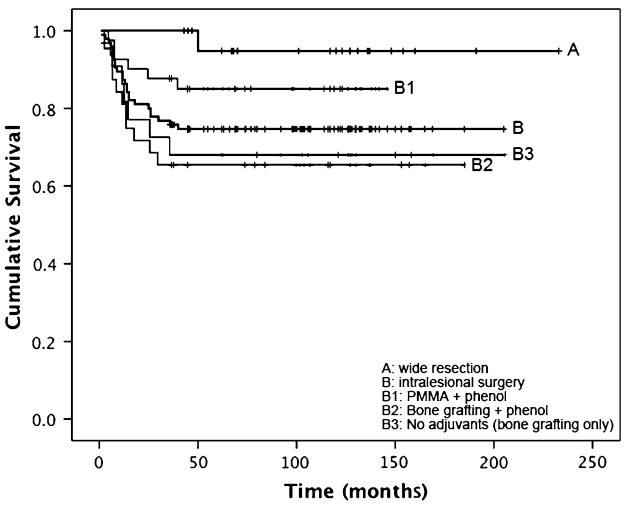

Fig. 2 Recurrence-free survival for patients with primary giant cell tumor (GCT) treated with wide resection (A) and intralesional surgery (B) is shown. Treatment subgroups for patients were intralesional surgery included the use of polymethylmethacrylate (PMMA) and phenol (B1), the use of bone grafting and phenol (B2), and intralesional surgery without adjuvants (B3). The estimated cumulative recurrence free survival (95% confidence interval) rates were 0.947 (0.847–0.999) for Group A, 0.747 (0.659–0.835) for Group B, 0.851 (0.741–0.961) for Group B1, 0.656 (0.491–0.821) for Group B2, and 0.682 (0.488–0.876) Group B3.

Table 3. Kaplan-Meier survival analysis of recurrence-free survival 10 years after surgery

Surgical treatment	Recurrence-free survival	Standard error	Mean recurrence-free survival (months)	95% confidence interval	p (versus wide resection)	p (versus PMMA + phenol)
Wide resection	0.955	0.051	116	109–123	–	–
Intralesional surgery	0.747	0.045	93	84–103	0.036	–
PMMA + phenol	0.854	0.056	105	93–116	0.209	–
Bone grafting + phenol	0.656	0.084	83	66–101	0.009	0.044
No adjuvants (bone grafting)	0.682	0.099	87	67–107	0.018	0.107

($p = 0.042$) of local recurrence compared with wide resection (hazard ratio, 8.71) (Table 4). Among patients undergoing intralesional procedures, those treated with polymethylmethacrylate and local phenol application had a smaller risk ($p = 0.030$) for local recurrence than patients treated with bone grafting and local phenol application (hazard ratio, 3.232). For patients treated with bone grafting, additional phenol application did not decrease the risk ($p = 0.799$) of recurrence (hazard ratio, 1.129).

Among the disease-related and demographic factors analyzed for their impact on recurrence, only age at the time of diagnosis was associated with risk ($p = 0.019$) of local recurrence. Subgroup analysis revealed patients 25 years and younger at diagnosis had the greatest hazard of local recurrence. Age at diagnosis was an independent risk factor for recurrence regardless of the status of the disease and the chosen treatment. The increased risk of recurrence in young patients was not biased by other variables such as type of surgery ($p = 0.089$), adjuvants ($p = 0.22$), tumor grade ($p = 0.67$), tumor extension ($p = 0.72$), and pathologic fractures ($p = 0.63$).

Pulmonary metastases occurred in five patients. In three, pulmonary metastases were associated with recurrent disease; two patients had pulmonary metastases develop without local recurrence. Treatment of pulmonary metastases consisted of a multidisciplinary approach, including wedge resection, chemotherapy, and radiotherapy. With this approach, a status of no evidence of disease or stable disease was achieved in two and three patients, respectively.

Discussion

Intralesional curettage has been established as the preferred treatment for most GCTs. Wide resection is reserved for tumors with extensive destruction, impossible joint salvage, and when expendable bones (ie, fibular head or distal ulna) are affected [14, 16, 23, 27, 31, 32, 51]. We analyzed the recurrence-free survival after treatment of GCT with an emphasis on the impact of surgical approach, adjuvant therapy, tumor presentation, and demographic factors on the risk of recurrence in 118 patients.

Although this investigation benefits from a large group of patients with extended followup, there are several clear limitations to this retrospective study. First, data were gathered from clinical files, and patients were not contacted to assess ultimate outcomes. Second, although the total sample size is relatively large, the number of patients in each treatment group becomes relatively small and limits our ability to draw conclusions. Finally, we limited patients to those treated primarily at our institution. However, this study design did allow us to analyze a large cohort of patients consistently treated. We also had access to a complete set of data for the patients included in this study.

Similar to previous reports [1, 3, 6, 15, 22, 31, 45, 46], we found wide resection was associated with a lower risk of recurrence than intralesional surgery. When intralesional procedures are performed, local adjuvants (polymethylmethacrylate, phenol, hydrogen peroxide, and cryotherapy) have been reported to improve tumor control [1, 3, 5, 11, 28]. We found polymethylmethacrylate use decreased the risk of local recurrence. Similar risk reductions have been observed by others [1, 3, 22], and have been attributed to thermal and toxic effects on tumor cells [33, 36]. Additionally, polymethylmethacrylate may decrease the risk of collapse and allow for more aggressive tumor removal as a result of its favorable mechanical properties. Considering the importance of thorough tumor removal, this capacity may overshadow the effects of heat-mediated tumor effects, a suggestion that also was made by Ghert et al. [18].

Phenol is a commonly used adjuvant for GCT treatment. Phenol induces tumor necrosis [24, 41] with few adverse effects [35, 47]. However, tissue penetration is poor and limits tumor necrosis to superficial cell layers [24]. Yun et al. found a negligible necrotizing effect of phenol and discounted it as an adjuvant after curettage of bone tumors [54]. Others also have reported little effect of phenol on recurrence [1, 47, 49]. However, Durr et al. did report decreased local recurrence with the use of phenol [11]. In the current study, we did not find any effect of adjuvant phenol treatment on GCT recurrence.

Age at diagnosis independently predicted recurrence regardless of the status of the disease and the aggressiveness

Table 4. Hazard of recurrence in association with potential risk factors

Factor	Hazard	95% confidence interval for		p
		Lower	Upper	
Gender				
Male	1.000			
Female	0.825	0.373	1.825	0.635
Age at diagnosis				
≤ 25 years	1.000			
26–50 years	0.519	0.226	1.195	0.123
≥ 51 years	0.190	0.043	0.844	0.029
Location				
Distal femur	1.000			
Proximal femur	0.000	0.000		0.987
Distal tibia	1.744	0.340	8.948	0.505
Proximal tibia	0.618	0.163	2.341	0.479
Proximal fibula	4.897	0.505	47.439	0.170
Distal humerus	0.000	0.000		0.994
Proximal humerus	3.724	0.635	21.859	0.145
Distal radius	0.000	0.000		0.995
Distal ulna	1.032	0.194	5.481	0.970
Proximal ulna	0.000	0.000		0.992
Hand	4.199	0.779	22.635	0.095
Scapula	0.000	0.000		0.994
Spine	1.375	0.250	7.546	0.714
Sacrum	0.594	0.103	3.410	0.559
Pelvis	1.100	0.203	5.969	0.912
Grade (Campanacci)				
Grade I	1.000			
Grade II	0.679	0.072	6.438	0.736
Grade III	1.152	0.103	12.944	0.909
Tumor extension				
T1	1.000			
T2	0.833	0.205	3.380	0.789
Pathologic fracture				
No	1.000			
Yes	0.698	0.138	3.545	0.665
Surgery				
Wide resection	1.000			
Intralesional surgery	8.711	1.063	71.415	0.042
Adjuvants				
PMMA + phenol	1.000			
Bone grafting + phenol	3.232	1.122	9.310	0.030
No adjuvants (bone grafting)	2.862	0.908	9.022	0.073

of the chosen treatment: recurrence rate decreased as the patient's age increased. The greater risk of young patients having recurrence develop has been reported [22] and may be associated with increased bone turnover in young people [21, 34]. This hypothesis is supported by studies showing inhibition of bone turnover with bisphosphonates reduced the risk of recurrence of GCT [7, 9, 17, 48].

Other demographic and disease-related variables (gender, location, tumor grade, soft tissue extension, and pathologic fracture) had no influence on local recurrence in our patients included in this study. Previous studies also have shown that gender, location, and tumor grade did not influence recurrence [1, 3, 43, 50]. The prognostic relevance of soft tissue expansion and pathologic fractures is controversial [1, 3, 15, 22, 31, 38, 40, 50]. Becker et al. found the prevalence of soft tissue extension influenced the risk of local recurrence [1] and O'Donnell et al. reported pathologic fractures were associated with an increased recurrence rate [38]. The aggressiveness of the treatment should be considered when interpreting the correlation of soft tissue expansion or pathologic fractures and local recurrence. In the current study, wide resection was performed in 18% and 20% of T1 and T2 tumors, respectively, indicating the recurrence rates of T1 and T2 tumors were not biased by differences in the aggressiveness of surgical treatment. In tumors with and without pathologic fractures, wide resections were performed in 47% and 14%, respectively. Thus, patients with pathologic fractures more commonly received resections. In this retrospective study, this may underestimate the risk of recurrence in patients with pathologic fractures.

The rate of pulmonary metastases in our study patients was 4%, similar to previous reports reporting ranges from 0% to 4% [3, 4, 8, 10, 15, 20, 30, 39, 42, 44, 49]. Two of five patients were diagnosed with metastases at presentation, showing patients with GCT are at risk for development of synchronous pulmonary metastases. Although GCT is classified as a benign lesion [52], few patients develop progressive lung metastases with poor outcomes [2, 6, 44]. Our treatment approach, including wedge resections, radiotherapy, and chemotherapy, achieved disease eradication or stability in all patients with pulmonary metastases.

It is difficult to quantify the real morbidity (physical and emotional) of patients who experience recurrence and require repeat surgery. Based on the results of this study, we recommend intralesional surgery for treating most GCTs; the selection of bone graft versus polymethylmethacrylate remains individualized. Because young age is a risk factor for local recurrence, we favor the use of polymethylmethacrylate in young patients as the best way to minimize recurrence and preserve the native joint. Similarly, when little bone stock remains or for patients with questionable compliance for a limited weightbearing rehabilitation, methylmethacrylate is favored for its immediate stability. Local phenol treatment did not reduce

the risk of recurrence, and we no longer consider phenol an effective adjuvant. Finally, patients with adverse presentations or an adamant desire for one surgery may be best suited for resection at the time of presentation. However, because the treatment of pulmonary metastases in patients with GCT usually controls the disease and metastases may occur independent of recurrence, we believe the potential risk for development of pulmonary metastases should not by itself create an indication for wide resection of primary tumors.

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