

## References

- 47.** Capanna R, Fabbri N, Bettelli G. Curettage of giant cell tumor of bone. The effect of surgical technique and adjuvants on local recurrence rate. *Chir Organi Mov.* 1990;75(1)(Suppl):206.
- 48.** O'Donnell RJ, Springfield DS, Motwani HK, Ready JE, Gebhardt MC, Mankin HJ. Recurrence of giant-cell tumors of the long bones after curettage and packing with cement. *J Bone Joint Surg Am.* 1994 Dec;76(12):1827-33.
- 49.** Wittig JC, Simpson BM, Bickels J, Kellar-Graney KL, Malawer MM. Giant cell tumor of the hand: superior results with curettage, cryosurgery, and cementation. *J Hand Surg Am.* 2001 May;26(3):546-55.
- 50.** Ghert MA, Rizzo M, Harrelson JM, Scully SP. Giant-cell tumor of the appendicular skeleton. *Clin Orthop Relat Res.* 2002 Jul;400:201-10.
- 51.** Ward WG Sr, Li G 3rd. Customized treatment algorithm for giant cell tumor of bone: report of a series. *Clin Orthop Relat Res.* 2002 Apr;397:259-70.
- 52.** Saiz P, Virkus W, Piasecki P, Templeton A, Shott S, Gitelis S. Results of giant cell tumor of bone treated with intralesional excision. *Clin Orthop Relat Res.* 2004 Jul;424:221-6.
- 53.** Benevenia J, Patterson FR, Beebe KS, Abdelshahed MM, Ugolaloro AD. Comparison of phenol and argon beam coagulation as adjuvant therapies in the treatment of stage 2 and 3 benign-aggressive bone tumors. *Orthopedics.* 2012 Mar;35(3):e371-8. Epub 2012 Mar 07.

**TABLE E-1 Reported Recurrence Rates After Curettage of Giant Cell Tumors with Use of Various Local Adjuvants\***

Study	Follow-up (Range) (mo)	N	Recurrence Rate According to Local Adjuvant Used					
			None	P + BG	P + PMMA	PMMA	LN + BG	LN + PMMA
Marcove 1978 <sup>21†</sup>	43 (3-120)	52	—	—	—	—	23% (12/52)	—
Jacobs 1985 <sup>29</sup>	(26-132)	12	—	—	—	—	17% (2/12)	—
Capanna 1990 <sup>47</sup>	NR	667	45% (126/280)	19% (28/147)	3% (1/33)	19% (36/187)	20% (4/20)	—
Marcove 1994 <sup>25‡</sup>	147 (24-170)	7	—	—	—	—	29% (2/7)	—
O'Donnell 1994 <sup>48</sup>	48 (24-120)	60	—	—	18% (3/17)	28% (12/43)	—	—
Alkalay 1996 <sup>27</sup>	24-48	5	—	—	—	—	—	0% (0/5)
Dürr 1999 <sup>17</sup>	61 (6-178)	26	43% (3/7)	9% (1/11)	—	—	—	—
Malawer 1999 <sup>24</sup>	78 (48-180)	102	—	—	—	—	9% (8/86)	—
Schreuder 1999 <sup>26</sup>	34 (18-79)	13	—	—	—	—	31% (4/13)	—
Trieb 2001 <sup>16</sup>	121 (48-516)	47	21% (3/14)	25% (3/12)	—	—	—	—
Wittig 2001 <sup>49§</sup>	54 (49-62)	3	—	—	—	—	—	0% (0/3)
Boons 2002 <sup>13</sup>	84 (24-372)	21	—	—	—	25% (1/4)	42% (5/12)	20% (1/5)
Ghert 2002 <sup>50</sup>	62 (24-224)	75	—	—	33% (3/9)	16% (6/38)	—	—
Turcotte 2002 <sup>42#</sup>	57 (24-192)	148	—	18% (NR/37)	18% (U/U)	18% (NR/62)	0% (0/10)	—
Wada 2002 <sup>32</sup>	46 (24-188)	15	—	—	—	7% (1/15)	—	—
Ward 2002 <sup>51</sup>	59 (12-115)	24	—	11% (1/9)	8% (1/13)	0% (0/1)	—	—
Saiz 2004 <sup>52</sup>	76 (28-175)	40	—	—	13% (5/40)	—	—	—
Su 2004 <sup>43</sup>	62 (28-138)	87	—	18% (10/56)	—	—	—	—
Abdelrahman 2009 <sup>28</sup>	34 (24-40)	28	—	—	—	—	—	4% (1/28)
Balke 2009 <sup>7**</sup>	60 (8-281)	214	58% (32/55)	—	12% (5/42)	29% (26/91)	—	—
Becker 2008 <sup>9</sup>	64 (1-440)	256	49% (32/65)	—	26% (13/50)	22% (15/69)	—	—
Kivioja 2008 <sup>1</sup>	60 (3-216)	294	51% (24/47)	—	—	22% (32/147)	—	—
Errani 2010 <sup>5</sup>	91 (36-204)	349	—	18% (24/136)	13% (8/64)	—	—	—
Gaston 2011 <sup>33</sup>	77 (2-319)	330	30% (73/246)	—	—	14% (12/84)	—	—
Klenke 2011 <sup>10</sup>	108 (36-233)	118	32% (7/22)	34% (11/32)	15% (6/40)	0% (0/1)	—	—
Lin 2011 <sup>19</sup>	58 (36-156)	26	—	12% (3/26)	—	—	—	—
Benevenia 2012 <sup>53</sup>	55 (10-184)	93	—	22% (4/18)	—	—	—	—
van der Heijden 2012 <sup>11</sup>	96 (24-288)	93	—	—	27% (20/75)	28% (5/18)	—	—
Present study	93 (24-266)	132	—	—	28% (23/82)	—	38% (9/24)	31% (8/26)
Mean recurrence rate (range) (%)		41 (21-58)	19 (9-34)	19 (3-33)	20 (0-29)	19 (0-42)	15 (0-31)	

\*P = phenol, BG = bone grafts, LN = liquid nitrogen, NR = not reported, and U = unknown. †In later cases only, PMMA was used instead of bone grafts, but the number receiving such treatment was not stated. ‡Only giant cell tumors of the sacrum were reported. §Only giant cell tumors of the small bones of the hand were reported. #Only the overall recurrence rate (18%) was given after curettage with various adjuvants including phenol, PMMA, liquid nitrogen, and combinations thereof. The recurrence rate was further specified only for the use of liquid nitrogen (0%). \*\*H<sub>2</sub>O<sub>2</sub> was used as an alternative to phenol as a local adjuvant.

**TABLE E-2 Reported Complications After Curettage of Giant Cell Tumors with Use of Various Local Adjuvants**

Study	Follow-up (Range) (mo)	Local Adjuvant*	N	No. of Complications						
				Total	Fracture	Wound Infection	Skin Necrosis	Degenerative Change	Nerve Palsy	Other
Marcove 1978 <sup>21</sup>	43 (3-120)	LN ± PMMA	52	31 (60%)	13	8†	4	2	4	—
Jacobs 1985 <sup>29</sup>	(26-132)	LN	12	6 (50%)	6	—	—	—	—	—
Marcove 1994 <sup>25†</sup>	147 (24-170)	LN	7	3 (43%)	—	2	—	—	—	1 rectal fistula
Alkalay 1996 <sup>27§</sup>	(24-48)	LN + PMMA	5	0 (0%)	—	—	—	—	—	—
Malawer 1999 <sup>24</sup>	78 (48-180)	LN	102	12 (12%)	6	—	3	2	1	—
Schreuder 1999 <sup>26</sup>	34 (18-79)	LN	13	2 (15%)	—	1	—	1	—	—
Wittig 2001 <sup>49#</sup>	54 (49-62)	LN + PMMA	3	0 (0%)	—	—	—	—	—	—
Boons 2002 <sup>13</sup>	84 (24-372)	PMMA	4	1 (25%)	—	1	—	—	—	—
		LN	12	4 (33%)	—	1	—	—	3	—
		LN + PMMA	5	0 (0%)	—	—	—	—	—	—
Ghert 2002 <sup>50</sup>	62 (24-224)	PMMA (with P)	47 (9)	8 (17%)	5	—	—	3	—	—
Wada 2002 <sup>32</sup>	46 (24-188)	PMMA	15	2 (13%)	1	—	—	1	—	—
Ward 2002 <sup>51</sup>	59 (12-115)	P + PMMA	13	5 (38%)	—	—	—	3	—	1 nonunion, 1 pain
Saiz 2004 <sup>52</sup>	76 (28-175)	P + PMMA	40	3 (8%)	1	—	—	2	—	—
Abdelrahman 2009 <sup>28</sup>	34 (24-40)	LN + PMMA	28	4 (14%)	2	1	1	—	—	—
Present study	77 (2-319)	None	246	14 (6%)	4	1	—	3	3	1 neuroma, 2 pain
		PMMA	84	18 (21%)	4	2	—	11	—	1 neuroma
	93 (24-266)	P + PMMA	82	9 (11%)	—	1	—	6	—	2 nonunion
		LN + PMMA	26	7 (27%)	1	1	—	4	—	1 PMMA leakage
		LN	24	8 (33%)	2	2	—	3	1	—

\*LN = liquid nitrogen, and P = phenol. †Four deep wound infections and four superficial wound infections. ‡Only giant cell tumors of the sacrum were reported. §Two-stage local excision with LN + PMMA was performed for giant cell tumors with intra-articular fracture, first aiming at fracture reduction and union with temporary bone graft and PMMA filling, followed by meticulous repeat curettage with LN + PMMA. #Only giant cell tumors of the small bones of the hand were reported.