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Surgical Management for Giant Cell Tumor of Bones

EL SAYED ASHRAF KHALIL, M.D. FRCS; ALAA YOUNIS, M.D.;
SHERIF A. AZIZ, M.D and MAGDY EL SHAHAWY, M.D.

The Department of Surgical Oncology, National Cancer Institute, Cairo University.

ABSTRACT

Purpose: To evaluate the different surgical techniques used in the treatment of giant cell tumor of bone and their effect on the rate of local recurrence.

Patients and Methods: This is a prospective study of fifty-two patients with giant cell tumor (GCT) of the bones treated at the National Cancer Institute, Cairo University between 1998 and 2002. All patients were evaluated by clinical examination, plain X-ray, CT scan and MRI (in some cases). Biopsy was taken in all cases to confirm the diagnosis and to define the grade of the tumor. All patients underwent surgical treatment including curettage, curettage combined with cryosurgery and bone cement or bone graft, bone resection and amputation. Selection of the surgical technique was based on site and size of the lesion, soft tissue involvement (intra- or extra-compartmental), tumor grade and if recurrent or not. Patients were followed-up for a minimum of twenty-four months.

Results: Out of 52 patients 14 patients were males and 38 patients were females, (male to female ratio was (1: 2.7). The age of our patients ranged from 13 to 71 years, with a mean age of 32.9 years. Based on Enneking's staging system, 40 patients (77%) were stage IA, 9 patients (17%) were stage IB & 3 were stage IIB. Histopathological examination of all cases revealed giant cell tumor of borderline malignancy. Curettage alone was done in 4 patients, curettage and bone cement in 7 patients, curettage, cryosurgery and bone graft in 4 patients, curettage, cryosurgery and bone cement in 18 patients, resection in 16 patients and amputation in 3 patients. There were no mortalities among our cases. Local recurrence was highest in cases treated with curettage only (50%), lowest in cases treated with curettage and cryosurgery with bone cement (16.6%).

Conclusion: The main primary treatment of GCT is surgery; the type of which depends on preoperative evaluation, which includes clinical evaluation that involves the site and size of the tumor in relation to surrounding structures, together with plain X-ray, CT scan and/or MRI as indicated, and tissue biopsy to define tumor grade.

Curettage alone results in high rate of local recurrence. On the other hand, curettage and adjuvant cryosurgery using bone cement or bone grafts give low rate of local recurrence. Resection is recommended for stages IB and IIB, extremely large lesions, and in cases where resection results in no significant morbidity as proximal fibula and flat bones. Amputation is preserved for massive recurrences and malignant transformation.

Key Words: *Giant cell bone tumor - Surgical management - Curettage - Cryosurgery - Bone cement.*

INTRODUCTION

Giant cell tumor of bones is an unusual neoplasm that accounts for 4% of all primary tumors of bone, and it represent about (10%) of malignant primary bone tumors with it's different grades from borderline to high grade malignancy. Usually, the age of patients ranges from 20 to 55 years , and the peak age incidence is in the third decade of life, with slight female predominance (1.2:1) **[1]**.

It is a locally aggressive tumor which involves the ends of long bones in skeletally mature individuals in more than 80% of cases, and 75% of them occur around the knee joint. Less frequently, giant cell tumors occur in the vertebrae (2-5%) and in the sacrum 10% **[2]**.

The common clinical symptoms are pain related to affected bone, swelling, and decreased range of movement in adjacent joint **[3,4]**.

The diagnosis of giant cell tumor of bones depends mainly on clinical and radiological examination (plain X-ray, and CT scan) on the site of the lesion.

Preoperative biopsy should be taken to confirm the diagnosis and to define the grade of the malignancy **[3]**.

The staging system adopted by Enneking in 1986 **[5]** is used for staging of GCT. It depends on tumor grade (G), location of tumor whether

intra-compartmental or extra-compartmental (T) and presence or absence of metastases (M). According to this classification there are three stages:

1- Stage IA (G1, T1, Mo), low grade intra-compartmental without metastases.
2- Stage IB (G1, T2, Mo), low grade extra-compartmental without metastases.
3- Stage IIA (G2, T1, Mo), high grade intra-compartmental without metastases.
4- Stage IIB (G2, T2, Mo), high grade extra-compartmental without metastases.
5- Stage IIIA (G1or G2, T1, and M1); low or high grade intra-compartmental with metastases.
6- Stage IIIB (G1or G2, T2, M1), low or high grade extra-compartmental with metastases.

Surgery is the main treatment modality for giant cell tumors of bone and includes curettage alone, curettage combined with adjuvant therapy (cryosurgery and bone cement or bone graft), bone resection and amputation **[1,3]**.

Curettage is more extensively used now than before, using both mechanical curettage and mechanical burr. This technique results in decrease in local recurrence rate to 15%-25% **[6]**.

Cryosurgery has been utilized more successfully for giant cell tumors than for any other type of bone tumor because it decreases the local recurrence rate compared to results of curettage alone and also there is no risk of sarcomatous change **[7]**.

Giant cell tumor is not radio-resistant as it was previously believed. It is reported by many authors that there is local control of 75%-85%. Many authors recommend megavoltage radiation as a reasonable alternative to complex and difficult surgery, especially in areas where surgery is not accessible or in patients with high risk for surgery **[8,9]**.

The aim of this study is to evaluate the different surgical modalities used in the treatment of giant cell tumor of bones and their effect on local control of the disease.

PATIENTS AND METHODS

The study population consisted of 52 patients with giant cell tumor of bone treated in the surgical department of the National Cancer Institute, Cairo University, during the period from 1998 to 2002.

After complete general and local examination, the following investigations were done for all patients:

- Routine pre-operative laboratory investigations (complete blood count, liver function tests, kidney function tests, fasting blood sugar and coagulation profile).
- Plain chest x-ray, local plain x-ray and CT scan on the site of the lesion and magnetic resonance imaging (MRI), if needed.
- Preoperative biopsy was done for all patients to confirm the diagnosis and to define the grade of malignancy.

Enneking's staging system was used for staging of our patients.

Different treatment modalities were used including curettage alone, curettage combined with adjuvant therapy (cryosurgery and bone cement), and resection and amputation. Selection of the surgical technique was based on the site and size of the lesion, soft tissue involvement (intra- or extra-compartmental), tumor grade and if recurrent or not.

Surgical technique for curettage and curettage with cryosurgery:

A pneumatic tourniquet was used in limb lesions of distal to middle third of humerus and femur to decrease bleeding and to prevent blood from acting as a thermal barrier when cryosurgery was performed.

After exposure of the involved bone and soft tissues, a cortical window the size of the longest longitudinal dimension of the tumor is made, large enough to expose the entire tumor to reduce the stress rising effect. All gross tumors were removed with hand curettes. In some cases, high speed burr drilling was used if there was doubt regarding removal of the tumor of the inner reactive shell. If cryosurgery was to be done before introduction of liquid nitrogen, bony perforations were identified and sealed, and the surrounding skin, soft tissues and neurovascular bundles were protected and shielded using gauze soaked with saline and large skin flaps were retracted.

The direct pour technique as described by Marcove 1978 **[7]** is still used-up till now and it was performed in our cases. Liquid nitrogen

(-196ºC) was poured through a stainless steel funnel into the tumor cavity. The surrounding soft tissues were irrigated with warm normal saline to avoid thermal injury. Two freeze and thaw cycles were administered, each cycle lasting 1 to 2 minutes and spontaneous thaw was allowed to occur for 3 to 5 minutes. After evaporation, the cavity was irrigated with normal saline and good haemostasis was ensured.

Surgical technique of curettage and bone cement or bone graft:

After all the tumor had been removed as previously described, the cavity was irrigated thoroughly with water and with hydrogen peroxide. The cavity was then filled with polymethylmethacrylate bone cement or a suitable bone graft from the iliac crest.

Wide local resection depends on the site of the tumor (intra-compartmental resection) and was performed in cases where resection was indicated. This en bloc resection included the entire lesion with the reactive zone and a cuff of normal tissue to ensure a good safety margin.

Amputation was reserved for massive recurrence and malignant transformation.

Follow-up was done for 24 months postoperatively by clinical examination, local plain X-ray and CT scan to detect local recurrence.

RESULTS

The age of our patients ranged from 13 to 71 years, with a mean age of 32.9 years. Fourteen patients were males and 38 patients were females, (male to female ratio was (1: 2.7). Fig. (1) shows age and sex distribution among cases with GCT.

In our patients, a higher frequency of distal femur affection was present, representing 13 out of 52 patients (25%) followed by proximal tibia and distal radius with a frequency of 13% and 7% respectively. Rarely affected sites included proximal radius, clavicle, scapula, iliac bone, pubic bone and maxilla, one case each (2% of cases). The anatomic distribution of the tumor is shown in table (1).

Based on Enneking staging system, 40 patients (77%) were stage IA, 9 patients (17%) were stage IB and 3 were stage IIB (Fig. 2). Histopathological examination of all cases revealed giant cell tumor of borderline malignancy.

In our study, different treatment modalities were adopted. Curettage alone was done in 4 patients while curettage and adjuvant therapy was carried out in 29 patients (Table 2). Of the latter, curettage, cryosurgery and bone cement were done in 18 patients (Fig. 3), curettage and bone cement in 7 patients (Fig. 4) and curettage and cryosurgery and bone graft in 4 patients. Resection was performed in 16 patients (Fig. 5). Amputation was done in 3 patients with massive recurrent lesions at the upper end of tibia, lower end of femur and proximal end of radius (Table 3).

The recurrence rate according to each site and treatment modality during the first year of follow-up is listed in table (4). As shown, local recurrence occurred in the two patients with metatarsal and pubic bone GCT where the treatment modality was curettage alone. On the other hand, the lowest rate of recurrence was in patients with distal femur affection who did receive adjuvant treatment in the form of curettage and cryosurgery.

Table (1): Distribution of cases with GCT according to the site.

Site	No.	Percentage
Distal femur	13	25
Proximal tibia	10	19
Distal radius	7	13
Humerus	4	7
Lower tibia	2	4
Vertebrae	2	4
Sacrum	2	4
Proximal fibula	2	4
Distal ulna	2	4
Metacarpal	1	2
Metatarsal	1	2
Proximal radius	1	2
Clavicle	1	2
Scapula	1	2
Iliac bone	1	2
Pubic bone	1	2
Maxilla	1	2
Total	52	100

Table (2): Distribution of cases with GCT according to treatment modality.

Treatment Modality	No. of cases	Percentage
Curettage	4	7.7
Curettage-bone cement	7	13.4
Curettage-cryosurgery-bone cement	18	34.6
Curettage-cryosurgery-bone graft	4	7.7
Resection	16	30.8
Amputation	3	5.8
Total	52	100

Table (3): Surgical technique for each site in GCT patients.

Site	Curettage	Curettage-cement	Curettage-cryosurgery-cement	Curettage-cryosurgery-bone graft	Resection	Amputation	Total No.
Proximal tibia		2	5		2	1	10
Distal femur		3	7	1	1	1	13
Distal radius		1	2	2	2		7
Humerus		1	1	1	1		4
Lower Tibia			2				2
Metacarpal			1				1
Metatarsal					1		1
Vertebrae	2						2
Sacrum					2		2
Proximal fibula					2		2
Distal ulna					2		2
Proximal radius						1	2
Clavicle					1		1
Scapula					1		1
Iliac bone					1		1
Pubic bone	1						1
Maxilla	1						1
Total	4	7	18	4	16	3	52

Table (4): Recurrence rate in 24 months follow-up according to each site and treatment modality among cases with GCT.

Site	Total	LR	Curettage	Curettage-cement	Curettage-cryosurgery-cement	Curettage-cryosurgery-bone graft	Resection	Amputation
Proximal tibia	10	3		1	1		1	
Distal femur	12	3		1	2		1	
Distal radius	7	2		1		1		
Humerus	4							
Lower femur	2							
Metacarpal	1							
Metatarsal	1	1						
Vertebrae	2	1	1					
Sacrum	2							
Proximal fibula	2							
Distal ulna	2							
Proximal radius	1							
Clavicle	1							
Scapula	1							
Iliac bone	1							
Pubic bone	1	1	1					
Maxilla	1							
Total	52	11	2	3	3	1	2	

LR : Local recurrence

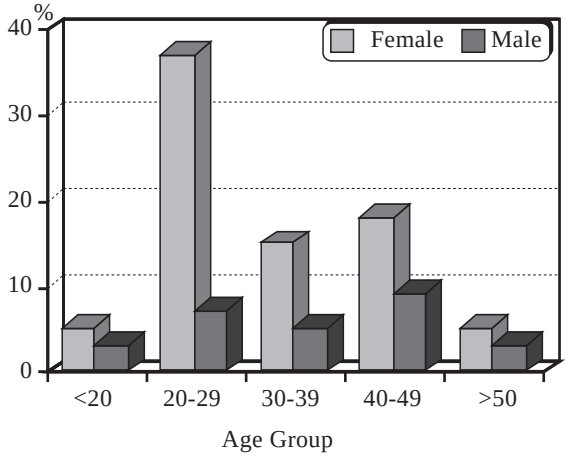

Fig. (1): Age and sex distribution among cases with GCT.

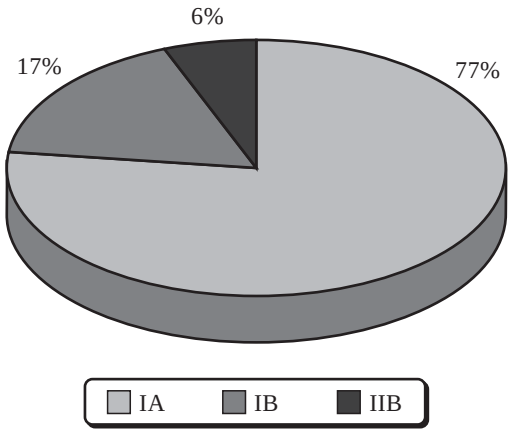

Fig. (2): Distribution of cases with GCT according to the stage.

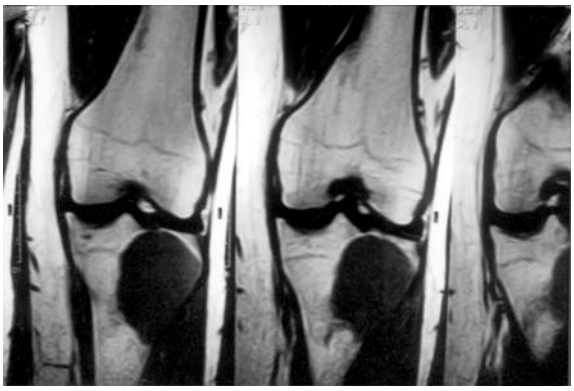

Fig. (3-A): Pre-operative MRI for a patient with GCT upper tibia.

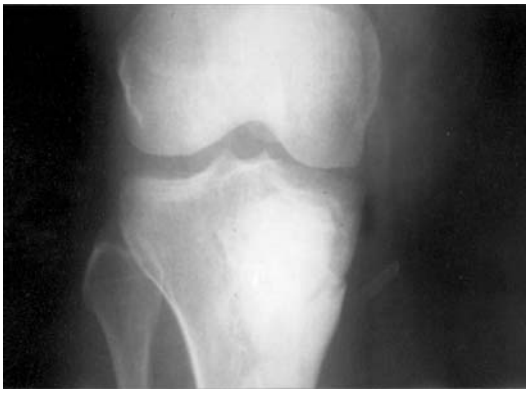

Fig. (3-B): Post-operative plain x-ray for the same patient after curettage, cryosurgery and bone cement.

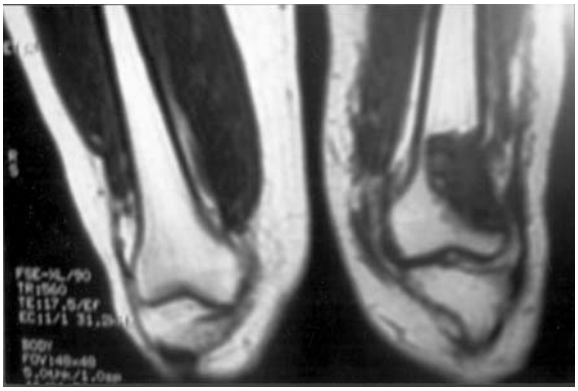

Fig. (4-A): Pre-operative MRI for a patient with GCT lower femur.

Fig. (4-B): Post-operative plain x-ray for the same patient after curettage, cryosurgery and bone graft (using bone chips from the iliac crest).

Fig. (5-A): Photograph for GCT Lower end of ulna.

Fig. (5-B): Plain x-ray lower end of ulna.

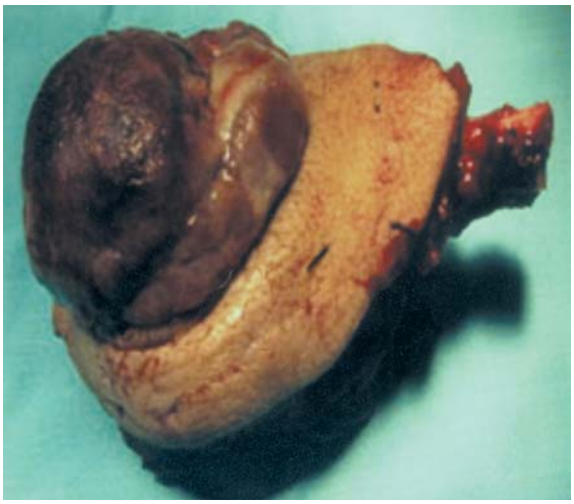

Fig. (5-C): Specimen after resection.

DISCUSSION

Difficulties in local control of GCT of bones as well as high rate of local recurrence following initial surgery have led the investigators to use different surgical modalities for the treatment of GCT according to stage of the disease aiming at decreasing the rate of local recurrence with good functional and cosmetic results **[10]**.

The use of physical adjuvants as cryosurgery and phenol in combination with curettage together with the use of bone cement and bone grafts to preserve shape and strength of the bone helps to achieve good results and limits the indications of resection and amputation. Bone cement compared to bone graft provides immediate support and allows for intensive curettage even of large tumors **[11]**.

Cryosurgery extends the margin of simple curettage, making it biologically equivalent to wide intra-compartmental resection. Cryosurgery entails using a wide excision in situ but without the morbidity of en bloc resection and the need to sacrifice the joint with low rate of local recurrence **[7,12]**. Corticocancellous grafts are required to strengthen the subcortical bone; whereas fibular struts reconstitute the cortical defects **[12]**.

In our study, different treatment modalities were used including curettage, curettage combined with adjuvant therapy, and resection and amputation. The highest rate of local recurrence was in cases treated by curettage alone where two of four cases (50%) had local recurrence within one year of treatment. This result was supported by Persson et al. **[13]** also reported 40% recurrence rate for GCT treated with curettage alone. On the other hand, Khan et al. **[6]** reported a lower rate of local recurrence (17%) in cases of GCT of lower radius treated by adequate curettage and bone stabilization.

With respect to curettage and bone cement, the reported rate of local recurrence by O'Donnell et al. **[14]** using curettage and bone cement was 33.3% that decreased to 16.6% when mechanical burr was used, so they recommend using the burr at the end of all procedures. In addition, when the lesion reached the subchondral bone in weight bearing areas they put a layer of bone cement first under the subchondral plate to support it and then fill the rest of

the cavity either by bone cement or bone graft. Use of barium-impregnated cement allows for early detection of the recurrence because of contrast between it and the bone **[15]**. In our study, we used curettage and bone cement in 7 patients. We did not use mechanical burr in any of our cases, and we did not use barium-impregnated cement in any of our cases. Local recurrence developed in 3 cases (40%).

Curettage and cryosurgery with bone cement or bone graft were done in 22 patients with lowest rate of local recurrence occurring in 4 cases (18%). This result is in harmony with the results of other authers who reported recurrence rates lower than 15% in cases of GCT treated with curettage and cryosurgery **[7,12]**.

Bone resection is not usually recommended because of its significant morbidity. It is only indicated in proximal radius and fibula and distal ulna, tubular bones of hand and foot, coccyx, sacrum and pelvic bones, also in situations in which their reconstruction is not possible as in some patterns of pathological fractures and massive involvement with an incomplete shell of cortex that is insufficient to contain cement **[16]**.

Follow-up for one year revealed that two patients with GCT of distal femur and proximal tibia had recurrence out of sixteen patients with deferent sites of bone affection (Table 3). They were treated primarily by bone resection.

Amputation was reserved for massive recurrence and malignant transformation and it was done for 3 patients in our study in distal femur, proximal tibia and proximal radius.

Radiation therapy as adjuvant treatment is not routinely used because of concerns regarding efficacy of therapy as well as reports that mentioned sarcomatous change after radiotherapy **[16]**. Radiotherapy can be used as an alternative to surgery in cases that cannot be treated with surgery or left with severe disfigurement after surgery **[9,18,19]**. In our study we did not use radiotherapy in the treatment of our patients.

Conclusion:

The main primary treatment of GCT is surgery, the type of which depends on preoperative evaluation which includes clinical evaluation that involves the site and size of the tumor in relation to surrounding structures, together with plain X-ray, CT scan and/or MRI as indicated and tissue biopsy to define tumor grade. Curettage alone results in high rate of local recurrence. On the other hand, curettage and adjuvant cryosurgery using bone cement or bone grafts give low rate of local recurrence. Resection is recommended for stages IB and IIB, extremely large lesions, and in cases where resection results in no significant morbidity as proximal fibula and flat bones. Amputation is preserved for massive recurrences and malignant transformation.

REFERENCES

1- Dahlin DC. Caldwell Lecture. Giant cell tumor of bone: Highlights of 407 cases. AJR Am J Roentgenol. 1985, 144: 955-60.

2- Dahlin DC, Cupps RE, Johnson EWJr. Giant cell tumor: A study of 195 cases. Cancer. 1970, 25: 1061-70.

3- Campanacci M, Baldini N, Boriani S, Sudanese A. Giant cell tumor of bone. J Bone Joint Surg Am. 1987, 69: 106-14.

4- Larsson SE, Lorentzon R, Boquist L. Giant cell tumors of the spine and sacrum causing neurological symptoms. Clin Orthop. 1975, 111: 201-11.

5- Enneking WF. A system of staging musculoskeletal neoplasms. Clin Orthop. 1986, 204: 9-24.

6- Khan MT, Gray JM, Carter SR, Grimer RJ, Tillman RM. Management of the giant-cell tumors of the distal radius. Ann R Coll Surg Engl. 2004, 86 (1): 18-24.

7- Marcove RC, Weis LD, Vaghaiwalla MR, Peerson R, Huvos AG. Cryosurgery in the treatment of giant cell tumor of bone. A report of 52 consecutive cases. Cancer. 1978, 41: 957-69.

8- Chakravarti A, Spiro IJ, Hug EB, Mankin HJ, EFrid JT, Suit HD. Megavoltage radiation therapy for axial and inoperable giant-cell tumor of bone. J Bone Joint Surg Am. 1999, 81 (11): 1566-73.

9- Caudell JJ, Ballo MT, Zagars GK, Lewis VO, Weber KL, Lin PP, et al. Radiotherapy in the management of giant cell tumor of bone. Int J Radiat Oncol Biol Phys. 2003, 57 (1): 158-65.

10- Bennett CJ, Marcus RB, Million RR, Enneking W. Radiation therapy for giant cell tumor of bone. Int J Radiat Oncol Biol Phys. 1993, 26: 299-304.

11- Tunn PU, Schlag PM. Giant cell tumor of bone. An evaluation of 87 patients. Z Orthop Ihre Grenzgeb. 2003, 141 (6): 690-8.

12- Malawar MM, Bickels J, Meller I, Buch RG, Henshaw RM, Kollender Y. Cryosurgery in the treatment of giant cell tumor. Clin Orthop. 1999, 359: 176-88.

13- Persson BM, Ekelund L, Lovdahl R, Gunterberg B. Favorable results of acrylic cementation for giant cell tumors. Acta Orthop Scand. 1984, 55: 209-14.

14- 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, 76 (12): 1827-33.

15- Pettersson H, Rydholm A, Persson B. Early radiologic detection of local recurrence after curettage and acrylic cementation of giant cell tumors. Eur J Radiol. 1986, 6: 1-4.

16- Doita M, Harada T, Iguchi T, Sumi M, Sha H, Yoshiya S, Kurosaka M. Total sacrectomy and reconstruction for sacral tumors. Spine. 2003, 28 (15): 296-301.

17- Malawar MM, Link MP, Donaldson SS. Sarcomas of bone. Cancer Practice of Oncology. 2001, 323: 1926.

18- Bell RS, Harwood AR, Goodman SB, Fornasiever VL. Supervoltage radiotherapy in the treatment of difficult giant cell tumors of bone. Clin Orthop. 1983, 174: 208-16.

19- Schwartz LH, Okunieff PG, Rosenberg A, Suit HD. Radiation therapy in the treatment of giant cell tumors. Int. J Radiat Oncol Biol Phys. 1989, 17: 1085-8.