

Long-term results of reconstruction of giant cell tumor around the knee treated by extended curettage; bone cementing versus autogenous bone grafting

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Abstract:

Introduction

Giant cell tumor (GCT) of bone is a generally benign but locally aggressive, primary bone tumor that is notorious to have a high rate of local recurrence after treatment.

Patients and methods

A prospective randomized clinical study of 40 GCT patients. The cases will be evaluated for functional and oncological outcome after management of giant cell tumor around the knee by extended curettage to compare between reconstruction using bone cementing or bone grafting. All cases were done, in El-Hadara University Hospital. The patients will be divided into 2 groups according to the surgical technique used. Group A, all the patients that will be managed by extended curettage and bone grafting. Group B, All the patients that had extended curettage and bone cementing. Each group consists of 20 patients.

Results

All the results and data of the patients were reported, and scheduled in tables and a comparison was performed statistically between the two methods of surgical treatment and evaluated for oncological and functional outcome. Postoperative local recurrence in bone graft group was less than cement group, however this was not statistically significant. Mean final MSTS score for Group A was more than Group B, however this also was not statistically significant. Four cases in group A had arthritis when compared with Group B six cases. Only one case in group A had knee stiffness while Group B two cases.

Conclusion

From the study, it seems that the long-term functional outcome for cases reconstructed with bone graft is much better than those, reconstructed with bone cement. Although local recurrence was less in cases reconstructed with autogenous bone graft, it is likely that the local recurrence is more related to the adequacy of tumor clearance rather than the reconstructive method. In this context, the use of a high-speed burr is strongly recommended because it allows for more thorough curettage.

INTRODUCTION:

Giant cell tumor (GCT) of bone is generally benign and characterized histologically by multinucleated giant cells with a background of mononuclear stromal cells. The multinucleated giant cells appear similar to osteoclasts, which led to the older term osteoclastoma.⁽¹⁾ Despite being categorized as a benign lesion, GCT may be locally aggressive and may recur after surgical resection.⁽²⁾

It accounts for 5.0% of all primary bone tumors and 20.0% of benign skeletal tumors and show an increased prevalence among females.⁽³⁾

The prevalence of GCT peaks during the 3rd decade, with 80% of cases occurring between 20 and 50 years of age. Less than 3% of cases occur before the age of 14 years, and only 13% of cases occur in patients over the age of 50 years. Most lesions develop in long bones (75%–90%), with

the majority of cases (50%–65%) occurring about the knee.⁽⁴⁾

GCT usually has a well-defined but nonsclerotic margin, and is eccentric in location, extending near the articular surface, and occurs in patients with closed physes. However, it may also have aggressive features or fluid-fluid levels and can mimic other lesions at both radiologic evaluation and histologic analysis.^(3,5,6)

Being a benign locally malignant tumor, GCT treatment is mainly directed towards local control with preservation of related joint function. This is usually performed by intralesional resection of the tumor tissue by curettage with autograft reconstruction by packing the cavity of the excised tumor with morsellised iliac cortico-cancellous bone. Regardless of how thoroughly performed, intralesional excision leaves residual microscopic disease in the bone and hence has a reported recurrence rate as high as 60%. Also autograft quantity is limited and the use of large

amount of allograft for reconstruction of large defects might be limited by the cost.⁽⁷⁾

Alternatively, GCT of bone has been treated surgically with curettage and placement of cement (polymethylmethacrylate) which gives immediate structural support which subsequently allows more rapid weight-bearing ambulation post-operatively. Also Methylmethacrylate monomer is cytotoxic and the thermal effect may help in removing any residual tumor tissue.⁽⁵⁾ Recurrence is suggested by development of progressive lucency at the cement-bone interface. Aggressive GCTs may require wide excision and reconstruction with a modular endoprosthesis.^(8,9)

The aim of this prospective randomized clinical study was to compare the long term results of treatment of Giant cell tumor at the knee by extended curettage and bone cementing versus bone grafting.

PATIENTS AND METHODS:

This study included 40 GCT patients. The cases were evaluated for functional and oncological outcome after management of giant cell tumor around the knee by extended curettage to compare between reconstruction using bone cementing or bone grafting. All cases were done in the period between 2003 and 2014, in El-Hadara University Hospital. The patients were divided into 2 groups based on the surgical reconstructive technique used; Group A, all the patients that had extended curettage and bone grafting. Group B, All the patients that had extended curettage and bone cementing. Each group consisted of 20 patients. The mean duration of follow up was 7.3 years.

The study was done according to the internationally accepted ethical standards, and was approved by the local institutional Ethical committee.

Randomization was done using the closed envelope method, and fully informed consent was taken from all patients.

Patients characterization:

The youngest patient was 14 years old. The mean age at presentation was 32 ± 9.98 years for group A, while the mean age for group B was 30.60 ± 12.04 , the oldest was 56 years. There were 18 males and 22 females. The differences between both groups regarding age and gender were not statistically significant. Both groups were of comparable demographic data.

Site:

A higher frequency of distal femur affection was present in group A representing 14 patients (70%). While a higher frequency of proximal tibia

affection was present in group B representing 12 patients (60%).

Size

<2 cm size Group:

None of the cases among Group A and Group B fitted in this group.

2 – 5 cm size Group:

2 – 5cm size in Group A is 11 out of 20 cases (55% of patients), in contrast to Group B in which 14 out of 20 cases (70% of patients) fitted in this size group.

>5 cm size Group:

In Group A, nine out of 20 cases (45% of patients) were more than 5 cm. In comparison to Group B in which six out of 20 cases (30% of patients) were larger than 5 cm.

Mean final Size for Group A is 5.16 ± 0.80 while in Group B is 4.84 ± 0.85 without statistically significant difference.

Campanacci staging:

Eleven patients of group A were of stage II, while ten patients of group B were of stage II. On the other hand nine patients of Group A are of stage III while 10 patients of Group B are of stage III. None of cases in either group were of stage I. No statistically significant difference between both groups.

Pathological fracture:

Nine patients (45%) presented by pathological fracture in both Group A and B.

I) Preoperative evaluation

All patients were subjected to both clinical and radiological assessment. The later included plain radiographs of the knee, computed tomography as well as MRI of the knee. Fig 1 Also routine preoperative laboratory investigations were done.

II) Methods of Treatment:

Surgical technique:

General or spinal anesthesia was administered as required. A high thigh tourniquet was applied. Extended curettage was done through adequate exposure of the lesion then making a large cortical window to access the tumor. A high power burr to break the bony ridges helps extend the curettage and is recommended. A pulsatile jet lavage system used at the end of the curettage helps to bare raw cancellous bone and physically wash out tumor cells.

Reconstruction using cementation or bone graft alternatively. Fig 2.

Follow up:

Every patient was subjected to a first visit after six weeks then regular visits every three months for at

least two years , with a mean duration of follow up was 7.3 years. In each visit the following data were recorded:

- Clinical assessment in the form of pain, limping and range of motion limitations.
- Radiological assessment check x-rays to assess radiological signs of infection or recurrence. Fig 3

III) Methods of assessment of the results:

Clinical and Functional:

During follow-up (at least two years), patients were evaluated with Musculoskeletal Tumor Society (MSTS) scores. The MSTS system scores 6 categories (pain, overall function, acceptance, supporting tools, walking, and gait). Each category is rated 0–5 with 0 being the worst score and 5 the best (e.g., for the pain category 0 = serious pain and 5 = no pain), for a total score of 30. A score of 24 to 30 is considered excellent, 18 to 23 good, 12 to 17 fair, and < 12 points poor.

IV) Methods of statistical analysis:

Descriptive statistics was done using mean and standard deviation, and significance tests were used. SPSS software package version 20 (IBM Corp. Released 2011. IBM SPSS statistics for windows, version 20.0. Armonk, NY; IBM Corp.)

RESULTS:

Oncological outcome:

Postoperative local recurrence in Group A was confined to one case (5.0% of patients), while in group B there were four cases of recurrence out of twenty (20% of Patients). It is of p value 0.342 with no statistically significant difference.

Functional outcome:

Fair and poor function (Below 17 score) Group:

None of the patients in group A had a score below 17 when compared with Group B 1/20 cases (5% of Patients).

Good and excellent function (Above 17 score) Group:

All the cases in group A had a score above 17, when compared with Group B 19/20 cases (95.0% of Patients).

Mean final MSTS score for Group A is 26.0 ± 3.92 , while in Group B is 25.70 ± 2.81 , however this was not statistically significant.(table 1)

Table (1): Comparison between the functional outcome of both groups According to Musculoskeletal Tumor Society Rating Scale (MSTS) for functional evaluation

Total MSTS score	Group A (n = 20)		Group B (n = 20)		Test of Sig.	P
	No.	%	No.	%		
Unsatisfactory	0	0.0	1	5.0	$\chi^2 = 1.387$	MC p= 0.712
Poor (<12)	0	0.0	0	0.0		
Fair (12 – 17)	0	0.0	1	5.0		
Satisfactory	20	100.0	19	95.0		
Good (18 – 23)	6	30.0	4	20.0		
Excellent (24 – 30)	14	70.0	15	75.0		
Mean \pm SD.	26.0 ± 3.92		25.70 ± 2.81		t = 0.278	0.782

Four cases in group A had arthritis when compared with Group B 6/20 cases (30%). It is of p value 0.465,(Statistically insignificant).

Complications:

Only one case in group A had knee stiffness while Group B 2/13 cases (10%). It is of p value 1.000 (Statistically insignificant).Table 2.

Table (2):Comparison between both groups regarding the occurrence of Knee stiffness

Complication	Group A (n = 20)		Group B (n = 20)		χ^2	FE p
	No.	%	No.	%		
No	19	95.0	18	90.0	0.360	1.000
Yes (Stiff knee)	1	5.0	2	10.0		

Case presentation:

Female patient 17 years old complaining from painful swelling of the left knee 4 months duration. Patient sought medical advice and had radiological and histopathological investigations. Patient was diagnosed as GCT of left distal femur. She underwent surgery in the form of curettage of the lesion and bone graft.

- The patient's functional score was 96.6% after 25 months follow up.

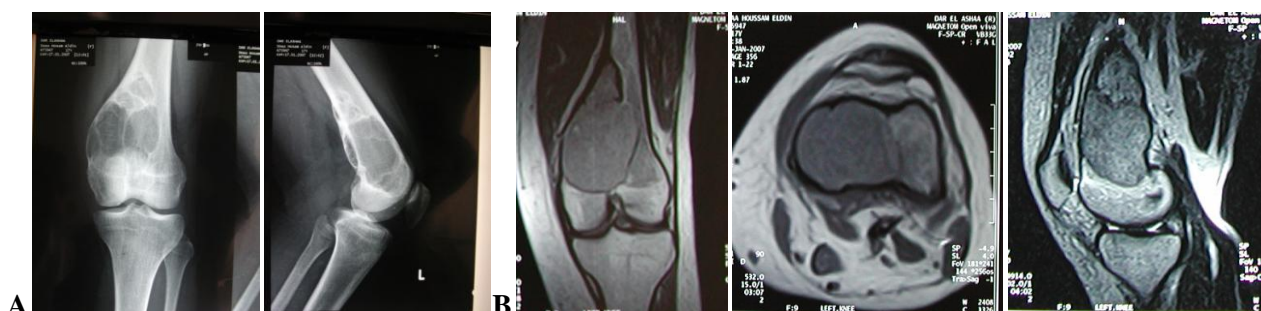


Fig. (1): A): The preoperative x-ray, B): MRI showing lesion in the distal femur.

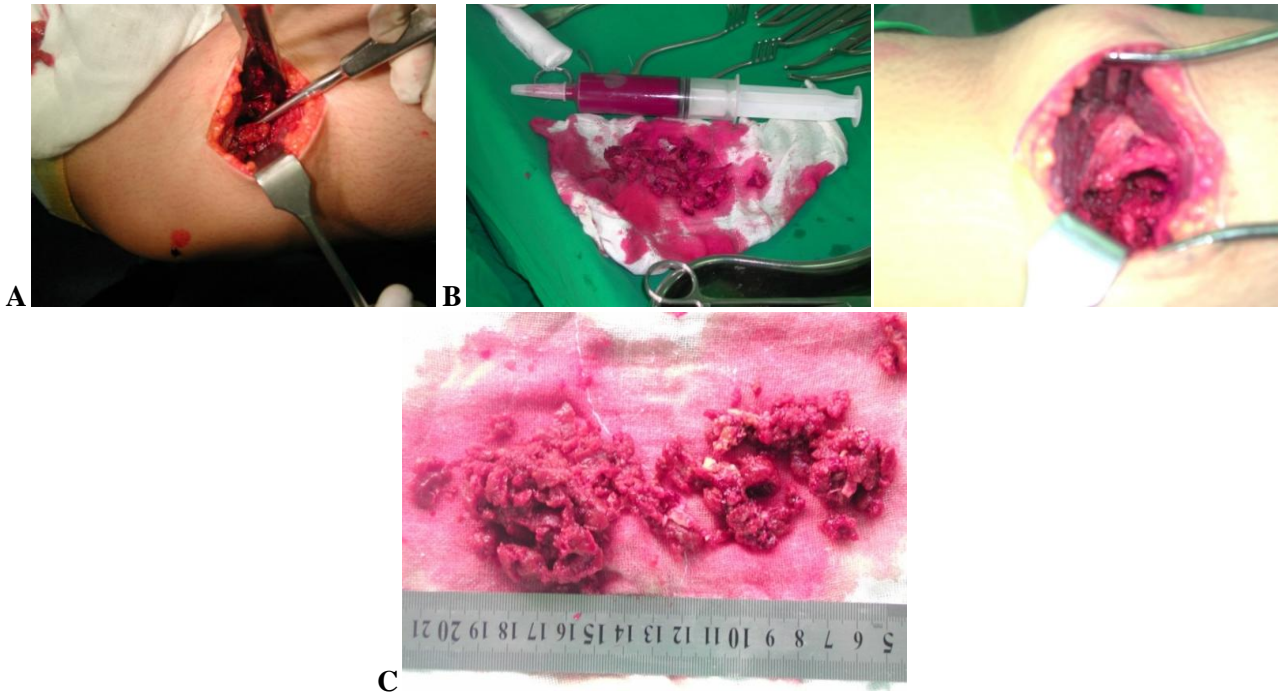


Fig. (2): Intraoperative steps; (A) curettage of the lesion, (B) application of iliac bone graft, (C) the specimen.

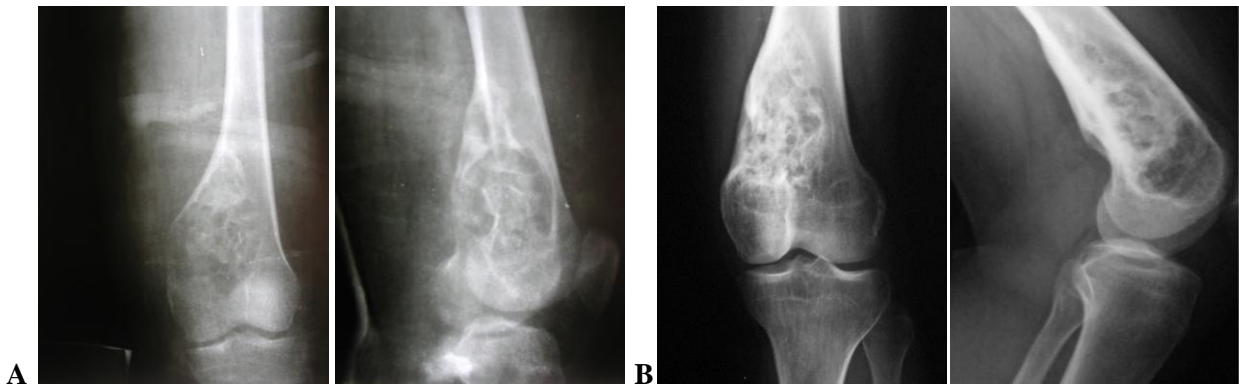


Fig. (3): A): The immediate postoperative x-ray. B):27 months follow up x-ray showing no recurrence.

DISCUSSION:

In our study, postoperative local recurrence on follow up was more in group B (4/20 patients) 20% than in group A (1/20 patient) 5% (p value=0.342) this was not statistically significant. The functional outcome was comparable in both groups with slightly non significant better result for group A. However, the incidence of long-term complications as knee stiffness and arthritis was higher in group B.

In spite of the fact, by reviewing the literature, that curettage and bone grafting for GCT had been reported to have a higher recurrence rate. In our study, we used a high speed burr that allowed a more thorough curettage, and obtained a lower recurrence rate. Therefore, it seems that adequate resection of the tumor tissue is the single most important factor to determine the rate of local recurrence rather than the reconstructive method.

In the literature, Jamshidi et al,⁽¹⁰⁾ in their study they had statistically significant lower recurrence rate in patients treated by high speed burr for tumor resection.. They also stated that there was no difference in the recurrence rate when correlated to the reconstructive technique. The use of the mechanical burr easily can extend the curettage and allow for a more controlled debridement of the cavity walls to minimize damage to uninvolved tissues while it may reduce the residual disease observed. They agree with us that the local recurrence is more related to the adequacy of tumor resection rather than the reconstructive technique. Jamshidi et al, 2008⁽¹⁰⁾ which was compatible with our study.

Ahmed AR et al, ⁽¹¹⁾ were also pioneers in introducing the principle of extended curettage using high speed burr. They recommended the use of bone graft for biological reconstruction

rather bone cement. In a retrospective study done by them, 2014⁽¹⁶⁾ using the technique of extended curettage through a large bone window, followed by bone grafting and spanning external fixation. Thirty patients (ten males, twenty females), aged from 15 to 67 years (average 38 years). All 30 patients are continuously free of disease and there is no local recurrence. The average functional score was 95% (77–100%). None of the patients had pain and none of the patients demonstrated serious instability of the knee joint.

Another study done by Blackley et al, in 1999.⁽¹²⁾ The study prospectively collected records of fifty-nine patients who had a giant-cell tumor of a long bone. In their study, they used high speed burr for extended curettage in all patients. They tested the recurrence rate among different reconstructive techniques. They found no statistically significant difference whether the tumor was reconstructed using autogenous bone graft with or without allograft or using bone cement and other adjuvants.

On the other hand a study was done by Kafchitsas et al, in 2010⁽¹³⁾ on Thirty-eight patients with histologically proven giant cell tumor near the knee joint. Group 1 included 21 patients with cavity reconstruction using bone cement and additional osteosynthesis after curettage. Group 2 included 17 patients of which 10 were treated with curettage and filling with cancellous bone and 7 were treated with curettage alone. The functional score at the final follow-up was 92.9% as an average. In the group with bone cement filling after curettage, the recurrence rate was 23.8%, whereas a recurrence rate of 52.9% was detected in the group with cancellous bone filling or curettage alone, determining lower recurrence rates with bone cement filling after curettage.

A study was done by Zheng et al, 2017⁽¹⁴⁾ on 136 cases with GCTs around the knee treated by curettage. All patients were divided into two groups according to reconstructive technique. Bone graft was used for cavity reconstruction in 86 patients (63.2%), while bone cement was used in 50 patients (36.8%). The recurrence-free survival proportions showed that the recurrence rate was higher in bone grafting group than in cementation group ($P = 0.034$).

In the present study we used the MSTS functional evaluation system which was published in 1993 by Enneking et al.⁽¹⁴⁾ The system proved simple in use for the functional evaluation of a group of patients after surgery for bone and soft tissue tumors. We divided the MSTS scores into 2 divisions, above 17/30 score which indicates good and excellent functional outcome and below 17/30 score which indicates fair and poor functional

outcome. Comparison between the groups, revealed the following:

Group A: 100% scored over 17/30 (20/20 cases) as compared to 95% in Group B (19/20 cases) while Group A 0% scored below 17/30 as compared to 5% in Group B (1/20 cases).

In this study, it was found that MSTS score in group A of mean value of 26.0 ± 3.92 while that in group B 25.70 ± 2.81 .

From these results it was found that group A (bone grafting), representing biological reconstruction, was functionally better than group B (bone cementing). However, this was not statistically significant.

A study was done by Wallace et al, 2014⁽¹⁶⁾ on 36 skeletally immature patients who underwent intralesional resections of locally aggressive bone tumors. These patients were divided into 17 patients who received reconstruction with PMMA cement, and 19 patients who were reconstructed with bone graft. The average patient age at the time of surgery was 11.79 years (range, 6 to 15 y). There were no statistically significant differences observed between both groups regarding the oncological outcome which is compatible with our study.

On the other hand a study by Gaston et al, 2011⁽¹⁷⁾ in a retrospective study to show the long term effect of using bone cement as a method of reconstruction. The study compared the outcome after the treatment of giant cell tumors of bone either with curettage alone or with adjuvant cementation. The use of cement was associated with a higher risk of the subsequent need for joint replacement. In patients without local recurrence, 18.1% of those treated with cement needed a subsequent joint replacement compared to 2.3% of those treated with curettage alone without cement ($p = 0.001$).

These findings conform with our study, as regarding complications; arthritis was found in four cases (20%) in group A, compared with group B six cases (30%) of arthritis with p value of 0.465. Only one case in group A had knee stiffness while in group B two cases had knee stiffness (p value = 1.000).

Another study was done by Gao et al, 2014⁽¹⁸⁾ on 65 patients compared the outcome after extended curettage followed by cavity reconstruction using either bone graft or cement. The Musculoskeletal Tumor Society Score was used as an outcome measurement tool. The score for bone graft patients was 91.1%, which was significantly lower than that for patients treated with bone cement (94.7%). This was against our findings may be due to the larger sample size and shorter duration of follow up in this study.

The use of multiple adjuvants or multimodality reconstructive techniques after extended curettage might improve the functional outcome as stated by study Kundu et al, 2015⁽¹⁹⁾ who used the sandwich reconstructive for GCT tumors around the knee tumors with Campanacci stage II and stage III. All the patients had favorable functional outcome.

Also a study done by Abdelrahman et al, in 2009⁽²⁰⁾ on twenty-eight cases of proven giant cell tumors of the distal femur and proximal tibia. Extended curettage was done using high-speed burr and adjuvant cryotherapy to make sure of removal of all residual tumor tissue. This was followed by multimodal reconstruction using combined bone graft and cement impaction of the cavity with subchondral iliac crest bone graft. The functional score average at the final follow-up was 93.9%. However, no control group was used. Drawbacks of this study, is the relatively small number of study groups which is not enough to reach to solid conclusion about the preferred reconstructive method after extended curettage of tumor so a powered prospective randomized study preferably done on a multicentric base is recommended to allow this in future.

CONCLUSION:

From the present study, the following can be concluded: There was no significant difference between cement and bone graft in local recurrence or functional outcome. It is likely that the adequacy of the removal of the tumor rather than the method of reconstruction is what determines the risk of recurrence. The later can be effectively done using high speed burr to decrease rate of recurrence.

Although bone cement compared to bone graft provides immediate mechanical support which has an impact on earlier postoperative weight-bearing mobilization, and allows for aggressive curettage even of large tumors. However, the long-term complications as knee stiffness and arthritis are more likely to happen in patients treated with bone cement.

All patients should be closely followed for local recurrence, especially during the first two years. The assessment of the radiolucent zone in the case of cement filling can be used as an indicator for local recurrence.

A further long term study of this group is needed to evaluate the long term results. Also a wider

scale of cases is needed to extract more significant conclusion.

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