Orthopaedics & Traumatology: Surgery & Research (2009) **95**, 402—406

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ORIGINAL ARTICLE

Long bones giant cells tumors: Treatment by curretage and cavity filling cementation

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Accepted: 22 July 2009

KEYWORDS
Giant cell tumor;
Cement;
Curettage;
PMMA

Summary
Objective: Giant cell tumors (GCT) of bone are benign tumors with local aggressiveness that most of the time occur around the metaphyseal area of long bones, often in contact with the articular cartilage. Their treatment remains controversial because of their high recurrence rate. The authors report a retrospective series of 30 cases treated using curettage followed by cementation. They suggest demonstrating the mechanical and functional benefit of this technique, its benefit controlling the risk of recurrence, and of osteoarthritis potential.
Material and Methods: Between 1992 and 2005, 30 patients with GCT were treated using curettage and cementation. Twenty-six of these tumors were present around the knee: 14 at the distal femur and 12 at the proximal tibia. Preoperative radiological evaluation with standard X-rays showed that the tumor measured a mean 71×45 mm, for a mean volume of 78 cm^3. Seventy-three percent of these GCT were in direct contact with the articular cartilage and 40% extended to the soft tissues as seen on the CAT scan and/or MRI. All patients were treated with curettage and cementation, 16 additional internal fixation procedures were performed. The mean follow-up of this series was 6 years and 4 months. All patients continue to be monitored, with none lost to follow-up.
Results: In all our cases, nine recurrences (30%) were observed during the first 2 years. Six patients were treated with a new curettage and cementation procedure and three underwent a total knee arthroplasty. None of these lesions had recurred at the last follow-up. The MSTS score, reflecting the function of the operated limb was a mean 93.33% ($28 \pm 2/30$). Standard radiological assessment showed a thin scalable border on four patients and was normal for the all-total arthroplasty cases. Two cases of minor osteoarthritis progression were noted (one less than 50% and a simple densification of subchondral bone), requiring no specific treatment.

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1877-0568/$ - see front matter
doi:10.1016/j.otsr.2009.07.004

Three complications were noted: one leg deep venous thrombosis, one hematoma, and one deep infection without impacting the initial treatment outcome over the long term.
Discussion: The curettage and cementation technique is usual practice in GCT treatment. Simple and reproducible, this technique has a lower rate of complication than other treatment options such as cryotherapy. It produces a lower rate of recurrence with the dual benefit of excellent mechanical and functional qualities. Diagnosis of recurrence can be made earlier because of the thin scalable border at the bone-cement interface. This technique does not generally cause osteoarthritis, which was found in only two cases with no evidence of the cement having a direct effect. The 30% recurrence rate observed in this series shows that the benefit provided by the cement as an adjuvant preservative remains modest.
Conclusion: The cement mechanical and cytotoxic properties as well as its innocuity and its ease of handling make curettage and cementation one of the top-ranking GCT treatment options. An even lower rate of recurrence may be obtained through development of additional adjuvant treatments such as calcitonin and bisphosphonates.
Level of evidence: Level IV; Therapeutic study.

Introduction

Giant cell tumors (GCT) of bone are benign tumors with local aggressiveness that most frequently occur around the metaphyseal area of long bones, with frequent invasion of subchondral bone, often in contact with joint cartilage. These are relatively frequent tumors, accounting for 4—5% of bone tumors and 21% of benign tumors of the bone according to Babinet [1] and Campanacci et al. [2]. Joint extension is exceptional. Treatment of the periarticular tumors remains controversial because of the high recurrence rate. Resection treats the tumor and prevents the risk of recurrence at the cost of a less desirable functional result. Simple tumor curettage makes joint preservation possible, with a better functional result, but the recurrence rate is higher: approximately 30—50% in the series reported by Babinet [1], Campanacci et al. [2], and Sung et al. [3]. This is why various adjuvant measures have been taken: intraoperative use of phenol [1], cryotherapy by Malawer et al. [4] and Marcove et al. [5], combined with cementation with acrylic cement [1].

According to Turcotte et al. [6], the curettage and cementation technique with acrylic cement has the advantages of preservation of dynamic stability, thus allowing rapid loading, early detection of recurrence with radiological observation of lysis at the cement—bone interface, as well as the toxic properties of the methylmethacrylate monomer and the necrotic effect of the heat given off during polymerization on the tumor cells. It can also be used at the onset of pathological fracture. Nevertheless, the contact of the cement with cartilage can damage the cartilage, possibly generating osteoarthrosis, which has been studied by Vult Von Steyern et al. [7]. Thus, the problem of recurrence is raised.

We have studied the results of this method on the recurrence rate and the iatrogenic osteoarthritis rate. The series presented includes 30 patients with tumors located in the knee (26 cases), the lower tibia (one case), the upper humerus (one case), the wrist (one case), and the talus (one case).

Material and method

Between 1992 and 2005, 30 patients (12 females and 18 males), with a mean age of 36 years (range, 19—58), with GCT of the long bones were treated using the curettage and cementation technique. Tumor type diagnosis was histological based on surgical biopsies taken before any therapeutic act in all cases. All patients who had been operated on for a benign giant cell tumor confirmed histologically with this method were included retrospectively in the study. No diagnosis was made on extemporaneous anatomical-pathological data.

Since histological grading of the benign GCT has not proven to have a prognostic or therapeutic value and is no longer used, it was not taken into account [6].

In 14 cases (46.66%), the tumor was located in the lower femur, in 12 cases (40%) at the upper tibia, in one case at the tibia, in one case at the upper humerus, in one case in the wrist, and in one case in the talus.

The preoperative plain AP and lateral radiological analysis studied the following parameters:

- tumor size: with a mean 71 × 48-mm AP dimension and 71 × 43-mm lateral dimension (range, 23—150 mm);
- ratio of the greatest tumor/bone diameter at the same horizontal level. This ratio was a mean 68% (range, 50%—93%) anteroposteriorly and 75% (range, 50%—97%) laterally. All the tumors studied therefore involved more than 50% of the diameter of the bone involved;
- mean volume calculated using the following formula: $0.5 \times D \times d^2$. This calculation was valid considering that GCT are roughly ellipsoid and regular in shape. This gave a mean tumor volume of 78 cm^3 (range, 36—203 cm^3);
- tumor position in relation to the cartilage: 22 tumors were in direct contact with the joint cartilage (73%). This distance was evaluated on plain AP and lateral X-rays.

The preoperative CT or MRI studies showed extension to the soft tissues in 12 cases (40%) (Fig. 1).

The indication for curettage and cementation surgery versus resection was based on the subjective appreciation of the mechanical stability expected after conservative

Figure 1 Preoperative X-ray.

treatment by the surgical team managing the patient (Fig. 2). None of the patients presented pathological fracture at the time of treatment.

The intervention consisted of meticulous curettage completed by mechanical reaming of the walls, then filling the intraosseous cavity with polymethylmethacrylate cement. Before polymerization of the cement, the curetted zone submerged in cement was fixed with an internal fixator to ensure optimal mechanical stability in 16 cases (11 plates, three plates + screws, and two with screws alone) (Fig. 3).

Adjuvant treatment was given in five cases: in three cases, an aqueous solution of 80% phenol was applied on the curetted wall with a compress, then rinsed in pure alcohol; this procedure was repeated three times. In two cases, a diphosphonate perfusion was given postoperatively.

The mean follow-up of this series was 6 years and 4 months (range, 7 months to 13 years).

None of the patients was lost to follow-up.

Figure 2 Intraoperative view after curettage. Mechanical reaming as a complement to curettage.

Figure 3 X-ray at 4 years of follow-up. No sign of osteoarthritis, no scalable border.

Results

Oncological results

During the clinical and radiological follow-up of the patients who had received this treatment, nine recurrences (30%) were identified. Seven occurred in the 2 years following surgery (mean, 19 months ± 10 months; range, 10—38 months).

Recurrence was diagnosed based on visualization of a progressive scalable border on the plain X-rays taken during the follow-up visits. MRI confirmed this and demonstrated the extension of the recurrence.

In six cases, the recurrence was found in the lower extremity of the femur. Three patients were treated with total knee arthroplasty, three with a second curettage and cementation procedure. One recurrence at the upper tibia, one at the lower tibia, and one in the wrist were also treated with a second curettage and cementation procedure.

Of these recurrences, seven were in contact with the cartilage, two with extension to soft tissues.

The mean follow-up of these recurrences was 5.5 years ± 3 years (range, 1—13 years).

At the last follow-up of this study, no recurrence after a second curettage and cementation treatment was noted.

Functional results

At the last follow-up, the function of the operated limb was studied using the MSTS score described by Enneking et al. [8] to evaluate the functional result after tumor surgery.

The MSTS takes into account pain, function, acceptance of the surgery, as well as assistance, limping, and walking distance for the lower limb or position for the hand, and dexterity or elevation for the upper limb. In this series, the score was a mean 93.33% (mean MSTS score, 28 ± 2/30).

Radiographic results

At the last follow-up, four nonprogressive scalable borders (15%) were found on plain radiographs out of 26 patients (Fig. 3). The four patients who had had total knee replacement had normal X-rays during the last follow-up visit, with no loosening, no wear, and no sign of recurrence.

We also noted two cases of minimal osteoarthritis (one impingement < 50% one simple condensation of the chondral bone) requiring simple monitoring, one at the talocrural joint and one at the upper extremity of the tibia, responsible for genu varum with little progression. In these two cases, the tumor was located at the contact with the cartilage, with extension to soft tissues. None of these cases of osteoarthritis was symptomatic and did not require surgical revision.

Early complications

Three complications were found, one case of sural phlebitis and one hematoma at the operative site, which was not revised. One patient developed sepsis in the surgical zone (upper tibia) 2 months after curettage and cementation. We treated it with removal of the cement, lavage, then filling with autograft plus biomaterials; the patient has experienced no new septic complications.

Discussion

Treating GCT with curettage and cementation was described by Vidal [9] in 1969; since then, this technique has become current practice for treating this type of tumor, adopted by a large number of surgical teams. Nevertheless, several questions remain concerning the recurrence rate after performing this technique, the toxic effect of the cement on cartilage, and the value of systematic osteosynthesis.

It is commonly accepted that the tumor recurrence rate after curettage and cementation treatment including filling with analogous tissue or simple allograft, i.e., with no adjuvant, ranges from 30 to 55% depending on the series [1—3,6,10,14,15]. Use of an adjuvant reduces the recurrence rate. Several methods have been proposed, for example, use of a chemical agent such as phenol, but the concentrations of this product authorized in France are too low to make it effective [1,11].

Use of liquid nitrogen results in a 2—8% recurrence rate [4,9,12], but this is a difficult technique with frequent complications, 30% according to Babinet [1]. Its use therefore remains rare in France.

Use of the cytotoxic properties of the cement can reduce the recurrence rate to between 17 and 25% [1,2,13,14,16]. The present study had a 30% recurrence rate during the first 2 years, corresponding to a modest benefit in terms of recurrence.

This technique is criticized for its arthrogenic potential. GCT occur around the metaphyseal—epiphyseal area of long bones and are therefore close to the joint cartilage. In our study, 73% were in contact with the joint cartilage. However, we only found 10% minimal osteoarthritis at the last follow-up, with no functional repercussions. In addition, the causal relation between the intervention and the beginning of osteoarthritis cannot be reliably established, whatever the volume of cementation. This was confirmed by a March 2007 study in Sweden conducted by Vult von Steyern et al. [7], which noted no osteoarthritis progression at 9 years of follow-up. Moreover, the mean MSTS score of 93.33% ($28 \pm 2/30$) shows that the functional result of this surgery is excellent at the longest follow-up.

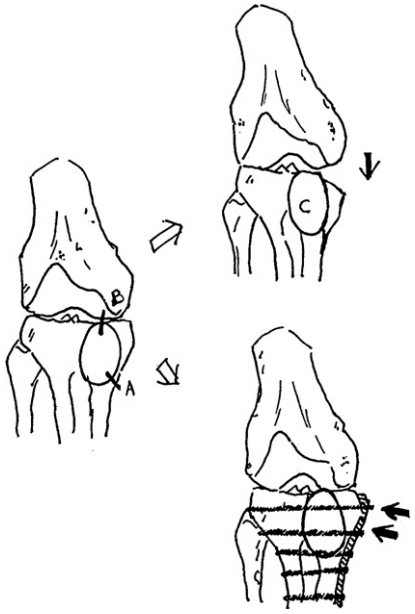

Figure 4 A. Window for curettage cementation. B. The subchondral bone fractures. C. The remainder of the tibial plateau between A and B rolls on the cement block [1]. Plate osteosynthesis prevents this effect.

Even though, no clinical study recommends systematic osteosynthesis to reinforce the cementation after curettage, we believe this is warranted. Babinet [1] described a bead effect (Fig. 4), rolling of the remainders of the tibial plateau on the cement block, resulting in treatment failure. Osteosynthesis could prevent this failure mechanism by interlocking the cement with the bony shell left in place, thus promoting peripheral bone repair. No bead effect was found in our series, in which 16 patients (53.33%) had osteosynthesis reinforcement whenever curettage left a substantial cavity volume.

Finally, curettage and cementation treatment allowed for early detection of recurrence [6,10,16,17] and therefore, early management. The cement forms a radiologically homogeneous and dense mass, with the appearance of a progressive scalable border at the cement—bone interface that is highly suggestive of recurrence, underscoring the importance of radiological follow-up every 4 months for the first 2 years in our view.

Conclusion

GCT can be treated easily and reproducibly with curettage and cementation with excellent and long-lasting functional results at the medium term. The arthrogenic effect that has been blamed on the cement coming in contact with cartilage has never been clearly demonstrated, even when used

for filling voluminous cavities. In addition, the results of the series presented herein showed that none of the patients treated with curettage and cementation suffered from secondary symptomatic osteoarthritis. All the mechanical and cytotoxic properties of the cement, as well as its innocuousness and ease of handling give it the top ranking in treatment of GCT, associated with osteosynthesis materials in cases of large cavities after curettage in our study. The 30% recurrence rate shows that acrylic cement plays a small role as adjuvant. Other complementary treatments such as diphosphonate or calcitonin are currently being studied in an attempt to reduce the recurrence rate.

References

[1] Babinet A. Tumeur à cellule géantes : cahier d'enseignement de la Sofcot. Elsevier SAS : Paris : France 2005:201—19.
[2] Campanacci M, Baldini N, Boriani S, Sudanese A. Giant cell tumor of bone. J Bone Joint Surg Am 1987;69:106—14.
[3] Sung HW, Kuo DP, Shu WP, Chai YB, Liu CC, Li SM. Giant cell tumor of bone: analysis of 208 cases in Chinese patient. J Bone and Joint Surg Am 1982;64:755—61.
[4] Malawer MM, Bickels J, Meller I, Buch RG, Henshaw RM, Kollender Y. Cryosurgery in the treatment of giant-cell tumor: a long-term follow-up study. Clin Orthop 1999;359: 176—88.
[5] Marcove RC, Weis LD, Vaghaiwalla MR, Person R, Huvos AG. Cryosurgery in the treatment of giant-cell tumors of bones. A report of 52 consecutive cases. Cancer 1978;41: 957—69.
[6] Turcotte RE, Isler M, Doyon J. Tumeur à cellules géantes. In: Encyclopédie médicochirurgicale : appareil locomoteur : Paris : France :Elsevier SAS 2001 : 14—772.
[7] Vult Von Steyern F, Kristiansson I, Jonsson K, Mannfolk P, Heinegård D, Rydholm A. Giant-cell tumour of the knee. The condition of the cartilage after treatment by curettage and cementing. J Bone Joint Surg Br 2007;89:361—5.
[8] Enneking WF, Dunham W, Gebhardt MC, et al. A system for the functional evaluation of reconstructive procedures after surgical treatment of tumors of the musculoskeletal system. Clin Orthop Relat Res 1993;286:241—6.
[9] Vidal J, Mimran R, Allieu Y. Plastie de comblement par méthacrylate de méthyle traitement de certaines tumeurs osseuses bénignes. Montpellier chirurgical tome 1969;15:389—97.
[10] Szendroi M. Giant-cell tumor of bone. J Bone and Joint Surg Br 2004;86:5—11.
[11] Turcotte RE, Wunder JS, Isler MH, Ell RS, Schasar N, Masri BA, et al. Giant cell tumor of long bone: a Canadian Sarcoma Group study. Clin Orthop Relat Res 2002;397:259—70.
[12] Marcove RC, Lyden JP, Huvos AG, Bullough PB. Giant-cell tumors treated by cryosurgery: a report of 25 cases. J Bone Joint Surg Am 1973;55:1633—44.
[13] O'Donnell RJ, Springfield DS, Motwani HK, et al. Recurrence of giant-cell tumours of the long bones after curettage and packing with cement. J Bone Joint Surg Am 1994;76:827—33.
[14] 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 Org Mov 1990;75(Suppl. 1):206.
[15] Blackley HR, Wunder JS, Davis AM, White LM, Kandel R, Bell RS. Treatment of giant-cell tumors of long bones with curettage and bone-grafting. J Bone Joint Surg Am 1999;81:811—20.
[16] Remedios D, Saifuddin A, Pringle J. Radiologic and clinical recurrence of giant cell tumor of bone after the use of cement. J Bone Joint Surg Br 1997;79:26—30.
[17] Stefano A, Gill KO, Johnston J. Giant cell tumor of bone curettage and cement reconstruction. Clin Orthop Relat Res 1995;321:245—50.