Lower recurrence rate in chondroblastoma using extended curettage and cryosurgery

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Received: 21 August 2013 / Accepted: 31 October 2013 / Published online: 19 November 2013
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Abstract

Purpose Various methods for the treatment of chondroblastoma of bone have been used including simple curettage, or combined with bone grafting, in addition to the use of adjuvant therapy. However, local recurrence still represents a challenge in the management of this aggressive tumour. This study focuses on evaluating the role of intraregional extended curettage together with the use of adjuvant cryotherapy and autogenous bone grafting in the treatment of benign chondroblastoma of bone aiming to decrease the recurrence rate.

Methods All patients with chondroblastoma included in this study underwent intralesional extended curettage, adjuvant cryotherapy using liquid nitrogen, and autogenous iliac crest bone grafting. Follow up for healing of chondroblastoma lesions and detection of any local recurrence was assessed on clinical and radiological bases. The functional outcome was assessed by the Musculoskeletal Tumour Society scoring system.

Results The mean follow-up period was 49 months. The average time for bone healing was 7.4 months. Our rate of local recurrence is 7.1 %. Two patients (14.3 %) developed physeal growth arrest. One patient had superficial skin sloughing (7.1 %). None of the cases had pathological fracture. The mean Musculoskeletal Tumour Society functional score was 92.7 %.

Conclusion Chondroblastoma is an aggressive benign bone tumour with a high rate of recurrence. The use of high-speed burr combined with adjuvant intralesional cryotherapy and iliac crest autogenous bone grafting is a reliable method of treatment with a low rate of recurrence.

Keywords Chondroblastoma · Benign bone tumour · Curettage · Cryosurgery · Recurrence · Bone graft

Introduction

Chondroblastoma is an uncommon benign bone tumour, which is locally aggressive [1–4], and arises from a secondary ossification centre in epiphyseal plates and apophyses [5–7]. Chondroblastoma accounts for approximately 1–2 % of all primary bone tumours [8]. It usually occurs in adolescents and young adults [2, 9], whereby males predominate with a ratio of 3 to 2 [3, 10]. It commonly involves the tibia, femur, and humerus [2, 3]. Flat bones are involved in about 10 % of cases [11].

The histopathological description of chondroblastoma according to the World Health Organisation [12] is “a benign, cartilage producing neoplasm with a characteristic cell (chondroblasts) that is remarkably uniform, round to polygonal with well-defined cytoplasmic borders. The cytoplasm is clear to slightly eosinophilic and the nucleus is round to ovoid. Randomly distributed osteoclast-type giant cells are usually present. A fine network of pericellular calcification defines the so called “chicken wire calcification” seen in many of cases. Individual chondroblasts may exhibit cytological atypia most often represented by large, hyperchromatic nuclei. Aneurysmal bone cyst-like changes may be found in up to third of cases.”

The recommended surgical treatment for chondroblastoma varies. Curettage, either alone or in conjunction with bone grafting using autogenous or allogeneic bone graft or both, have been described [1, 2, 4, 8, 10, 13]. Packing the cavity with polymethylmethacrylate is another advised treatment modality [5, 13–15].

A relatively high rate of recurrence (10–35 %) has been reported [1, 5, 7, 10, 14], and rare metastasis has been

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described [2, 7]. Risk factors for these two forms of aggressive behaviour (recurrence and metastasis) are not clearly defined.

The purpose of this paper was to present our experience in treating benign chondroblastoma by extended curettage using high-speed burr combined with cryosurgery, and biological reconstruction with iliac crest bone graft, aiming to decrease the relatively high rates of recurrence of this bone tumour.

Materials and methods

We treated 14 patients with chondroblastoma, who presented to our orthopaedic oncology unit between 2007 and 2012. The diagnosis was based on recognised radiological and histological criteria. There were ten males and four females with an average age of 17.3 (range, seven to 32) years. Locations of the tumours included the distal femur in six, proximal humerus in four, proximal tibia in three, and distal tibia in one (Table 1).

Plain radiographs and MRI were done for all patients for both diagnostic and staging purposes (Fig. 1). Lesions were classified into active and aggressive based on the Enneking classification for staging of musculoskeletal neoplasms [7, 16] indicative of the lesion's activities, adopted by the Musculoskeletal Tumour Society. Active lesions are either confined to the bone but have an incomplete reactive rim, or are contained within a rim of reactive periosteal bone. Aggressive lesions showed cortical disruption and soft tissue extension.

For all patients, the lesions were treated first by meticulous extensive intralesional curettage using straight and angled hand curettes to remove all the visualized tumour tissues, then the walls of the residual cavity were burred by high-speed burring and the defect was then washed thoroughly with

normal saline. For the curettage, a pneumatic tourniquet was applied to all tumours around the knee and those of the distal tibia to decrease bleeding and to prevent the blood from acting as a thermal barrier when cryosurgery was performed. Liquid nitrogen was used as an adjuvant cryotherapy for all patients by direct pore method in a two-cycle technique for quick freezing and then gradual thawing by warm saline after each cycle. Special care was taken during pouring of the liquid nitrogen to protect the skin, neurovascular structures and surrounding soft tissues.

We used gel foam and warm wet towels prior to application of liquid nitrogen. These protective towels and the surrounding tissues were continuously irrigated by warm saline during the procedure. The pouring was done directly into the cavity using a stainless steel funnel. The time for each freezing cycle was about one to two minutes, and the gradual thawing was performed over three to five minutes. Following the cryotherapy session, the cavity was irrigated again by normal saline. All patients treated had contained defects with intact cortical walls. We had four patients with aggressive lesions that were contained with minimal cortical defect in one wall. Whenever surgically accessible, the cortical breach was used as the bone window to access the tumour. If not possible, the bony defect was sealed by gel foam before pouring the liquid nitrogen. For all patients, autogenous cancellous iliac crest bone graft was harvested to reconstruct the resultant bony defects (Fig. 2).

The curetted tissues were histopathologically studied to confirm the diagnosis and to detect the presence of any associated aneurysmal bone cyst component.

Postoperatively, all patients were followed-up clinically on weekly bases during the first month, then every two weeks during the second and third months, and every month

Table 1 Patient data

Case	Gender	Age (years)	Location	Side	Stage	Duration of symptoms (months)	ABC component	Recurrence and complications	Follow-up (months)
1	Female	26	Distal femur	Left	2	18	No	No	24
2	Male	16	Distal femur	Right	2	11	No	No	48
3	Female	10	Distal femur	Left	3	7	Yes	Physcal growth arrest genu valgum	39
4	Male	7	Distal femur	Right	3	5	Yes	Physcal growth arrest genu valgum	60
5	Male	32	Distal femur	Right	2	17	No	No	38
6	Male	17	Distal femur	Right	2	9	No	No	32
7	Male	16	Distal tibia	Right	2	8	No	No	42
8	Female	14	Proximal humerus	Right	2	14	No	No	57
9	Male	16	Proximal humerus	Left	2	23	No	No	27
10	Female	18	Proximal humerus	Right	2	10	No	Superficial wound infection	50
11	Male	19	Proximal humerus	Left	2	28	No	No	54
12	Male	17	Proximal tibia	Left	3	9	No	No	56
13	Male	19	Proximal tibia	Left	2	13	No	No	44
14	Male	15	Proximal tibia	Left	3	8	No	No	26

Fig. 1 Chondroblastoma of the proximal humerus. **a** Plain radiograph; lesion in the proximal humerus. **b** MR scan

thereafter for the first year. Follow-up radiographs were done directly after surgery, then at six weeks, 12 weeks, and then every six weeks for the first year. Follow-up was every three months during the second year, then yearly thereafter. The average follow-up was 49 (range, 24–60) months. The functional outcome was assessed by the Musculoskeletal Tumour Society scoring system [17].

Recurrence of chondroblastoma lesions after surgery was suspected if there was any recurrence of symptoms or abnormality detected on plain radiography. MRI of the lesion and CT scan of the chest were done to suspected cases to confirm the presence of recurrence and to detect early metastasis. Confirmed histological diagnosis of chondroblastoma concluded at subsequent operation.

Results

The average age at presentation was 17.3 (range, 7–32) years. Eleven patients (78.6 %) were between ten and 20 years of age. The main presenting symptoms were pain in 12 patients

(85.7 %) and swelling in four patients (28.6 %). The average duration of symptoms at the time of presentation was 12.9 (range, five to 28) months. The distal femur was the most affected for all locations (six cases) with an average of 42.9 %. Proximal humerus was the second most affected site (four cases; 28.6 %), followed by proximal tibia with 21.4 % (three cases), and distal tibia in 7.1 % (one case). Males (71.4 %) were more affected than females (28.6 %) with a ratio of 5:2.

Radiologically, 12 lesions were active (85.7 %) and two were aggressive (14.3 %). Aneurysmal bone cyst components were noted histologically in two (cases 3 and 4) of the 14 tumours (14.3 %). These tumours were classified radiologically as aggressive lesions. These patient were the youngest of all (seven and ten years).

All patients were treated with extensive curettage using high-speed burr. Adjuvant therapy using liquid nitrogen was used for all cases followed by filling the lesions with autogenous cancellous bone graft. Radiographic evidence of bone healing was achieved when bridging new bone trabeculae are formed, the lesions consolidate, and graft is incorporated. At the end of the follow-up period all patients included in this

Fig. 2 Chondroblastoma of the proximal humerus; the lesion is classic in location and appearance. **a** The lesion after curettage (arrow). **b** After being filled with cancellous bone graft

study were free from disease. The average time for healing was 7.4 (range, six to nine) months (Fig. 3). The functional outcome after surgery was evaluated using the Musculoskeletal Tumour Society functional scoring system [17].

The mean follow-up period was 49 (range, 24–60) months. The functional outcome of patients at the end of follow-up was 92.7 % (range, 64–98 %).

Local recurrence of the tumour occurred in only one (case 4) of the 14 cases (7.1 %). The lesion was in the distal femur. This lesion was initially classified as aggressive on radiographs. There was histologic evidence of an aneurysmal component in the curetted tumour tissue. Recurrence occurred after seven months. The diagnosis was based on the return of clinical symptoms after surgery, together with radiologic appearance of the lesion. The MRI images showed recurrence of the tumour, and the histologic examination confirmed the recurrence of chondroblastoma. The patient was managed by the same technique and healed with no further recurrence till the latest follow-up (60 months).

None of our patients developed pathological fracture following cryotherapy. We had two cases (14.3 %) (cases 3 and 4) that developed physal growth arrest of the lateral femoral condyle with subsequent progressive valgus deformity of the knee. During follow-up, these two patients had obvious deformity with an unacceptable limb that needed to be corrected to improve their gait that was inevitable at this stage. Both cases underwent corrective later open wedge distal femoral osteotomies to correct the resultant deformities. Epiphysiodesis for the medial femoral condyles were not done. The need for a further future correction at an older age was clearly explained to their parents. These two patients were the youngest (ten and seven years) of all patients and they had aggressive lesions.

Fig. 3 Chondroblastoma of the proximal humerus. Plain radiograph showing incorporation of the graft at eight-months follow-up

Out of the 14 cases, only one (7.1 %) had superficial skin (case 12) sloughing that was treated as first degree burn and healed with topical ointments and regular dressings. Case 10 developed superficial wound infection. Management was by antibiotics according to culture and sensitivity and regular dressings. Infection resolved and the surgical wound healed completely.

Discussion

Chondroblastoma is a primary, locally aggressive tumour of bone. It is rare with an incidence of 1–2 % of all primary bone tumours [1, 3, 4, 7]. Males are affected more than females [2–4, 6]. It arises from a secondary ossific centre, mostly in the second decade of life [1, 9, 13]. More than 95 % of all chondroblastomas are epiphyseal [18]. The two most frequent sites of involvement were the proximal part of the humerus and the proximal part of the tibia [2–4, 19].

There is no accepted standard treatment for chondroblastoma [13]. Curettage, either alone, combined with packing of the cavity with bone graft or polymethylmethacrylate, or with associated cryosurgery are described [4, 13, 14]. Marginal resection [20] and radiofrequency heat ablation [21] are other options.

Since the introduction of cryosurgery by James Amott in the 18th century, cryosurgery has advanced from using the pouring technique, to using liquid nitrogen spray and finally cryoprobe [22]. Argon-based systems have been shown to achieve a more rapid rate of freezing than liquid nitrogen-based systems [23]. Bickels et al. [24] hypothesized that the use of a controlled system to deliver the cryogenic substance and the use of a cold-conducting medium would give a more efficient treatment through more precise control of the freezing temperature and duration. Unfortunately, these computer-based systems are expensive and not available in our country.

The local recurrence in chondroblastoma represents the main challenge, especially in young patients with open growth plates. Despite the different treatment modalities for chondroblastomas, local recurrences after curettage range from 10 % to 38 % [13, 14]. With more aggressive treatment methods, recurrence rates range from 8 % to 30 %, whereas systemic metastasis rates range from 0.8 % to 6 % [4, 6, 13, 14]. Metastases from chondroblastoma can arise from different primary sites. There is no reported relation of metastasis to previous surgery or nonsurgical treatment, tumour location, or patient age [7, 25]. The lung is by far the most common site of distant metastases. Bones different from those of the primary site, soft tissue, the skin, and the liver are also cited [14, 25]. The time reported for metastases to manifest clinically ranges from five months to 33 years (average, eight years) from the initial diagnosis of chondroblastoma [25, 26].

Metastasis only followed local recurrence in association with malignant transformation at the primary site [6, 27].

Patients usually survive several years with metastatic lesions. Yet, the prognosis is better when the metastases are resectable. In pulmonary metastasis, thoracotomy has produced apparent long-term cures, while in other sites the lesions have remained static following simple biopsy [7, 25, 27]. The benefit from chemotherapy is debatable [6, 25, 27]. Some authors recommend that any patient with a local recurrence should be screened for metastases [13].

In this series, all patients with chondroblastoma were treated with extensive curettage with the use of high-speed burr followed by adjuvant cryosurgery using liquid nitrogen. Our rate of local recurrence is 7.1 % which is lower than most of the reported rates of local recurrences in other studies which have included adjuvant methods as previously mentioned. We believe that this lower rate of recurrence may be due to the combined augmented effect of both the extensive curettage and adjuvant cryotherapy.

Many authors linked the aggressiveness of the chondroblastoma to the presence of an aneurysmal bone cyst component [2, 3]. Its incidence varies from 15 % to 20 % [13, 14]. Others contributed its presence to the incidence of local recurrence [3]. Huvoos and Marcove [19] reported the highest recurrence rate after curettage, with an incidence of 20 % if there was no aneurysmal bone-cyst component but 100 % if there was such a component.

Some reports indicated that surgeons use a less aggressive approach in treating chondroblastoma for fear of injury to the physis and resultant physal growth arrest [20]. It is not known whether the damage of growth plate is caused directly by the presence of chondroblastoma or due to surgical curettage. In their series of 70 cases of chondroblastoma, Springfield et al. [4] stated that in the rare patient in whom the adjacent joint or the growth plate was damaged, it was due to the aggressive behaviour of the tumour and not due to the surgical therapy. Suneja et al. [13] believe that the growth plate is resilient and, with proper care, aggressive curettage is appropriate.

In the meantime, the risk of physal damage in cases of non-aggressive curettage, with subsequently higher incidence of tumour recurrence, will end up in a second more aggressive surgical procedure, and would defiantly carry a higher risk of injury to the physis, with subsequent growth plate arrest and articular cartilage damage.

In support of this debate, Strong et al. [28] mentioned that they had to treat local recurrence of chondroblastoma to the femoral head using a direct approach to the lesion or through the articular cartilage of the femoral head.

Hsu et al. [5] reported that using high-speed burring after curettage was found to be an effective method. They recommend high-speed burring after curettage, especially for aggressive lesions. Suneja et al. [13] believed that aggressive intralesional curettage alone is curative in most cases. Their rate of recurrence is 13.2 %. On the other hand, Tomić et al.

[29] reported that the simple curettage with or without bone grafting is associated with recurrence rates of up to 30 %, and are thus unacceptable in the more aggressive forms of this disease. They stated that, “Aggressive disease requires an aggressive management strategy.” They recommended the use of wide marginal resection in such cases.

We believe that using liquid nitrogen following extensive curettage using high-speed burr is a successful treatment option in managing chondroblastoma cases and decreasing its rate of recurrence, which is a main cause of treatment failure. The presence of an open epiphyseal plate was not an obstacle in addressing the lesions. We recommend the use of extensive curettage followed by adjuvant cryotherapy as the standard method in treating chondroblastoma cases aiming at a lower rate of recurrence.

Conflict of interest The authors declare that they have no conflict of interest.

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