Phenolization and coralline hydroxyapatite grafting following meticulous curettage for the treatment of enchondroma of the hand. A case series of 82 patients with 5-year follow-up

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Abstract

Background Enchondromas are benign cartilaginous tumours. The most common location is in the long bones of the hand. Treatment methods fall into a broad spectrum ranging from conservative, medical therapies, to a variety of surgical procedures, which may or may not employ the use of local adjuvant treatment or bone grafting. The purpose of this study was to report our experience and evaluate the long-term results of patients with enchondroma of the hand, treated in our department with meticulous curettage, phenolization and coralline hydroxyapatite grafting.

Methods We present 82 patients with hand enchondromas treated surgically in our department during the last 10 years. The patients were treated operatively with meticulous curettage of the bone lesion, with use of phenol 5 % as local adjuvant and coralline hydroxyapatite bone graft to fill in the remaining cavity.

Results At a minimum of 5-year follow-up, radiographs and clinical examination showed adequate bone formation at the site of enchondroma excavation and no evidence of recurrence, fracture, infection or other complication related to the procedure.

Conclusion We concluded that the combination of meticulous curettage of the lesion, with the use of phenol as local adjuvant and coralline hydroxyapatite graft is a safe technique that prevents recurrence and allows adequate and uncomplicated local new bone formation.

Keywords Enchondroma · Surgical treatment · Phenol · Coralline hydroxyapatite · Adjuvant therapy · Recurrence

Introduction

Enchondroma is the most common primary benign tumour in the tubular bones of the hand and usually develops during the first through to the fourth decade of life. It is the second most benign chondroid lesion (following osteochondroma), representing 3–17 % of all primary bone tumours [9, 27]. The most common location is in the long bones of the hand, centrally in the diaphyseal medullary cavity, which account for 40–65 % of lesions. Forty to 50 % of enchondromas in the hand are present in the proximal phalanges, 20–30 % in the middle phalanges and 15–30 % in the metacarpals. Less frequently, they are located in distal phalanges where the incidence of appearance is 5–15 % [9].

Enchondromas are usually asymptomatic. They appear as lumps or swellings. Occasionally, they may be painful following strenuous hand activities or after an associated pathological fracture [18]. Radiological and histopathological similarities between enchondroma and low-grade chondrosarcoma, such as endosteal scalloping, positive uptake of radiotracer on bone scan and similar degrees of histologic abnormality [22, 25], often make the differential diagnosis very difficult. Cytologically, at least 50 % of medullary chondrosarcomas present as a cellular enchondroma [3]. The clinician can reach a definite diagnosis only by combining clinical, radiological and histopathological findings. On the other hand, a definitive diagnosis is mandatory for accurate treatment and good long-term prognosis.

Treatment can be either conservative with regular clinical reviewing and radiographic follow-up [22] or operative with curettage of the lesion. In addition to curettage, chemical cauterization with phenol [5, 26] or alcohol [22], cryotherapy

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with liquid nitrogen [1, 25] or CO₂-laser [11] could be performed. Autologous or allogeneic bone graft [21], coralline hydroxyapatite [13] or polymethylmethacrylate cement [15] could be additionally used to fill the bone cavity after the excision of the lesion.

The purpose of this study was to report our experience and evaluate the long-term results of patients with enchondroma of the hand, treated in our department, with meticulous curettage, phenolization and coralline hydroxyapatite grafting.

Material and Methods

Patients who presented with enchondroma of the long bones of the hand were considered for inclusion in the study. Patients with an associated disease, such as Ollier's disease or Maffucci syndrome were excluded. Eighty-two patients were treated for enchondroma of the hand between 2000 and 2009 at our department. Age, hand dominancy, site and size of the lesion were recorded.

Diagnosis was based on clinical assessment and radiological examination with radiographs and MRI scan. No histological examination was performed prior to operation. Patients were all treated surgically with an intralesional approach and meticulous curettage of the bone lesion. Haemostasis was achieved with a tourniquet and electrocautery. Phenol solution, 5 %, was used as local adjuvant, filling the bony cavity for 30 s. The soft tissues were well protected with retractors and dry swabs. The bone was washed out thoroughly and packed with chips of coralline hydroxyapatite (Interpore-200, Interpore International, Irvine, CA). The excised lesions were sent for histopathological examination in all of the cases. Plaster splint was used only in patients with pathological fractures, for 6 weeks postoperatively. The rest of the patients were advised to avoid heavy duties and manual work for 6–8 weeks but to start early mobilization and hand therapy to avoid stiffness. All operations were carried out by six consultant orthopaedic surgeons from the department, including two of the authors (DG, IB).

All patients were followed up for a minimum period of 5 years postoperatively with clinical and radiological assessments. Pain was assessed with the VAS score. The functional outcome was measured with the Musculoskeletal Tumour Society (MSTS) score. MSTS is a system of functional evaluation, used after procedures for musculoskeletal tumours. Particularly in upper limb operations, the system assigns numerical values (0–5) for each of six categories: pain, function, emotional acceptance, hand positioning, manual dexterity and lifting ability [6] (Table 1). Follow-up was carried out by all of the authors and the evaluation of the results by the senior authors (DG, IB).

Results

Between 2000 and 2009, 82 patients were diagnosed with enchondroma of the hand and treated in our hospital. Seventy-three were male and nine female, all military staff with a mean age of 22.5 (range 19–35) years.

Thirty-eight patients (46 %) had an injury of their hand, and 23 (28 %) had spontaneous onset of pain with no history of injury for a mean time of 4 (range 3–8) months. A lump without pain was the only predominant symptom in 17 cases (20 %). The lump was present for a mean time of 1 year (range 6 months–4 years). Finally, four patients (4.8 %) were absolutely asymptomatic and the diagnosis was established incidentally after radiographic examination of the hand for other reasons. All patients had radiographs of their hands. MRI scan was performed in 48 patients, and bone scan was performed in 16 of them.

Twenty-seven of the enchondromas (32.9 %) were located in proximal phalanges (eight in second, eight in third, 11 in fourth digit) (Fig. 1) and 13 (15.8 %) in distal phalanges-subungual (seven in thumb and six in third digit). Forty-two of the enchondromas (51.2 %) were located in diaphysis of metacarpals (nine in second, 19 in third, 14 in 4th) (Fig. 2). Twelve of the patients with hand injury sustained a pathological fracture through the lytic area (Fig. 3). The mean size of the enchondromas was 1.1 (range 0.7–2.2) cm.

The result of histopathological examination confirmed the diagnosis of enchondroma in all cases. This was hyaline cartilage tissue of lobular structure with groups of cartilage cells, which had uniformly round nuclei and lay in shiny cartilage cavities. The average time before the patients returned to demanding physical activities was 12 (range 8–16) weeks in the cases without fracture and 18 (range 14–22) weeks in the cases with pathological fracture across the lesion. All patients reported an excellent functional outcome at follow-up, where the mean MSTS score was 29.5 (range 28–30). VAS score was 0.8 preoperatively and 0.1 postoperatively at final follow-up.

No infection or pathological fracture was encountered postoperatively. None of the patients complained of recurrence of their symptoms subsequently after treatment. Healing of the fracture was confirmed radiologically, and there were no recurrence of the tumours.

Discussion

Enchondromas are the second most benign chondroid lesions (after osteochondromas) representing 3 to 17 % of all primary bone tumours [9]. The most frequent location is in the long bones of the hand where they represent 90 % of primary bone tumours and 30 % of all tumours in the hand [24].

Table 1 Musculoskeletal tumour society (MSTS) functional evaluation (upper limb data)

Score	Pain	Function	Emotional acceptance	Hand positioning	Manual dexterity	Lifting ability
5	No pain	No restriction	Enthused	Unlimited	No limitations	Normal load
4	(Intermediate)	(Intermediate)	(Intermediate)	(Intermediate)	(Intermediate)	(Intermediate)
3	Modest/non-disabling	Recreational restriction	Satisfied	Not above shoulder	Loss of fine movements	Limited (minor load)
2	(Intermediate)	(Intermediate)	(Intermediate)	(Intermediate)	(Intermediate)	(Intermediate)
1	Moderate/intermittently disabling	Partial occupational restriction	Accepts	Not above waist	Cannot pinch	Helping only (cannot overcome gravity)
0	Severe/continuously disabling	Total occupational restriction	Dislikes	None	Cannot grasp	Cannot move

The management and especially the need for surgical treatment of enchondromas remain controversial. However, we believe that conservative treatment [22, 28] is unable to establish the histological diagnosis of the tumour. Conservative management also involves the potential risk of pathological fracture through the lesion [31] as well as a prolonged period of rehabilitation with light duties. Both are not consistent with the daily activities of the particular population of our military hospital which is mainly consists of personnel of the National Armed Forces. Tumour curettage and filling of the resultant cavity with an autogenous cancellous bone graft is considered as treatment of choice of enchondromas of the hand [8]. Although, autogenous bone grafting has the advantages of there being no immunological reaction and good bone induction [34], this method has the disadvantage of morbidity of the harvesting area, increased surgical time and the need for general or regional anaesthesia [16]. Cancellous bone allograft has been used to fill the remaining cavity after curettage with good results [14] but allografts introduce the potential hazard of disease transmission [32].

We favoured the use of coralline hydroxyapatite bone graft, which eliminates the need for autogenous and allogeneic bone grafting and the associated complications especially related to the supply of donor bone for harvesting and transmission of diseases [13]. Coralline hydroxyapatite is an osteoconductive synthetic bone graft substitute material and is immunologically inert from the point of inducing inflammation. It is also absorbable, allowing gradual substitution by woven bone in the cavity left after curettage of the enchondroma [4]. In our series, we have not encountered any problems or complications related to the use of coralline hydroxyapatite synthetic bone graft.

Polymethylmethacrylate cement (PMMA) has also been used for filling the tumour cavity, providing immediate mechanical strength [2]. But PMMA is not biologically resorbed and thus could act as permanent foreign material. Calcium phosphate bone cement (CPC) injection has been also used as a filling material. It is consisted of 61 % α -tricalcium phosphate, 26 % calcium hydrogen phosphate, 10 % calcium carbonate and 3 % precipitated hydroxyapatite mixed in 4 %

Fig. 1 Radiographs of the right hand showing an enchondroma of the proximal phalanx of the middle finger preoperatively **a** and postoperatively **b**

Fig. 2 Anteroposterior radiograph of the left hand. Enchondroma of the fifth metacarpal **a** treated surgically. Four years postoperatively **b**, there was no recurrence of the tumour and the coralline hydroxyapatite graft was substituted by woven cancellous bone

aqueous solution of disodium hydrogen phosphate. It is a bioactive material with osteoconductive properties, biocompatible with soft tissue and bone, and is slowly absorbed to be replaced by woven bone. But the high price of calcium phosphate cement appears to be a disadvantage [16]. Finally, some surgeons do not reconstruct the remaining tumour cavity and suggest that curettage alone is sufficient enough to treat enchondroma of the hand [12, 30]. However, curettage alone leaves a thin cortical shell, easy to collapse during daily activities, if it is left without protection [33, 34].

Patients with grade I chondrosarcomas and enchondromas can have similar radiographic findings including endosteal scalloping, increased uptake of the radiotracer on the bone scan and similar histology abnormality [20, 22]. Grade I chondrosarcomas are slowly growing and do have low rate of metastasis [29]. For those reasons additionally to intralesional curettage and excision of the enchondromas, many surgeons have been using several adjuvant methods to obtain microscopic kill of tumour cells. Cryotherapy with

liquid nitrogen [23, 25] or CO₂-laser [11], chemical cauterization with phenol [5, 17, 26] or alcohol [22], and cauterization [7] have been used as adjuvant to surgical excision of enchondroma and low-grade chondrosarcoma.

We prefer phenol for chemical cauterization. Phenol is bacteriostatic in a 0.1–1 % solution and bactericide above 1 % by denaturing the proteins and destroying cell permeability. Concentrations of more than 3 % are necrogenic and of 5 % locally anaesthetic. Phenol can destroy 1–1.5 mm of tissue by coagulation necrosis [26]. That depth of necrosis is considered safer, compared with the 7–12 mm of osteonecrosis caused by liquid nitrogen which could complicate the treatment with postoperative fractures or articular surface damage due to difficulty in controlling the amount of necrosis induced [1, 19]. A 5 % phenol solution is considered safe, while the risk of undesirable effects from its resorption can be regarded as tolerable and its caustic properties are reduced by irrigation of skin and soft tissues with water [26]. In our series, we have not encountered any recurrence. The local recurrence rate after curettage and filling of defect, with or without adjuvant therapy such as phenol, cement or cryotherapy is reported to be between 0 and 13 % [8, 10, 17, 31, 33].

We recognize that the absence of a control group is a limitation of this study. However, the fact that none of the patients were lost to follow-up and the minimum follow-up period was 5 years increases the strength of the study. Another limitation is the peculiarity of our population which consisted only of military personnel with an age range 18 to 50 years. But, considering the fact that enchondroma usually develops during the first through fourth decade of life, we believe it did not bias our results. In conclusion, enchondromas can be treated using many different methods: conservatively or operatively, less or more aggressively in combination with other

Fig. 3 Anteroposterior view of the left hand revealed an enchondroma of the third metacarpal associated with a pathological fracture of its midshaft

treatment modalities. Although the recurrence rate or malignant transformation is very low in hand lesions (after operative treatment with simple curettage), we believe that the combination of meticulous excision of the lesion with the use of phenol as local adjuvant and bone grafting with coralline hydroxyapatite is a safer procedure.

Conflict of Interest Dimitrios Georgiannos declares that he has no conflict of interest.

Vasilios Lampridis declares that he has no conflict of interest.

Ilias Bisbinas declares that he has no conflict of interest.

Statement of Human and Animal Rights This article does not contain any studies with human or animal subjects.

Statement of Informed Consent As a retrospective study, neither an institutional review committee approval nor patient's informed consent was needed.

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