International Orthopaedics (SICOT) (1998) 22: 134–138

International
Orthopaedics

Simple bone cysts treated with aspiration and a single bone marrow injection

A preliminary report

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Accepted: 29 September 1997

Summary. *The results of a single percutaneous aspiration and injection of marrow into active, simple bone cysts are reported in 8 cases. Slow regression of the cyst was consistently observed except in one lesion in the distal tibia. All the patients have been free of symptoms after this treatment after a mean follow up of 31 months. The evolution of the cysts was monitored by a cyst index, cyst diameter measurements and computer assisted densitometric image analysis of serial radiographs.*

Résumé. *Les résultats de l'aspiration de kystes osseux essentiels en expansion suivie de l'injection de moëlle osseuse est rapportée chez huit enfants. Une lente régression du kyste fut constamment observée sauf pour un, situé au tibia distal et tous les patients sont asymptomatiques depuis cette unique injection. Un index kystique, une mesure par ordinateur de la densité optique du kyste et du diamètre kystique ont permis d'évaluer la réponse.*

Introduction

The treatment of simple bone cysts has evolved since the percutaneous injection of cortisone was introduced by Scaglietti in 1974 [20]. Curettage and bone grafting were the standard treatment previously, but resulted in only 65% satisfactory healing and 35% of recurrence [4, 17, 19]. With percutaneous injection of methylprednisolone acetate, there were about 20% recurrences and 10% did not respond [5]. More recently, several authors have advocated percutaneous multiple drilling with Kirschner wires [6, 12, 15], while others have proposed a prolonged decompression of the cyst through cannulated screws left in place without corticosteroid injection [8, 9].

Healing of the cyst may occur either spontaneously or after a fracture [1] which suggests that the cyst wall has the potential intrinsic capacity for bone formation. We therefore proposed that transient decompression performed with large gauge trocars and followed by an autologous bone marrow injection should promote the osteogenic healing phase of the cyst. A similar approach has been reported recently with good results [16].

The results of our preliminary series are presented in this paper.

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Patients and methods

Eight children with active, simple bone cysts have been treated since August 1991. Table 1 lists the main preoperative characteristics. The mean age was 7 ± 3.3 years. Fracture through the cyst had occurred in 5, and one patient had already undergone surgical curettage on 2 occasions before the third recurrence.

All the cysts were painful. Autologous bone marrow injection was the first treatment for the 6 last patients, but in the first 2 cases bone marrow and methylprednisolone acetate had been given together.

Table 1. Patient characteristics

Case	Patient	Sex	Age (years)	Location of the bone cyst	Initial lesion diameter[a]	Metaphyseal position[b]	Multiloculated	Presence of fracture	Previous fracture	Previous treatment	Treatment	Follow-up	Remarks
N°1	BS	M	9	Proximal humerus	>90%	<0.5 cm	+	–	+	–	Bone marrow + 160 mg triamcinolone	39	Asymptomatic
N°2	JV	F	8	Proximal humerus	>80%	0.5 cm	–	–	+	–	Bone marrow + 60 mg MPA	38	Asymptomatic
N°3	FS	M	10	Proximal humerus	>90%	>0.5 cm	+	+	+	Bone grafting Curettage (2×)	Bone marrow	25	Asymptomatic
N°4	DM	F	3	Proximal femur	>90%	0.5 cm	–	–	+	80 mg MPA	Bone marrow	54	Asymptomatic
N°5	SG	M	12	Proximal femur	>80%	>0.5 cm	–	–	–	–	Bone marrow	26	Asymptomatic
N°6	GM	F	5	Proximal femur	>85%	<0.5 cm	–	+	–	–	Bone marrow	26	Asymptomatic
N°7	GBG	M	3	Distal tibia	>80%	<0.5 cm	+	–	–	–	Bone marrow	36	Asymptomatic
N°8	LM	M	6	Proximal femur	>85%	<0.5 cm	–	–	–	–	Bone marrow	10	Asymptomatic

[a] according to Ahn and Park
[b] according to Neer
[c] Methylprednisolone acetate

Surgical technique

The procedure was performed under general anaesthesia. The cyst was localised under fluoroscopy. Firstly, a large trocar (13 gauge diameter, Unimed, Switzerland) was introduced into the upper part of the cavity and a second into the lower end (Fig. 1). The cyst fluid was spontaneously evacuated and then slowly aspirated. The final volume was measured and a sample sent for histology. No attempt was made to disrupt the lining membrane. A third trocar was used to obtain bone marrow from the anterior part of the iliac crest. About the same volume of aspirated marrow as of fluid obtained from the cyst was injected through one of the trocars. The patients stayed in hospital overnight and were then discharged. Normal activities were allowed immediately without restriction, or delayed for 3 months after healing of a fracture, if one had been present initially.

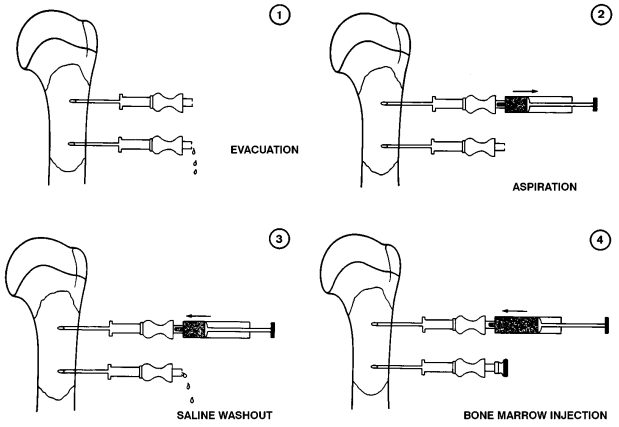

Fig. 1. Drawings illustrating the 4 stages of aspiration and injection of bone marrow into a bone cyst

Cyst activity measurement

The state and progress of cystic activity were assessed with computer-assisted image analysis of bone density, assessment of the cyst index as described by Kaelin and McEwen [13] and cyst diameter according to Ahn and Park [1]. Anteroposterior and lateral radiographs were digitised with a high resolution black and white video camera (Sony SSC-M370CE, 752×582 pixels, Sony Corp., Japan). The interface with image processing software (Global Lab Image 3.0, Data Translation, Marlboro, USA) allowed capture of a frame on board with a resolution of 752×512×8 bit pixels. The density of the whole cyst area was analysed using a grey level scale from 0 (black) to 255 (white). The cyst density value was compared to the metaphyseal bone density following the formula:

$$\text{Bone cyst density } (\%) = \frac{\text{Grey average of the cyst}}{\text{Grey average of the metaphysis}}$$

The cyst index of Kaelin and McEwen [13] was calculated from the following formula:

$$\text{Cyst Index} = \frac{\text{Area of the cyst}}{(\text{Diaphysis diameter})^2}$$

$$\text{Area of the Cyst} = \text{Trapezium area} = L + \frac{1}{2} \times H$$

Table 2. Evolution of the various parameters investigated before and after the injection of the cyst

Case	Patient	Location of the bone cyst	Cyst index[a]			Cyst density related to metaphysis (%)			Cyst diameter related to metaphysis (%)[b]			Distance from physis (cm)[c]			Follow-up (months)
			At the time of fracture	At the time of injection	At the final follow-up	At the time of fracture	At the time of injection	At the final follow-up	At the time of fracture	At the time of injection	At the final follow-up	At the time of fracture	At the time of injection	At the final follow-up	
N°1	BS	Proximal humerus	No RX	8.6	0	No RX	78	100	No RX	92	0	No RX	0.3	Disappearance	39
N°2	JV	Proximal humerus	5.25	2.1	1.11	62	89	114	86	71	68	0.2	0.5	3.1	38
N°3	FS	Proximal humerus	5.89	7.23	3.14	97	72	84	79	93	80	1.2	5.5	9	25
N°4	DM	Proximal femur	2.92	3.7	0.6	82	80	101	90	91	58	0.3	0.5	1.7	54
N°5	SG	Proximal femur	No fracture	2.47	1.72	No fracture	81	112	No fracture	84	63	No fracture	0.7	1.4	26
N°6	GM	Proximal femur	3.68	3.67	2.56	80	83	106	85	87	88	0.3	0.3	1.5	26
N°7	GBB	Distal tibia	No fracture	2.53	2.25	No fracture	90	97	No fracture	82	80	No fracture	0.3	2.6	36
N°8	LM	Proximal femur	No fracture	4.52	4.13	No fracture	70	99	No fracture	89	85	No fracture	0.1	0.2	10

[a] according to Mac Ewen and Kaelin
[b] according to Ahn and Park
[c] according to Neer

The cyst related to the metaphysis was measured using the following ratio:

$$\text{Diameter of the cyst } (\%) = \frac{\text{Maximal diameter of the bone cyst}}{\text{Diameter of the metaphysis at the same location}}$$

Results

Table 2 lists the pre- and postoperative characteristics of the bone cysts. Preoperative analysis of the cyst index and the cyst diameter showed that every patient was at risk of fracture at the time of treatment according to one or both criteria, except for one cyst whose healing was in progress after a recent fracture (case 2, Table 2). The fluid volume was over 20 cc in 3 cases only; the fluid aspirated was always serous at first, and then became serosanguinous. Biopsy confirmed that the lesion was a simple bone cyst in every case. The cysts stopped increasing in size after a single injection. A slow response was observed by 5 to 6 months after the injection and could be monitored by the decline of the cyst index and the concomitant increase of bone density (Fig. 2). These changes were more evident in the proximal humerus. At the last follow-up, radiographic aspects of the cysts could be classified, according to Capanna's criteria [5]:

- complete healing in one case
- incomplete healing in 6 cases with only one or more minor cystic areas.
- no response in one cyst (case 7).

No recurrences have been seen so far. The follow-up period is now 31 ± 13.6 months. No other treatment or a repeated injection has been necessary and all the patients resumed their activities without restriction immediately after the injection, or at 3 months after the healing of fracture if present.

Discussion

Percutaneous treatment of simple bone cysts has been the preferred surgical method since its introduction in 1974 when Scaglietti observed involution of cysts following percutaneous injection of methylprednisolone acetate (MPA). Campanacci et al. [4, 5] reported a series of 141 cysts treated with injection: 42% healed completely, 48% healed with an incomplete response, while 10% did not respond. A 15% rate of recurrence occurred in cysts that were not completely healed. An average of 3 to 4 injections were necessary to achieve healing in most cases [5]. In 10% of the cysts, no response was observed. Similar results had been earlier reported by Scaglietti [20]. Farber and Stanton [10] achieved a higher rate of primary

Fig. 2. Progressive healing of a simple bone cyst in the proximal femur in a 5-year-old girl (case 6). Postoperative radiographs at 1, 7 and 26 months

healing with MPA injection. After a single treatment, 70% healed and 88% did so after a second injection; the mean time for healing was 3.3 years in their series.

Our preliminary results indicate that at least incomplete healing could be obtained with a single injection of bone marrow after the cyst had been aspirated. Lokiec et al. [16] also used bone marrow injection, recording that they also performed multiple perforations of the cyst before the injection which in itself might also favour healing of the cyst.

The mechanism of action of this treatment is not fully established, but relief of pressure in the cyst appears to be one of the main factors [6, 7, 8, 15, 21]. We believe that the use of two large gauge trocars is critical in order to obtain a successful response by prolonged decompression. In addition, bone marrow has an osteogenic capacity that could promote cyst healing [2, 3, 11, 18]. Whether simple decompression by fluid aspiration would have been effective alone cannot be answered by our study. Whatever the mechanisms, aspiration of the fluid, followed by a single bone marrow injection, is an effective method of preventing expansion of the cysts.

The recurrence rate and the rate of no response have been found by Capanna et al. to be higher in children under 6 years of age [5]. This age at risk formed half of this small series. At present, we have had no recurrences and we do not recommend preventive osteosynthesis as advocated by Kaelin [4]. Bone marrow is more effective than MPA injection since an average of 3 injections of MPA has been necessary to obtain healing [5]. The percutaneous injection of bone marrow is safe and reliable, as a single injection was able to achieve quiescence in an expanding cyst and the children are free of symptoms.

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