Continuous decompression using a cannulated ceramic pin for simple bone cysts

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ABSTRACT

Purpose. To report the outcomes of continuous decompression using a cannulated ceramic pin for simple bone cysts (SBCs).

Methods. Seven boys and 3 girls aged 7 to 16 (mean, 11) years with SBCs underwent curettage and continuous decompression using a cannulated ceramic pin. The pin was made of hydroxyapatite and tricalcium phosphate. The clinical course, radiological findings, and complications were retrospectively assessed.

Results. The mean follow-up duration was 41 (range, 12–84) months. Five patients were evaluated as ‘healed’, 2 as ‘healing with defect’, one as ‘persistent cyst’, and 2 as ‘recurrent cysts’. No peri-operative complications were encountered. One patient had a postoperative fracture at the pin insertion site. Seven patients had pain relief and good outcomes; 2 had a thin cortical rim and complained of occasional pain and their sports activities were restricted.

Conclusion. Decompression using a cannulated ceramic pin for SBCs is minimally invasive, highly osteoconductive, and does not require bone grafting or a second operation to remove the device.

Key words: bone cysts; bone neoplasms; catheterization; surgery

INTRODUCTION

Surgical interventions for simple bone cysts (SBCs) may relieve pain and prevent restriction of activity, pathological fracture, growth arrest, and deformity.1–3 The pathogenic mechanisms responsible for SBCs involve venous congestion, loss of osteoblast activity, elevation of the internal cyst pressure, and production of interstitial fluid with bone-resorption activity.1,3–7 Treatment options for SBCs include curettage with bone graft,2 intralesional steroid injection,3,8 percutaneous bone marrow injection,1,3,5,6–10 intramedullary nailing11–15 and insertion of a cannulated screw.2,16–18 Bone cyst activity varies in relation to patient age, its site and distance from the
physeal plate. Evaluation methods also differ in each study. The variable treatment results may be due to heterogeneity of the samples and the variety of evaluation methods. Nevertheless, decompression techniques are reportedly superior to bone grafting or steroid injection. A cannulated ceramic pin made of hydroxyapatite and tricalcium phosphate has been developed for SBC treatment. It is osteoconductive and does not need removal. We report treatment results of this novel cannulation system in our institution.

MATERIALS AND METHODS

Between January 2001 and December 2006, records of 7 boys and 3 girls aged 7 to 16 (mean, 11) years with SBCs who underwent curettage and continuous compression using a cannulated ceramic pins (Kobayashi Medical, Tokyo, Japan) were retrospectively studied. The diagnosis was based on radiological findings, cyst wall pathology, and macroscopic features of the cyst fluid. Cysts were located in the proximal humerus (n=7), proximal femur (n=2), and calcaneus (n=1). The cyst was defined as active when the shortest distance from the physis to the cyst margin was <10 mm, and latent when ≥10 mm.

Eight patients had pre-existing pathological fractures. Patients 3 and 5 had received methylprednisolone acetate injection. Patient 4 had undergone intramedullary nailing for a displaced pathological fracture through a solitary bone cyst, but the cyst had persisted.

The pin was made of hydroxyapatite and tricalcium phosphate (Fig. 1). The head and central hole measured 8 and 3 mm in diameter, respectively. A hole of <1 cm in diameter was made in the wall of the cyst through a 2-cm incision, and intralesional curettage performed. Multiple drill holes were made in the wall of the cyst by a Kirschner wire, and the pin inserted. The tip of the pin was inserted into the cyst cavity under intra-operative imaging. Clear fluid was drained through the pin hole.

Postoperatively, rest (for upper limbs) or non-weight-bearing (for lower limbs) were prescribed for at least 4 weeks. Weight-bearing exercise was allowed after radiological confirmation of new bone formation. Clinical and radiological follow-up was performed at intervals of one to 2 months, and the pin position was confirmed.

Radiological results were evaluated based on new bone formation and extension of the radiolucent area and classified as ‘healed’, ‘healing with defect’, ‘persistent cyst’, and ‘recurrent cyst’. Clinical evaluation included restriction of activities of daily life and pain.

RESULTS

Patients were followed up for 12 to 84 (mean, 41) months (Table). No intra-operative or peri-operative complications were encountered. Five cysts healed (Fig. 2) and 2 were healing with defects (Fig. 3) after a mean of 6 (range, 5–8) months; all had pain relief. Patient 9 with a persistent cyst (Fig. 4) and patient 6 with a recurrent cyst complained of mild pain on movement and tenderness on palpation. To avoid pathological fracture, they were instructed to restrict sporting activity while pending a second intervention. Patient 5 with a recurrent cyst remained pain-free, probably because of cortical reorganisation (Fig. 5), and was not instructed to restrict activity. Patient 8 had a postoperative fracture necessitated plate fixation. Patients with good results (healed/healing with defect) were older than those with poor results (persistent/recurrent cysts), their mean ages being 11 vs 9 years.

DISCUSSION

Each treatment option for SBCs is based on their developmental and healing mechanisms, such that pathogenesis prevention enhances healing. Treatment comprises several biological procedures: decompression, bone marrow induction, activation of cytokines that promote bone formation and anti-inflammatory activity.

Cannulation is an effective option when venous obstruction is the primary cause of an SBC. Pathological fracture accelerates the healing of SBCs, although the rate of complete healing is less than 50%. Therefore, continuous drainage using a cannulated titanium screw has been used after
drilling holes in the closed space of the SBC\textsuperscript{6,7,22} and after decompression by an intramedullary nail.\textsuperscript{11,12,15,23}

The cannulated ceramic pin obviates the need for its removal,\textsuperscript{16,18} and has resulted in complete healing of the cyst without complications in all 11 patients (mean age, 14 years).\textsuperscript{18} Outcome is superior in patients who have reached bone maturity. Results in 3 of our 10 patients were poor (persistent/recurrent cysts), indicating that SBCs can be refractory and that cannulation carries a risk of recurrence secondary to obstruction of the drainage tube. For example in patient 5, recurrence may have been due to drainage obstruction secondary to new bone formation at the

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Sex/age (years)</th>
<th>Site involved</th>
<th>Pre-existing fracture</th>
<th>Cyst activity*</th>
<th>Healing time (months)</th>
<th>Follow-up (months)</th>
<th>Radiological results†</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M/9</td>
<td>Humerus</td>
<td>Yes</td>
<td>Active</td>
<td>8</td>
<td>84</td>
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<tr>
<td>2</td>
<td>F/13</td>
<td>Calcaneus</td>
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<td>60</td>
<td>Healed</td>
</tr>
<tr>
<td>3</td>
<td>F/7</td>
<td>Humerus</td>
<td>No</td>
<td>Active</td>
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<td>54</td>
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</tr>
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<td>4</td>
<td>M/16</td>
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<td>Yes</td>
<td>Active</td>
<td>6</td>
<td>53</td>
<td>Healed</td>
</tr>
<tr>
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<td>M/8</td>
<td>Femur</td>
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<tr>
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<td>Yes</td>
<td>Latent</td>
<td>7</td>
<td>29</td>
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<tr>
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<td>21</td>
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<tr>
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<td>M/7</td>
<td>Humerus</td>
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<td>Active</td>
<td>-</td>
<td>16</td>
<td>Persistent cyst</td>
</tr>
<tr>
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<td>M/11</td>
<td>Femur</td>
<td>Yes</td>
<td>Latent</td>
<td>6</td>
<td>12</td>
<td>Healed</td>
</tr>
</tbody>
</table>

* Cyst activity is defined as active when the shortest distance from the physis to the cyst margin was <10 mm, and latent when ≥10 mm
† ‘Healed’ is defined as formation of new bone with or without small static radiolucent areas of <1 cm. ‘Healing with defect’ is defined as a static, radiolucent area of <50% of the bone diameter, with adequate cortical thickness to resist fracture. ‘Persistent cyst’ is defined as a radiolucent area of >50% of the bone diameter, with a thin cortical rim. No increase in cyst size, but activity remains restricted or repeated treatment is required. ‘Recurrent cyst’ is defined as a cyst recurring in a previously obliterated area or an increase in residual radiolucent area.

Figure 2  Case 4: radiographs of a 16-year-old boy showing (a) a pathological fracture at the right humerus treated with intramedullary nailing, (b) bony union with the cyst remaining refractory and active, (c) new bone formation 6 months after insertion of a cannulated ceramic pin, and (d) the healed cyst with no recurrence at 53 months.
tip of the pin (Fig. 5). Postoperative fracture may occur when there is discrepancy between radiological findings and actual bone strength. Moreover, the hole through which the pin is inserted may weaken the structure.

In a study comparing intralesional steroid injection and percutaneous bone marrow injection, the mean healing period and number of interventions...
were 13 vs 14 months and 2.2 vs 1.6, respectively. In our study, decompression with a cannulated ceramic pin resulted in earlier bone healing with only one intervention. It was minimally invasive, highly osteoconductive, and did not entail bone grafting or a second operation to remove the device.\(^{16,18}\) 49% and 57% of patients required repeated interventions after intralesional steroid injection and percutaneous bone marrow injection, respectively.\(^3\)

The appropriate indications (intervention period, age, site, or cyst activity) for decompression using a cannulated ceramic pin are unknown. There was a trend toward treatment failure in younger patients and active lesions, which suggests that SBC development is related to bone maturation. The healing rate after prednisolone injection is significantly higher in older patients.\(^2\) However, clinical results after intralesional steroid injection or decompression by cannulation did not differ in relation to age or cyst activity.\(^2\) Thus, the appropriate age for SBC treatment remains controversial. If bone maturity does not affect the healing rate, early intervention confers greater quality-of-life benefits. Pilot studies comparing various SBC treatments have been reported.\(^2,3,8\) Controlled studies are needed to compare outcomes after matching age for size, activity, and site of the cyst.

REFERENCES