Percutaneous injection of bone cement (Cementoplasty) for the treatment of symptomatic subchondral cysts

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Aims and objectives

Introduction

Subchondral cysts are benign para-articular intraosseous cyst, consisting histologically of a cavity of a variable size, without an epithelial or synovial lining, and containing mucoid viscous material [1]. They are non neoplastic bone lesions; they occur in the skeletally mature at all ages with a peak incidence in the 4th and 5th decade and have a minor male preponderance. They are mostly located in weight-bearing long bones of the lower limb [1]. Subchondral cyst originally said to be rare, appears now to be a relatively frequent lesion. They often occur near a degenerative joint and are known to be associated with osteoarthritis [2]. Their etiology and pathogenesis still remain unknown [3]. Proposed theory of the pathogenesis of subchondral cyst formation in osteoarthritis include bony micro contusions leading to necrosis, increased intra-articular pressure leading to extension of synovial fluid into the subchondral bone though tiny gaps in the articular surface (bone contusion theory) or the proliferation of myxomatous tissue within the bone marrow (synovial breach theory).

A progressive increase in size, surrounding bone marrow edema, or pathological fracture can indicate "symptomatic" subchondral cysts.

Since its first use thirty years ago [4], vertebroplasty, consisting of percutaneous injection of bone cement under imaging guidance [5], has been used in numerous variations for the treatment of several lesions such as vertebral metastases [6], osteoporotic or traumatic vertebral fractures [7,8], but also cementoplasty of malignant osteolyses in the appendicular skeleton [9,10,11].

There are few articles related to cementoplasty for the treatment of articular degenerative lesions in the literature. To our knowledge, only one article describes the aim of these interventions [1] on a small population of heterogeneous patients.

The objective of our study was to tell our experience in the treatment of degenerative subchondral cysts by percutaneous injection of bone cement, on a population of homogeneous patients presenting with incapacitating functional disability and for whom a surgical approach by implementation of prosthesis was not wished or not indicated considering the presence of comorbidities.
Methods and materials

Patient population and selection

We present a prospective observational study on 13 consecutive patients (five men, eight women, mean age of 67 years) suffering from symptomatic degenerative subchondral cysts of the appendicular skeleton. From October 2011 to October 2013, 13 patients were enrolled with no traumatic or surgical history noted. Most patients were suffering from intense mechanical pain and disability for walking. The lesions were located in the hip (femoral head: four cases), knee (tibial plateau: four cases; femoral condyle: two cases), ankle (talus: two cases) and calcaneus (one case). These subchondral cystic lesions were the results of degenerative changes caused by arthrosis in seven cases, and the consequence of aseptic osteonecrosis in six cases.

A pre-operative magnetic resonance imaging (MRI) was available for all patients before treatment, which showed or confirmed the presence of the degenerative subchondral cyst and the bone marrow edema. A request of Institutional Review Board approval was obtained and informed consent was obtained for each patient, including the risk of articular cement leakage.

A prospective follow-up was made, consisting of a post-operative MRI at one month to evaluate the decrease of bone marrow edema, and a quantification of pain was done by each subject on an 11-point numeric visual analog scale (VAS) with values from 0 to 10 (where 10 indicates the strongest pain ever experienced and 0 indicates absence of pain) by an independent evaluator. A difference in VAS > 2 points was considered a clinically significant result [12]. A clinical examination was made before treatment and at one month and three months after treatment to evaluate pain evolution.

Statistical analysis

The VAS score was measured at these three follow-up examinations. Pre and post operative scores were compared using the non parametric Wilcoxon signed-rank test for paired data. P<0.05 was considered statistically significant. Statistical analyses were performed by using SPSS® Statistical Software (SPSS 11.0 for Windows).

Technique

All procedures were performed in a dedicated CT room for musculoskeletal radiological interventional procedures, using CT (Lightview 8-MDCT scanner, GE Healthcare,
Waukesha, WI, USA) guidance and fluoroscopy (Stenescop C-arm, GE Healthcare) guidance. All patients were treated by a senior interventional radiologist.

Volumetric CT acquisition with 1-mm slices was performed at level of the degenerative subchondral cyst involved, and then three-dimensional reconstructions allowed us to plan the procedure to abort the subchondral cyst by direct draining. The site of entrance assigned was located on the inferior part of the degenerative subchondral cyst, to avoid as best as possible intraarticular cement leakage during the progressive filling of the cyst.

Patients were placed in a supine position on the CT table (Fig. 1 on page 7).

![Fig. 1: Patients placed in a supine position on the CT table for the procedure done under CT and fluoroscopic guidance.](image)

**References:** Department of Radiology, Nice University Hospital, Nice/FR

Under aseptic surgical conditions and after local anesthesia, a 13-gauge 10-cm trocar (t'AM; Thiebaud, Thonon-les-Bains, France) was inserted under fluoroscopic and CT-
guidance until it reached the inferior intra-cystic part of the subchondral cyst. A CT scan was used to confirm the correct positioning of the tip of the trocar.

Then, radiopaque cement (PMMA, Biomet V; Biomet, Warsaw, IN) was injected at the time its viscosity was high. The cyst was progressively filled from the most distal part of the joint until the cement reached the portion of the cyst adjacent to the articular surface (Fig. 2 on page 7).

![Image showing the injection of radiopaque cement at the time its viscosity was high; then the filling of the cyst was made slowly and carefully from the most distal part of the joint until adjoin the articular surface, to avoid intra-articular cement leak.](image)

**Fig. 2**: Image showing the injection of radiopaque cement at the time its viscosity was high; then the filling of the cyst was made slowly and carefully from the most distal part of the joint until adjoin the articular surface, to avoid intra-articular cement leak.

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The injection was performed slowly and carefully, to avoid intra-articular cement leak. The mean amount of cement injected was 3 or 4 ml by patient.
A volumetric acquisition by CT scan was performed at the end of the procedure to confirm the optimal filling of the subchondral cyst and the absence of cement leakage.
Images for this section:

**Fig. 1:** Patients placed in a supine position on the CT table for the procedure done under CT and fluoroscopic guidance.

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**Fig. 2:** Image showing the injection of radiopaque cement at the time its viscosity was high; then the filling of the cyst was made slowly and carefully from the most distal part of the joint until adjoin the articular surface, to avoid intra-articular cement leak.

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Results

Data are summarized in Table 1 on page 14.

<table>
<thead>
<tr>
<th>Patients</th>
<th>Sex</th>
<th>Age</th>
<th>Location</th>
<th>Cause</th>
<th>VAS before treatment</th>
<th>VAS one month after treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1</td>
<td>Female</td>
<td>83 years</td>
<td>Tibial plateau</td>
<td>Degenerative</td>
<td>8/10</td>
<td>2/10</td>
</tr>
<tr>
<td>Case 2</td>
<td>Male</td>
<td>66 years</td>
<td>Femoral head</td>
<td>Aseptic osteonecrosis</td>
<td>4/10</td>
<td>4/10</td>
</tr>
<tr>
<td>Case 3</td>
<td>Female</td>
<td>75 years</td>
<td>Tibial plateau</td>
<td>Degenerative</td>
<td>9/10</td>
<td>6/10</td>
</tr>
<tr>
<td>Case 4</td>
<td>Male</td>
<td>80 years</td>
<td>Femoral condyle</td>
<td>Degenerative</td>
<td>7/10</td>
<td>3/10</td>
</tr>
<tr>
<td>Case 5</td>
<td>Male</td>
<td>64 years</td>
<td>Femoral head</td>
<td>Aseptic osteonecrosis</td>
<td>7/10</td>
<td>1/10</td>
</tr>
<tr>
<td>Case 6</td>
<td>Female</td>
<td>70 years</td>
<td>Calcaneus</td>
<td>Degenerative</td>
<td>10/10</td>
<td>2/10</td>
</tr>
<tr>
<td>Case 7</td>
<td>Female</td>
<td>70 years</td>
<td>Femoral condyle</td>
<td>Degenerative</td>
<td>9/10</td>
<td>0/10</td>
</tr>
<tr>
<td>Case 8</td>
<td>Male</td>
<td>45 years</td>
<td>Talus</td>
<td>Degenerative</td>
<td>7/10</td>
<td>1/10</td>
</tr>
<tr>
<td>Case 9</td>
<td>Female</td>
<td>61 years</td>
<td>Tibial plateau</td>
<td>Aseptic osteonecrosis</td>
<td>10/10</td>
<td>7/10</td>
</tr>
<tr>
<td>Case 10</td>
<td>Female</td>
<td>74 years</td>
<td>Femoral head</td>
<td>Aseptic osteonecrosis</td>
<td>10/10</td>
<td>2/10</td>
</tr>
<tr>
<td>Case 11</td>
<td>Male</td>
<td>34 years</td>
<td>Talus</td>
<td>Degenerative</td>
<td>8/10</td>
<td>6/10</td>
</tr>
<tr>
<td>Case 12</td>
<td>Female</td>
<td>91 years</td>
<td>Femoral head</td>
<td>Aseptic osteonecrosis</td>
<td>10/10</td>
<td>0/10</td>
</tr>
<tr>
<td>Case 13</td>
<td>Female</td>
<td>61 years</td>
<td>Tibial plateau</td>
<td>Aseptic osteonecrosis</td>
<td>7/10</td>
<td>1/10</td>
</tr>
</tbody>
</table>

Table 1: Percutaneous injection of bone cement in the treatment of symptomatic subchondral cysts: population, location, cause and follow-up

References: Department of Radiology, Nice University Hospital, Nice/FR

Procedure

Treatment was technically successful in 13 cases and clinically successful in 12 cases (Fig. 3 on page 14, Fig. 4 on page 15, Fig. 5 on page 16).
Fig. 3: Axial CT images showing a subchondral cyst of the talus before the procedure and after the procedure, with a complete filling of the cyst by the cement. 

References: Department of Radiology, Nice University Hospital, Nice/FR
Fig. 4: Axial CT images demonstrating an optimal filling of a subchondral cyst of the femoral head, and the absence of cement leakage.

References: Department of Radiology, Nice University Hospital, Nice/FR

Fig. 5: Axial CT images showing a subchondral cyst of the femoral condyle before and after the procedure, with an optimal filling of the cyst.

References: Department of Radiology, Nice University Hospital, Nice/FR

After percutaneous injection, all the lesions were totally filled with bone cement. The feasibility of the procedure was 100% in our study. We reported one case with para-articular asymptomatic cement leak at the knee. There were no other immediate or delayed complications observed. One patient had no relief of his pain after the treatment and underwent hip surgery.

Follow-up

Patient follow-ups in our series show supportive results: within 13 patients, 12 patients were satisfied after the procedure had been performed, and would recommend the intervention to relatives. The average evaluation of pain was 8/10 (SD: 0.49) median 8/10
before treatment, 3/10 (SD: 0,66) median: 2/10 one month after treatment and 1/10 (SD: 0,60) median 0/10 three months after treatment (Fig. 6 on page 16).

Fig. 6: Evolution of the VAS score before and after the procedure.

References: Department of Radiology, Nice University Hospital, Nice/FR

Our results show a significant decrease of the pain felt by patients between -before procedure and one month after the procedure- (p= 0,002), -before procedure and three months after the procedure- (p=0,002), and -one month after the procedure and three months after the procedure- (p=0,011).
The average follow-up period was 22 months (2-43 months). The MRI done one month after the treatment showed optimal filling of the lesions by the cement, and persistence of a small edema around lesions (Fig. 7 on page 17) corresponding to lasting inflammatory post-operative process.

**Fig. 7**: Axial T2-weighted fat-saturated MRI of the knee, showing the bone marrow edema around the multilocular cyst of the lateral tibial plateau before the procedure, and the optimal filling of the cyst by the cement after the procedure with persisting of a small edema around the treated lesion.

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Conclusion

Subchondral cysts can be responsible for acute or chronic articular pain in patients suffering from osteoarthritis due to the intraosseous development of the cyst and to the chondrolysis of the articular cartilage. As subchondral cyst lesion arises near osteoarthritis lesions, it is often difficult to estimate the benefit on patient's pain of a percutaneous injection of bone cement into the cystic lesion. Although subchondral cyst can be symptomatic, it may be difficult to ascertain whether the pain can be attributed solely to their presence.

Our study shows a significant decrease of patient's pain after the treatment by percutaneous injection of bone cement under CT and fluoroscopy guidance (p<0.05) at one and three months post procedure. The procedure indication was evaluated very carefully for each patient, as management of symptomatic subchondral cyst depends largely on the clinical symptoms and degree of degenerative joint disease. All the patients were suffering from a symptomatic subchondral cyst associated with bone marrow edema on the MRI performed before treatment, which indicated the concordance between clinical symptoms and imaging.

The procedures were performed under local anesthesia. No immediate or delayed complications were observed. The technique allowed early mobilization of the patients, with a minimal post-operative stay and a fast return to daily life activities. There was no blood loss, no major skin scar, relative absence of post-operative pain following the procedure, and a lowest cost compared to surgical treatment. Our procedure was performed under CT and fluoroscopy guidance which allowed a better control of the progression of the trocar into the lesion. The filling of the cysts was done very slowly and carefully to avoid intra-articular cement leak.

We observed one para-articular non symptomatic cement leak at the knee. After 3 months of follow-up, the patient was still asymptomatic and no chondrolysis was observed. Intra-articular cement leak can be very damaging for the joint considering the risk of rapid chondrolysis, reported in one case in the literature [13].

Limitations

Our study has some limitations. First, we did not compare our results to a control group treated conservatively. In fact, it was difficult not to treat demanding patients suffering from intense pain whom we could propose a safe and efficient treatment option. Second, long-term clinical outcome still needs to be evaluated, as our average
follow-up period was 22 months. Indications and benefits of cementoplasty in the treatment of symptomatic subchondral cysts have to be clearly defined for a usual use by interventional radiologists.

**Conclusion**

Percutaneous injection of bone cement under CT and fluoroscopy guidance seems to be a rapid, safe and efficient therapeutic option for symptomatic subchondral cysts. The balance benefits versus risks of this technique seems very satisfying, with significant decrease of patient’s pain and advantages of a mini-invasive procedure compared to classic surgery.
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