Interstitial laser photocoagulation for the treatment of osteoid osteoma

RESULTS OF A PROSPECTIVE STUDY
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We report the results of a prospective study of 23 patients in which interstitial laser photocoagulation (ILP) was used to treat an osteoid osteoma. ILP is a technique in which tumour tissue is destroyed by direct heating using low-power laser light energy delivered by thin (400 µm) optical fibres which are introduced percutaneously into the tumour under image guidance.

Pain was evaluated before operation and at the latest follow-up using a visual analogue scale with 0 denoting no pain and 10 the worst pain imaginable. The mean follow-up was for 15 months.

The results showed that the mean pain score decreased from 7.5 before operation to 0.95 at the latest follow-up. Fourteen patients had no pain and eight had minor discomfort, not requiring analgesia. One patient required a second procedure because placement of the fibre had not been accurate enough and one developed recurrent symptoms eight months after treatment. All patients were satisfied with the operation because of the rapid resolution of pain, the minimally invasive nature of the procedure, and the fact that there was no postoperative restriction of activity.

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Osteoid osteoma is a benign tumour of bone characterised by an osteoid-rich nidus in a highly vascular connective-tissue stroma. Its size (< 2 cm) distinguishes it from an osteoblastoma. It occurs most commonly between the ages of five and 40 years and tends to affect the long bones with the femur, tibia, and humerus being the sites most commonly involved.

Pain is the usual presenting symptom and is often severe, worse at night, and classically relieved by non-steroidal anti-inflammatory drugs (NSAIDs). When left untreated, the tumour can cause symptoms related to synovitis, bone overgrowth and scoliosis. There is some evidence that these tumours are non-progressive and may resolve spontaneously with time. The problem for the patient, however, is the severe persistent pain and the intolerance to NSAIDs which may develop. Removal of the nidus is the most effective cure.

Surgical options include wide excision with surrounding normal bone, removal of the roof of the nidus and curettage, or a variety of less invasive techniques such as CT-guided core drill excision, radiofrequency ablation, injection of ethanol or interstitial laser photocoagulation (ILP).

The main disadvantages of open procedures are the difficulties in identifying and localising the nidus at the time of surgery, the postoperative restriction of activity which may be required after removal of bone, and sometimes the awkward anatomical location of the tumour which may require an extensive surgical approach (Fig. 1).

ILP was first described in 1983. In this technique, a bare optical fibre or fibres is inserted directly into the target tissue which is then treated by low levels of power (typically 2 to 4 W) for several minutes. This causes a relatively predictable area of coagulative necrosis. The technique has been applied clinically to treat tumours of the breast, liver, prostate, brain and pancreas.

Experimental studies have shown a good correlation between the energy delivered and the size of the lesion. In the femur of the pig, the mean axial diameter of coagulation with a constant power of 2 W varied from 3.4 mm with 200 J to 9.2 mm at 1000 J. The longitudinal diameter of coagulation along the fibre track was greater than the axial diameter with 4 mm at 200 J and 11.1 mm at 1400 J. The maximum effect was reached after a delivery of energy of 1000 to 1200 J and more energy at the same location did not alter the area of coagulation. These findings agree with...
other results indicating that transmission of heat within bone is sharply limited by blood flow, and consequently lethal temperatures cannot be sustained over great distances.

Our aim was to assess prospectively the efficacy of ILP in the treatment of osteoid osteoma.

Patients and Methods

Between August 1997 and June 1999, we studied 23 consecutive patients with typical clinical and radiological features of osteoid osteoma. One had had unsuccessful surgery elsewhere. In all the patients plain radiography, an isotope bone scan and fine-cut (2 mm) CT were performed. Before treatment and at latest follow-up patients were asked to mark the level of pain on a visual analogue scale in which 0 represented no pain and 10 the worst pain that they could imagine.

There were 19 men and four women with a mean age of 21 years (5 to 47). The mean duration of symptoms was 22 months (6 to 84). Table I gives the sites involved by the tumour. The mean length of follow-up after treatment was 15 months (7 to 30).

Operative technique. All procedures were performed in the CT scanner and under general anaesthesia except for one patient who had a regional block.

The nidus of the tumour was localised by CT, and its largest diameter was measured. The optimal approach to the lesion was planned at the time of the procedure, particularly with regard to adjacent neurovascular structures. In nine patients in whom the nidi were subperiosteal we used an 18-, 19- or 16-gauge spinal needle for penetration. In one patient with a small amount of cortical bone an 11-gauge bone-marrow biopsy needle was used and in 13 with thick cortical bone a threaded guide wire followed by a 2.7 mm cannulated drill was used to penetrate the nidus.

We performed ILP using a portable semiconductor diode laser (Diomed, Cambridge, UK) connected to a sterilised bare-tipped optical fibre of 400 µm in diameter. Once the needle/drill was satisfactorily positioned, the optical fibre was then inserted into the nidus through the needle so that the tip lay 5 mm proud of the needle tip and within the nidus. The energy required to coagulate the tumour was calculated from the largest diameter of the nidus. A power of 2 W was delivered down the fibre for 500 to 700 seconds (1000 to 1500 J) depending on the size of the nidus which ranged from 2 to 12 mm.

Most patients were treated by a single optical fibre. In two, the nidus measured over 10 mm and the lesion was treated by two fibres inserted through two needles positioned 4 mm apart. Any lesion which was treated in an area with little overlying subcutaneous tissue was routinely irrigated with iced saline to avoid heat damage to the skin.

All patients were routinely given a single preoperative dose of intravenous antibiotic (cefuroxime 1.5 g). After operation they were allowed to mobilise as comfort allowed without specific restrictions. It was important that they received opiate analgesia before waking from anaesthesia since there was severe discomfort related to the procedure for the first one to two hours. They were all discharged on the following day.

Results

Most patients noticed a change in the nature of their pain within 24 to 48 hours after ILP and by 72 hours 20 found that they could stop taking analgesic medication. In one patient symptoms persisted for one week and in two for three weeks. One patient required a second treatment.

Table I. The site of osteoid osteoma in the 23 patients

<table>
<thead>
<tr>
<th>Site</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetabulum</td>
<td>3</td>
</tr>
<tr>
<td>Femoral neck</td>
<td>4</td>
</tr>
<tr>
<td>Femoral shaft</td>
<td>3</td>
</tr>
<tr>
<td>Distal femur</td>
<td>1</td>
</tr>
<tr>
<td>Patella</td>
<td>1</td>
</tr>
<tr>
<td>Tibial shaft</td>
<td>1</td>
</tr>
<tr>
<td>Distal tibia</td>
<td>2</td>
</tr>
<tr>
<td>Lateral malleolus</td>
<td>1</td>
</tr>
<tr>
<td>Great toe</td>
<td>1</td>
</tr>
<tr>
<td>Second toe</td>
<td>1</td>
</tr>
<tr>
<td>Talus</td>
<td>1</td>
</tr>
<tr>
<td>Pubic ramus</td>
<td>1</td>
</tr>
<tr>
<td>L4 vertebra</td>
<td>1</td>
</tr>
<tr>
<td>Radial shaft</td>
<td>1</td>
</tr>
<tr>
<td>Proximal humerus</td>
<td>1</td>
</tr>
</tbody>
</table>
because symptoms did not subside. This was because the needle was not precisely positioned within the nidus. His symptoms subsided immediately after the second treatment.

The mean preoperative pain score was 7.5 (4 to 10) and at the latest follow-up 0.95 (0 to 5). Fourteen patients had no pain and eight had varying degrees of discomfort but none required regular analgesia or had disturbance of sleep. One patient, a five-year-old boy, developed recurrent symptoms eight months after treatment of an osteoid osteoma in the neck of the femur and has been scheduled for a repeat treatment. All patients expressed satisfaction with the procedure, particularly as there was minimal discomfort, scarring or restriction of activity.

**Complications.** Two patients had delayed healing of the needle puncture marks and one with an osteoid osteoma of the distal phalanx of the second toe lost the nail.

### Discussion

The aim of treatment of patients with an osteoid osteoma is primarily to relieve pain. The tumour itself is usually only a few millimetres in diameter and is benign. In most cases it can be recognised by its clinical presentation and radiological appearance and therefore histological confirmation is not necessary. It would seem reasonable therefore to approach the treatment of this condition in a manner which will cause as little trauma, discomfort and restriction of activity to the patient as possible.

Although both wide excision and deroofing with curettage of the nidus have reported rates of cure of 75% to 100%, they often involve a major surgical procedure and several weeks of restricted activity. The results of a number of percutaneous techniques have been reported and these give findings which are very similar in terms of achieving a cure. Campanacci et al. recently reviewed the literature pertaining to percutaneous methods. Of 247 patients treated percutaneously under CT guidance, 204 (83%) were reported as having achieved a primary cure, 22 (9%) received a second, successful, percutaneous procedure, 15 (6%) subsequently had surgical excision, and six (2%) had no change in pain after percutaneous treatment.

To date as far as we are aware, there has been only one other study of the use of ILP in the treatment of osteoid osteoma. Gangi et al. described successful results in 14 out of 15 patients with a mean follow-up of 15.4 months (12 to 40). One patient required a further treatment after recurrence of pain at six weeks because the needle tip had not been placed precisely enough in a large (9 mm) nidus. This was very similar to our patient who needed a second procedure. The same authors have also reported successful results using this technique in the spine.

Of interest is the number of patients who have some degree of residual discomfort at follow-up, which was also highlighted in the series by Rosenthal et al. They noted that six of 26 patients (23%) who had had percutaneous radiofrequency ablation and eight of 27 (30%) who had had operative excision had persistent symptoms. This is not mentioned in other series in which recurrence is presumably considered to have occurred when pain returned to the preoperative level.

An advantage of ILP over other percutaneous methods is that the treatment can be delivered through fine-gauge needles in most cases, because of the small diameter of the optical fibres used (Fig. 2). When the cortex needs to be drilled, we use a 2.7 mm cannulated drill. A further advantage is that treatment can be repeated easily and atraumatically if there is recurrence. This is made easier by the absence of a surgical artefact which can make repeat imaging of the tumour difficult to interpret.

Our results show that ILP is an effective way of treating patients with osteoid osteoma and we now use this technique routinely. It would appear that with the good results now obtained with percutaneous techniques, open procedures are difficult to justify.

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### References