Osteofibrous dysplasia of the tibia

IS THERE A NEED FOR A RADICAL SURGICAL APPROACH?

Osteofibrous dysplasia is an unusual developmental condition of childhood, which almost exclusively affects the tibia. It is thought to follow a slowly progressive course and to stabilise after skeletal maturity. The possible link with adamantinoma is controversial and some authors believe that they are part of one histological process.

We retrospectively reviewed 16 patients who were diagnosed as having osteofibrous dysplasia initially or on the final histological examination. Their management was diverse, depending on the severity of symptoms and the extent of the lesion. Definitive (extraperiosteal) surgery was localised ‘shark-bite’ excision for small lesions in five patients. Extensive lesions were treated by segmental excision and fibular autograft in six patients, external fixation and bone transport in four and proximal tibial replacement in one. One patient who had a fibular autograft required further excision and bone transport for recurrence. Six initially underwent curettage and all had recurrence. There were no recurrences after localised extraperiosteal excision or bone transport. There were three confirmed cases of adamantinoma.

The relevant literature is reviewed. We recommend extraperiosteal excision in all cases of osteofibrous dysplasia, with segmental excision and reconstruction in more extensive lesions.

Osteofibrous dysplasia is an unusual developmental tumour-like fibro-osseous condition. Originally reported by Frangenheim1 in 1921 it has since been described by a variety of other terms such as congenital fibrous dysplasia2 and ossifying fibroma of the long bones.3 Campanacci and Laus4 coined the term ‘osteofibrous dysplasia of the tibia and fibula’, emphasising the histological similarity to fibrous dysplasia and also its near-exclusive predilection for the tibial diaphysis. Lesions solely affecting the fibula,4 radius and ulna5,7 have also been reported.

The other important differential diagnosis is adamantinoma,5,9 a rare malignant condition which mimics the radiological and clinical picture of osteofibrous dysplasia and may be difficult to differentiate histologically. Several authors have highlighted the possibility of adamantinoma being masked by osteofibrous dysplasia10 and have used terms such as ‘osteofibrous dysplasia-like’, ‘differentiated’ or ‘juvenile’ adamantinoma to suggest that the conditions may be at different ends of the same spectrum of disease.11,12 To our knowledge, the risk of coexisting adamantinoma has not been quantified in the literature.

Other factors involved when deciding upon the optimum treatment are that both curettage and localised subperiosteal excision carry the risk of recurrence,4-6,13,14 while more radical excision and reconstruction may be complicated by problems such as pseudarthrosis.5 As a result, many authors have advocated conservative treatment.5,6,13,15,16

We present our experience of osteofibrous dysplasia of the tibia and explain why we feel that a more radical approach to management should be considered.

Patients and Methods

Using the extensive bone-tumour database at the Royal National Orthopaedic Hospital, Stanmore, we identified 16 patients over a period of ten years from October 1992 to October 2002 who had been diagnosed, initially or finally, as having osteofibrous dysplasia of the tibia. All their notes, including histological reports and radiographs were available and examined retrospectively. All follow-up clinic appointments were reviewed up to October 2004.

Details of age, history of presentation, site and extent of the disease, biopsy results, treat-
### Table I.

| Case | Gender | Age at presentation (yrs) | Side | Location | Injury at site of disease | Initial presentation | Referred diagnosis | *Biopsy result†| Operative treatment‡ | Final histology | Complications | Follow-up (mths) | Current status |
|------|--------|---------------------------|------|----------|--------------------------|---------------------|-------------------|------------------|------------------|----------------|----------------|----------------|---------------|---------------|
| 1    | M      | 17.3                      | Right| Diaphysis| Swelling for 18 months   | OFD                 | OFD               | Pure OFD         | None             | Symptom-free    |                | 126            |               |
| 2    | F      | 11.9                      | Left | Diaphysis| Swelling                 | OFD                 | OFD               | Pure OFD         | None             | Symptom-free    |                | 99             |               |
| 3    | M      | 33.1                      | Right| Diaphysis| Pain and swelling after football injury 4 years ago | Infection          | Stress fracture    | Osteoid osteoma | None but imaging suggests OFD |                |                | 11/94          | Discharged     |
| 4    | M      | 16.7                      | Left | Diaphysis| Pain and swelling for 1 year | OFD                 | OFD               | Pure OFD         | None             | Symptom-free    |                | 26             |               |
| 5    | F      | 5.2                       | Right| Diaphysis| Swelling after 6 months ago | Brodie's abscess   | ABC or ABC change in non-ossifying fibroma. Possible OFD |                |                |                |                | 2/01           | Symptom-free    |
| 6    | F      | 13.9                      | Left | Diaphysis| Swelling after fall | Referred after initial surgery with recurrence | Fibrous dysplasia |                |                |                |                | 38             | Symptom-free    |
| 7    | F      | 13.3                      | Left | Diaphysis| Pain and swelling for 1 month | OFD                 | OFD               | Pure OFD         | None             | Symptom-free    |                | 10/00          |               |
| 8    | M      | 2.2                       | Right| Diaphysis| Pain and swelling for 5 months | OFD                 | OFD               | Pure OFD         | None             | Symptom-free    |                | 6              |               |
| 9    | F      | 3.0                       | Right| Diaphysis| Referred after initial surgery with recurrence | OFD                 | OFD               | Pure OFD         | None             | Symptom-free    |                | 04/99          |               |
| 10   | F      | 12.1                      | Left | Diaphysis| Pain and swelling         | OFD                 | OFD               | Pure OFD         | None             | Symptom-free    |                | 11/00          |               |
| 11   | F      | 11.9                      | Left | Diaphysis| Swelling                 | OfD                 | OfD               | Pure OFD         | None             | Symptom-free    |                | 11/00          |               |
| 12   | M      | 1.2                       | Right| Diaphysis| Swelling                 | OFD                 | OfD               | Pure OFD         | None             | Symptom-free    |                | 11/00          |               |
| 13   | F      | 1.7                       | Right| Diaphysis| Swelling                 | OFD                 | OfD               | Pure OFD         | None             | Symptom-free    |                | 11/00          |               |
| 14   | M      | 1.0                       | Right| Diaphysis| Swelling                 | OfD                 | OfD               | Pure OFD         | None             | Symptom-free    |                | 11/00          |               |
| 15   | F      | 0.9                       | Right| Diaphysis| Swelling                 | OfD                 | OfD               | Pure OFD         | None             | Symptom-free    |                | 11/00          |               |
| 16   | F      | 0.8                       | Right| Diaphysis| Swelling                 | OfD                 | OfD               | Pure OFD         | None             | Symptom-free    |                | 11/00          |               |

* OFD, osteofibrous dysplasia
† ABC, aneurysmal bone cyst; FD, fibrous dysplasia
‡ POP, plaster of paris; MUA, manipulation under anaesthesia; EUA, examination under anaesthesia; AK, above knee; PTR, proximal tibial replacement
§ ER, external rotation; FFD, fixed flexion deformity; IP, in-patient; EHL, extensor hallucis longus; ITU, intensive therapy unit
¶ surgery before referral to our institution
### Table I continued.

<table>
<thead>
<tr>
<th>Case</th>
<th>Gender</th>
<th>Age at presentation (yrs)</th>
<th>Side</th>
<th>Location</th>
<th>Injury at site of disease</th>
<th>Initial presentation</th>
<th>Referral diagnosis</th>
<th>Operative treatment</th>
<th>Postop histology</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>F</td>
<td>14.2</td>
<td>Right</td>
<td>Diaphysis</td>
<td>No</td>
<td>Swelling for 3 months</td>
<td>OFD OFD</td>
<td>9/93 Excision and bone transport</td>
<td>Pure OFD</td>
<td>Docking failure requiring nail</td>
</tr>
<tr>
<td>12</td>
<td>M</td>
<td>3.0</td>
<td>Left</td>
<td>Metaphysis</td>
<td>Yes</td>
<td>Fracture and swelling</td>
<td>Referred after initial surgery with recurrence</td>
<td>Curettage</td>
<td>None but imaging suggests OFD</td>
<td>Non-ossifying fibroma fibrous lesion</td>
</tr>
<tr>
<td>13</td>
<td>F</td>
<td>8.8</td>
<td>Right</td>
<td>Diaphysis</td>
<td>No</td>
<td>Pain and swelling for 3 months</td>
<td>Referred after initial surgery with recurrence</td>
<td>Curettage</td>
<td>Further pain</td>
<td>Curettage, followed by bone transport, then excision docking site, chamfering and bone graft, followed by EUA and removal of Ilizarov frame</td>
</tr>
<tr>
<td>14</td>
<td>M</td>
<td>10.4</td>
<td>Left</td>
<td>Diaphysis</td>
<td>No</td>
<td>Pain and swelling for 3 months</td>
<td>OFD OFD</td>
<td>1/00 Excision and bone transport</td>
<td>Pure OFD</td>
<td>Transient EHL weakness, chronic pain (child psych), skin puckering, non-union docking site</td>
</tr>
<tr>
<td>15</td>
<td>F</td>
<td>11.4</td>
<td>Left</td>
<td>Diaphysis</td>
<td>No</td>
<td>Pain and swelling and deformity</td>
<td>OFD OFD</td>
<td>5/01 Excision and bone transport</td>
<td>Pure OFD</td>
<td>Recurrence after curettage, pin site infections, ITU admission for sepsis, 10˚ equinus contracture (improving), proximal tibial replacement</td>
</tr>
<tr>
<td>16</td>
<td>M</td>
<td>7.3</td>
<td>Left</td>
<td>Metaphysis</td>
<td>No</td>
<td>Pain and swelling</td>
<td>Referred after initial surgery with fracture with recurrence</td>
<td>Curettage (histology non-ossifying fibroma)</td>
<td>Non-ossifying fibroma – low grade central osteosarcoma – superficially resembles fibrous dysplasia</td>
<td>Curettage, followed by lengthening PTR, then Proximal tibial replacement</td>
</tr>
</tbody>
</table>

* OFD, osteofibrous dysplasia
† ABC, aneurysmal bone cyst; FD, fibrous dysplasia
‡ POP, plaster of paris; MUA, manipulation under anaesthesia; EUA, examination under anaesthesia; AK, above knee; PTR, proximal tibial replacement
§ ER, external rotation; FFD, fixed flexion deformity; IP, in-patient; EHL, extensor hallucis longus; ITU, intensive therapy unit
¶ surgery before referral to our institution
ment, final histological findings and follow-up details were obtained (Table I).

Results
The mean follow-up period for the 16 patients was 61 months (23 to 128). The mean age at presentation was 11.5 years (2.2 to 33.1; median 11.7), with a male-to-female ratio of 7:9. The left tibia was affected in nine patients and the right in seven. In most patients (14 of 16), the diaphysis (Fig. 1), as opposed to the metaphysis, was affected. Of the 16 patients, five gave a history of injury at the site of disease.

Although the initial diagnosis of osteofibrous dysplasia was made on the basis of radiological signs in ten patients, a host of initial differential diagnoses was put forward in the other six. These included fibrous dysplasia, osteoid osteoma, stress fracture and Brodie’s abscess.

In some patients, plain radiographs were sufficient to establish a working diagnosis, while in others additional imaging such as bone scanning, CT and MRI was requested as part of the initial work-up or required to delineate the extent of the lesion and to aid pre-operative planning.

Biopsy was undertaken in 13 patients. Although osteofibrous dysplasia was diagnosed in ten, three were given other diagnoses (fibrous dysplasia or aneurysmal bone cyst and low-grade central osteosarcoma which superficially resembled fibrous dysplasia). Three patients did not have a biopsy and were treated on clinical and radiological evidence alone.

Table I has been presented according to the final method of treatment. A total of five modes of management were used: curettage, excision, fibular grafting, external fixation with bone transport and proximal tibial replacement. Some patients had more than one operative technique during the period of study.

Curettage. Six patients presented with recurrence after initial curettage and underwent more extensive surgery (cases 6, 9, 10, 12, 13 and 16). All had their curettage procedure elsewhere, before being referred for recurrence.
Excision. Five patients (cases 1 to 5), in whom the lesion was small and not circumferential on imaging, underwent localised extraperiosteal or ‘shark-bite’ excision (Fig. 2) and all have remained symptom-free at a mean follow-up of 76 months (26 to 126).

In more extensive lesions extraperiosteal excision was performed and the type of reconstruction was chosen according to the preference of the surgeon. Excision and fibular autografting. Six patients, of whom three had initial curettage, underwent fibular autografting, using the ipsilateral (vascularised) fibula in three and the contralateral (non-vascularised) fibula in three (cases 6 to 10, 12). Plating (Fig. 3a) was used for fixation in all but one. In one patient (case 10) histological examination of the original limited curettage showed osteofibrous dysplasia. A second curettage one month later showed adamantinoma. The final histological findings indicated classic adamantinoma. The mean follow-up was 51 months (23 to 128). Complications from this type of treatment, such as nonunion (Fig. 3b), were common and required further corrective surgery in four patients. Other complications included a valgus deformity of the ankle and a considerable leg-length discrepancy. One patient (case 6) is currently awaiting ankle fusion for pain and another (case 12) suffered a recurrence three months after a contralateral fibular graft. Review of the operating records suggested that the tibial resection had been subperiosteal only. He was subsequently treated successfully by re-excision and bone transport.

Excision and primary bone transport. Five patients (cases 11 to 15), two of whom had initial curettage, underwent excision and primary bone transport using an external fixator technique (Orthofix Ltd, Maidenhead, United Kingdom; in case 11 and the Ilizarov frame in the others; Fig. 4). In two patients (cases 13 and 15), osteofibrous dysplasia was diagnosed on the initial biopsy but co-existent adamantinoma was found on the final histological examination. The mean follow-up was 55 months (37 to 106). As with fibular grafting, complications were common. These included nonunion at the docking site (three patients; cases 11 to 13), severe pin-site infections (two patients; cases 13 and 15) and neurogenic pain (two patients; cases 13 and 14). The cases of nonunion required exploration and bone grafting. Union was achieved without deformity in all. Moreover, all of these patients are now symptom- and disease-free.

Proximal tibial replacement. One patient (case 16) underwent a proximal tibial replacement. Curettage five years earlier had shown non-ossifying fibroma. Fracture occurred after a recurrence of the lesion and biopsy revealed a low-grade central osteosarcoma, but the final histological examination showed osteofibrous dysplasia. At follow-up (72 months) he was pain-free but had shortening of 1 cm to 2 cm.

In summary, of our series of 16 patients, three were found to have coexistent adamantinoma at the final histological examination or initial curettage, showing a risk of adamantinoma of approximately 19%. Six patients treated initially by curettage were referred to us for recurrence and required further surgery.

Histology. In osteofibrous dysplasia the delicate trabeculae of woven bone are covered by prominent osteoblasts, in contrast to those of conventional fibrous dysplasia. In most cases, the fibrous component contains scattered single cells or small strands of cells which react positively for pan-cytokeratin. These cells are not identified in routine sections stained with haematoxylin and eosin. There is also a progressive maturation of the bone trabeculae from a central zone of delicate and sometimes sparse trabeculae of woven bone set in a vascular fibrous stroma, to an outer zone in which a proportion of the bone is lamellar. The prominence of the osteoblasts led Kempson in 1966 to describe the entity as ossifying fibroma of the long bones. The term ossifying fibroma is best reserved for ossifying fibroma of the jaw which is regarded as a benign tumour and in a small series showed no evidence of cytokeratin-positive stromal cells.

A small number of cases of osteofibrous dysplasia contain small islands or strands of epithelial cells which can be identified on the stained sections. Various names have been suggested to describe these lesions including differentiated, regressive, juvenile (intracortical) and osteofibrous dysplasia-like adamantinoma. The biological significance of these cases is difficult to predict. The biopsy sample may show only osteofibrous dysplasia while a curettage or resection may show juvenile or even conventional classic adamantinoma. When needle biopsy is carried out by an experienced bone radiologist, any more aggressive component, such as adamantinoma, is more likely to be represented in the biopsy sample. Recent studies using immunohistochem-
and cytogenetics have confirmed the close links between osteofibrous dysplasia, juvenile and conventional adamantinoma.

**Discussion**

Early descriptions of osteofibrous dysplasia were preoccupied with its nomenclature and its relationship to fibrous dysplasia and recommended a mostly conservative approach to management. Limited surgery was associated with recurrence or even thought to stimulate progression. More extensive surgery was often fraught with complications. For this reason and because the natural history was thought to be one of regression at skeletal maturity, extensive surgery was usually not recommended.

We agree that osteofibrous dysplasia can take a benign course but our results suggest that in the most cases it usually does not. Although fracture has been reported to be a common complication, we saw only one fracture after a recurrence five years following the initial diagnosis (case 22). Six patients were referred to us who had undergone...
curettage, but subsequently had a recurrence and required further surgery. In comparison, there are no reported cases of recurrence after radical extraperiosteal excision. Despite this, the management recommended by many has been conservative with observation and bracing for severe deformity and fracture.5,6,13,15,16

Some authors4,14 have noted striking clinical and radiological similarities between osteofibrous dysplasia and adamantinoma, which is a rare, slow-growing, and occasionally metastasising bone tumour. It was not thought that histological confirmation was always required to distinguish the two conditions. Others have concentrated on the relationship between osteofibrous dysplasia and adamantinoma and the consequences for management.9,13,17

The term osteofibrous dysplasia-like adamantinoma was also used by Springfield et al.10 who felt that this condition was probably often underdiagnosed, particularly in earlier series of osteofibrous dysplasia. In their histological review of 32 cases (with initial diagnoses of fibrous dysplasia, osteofibrous dysplasia or adamantinoma of the tibia), six of nine patients with classic adamantinoma and six of ten with osteofibrous dysplasia-like adamantinoma, had previous benign diagnoses such as fibrous dysplasia and osteofibrous dysplasia. This supported the view that the diagnosis of adamantinoma can be difficult for the non-musculoskeletal pathologist and therefore may have been delayed or missed, particularly before the advent of immunohistochemical analysis.

Furthermore, it was argued that osteofibrous dysplasia could be a precursor of adamantinoma as suggested by Hazelbag et al.11 In their series of 32 patients with adamantinoma there were seven with osteofibrous dysplasia-like adamantinoma, of whom three progressed to a classic histological subtype and one developed a metastasis. This is in contrast to the view in the literature that osteofibrous dysplasia-like adamantinoma may potentially show a different, more benign biological behaviour from that of classic adamantinoma. Therefore, the most likely association of osteofibrous dysplasia, osteofibrous dysplasia-like adamantinoma and adamantinoma is that they represent a spectrum of disease.

In our review of 16 patients we had three with a definitive diagnosis of adamantinoma. Two (cases 13 and 15) were initially diagnosed as having osteofibrous dysplasia by the same pathologist from previous biopsy and curettage specimens and were found to have osteofibrous dysplasia-like adamantinoma in the fully-excised tissue. The third patient (case 10) had diagnoses of osteofibrous dysplasia and adamantinoma made on consecutive curettage slides. We believe that this demonstrates that osteofibrous dysplasia carries a small but significant risk of containing co-existing adamantinoma or developing into adamantinoma unless widely excised. In our series there has been one case of recurrence after wide excision. This may have been because of either spillage of osteofibrous dysplasia tissue or cells during surgery or because wide excision had not been performed extraperiosteally.

In summary, we believe that based on these results and recently published series10,11 surgical treatment should be more radical than previously recommended. In view of the risk of the association of osteofibrous dysplasia with adamantinoma and also to some extent the continuous morbidity of osteofibrous dysplasia if left untreated, we advise that radical extraperiosteal excision is indicated in all cases of osteofibrous dysplasia.

No benefits in any form have been received or will be received by a commercial party related directly or indirectly to the subject of this article.

References