Our aim was to investigate the outcome of excision of osteochondromas. Between 1994 and 1998, 92 symptomatic osteochondromas in 86 patients were excised. There were 40 women and 46 men with a mean age of 20 years (3 to 62). Of these, 56 had a solitary osteochondroma and 30 had multiple hereditary tumours. The presenting symptoms were pain (79.1%), swelling (23.3%), reduced range of movement (19.8%), cosmetic abnormalities (17.4%), and bursitis (12.8%). The most common site (37.6%) was around the knee.

Four patients had major complications (4.7%) including one intra-operative fracture of the femoral neck and three nerve palsies which resolved after decompression. Six patients had minor complications. Overall, 93.4% of the preoperative symptoms resolved after excision of the tumours. Excision is a successful form of treatment for symptomatic osteochondromas with a low morbidity.

The incidence of sarcomatous change in patients with a solitary osteochondroma has been reported to be between 1% and 2%, whereas the incidence in patients with multiple hereditary osteochondromas varies between less than 1% and 25%. Only one case of malignant transformation was reported in 134 patients of three families with multiple hereditary osteochondromas. Patients may undergo surgical treatment because of pain, disturbance of growth, decreased range of movement, cosmesis, symptoms secondary to compression of peripheral nerves (Fig. 1), tendons (Fig. 2), vessels and the spinal cord, intestinal or urinary obstruction, dysphagia, pleural irritation or the formation of a bursa. Although it has been suggested that surgery is an effective treatment for symptomatic osteochondromas, there are no large follow-up studies in the literature and the indications for surgery have not been defined. We have, therefore, evaluated retrospectively the outcome of surgery in 86 patients.

Patients and Methods

Between January 1994 and December 1998, 92 symptomatic osteochondromas were excised from 86 patients.
There were 40 women and 46 men with a mean age of 20 years (3 to 62); at the time of surgery 25 men were less than 16 years of age and 12 women less than 14 years of age. Fifty-six patients had solitary and 30 multiple osteochondromas. The sites of the lesions were the distal femur (17.4%), the proximal femur (15.2%), the proximal tibia (14.2%), the foot (10.8%), humerus (10.8%), scapula (7.6%), pelvis (6.5%), the proximal fibula (6.5%), the distal tibia (3.3%), the distal radius (3.3%), the distal fibula (1.1%), rib (1.1%), the proximal radius (1.1%) and the hand (1.1%). Excision was undertaken in 83 patients and open biopsy in three. Eleven also had excision of an inflamed bursa and eight decompression of a peripheral nerve. The mean length of stay in hospital was 15 days. The mean follow-up was 62 months (41 to 99).

The medical records were reviewed retrospectively and the indication for surgery, the surgical technique, the length of stay in hospital, the post-operative management and complications were recorded. The records of the most recent attendance at the orthopaedic oncology clinic were also reviewed. A standardised questionnaire was developed. Patients were evaluated as to whether they had persisting symptoms, new symptoms secondary to surgery and whether they would undergo surgery again under the same circumstances. Satisfaction with the outcome was graded as fully satisfied, partially satisfied and not satisfied. All patients were questioned regarding local recurrence and further surgery. Time away from school or work and non-participation in sport were recorded. The patients were also asked whether the disease had an impact on their everyday life and professional career.

### Results

For all 86 patients the presenting symptoms were pain (79.1%), swelling (23.3%), reduced range of movement (19.8%), cosmetic abnormalities (17.4%) and bursitis (12.8%) (Table I). Most patients (51.1%) had had symptoms for more than two years, 8.7% for 12 to 24 months, 17.4% for six to 12 months and 22.8% for less than six months. Overall, 93.4% of the pre-operative symptoms resolved after surgery (Table II).

Seventy-two (83.7%) were fully satisfied with the outcome, ten (11.6%) were partially satisfied and four (4.7%) were not satisfied.

### Table I. Symptoms before surgery in 86 patients with 92 osteochondromas

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>68</td>
<td>79.1</td>
</tr>
<tr>
<td>Swelling</td>
<td>20</td>
<td>23.3</td>
</tr>
<tr>
<td>Decreased range of movement</td>
<td>17</td>
<td>19.8</td>
</tr>
<tr>
<td>Cosmetic problems</td>
<td>15</td>
<td>17.4</td>
</tr>
<tr>
<td>Bursitis</td>
<td>11</td>
<td>12.8</td>
</tr>
<tr>
<td>Compression of peripheral nerves</td>
<td>7</td>
<td>8.1</td>
</tr>
<tr>
<td>Vessel compression</td>
<td>4</td>
<td>4.7</td>
</tr>
<tr>
<td>Leg-length discrepancy</td>
<td>2</td>
<td>2.3</td>
</tr>
<tr>
<td>Deep-vein thrombosis</td>
<td>2</td>
<td>2.3</td>
</tr>
<tr>
<td>Synovitis</td>
<td>1</td>
<td>1.2</td>
</tr>
</tbody>
</table>
Complications. Four patients (4.7%) developed major postoperative complications of which three had a peroneal nerve palsy, the symptoms of which resolved after decompression. An intra-operative fracture occurred in an obese 44-year-old patient with a large osteochondroma of the femoral neck. Total hip replacement was undertaken after failed osteosynthesis. Six patients (7.0%) had minor complications.

Pain. Of the 68 patients who had surgery because of pain, 11 (16.2%) had persistent pain at the latest follow-up. Of these, four (5.9%) would not undergo surgery again. In only one of these patients was pain the sole presenting symptom. Of the remaining three, one with an osteochondroma of the femoral neck had limitation of movement and persistent pain. One patient with an osteochondroma of the proximal humerus had pain and a sensory deficit. Three patients with the peroneal nerve palsy, the symptoms of which resolved after decompression. The latter was a patient with an osteochondroma of the femoral neck who had had symptoms for more than two years which persisted after surgery.

Cosmesis. Fifteen patients had surgery because of cosmetic abnormalities and all would undergo surgery again. However, in only four was the cosmetic abnormality the sole indication for surgery. The remaining patients also had pain (nine), bursitis (two) and one also had a decreased range of movement. Under the same circumstances 12 of 15 patients with cosmetic abnormalities and other symptoms and three of four with cosmetic abnormalities alone would wish to undergo surgery earlier. Eleven of these patients had waited for more than two years before surgery. All patients undergoing surgery for cosmesis were satisfied with the outcome.

Nerve lesions. Seven patients underwent surgery because of paraesthesiae (five), weakness (one) or combined sensorimotor (one) dysfunction. The latter was a patient with an osteochondroma of the proximal humerus who had had symptoms for more than two years which persisted after surgery and would not undergo surgery again. The remaining six patients had dysfunction of the peroneal nerve secondary to osteochondromas of the distal femur, proximal fibula and proximal tibia. Although three had had nerve dysfunction for more than two years all had complete relief from symptoms at follow-up. One who had undergone surgery because of paraesthesiae, pain and compression of the popliteal artery sustained a fracture of the fibula and had persistent pain at the latest follow-up. In contrast to the other patients with associated nerve lesions this patient would not undergo surgery again.

Malignant transformation. Histological evaluation showed a low-grade chondrosarcoma in three patients (3.5%) who were 15, 25 and 29 years old, respectively. The first two had solitary and the latter multiple osteochondromas. Two lesions were located in the proximal femur and one in the pelvis.

Local recurrence. Five patients (5.8%) had a local recurrence. One child, aged three years, with a solitary osteochondroma had a recurrence (1.2%) seven years later. Four of 30 patients (13.3%) with multiple osteochondromas had a local recurrence. They were 9, 10, 21 and 34 years of age respectively. In ten patients a symptomatic osteochondroma had developed at a different site during the follow-up period.

Social factors. Patients were absent from school or work for a mean of six weeks and it took a mean of 35 weeks before they were able to return to sport at the previous level. The development and treatment of the lesion had an impact on job selection and professional education in eight patients (9.3%). Seven were not able to start (four) or continue (three) a career in a highly physically demanding job but only one discontinued education because of the lesion.

At the time of final follow-up, eight patients (9.3%) had some limitation of daily life because of persistent symptoms or the complications of surgery and nine with multiple osteochondromas had some limitations because of an osteochondroma at another site.

Discussion

There is only one report in the literature concerning the possible surgical risks of elective excision of benign osteochondroma. This described lesions in 80 patients who were under 21 years of age. The presenting symptoms were pain (86%), swelling (12.5%), limited range of movement

### Table II. Number of patients who had persistent symptoms and the impact on their decision to undergo surgery again under the same circumstances

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Symptom preoperatively</th>
<th>Number who would undergo surgery again</th>
<th>Number with symptoms at follow-up</th>
<th>Number with symptoms at follow-up who would undergo surgery again</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>68</td>
<td>64</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>Swelling</td>
<td>20</td>
<td>20</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Decreased range of movement</td>
<td>17</td>
<td>17</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Cosmetic problems</td>
<td>15</td>
<td>15</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bursitis</td>
<td>11</td>
<td>11</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Compression of peripheral nerves</td>
<td>7</td>
<td>6</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Vessel compression</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leg-length discrepancy</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Deep-vein thrombosis</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Synovitis</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

VOL. 85-B, No. 8, NOVEMBER 2003
(6.25%), compression of a peripheral nerve (5%), cosmetic abnormalities (2.5%) and vascular compromise (1.25%). Excision was complicated by peroneal neurapraxia in seven patients, compartment syndrome in one, arterial damage in one and fibular fracture in one. The overall rate of complications (12.5%) is comparable with that of our study (10.8%). The morbidity of the excision of symptomatic osteochondroma has been shown to be comparable with that of the removal of hardware.

There are no studies evaluating the outcome after the excision of symptomatic osteochondromas. In our study, 93.4% of all pre-operative symptoms resolved after surgery. However, 11 patients (16.2%) who complained of pain pre-operatively had persistent pain at follow-up, and four of these would not undergo surgery again. Since there is little relevant information in the literature, the indications for surgery should be considered cautiously in patients whose only symptom is pain, and they should be informed about the risks of pain secondary to the surgery itself. In our department, all patients who have painful osteochondromas are initially treated conservatively for a period of three months. During this time they are asked to document the amount of pain which they feel each day on a visual analogue scale. The indication for surgery may then be based on the level of pain and the impact of the tumour on the patient’s life.

Surgery for cosmetic abnormalities remains controversial. However, all 15 patients in our study who complained of such abnormalities were satisfied with the outcome. Under the same circumstances, 12 would have chosen to undergo surgery earlier. Cosmesis is an important aspect of the disease and therefore reluctance to advise surgery and prolonged waiting times appear unreasonable. In the literature there are reports of five patients with paraesthesiae secondary to compression of the lateral popliteal nerve in patients with an osteochondroma. The function of the nerve recovered in all patients despite a delay of surgery for up to 24 months. By contrast, two of six patients undergoing surgery because of progressive weakness of the ankle did not recover completely. In our study, there was recovery of nerve function in six patients with dysfunction of lateral popliteal nerve although there was a history of more than two years in three patients. There is no convincing evidence in the literature that delayed surgery jeopardises the outcome, but since two of the three patients described by Cardelia et al. had persistent weakness, they recommended early surgery. In a report of 408 osteochondromas the incidence of malignant change was described as 13% in patients with multiple osteochondromas. Although in the past studies have shown malignant change in up to 25% of patients only 3.3% (one patient) of the patients with multiple osteochondromas in our study had such change. Considering that our hospital is a referral centre for bone and soft-tissue tumours the number may be high because of a selection bias. This low incidence is in accordance with current opinion that the incidence of malignant change may be <1%. In our study two secondary chondrosarcomas were located in the proximal femur and one in the pelvis. This is in accordance with the findings of Apria, Riseborough and Hall who showed that 8 of 12 chondrosarcomas in adolescent patients were in the proximal femur or pelvis. One patient in our study and three of 43 patients with secondary chondrosarcoma presented by Wuisman, Jutte and Ozaki were less than 20 years of age at the time of diagnosis highlighting the fact that secondary chondrosarcoma does occur before the age of 20 years.

Although osteochondromas of the proximal femur and acetabulum are mainly followed up because of the risk of malignant change, a periacetabular osteochondroma may cause acetabular dysplasia and a proximal femoral osteochondroma may cause coxa valga and overgrowth of the femoral neck. Weiner and Hoy identified coxa valga and increased femoral anteversion in 25 patients with osteochondroma adjacent to the lesser trochanter. However, osteochondromas of the femoral neck in our study were removed because of malignant change in two, decreased range of movement in three and pain in nine. An adequate surgical approach to the whole lesion is often difficult since it often involves the anterior, inferior and posterior aspects of the femoral neck. Having experienced a major vascular complication after the resection of an osteochondroma of the proximal femur, Tschokanow recommended the use of two separate incisions (Watson Jones and Smith-Petersen) in a one- or two-staged procedure. Although the most severe complication, an intra-operative fracture with failed osteosynthesis and subsequent total hip replacement occurred during the resection of an osteochondroma of the femoral neck, most patients underwent excision without complications using a single standard incision. Siebenrock and Ganz recommended a versatile surgical approach with dislocation of the femoral head for osteochondroma of the femoral neck. While this approach offers excellent exposure, there may be an increased risk of necrosis of the femoral head. As seen in the current study, most osteochondromas of the proximal femur can be removed using a single incision, but careful preoperative planning and intraoperative fluoroscopy are required. Local recurrence after excision of a solitary osteochondroma occurred in one patient (1.8%) and is described in less than 2% in the literature. Of the 114 patients presented by Humber et al. and the 56 in our study, there were two patients with a recurrent solitary osteochondroma requiring a second resection who were less than 4 years of age. It has been suggested that incomplete removal of the cartilage cap is responsible for local recurrence, but young age at the time of surgery may be an additional prognostic factor. Our study suggests a higher rate of local recurrence after surgery in patients with multiple osteochondromas but there is no conclusive evidence in the literature to support this.

Most patients in our study had symptoms for more than two years before undergoing surgery. Under the same circumstances 66% of the patients would have liked to have surgery earlier. The data show convincing evidence that...
early surgery for swelling, decreased range of movement, bursitis, compression of peripheral nerves, vascular complications and cosmesis should be recommended.

In conclusion, symptoms related to an osteochondroma will usually be relieved by surgery. Major complications and local recurrence are rare. Most patients in our study were satisfied with the outcome, but 66% would have liked to have had surgery earlier. Under the same circumstances most patients (96%) would undergo surgery again. Of those who underwent surgery because of pain, 16.2% still had pain at the time of follow-up. Thus patients who primarily complain of pain should be informed that there is an increased risk of pain related to surgery or its complications. Considering that 11.6% of the patients were not fully satisfied with the surgery and that 4.7% would not have surgery again, we see no justification for the prophylactic excision of asymptomatic osteochondromas.

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

References

4. Wiater JM, Farley FA. Popliteal pseudoaneurysm caused by an adja-
22. Watson LW, Torch MA. Peroneal nerve palsy secondary to compres-
31. Humblet ET, Mehlman C, Crawford AH. Two cases of osteochon-