The pathology of bone allograft

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We analysed the histological findings in 1146 osteoarthritic femoral heads which would have been considered suitable for bone-bank donation to determine whether pathological lesions, other than osteoarthritis, were present. We found that 91 femoral heads (8%) showed evidence of disease. The most common conditions noted were chondrocalcinosis (63 cases), avascular necrosis (13), osteomas (6) and malignant tumours (one case of low-grade chondrosarcoma and two of well-differentiated lymphocytic lymphoma). There were two with metabolic bone disease (Paget’s disease and hyperparathyroid bone disease) and four with inflammatory (rheumatoid-like) arthritis.

Our findings indicate that occult pathological conditions are common and it is recommended that histological examination of this regularly used source of bone allograft should be included as part of the screening protocol for bone-bank collection.

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Allograft bone from osteoarthritic femoral heads is commonly utilised in hip arthroplasty and tumour reconstruction. Procedures designed to ensure the supply of safe allogeneic bone of good quality for clinical use are well established.1,2 These include guidelines on donor selection, tissue procurement, tissue preservation, tissue storage and adequate record-keeping. Screening is undertaken to exclude donors with potentially serious transmissible diseases (e.g., hepatitis, HIV and syphilis), malignancy, systemic disorders that may compromise the biological or biomechanical integrity of the skeleton (e.g., rheumatoid arthritis, autoimmune disease, long-term corticosteroid treatment), significant exposure to toxic substances and diseases of unknown aetiology (e.g., Alzheimer’s disease, Creutzfeldt-Jakob disease, multiple sclerosis).

In the analysis of specimens of allograft bone, screening has been directed towards identifying microbial contamination.3,4 Less attention has been paid towards assessing evidence of other pathological conditions in the harvested bone. We made a retrospective examination of 1146 osteoarthritic femoral heads which would have been used as bone allograft in order to determine the nature and range of pathological conditions which may be found.

Materials and Methods

Between September 1995 and September 1997 we reviewed the histological reports of 1146 osteoarthritic femoral heads derived from elective total hip replacement for the presence of pathological conditions other than osteoarthritis.

The excised femoral head was divided into slices with a band saw. Radiographic examination of a slice through the foveal region, 0.3 to 0.5 mm thick, was undertaken. The slice was then decalcified in 5% nitric acid. Paraffin sections were stained with haematoxylin and eosin and examined using an Olympus BH2 light microscope. Samples of the synovial membrane and articular surface were also taken and routinely processed. Pathological features in the radiographs and sections were noted and recorded to indicate the type of arthritis affecting the joints as well as any other tissue changes of interest.

We reviewed the case notes of all patients who had evidence of pathology other than osteoarthritis to confirm that these conditions were undiagnosed and therefore that patients would have satisfied the clinical criteria for bone donors. Since our study covered a period before osteoarthritic femoral heads were routinely used as a source of allograft in our hospital, none of the heads assessed in the study had been used for this purpose. All femoral heads with known pathological conditions (e.g., inflammatory arthritis, avascular necrosis and previous infection), which would not have been considered suitable for the bone-bank, were excluded from the study.
Results

Of the 1146 heads which would have been assessed as suitable for allograft, 91 (8%) were found to contain evidence of pathology other than osteoarthritis (Table I). In all the specimens, the case notes indicated that these conditions were not known before surgery.

The most common abnormalities noted were chondrocalcinosis (63 cases) and avascular necrosis (13 cases). In two cases, both of these conditions were found in addition to degenerative arthritis. In six, the specimen of femoral head was found to contain a single osteoma, a benign bone-forming hamartoma. Three occult malignant tumours were found, one low-grade chondrosarcoma and two cases of marrow-based well-differentiated lymphocytic lymphoma. Two cases of metabolic bone disorders, one of Paget’s disease and the other of hyperparathyroid bone disease, were also diagnosed by histological examination of the subchondral bone of the femoral head. In both, the histological diagnosis was confirmed by subsequent biochemical investigation.

Four specimens showed extensive rheumatoid-like inflammatory changes in joint tissues with a marked inflammatory synovitis, formation of pannus and destruction of bone and cartilage. Although it is recognised that an inflammatory infiltrate may be found in the synovium of some cases of osteoarthritides, the pattern and degree of inflammation and the destruction of articular tissues seen in these four cases were much more typical of rheumatoid than degenerative joint disease.

Localised osteopenia of subchondral bone was seen in most osteoarthritic heads. This finding was not included in Table I since it is generally considered to be a pathological feature associated with osteoarthritis. In cases in which specimen radiographs showed that more than 30% of the subchondral bone had osteopenia, and when this was evident histologically, the finding was commented on specifically in the pathology report. Of all specimens examined, this degree of osteopenia was seen in 27% and 3% showed marked generalised osteopenia with thinning of cortical and cancellous bone.

Discussion

The selection of patients suitable for donation to a bone-bank relies on careful evaluation of the history and examination in order to avoid the transfer of infection, malignancy, systemic disorders, toxins, or potentially transmissible diseases of viral or unknown aetiology. In our institution bone is collected under aseptic conditions and a microbiological culture from the femoral head is taken before storage. The head is then stored temporarily at -18°C for six hours and later transferred to long-term storage at -80°C. The stored bone is not treated in any other way before use as allograft unless bacterial contamination is identified. Thus, prevention of transfer of disease from donor to recipient relies heavily on donor screening.

Table I. Histopathological findings in 91 of 1146 femoral heads which contained pathological lesions other than osteoarthritis

<table>
<thead>
<tr>
<th>Histopathological findings</th>
<th>Number of cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chondrocalcinosis</td>
<td>63</td>
<td>5.5</td>
</tr>
<tr>
<td>Avascular necrosis</td>
<td>13</td>
<td>1.1</td>
</tr>
<tr>
<td>Osteoma</td>
<td>6</td>
<td>0.5</td>
</tr>
<tr>
<td>Well-differentiated lymphoma (pre-CLL*)</td>
<td>2</td>
<td>0.2</td>
</tr>
<tr>
<td>Low-grade chondrosarcoma</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Paget’s disease</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Hyperparathyroid bone disease</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Inflammatory arthritis</td>
<td>4</td>
<td>0.4</td>
</tr>
<tr>
<td>Total</td>
<td>91</td>
<td>8.0</td>
</tr>
</tbody>
</table>

* chronic lymphocytic leukaemia

The results of our study indicate that a number of osteoarthritic femoral heads, which would have been considered suitable for donation to the bone-bank, were found to have pathological lesions which were unknown to both the patient and medical staff at the time of joint replacement. These conditions would not have been detected by current screening protocols since they do not include submission of a sample for histological examination. Undiagnosed malignant bone tumours were found in three patients. These included a small low-grade chondrosarcoma and two marrow-based well-differentiated lymphocytic lymphomas. It is not known if the processing and freezing methods used for storage of banked femoral head bone would have destroyed these tumour cells.

The finding of avascular necrosis, Paget’s disease, hyperparathyroidism and marked osteopenia is also of significance in terms of the quality of allograft bone harvested. Four specimens of femoral head and synovium also showed histological changes of an inflammatory arthritis. The pathogenesis of conditions such as rheumatoid arthritis and Paget’s disease is unknown; a viral or other microbial aetiology has been proposed and it is not known whether such agents could be transmitted to graft recipients after processing by the bone-bank. The transmission of disease from donor to recipient is an important and emotive issue, particularly highlighted by the problems with HIV and hepatitis. There is evidence that fatal conditions such as rabies and Creutzfeldt-Jakob disease have been transferred to recipients of corneal grafts.

In addition to considering the implications for the host of receiving allografted bone of unknown nature and quality, it is important to recognise that histological examination of the potential bone-allograft specimens analysed in our study resulted in a number of important pathological findings being identified in the donors. This is obviously of significance in those few cases in which an occult malignancy was found and in others in which either chondrocalcinosis, avascular necrosis, inflammatory arthritis or a metabolic bone disease was identified.

Although the finding of chondrocalcinosis in 5.5% of the osteoarthritic femoral heads examined may not be significant in terms of the quality of the bone harvested, it is...
important in the context of arthritic disease affecting the hip. It is also associated with a number of other metabolic conditions such as hyperparathyroidism, hypothyroidism, gout and haemochromatosis. Since chondrocalcinosis is known to affect other joints, it would be useful to have pathological confirmation of the deposition of calcium pyrophosphate crystals in patients who may subsequently present with acute or chronic disease in other joints.

Histological changes of avascular necrosis or bone infarction were found in 1.1% of femoral heads which were considered preoperatively, clinically and radiologically to represent osteoarthritis. As a number of cases of idiopathic osteonecrosis of the femoral head are known to be bilateral, this finding also has clinical implications. A recent study of the diagnostic histology of hip specimens removed at primary arthroplasty also noted discrepancies between the clinical and histological diagnosis, particularly with regard to avascular necrosis of the hip.

The demand for bone allograft is likely to increase in the future, particularly for use in revision arthroplasty, and it is important that appropriate safeguards are taken to ensure that the safety of both donor and recipient is not compromised. Our study has shown that other significant abnormalities may be present in some femoral heads removed for osteoarthritis. It is important to screen donors critically and to ensure that histopathological examination is included as part of the protocol for the collection of bone allografts.

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References