Microbiological culture results for the femoral head

ARE THEY IMPORTANT TO THE DONOR?

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We determined the rate of contamination of donated femoral heads at primary hip arthroplasty within a single region between July 1992 and July 2001. We established the null hypothesis that culture results played no role in predicting early failure of the joint because of infection.

The rate of contamination was 9%. A positive culture, at the time of retrieval, was found in 367 of 4045 femoral heads. Coagulase-negative staphylococcus was isolated in 77% of the positive cases. At a minimum follow-up of one year, there was no statistically significant difference in the rate of complications or of revision of age-matched patients whose femoral heads had a positive culture compared with those whose femoral heads were sterile.

Our findings confirm that culture of the femoral head plays no part in determining future failure of joint replacement in the donor.

Osteolysis is a major limitation to the long-term survival of arthroplasties. The success of arthroplasty in improving the quality of life and its use in younger patients have led to an increasing number of cases which require revision for osteolysis. The impaction of cancellous allografts is a technique which restores bone stock. Hastings and Parker\(^1\) first reported its use in three cases of protrusio in primary total hip arthroplasty (THA). Slooff et al\(^2\) then expanded the technique using autogenous and allograft bone in the reconstruction of the acetabulum for protrusio which was secondary to either disease or failed arthroplasty. Gie et al\(^3\) subsequently used allografts for femoral revision arthroplasty in the presence of poor bone stock.

Femoral heads which are donated at the time of primary THA provide a supply of bone which is suitable for grafting. Bone banks have been established in many centres in order to collect and store this bone according to stringent standards.\(^4,6\) Our regional bone bank, a non-profit making, hospital-based tissue bank, was established in 1989. At the time of harvest of the femoral head, a surface swab and a cancellous bone chip are sent for culture in order to verify the sterility of the donated head.

Earlier studies identified coagulase-negative staphylococcus as the organism which is most commonly isolated from donated allografts,\(^7,12\) and it is often responsible for infection after THA.\(^13-15\) Such infections fall into two broad categories.\(^13,16,17\) First, early infection can occur in the initial months following surgery. This is thought to be because of the seeding of organisms at the time of operation. Secondly, a late infection may appear many years after the initial operation. The cause of this is unknown although it may be associated with concurrent systemic infection or a compromised immune system. We wished to determine the rate of contamination of donated femoral heads and to establish whether or not microbial contamination was a predictor of early infection in the arthroplasty of the donor.

Patients and Methods

Our study was based upon information which was recorded prospectively by the bone bank and our Arthroplasty Audit Group between 1992 and 2001. All patients who had a primary THA were asked to donate their femoral heads. If they agreed, informed consent was obtained. The patients were next screened for medical conditions, according to local policies, which may have pre-empted them from being donors.

The detached femoral head was passed to the scrub nurse who trimmed the remaining soft tissue, washed the head in normal saline and dried it with a swab. A bacterial swab was wiped over the surface of the head and a small piece of cancellous bone from the cut surface...
was taken for microbiological screening. The head was then placed in a sterile double jar, sealed, and stored in a freezer. The swab was cultured aerobically and anaerobically on agar and then placed in broth. The bone fragment was placed directly into broth. Primary plates were incubated for up to 48 hours before reporting. Broth samples were subcultured for 48 hours, after 48 hours on agar, before reporting. All information was recorded according to guidelines determined by the Department of Health.

Patients were also asked to participate in an ongoing audit of primary and revision hip and knee surgery. If they agreed, informed consent was obtained and the surgeon recorded the details of their primary or subsequent revision surgery. For those patients who had a primary THA, a self-administered, validated questionnaire which assessed satisfaction and complications was issued at one year. All the data received were entered into the Arthroplasty Audit Group database.

We reviewed the culture results of all the femoral heads which had been donated to the bone bank. The source of the contaminant (swab or bone) and the number and type of organisms which had been isolated were determined. All patients with a contaminated femoral head (group 1) who underwent surgery in our region were then compared with a similar group without contamination of their femoral heads (group 2). Both groups were cross-referenced against the data in the Arthroplasty Audit Group database. The details which were reviewed included the use of an ultra-clean air theatre, the use of prophylactic antibiotics, diagnosis and complications and whether revision surgery had taken place. The records of all patients who had experienced a complication or revision surgery were also reviewed in order to determine the outcome.

**Statistical analysis.** A power calculation was performed before undertaking the study. This showed that 284 patients in each group were required to demonstrate a significant difference between the groups at a level of significance of $p < 0.05$. The patients in group 2 were obtained by using random numbers which were generated by Excel 2000 (Microsoft, Seattle, Washington). Further analysis involved the use of the chi-squared test and the calculation of appropriate confidence intervals (CI) for both groups.

**Results**

During the period of study 4045 femoral heads were donated. Of these, 367 (9%) were contaminated. Organisms were mainly isolated from surface swabs (83%), but bone chips had a positive culture in 24% of cases with 7% of positive samples being isolated from both bone chips and surface swabs. Coagulase-negative *Staphylococcus* was the most common contaminant isolated (Table I) and was found in 77% (283) of the contaminated heads. Single organisms were present in 95% (347) of the cultures.

<table>
<thead>
<tr>
<th>Organisms</th>
<th>Number of positive culture reports from bone chips or culture swab</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Staphylococcus epidermidis</em></td>
<td>197</td>
</tr>
<tr>
<td><em>Coliforms</em></td>
<td>21</td>
</tr>
<tr>
<td><em>Pseudomonas</em></td>
<td>6</td>
</tr>
<tr>
<td><em>Streptococcus</em></td>
<td>14</td>
</tr>
<tr>
<td><em>Bacillus species</em></td>
<td>12</td>
</tr>
<tr>
<td><em>Corynbacteria</em></td>
<td>6</td>
</tr>
<tr>
<td><em>MRSA</em></td>
<td>3</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
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</tr>
</tbody>
</table>

* methicillin-resistant *Staphylococcus aureus*

Table I. Organisms isolated from bone and swab samples

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean age in years (range)</th>
<th>Number of men</th>
<th>Number of women</th>
<th>Pre-operative diagnosis</th>
<th>Prophylactic antibiotics</th>
<th>UCA†</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>68 (38 to 88)</td>
<td>106</td>
<td>149</td>
<td>215 OA* 1 RA† 5 Other 210 221</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>70 (42 to 88)</td>
<td>104</td>
<td>149</td>
<td>216 OA* 2 RA† 1 Other 205 219</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* osteoarthritis
† rheumatoid arthritis
‡ ultra-clean air

Over the period of study, seven revisions (3.2%) were carried out in group 1 (Table III) compared with four (1.8%) in group 2 (Table IV). The difference in the frequency of revisions between the groups was 4% (chi-squared test $= 2.991; p = 0.084$; 95% CI: -0.3 to 8.3) and was not significant.

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No infection occurred in any of the patients in group 1 (95% CI 0.0 to 1.7); but there was one in group 2 (95% CI 0.0 to 2.5) 15 months after the initial operation. The infecting organism was coagulase-negative *Staphylococcus*. 

Table II. Details of the two groups of patients
can decrease this rate still further. In our study, most patients received peri-operative intra-vanous antibiotics. In only one patient for both groups was an antibiotic not given. Similarly, all but one of the procedures took place in an operating theatre with UCA facilities. Although both the rates of complications and re-operation were higher in group 1, this was not significant. We were unable to demonstrate any evidence of increased rates of infection in patients whose femoral heads were contaminated. Other authors have also failed to find any relationship between contamination of the femoral head and increased infection in donors. Unfortunately, none of these studies reported whether or not the operations were performed in a UCA environment or whether peri-operative antibiotics had been used routinely.

Our rate of contamination of 9% is consistent with other studies. However, there is a wide variation in the literature. We suggest that the method of retrieval of femoral head allograft and the number and type of specimens sent for microbial analysis, should be standardised. This would allow for a clearer interpretation of the rate of contamination. Tissue banks would also be in a better position to use this information in order to identify any breakdown in systems if their rates were higher than expected.

Although our study failed to achieve the statistical power required, it has added to the growing evidence already available. We believe that our main research question has been adequately answered. There is no association between bacterial contamination of the femoral head allograft and the early failure of a THA in a donor because of infection. Orthopaedic surgeons who routinely receive bacteriological results from femoral head allografts could justifiably ignore them if the donors are asymptomatic.

The authors are grateful for the kind assistance received from the staff of the Arthroplasty Audit Group and the Bone Bank in obtaining our data. We would also like to thank the Department of Epidemiology and Public Health at the University for their help with this paper.

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

Discussion
The donation of femoral heads at the time of a primary THA provides a useful source of bone allografts. Strict precautions are taken according to regional and national guidelines in order to minimise the cross-infection of potential recipients. Among these is the microbial screening of specimens for contamination. The rate of contamination of allografts ranges from 2% to 22%, The true rate of contamination is probably underestimated since it depends upon the type and number of specimens which are sent for analysis.

In our study the rate of contamination was 9%. Most of the positive samples were from surface swabs (83%) which may represent contamination from handling. However, 24% of the positive results were obtained from bone chips. Contaminated femoral head allograft is normally discarded or irradiated in order to minimise the risk of cross-infection. However, positive culture results may be helpful in guiding antibiotic therapy should the donor subsequently develop a deep infection. Infection after primary THA is a serious complication which results in significant morbidity and mortality. It is estimated that there is a risk of infection of 1% over the lifetime of the prosthesis.

Early infection after THA can be treated by appropriate antibiotic therapy and wound debridement. Any clue which helps to identify the causative organism is invaluable.

It has been shown that the use of peri-operative antibiotics and an ultra-clean air (UCA) operating theatre can reduce the rates of deep infection of a prosthesis from 11% to 0.3% Other factors such as using occlusive clothing, strict theatre discipline and careful surgical technique can decrease this rate still further.

In our study, most patients received peri-operative intravenous antibiotics. In only one patient for both groups was an antibiotic not given. Similarly, all but one of the procedures took place in an operating theatre with UCA facilities. Although both the rates of complications and re-operation were higher in group 1, this was not significant. We were unable to demonstrate any evidence of increased rates of infection in patients whose femoral heads were contaminated. Other authors have also failed to find any relationship between contamination of the femoral head and increased infection in donors. Unfortunately, none of these studies reported whether or not the operations were performed in a UCA environment or whether peri-operative antibiotics had been used routinely.

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Table III. Timing and reasons for revision surgery in group 1

<table>
<thead>
<tr>
<th>Time from initial surgery</th>
<th>Reason for revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 year 1 mth</td>
<td>Periprosthetic fracture</td>
</tr>
<tr>
<td>2 yrs 4 mths</td>
<td>Recurrent dislocation</td>
</tr>
<tr>
<td>3 yrs 2 mths</td>
<td>Aseptic loosening</td>
</tr>
<tr>
<td>3 yrs 3 mths</td>
<td>Recurrent subluxation</td>
</tr>
<tr>
<td>5 yrs 10 mths</td>
<td>Aseptic loosening</td>
</tr>
<tr>
<td>6 yrs 7 mths</td>
<td>Periprosthetic fracture</td>
</tr>
<tr>
<td>8 yrs 1 mth</td>
<td>Aseptic loosening</td>
</tr>
</tbody>
</table>

Table IV. Timing and reasons for revision surgery in group 2

<table>
<thead>
<tr>
<th>Time from initial surgery</th>
<th>Reason for revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 mths</td>
<td>Recurrent dislocation</td>
</tr>
<tr>
<td>1 yr 2 mths</td>
<td>Infection</td>
</tr>
<tr>
<td>2 yrs 10 mths</td>
<td>Aseptic loosening</td>
</tr>
<tr>
<td>4 yrs 9 mths</td>
<td>Aseptic loosening</td>
</tr>
</tbody>
</table>


