METHICILLIN-RESISTANT STAPHYLOCOCCUS EPIDERMIDIS IN INFECTION OF HIP ARTHROPLASTIES

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We investigated the incidence of cephalosporin-resistant bacteria in infected hip arthroplasties. Of 740 patients having hip replacement or related procedures performed over three years, 30 had positive bacteriological cultures from tissue removed at the time of surgery. In 18 of the 30 cultures Staphylococcus epidermidis was grown and 12 of these were methicillin-resistant.

A prospective study of skin swabs taken from 100 consecutive patients at the time of admission for THR showed methicillin-resistant Staphylococcus epidermidis in 25. This cephalosporin-resistant organism was shown to be the commonest proven cause of infection, and its presence as a skin commensal raises important questions about current antibiotic prophylaxis for joint replacement.

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The use of antibiotic prophylaxis to reduce the risk of infection in total joint replacement is an established routine. The synthetic penicillins were the first antibiotics to be used in this way, but the emergence of organisms resistant to flucloxacillin prompted a change to second-generation cephalosporins (Pollard et al 1979), chosen for their broad spectrum. Cephalosporin-resistant organisms have now become increasingly common (Hope et al 1989), and these were found in six of the last 12 revisions performed in our unit for infection of total hip replacement (THR). This finding made us question the continued use of cephalosporins and led to more detailed studies of the incidence of methicillin-resistant Staphylococcus epidermidis (MRSE) in our patients. Methicillin resistance implies clinical resistance to all beta-lactam antibiotics, including the cephalosporins (John and McNeill 1980).

We therefore reviewed retrospectively the bacteriology of all infected hip arthroplasties treated during a three-year period. We also performed a prospective study to identify the commensal organisms found on the skin of patients admitted for elective hip arthroplasty.

PATIENTS AND METHODS

Bacteriology of infected hip arthroplasties. We reviewed the clinical notes and bacteriological records of all patients who had undergone primary or revision hip surgery in our unit in the three years from January 1989 to December 1991. Excluding reoperations for known, obvious infections, there were 632 primary hip replacements, 108 revision arthroplasties and 28 aspirations or biopsies for suspected infection. All of the arthroplasties were cemented total hip replacements using polyethylene sockets with metal stems. The two designs were the Charnley and the Howse straight-stem.

All the operations had been performed in rooms with vertical or horizontal laminar-flow ventilation. All patients having primary hip replacement had received antibiotic prophylaxis by cefuroxime 1.5 g intravenously at induction of anaesthesia followed by 750 mg every eight hours for 48 hours.

At revision arthroplasty antibiotic prophylaxis was started during the operation, after tissue specimens and wound swabs had been taken for bacteriology. At least three tissue samples were taken at each revision, including specimens from the capsule, the acetabular socket and the femoral canal. Each specimen was swabbed on to standard media and then placed into broth culture for prolonged aerobic and anaerobic incubation. Bacterial infection was diagnosed only if the same organisms were grown from at least 60% of the cultures.

At primary hip arthroplasty, specimens were taken only when tissue or fluid suggestive of infection was encountered. The bacteriological records for all samples obtained at operation were studied.

Skin bacteriology. Because of the high incidence of MRSE in the retrospective study, we investigated its incidence in the bacterial skin flora of 100 consecutive patients admitted for THR during 1990 and 1991. Swabs were taken from the intact skin over the greater trochanter.
on the side of the proposed THR. These swabs were obtained within eight hours of admission and were cultured on a selective medium containing a 10 μg dose of methicillin to suppress the growth of organisms other than MRSE.

RESULTS

Retrospective review. The bacteria isolated during the period of the retrospective review are listed in Table I, which shows that *Staphylococcus epidermidis* was present in 18 of the 30 positive cultures (60%). In 108 revision hip arthroplasties performed for presumed aseptic loosening, there were 21 positive cultures (19%). Of these, 14 were *Staphylococcus epidermidis*, 10 of which were methicillin resistant.

Of the 28 prerevision aspiration biopsies performed for suspected infection, seven gave positive cultures (25%) with MRSE in two. Positive cultures of other organisms were also obtained from two of the 632 primary arthroplasties in which tissue suggestive of infection had been encountered at the time of surgery. The organisms cultured were *Pseudomonas* and an anthracoid bacillus.

Skin bacteriology. In the prospective study of preoperative skin flora, methicillin-resistant staphylococci were grown from 25 of 100 consecutive patients.

DISCUSSION

The incidence of infection after primary THR for osteoarthritis has been reported to be 1.5% (Lynch et al 1987) with a higher incidence of 11.8% after revision surgery (Echeverri, Shelley and Wroblewski 1988). Infection gives a poor outcome, with a high incidence of morbidity and repeated operations (Hunter and Dandy 1977). The financial cost of prolonged hospital stay, complex surgery and long courses of expensive antibiotics is considerable (Dreghorn and Hamblen 1989). It is therefore important that infection rates be minimised by appropriate prophylaxis.

Postoperative infection has many causes. Patient resistance is important: higher infection rates are reported in those with rheumatoid arthritis (Lynch et al 1987) and in immunosuppressed patients (Ryan 1976). The operating environment and especially the quality of ventilation influence the risk of airborne contamination, and this can be minimised by the use of filtered laminar airflow, Charnley enclosures, and ultraviolet light, all of which have been shown to reduce infection rates (Charnley 1972; Lidwell et al 1982; Lidwell 1986; Berg, Bergman and Hoborn 1991). The use of impervious gowns (Mitchell, Evans and Kerr 1978), double gloves (Hester, Nelson and Harrison 1992) and body-exhaust suits (Whyte et al 1983; Nelson 1984) is also recommended.

The use of prophylactic antibiotics complements these preventive measures (Hill et al 1981) and has become accepted. Antibiotics may be administered locally, systemically or by both routes. Local use of antibiotic-impregnated cement can provide high local tissue levels without systemic toxicity (Buchholz, Elson and Heinert 1984), but the use of such cement has been questioned (Lynch et al 1987) because of the danger of producing antibiotic-resistant strains of bacteria (Hope et al 1989).

Systemic antibiotic prophylaxis should meet the following criteria: simple administration, adequate tissue levels of antibiotic, known action on potential infecting organisms and few complications or side-effects. Cephalosporins are widely used since they satisfy most of these criteria. A three-dose intravenous regime for 24 to 48 hours can achieve good tissue levels, and side-effects are rare other than occasional allergy and cross-sensitivity with penicillin.

Our studies highlight the potential problems of increasing bacterial resistance. We have identified *Staphylococcus epidermidis* as the commonest organism cultured at revision of THRs. This may be due to colonisation of the prostheses by these organisms, which can exist in a protective biofilm around the implant (Gristina and Costerton 1984). Although it is possible that bacterial contamination of the sample material occurred at the time of revision surgery or in the laboratory, the isolation of the same organism from at least two separate specimens in each case makes this unlikely.

Our results from preoperative skin swabs suggest that 25% of patients have MRSE on their skin at the time of, or soon after, admission. This organism may now be part of normal skin flora outside hospital (Larson et al 1986), or it may rapidly colonise the skin of patients after admission. The incidence of MRSE on the skin is likely to increase when patients spend several days in hospital before operation, for investigation or because surgery is delayed for other reasons. It has been shown that there is a greater increase in the colonisation rate with MRSE when prophylactic synthetic penicillins are given before surgery (Thore et al 1990).

Further investigation will require a study of the

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### Table I. Results of a retrospective review of organisms isolated at hip arthroplasty or biopsy

<table>
<thead>
<tr>
<th>Organism</th>
<th>Revision</th>
<th>Biopsy</th>
<th>Primary</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Staph. epidermidis</em></td>
<td>4</td>
<td>2</td>
<td>–</td>
<td>6</td>
</tr>
<tr>
<td>Methicillin-resistant <em>Staph. epidermidis</em></td>
<td>10</td>
<td>2</td>
<td>–</td>
<td>12</td>
</tr>
<tr>
<td><em>Staph. aureus</em></td>
<td>1</td>
<td>1</td>
<td>–</td>
<td>2</td>
</tr>
<tr>
<td>Diphtheroids</td>
<td>2</td>
<td>1</td>
<td>–</td>
<td>3</td>
</tr>
<tr>
<td><em>Propionibacterium acnes</em></td>
<td>2</td>
<td>–</td>
<td>–</td>
<td>2</td>
</tr>
<tr>
<td><em>Streptococcus faecalis</em></td>
<td>1</td>
<td>1</td>
<td>–</td>
<td>2</td>
</tr>
<tr>
<td><em>Pseudomonas</em></td>
<td>–</td>
<td>–</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Mixed anaerobes</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td>1</td>
</tr>
<tr>
<td>Anthracoid bacillus</td>
<td>–</td>
<td>–</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
distribution of MRSE in the hospital environment and in surgical and nursing staff. A preliminary study using overnight settle plates in our wards showed the presence of MRSE in five of six rooms.

In our prospective group of patients, the later use of cephalosporins clearly failed to satisfy one of the major criteria for effective prophylaxis: 25% of the patients had resistant organisms in their skin flora before arthroplasty. We therefore recommend the routine monitoring of the skin flora of both patients and staff with documentation of the causative organisms and their antibiotic sensitivities in all infected cases. It will then be possible to identify the local pattern of infection and to monitor the development of resistant organisms. This will allow for the more selective use of prophylactic antibiotics, especially for the high-risk group undergoing revision operations.

The choice of antibiotic remains difficult. Teicoplanin has a similar spectrum to vancomycin and has been used for prophylaxis (Mollan, Haddock and Webb 1992), but there is already some concern that resistance is developing to this antibiotic. At present there are no reported cases of resistance to vancomycin, but this antibiotic is difficult to administer and has numerous potentially serious side-effects which prevent its routine use for prophylaxis. These risks, however, may be justifiable for revision surgery; its potential toxicity can be reduced by local administration in impregnated cement.

The results of our two-part study raise major concerns. The emphasis of the prevention of infection has until now centred on the operating theatre and the reduction of airborne contamination during surgery. It may be that equal importance should be given to the prevention of skin contamination in the hospital environment and to the development of new methods of prophylaxis to keep pace with the occurrence of resistant organisms.

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REFERENCES


