THE TIMING OF Tourniquet Application
In Relation to Prophylactic Antibiotic Administration


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Antibiotic levels in bone and fat were measured in patients undergoing knee replacement to determine the time that should elapse between intravenous injection and tourniquet inflation.

The tissue levels increased progressively with time, and there was wide variation in absorption rate between patients and between the two cephalosporins assessed. Five minutes should probably be left between systemic injection and inflation of the tourniquet, though two minutes may be long enough for drugs which are rapidly absorbed.

Prophylactic antibiotic administration has been shown to reduce the incidence of postoperative infection, provided the drug is present at the time and site of operation (Bowers, Wilson and Greene 1973). To ensure adequate blood levels many surgeons administer the antibiotic intravenously during the induction of anaesthesia. For operations on the hip and shoulder the timing of this is probably not critical, but most patients undergoing a more distal arthroplasty have the limb exsanguinated and a tourniquet applied shortly afterwards. It is uncertain how much time must elapse between administration of the drug and application of the tourniquet in order to achieve adequate tissue levels. We set up a study to try and determine this time interval.

METHOD

We studied 37 patients during operation for knee replacement. Each received an appropriate intravenous dose of antibiotic at an accurately recorded time in relation to the time of application and inflation of the tourniquet. Samples of tibial and femoral bone were then obtained 30 and 60 minutes after tourniquet application; specimens of subcutaneous fat and blood were taken at 30, 60 and 90 minutes. Two antibiotics were assessed: cefuroxime (1.5 g) and cefamandole (1 g).

Blood specimens were centrifuged immediately postoperatively and the serum stored with the tissue samples at −20°C. Antibiotic assays were subsequently performed by a solid agar diffusion method (Leigh et al. 1982).

RESULTS

No significant difference was found between the antibiotic levels obtained in tibia and femur; in each patient the measurements from these two bones have therefore been combined. If either of the drugs was given after tourniquet inflation inadequate tissue concentrations were achieved. Tissue concentrations increased progressively with the time allowed between antibiotic administration and tourniquet application (Table I), but even when there was a five-minute interval, the average maximal bone concentration of either drug was lower than that obtained in the hip (Leigh et al. 1982).

Antibiotic levels are regarded as bactericidal when tissue levels reach four times the minimal inhibitory concentration (MIC) (Quinti!iani and Nightingale 1984). The MIC will vary with the organism concerned, but for Staphylococcus aureus it is 0.5 mg/l for cefamandole, and 1.0 mg/l for cefuroxime. Figure 1 shows that the mean tissue antibiotic level for both drugs far exceeded the bactericidal level, provided that 30 seconds was allowed before inflation of the tourniquet. However, there were considerable variations between patients, and after 30 seconds’ interval, the bactericidal level was exceeded in only 61% of the patients. The percentage with bactericidal levels rose to 83% with two minutes’ delay and to 100% with five minutes.

Similar trends were seen in antibiotic concentrations in fat. A bactericidal level was reached in 54% after a 30-second delay, and in 67% after a two-minute interval. With an interval of five minutes, 100% cover was achieved (Fig. 2). Figures 1 and 2 also show that there was a difference in the rate of absorption of the two drugs, cefamandole tending to be effective more rapidly.
Table I. Mean antibiotic levels in bone after various timings of administration

<table>
<thead>
<tr>
<th>Timing</th>
<th>Cefamandole</th>
<th>Cefuroxime</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean level (mg/l)</td>
<td>Standard error</td>
</tr>
<tr>
<td>After tourniquet</td>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Before tourniquet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 seconds</td>
<td>7.9</td>
<td>6.9</td>
</tr>
<tr>
<td>2 minutes</td>
<td>12.7</td>
<td>6.1</td>
</tr>
<tr>
<td>5 minutes</td>
<td>15.8</td>
<td>10.7</td>
</tr>
</tbody>
</table>

Fig. 1
Average level of antibiotic in bone from each patient. ● mean value for each timing.

Fig. 2
Average level of antibiotic in fat from each patient. ● mean value for each timing.
DISCUSSION

Although the use of prophylactic antibiotics is widely accepted there is still some debate about the best drug and the method of administration. Many surgeons choose a cephalosporin because of the broad spectrum of activity. Intravenous administration in the operating theatre ensures peak tissue levels at the time of surgery (Schurman, Hirshman and Burton 1980). For these reasons we studied the rates of absorption of two commonly used cephalosporins given by intravenous injection.

There are few guidelines for the optimal tissue concentration of antibiotics but it seems logical to aim for bactericidal levels in both bone and fat since infection probably starts at these sites. Many organisms may be involved but Staphylococcus aureus is the commonest pathogen and we therefore considered a tissue level of four times the MIC for this organism. Although many patients achieved satisfactory bone and fat antibiotic levels even when the tourniquet was inflated only 30 seconds after the intravenous injection, the considerable variation meant that 40% of patients had inadequate protection.

Many studies have shown that cephalosporins are absorbed at different rates (Cunha et al. 1977; Schurman et al. 1980; Leigh et al. 1982), and this difference has again been demonstrated. Because of the variability in absorption we recommend that with most antibiotics the tourniquet is not inflated until five minutes after intravenous injection of the drug, though for a rapidly absorbed drug two minutes is probably adequate. It is therefore suggested that the antibiotic is given intravenously at an early stage of the induction of anaesthesia.

REFERENCES


