DISCITIS AFTER DISCOGRAPHY

THE ROLE OF PROPHYLACTIC ANTIBIOTICS

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Discitis after discography is due to bacterial penetration into the intervertebral disc by a contaminated needle and has an incidence of 1% to 4%. We have examined the prophylactic role of cephazolin administered at the time of discography.

An experimental study in sheep using radiographic contrast containing *Staphylococcus epidermidis* showed that either adding the antibiotic to the intradiscal suspension or giving it intravenously 30 minutes before intradiscal inoculation of bacteria prevented any radiographic, macroscopic or histological signs of discitis; all the intervertebral disc cultures were negative.

In a prospective clinical study of 127 consecutive patients having lumbar discography, the injected contrast contained cephazolin 1 mg per ml. None of the patients developed clinical or radiographic signs of discitis. We recommend the use of a suitable broad spectrum antibiotic in a single prophylactic dose whenever the intervertebral disc is entered.

Discitis following discography is due to penetration of bacteria into the disc by a contaminated needle (Fraser, Osti and Vernon-Roberts 1987). This is followed by destruction of the cartilage end-plates, herniation of nuclear material from the intervertebral disc into the adjacent vertebral bodies and extensive replacement of the nucleus pulposus by granulation tissue (Figs 1 and 2). This condition has a higher incidence than previously reported; according to recent studies it varies from 1% to 4% (Crock 1983; McCulloch, personal communication, 1985; Crock and Patrikios, personal communication, 1986; Fraser et al 1987).

Antibiotics have been advocated for the treatment of established postoperative discitis (Lindholm and Pylkkänen 1982; Kirkaldy-Willis 1983; Fernand and Lee 1986), but there is controversy concerning their efficacy

(Pilgaard 1969; Taylor and Dooley 1978) and on their ability to penetrate the intervertebral disc (Gibson et al 1987) which is, in physiological circumstances, an avascular structure.

In this paper we report an experimental study in sheep to verify the prophylactic role of intradiscal and intravenous cephazolin (a first generation cephalosporin) administered at the time of discography. We also report the results of a prospective trial of prophylactic cephazolin in 127 consecutive patients undergoing discography for the investigation of low-back pain.

EXPERIMENTAL STUDY IN SHEEP

Material and methods

Intradiscal antibiotics. In four two-year-old Merino wether sheep, the lumbar spine was exposed through a left-sided retroperitoneal approach under general anaesthesia. Five adjacent lumbar intervertebral discs were injected using 27.5 gauge needles, each disc being injected with a suspension of 0.1 ml of radiographic contrast (Conray 280) containing an estimated 20 *Staphylococcus epidermidis* and 10 µg of cephazolin.

The antibiotic was added to the suspension immediately before injection. The survival of *Staphylococcus epidermidis* in the suspension with cephazolin was measured both in protein and protein-free media. The protein medium consisted of Isosensitest broth (oxoid

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CM) to which 10% sterile horse serum was added as a source of protein. The protein-free medium was Isosensitest broth only. Each broth was dispensed in 5 ml aliquots; doubling dilutions of cephazolin were prepared in these broths. The two media were inoculated with *Staphylococcus epidermidis* and incubated at 35°C in a water bath. At various time intervals 100 µl samples were removed and plated onto 5% sheep blood agar plates. These plates were incubated at 35°C for 48 hours and examined for growth.

Plain radiographs were taken at operation to check the levels injected, and six weeks later, when the sheep were killed. The lumbar spine was then removed en bloc and, under direct vision with a sterile technique, needle biopsies were obtained from all lumbar intervertebral discs. The specimens were cultured on 1) blood agar incubated in 5% carbon dioxide; 2) anaerobic agar incubated in 7% carbon dioxide, 83% nitrogen and 10% hydrogen; and 3) glucose cooked meat broth. Media 1 and 2 were incubated for seven days and inspected daily for growth. Medium 3 was incubated for seven days and then cultured, whether turbid or clear, on media 1 and 2 for two additional days.

The spine was fixed in formal saline and after fixation, cut with a band-saw in the mid-sagittal plane, cleaned of debris, observed macroscopically and photographed. Blocks were obtained from single discs and adjacent end-plates, decalcified and processed for histology. Decalcification was checked with daily radiographs. **Intravenous antibiotics.** In another five two-year-old Merino wether sheep the lumbar spine was exposed as previously and up to six adjacent intervertebral discs were injected using 27.5 gauge needles. In four of these sheep, five adjacent lumbar intervertebral discs were injected with 0.1 ml of Conray 280 containing an estimated 20 *Staphylococcus epidermidis*. Intravenous cephazolin was administered 30 minutes prior to the inoculation of bacteria. In two of these sheep the dose of antibiotic was 0.5 g and in the other two 1 g.

The fifth sheep had six lumbar discs injected with 0.1 ml of Conray 280 containing an estimated 20 *Staphylococcus epidermidis* in two discs, 200 bacteria in another two discs and 2 000 in the remaining two discs. This sheep had 1 g of cephazolin given intravenously 30 minutes before the inoculation.

Plain radiographs were taken at the time of operation and six weeks later when the sheep were killed. Venous blood samples at the time of inoculation were used to determine the serum level of cephazolin. The lumbar spine was again removed en bloc and processed as described above.

Results

Culture results showed that approximately half of the organisms were still viable in both media 30 minutes after contact with the antibiotic (Fig. 3). It was therefore assumed that in our experimental conditions, the addition of antibiotic would have had little effect on the actual

numbers of viable bacteria injected. In the two sheep given 0.5 g of intravenous cephazolin the serum antibiotic levels at the time of inoculation of bacteria (30 minutes after antibiotic administration) were 22.3 and 53.4 µg/ml respectively. In the three sheep given 1 g of intravenous cephazolin these levels were 61, 70 and 131 µg/ml respectively.

No evidence of discitis was found at any level in any sheep: all cultures were negative and the 46 discs were radiographically, macroscopically and histologically normal (Figs 4 and 5).

PROSPECTIVE CLINICAL TRIAL

Following the experimental study, we started a prospective trial of prophylactic cephazolin in patients undergoing discography for the assessment of low back pain.

Material and methods

A total of 127 consecutive patients undergoing lumbar discography between May 1986 and January 1989 were reviewed three weeks after the procedure, and again at three months. All procedures were carried out by one of three radiologists with the patient lying in the left lateral position. The skin was prepared with Betadine and draped with a sterile towel. After premedication and local anaesthesia, the gloved and gowned operator used the lateral approach (McCulloch and Waddell 1978) and a two-needle technique at all levels with stilette needles. Angiografin was the contrast agent; this was mixed immediately before injection with cephazolin at a concentration of 1 mg of antibiotic per 1 ml of contrast. A total of 337 lumbar discs were injected, an average of 2.6 levels per patient.

Any patient with increased back symptoms at three weeks was investigated by ESR, plain radiography and lateral tomography.

Results

None of the 127 patients developed any clinical or radiographic signs of discitis. Only one patient had exacerbation of symptoms at three weeks after discography at L3/4, L4/5 and L5/S1. This patient had been treated by an anterior spinal fusion at the lumbosacral level two weeks after discography and his ESR was elevated to 50 mm, possibly due to the operation. However, lateral tomography failed to demonstrate any end-plate erosion or disc space narrowing at either the L4/5 or L3/4 levels. His condition improved and follow-up radiographs taken 12 months after surgery showed no evidence of previous discitis.

DISCUSSION

In our previous experimental studies using the same sheep model, we showed that an estimated seven or more *Staphylococcus epidermidis* inoculated into a lumbar intervertebral disc produced discitis with end-plate erosion after two weeks in every instance (Fraser, Osti

Macroscopic view and low power micrograph of a lumbar disc from a sheep six weeks after injection of radiographic contrast medium and bacteria. There is marked central discitis with destruction of both end-plates. The intervertebral disc and adjacent bone has been extensively replaced by granulation tissue. (Haematoxylin and eosin $\times 6$).

Fig. 1

Fig. 2

Fig. 3

The survival of *Staphylococcus epidermidis* in protein and protein-free media containing cephalosporin.

and Vernon-Roberts 1986, 1987). This was seen in 17 discs from five sheep injected with bacteria and contrast medium and in 16 discs from four sheep injected with bacteria and reconstituted chymopapain. In contrast with this, we have now found no evidence of discitis in any of 46 discs when prophylactic intradiscal or intravenous antibiotics were employed.

In 1987 we reported a series of 61 consecutive patients having discography at 134 levels performed by the same radiologists using the same technique but without prophylactic antibiotics (Fraser et al, 1987). Discitis was then diagnosed at four levels in three patients (incidence 4.9%). In the present series, using prophylactic cephalosporin, there were no cases of discitis. The difference between the series was statistically significant ($p < 0.04$, Fisher's Exact test).

Many authors have advised the use of systemic

Fig. 4

Fig. 5

Macroscopic view and low power micrograph of the lumbar disc of a sheep six weeks after injection of radiographic contrast and bacteria. One gram of intravenous cephalosporin had been given 30 minutes before the inoculation. The disc appears normal with intact end-plates, and there is no evidence of discitis. (Haematoxylin and eosin $\times 6$).

antibiotics for suspected disc space infection. However, Gibson et al (1987) failed to detect cephadrine and flucloxacillin in human intravertebral disc tissue removed at spinal surgery after the parenteral administration of the drugs. Using a rabbit model, Eismont et al (1987) showed that clindamycin and tobramycin could diffuse into the intervertebral disc, but could not detect cephalothin or oxacillin in the disc following intravenous administration. Our study strongly suggests that cephalozin (a first generation cephalosporin) is able to penetrate the intervertebral disc in sufficient amount to destroy up to 2 000 *Staphylococcus epidermidis*. In a separate investigation we found that the penetration of cephalozin into the intervertebral disc was approximately 1% of the antibiotic serum level.

The key factors affecting the level and retrieval of antibiotics from intervertebral discs after intravenous administration appear to be the serum level of antibiotic and the time interval between administration and the removal of disc tissue for assay.

If antibiotics with a short half-life are employed, such as cephalozin or other beta-lactam antibiotics, disc tissue should be assayed between 30 and 45 minutes, shortly after peak serum levels are reached. In a separate experimental study using the same sheep model we found that cephalozin could be retrieved from lumbar intervertebral disc 30 minutes after intravenous administration of 1 g but not after 60 minutes. We found no difference between the prophylactic effect of intradiscal or intravenous cephalozin given at the time of inoculation of bacteria.

Based on our results, we recommend the addition of a broad spectrum antibiotic to the radiographic contrast material at the time of discography. In patients undergoing chemonucleolysis, however, because of the possible interference of the antibiotic with the enzyme and the fact that an intravenous line would be available, a broad-spectrum antibiotic known to penetrate the intervertebral disc should be administered intravenously at the time of the intradiscal injection.

The increased popularity of discometry, discography with or without computerised tomography, percutaneous nucleotomy, chemonucleolysis and microdiscectomy, make it likely that discitis will become a more frequent complication. Our study suggests that prophylactic antibiotics are effective. However, in a separate sheep study, we found that high-dose intravenous cephalozin started one week after intradiscal inoculation of *Staphy-*

lococcus epidermidis and administered for up to 21 days failed to arrest or modify the course of discitis. This finding implies that for an antibiotic to be effective it must be given before the intradiscal multiplication of bacteria has led to destruction of the end-plates and degradation of the disc. This apparent failure of antibiotics in the treatment of established discitis emphasises the importance of adequate prophylactic measures.

Conclusions. We recommend the use of a suitable broad-spectrum antibiotic in a single prophylactic dose whenever the intervertebral disc is entered. Extreme care in following a strict aseptic technique is also essential in view of the central role of bacteria in the aetiology and pathogenesis of discitis.

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REFERENCES

- Crock HV. *Practice of spinal surgery*. Wien etc: Springer-Verlag, 1983.
- Eismont FJ, Wiesel SW, Brighton CT, Rothman RH. Antibiotic penetration into rabbit nucleus pulposus. *Spine* 1987; 12:254-6.
- Fernand R, Lee CK. Postlaminectomy disc space infection: a review of the literature and a report of three cases. *Clin Orthop* 1986; 209: 215-8.
- Fraser RD, Osti OL, Vernon-Roberts B. Discitis following chemonucleolysis: an experimental study. *Spine* 1986; 11:34-43.
- Fraser RD, Osti OL, Vernon-Roberts B. Discitis after discography. *J Bone Joint Surg [Br]* 1987; 69-B:26-35.
- Gibson MJ, Karpinsky MRK, Slack RCB, Cowlshaw WA, Webb JK. The penetration of antibiotics into the normal intervertebral disc. *J Bone Joint Surg [Br]* 1987; 69-B:784-6.
- Kirkaldy-Willis WH. Complications of disc surgery - discitis. *Orthop Trans* 1983; 7:110.
- Lindholm TS, Pylkkänen P. Discitis following removal of intervertebral disc. *Spine* 1982; 7:615-22.
- McCulloch JA, Waddell G. Lateral lumbar discography. *Br J Radiol* 1978; 51:498-502.
- Pilgaard S. Discitis (closed space infection) following removal of lumbar intervertebral disc. *J Bone Joint Surg [Am]* 1969; 51-A:713-6.
- Taylor TKF, Dooley BJ. Antibiotics in the management of postoperative disc space infections. *Aust NZ J Surg* 1978; 48:74-7.