ARTHROSCOPY IN SEPTIC ARTHRITIS

Lidocaine- and Iodine-Containing Contrast Media are Bacteriostatic

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Puncture of septic foci is usually performed to determine the responsible bacteria. If contrast medium is used instead of saline to rinse the lesion and to withdraw an adequate bacteriologic specimen, the opacification provides valuable information about the extent of the changes. Since lidocaine is usually used as a local anesthetic when patients undergo this procedure, we tested the in vitro antibacterial effects of lidocaine 1%, as well as those of 2 contrast media—meglumine amidotrizoate and metrizamide—on several bacteria. In particular, we looked at the influence of the concentration of inoculum used and the duration of contact before culture. The contrast media did not significantly affect bacterial growth when contact before culture did not exceed 3 hours. In contrast, lidocaine had a significant antibacterial effect, indicating that it should not enter into contact with the bacteriologic specimen.

Puncture of septic lesions does not always provide adequate specimens for bacteriologic examination. In such cases, injection of normal saline is recommended in order to obtain the needed material. If contrast medium is used for this purpose, it can demonstrate the size of the abscess and eventual fistulous tracts, which are often surprisingly extensive. The relation of the septic lesion to the adjacent structures can thus be evaluated more thoroughly. In this paper, we present 4 case reports to illustrate the usefulness of this technique. Since most punctures are performed with the use of lidocaine as a local anesthetic, we have investigated the antibacterial effects of lidocaine and of 2 currently used arthrographic contrast media, on several bacteria. In particular, we examined the variation of bacterial growth with reference to the size of the inoculum and the duration of contact between the drugs and the bacteria before culture.

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PATIENTS AND METHODS

Puncture technique. Puncture technique depended on the affected region. If a joint was involved, classic arthrographic technique was used. If an intervertebral disc was affected, a posterolateral approach was used to perform the discography. Other septic lesions were directly punctured under fluoroscopic control and, rarely, under computed tomography (CT) scan control. All punctures were undertaken using 20- or 22-gauge needles. The amount of injected contrast medium varied with the structure to be opacified; however, the injections were always performed very slowly and with minimal pressure.

Depending on the structure to be opacified, dilution of the contrast medium was sometimes necessary in order to reduce the contrast. Lidocaine was always used for this purpose. However, based on previous bacteriologic experiments, we avoided injection of this drug into septic lesions.

Contrast media and lidocaine. Meglumine amidotrizoate (306 mg iodine/ml Angiographine; Schering, Berlin, West Germany) and metrizamide (170 mg iodine/ml Amipaque; Nyegaard, Oslo, Norway), currently used for arthrographic examinations, were tested as contrast media. The antibacterial activity of lidocaine 1% (Xylocaine; Astra, Lakemadel, Sweden) was also investigated. All of these drugs were tested at commonly used concentrations. We also tested a mixture of meglumine amidotrizoate/lidocaine 1% (1:1, volume:volume).

Bacteria. Bacteria studied were *Staphylococcus aureus, Streptococcus viridans (milleri), Escherichia coli* (4 strains isolated from urine and feces), *Pseudomonas aeru-*

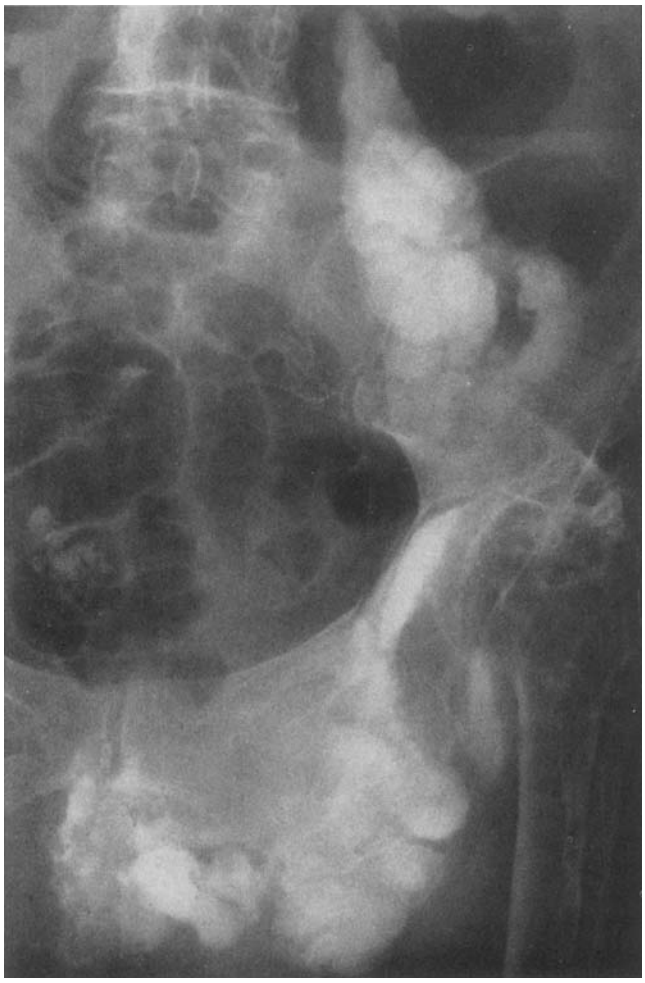

Figure 1. Patient 1. Percutaneous opacification of large prepubic and inguinal abscesses communicating through the hip joint, with another collection spreading high into the psoas muscle.

ginosa, Streptococcus group B (*agalactiae*), and *Mycobacterium tuberculosis*.

Bacteriologic experiments. We used inocula containing 10^8, 10^5, 10^4, and 10^3 bacteria/ml. Except for *M tuberculosis*, 2 colonies of each organism were cultured in 2.5 ml Mueller-Hinton broth or brain heart infusion (BHI) broth and incubated overnight at 35°C. The next morning, each culture was diluted to MacFarland no. 1 standard ($\pm 10^8$ bacteria/ml) with BHI broth, and then diluted to obtain inocula ranging from 10^5–10^3 bacteria/ml. The 4 inocula (10^8, 10^5, 10^4, 10^3 organisms/ml) were then mixed with each contrast medium or lidocaine at a ratio of 1:10 (final bacterial concentration 10^7, 10^4, 10^3, and 10^2 bacteria/ml), allowed to stand at room temperature, and observed at times 0, 30 minutes, 1 hour, 3 hours, 5 hours, and 24 hours. Tubes were covered with aluminum foil to keep out light. For the inocula with 10^8 and 10^5 bacteria/ml, sterile 0.85% NaCl was used as control under the same conditions. At time 0 and at 30 minutes, 1 hour, 3 hours, 5 hours, and 24 hours of incubation, 0.1 ml of each solution was inoculated on the entire surface of BHI-agar plates and incubated overnight at 35°C.

The next morning, results were evaluated as follows: on cultures of inocula containing 10^2–10^4 organisms/ml, the colonies were counted with the naked eye when possible. For the inocula containing $>10^4$ bacteria/ml, the eventual inhibitory effect was evaluated by observing the apparent decrease of the density of the subcultures and the appearance of semiconfluent colonies on the agar plates. If the growth inhibition was already quite pronounced, it was possible to count the colonies.

M tuberculosis drawn from another rich culture was massively inoculated onto Loewenstein medium in the presence of approximately 1 ml meglumine amidotrizoate or 1 ml lidocaine 1%, and incubated 6–8 weeks at 35°C. Growth or lack of growth was thereafter observed.

Patients. *Patient 1.* Patient 1 was a woman who, at the age of 68, developed a septic loosening of a left total hip prosthesis, which subsequently had to be removed. Five years later, she was admitted to the hospital for an inflammatory left inguinal mass. That mass was punctured, and a small

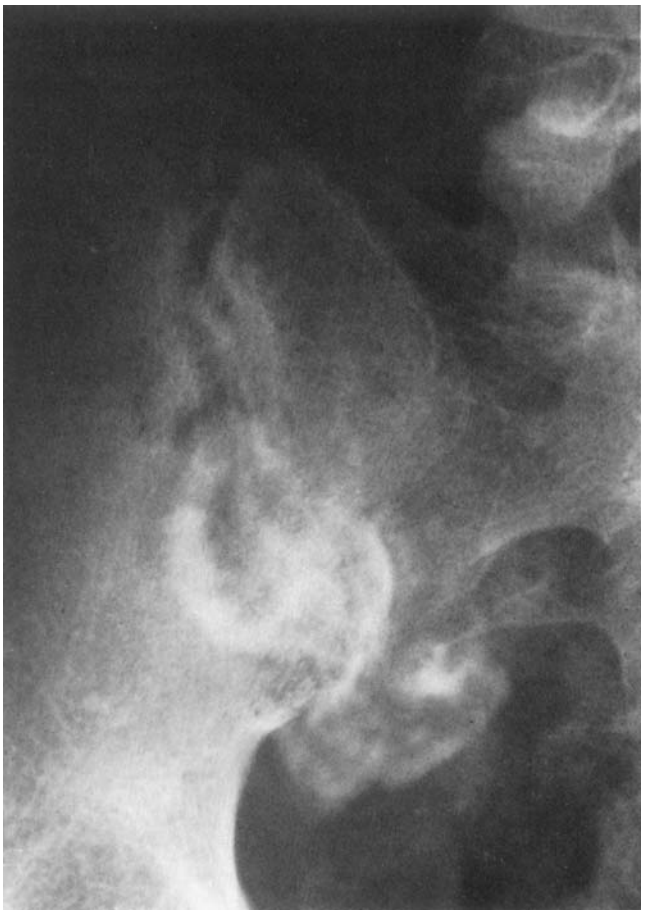

Figure 2. Patient 2. Arthrography of the right sacroiliac joint, anteroposterior view.

amount of green-grey pus was aspirated. Injection of meglumine amidotrizoate demonstrated a large prepubic and inguinal abscess communicating with the hip joint, and another collection located high within the left psoas muscle (Figure 1). Bacteriologic examination of the pus and the reaspirated contrast medium produced negative results; the patient had been receiving antibiotic treatment for a long period of time. Surgical drainage was performed and healing occurred after a few weeks.

Patient 2. Patient 2, a 57-year-old man, presented with arthritis of the right sacroiliac joint. Two previous punctures of the joint had not provided bacteriologic diagnosis. Transiliac puncture of the joint was performed under CT scan control. A 1:1 mixture of meglumine amidotrizoate and lidocaine 1% was injected, and it demonstrated polylobulate collection at the ventral aspect the of the joint (Figures 2 and 3). *M tuberculosis* was isolated by culture of the reaspirated material. Healing occurred after 1 year of specific antibiotic therapy.

Patient 3. Patient 3, a 75-year-old man, had developed right tuberculous trochanteritis at the age of 55. At the time of this admission he was suffering from arthritis of the right hip, of about 2 months duration. No material was withdrawn at articular puncture. Injection of meglumine amidotrizoate demonstrated an abscess which was located at the anterior aspect of the ischium and continued through a posterior fistulous tract to the hip joint (Figure 4). *M tuberculosis* was isolated by culture of the reaspirated contrast medium. The femoral head and neck were removed and the abscess was surgically drained.

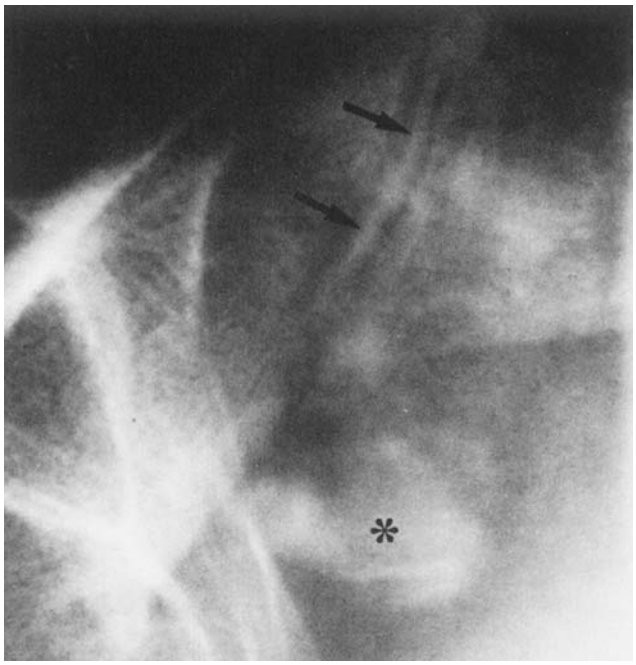

Figure 3. Patient 2. Arthrography of the right sacroiliac joint, craniocaudal view of the opacified area (**arrows**) and the ventral abscess (*).

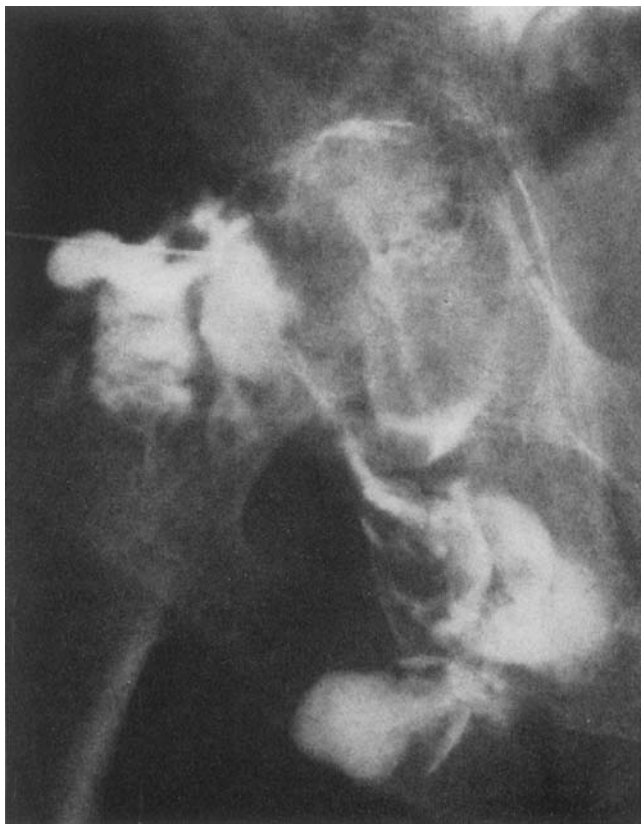

Figure 4. Patient 3. Arthrography of the right hip joint. Abscess located at the ventral aspect of the ischium was also opacified.

Patient 4. Patient 4 was a 2-year-old girl who had L5–S1 discitis. Disc puncture by right posterolateral approach was performed, but no material was withdrawn. Injection of metrizamide demonstrated disc destruction and a fistulous tract extending within the left first sacral foramen (Figure 5). *S aureus* was isolated by culture of the reaspirated contrast medium. Antibiotic therapy provided prompt recovery.

RESULTS

Growth inhibition. Table 1 exhibits the maximal growth inhibition observed for each organism. This generally occurred if inoculation was performed after 24-hour contact between the bacteria and the tested drug. However, the tested contrast media did not significantly inhibit bacterial growth if culture was made within 3 hours of incubation; under those conditions the tested bacteria could always be distinguished (Table 2). Lidocaine, however, produced inhibitory effects even in cases of short duration of contact before culture.

Meglumine amidotrizoate and metrizamide. When meglumine amidotrizoate or metrizamide was

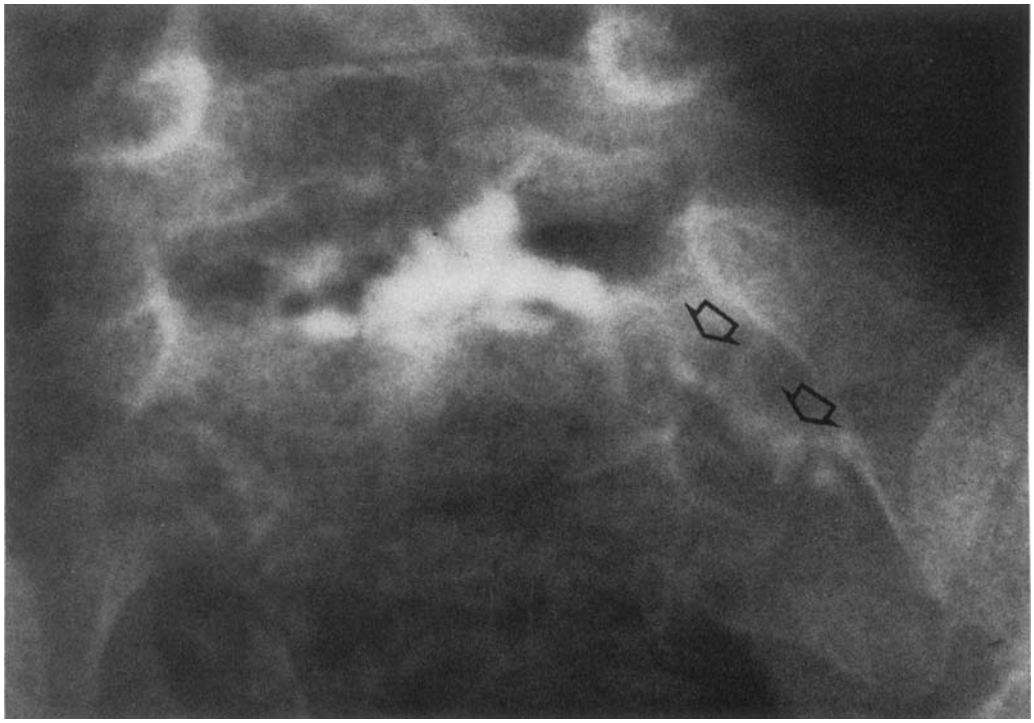

Figure 5. Patient 4. L5–S1 discography showing opacification of a fistulous tract (**arrows**) extending into the first left sacral foramen.

used as contrast medium, no significant growth inhibition of the gram-positive bacteria was observed at the different concentrations tested.

For gram-negative bacteria, metrizamide did not significantly inhibit culture of inocula containing $>10^4$ bacteria/ml. With meglumine amidotrizoate, we observed a partial decrease in the number of the colonies after 5 hours of incubation; growth inhibition was significant but not complete after a 24-hour incubation period. For the inocula containing $<10^4$ bacteria/ml, a significant inhibitory effect of meglumine amidotrizoate was observed on *E coli* and *P aeruginosa* after a 24-hour incubation period. A partial decrease could be observed even after 3 hours of incubation.

The effects of metrizamide on *E coli* were similar to those of meglumine amidotrizoate. However, on *P aeruginosa,* metrizamide produced a reaction

Table 1. Maximal antibacterial effects observed with meglumine amidotrizoate, metrizamide, and lidocaine*

Bacteria	Inoculum size (bacteria/ml)	Meglumine amidotrizoate	Metrizamide	Lidocaine
Gram-positive				
(*Staphylococcus aureus*,	$>10^4$	–	–	–
Streptococcus group B,	$\leq 10^4$	–	–	+
Streptococcus viridans)				
Gram-negative				
Escherichia coli	$>10^4$	±	–	+
	$\leq 10^4$	+	+	+
Pseudomonas aeruginosa	$>10^4$	±	–	–
	$\leq 10^4$	+	–	+

* – = no inhibition; ± = partial inhibition; + = total inhibition (no growth).

Table 2. Antibacterial effects observed with meglumine amidotrizoate, metrizamide, and lidocaine, with ≤3 hours contact before culture*

Bacteria	Inoculum size (bacteria/ml)	Meglumine amidotrizoate	Metrizamide	Lidocaine
Gram-positive				
(*Staphylococcus aureus*,	$>10^4$	–	–	–
Streptococcus group B,	$\leq 10^4$	–	–	±
Streptococcus viridans)				
Gram-negative				
Escherichia coli	$>10^4$	–	–	+
	$\leq 10^4$	±	±	+
Pseudomonas aeruginosa	$>10^4$	–	–	–
	$\leq 10^4$	±	–	+

* – = no inhibition; ± = partial inhibition; + = total inhibition (no growth).

opposite to that seen with meglumine amidotrizoate: the number of the colonies increased with time, showing the ability of some bacteria to multiply when exposed to metrizamide.

Lidocaine. With lidocaine 1%, gram-positive bacteria were not inhibited if the inoculum contained $>10^4$ organisms/ml, but an almost total inhibition was observed after a 24-hour incubation for inocula containing $<10^4$ *S aureus* or *S agalactiae*/ml. Partial inhibition of gram-positive bacteria had already occurred after 3-hour and 5-hour incubations, depending on the size of the inoculum. For *S agalactiae* inoculum containing 10^4 bacteria/ml, the number of colonies decreased steadily from the start of the incubation. Low-concentrated inocula of *S viridans* were not tested.

There was some variation in lidocaine's effects on different gram-negative bacteria. After overnight incubation, the 4 strains of *E coli* were totally inhibited by this drug. Partial inhibition was seen under other conditions, depending on the duration of contact, the initial concentration of the inoculum, and the strain tested. When *P aeruginosa* was used, it was resistant to lidocaine 1% if the inoculum contained $>10^4$ bacteria/ml, but growth inhibition was observed, beginning at 3 hours, for the inoculum at a concentration of 10^4 bacteria/ml. The tests were uninterpretable for the inocula at 10^2 and 10^3 bacteria/ml.

Meglumine amidotrizoate:lidocaine mixture. This solution was tested only on inocula containing $>10^4$ bacteria/ml. It inhibited the strains of *E coli* in proportion to the concentration of lidocaine and was ineffective on the other bacteria.

When *M tuberculosis* was used as the inoculum, the strains grew in the presence of all of the drugs tested.

DISCUSSION

The opacification of septic areas provides valuable information about the size of the lesion, its precise extent, and the eventual presence of adjacent abscesses or fistulous tracts (1,2). This procedure is especially helpful in cases of osteitis or septic arthritis, as in our patients 2 and 3. Detection of an unexpected abscess during arthrography in septic arthritis helps the physician select the most appropriate therapy. This is equally true in spondylodiscitis: opacification of the intervertebral space can provide demonstration of an eventual abscess, particularly one that is spreading into the psoas muscle. In a child presenting with discitis caused by *S aureus* of the L5–S1 space (patient 4), we observed a fistulous tract extending within the first sacral foramen.

During puncture of articular replacements, arthrography has to be performed in order to detect possible loosening. However, positive findings from bacteriologic examination of the aspirated material are quite rare in these cases, even with the use of surgical specimens (3). The injection of contrast medium sometimes allows visualization of fistulous tracts that can extend far from the joint, as in our patient 1. Adequate precautions must be taken so that injection of contrast medium does not disturb bacteriologic isolation of the reaspirated material.

Some researchers have reported an absence of antibacterial effects of meglumine amidotrizoate and metrizamide (4,5); however, in their studies, relatively rich bacterial inocula, containing more than 10^6 bacteria/ml, were used. Kim and Lachman (1) drew our attention to the relation between the concentration of the bacterial inoculum and the antibacterial effects of

the contrast media, but they tested only cultures of *S aureus*.

Our experiments do not demonstrate significant effects of the contrast media on gram-positive bacteria, regardless of the concentration of the inoculum. The results regarding gram-negative bacteria are quite different, depending on bacterial concentration. Meglumine amidotrizoate inhibited cultures of *E coli* and *P aeruginosa* to varying degrees, while metrizamide acted only on low-concentrated inocula of *E coli*, ($<10^4$ bacteria/ml). The antibacterial effects of these drugs were altered according to the duration of contact before culture, with the effects being generally insignificant if the specimen was cultured a short time after removal.

Regardless of the duration of the contact, the inhibitory effect of metrizamide on gram-negative bacteria was lower than that of meglumine amidotrizoate. However, we do not believe this justifies the systematic use of this more expansive contrast medium. Rather, it should be reserved for special conditions, e.g., in the case of possible intradural injection.

Inhibitory effects of the contrast media could be due to the release of inorganic iodine in the sample tests. Lang et al (6) demonstrated that samples exposed to sunlight had increased inorganic iodine concentration, whereas room light provoked only slight liberation of this molecule. The influence of duration of contact before culture could be partially due to this phenomenon. During our investigations we covered the test tubes with aluminum foil to prevent light exposure, but this precaution may have been insufficient. The multiplication of *P aeruginosa* observed during incubation in metrizamide was probably due to the capacity of this bacterium to grow easily in aqueous solutions.

Our results with lidocaine were consistent with those previously reported (7,8) for concentrations $>10^4$ bacteria/ml in the inoculum. Gram positive bacteria and *P aeruginosa* were not inhibited, whereas *E coli* were sensitive to this drug, depending on the duration of incubation. Lidocaine did inhibit bacterial growth when the inoculum contained $<10^4$ bacteria/ml. Complete inhibition was observed after 24-hour incubation of some gram-positive bacteria; inhibition began sooner with gram-negative bacteria. Since bacterial concentration within lesions cannot be predicted, lidocaine should not be allowed to enter into contact with the withdrawn specimen.

M tuberculosis seems to be insensitive to all of the tested drugs under the experimental conditions used. These results differ from those of Schmidt and Rosenkranz (7). We may have used much larger concentrations of the inocula. However, our in vitro findings are consistent with our clinical observations. Indeed, we never observed any inhibitory effect of the contrast media or lidocaine on the cultures of samples obtained after opacification of tuberculous lesions. One of us (2) previously reported a case of tuberculous discitis confirmed by bacteriologic examination of the material withdrawn after discography.

Lidocaine must be used very prudently during diagnostic puncture of septic lesions, and it should not come into contact with the lesion. After aspiration of any material, contrast media should be injected to provide adequate demonstration of the extent of the lesion. Thereafter, contrast medium must be reaspirated for bacteriologic examination. Under any circumstance, the specimen should be inoculated as quickly as possible after removal.

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