Pyogenic Liver Abscess Due to Microaerophilic Streptococci

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VEILLON first isolated anaerobic streptococci from infections of the mouth and genito-urinary tract in 1893.[33] Subsequently, these organisms have been found among normal bacterial flora of the mouth, upper respiratory tract, colon, female genital tract, urethra, and skin.[9, 21, 24, 32, 34] The role of anaerobic streptococci in disease has frequently been overlooked, not only because effective anaerobic cultures are not done, but also because these organisms are often found in mixed infections. Although anaerobic cocci are recognized as a frequent cause of puerperal infection, it is less well appreciated that these organisms may also be isolated from virtually every type of infection in every major organ system.

Pyogenic liver abscess due to anaerobic and microaerophilic streptococci has been reported rarely. We recently observed two cases within a two-month period. These cases, a review of the literature, and selected observations regarding pyogenic liver abscess and anaerobic cocci are the subject of this report.

Case Reports

Case 1. A. G., a 35-year-old Spanish-American man, had rapid onset of fever, chills, weakness, anorexia, vomiting, diarrhea, and right upper quadrant pain on June 15, 1965. Diarrhea subsided after three days, but the other symptoms persisted and were unaffected by a short course of chloramphenicol prescribed by a physician. During the following three weeks he lost 20 lbs.

The patient had had a vagotomy and hemigastrectomy with Billroth I anastomosis performed 13 months previously. His postoperative course had been complicated by thrombophlebitis and partial obstruction of the proximal jejunum which subsided. In August 1964, he had swelling in the incision which spontaneously drained a thin, grey material. Drainage persisted until January 1965, when an infected sinus tract was resected. Bacteriologic examination of the drainage was not performed. For several months before and after the second operation he returned to his usual occupation, although he complained of malaise and easy fatigability.

He appeared to be acutely ill when admitted to the Veterans Administration Hospital in Whipple, Arizona, on July 8, 1965. His temperature was 39.4° C., and pulse rate 108. A few crepitant rales were heard at the left lung base. The liver was percussed 2 cm. below the right costal margin and tenderness was present in the right epigastrium and in the right lumbar region.

White blood count was 5,600/mm.^{3} with 56% neutrophils, 32% bands, and 9% lymphocytes. Hematocrit was 43%. Extensive laboratory and x-ray studies revealed the only abnormalities to be serum globulins of 3.8 Gm./100 ml. and deformity of the duodenal cap. Blood cultures were sterile.

Because of persisting fever and chills and increasing abdominal pain, laparotomy was performed on July 16, 1965 at which no abnormalities except firmness of the right lobe of the liver were found. Biopsy of the liver showed intrahepatic cellular infiltrates of the periportal spaces. Postoperatively the patient was treated with cephalothin (2.0 Gm. daily) and within five days was afebrile. The drug was stopped 14 days later because of emesis. The emesis persisted, however,

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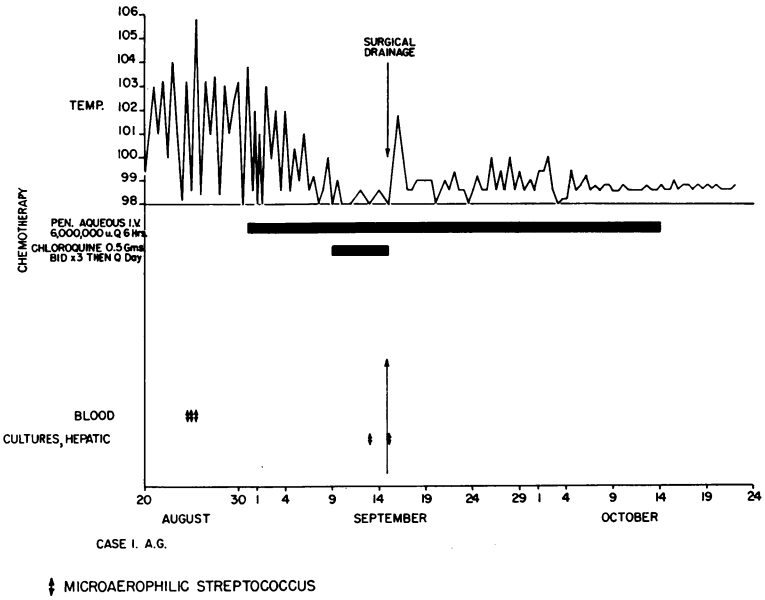

FIG. 1. Clinical summary of Case 1, during hospitalization at Wadsworth Veterans Administration Hospital.

and three days later fever returned. After taking chloramphenicol for four days (1.0 Gm. daily) the fever again subsided. Administration of the drug was stopped after five days, and fever and chills returned within two days.

The patient was transferred to the Wadsworth Veterans Administration Hospital, Los Angeles, on August 20, 1965. At that time, he complained of pain in the right shoulder in addition to fever, chills, night sweats, weakness, anorexia, occasional vomiting, weight loss, and epigastric pain. Temperature was 38.9° C. Physical findings were not significantly different from those on July 8, 1965.

White blood cell count was 16,700/mm.^{3} with 84% neutrophils, 3% band cells, 8% lymphocytes, and 4% monocytes. Hematocrit was 40%. Serum alkaline phosphatase was 16.2 King-Armstrong units, and serum bilirubin, serum glutamic oxalacetic, and glutamic pyruvic transaminases were normal. Chest x-ray film was negative, and fluoroscopy revealed normal movement of both leaves of the diaphragm. Stool examination for parasites was negative.

The patient remained acutely ill with daily temperature elevations (Fig. 1). Three blood cultures drawn on August 25, 1965, yielded growth of microaerophilic streptococci after several days. There was no clinical evidence of endocarditis. On September 1, 1965, intravenous aqueous penicillin was given in doses of six million units every six hours. The patient was symptomatically improved and one week later was afebrile.

Liver photoscan showed a large defect in the upper portion of the right lobe (Fig. 2). A hemagglutination test for amebiasis was negative. Aspiration of the area was attempted twice using a 5-inch #18 gauge needle without success. On September 13, 1965, however, aspiration with a 7-inch #17 gauge, thin-walled aortography needle yielded 100 cc. of thick, yellow-green purulent material. Injected air outlined a large cavity (Fig. 3). Gram stain of the pus revealed gram-positive cocci in chains and microaerophilic streptococci were isolated in pure culture from the pus after 24 hours (Tables 1 and 2).

Subsequently, the patient was operated upon through the bed of the 12th rib. A large, multiloculated abscess in the dome of the liver was found which measured six to seven inches in the long diameter. An attempt was made to open all loculations and a sump drain was inserted. During the procedure, two complications occurred. The right lung was punctured during needle aspiration to locate the abscess. The pleural cavity was entered during the incision. The pleural defect was closed, and a chest tube with water seal was placed before exposing the liver.

The postoperative course was uncomplicated. The chest tube was removed on the second day and the sump drain on the tenth day. A sinogram on the 16th postoperative day showed no residual cavity. Rapid resolution of the abscess was further demonstrated by liver scan three weeks later (Fig. 4). Penicillin was discontinued one month after operation, and the patient was discharged. Tetracycline, 2.0 Gm. daily, was given for another month to minimize likelihood of relapse. When last examined on December 29, 1965, the patient

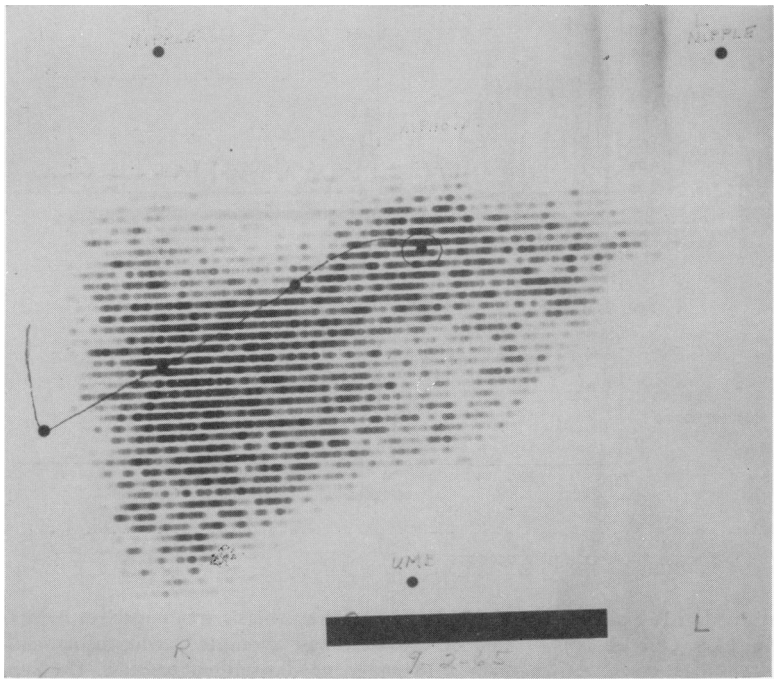

FIG. 2a, b. A-P and lateral Au^{198} liver scan, Case 1, showing a large space-occupying lesion in the upper right lobe.

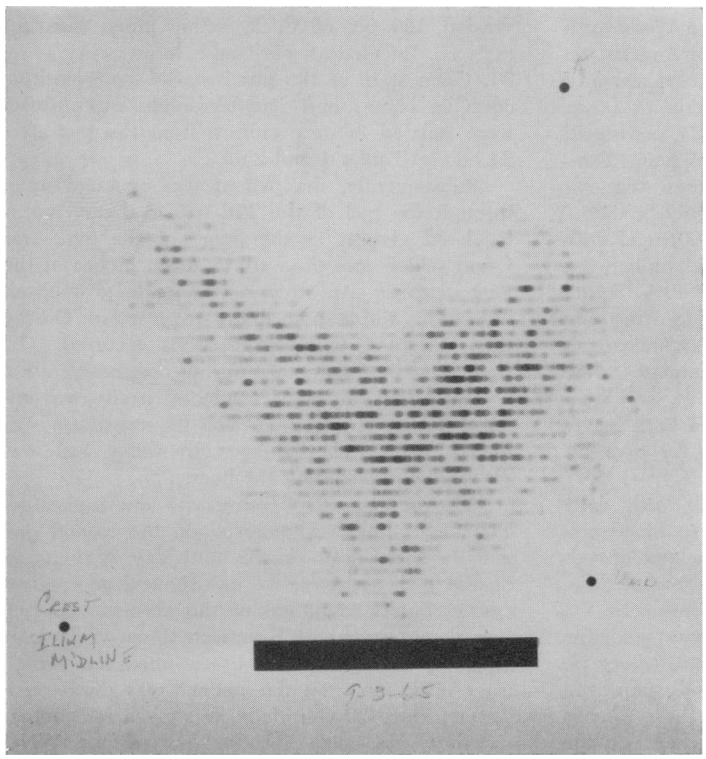

FIG. 2b.

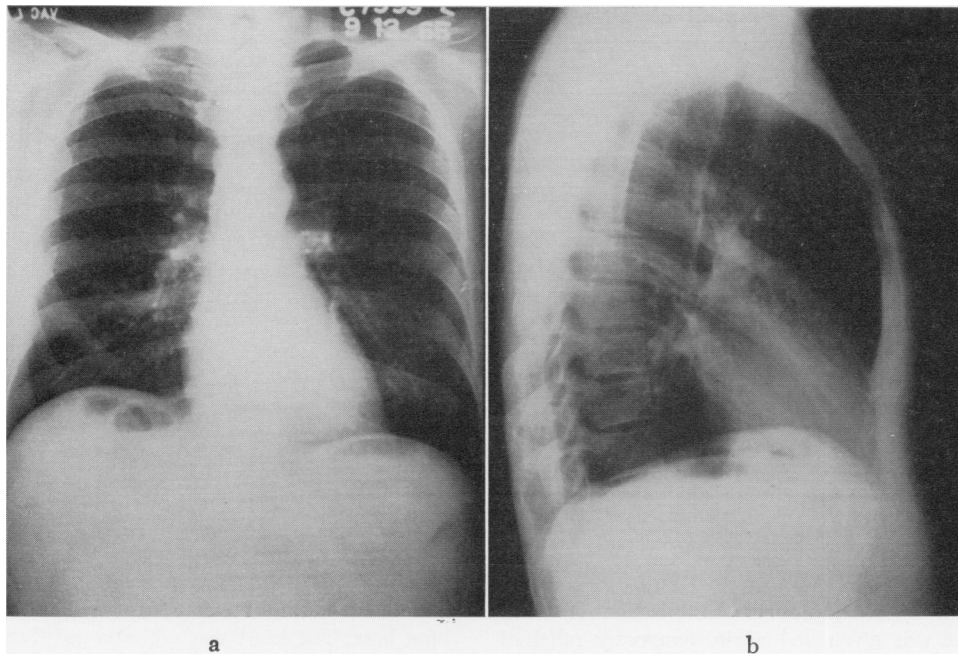

FIG. 3a, b, c. P-A and lateral chest and upright abdominal x-rays, Case 1, after needle aspiration and injection of air into the liver abscess.

had continued in good health. He returned to work on January 3, 1966.

Case 2. T. D., a 47-year-old Caucasian man, had been in excellent health until September 1, 1965, when he suddenly developed fever and chills, followed by malaise and arthralgias of the knees and ankles. These symptoms persisted, and two days later he consulted a physician who gave him a penicillin injection. For two days he felt well, but then fever and chills recurred. During the subsequent eight weeks he continued to have mild fever and chills, frequent night sweats, malaise and anorexia, and a nonproductive cough appeared. Four weeks after the onset of symptoms, he again sought medical attention. Physical examination, hemoglobin, white blood cell count, and

TABLE 1. *Morphology of Microaerophilic Streptococcus Isolates*

Patient	A. G.	A. G.	T. D.
Source	Liver abscess	Blood	Liver abscess
Colonial Morphology			
Blood Agar Base with 5% Sheep Blood (Anaerobic)	Rough, gray, 0.5 mm. diameter, growth into agar; greening present	Rough, gray 0.5–0.7 mm. diameter, growth into agar; greening present	Smooth, white 1.0–1.2 mm. diameter, greening absent
Albimi-Brucella Agar with 5% Sheep Blood (Anaerobic)	Mucoid, gray, 3.0 mm. diameter, slight *B*-hemolysis	Mucoid, gray, 3.0 mm. diameter, slight *B*-hemolysis	Rough, white, 1.0–2.0 mm. diameter, marked *B*-hemolysis
Type of Growth in Broth	Turbid in 24 hrs. Sedimentation after 2–5 days	Turbid in 24 hrs. Sedimentation after 2–5 days	Granular growth on bottom and side of tube
Microscopic Morphology in Brain Heart Infusion Broth	Gram-positive cocci, 0.7 microns diameter, in chains of paired cocci averaging 6 cells in length	Gram-positive cocci, 0.7 microns diameter, in chains of paired cocci averaging 6 cells in length	Gram-positive cocci, 0.8–1.0 microns diameter, in chains of 6–20 cells

chest x-ray were normal. An injection of tetracycline was given and again, temporary relief of his symptoms followed.

On October 30, 1965, the patient was admitted to the Wadsworth Veterans Administration Hospital. He appeared only mildly ill. Temperature was 38.3° C. and pulse rate 100. Breath sounds and tactile fremitus were decreased at the right lung base. The heart was not enlarged, but a soft Grade II/VI, mid-systolic murmur was heard at the apex. The liver edge was rounded, firm, nontender, and extended 3 cm. below the right costal margin. The spleen tip was palpated 1 cm. below the left costal margin. Hematocrit was 39% and

TABLE 2. *Biochemical Data on Microaerophilic Streptococcus Isolates*

Patient	A. G.	A. G.	T. D.
Source	Liver abscess	Blood	Liver abscess
End Products of Glucose Fermentation*			
Formic acid	0.3	0.35	0
Acetic acid	−0.05**	0.05	0.5
Succinic acid	−0.05	0.05	0.1
Lactic acid	4.15	3.92	3.2
End pH after 7 Days' Incubation†			
Glucose	4.5	4.5	4.5
Lactose	5.2	4.8	4.6
Sucrose	4.8	4.5	4.6
Maltose	4.7	4.5	4.4
Fructose	4.5	4.6	4.6
Galactose	4.9	5.0	4.5
Pyruvate	7.9	ng††	7.6
Citrate	7.6	ng	6.2
Tartrate	ng	ng	ng
Lactate	ng	ng	ng
Base medium (without carbohydrate or organic acid)	7.9	7.8	7.6

* Reported as micrograms of acid/100 milliliters.

** Negative values mean utilization rather than production of the compound.

† No gas formation from any of these substrates.

†† No growth.

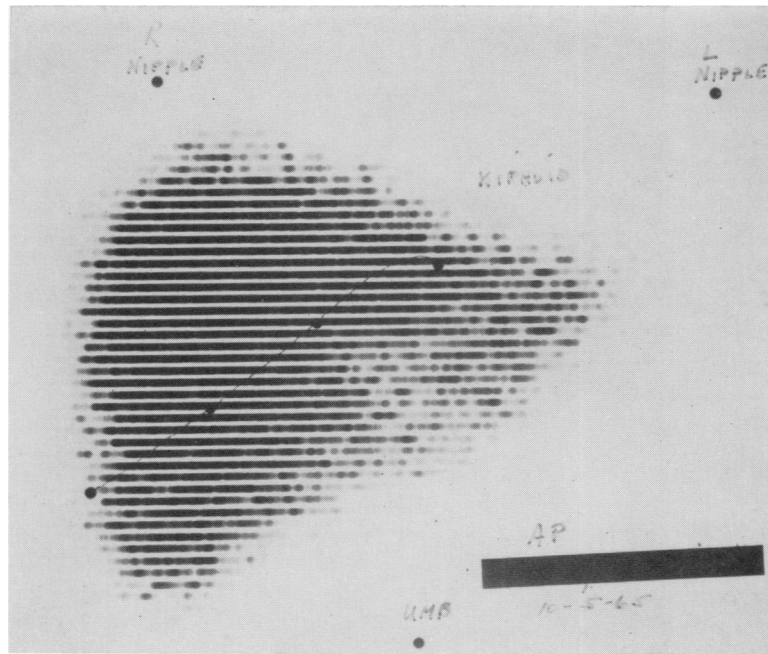

FIG. 4. A-P liver scan three weeks after surgical drainage of the solitary liver abscess, showing almost complete resolution of the lesion in Figure 2.

white blood cell count 14,500, with 82% neutrophils and 15% lymphocytes. A trace of albumin was found in the urine and occasional white blood cells were seen in the urinary sediment. Serum albumin was 4.0 Gm./100 ml., and globulin, 3.8 Gm./100 ml. Total bilirubin was 0.7 mg./100 ml., prothrombin time, 26% and serum glutamic pyruvic transaminase, 84 units. Chest x-ray was normal.

Low-grade fever, frequent diaphoresis, occasional chills, and marked anorexia persisted (Fig. 5). On the sixth hospital day, further enlargement of the liver and spleen was noted. That evening the patient experienced pleuritic right chest and shoulder pain coincident with a shaking chill and temperature elevation to 39.8° C. The next day, chest x-ray showed elevation of the right diaphragm and a photoscan of the liver using Au^{198} demonstrated a 5 × 7-cm. defect in the posterior-superior portion of the right lobe of the liver (Fig. 6). Attempted aspiration of this area with a #18 spinal needle was unsuccessful. Tetracycline (2.0 Gm. daily) and chloroquine (1.0 Gm. daily) were given on the eighth hospital day. At this time hematocrit was 31%; white blood cell count, 19,400, with 93% neutrophils; total bilirubin, 1.3 mg./100 ml.; alkaline phosphatase, 31 King-Armstrong units; and 45-minute bromsulphalein

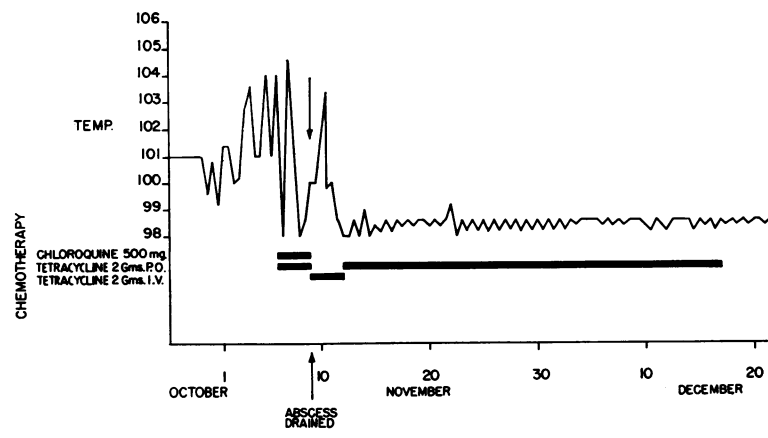

FIG. 5. Clinical summary, hospital course of Case 2.

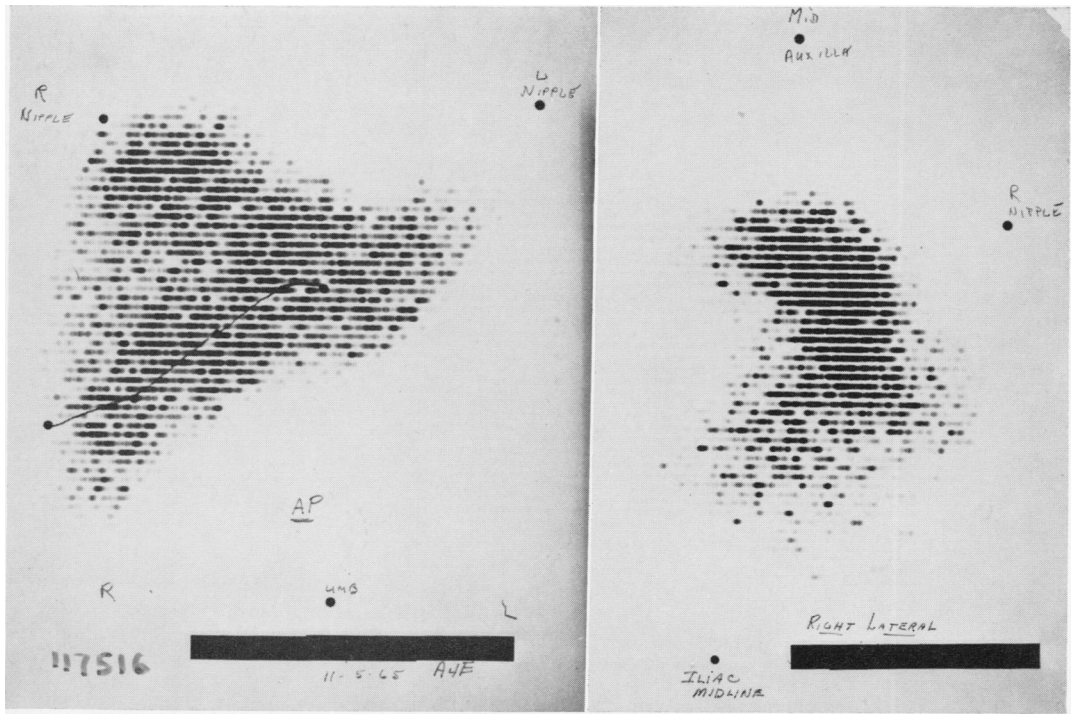

FIG. 6a, b. A-P and lateral liver scan, Case 2. The distinct space-occupying lesion demonstrated on the lateral view is only vaguely seen in the A-P projection.

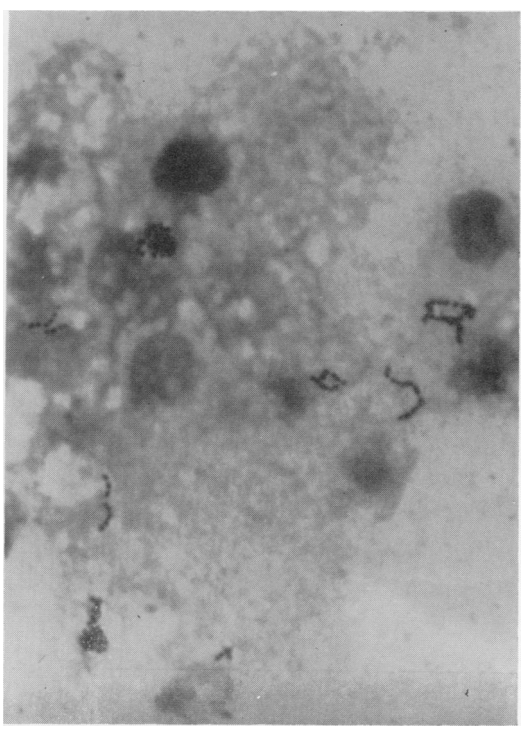

FIG. 7. Gram stain of pus from the liver abscess, Case 2, showing many gram-positive cocci in chains. (Magnification ×1,000.)

was 26% retention. After five daily injections of vitamin K_1, prothrombin time was 31%. Prothrombin consumption was 90% and Factor V assay was 45%.

On the 11th hospital day, the patient was operated upon through the bed of the 12th rib. A softened, bulging area was found along the posteroinferior portion of the right lobe of the liver. Needle aspiration returned 200 cc. of brown, purulent, putrid-smelling material which contained numerous small gram-positive cocci in chains (Fig. 7). The abscess contained two loculations, which together measured four inches in the greatest diameter. A sump drain and a Penrose drain were inserted into the cavity and brought out through the incision.

Cultures from the abscess grew only microaerophilic streptococci (Tables 1 and 2). The patient was given tetracycline postoperatively. By the third day his temperature returned to normal, and he subsequently made a rapid and uneventful recovery. A sinogram two weeks later showed a small remaining cavity. By four weeks after operation the cavity could no longer be demonstrated by either sinogram or liver photoscan (Fig. 8). Tetracycline was discontinued, and the patient was discharged feeling completely well. He had continued in good health when last seen on January 17, 1966.

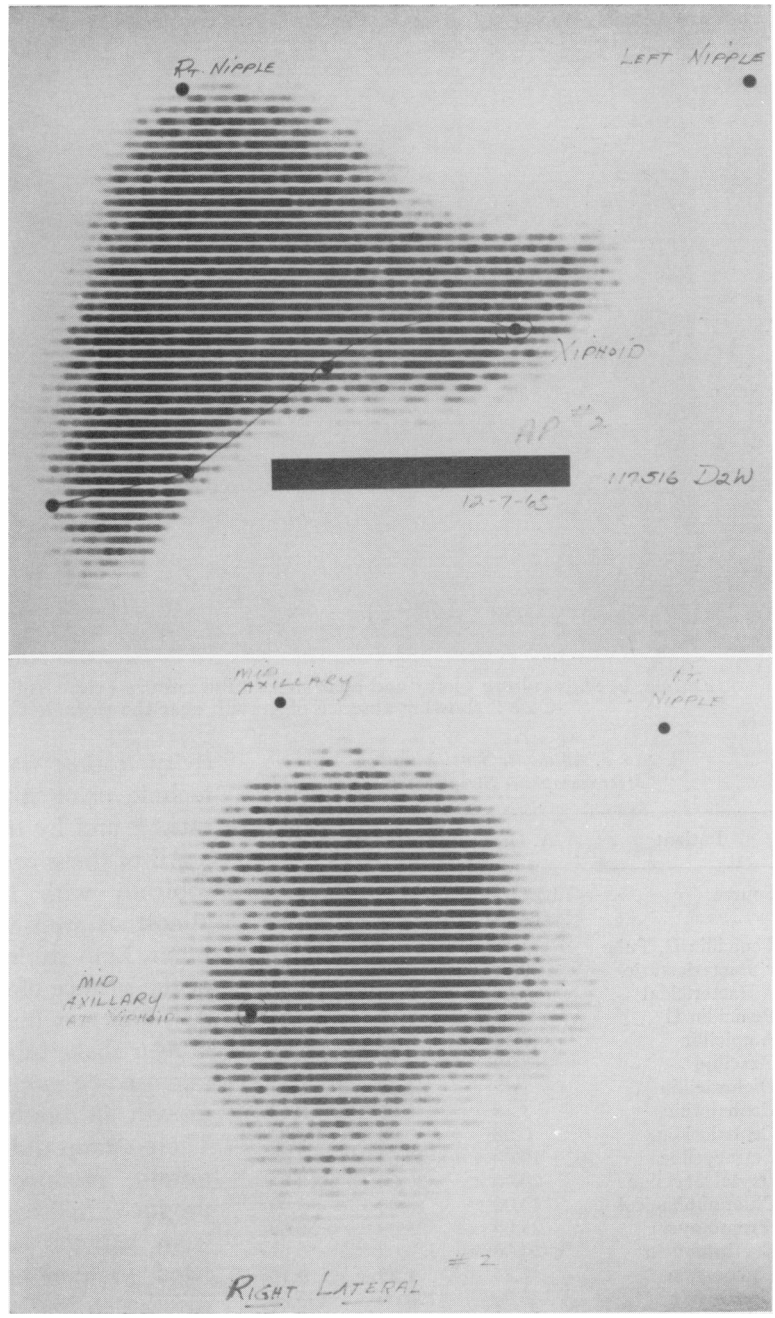

FIG. 8a, b. A-P and lateral views of follow-up liver scan, Case 2, eight weeks after surgical drainage. A small defect, seen only on the lateral projection, persists at the site of the abscess.

Bacteriologic Studies

The organisms isolated from the liver abscesses and the blood were classified by existing taxonomic schemes.[4, 32] All tests were done by the methods described by Conn[7] and Thomas and Hare.[32] Studies of end products of glucose fermentation were done by silicic acid column chromatography according to the technic of Bruno and Moore[6] and Moore and Cato.[18] Sensi-

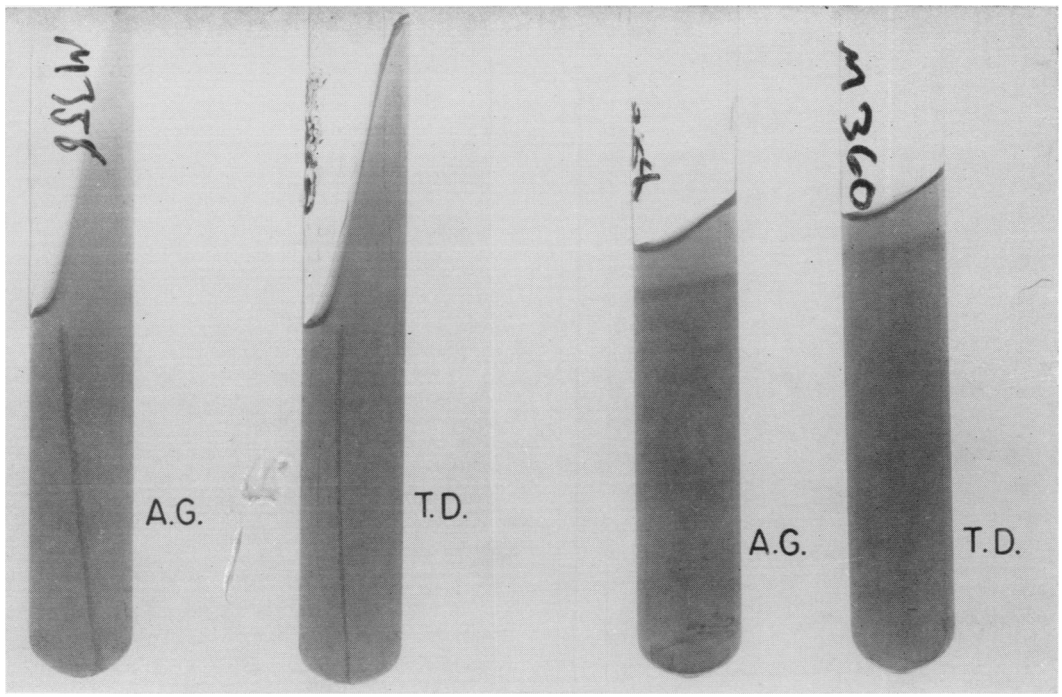

FIG. 9a, b. Stab culture (left) and agar shake tube culture (right) of isolates from Case 1 and Case 2 showing absence of growth near the surface of the agar.

TABLE 3. *Antibiotic Sensitivities*— Microaerophilic Streptococci*

Patient	A. G.	A. G.	T. D.
Source	Liver abscess	Blood	Liver abscess
Penicillin G, Tube			
Bacteriostatic	0.08	0.08	0.04
Bactericidal	0.32	0.32	0.04
Penicillin G	0.15	0.15	0.04
Ampicillin	0.32	0.32	0.16
Oxacillin	2.50	2.50	0.62
Dicloxacillin	1.25	1.25	0.62
Cephalothin	1.25	1.25	0.62
Cephaloridine	0.08	0.08	0.08
Tetracycline	10.00	10.00	5.00
Oxytetracycline	20.00	20.00	10.00
Chloramphenicol	10.00	10.00	5.00
Streptomycin	25.00	25.00	50.00
Erythromycin	<0.08	<0.08	<0.08
Lincomycin	1.25	1.25	0.16
Kanamycin	100.00	100.00	100.00
Polymyxin B	>400.00	>400.00	>400.00
Bacitracin	1.25	1.25	10.00
Vancomycin	1.25	1.25	1.25
Sodium fusidate	>10.00	>10.00	>10.00

* Reported as micrograms/milliliter, except for bacitracin which is in units/milliliter; plate dilution technic except as specified for penicillin G.

tivity testing was done by plate dilution technic using a replica inoculating apparatus [29] and by tube dilution technic.[35]

All of these organisms grew better anaerobically with 10% carbon dioxide, but almost as well with 10% carbon dioxide in air. Both strains grew to within 2–3 mm. of the surface of agar in stab cultures (Fig. 9a), and to within 4–5 mm. of the surface of agar shake tubes (Fig. 9b). Colonial and microscopic morphology, as well as type of growth in broth, are noted in Table 1. These strains did not require blood, reduce nitrate, produce indole, liquefy gelatin, produce hydrogen sulfide, produce gas from peptone broth, break down coagulated protein, coagulate serum broth, or dissolve in bile salts. The isolates from patient A. G. differ from the other strain in that these organisms did not clot litmus milk or grow at room temperature, and showed yellow fluorescence in 0.01% neutral red broth. Further biochemical studies are presented in Table 2. Additional dif-

TABLE 4. *Liver Abscess Due to Anaerobic Streptococci. Summary of Reported Cases*

	Age	Sex	Organism	Primary Source of Infection	Site of Abscess				Treatment
					Solitary		Multiple		
					Right Lobe	Left Lobe	Right Lobe	Left Lobe	
Fisher and Abernethy (1934)[11]	25	M	Anaer. strep. Bacteroides	Appendicitis			+	+	Diagnosed at autopsy
McDonald *et al.* (1937)[14]	—	—	Anaer. strep.	Perforated duodenal ulcer			+	+	Diagnosed at autopsy
St. John *et al.* (1942)[23]	19	F	Anaer. strep.	Unknown	+				Open drainage, transthoracic
Flynn (1946)[12]	23	M	Microaero. strep.	?Cholecystitis			+	+	Open drainage, laparotomy; penicillin—160,000 units/day for 3 weeks
Michel and Wirth (1947)[17]	22	F	Anaer. strep.	?Pelvic infection			+		Penicillin—120,000 units 1st day, decreasing doses next 13 days
Wellman (1948)[36]	20	M	Anaer. strep.	Unknown	+				Open drainage, laparotomy; penicillin and streptomycin
Fuss *et al.* (1950)[13]	43	M	Anaer. strep. viridans	Ruptured appendix			+		Open drainage, Ochsner approach; bacitracin intracavitary, penicillin and streptomycin
McFadzean (1953)[15]	27	M	Anaer. strep. and B. coli	Unknown	+				Needle aspiration; penicillin and streptomycin, intracavitary and systemic
	41	M	Anaer. strep.	Unknown		+			Needle aspiration; penicillin and streptomycin, intracavitary and systemic—1 week; then chloramphenicol—10 days
Stokes (1960)*[31]	61	M	Anaer. strep.	Unknown	+				Open drainage, laparotomy; penicillin
	33	F	Microaero. strep. and Strep. fecalis	Unknown	+				Open drainage, laparotomy; penicillin
Sherman and Robbins (1960)**[27]	—	—	Microaero. strep. 2 cases	—		—		—	—
McKenzie (1964)[16]	41	M	Anaer. strep.	1. ?Diverticulitis 2. Subphrenic abscess	+				Open drainage, laparotomy; tetracycline
Schwartz (1964)**[26]	—	—	Microaero. strep.	—		—		—	—
Authors' cases	35	M	Microaero. strep.	?Post-gastrectomy infection	+				Open drainage, Ochsner approach; penicillin G—20 million units/day for 4 weeks, then tetracycline—2.0 Gm./day for 4 weeks
	47	M	Microaero. strep.	Unknown	+				Open drainage, Ochsner approach; tetracycline—2.0 Gm./day for 4 weeks

* Two additional cases: Case #1: No anaerobic cultures but gram-positive cocci in chains on smear, no growth on aerobic plates. Case #3: Clinical details insufficient to distinguish between lung and liver abscess.

** Clinical details not specified.

ferences between the strains from the two patients were observed in antibiotic sensitivity end points (Table 3).

Because all three strains are streptococci which produce acid without gas from carbohydrates and do not produce gas from salts of organic acids, they are classified in Group VIa of Thomas and Hare.[32] Using the scheme in Bergey's Manual,[4] the isolate from patient T. D. would be classified as *Peptostreptococcus intermedius* and the isolates from patient A. G. as *Peptostreptococcus intermedius or Peptostreptococcus micros.*

Discussion

Pyogenic liver abscess was found in 0.36% of 19,700 autopsies at Strong Memorial Hospital from 1925 through 1960.[26] Bacteriologic information in most series is insufficient to establish the incidence of infection by anaerobic organisms. The failure to isolate bacteria in 40 to 60% of cases [19, 22, 26] may be due to failure to use adequate anaerobic culture technics in all cases. Fifteen instances of liver abscess due to anaerobic and microaerophilic streptococci have been reported in the literature, and these are summarized in Table 4.[11-17, 23, 26, 27, 31, 36] In thirteen cases in which complete bacteriologic data are given, anaerobic cocci were present in pure culture ten times and in mixed culture three times.

Fisher and Abernethy [11] recorded the first case of anaerobic streptococcal liver abscess in 1934 in a young man who died after a short illness and who was found to have pylephlebitis and multiple liver abscesses complicating subacute appendicitis. McDonald *et al.*[14] reviewed 23 autopsied cases of various fatal infections due to anaerobic streptococci including one case of multiple liver abscesses contiguous with a large subdiaphragmatic abscess following perforation of a duodenal ulcer.

A patient with a large solitary abscess cured by surgical drainage was described by St. John *et al.*[23] in 1942—the first recorded survivor of this disease. All twelve cases reported since have been treated successfully with a combination of antibiotic therapy and drainage.

TABLE 5. *Liver Abscess—Anaerobic Streptococci Clinical Findings in 13 Cases**

Symptoms	Number of Patients
Fever	13
Abdominal pain	11
Anorexia	7
Chills	7
Nausea	5
Weight loss	5
Cough	5
Pleuritic pain	4
Malaise	3
Weakness	2
Vomiting	3
Physical Signs	
Hepatomegaly	11
Hepatic tenderness	10
Right lower lobe signs	6
Splenomegaly	4
Jaundice	3

* Includes our two cases. Clinical details not available in four other cases.

Clinical Findings

The clinical features in these cases are tabulated in Tables 4 and 5 and are typical of pyogenic liver abscess as described by several authors.[19, 22, 26, 27] Fever was present in every case and pain was usually in the right upper quadrant or epigastrium. In four instances, including both patients in the present report, a pleuritic right chest pain appeared late in the illness. Referral to the right shoulder occurred in three of the four cases. Approximately one-half of the patients complained of anorexia and nausea, shaking chills, and a dry cough.

In addition to temperature elevation, an enlarged and tender liver was the most important physical finding; often, the hepatic tenderness was a late sign. Abnormal physical signs over the right lower chest in one-half of the cases, included decreased expansion of the right thorax, dullness to

percussion, decreased excursion of the right diaphragm, diminished breath sounds, fine moist rales, and in one instance a pleural friction rub. A friction rub over the liver, a late sign reflecting inflammation of the serosal surface, was not observed.

White blood cell counts were usually elevated with increased numbers of neutrophils. Mild to moderate anemia was present in the more chronic cases. Roentgenographic abnormalities included pleural effusion or thickening, elevated right diaphragm, and hepatomegaly. In one striking case, a gas fluid level was noted in the liver.

Hepatic photoscanning after intravenous injection of radioisotope-labeled Rose-Bengal or gold is the most valuable aid in establishing the diagnosis and location of a solitary liver abscess.[25] In our Case 1, liver abscess had not been strongly considered until this procedure was done. In both cases, the precise localization of the abscess facilitated surgical exposure and drainage. Follow-up scanning during the recovery period (Figs. 4, 8) also gives a more reliable picture of the healing process than does x-ray with injection of contrast material. The importance of two projections is demonstrated in Figure 6.

The absence of a definite predisposing source of infection in 50% of cases (Table 4) and the preponderance of involvement of the right lobe are consistent with the observations on liver abscess in general in various series.[19, 22, 26] Our Case 1 had had a known intra-abdominal infection five months before the onset of an acute illness. He experienced a brief episode of diarrhea initiating the present illness. Beaver [2] and Stokes [31] suggest that minor inflammatory changes of the intestinal mucosa might predispose to invasion of the portal system by normal bacterial residents of the intestines. Patients with ulcerative colitis are known to have portal vein bacteremia which often causes pericholangitis.[5] Sparberg *et al.*[28] recently reported two cases of "sterile" liver abscess complicating regional enteritis. A gram stain showing chains of gram-positive cocci with the sterile cultures in their second case is strong presumptive evidence for anaerobic streptococcal infection. Both patients were taking corticosteroids which, the authors suggest, may have predisposed to the development of liver abscess. The actual incidence of liver abscess complicating these two chronic inflammatory bowel diseases has not been studied, but clinical experience has not suggested a frequent occurrence. With regard to our Case 1, it is likely that the liver abscess preceded the diarrhea. In Case 2, no primary source of infection could be identified.

Anaerobic Infections

The frequency with which anaerobic or microaerophilic streptococci were isolated in pure culture (14 of a total of 17 cases, including the two in this report) suggests that these organisms may have significant virulence despite observations of other investigators who were unable to demonstrate animal pathogenicity with pure cultures of these organisms.[20]

Data from several authors indicate that anaerobic coccal infections are much more common than has generally been recognized.[8, 30] Our knowledge regarding the role of anaerobic cocci in human disease is inadequate. There are three major reasons for this. First, adequate anaerobic technic is often not used in culturing clinical specimens; therefore, many anaerobic infections are completely overlooked and valuable clinical data lost. Second, most articles on anaerobic cocci are written by bacteriologists. These often lack clinical information suitable for proper evaluation of the role of these isolates in disease. Third, as anaerobic cocci are present in large numbers in various parts of the body as normal flora, isolation from such specimens as

sputum (even secretions obtained at bronchoscopy) and vaginal discharge is difficult to evaluate. Isolation of anaerobic cocci from blood, body fluids or abscesses is the most reliable evidence for infection with these organisms. Transtracheal aspiration and suprapubic bladder puncture may be used to bypass areas of normal flora so that reliable specimens can be obtained.

The statement of Thomas and Hare that Group I anaerobic cocci may be the most common potential pathogens is based upon a study in which the majority of specimens were from patients with puerperal fever.[32] The experience with anaerobic cocci isolated in pure culture from patients at this hospital (liver abscess, necrotizing pneumonia and empyema,[10] and subacute bacterial endocarditis) indicates that Group VIa also is a significant pathogen.

Treatment

The treatment of solitary pyogenic liver abscesses includes 1) adequate surgical drainage and 2) appropriate antibiotic therapy.

Since amebic abscess often cannot be ruled out clinically, it is desirable to obtain a sample of pus by needle aspiration before undertaking operation. It is essential that the needle used for this procedure be large enough (#15 to #17 gauge) to aspirate thick pus, and long enough (5 to 7 inches) to reach deeply located abscesses. Open surgical drainage should then be accomplished by the shortest, most direct route. If possible, contamination of the pleural and peritoneal cavities should be avoided.

Solitary pyogenic liver abscesses occur much more frequently in the right than in the left lobe and are commonly found either superiorly or laterally.[19, 26] Ochsner stated almost thirty years ago that the safest and most direct approach for surgical drainage was posteriorly through the bed of the 12th rib.[19] In the past, difficulty in establishing the diagnosis of the exact location of a liver abscess led to laparotomy as the most frequent procedure. Liver photoscanning effectively resolves both of these problems in most cases and should afford better utilization of posterior drainage.

It is noteworthy that one of our patients had had a recent abdominal operation at which time the abscess was not found. Block *et al.*[3] report a similar event in one of their patients and point out that an abscess high in the right lobe of the liver may easily be missed at laparotomy. They also note that their patients who had other types of drainage operations ultimately required a flank operation as a second or third procedure before achieving good drainage.

In both our patients the Ochsner approach was used. Incision is made over the 12th rib, and the rib is removed subperiosteally. A transverse incision is then made through the rib bed below the level of the first lumbar spine to avoid entering the pleural space. The suprahepatic area is entered, and the liver is examined for bulging or softening at the site of the abscess. Suspicious areas are aspirated with a large needle and when pus is obtained, the abscess is incised. If palpation of the abscess cavity reveals any loculations, these are broken. Drains are placed into the abscess and brought out through the incision which is loosely closed. We have usually used sump drains which can be placed on suction for several days. These are gradually replaced by smaller catheters as the abscess closes in. Progress of resolution of the abscess can be evaluated by liver scan and by sinograms made by injection of water-soluble radio-opaque media into the catheters.

McFadzean advocated needle aspiration as the only drainage procedure for pyogenic as well as amebic abscesses.[15] Because of the frequency of multiloculated abscesses, this method is less satisfactory

than open drainage. In areas where surgical facilities are substandard, however, needle aspiration may be the drainage procedure of choice.

When an exact or presumptive bacteriologic diagnosis can be made by blood cultures, by demonstration of a likely primary source of infection, or by gram stain and culture of material from needle aspiration, the selection of an appropriate antibiotic is not difficult. Foul or putrid-smelling pus is a definite indication that anaerobic organisms are present. Although such material is often referred to as "*E. coli* pus," Altemeier showed conclusively that the odor is due to anaerobes.[1] Failure to isolate organisms on routine culture of pus suggests the presence of organisms which are difficult to cultivate. This would include anaerobes as well as amoebae, fungi and *M. tuberculosis.* Demonstration of gram-positive cocci on smear of the pus, with sterile cultures, indicates the presence of anaerobic cocci.

In cases of *cryptogenic* liver abscess in which bacteriologic studies are negative, the choice of antibiotic(s) must be based upon knowledge of the relative incidence of infection by various organisms and upon recognition that mixed infections are frequent. While *Escherichia coli* and *Staphylococcus aureus* are most frequently isolated, Sherman and Robbins note a significant increase in the isolation of *Proteus,* Klebsiella-Aerobacter, *Streptococcus fecalis* and *Pseudomonas* since the introduction of antibiotic agents.[27] As indicated above, anaerobic organisms may occur more often than has been previously recognized. Chloramphenicol and tetracycline are generally effective against the most commonly encountered aerobic and anaerobic organisms.

In infections due to anaerobic streptococci, aqueous crystalline benzyl penicillin (penicillin G) in a minimum dose of two million units daily is clearly the drug of choice. The other penicillins and the cephalosporins are less active. Erythromycin (2.0 Gm./day p.o.), chloramphenicol (2.0 Gm./day p.o.), lincomycin (2.0–4.0 Gm./day p.o.), and tetracycline (0.5 Gm. q. 8–12 h. I.V. or 2.0 Gm./day p.o.) are satisfactory alternatives in penicillin-allergic patients. Although a small percentage of strains are resistant to tetracycline *in vitro,* excellent clinical response to this drug may be observed as in our Case 2. This is probably due to the high concentration of tetracycline in liver tissue and bile.

Summary

Two cases of liver abscess due to microaerophilic streptococci are described, and 15 cases from the literature are reviewed. The true incidence of anaerobic organisms and anaerobic cocci specifically in cases of liver abscess is unknown because adequate anaerobic cultures often are not done. An important, frequently overlooked indication of anaerobic infection is putrid or foul-smelling purulent exudate.

Liver photoscanning proved to be the most useful procedure leading to a diagnosis in our cases, and was very helpful in planning the surgical approach. The primary treatment of pyogenic liver abscess is surgical drainage, and this is best accomplished with the posterior approach in 80% of the cases. Antibiotic therapy for liver abscess in general and for infections due to anaerobic cocci is discussed.

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