THE DIAGNOSTIC VALUE OF ANTERIOR CHAMBER PARACENTESIS IN 14 CASES OF POSTOPERATIVE ENDOPHTHALMITIS*

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THE OPHTHALMOLOGIST NEEDS very much to know whether or not a postoperative endophthalmitis is being caused by a microorganism, and if so by what microorganism. A sample from the wound edge may or may not contain the organism that has entered the eye. Culture of the aqueous from an anterior chamber paracentesis would seem to be the best way to capture the pathogen. But ophthalmologists are reluctant to insert a needle into an inflammed, recently operated eye unless there is a reasonable chance that some decision-making information can be obtained.

Since no report of a study of the anterior chamber tap as a diagnostic procedure in postoperative endophthalmitis could be found in the literature, we undertook the following retrospective study.

MATERIALS AND METHODS

All of the records of the ocular microbiology laboratory of the Francis I. Proctor Foundation for Research in Ophthalmology, from the time of the Foundation's establishment in 1947 through May 1969, were reviewed, and the information on all aqueous paracenteses was extracted. In these 22 years, specimens from more than 20,000 patients were processed. The overwhelming majority of specimens were lid-margin and conjunctival scrapings that were subjected to direct cytologic examination and to cultivation attempts on various media. Only 115 were specimens of aqueous, and of these only 14 were from

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patients with clear-cut postoperative endophthalmitis. These 14 cases are the subject of this study; the remaining 101 are discussed briefly but were of subsidiary interest only.

The 115 cases could be defined as cases in which anterior chamber paracentesis (and occasionally also vitreous paracentesis) was performed on living eyes for diagnostic purposes. Eliminated from consideration were data on aqueous obtained from enucleated eyes. No attempt was made to determine the over-all incidence of postoperative endophthalmitis at the University of California in this period or the total number of aqueous taps performed.

A search was made for the hospital records of all 14 cases diagnosed in the microbiology log-book as "postoperative endophthalmitis." The search was successful in all but three cases: Cases v, vii, and xiii. In these our information was derived from the microbiology records alone.

The individual aqueous samples ranged in quantity from two drops to about 0.2 cc. The samples were obtained from various surgeons under a variety of clinical conditions, but when received in the laboratory they were usually in the original syringe and had been delivered by messenger directly from the operating room or clinic. In all instances, the samples were received within four hours of the surgical procedure.

The laboratory routine was as follows: As soon as the sample was received, one drop of uncentrifuged aqueous was placed on a slide and stained with Giemsa's stain. If bacteria were suspected, a second preparation was stained with Gram's stain. The remaining aqueous was plated on sheep-blood agar and thioglycolate semiliquid medium. If a fungus was suspected, and if the quantity of aqueous permitted, a drop was also placed on Sabouraud's agar.

Variations from this procedure were dictated by clinical indications and the volume of aqueous available for examination. When the volume was limited, for example, several cytologic examinations were made in preference to culture study if the diagnosis was "chronic uveitis"; but in patients with postoperative endophthalmitis and other suspected bacterial infections, culture study received priority after the preparation of the initial smear. In all cases, cultures were considered contaminated if the organism grew on only one medium or if all colonies were located outside the area of inoculation.

The microbiological records were uniformily well kept, and the two men responsible for them were available to answer questions. Dr Phillips Thygeson has been director of the laboratory since its establishment in 1947, and Mr Masao Okumoto has been its micro-

biologist since 1951. The importance of the excellence of the management of this laboratory to the validity of its records, and thus to this study, cannot be emphasized too strongly.

CLASSIFICATION OF CASES

Four our purposes, the 115 patients from whom aqueous specimens had been taken were divided into Groups A, B, and C (Table 1). Assignment to a group was determined by the original clinical diagnosis as given in the laboratory records or on the patient's chart, without regard to the results of subsequent cytologic examination or cultivation attempt.

TABLE 1. CLASSIFICATION OF 115 CASES SUBJECTED TO ANTERIOR CHAMBER PARACENTESIS FOR DIAGNOSTIC PURPOSES

Group	Diagnosis	No. of cases
A	Postoperative endophthalmitis	14
B	Endophthalmitis, not postoperative	10
C	Other inflammations (uveitis, etc.)	91
		115

Group A

Fourteen patients had been diagnosed clinically as postoperative endophthalmitis, or in such equivalent terms as "postoperative infection," "infection following cataract extraction," etc.

Group B

Ten patients had been diagnosed clinically as endophthalmitis related to trauma, foreign body, parasites, or infection not attributable to any surgical procedure. One patient (Case x), from whom a foreign body was removed at surgery, was placed in Group B because the endophthalmitis could not be attributed wholly to the surgery. Endophthalmitis developed in a second patient in this group (Case VIII) three years after a filtering procedure on the same eye. At the time of diagnosis, the infecting organism's apparent route of entry was the filtering bleb. Although this patient's endophthalmitis was probably a consequence of surgery, he was not included in Group A because of the three-year interval, which was regarded as disqualifying him as a case of strictly postoperative endophthalmitis.

Group C

Ninety-one patients were not included in Groups A or B. Their clinical diagnoses included chornic granulomatous uveitis, acute uveitis, her-

petic uveitis, Vogt-Koyanagi syndrome, Behçet's syndrome, Harada's disease, phacolytic reaction, heterochromic iritis, panuveitis, and anterior uveitis.

RESULTS

Group A

Of the aqueous cultures prepared from the 14 patients in Group A, five (roughly one-third) were positive. None was thought to be contaminated. *Staphylococcus aureus* was cultivated from three (Table 2: Cases IX, XI, XIV) paracolon bacillus (*Paracolobactrum sp.*) from one (Case II), and *Bacillus subtilis* from one (Case XII).

In all five of the culture-positive cases, direct smear examination showed the cellular response to be predominantly polymorphonuclear. Smear examination of the nine culture-negative cases revealed the following: Gram positive cocci and a predominance of polymorphonuclear cells but no bacteria in three (Cases V, VIII, XIII); and only amorphous debris in one case (Case III). In the four remaining culture-negative cases (IV, VI, VII, X), monocytes predominated but there were no bacteria. Thus, in all cases in which bacteria were found in culture or smear, the response was polymorphonuclear.

Summaries of the available case histories of the patients in Group A follow.

Case I This 78-year-old woman entered the hospital for discission of a membrane secondary to an extracapsular cataract extraction performed one year previously. Discission was performed uneventfully and the patient was discharged on the second postoperative day. A month later she complained of a red, painful eye. The clinical diagnosis was postoperative endophthalmitis, and an anterior chamber tap was performed. The smear contained many cocci resembling staphylococci, a few polymorphonuclear cells, and an occasional rod-shaped bacterium. The culture was sterile. No further details of the history of this case were available.

Case II This 65-year-old man was admitted to the hospital because of progressive decrease in vision in the left eye over several years. Routine extracapsular cataract extraction, left eye, was performed the next day. Preoperative cultures one week before surgery had shown gram-negative rods in material from the right lid and *Staphylococcus albus* in material from the left lid and both conjunctivas.

For the first three postoperative days, the eye showed a normal amount of inflammation, but on the fourth day hypopyon developed. Treatment with oral Chloromycetin and sulfadiazine was begun immediately. On the fifth postoperative day, an anterior chamber tap was performed at the site of the flap. A smear of aqueous showed red blood cells and polymorpho-

TABLE 2. GROUP A: POSTOPERATIVE ENDOPHTHALMITIS (14 CASES)

Case no.	Year	Age	Sex	Operation	Systemic antibiotics (pre-tap)	Postoperative tap (day)	Culture	Smear examination*	Predominant cells†	Visual outcome
I	1954	78	F	Discission of secondary membrane		38	0	+	P	
II	1954	65	M	Intracapsular cataract extr.	Yes–1 day	5	Paracolon bacillus	0	P	20/30
III	1959	55	M	Cataract extr. intentionally extracapsular	No	2	0	0	Debris	hand motions at 6 ft
IV	1960	66	F	Cataract extr. intentionally extracapsular	Yes–2 days	23	0	0	M	finger counting at 2 ft without correction
V	1960	59	M	Retinal reattachment			0	0	P	
VI	1960	45	M	Intracapsular cataract extr.	Yes–11 days	22	0	0	M	20/30
VII	1960		F				0	0	M	
VIII	1960	37	F	Cataract extr. unintentionally extracapsular	No	3	0	0	P	
IX	1961	60	M	Intracapsular cataract extr.	Yes–2 days	5	*S. aureus*	+	P	20/80
X	1962	65	M	Cyclodialysis	Yes–7 days	87	0	0	M	finger counting at 2 ft
XI	1963	67	F	Intracapsular cataract extr.	No	9	*S. aureus*	+	P	20/15
XII	1966	16	F	Discission of cataract	No	2	*B. subtilis*	+	P	Enucleation
XIII	1967	60	M	Intracapsular cataract extr.		2	0	0	P	
XIV	1967	20	M	Cataract extr. intentionally extracapsular	Yes–14 days	17	*S. aureus*	+	P	20/30

*+ = bacteria seen. 0 = no bacteria seen.
†P = polymorphonuclear cells. M = mononuclear cells.

nuclear cells but no organisms. The culture grew several colonies of paracolon bacillus. On the seventh day, paracolon bacilli were again recovered in cultures. The patient was taken immediately to the operating room where the anterior chamber was irrigated thoroughly with a solution of polymyxin B (10,000 units/cc). The flap was not resutured. The eye improved and the patient was discharged on the twentieth postoperative day. Eleven months later the eye's corrected visual acuity was 20/30. This compared favorably with the unoperated eye's acuity of 20/70.

Case III This 55-year-old man's vision in his left eye had been decreasing for five years and was reduced to hand motions by virtue of a dense, mature, senile cataract. The vision in the right eye was 20/20. Seven days before surgery, *Staphylococcus albus* was recovered from the right lids and conjunctiva; several colonies of alpha hemolytic streptococci were recovered from the left lids; and a few diphtheroids were recovered from the left conjunctiva. An extracapsular cataract extraction was performed.

On the second postoperative day, the eye became unusually inflamed. Bacterial endophthalmitis was suspected. Material for culture was taken from the conjunctival flap just prior to an anterior chamber paracentesis. After removal of aqueous, the anterior chamber was irrigated with a solution of penicillin, and penicillin was injected subconjunctivally. Treatment with chloramphenicol and erythromycin was begun. The conjunctival and aqueous cultures were sterile. Cytologic examination of aqueous material showed only amorphous debris. The eye healed with a secondary membrane. When last seen, seven months after cataract extraction, the patient was awaiting discission of the secondary membrane. His vision was 20/20 for the right eye, and hand motions at six feet for the left eye.

Case IV This 66-year-old woman reported that her vision had been failing in both eyes for six months. On hospital admission her vision was 20/100 in each eye, and cortical cataracts were in evidence. An intentional extracapsular cataract extraction was performed on the right eye. About two weeks after surgery, the eye became sore. Three weeks after surgery, the eye was inflamed and there were keratic precipitates and hypopyon. A lens reaction was suspected, but bacterial endophthalmitis could not be excluded. Treatment with systemic penicillin and streptomycin was begun on the twenty-first postoperative day. An anterior chamber tap was performed two days later. This showed a few monocytes, eosinophils, and pigment granules, but no organisms. The culture was sterile. It was concluded from these results that the endophthalmitis was not bacterial in origin.

On Day 25 an anterior chamber irrigation to remove remaining cortex was performed. At the same time a piece of iris was removed to convert the peripheral iridectomy to a full iridectomy. When examined histologically, the iris tissue showed macrophages, lens material, no polymorpho-

nuclear cells, and no eosinophils. The inflammatory reaction subsided. Three months after cataract extraction, a cyclodialysis for glaucoma in the right eye was performed without complication. Before this procedure, the visual acuity without correction was finger counting at two feet in the right eye and 20/100 in the left.

Case v Hospital record not available.

Case vi This 46-year-old man was admitted for extraction of a secondary cataract, right eye. The patient had been treated for 16 years for extensive rheumatoid spondylitis and associated uveitis. When admitted for cataract surgery, he was malnourished but otherwise in no acute distress. An uneventful intracapsular cataract extraction was performed, and the patient was discharged in good condition.

On the eleventh postoperative day, he was readmitted with a painful, acutely inflamed eye. An organismal endophthalmitis was suspected, but a flare-up of the old uveitis could not be ruled out. He was treated immediately with Chloromycetin, penicillin, streptomycin, and prednisone. Neosporin and Chloromycetin drops were also frequently instilled into the eye. On this regimen the eye failed to improve. Systemic antibiotics were discontinued on the twenty-first postoperative day, and depot corticosteroids were injected beneath Tenon's capsule. On Day 22 an anterior chamber tap was performed. Only a few mononuclear cells were seen in the aqueous smear. The culture was sterile. The fact that only a few monocytes, no polymorphonuclear cells, and no bacteria were found suggested that the alternative diagnosis of acute uveitis was correct. The patient improved and was discharged four days later. His visual acuity was not recorded and he did not return for further examination.

Case vii Hospital record not available.

Case viii This 37-year-old female was admitted for extraction of a cataract secondary to uveitis. Two days after admission a cataract extraction, unintentionally extracapsular, was performed. During the first two postoperative days, the operated eye became progressively more painful and inflamed. On the third day an anterior chamber tap was performed, and treatment with penicillin and Chloromycetin was begun immediately. The smear showed polymorphonuclear cells and pigment granules, but no organisms. The cultures were sterile. The antibiotic regimen was continued and the eye improved. The patient's white blood cell count, however, continued to be elevated at about 18,000 cells/cc. On the eighth postoperative day, inferior iridectomy was performed for pupillary block with iris bombé. The eye improved further and the white blood cell count decreased. The patient improved and was discharged on the nineteenth postoperative day. The visual acuity was not recorded and the patient did not return for further examination.

Case IX This 60-year-old chronic alcoholic had senile cataracts that had reduced the vision in his right eye to 20/100 and that in his left eye to light perception with projection. An intracapsular cataract extraction was performed on the left eye with difficulty as the lens was large and swollen. On the fifth postoperative day, an hypopyon and severe anterior chamber reaction developed. Treatment with penicillin and chloramphenicol was begun. On the seventh postoperative day, an anterior chamber tap was performed. The aqueous culture grew several colonies of coagulase-positive *Staphylococcus aureus*. Direct examination of an aqueous smear showed a few budded yeast forms and polymorphonuclear cells. Cultures of lid-margin material taken at the time of the anterior chamber tap grew a few colonies of *Staphylococcus aureus*. Cultures of material from the wound edge were sterile. The yeast forms in the smear suggested that the patient had monilial as well as staphylococcal endophthalmitis. He was treated with amphotericin B topically and systemically. Eventually the eye healed, but secondary glaucoma requiring cyclodialysis developed five weeks after cataract surgery. The cyclodialysis opening closed, and discission of the inflammatory membrane was performed one year after cataract surgery.

Shortly after the discission on the left eye, a cataract extraction was performed on the right eye without complication. Five years after the first cataract extraction (on the left eye), the corrected vision was 20/40 J2 in the right eye, and 20/80 J2 in the left eye.

Case X This 65-year-old man was admitted for treatment of glaucoma and secondary bullous keratopathy. He had had cataract extractions five and nine years prior to admission. Four years prior to admission bullous keratopathy associated with Fuch's dystrophy had developed in the right eye. The same condition developed in the left eye within a year. Two years before admission a conjunctival flap was performed on the right eye; and one year before admission (in addition to the bullous keratopathy), vitreous was seen adhering to the old wound site in the left eye. A penetrating keratoplasty was performed on the left eye and the adherent vitreous was removed.

When the patient was readmitted for treatment of his glaucoma and keratopathy because of the failure of medical treatment, a cyclodialysis, a synecheolysis, and a full iridectomy were performed on the left eye. Attempts to reform the anterior chamber were unsuccessful. The patient was discharged in fair condition but was readmitted two and a half months later with "probably septic endophthalmitis secondary to cyclodialysis." He was treated immediately with penicillin. On the fourth day of therapy an aqueous tap was performed. Examination of a smear of the aqueous revealed mononuclear cells only. The culture was sterile. It was concluded from these findings that the endophthalmitis was probably not organismal. The patient was discharged several days later and was reexamined periodically in the clinic for three months. During this period

the flap on the right eye was cloudy and the vision was finger counting at two feet in both eyes.

Both eyes continued to fail as a result of endothelial dystrophy. Three years after the onset of endophthalmitis in the left eye, the vision in that eye was light perception. The vision in the right eye was hand motions at two feet.

Case XI This 67-year-old woman had an uneventful cataract extraction at another hospital eight days prior to her admission to the University of California Hospital. She was referred for diagnosis and treatment of a possible postoperative endophthalmitis. Her physician had seen a faint aqueous flare, slight clouding of the anterior vitreous, and chemosis of the lower conjunctiva. The patient also had a dull ache in the region of the left temple.

Immediately after admission, a diagnostic anterior chamber tap was performed. Smear examination revealed gram-positive diplococci, some in clusters but none in chains. Treatment with penicillin and streptomycin was begun immediately. On the following day, cultures revealed hemolytic, coagulase-positive *Staphylococcus aureus* that were found to be sensitive to penicillin and other antibiotics. Streptomycin was withdrawn from the treatment regimen, but in addition to penicillin the patient received topical Chloromycetin drops throughout her hospital stay. She responded to therapy, and on the day of discharge the left eye was moderately injected but there was no edema and the cornea was clear. Small abscesses on the vitreous face, which had been present at the time of admission, were gone. The vitreous remained slightly hazy. Five months after the cataract extraction, the corrected visual acuity in the left eye was 20/15 – 2.

Case XII This 16-year-old girl was born with what is presumed to have been retinoblastoma of the left eye. At 18 months of age the eye was enucleated. When she was 13 years old, retinoblastoma of the right eye was diagnosed and was treated with radiation for three years. This resulted in a "dry eye" and radiation cataract. On admission for cataract extraction, a satisfactory red reflex was obtained and the patient could count fingers at five inches. A discission and aspiration were performed without incident.

On the morning after surgery, the cornea was slightly hazy but there was no real abnormality. Later in the day the patient had a swollen conjunctiva, diffuse corneal infiltration with abscess formation, and an anterior chamber reaction. On the second postoperative day the cornea had become necrotic and an aqueous tap was performed. At the same time penicillin was instilled into the anterior chamber. Direct examination of the aqueous material revealed gram-positive rods resembling Bacillus organisms, many polymorphonuclear cells, and pigment granules. Immediately after surgery, antibiotic treatment was instituted: penicillin, Keflin, Chloromycetin, and Neosporin ointment topically. Cultures grew three colonies of *Bacillus*

subtilis. The infection was controlled within three days, but the corneal necrosis continued. Because of this necrosis and the persistent elevation of both temperature and white blood cell count, the antibiotic regimen was continued.

On the thirteenth day, the patient was taken again to surgery because of perforation and iris prolapse. The cornea was covered with a thin conjunctival flap brought up from the lower fornix. The postoperative course was uneventful, the wounds healed, and the flap was secure. The patient was discharged on the eighteenth postoperative day. About a month and a half after cataract extraction, phthisis bulbi developed and the right eye was enucleated. There was no evidence of tumor in the eye or socket.

Case XIII Hospital record not available.

Case XIV This 20-year-old male entered the hospital with active atopic eczema and atopic cateract. Cateract extraction (inadvertently extracapsular) was performed on one eye the next day. For several months before entering the hospital, the patient had been taking tetracycline by mouth for his dermatitis. The tetracycline was continued throughout his hospital stay.

The postoperative course was uneventful until haziness developed in the anterior chamber of the operated eye on the third postoperative day. On the night before surgical intervention, a "dirty" case had been operated on in the same operating room; and on the day the patient was operated on, his roommate had undergone an uneventful intracapsular cataract extraction, and haziness had also developed in the anterior chamber. Since endophthalmitis was suspected on the basis of these circumstances, intravenous therapy with penicillin, Chloromycetin, and sulfa was begun immediately. By the second postoperative week the eye had become more inflamed, painful, and chemotic. The anterior chamber was filled with yellowish material assumed to be pus. On the seventeenth postoperative day, an anterior chamber tap was performed on the affected right eye. The anterior chamber was irrigated at the same time and penicillin was instilled. Direct examination of aqueous material showed some polymorphonuclear cells, amorphous material, and coccoid bodies resembling staphylococci; no rods, fungi, or eosinophils were seen. The aqueous culture grew *Staphylococcus aureus* that was found to be penicillin-resistant. Methicillin was substituted for the previous antibiotic regimen, the eye slowly improved, and the patient was discharged with a visual acuity of 20/30 in the right eye.

Group B (10 patients)

In Group B (Table 3), bacteria were recovered from the aqueous in Case VIII. This patient had a mixed infection with *Bacillus subtilis*, alpha streptococcus, and *Staphylococcus aureus*. Although aqueous

TABLE 3. GROUP B: ENDOPHTHALMITIS, NOT POSTOPERATIVE (10 CASES)

Case no.	Year	Sex	Age	Clinical diagnosis	Culture	Bacteria seen in smears	Predominant cells*
I	1960	M		Metastatic endophthalmitis	Anerobic streptococcus†	+‡	P
II	1960	F	67	Diabetes and panophthalmitis	Anerobic streptococcus†	+‡	P
III	1961	M	3	Worm endophthalmitis	0	0	M E
IV	1963	F		Endophthalmitis	0	0	M
V	1964	M	47	Endophthalmitis and recurrent vitreous hemorrhage	*S. albus*	0	P
VI	1964	M		Endophthalmitis after corneal laceration	0	0	P M
VII	1965		40	Panophthalmitis	0	0	P
VIII	1967	F	57	Endophthalmitis after filtering procedure	Streptococcus *S. aureus*	0	P
IX	1968	M		Endophthalmitis after chickenwire injury	*S. aureus*	0	P
X	1969	M	37	Endophthalmitis after steel foreign body	0	0	P

*P = polymorphonuclear leucocyte. M = mononuclear leucocyte. E = eosinophil.
†Grown from vitreous; aqueous material sterile.
‡Grown from vitreous; no bacteria seen in aqueous material.

cultures were sterile in the other cases, cultures of vitreous were positive in four (Cases I, II, V, IX). The charts of the patients in Group B were not analyzed exhaustively since this group was not the focus of our interest in this study. However, we did note that the affected eyes in Cases II, V, VIII, and IX were eventually enucleated. The visual acuity of Case III, Group B, was light perception after three years, and the eye continued to be inflamed as a result of what was presumed to be a worm endophthalmitis.

Group C

Information on Group C is summarized in Table 4. Aqueous from 47 of 91 patients was cultured. Although bacteria were recovered from 5 of the 47, the recovery was attributed to contamination in four. Diphtheroids grew on one plate, *Staphylococcus albus* on two others, and *Stapylococcus aureus* on the fourth. In all four cases, growth consisted of one or two colonies on sheep-blood agar only; the thioglycolate and Sabouraud's agar plates were negative. In all four cases the colony growth was located outside the area of inoculation on the plate.

TABLE 4. GROUP C: OTHER INFLAMMATIONS (UVEITIS, ETC.) (91 CASES)

	Total no. cases	Positive for bacteria	Contaminated*	Mononuclear cell (M)	Polymorphonuclear cell (P)	M & P	No cells
Cultures	47	1 (Listeria)	4				
Smears	88	1 (Listeria)		50	25	4	9

*2 *S. albus*, 1 *S. aureus*, 1 diphtheroid.

Only the one remaining positive culture yielded diagnostically significant information. The patient had had an acute iritis of unknown etiology for ten days. Diagnostic anterior chamber paracentesis was performed when the eye failed to respond to treatment with prednisone and acetazolamide. *Listeria monocytogenes* was recognized by direct examination of the stained aqueous smear and by its cultural growth. The cellular response was predominantly polymorphonuclear. This case has been presented and discussed elsewhere.[1]

The small number of cases yielding bacteria in either slides (1 per cent or cultures (2 per cent) of the aqueous obtained from this group of patients is not surprising since none of them had been diagnosed as cases of bacterial endophthalmitis.

Of the 91 patients in Group C, smears of the aqueous were pre-

pared for direct examination in 88. Of these, 50 showed a predominantly mononuclear or lymphocytic reaction; 25 showed predominantly polymorphonuclear cells; 4 showed an approximately equal number of polymorphonuclear and mononuclear cells; and on 9 slides no cells at all were seen. By rough estimation (of those cases in which the acuteness or chronicity of the process was suggested by the diagnosis), there seemed to be little correlation between the clinical diagnosis and the cellular response. The only exception was hypopyon, which correlated positively with the presence of polymorphonuclear cells.

Discussion

Anterior chamber paracentesis can be a useful tool in the etiologic diagnosis of postoperative endophthalmitis. In our series of 14 cases, bacteria were recovered by culture from five, or about one-third of the specimens; and in one additional case, bacteria were seen in an aqueous smear. *Staphylococcus aureus* was recovered most commonly. Although a tap should be performed before antibiotic therapy is begun, in two of our cases (Group A, Cases II and XIV) organisms were recovered after antibiotics had been started.

It is unlikely that all 14 cases had *bacterial endophthalmitis.* In Cases IV, VI, VII, and X of Group A, the cellular response was mononuclear, not polymorphonuclear, and it is unusual to have a mononuclear response to a bacterial infection. In our entire series, moreover, no bacteria were recovered in cultures or seen in smears from cases with a mononuclear cell response, whereas in all 11 cases from which organisms were recovered from inside the eye (aqueous or vitreous) the response was polymorphonuclear.

We agree with Burns[2] that patients with "weak tissue" have more postoperative endophthalmitis than patients with healthy tissue. Cases I, VI, X, XII, and XIV of Group A, or nearly one-half, might be said to have had "weak tissue."

We also agree with Allen and Mangiaracene[3] that extracapsular cataract extraction seems to have a higher incidence of endophthalmitis than intracapsular extraction. Four of our cases had extracapsular extractions (Cases III, IV, VIII, XIV, Group A). It may be, however, that some of these were reactions to lens material and not organismal endophthalmitis. Case IV in Group A may reflect such a reaction.

In several large series in which the bacterial causes of postoperative endophthalmitis have been reported, the bacterium has not been

recovered from inside the eye. Both Allen and Mangiaracene[3] and Burns[2] have stated in personal communications to one of us that culture material in their series was usually taken from the wound edge or conjunctiva. Unfortunately, Locatcher-Khorazo and Gutierrez[4] and Dunnington and Locatcher-Khorazo[5] did not state whether their figures on organisms causing endophthalmitis were based on cultures from outside or inside the eye. There is no information available as to whether or not an organism causing endophthalmitis will also be found on the wound edge. At the completion of surgery, the wound edge frequently yields bacteria, although the eyes then pursue a normal postoperative course.[6,7]

Many ophthalmologists feel that the anterior chamber tap fails to yield useful information. This opinion derives at least in part from the results of taps reported in the literature. We hasten to point out, however, that the studies published so far have all been aimed at evaluating uveitis. Any cases of postoperative endophthalmitis that have come under consideration have been included only incidentally.

Perhaps the largest and most comprehensive study of human aqueous obtained by diagnostic paracentesis was conducted by Verrey in 1957.[8] In over 2,000 cases, bacterial cultures were found to be positive in about 4 per cent of cases after contaminated specimens were eliminated. Direct bacteriologic examination of the aqueous in the same series yielded positive results in about 20 per cent of cases. Most of the bacteria were intracellular. The results of the cytological examinations have not been duplicated.

Von Sallmann et al.,[9] in a series of 88 patients (103 taps) with various forms of uveitis, obtained positive bacteriologic cultures in four cases. Two of the cultures were probably contaminated. Of those not contaminated, one positive culture was obtained from the aqueous of a patient who contracted endophthalmitis three months after extracapsular cataract extraction. The organism was *Staphylococcus aureus*, coagulase-positive and mannitol-negative. Smears of the centrifuged aqueous from this case also contained free and phagocytosed gram-positive cocci. Of the 103 slide preparations in the series, this was the only one positive for bacteria. The second positive aqueous culture was from a case of endogenous purulent iridocyclitis in which the organism was identified as *Aerobacter aerogenes*. The slide in this case was bacteriologically negative.

In a series of 22 patients with clinical uveitis, Murray[10] was unable to identify a single microorganism in aqueous material examined directly or cultured. Nor was there any correlation between the

clinical picture and the cellular count or morphology as seen in aqueous smears. The single postoperative case in this group was a case of low-grade uveitis that appeared one year after cataract extraction.

Berens and his co-workers[11] cultured the aqueous of 33 patients, 27 of them with uveitis and 6 with other eye diseases. These cultures failed to yield bacterial growth in any case. Whether or not any postoperative cases were included coincidentally in this series was not clear from the text. No cytological studies were undertaken.

Irvine et al.[12] studied a series of aqueous paracenteses on 43 patients with uveitis. The aqueous was not subjected to bacterial culture or smear identification, however, and cellular studies were diagnostically inconclusive. A single postoperative case was included, but it was not a case of true postoperative endophthalmitis.

Bacteriologic examination of 14 enucleated "uveitis eyes" was made by Brown[13] and the findings were negatlve in all 14. No postoperative cases were included.

Offret and Saraux[14] studied the aqueous from 113 patients (126 taps) with a variety of eye diseases. The patients were grouped according to clinical diagnosis, and aqueous from each patient was subjected to bacteriologic and cytologic study. Except for cases with hypopyon ulcers, corneal diseases, and foreign bodies, the subjects of this study were uveitis patients of various types. In one group of six patients with iridocyclitis following extracapsular extraction, staphylococci were cultivated from the aqueous of three, but in one of these the organisms were attributed to contamination. From centrifuged specimens of the aqueous of other, non-postoperative patients in the study, staphylococci were recovered on two occasions, and both staphylococci and diplococci on a third. No information of value was deduced from the cellular counts.

It is clear from these studies taken collectively that cytologic examination of the aqueous has very little diagnostic value in uveitis. Nor do cellular counts correlate significantly with any disease parameter.[10,12,13] Although a variety of cells in varying numbers may be found in the aqueous in uveitis,[15] the significance of the cellular response is not understood.

Determination of the predominant cell type may be of some help in differentiating a postoperative uveitis from a postoperative bacterial infection (see Case IV, Group A). In our series, only smears with a predominance of polymorphonuclear cells were associated with recovery of bacteria. However, strictly bacteriologic tests yield more etiologic information than cytologic examination.

Reluctance to make an anterior chamber tap in postoperative endophthalmitis stems not only from failure to appreciate what can be learned from the procedure but from fear of further complicating an already complicated case. This can only be regarded as a personal feeling, however, since no one has published information on the frequency with which complications may follow anterior chamber tap in endophthalmitis. Several pieces of evidence on the complication rate of aqueous taps in general are available, however. Von Sallmann et al.[9] in their series of 103 taps had five complications. In two instances, hemorrhage into the anterior chamber occurred, one filling the chamber half-full of blood and the other filling it two-thirds full. Small hyphemas formed in two other patients. The absorption of blood was rapid and without sequelae. In a fifth case, the aspiration of aqueous was followed by a steep rise in intraocular tension, which lasted two days.

Theodore[16] has performed many paracenteses and has stated repeatedly that "it is more conservative to do a tap in postoperative endophthalmitis than not to do one."

In our study, most of the taps in Group C, and several in Groups A and B, were performed by one of us (SJK). It is our opinion too that the information to be gained from the procedure far outweighs the risk it entails.

The number of operated eyes that develop postoperative endophthalmitis each year is substantial. If we assume the incidence to be about 2/1000 (Table 5), and if we make a calculation based on the nearly 400,000 cataract extractions performed in the United States each year, we find that we have annually some 800 cases of postcataract extraction endophthalmitis alone. By rough estimate, cataract

TABLE 5. INCIDENCE OF POSTOPERATIVE INFECTIONS IN 8 SERIES OF CASES

Author	Year reported	Operations	Infections	Rate/1,000
Allen & Mangiaracene[3]	1964	20,000	22	1.1
Burns[2]	1959	8,038	11	1.4
Callahan[17]	1953	1,653	5	3.0
Locatcher-Khorazo & Gutierrez[4]	1956	7,662	6	0.8
Luke[18]	1960	2,300	12	5.1
Mullen[19]	1951	4,000	6	1.5
Neveu & Elliot[20]	1959	1,047	7	7.0
Pearlman[21]	1956	6,201	13	2.1
Total		50,901	82	1.6*

*Rate/1,000 in total of 8 series (82/50,901 cases).

TABLE 6. PROGNOSIS OF POSTOPERATIVE ENDOPHTHALMITIS IN 12 SERIES OF CASES

Author	Year of report	Number of cases	Eye enucleated or eviscerated	Eye saved without useful vision	Eye saved with useful vision*	Vision lost
Allen & Mangiaracene[3]	1964	22	10	8	4	18/22
Burns[2]	1959	11	5	3	3	8/11
Neveu & Elliot[20]	1958	8	2	5	1	7/8
8 other authors[17,22–28]	1946–53	18	5	5	8	10/18
Theodore et al.[29]	1961	8	2	4	2	6/8
Total		67	24	25	18	49/67 (more than 2/3)

*Counts fingers at two feet, or better.

extractions make up about 70 per cent of all ocular procedures performed on hospitalized patients; muscle corrections, about 20 per cent; operations on the retina, about 5 per cent; and corneal transplantation, about 0.4 per cent. Thus, there may be about 1,100 cases of postoperative endophthalmitis per year.

These figures may in fact be too low since the occurrence of postoperative endophthalmitis is not carefully recorded in most university or community hospitals. This is a natural consequence of the fact that the entity is not well defined and is particularly unwelcome to the surgeon. Then again, 1,100 cases of bacterial endophthalmitis per year may be too high. An unknown number in all the published series, including our own, are probably non-bacterial endophthalmitis.

Certainly the final outcome of clinically diagnosed postoperative endophthalmitis needs to be improved. In 67 cases reported by a total of 12 authors (Table 6), the final visual acuity was given. In 24 cases, the eye was enucleated or eviscerated; in 25, it was saved but without useful vision; and in only 18, it was saved with useful vision. In these 67 cases, then, the vision was lost in 49, or in more than two-thirds of the eyes. We would hope that with earlier and more accurate etiologic diagnosis, this loss might be reduced.

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DISCUSSION

DR HENRY F. ALLEN. This excellent retrospective study of 14 cases shows the value of two things – examination of the anterior chamber contents and careful record keeping. Both are essential to establishing the diagnosis of postoperative endophthalmitis and the etiologic spectrum of exogenous infection at the time of intraocular surgery.

When acute inflammation appears in an eye shortly after trauma or intraocular surgery, the most important question to be answered is whether the clinical appearances are due to bacterial or fungal infection or to

non-specific causes. The only way this question can be definitely resolved is by aspiration, examination, and cultivation of the intraocular fluids.

Certain technical considerations may influence the results. The possibility of contamination of the specimen is one. It is unlikely that with careful technique the needle or the inside of the syringe could become contaminated during the taking of the specimen, unless frank pus were bathing the surface of the cornea, a condition under which the chamber should not be entered at all. Thus, it should be possible to exclude false positives with careful technique.

The possibility of false negatives cannot be disregarded. In Case I the authors observed "many cocci resembling staphylococci," yet the culture was sterile. Two possible explanations are that either the blood agar plate or the thioglycolate medium failed to grow these presumptive bacteria. In our experience false negatives on both these media are common. We recommend freshly prepared, non-lyophilized beef heart infusion broth as the most sensitive medium for isolation of organisms present in scanty inocula.

The positive results obtained by the authors confirm the importance of *Staphylococcus aureus* as a cause of postoperative endophthalmitis. Of interest is the successful treatment of Cases XI and XIV with antibiotics. Recovery in Case II, after infection with a paracolon bacillus, is also noteworthy. These cases could not have been positively identified as of bacterial origin without anterior chamber aspiration.

Our experience with aspiration of aqueous after cataract extraction is neither as large nor as well documented as that of the authors. However, we are convinced of the value of the procedure and have used it many times. One of our more interesting positive results was the isolation of *Staphylococcus albus*, coagulase-negative, from the aqueous of a patient four days after cataract extraction. This organism would surely have been considered to be a contaminant if it had not been seen in smears and identified in cultures of the anterior chamber contents.

As many ophthalmologists have learned by personal experience, aseptic uveitis can mimic bacterial endophthalmitis after cataract extraction. Symptoms and signs of both may include pain, hypopyon, and cloudy vitreous. Corneal edema, chemosis, and rapidly diminishing light sense are more likely to portend pyogenic endophthalmitis, but differential diagnosis is difficult on a clinical basis alone.

Ophthalmologists who encounter these disturbing inflammatory phenomena after surgery would do well to consider smears and cultures of the aqueous, employing the best fluid medium they can obtain from their hospital-based or community microbiologist. A positive culture and sensitivity spectrum can be the indication and the guide for specific antibiotic therapy, whereas a negative or mononuclear cytology suggests the need for an intensive anti-inflammatory regimen.

We, therefore, concur with the authors in their thesis and commend

them on their results. A prospective study employing freshly prepared media from naturally occurring substrates should be undertaken to extend and amplify their observations.

DR PHILIP M. LEWIS. I would like to ask the essayists if they have had any experience in tapping and examining the aqueous of metastatic endopthalmitis cases. When I was doing my thesis for this Society between 1930 and 1935, I had the opportunity of studying approximately 350 cases of meningococcal meningitis. A number of these developed metastatic endopthalmitis, and we did taps on several of these and were able to grow the meningococcus. At that time, having no antibiotics, many of these eyes came to enucleation. I would like to know if the authors have had any experience along that line.

DR MATHEA ALLANSMITH. As far as the proper media to use when culturing aqueous from a paracentesis is concerned, the best recommended by your hospital infectious control person is of course the media to use. However, if this person is not available, one should treat the aqueous fluid the same as one treats spinal fluid. Ask a pediatrician, for every pediatrician should know how to handle spinal fluid. All laboratories have enriched media in which to plant spinal fluid from taps for meningitis. This is very rich and will serve adequately as a media for aqueous.

We find thioglycolate an adequate liquid medium in which to grow the bacteria which might be present in an eye.

The low incidence of positive cultures is a problem. One should not put the aqueous material into a tube and send it to the laboratory. The few bacteria present in even the infected eyes will probably not survive the trip to the laboratory. The culture media for the aqueous should be present in the operating room. The aqueous should be planted in bacteriologic media at the operating table.

We had one case in which material taken at surgery was laden with macrophages. This was the case we thought had a reaction to lens material after an extracapsular cataract extraction.

In group B (with non-postoperative endopthalmitis) we had one case thought to be a metastatic endopthalmitis. The culture was negative.