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Improved Laboratory Efficiency and Diagnostic Accuracy with New Double-Lumen-Protected Swab for Endometrial Specimens

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Intrauterine specimens were obtained from 22 patients with endometritis and 24 control patients following cesarean section by using both a new protected swab and a standard anaerobic swab. The protected swab improved the value of the direct smear and Gram stain, resulted in fewer false-positive cultures, better defined endometrial flora in patients with endometritis, and permitted major savings in laboratory personnel time and materials.

Endometritis following cesarean section is a major cause of obstetrical morbidity and mortality. With the recent trend toward more liberal indications for cesarean section, endometritis is an increasing clinical problem. The microbial etiology of postpartum endometritis is often obscure, because standard transcervical swabs or aspirates usually grow multiple aerobic and anaerobic organisms representative of vaginal-cervical flora (3, 4, 8). Attempts by previous investigators to obtain specimens for culture directly from the fundus with minimal contamination from cervical-vaginal flora have produced inconsistent results and have led some investigators to state that endometrial cultures are of no clinical value (3).

This investigation was undertaken originally to define the microbial flora in postoperative cesarean section patients with and without suspected endometritis and to evaluate a new double-lumen-protected swab technique for obtaining endometrial specimens. Results previously presented showed that, in post-cesarean section patients, the new protected swab provided specimens of improved diagnostic significance in differentiating endometritis patients from febrile and afebrile controls (T. Morgan, J. Hesser, M. Pezzlo, and L. Thrupp, Program Abstr. Intersci. Conf. Antimicrob. Agents Chemother. 15th, Washington, D.C., Abstr. no. 223, 1975). The present paper presents analyses also from the standpoint of laboratory efficiency of the endometrial cultures from these postpartum cesarean section patients obtained by standard anaerobic swabs compared to the new protected swabs.

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MATERIALS AND METHODS

A total of 22 patients with clinical findings suggestive of endometritis following cesarean section were studied along with 24 "control" patients. The majority of patients were delivered by cesarean because of either cephalopelvic disproportion or malpresentation. The group with clinical findings indicating endometritis more often had shown premature rupture of membranes, as anticipated. However, patients with grossly prolonged rupture of membranes were excluded because they received prophylactic antibiotic therapy. The "control" patients included both afebrile uncomplicated post-cesarean section patients and post-cesarean section patients febrile due to other complications. The laboratory findings are summarized in this report, including follow-up swab sets obtained from 18 of the patients during convalescence.

Specimens for direct smear and culture were collected by using both a standard swab and the protected swab in each patient. The sequence of swabs was randomly alternated by prior random-number coding of culture packs. For the "standard" swab culture technique, a prereduced, anaerobically sterilized Anaswab (Scott Laboratories, Fiskeville, R.I.) was introduced directly through the cervix into the uterus.

The new protected swab, designed and handmade for these studies, consists of an inner malleable wire with a small cotton swab, enclosed within an inner plastic carrier tube which is carried within an outer plastic protective tube. The outer protective tube is sealed lightly at the swab end. The entire apparatus is curved gently to fit the uterine curve. The unit is placed in the uterine cavity, and the inner plastic carrier tube is pushed through the seal of the outer tube. The swab in then extended, and the swab and unit are rotated to obtain the endometrial sample. The swab and then the inner tube are retracted into the outer tube before the unit is removed from the uterine cavity.

Both swabs were smeared directly onto sterile slides for Gram stains, placed immediately in Carey-Blair prereduced transport media, and then inoculated

promptly onto plated media which had been held in an anaerobic holding jar for at least 4 h before inoculation. The media included brucella agar with 5% sheep blood and 5% laked blood agar plates (7) with kanamycin (75 μg/ml) and vancomycin (7.5 μg/ml) for anaerobic incubation in Gas-Pak jars; and thioglycollate broth. Anaerobic isolates were presumptively grouped based on Gram stain, growth characteristics on selective media, and antimicrobial susceptibility pattern (5–7). Gas chromatography (5) was performed on selected isolates recovered either in pure culture or from blood culture in addition to the endometrial cultures.

For parallel recovery of aerobic and facultative organisms, 5% sheep blood, MacConkey, 5% sheep blood agar with polymyxin B (15 μg/ml) and nalidixic acid (15 μg/ml), and Thayer Martin agar plates were incubated in 5% CO_2. Microbiological methods included standard biochemical identification procedures (6) and antimicrobial susceptibility tests (1, 9) on selected predominant isolates.

Gram-stained smears, coded at the bedside and examined later, were evaluated according to the presence and number of polymorphonuclear leukocytes (PMN). The classifications ranged from "occassional," for 1 PMN/2 to 4 oil immersion fields, up to "4+" for 15 PMN/oil immersion field.

RESULTS

PMN in the Gram-stained endometrial smears are summarized in Fig. 1 according to the type of swab used to obtain the specimen. With the standard swab, smears from 6% of the endometritis cases showed no PMN, and a similar 14% of the smears from control patients showed no PMN. With the protected swab, 14% of the smears from endometritis specimens had no PMN but, in contrast, for control patients, 52% of the specimens showed no PMN. Thus, a much greater difference between endometritis and control specimens collected by the protected swab was evident than for duplicate specimens collected with the standard swab.

The anaerobic and facultative isolates in endometrial specimens from each type of swab are shown in Table 1. A total of 33 anaerobic isolates were obtained with the standard swabs from endometritis specimens, compared to only 21 by the protected swab. From the control patients, the standard swab yielded nine anaerobic isolates and the protected swab yielded only three isolates. Thus, the standard swab produced a greater number of anaerobic isolates from both endometritis and control patients than did the protected swab.

For facultative and aerobic bacterial isolates from endometrial specimens, the results were similar (Table 1). Among the endometritis patients, there were 59% more isolates from specimens obtained by the standard swab. From the control patients, approximately four times as many aerobic isolates were obtained by using the standard swab as compared to the protected swab.

Table 2 summarizes the overall culture results and shows that in endometritis patients 58% more total bacterial isolates (102 compared to 65) were recovered from the standard swab as compared to the protected swab. In the control groups, 28 of 29 standard-swab specimens

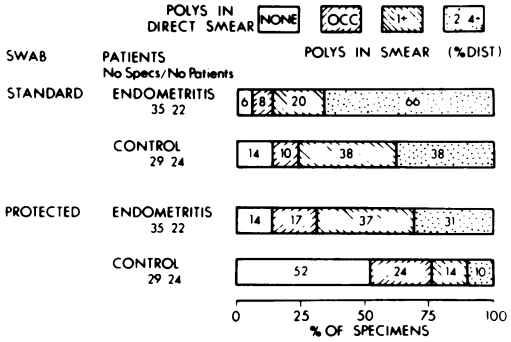

FIG. 1. *Gram stains of direct smears from standard and protected swabs from endometritis and control patients.*

TABLE 1. *Anaerobic bacterial isolates from endometrial specimens*

Organism	Standard swab		Protected swab	
	Endometritis	Control	Endometritis	Control
Anaerobes				
Bacteroides sp.	15	1	10	1
Gram-positive cocci	5	2	5	1
Clostridia	2	1	2	0
Other Gram-positive bacilli	8	4	2	0
Veillonella	2	1	2	1
Total anaerobic isolates	32	9	21	3
Aerobes (facultative)				
E. coli	6	4	2	—[a]
Other enteric bacilli	5	1	1	—
Streptococcus group D	10	3	9	1
Streptococcus group B	7	3	8	3
Streptococcus, other species	13	7	9	3
Staphylococcus aureus	3	—	2	—
S. epidermidis	7	7	4	—
Diphtheroids	12	6	5	1
Lactobacillus	2	9	3	2
Haemophilus sp.	2	—	—	—
Candida sp.	3	1	1	1
Total aerobic isolates	70	41	44	11

[a] —,

showed growth, whereas only 12 of 29 protected-swab specimens showed growth, with over three times as many isolates recovered from the standard swab compared to the protected swab.

Analysis of the number of isolates from each of the paired swabs, done at the same time from each patient, showed similar findings; more isolates were recovered from the standard swab in both endometritis and control patients in all but two instances. The only two specimens with more isolates obtained by the protected swab than the standard swab were both follow-up cultures, and only one organism, beta-hemolytic group B streptococcus, was isolated in each case. In the 22 specimen pairs showing more isolates from the standard swab, the large majority of these isolates represented vaginal-cervical flora such as diphtheroids and lactobacilli. Additional analyses not presented here showed that these excess isolates from the standard swabs did not correlate with clinical findings suggesting pathogenicity. (J. Hesser, T. Morgan, M. Pezzlo, and L. Thrupp, Abstr. Dist. VIII Annu. Meet. Am. Coll. Obstet. Gynecol., 1975).

In the endometritis patients, the organisms recovered by the protected swab which correlated with clinical findings suggesting greatest pathogenicity included group B streptococci, *Bacteroides* species, and anaerobic gram-positive cocci. These strains were also found in the paired specimens obtained by the standard swab. However, an additional 38 isolates from the standard swabs were absent from the protected swab. Most of these extra isolates apparently represented contamination by cervical-vaginal flora.

The numbers of test procedures required in the clinical microbiology laboratory, including Gram stains, biochemical tests, and antimicrobial susceptibility tests are presented in Table 3 for specimens from both control and endometritis patients. Specimens collected by the standard swab required 389 test procedures, whereas specimens collected by the protected swab required only 203 test procedures. Thus the standard swab required an overall 92% excess of procedures.

Table 4 presents the excess workload, in hours, required for processing standard swabs compared to that for the new protected swabs, as determined by multiplying the number of excess procedures times the minutes required per test according to the College of American Pathologists workload recording system (2). The total excess cost for the standard swab specimens from control, nonendometritis patients and for those from endometritis patients was \$160 and \$90, repectively, or a total of \$250. Subtraction of the estimated \$2-per-swab added cost of the new protected swab leaves an overall average net excess cost per specimen of \$2.17 for all specimens.

TABLE 2. *Culture results from endometrial specimens: Standard versus protected swabs*[a]

Swab	Total no. of bacterial isolates		No. of specimens: With more isolates		With growth		Total	
	E	C	E	C	E	C	E	C
Standard	102	50	22	25	33	28	35	29
Protected	65	14	2	0	34	12	35	29

[a] E, Endometritis patients; C, control patients.

TABLE 4. *Laboratory processing of endometrial specimens—excess workload: standard swab versus protected swab*[a]

Test procedure	Excess workload			Excess cost (\$)[b]	
	No. of tests	Time per test (min)	Total (h)	Materials	Personnel
Gram stain	44	2.2	1.5	18	15
Biochemicals	103	2.5	4.3	52	40
AST	39	7.5	4.8	60	50
Clerical time		2.8	3.0		

[a] SS, Standard swab; PS, protected swab; AST, antimicrobial susceptibility test.

[b] Average excess cost per specimen with standard swab was \$2.17, based on total excess cost for standard swab (\$250) less estimated cost of new protected swab (\$128, or \$2 per swab).

TABLE 3. *Laboratory processing of endometrial specimens—excess procedures: standard swab versus protected swab*[a]

Test procedure	Control Patients			Endometritis Patients			Total excess tests (SS − PS)
	SS total tests	PS total tests	Excess (SS − PS)	SS total tests	PS total tests	Excess (SS − PS)	
Gram stain	41	10	31	71	58	13	44
Biochemicals	80	19	61	104	62	42	103
AST	38	12	26	55	42	13	39

[a] SS, Standard swab; PS, protected swab; AST, antimicrobial susceptibility test.

DISCUSSION

Prior investigations of the microbial cause of postpartum endometritis have produced inconsistent results, probably in large part because of variable success in avoiding contamination by normal cervical-vaginal flora. For example, in the Hite study of 50 normal and 45 pathological postpartum uteri, using standard swabs, the organisms recovered from the two groups were indistinguishable, except that more *Bacteroides* were isolated from the infected group (4). More recently, Gibbs tried a transcervical endometrial rinse technique and also found essentially no difference between patients with endometritis and normal patients, again probably because of some degree of contamination by cervical-vaginal flora (3). Such findings have prompted many investigators to suggest that standard cultures are useless in diagnosing endometritis.

In the present study, intrauterine specimens were obtained from 22 patients with endometritis following cesarean section and 24 febrile and afebrile control post-cesarean section patients. Each patient was sampled by using both a new protected swab and a standard anaerobic swab, with either the standard or protected swab first, according to a random alternating sequence. With the protected swab, the Gram-stained smear clearly differentiated the endometritis specimens as a group from the control group by the presence and number of PMN, and with little overlap. However, the Gram stain of the standard swab was of limited differential diagnostic value.

Culture results with the new protected swab were also of differential diagnostic significance particularly in distinguishing endometritis patients from "control" cesarean section patients who were febrile from complications other than endometritis. Thus, in the controls, the protected swab showed no growth or scant growth in 72% of all cultures. In contrast, with the standard swab, 97% of the cultures from control patients showed heavy growth of mixed flora. The heavy growth from the standard swabs represented normal cervical-vaginal flora and included some species such as *Bacteroides* species shown in detailed clinical analyses (presented previously) to correlate with morbidity in endometritis patients. Similarly, in the endometritis patients the protected swab revealed relatively pure growth of apparent pathogens (i.e., strains shown to correlate with clinical morbidity), whereas the standard swab recovered mixtures of less diagnostic value. Thus, the primary value of the protected swab in the cesarean section patient groups studied was to permit definitive microbiological diagnosis from endometrial specimens with resulting improvement in the clinical relevance of the specimen.

These findings demonstrated that in these cesarean section patients studied, the new protected swab greatly improved the value of the direct smear and Gram stain as an immediate diagnostic aid, resulted in fewer false-positive cultures in patients without endometritis, better defined true endometrial flora in patients with endometritis, and permitted major savings in laboratory personnel time and materials. Thus, the protected swab produced results of improved clinical relevance compared to the standard swab, and at significantly less cost. Further evaluation of the new protected swabs is warranted in the diagnosis of suspected infection following vaginal as well as cesarean delivery.

LITERATURE CITED

1. **Barry, A. L., F. Garcia, and L. D. Thrupp.** 1970. An improved method for testing the antibiotic susceptibility of rapidly growing pathogens. Am. J. Clin. Pathol. **53**:149–158.
2. **College of American Pathologists.** 1976. Laboratory workload recording method. College of American Pathologists, Skokie, Ill.
3. **Gibbs, R. S., T. N. O'Dell, R. R. MacGregor, R. H. Schwarz, and H. Morton.** 1975. Puerperal endometritis: a prospective microbiologic study. Am. J. Obstet. Gynecol. **121**:919–925.
4. **Hite, K. E., H. C. Hesseltine, and L. Goldstein.** 1947. A study of the bacterial flora of the normal and pathologic vagina and uterus. Am. J. Obstet. Gynecol. **53**: 233–240.
5. **Holdman, L. V., and W. E. C. Moore (ed.).** 1975. Anaerobe laboratory manual, 3rd ed. Virginia Polytechnic Institute and State University, Blacksburg.
6. **Lennette, E. H., E. H. Spaulding, and J. P. Truant (ed.).** 1974. Manual of clinical microbiology, 2nd ed. American Society for Microbiology, Washington, D.C.
7. **Sutter, V. L., V. L. Vargo, and S. M. Finegold.** 1975. Wadsworth anaerobic bacteriology manual, 2nd ed. UCLA Dept. of Continuing Education in Health Sciences, Los Angeles, Calif.
8. **Sweet, R. L., and W. J. Ledger.** 1973. Puerperal infectious morbidity. Am. J. Obstet. Gynecol. **117**: 1093–1100.
9. **Wilkins, T. D., and T. Thiel.** 1973. Modified broth-disk method for testing the antibiotic susceptibility of anaerobic bacteria. Antimicrob. Agents Chemother. **3**: 350–356.