

Effect of hysterectomy on genital infections

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SUMMARY In a study of women with anogenital gonorrhoea who had undergone hysterectomy, the sensitivities of urethral, vaginal, and anal canal cultures were 88·9, 55·7, and 40·7% respectively in specimens from 27 women. To obtain the greatest sensitivity, however, we recommend that specimens from all three sites should be cultured routinely. After the raising effects of trichomoniasis and menstrual blood on the pH values have been allowed for, the vaginal pH of 74 women in the study group and of 137 healthy controls was similar.

Introduction

The prevalence and course of sexually transmitted genital infections could theoretically be influenced by the absence of the uterine body and cervix. Several factors may play a part, such as the predilection of gonococci for endocervical columnar epithelium (Harkness, 1948), the pH-buffering effect of cervical mucus (Peeters *et al.*, 1972), the bacteriological effects of mucin (Enhörning *et al.*, 1970), the competition from endocervical bacterial flora and their metabolic products (Bartlett *et al.*, 1978), and the presence of menstrual blood (Cohen, 1969). Our aim was to study how surgical removal of the cervix affects the prevalence of sexually transmitted genital infections by comparing disease-specific infection rates in women who had undergone hysterectomy with rates in a control group of women with an intact uterus. In addition, we have attempted to identify the most sensitive site for culturing *Neisseria gonorrhoeae* from women after hysterectomy.

Patients and methods

The Denver Metro Health Clinic is a major clinic for the treatment of sexually transmitted diseases (STD) in the Denver metropolitan area. The clinic records about 22 000 patient visits each year and more than 65% of the cases of gonorrhoea reported from Denver are treated there.

A standardised clinic visit form was used to collect an extensive STD data base for each patient

(Rothenberg and Judson, 1979). The data base did not include the reason(s) for the hysterectomy or whether or not oophorectomy had also been performed. In this study, women were considered to be 'symptomatic' if they complained of vaginal discharge.

CULTURE TECHNIQUES

At the initial visit (a first-time or a subsequent visit more than 30 days after a previous visit), two specimens for culture for gonococci were obtained from the endocervix and one from the anal canal (without a proctoscope) of healthy control women whereas one specimen was obtained from each of the urethra, posterior vaginal fornix, and anal canal of women who had undergone hysterectomy. Calcium-alginate urethrogenital swabs were used for urethral specimens whereas cotton-tipped swabs were used for specimens from other sites. Specimens were streaked directly on to modified Thayer-Martin medium and placed in an incubator at 36°C in an atmosphere containing 5-10% carbon dioxide. After 40-48 hours' incubation, cultures showing morphologically typical oxidase-positive colonies of Gram-negative diplococci were considered to give a positive result.

Cotton-swab specimens for saline wet preparations and 10% potassium hydroxide (KOH) mounts were obtained from the posterior vaginal fornix of all women and examined microscopically within five minutes for the presence of trichomonads and yeasts. Vaginal discharge was graded according to (a) quantity—none, scanty (insufficient quantity to flow into the lower half of the speculum), moderate (sufficient quantity to flow into the speculum but not from the introitus), and profuse (spontaneous flow from the introitus); and (b) quality—clear, white, or

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purulent. Finally, the pH value of the posterior vaginal secretions was determined with nitrazine paper (phenolphthiazine paper, E. R. Squibb and Sons Inc., Princeton, New Jersey) in all study group women and in a 50% sample of the healthy control group.

DEMOGRAPHIC DATA

Study group

From 26 May 1977 to 13 May 1978 91 women under 40 years of age who had undergone hysterectomy presented to the clinic. The age limit was applied to avoid any effects of the menopause on the vaginal pH value and on the infection rates of the control group of women.

Control group

Out of 8141 women with an intact uterus seen during the same period a control group of 264 women (three controls for 82 women and two controls for nine women), under 40 years of age was selected by computer for identical composition to the study group for age (mean 32.6 years), race (78% white, 10% black, 10% Hispanic, and 2% others), sexual activity (mean 2.1 different sexual partners within 30 days of the clinic visit), period since most recent sexual contact (mean 5.8 days), and history of exposure to gonorrhoea (15.4% had been exposed within 30 days of the clinic visit).

To determine the relative sensitivities of urethral, vaginal, and anal canal cultures for *N. gonorrhoeae* more accurately, we continued to investigate the study group until December 1978.

Differences between the study group and the control group were analysed using a critical ratio for the difference of proportions (z test). The differences in pH were examined with an unpaired Student's t test for comparison of means.

Results

Vaginal discharge was significantly ($z = 3.5847$, $P < 0.001$) more common in the study group (77%) than in the control group (56%). This difference was also noted for subgroups with gonorrhoea (75%

compared with 44%), trichomoniasis (88% compared with 76%) and yeast infection (90% compared with 74%). In contrast, there was no significant difference between the two groups in terms of quantity and quality of vaginal discharge as determined by the clinician during vaginal examination. Thus, it appears that women who have undergone hysterectomy are more aware, or less tolerant, of vaginal discharge.

Comparative rates of genital infection are shown in Table 1. Trichomoniasis was significantly more common in the study group than in the controls; on the other hand, for gonorrhoea and yeast infection there were no significant differences. In the study group, seven (50.6%) of 14 women exposed to gonorrhoea were infected compared with 19 (65.5%) of 29 in the control group ($P =$ not significant).

In Table 2, the range of posterior vaginal pH

Table 2 Comparison of vaginal pH in 74 women who had undergone hysterectomy and in 137 healthy controls, none of whom had trichomoniasis or were menstruating

pH value	Study group (n = 74)		Control group (n = 137)	
	No.	% of total	No.	% of total
4.5	34	45.9	54	41.9
5.0	14	18.9	28	21.7
5.5	11	14.9	19	14.7
6.0	8	10.8	20	15.5
6.5	5	6.8	7	5.4
7.0	2	2.7	8	6.2
7.5	0	0	1	0.8

values in 74 women in the study group are compared with that in 137 women in the control group who did not have trichomoniasis and who were not menstruating (controls only). The mean pH value of women in the study group was 5.1, which was similar to the mean of 5.2 for the healthy controls. The mean pH of women with trichomoniasis in both groups (5.6 and 5.8) was higher than that for women with no infection and no abnormal discharge (4.8 and 5.1) (Table 3).

Of 27 women in the study group who had *N. gonorrhoeae* cultured from any site (Table 4), the urethra gave a positive result in 88.9% and was the

Table 1 Rates of gonorrhoea, trichomoniasis, and yeast vaginal infection in 91 women after hysterectomy and in 264 healthy controls

Infection	Study group (n = 91)		Control group (n = 264)		z test*	Probability
	No.	% of total	No.	% of total		
Gonorrhoea	12	13.2	34	12.9	0.0755	NS
Trichomoniasis	17	18.7	23	8.7	2.5937	<0.01
Yeast	10	11.0	19	7.2	1.1389	NS

*Critical ratio for the difference of proportions
NS = not significant

Table 3 Comparison of vaginal pH in 61 women after hysterectomy, and in 99 healthy controls, some of whom had gonorrhoea, trichomoniasis, yeast infection, or no genital infection or abnormal discharge

Infection	Study group (n = 61)		Control group (n = 99)	
	No.	Mean pH	No.	Mean pH
Gonorrhoea	12	5.2	20	5.5
Trichomoniasis	17	5.6	11	5.8
Yeast	10	4.8	12	5.2
No infection and no abnormal discharge	22	4.8	55	5.1

Table 4 Comparison of urethral and vaginal culture results in 27 women with anogenital gonorrhoea who had undergone hysterectomy

Culture results for specimens from			
Urethra	Vagina	No.	% of total
+	+	13	48.2
+	-	11	40.7
-	+	2	7.4
-	-	1*	3.7

+ Positive - negative

*Result from anal canal alone was positive

only site giving a positive result in 40.1% compared with the vagina, which gave a positive result in 55.6% and was the only site giving a positive result in 7.4%. The anal canal gave positive results in 11 (40.7%) and was the only site giving a positive result in one (3.7%).

Discussion

The uterine cervix is a secretory organ lined by mucus-producing columnar epithelial cells which serves as a conduit for endometrial secretions in one direction and spermatozoa and microbes in the other. Once genital contact with a pathogen has occurred, the cervix can affect both the rate of acquisition and the course of sexually transmitted genital infections.

Because *N. gonorrhoeae* is more frequently isolated from the endocervix than from the vagina (Dans and Judson, 1975), it has been argued that the endocervix is preferentially susceptible to gonorrhoea, possibly because of its columnar epithelial lining (Harkness, 1948). Brown and Lucas (1973) have even stated that 'the gonococcus is unable to penetrate normal stratified squamous epithelium and infection develops only on those surfaces lined with vulnerable columnar epithelium'. However, this opinion is contradicted by Evans's (1977) ultrastructural studies, which show primary squamous cell infection, and by clinical studies that document infections of the posterior pharynx

(Wiesner *et al.*, 1973), the vagina and not the cervix in prepubescent girls (Harkness, 1948), the vagina in women after hysterectomy (Klaus *et al.*, 1978), the urethra in women (Dans *et al.*, 1975), and the anal canal in men and women (Dans *et al.*, 1975).

Harkness (1948) has proposed that while the gonococcus may infect vaginal squamous epithelium it more avidly attacks columnar epithelium and hence the cervix with its abundance of this cell type. Evans (1977), however, was unable to demonstrate gonococci in or on cervical epithelium from 25 women with gonococcal cervicitis, finding it instead within and on stratified squamous epithelium of the portio vaginalis. Thus, the question of which cell type *N. gonorrhoeae* prefers remains unanswered.

Other factors which might be important to preferential endocervical survival of gonococci may be the qualitatively different microflora (Bartlett *et al.*, 1978) and the higher pH of the cervical os. The usual pH value of secretions from the os is about 6.8 (Peeters *et al.*, 1972) compared with 5.0 for vaginal secretions and 7.5 for the optimal growth of *N. gonorrhoeae* (Cohen, 1969). Cervical mucus itself may cyclically affect bacterial growth since it has been shown to be bactericidal for *Proteus mirabilis* (Enhorning *et al.*, 1970). A recent study by Bartlett *et al.* (1978) comparing cervical and vaginal bacterial flora undermines much of this argument, for on the whole there were no quantitative differences in the flora of the two sites.

Furthermore, menstrual blood which passes through the uterine cervix is an excellent culture medium and could buffer vaginal pH into a range more conducive to the growth of *N. gonorrhoeae*. In reality this may not be important, as Dans and Judson (1975) have shown that endocervical culture positivity rates do not vary during the menstrual cycle.

Hysterectomy, by removing any predisposing effects of the endocervix to gonococci and by leaving behind primarily vaginal and urethral stratified squamous epithelium, should provide a model to resolve partly some of these controversies. We found no significant difference between the prevalence rates of genital gonorrhoea in women who had undergone hysterectomy and in matched healthy women. More importantly, the gonorrhoea attack rate in women exposed to gonorrhoea after hysterectomy was similar to that in healthy women exposed to gonorrhoea ($P > 0.2$). Thus, although the gonococcus has been assumed to favour cervical epithelium, it establishes infection quite well in its absence. Unfortunately, our study methods did not permit us to determine what, if any, contribution was made by infection of columnar epithelium within perivaginal and periurethral glands to the positive culture rate.

For women with an intact uterus, the endocervix and anal canal have been the preferred sites from which to culture *N. gonorrhoeae* (Center for Disease Control, 1974). Similar guidelines for women who have undergone hysterectomy do not exist, but our study clearly indicates that urethral cultures are the most sensitive, detecting infection in 89% of 27 women with anogenital gonorrhoea after hysterectomy. This agrees, in general, with the recent report of Klaus *et al.* (1978), in which urethral, vaginal, and anal canal cultures gave a positive result in 100, 41, and 12% respectively of 17 women with anogenital gonorrhoea after hysterectomy.

Although we did not take urethral specimens for culture from our healthy women, previous studies have shown that after endocervical cultures vaginal rather than urethral cultures are the next most sensitive in detecting genital gonorrhoea. Thus, in 432 women with gonococci isolated at any anogenital site, Dans *et al.* (1975) found the endocervix to give a positive result in 96.1%, the vagina in 84.9%, and the urethra in 65%. Lucas *et al.* (1967) obtained similar results in 1268 women with gonorrhoea; the endocervix gave a positive result in 86%, the vagina in 79%, and the urethra in 60%. The greater sensitivity of a vaginal culture in women with an intact uterus is probably best explained by the discharging of viable gonococci from the cervix into the vagina.

As with the endocervix, the reasons for preferential colonisation of the urethra are not known but probably relate to the same, as yet poorly defined, combination of factors such as pH, competing microflora, and cell type. To obtain the greatest sensitivity, we recommend that specimens from all three sites be cultured routinely.

In Gry's study (1964) of the prevalence of *T. vaginalis* in 387 women, the organism was cultured from cervical specimens in only 13.1%. It was never cultured from the cervix alone, and thus the presence of a cervix seems to have little effect on the prevalence of trichomoniasis. However, optimal growth of *T. vaginalis* occurs during menses (Banner, 1974). If this were due solely to the buffering action of menstrual blood, we would expect a lower prevalence of trichomoniasis in women after hysterectomy. Inexplicably, we found trichomoniasis to be significantly more common in women who had undergone hysterectomy than in healthy women (18.7% compared with 8.7%, $P < 0.01$). This may result from our methods of selection in that a significantly greater proportion of women who had undergone hysterectomy complained of vaginal discharge. The explanation does not lie in vaginal acidity, because with or without trichomoniasis, the mean pH value of women after hysterectomy did not

significantly differ from that of the control women. It is not known whether the high pH associated with trichomoniasis is actually caused by the protozoan or instead helps to provide a favourable environment for infection (Cohen, 1969).

Candidosis is seldom sexually transmitted (Miles *et al.*, 1977) but is nonetheless a common genital infection which could be influenced by the presence of the cervix. Rosenberg (1976) found that only 44% of women with the 'typical symptoms complex' of candidosis had positive results when cultures were performed throughout the cycle, while 85% had positive results when cultures were performed within four days of the onset of menstruation. If a change in premenstrual cervical mucus was responsible, the prevalence of yeast infections in women after hysterectomy would be lower than in controls. However, we found yeasts on KOH preparations in 11% of women who had undergone hysterectomy and in 7.2% of control women ($P > 0.2$). As with trichomoniasis, the slightly higher prevalence of yeast infections in women after hysterectomy may be due to the higher percentage of these women who were symptomatic.

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