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Changes in the Aerobic Bacterial Flora in the Urinary Tract of Patients with Long-Term Indwelling Foley Catheters

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Summary. The urethral and urinary flora and their changes during long term catheterisation were studied in 21 patients not receiving antibiotic treatment. It was found that normal urethral flora was suppressed and that gram-negative rods predominated. The bacterial strains found in urethra and urine can be divided into two groups: those with bacteria not found in repeated samples and those with a different flora, usually proteus mirabilis where the same strains were found repeatedly. The urethral flora changed more rapidly than the urinary flora. The number of strains per sample was higher for women both for urethra and urine, pseudomonas being found almost only in males.

Key words: Urethral catheterisation, Bacterial flora.

The insertion of an indwelling urethral catheter rapidly induces a bacteriuria by a bacterial invasion along the catheter lumen. The use of a strictly closed system delays the bacteriuria; the invasion in this case is probably being "extra-luminal" via the secretion outside the catheter.

The end result is infection in both urethra and urine in virtually all hospitalised patients with long term indwelling Foley-Catheters. The bacterial flora inducing the bacteriuria differs from patients without catheters. Proteus, Pseudomonas, Klebsiella and Enterococci substantially replace Escherichia coli as the dominating pathogen. A change is also seen in the urethral flora where the above-mentioned bacterial strains constitute an increasing portion. The infection in catheterised patients is notoriously difficult to eliminate owing to the continuous exposure to enteric bacterial strains together with the foreign-body effect of the catheter. Administration of systemic antibiotics selects or induces the formation of resistant strains and thereby merely leads to temporary changes in the bacterial flora.

The aim of this study was to investigate the changes in the urinary and urethral flora during prolonged urethral catheterisation in patients without antibiotic treatment.

MATERIAL

Twenty one patients were studied, thirteen females aged 69-92 years (85 ± 6 years) and eight males aged 51-85 years (73 ± 10 years).

Only two were bedridden, the others were either confined to chairs or mobile. All had been catheterised because of incontinence, and for at least two months. None had bladder training. A closed drainage system was used. The catheters were changed regularly every 6th week or more often as needed, for instance because of obstruction or the patient having pulled it out himself.

Antibiotics were not used locally, and systematically only for one short period (ten days) in three patients and without any significant change in the bacterial flora. No bladder washouts were given except temporarily in the three above-mentioned patients.

The observation period ranged between 6 and 36 weeks (mean 24 weeks).

METHODS

Urinary and urethral cultures were obtained every 6th week. The urinary cultures were taken from the catheter end, as this sampling technique is, in our experience, as reliable as catheter puncture (3).

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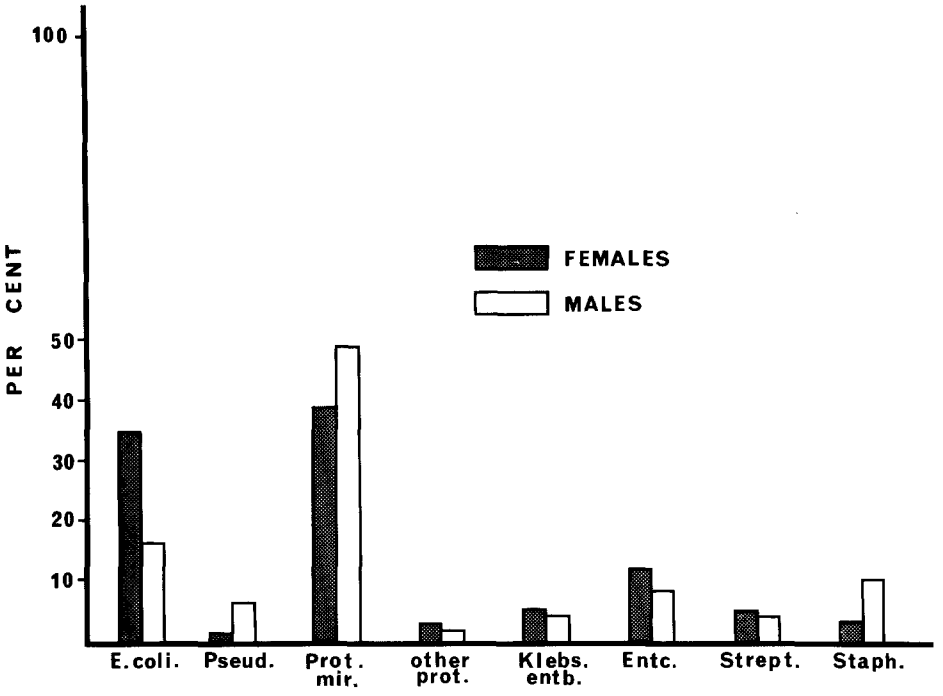

Fig. 1. The urethral flora. Bacterial strains cultured from the urethra in 8 males and 13 females, followed during prolonged catheterisation

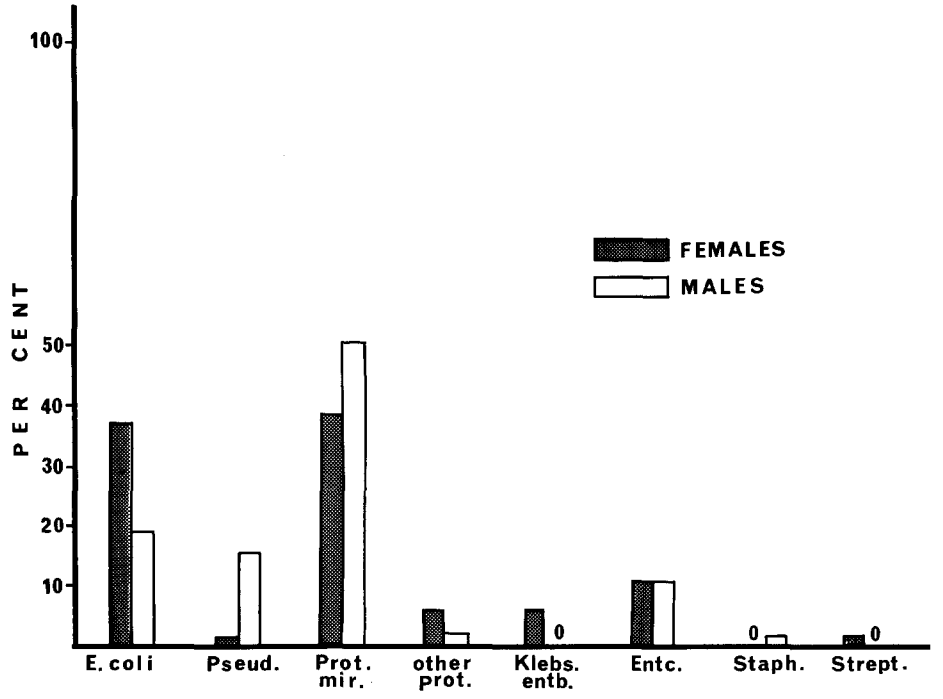

Fig. 2. The urinary flora. Bacterial strains cultured from the catheter urine in 8 males and 13 females, followed during prolonged catheterisation

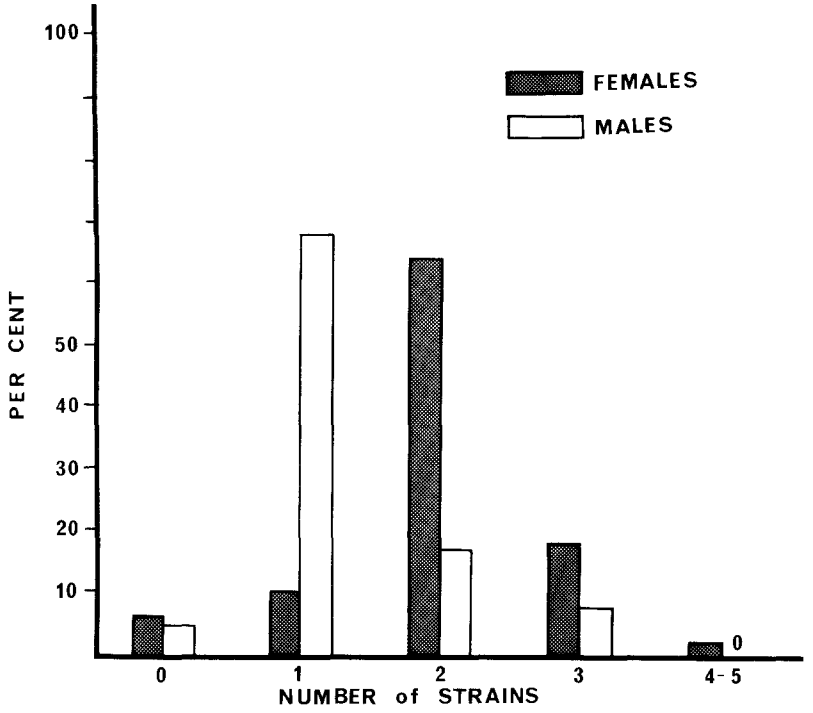

Fig. 3. Number of bacterial strains in each sample of catheter urine, during prolonged catheterisation

Bladder aspiration could not be used as most of the patients had a contracted bladder.

Urethral samples were taken from the fossa navicularis in the male patients and from the distal urethra in the females.

The samples were immediately taken to the bacteriological laboratory, stored at +4°C and analysed.

RESULTS

Figure 1 shows the urethral flora. Seventy-three samples were obtained from the 13 females and 41 from the 8 males. All samples yielded bacterial growth, the female patients 2.3 ± 0.8 strains per sample compared with 1.5 ± 0.7 for the males ($P < 0.001$).

The females provided 73 urinary samples and the males 44, all with bacterial growth. The number of strains per sample is, as in the urethral flora, higher for the females, 2.0 ± 0.9, than for the males, 1.3 ± 0.7, ($P < 0.005$). Figure 3 shows this graphically. As Figure 2 shows, the urinary flora is similar to the urethral, but the number of strains per sample is significantly lower in the urine ($P < 0.005$).

Table 1 lists the difference between the occasionally found and the more repeatedly and constantly found strains.

Table 1. Strains cultured from urine

Number of patients with:	Constant or frequent strains		Occasional strains	
Proteus mirabilis	16/21	76%	1/21	5%
Escherichia coli	12/21	57%	2/21	10%
Enterococci	6/21	28%	5/21	24%
Pseudomonas	3/21	14%	2/21	10%
Other proteus spec.	2/21	10%	4/21	18%
Klebsiella-Enterobacter	0/21	0%	5/21	24%
Others	0/21	0%	3/21	14%

Table 2 shows that the urethra harbours a more transient flora; the difference between urine and urethra is significant ($P < 0.001$).

Table 3 shows the correlation between the urethral and urinary bacterial flora; no sex difference can be detected.

Proteus mirabilis was found repeatedly in 16 patients. 13 had strains sensitive to all except two of the nine tested antibiotics. Three patients had strains resistant to all except two of the tested antibiotics. No patients revealed any significant change in the resistance pattern during the observation period.

Table 2. Changes in the bacterial flora

	Occasional strains	
	Cultures with a strain found in a single sample	
Urine		
Males	5/42	12%
Females	16/73	22%
Urethra		
Males	22/42	52%
Females	44/73	60%

Table 3. Correlation between urethral and urinary flora during prolonged chatheterisation

	Males	Females
Exactly the same in urethra and urine	63%	60%
1 extra strain in urethra	22%	22%
2 extra strains in urethra	5%	8%
4 extra strains in urethra	-	1%
Other combinations, all with an extra strain in the urine	10%	10%

DISCUSSION

Gram positive organisms dominate the normal urethral flora; but coliform bacteria are also found. The frequency with which they are cultured is debated. They seem to be transient in females without urinary tract infections. The frequency is 20% or less, although higher in females with recurrent urinary tract infections (2, 5, 8). Changes in the bacterial flora occur with long term indwelling urethral catheters. A study (7) where women with an indwelling catheter for at least 48 hours were studied showed a moderate increase in the number of patients with gram negative organisms. Studies before and after prostatectomy (4, 9) found a marked increase in the frequency of gram negative organisms. As our material shows, the urethral flora changes markedly after prolonged catheterisation, Proteus mirabilis and Escherichia coli predominating in both males and females.

Several investigators have shown that an indwelling catheter induces bacteriuria. The bacterial invasion is dominated by a flora other than the one usually seen in urinary tract infections where Escherichia coli dominates, seen in about 85% of the infections. The bacteria seen together with Escherichia coli after the catheter insertion are Pseudomonas, Klebsiella, Enterobacter and especially Proteus mirabilis. Our study shows good correlation of the bacterial floras in the two sexes, except for pseudomonas, a bacteria seen much more often in males (Figs. 1 and 2). This is in agreement with other studies (1).

The urinary bacterial flora can be divided into two groups: the constantly or repeatedly found strains, and the occasionally found strains. Of the constantly found bacteria, Proteus mirabilis and Escherichia coli dominate, most of the patients being infected with one or both when the investigation began. Once cultured in a patient, they were found in nearly all the following samples. The occasionally found bacteria are other species, Proteus mirabilis being found as an occasional bacterium in only one patient.

The urethral and urinary flora are of almost the same composition but the number of strains per sample and the frequency of occasionally found bacteria is significantly higher than in the urine. It seems that the urethral mucosa harbours a much more changing bacterial flora of which only a few of the 'occasional' strains reach the urine. The agreement of 60% between the urethral and urinary flora in the particular sample is explained by Proteus mirabilis and Escherichia coli dominating and being constant in both places.

Alling et al. (1) also studied the changes in the urinary flora in geriatric patients. Urine cultures were carried out weekly for 5 successive weeks. In their material, 24/27 women and 3/7 men had a catheter. They found that the flora changed rapidly, especially in women. This only partly agrees with our results, where there was a rapidly changing flora, especially in women, but also a constant flora with Proteus mirabilis and Escherichia coli. Shackman et al. (9) also found that catheterised males had a degree of constancy of the organism cultured.

Proteus mirabilis has probably found its way into the urine via cross contamination or from the colonic flora. Liedberg (6) demonstrated that a large number of hospitalised patients with a catheter develop a Proteus mirabilis infection caused by the catheter and not by the hospitalisation; this refers to a patient material with antibiotic treatment.

The persistance of Proteus mirabilis during the constant urinary exposure to other strains via the urethra, as found in the present study, can be due to a specially high resistance to the defence mechanism of the body when associated with a foreign body such as the catheter. An antagonistic effect towards other bacterial strains is also possible.

The suppression of other bacteria by antibiotics cannot explain the Proteus mirabilis persistence in this study, as antibiotics were not administered.

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