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A quantitative study of genital skin flora and urinary colonization in spinal cord injured patients

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This study was performed to define the relation between colonization of genital skin flora and bacteriuria in spinal cord injured patients with neurogenic bladder dysfunction. Twenty-seven female and 23 male spinal cord injured patients were included in the study. Patients were evaluated regarding their type of bladder management, educational status, level and degree of the spinal cord lesion. Quantitative cultures were obtained from the perineum, labium/dorsum of penis, external meatus of urethra, and urine. We investigated whether the organisms isolated from urine were also present in one or more skin sites in every patient. In total 54 identical bacterial isolates were observed both from urine and one or more skin sites in 43 of the patients. *Escherichia coli, Proteus mirabilis, Klebsiella pneumoniae*, and *Proteus stuartii* were the most common bacterial isolates. The distribution of identical colonization of genital skin flora with urine were as follows: 30 in urethra, one in perineum, four in urethra and perineum, nine in urethra and labium/dorsum of penis, and 10 in both three skin sites. Identical colonization of both perineum and labium/dorsum of penis with urine were significantly higher in female patients than those of males ($P=0.037$, $P=0.003$, respectively). No significant difference was found in the presence/distribution of colonization with respect to type of bladder management, educational status, and neurologic status. These results demonstrate the importance of the urethra, perineum, and labium/dorsum of penis as a source of bacteria causing urinary infection in spinal cord injured patients.

Keywords: spinal cord injury; genital flora; urinary tract infection

Introduction

Spinal cord injured patients with neurogenic bladder dysfunction are susceptible to urinary infection with diverse, multidrug-resistant Gram-negative bacteria.[1–5] Perineal colonization of the microorganisms can be responsible for bacteriuria in spinal cord injured patients. Genital skin flora has been characterized by several studies and is reported as a reservoir for nosocomial urinary tract infection in patients with spinal cord injury.[1–6]

The present study was carried out both to define the genital skin flora of the spinal cord injured patients quantitatively and to determine whether the organisms isolated from urine were also present in one or more skin sites (perineum, labium/dorsum of penis, external meatus of urethra). We also investigated if any difference could be found in the presence/distribution of colonization with respect to sex, type of bladder management, educational status, and neurologic status.

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Materials and methods

Twenty-seven female and 23 male spinal cord injured patients with neurogenic bladder dysfunction were included in the study. Patients with (1) decubitis ulcers, (2) long term antibiotic usage for prophylaxis or treatment of urinary tract infections, (3) markedly increased spasticity which prevents the passive movement of the joints of the affected limbs through the full range of motion and (4) contractures which might affect the hygienic practices, were not included in the study. Patients were evaluated regarding their type of bladder management, educational status, level and degree of the spinal cord lesion.

Quantitative cultures were obtained from the perineum, labium/dorsum of penis, external meatus of urethra and urine. We investigated whether the organisms isolated from urine were also present in one

or more skin sites (perineum, labium/dorsum of penis, external meatus of urethra). Urine specimens were obtained by a sterile technique by catheterizing the patients after cleansing of the genitalia with povidone-iodine except the patients who were voiding voluntarily. Samples from perineum, urethral meatus, labium/dorsum of penis were taken with a cotton swab. All samples were inoculated 5% sheep blood agar and eosin methylene blue agar. All plates were evaluated after 18 h of incubation at 37°C under aerobic conditions. A colony count of $\geqslant 10^5$ cfu/ml was considered significant for bacteriuria. Bacteria that were identical in phenotypes obtained by conventional methods were further confirmed by API 20E, API 20NE (Bio-merieux) tests. Antibiotic susceptibility tests were performed by Kirby-Bauer disk diffusion methods. Biochemical characteristics and antibiotic susceptibility patterns were used together to reveal whether the isolates were identical or not.

Demographic results were descriptive and expressed as percent or as mean $\pm$ SE. Chi square and Fisher exact tests were applied for comparison of the presence/distribution of identical colonization regarding sex, type of bladder management, educational status, and neurologic status. Comparing the type of bladder management only the patients with intermittent catheterization and indwelling catheterization were included in the statistical analysis. While performing statistical analysis, P values of less than 0.05 were considered as statistical significance.

Results

Patients ranged in age from 12 to 49 years with a mean of 28.7 ± 1.4. There were 27 female and 23 male patients with the mean ages 27.2 ± 2.0, 30.5 ± 1.8, respectively ($P > 0.05$). Educational status of the patients were as follows; uneducated: 5 (10%), primary school: 24 (48%), secondary school: 9 (18%), high school: 7 (14%), university: 5 (10%). Forty-one patients (82%) were paraplegic and nine (18%) were tetraplegic. Complete/incomplete ratios of para and tetra patients were 23/18 and 3/6, respectively. Frankel classification of the patients were as follows: Frankel A: 26 (52%), Frankel B: 9 (18%), Frankel C: 7 (14%), Frankel D: 8 (16%). Neurological level of the lesion was between C4–8 in nine (18%), T1–9 in 11 (22%), T11–L1 in 23 (46%), and L2–3 in seven (14%) of the patients. Subjects had neurogenic bladder dysfunction managed by indwelling catheterization in 27 (54%), intermittent catheterization in 18 (36%), and condom drainage in two (4%) of the patients. Three (6%) of them were voiding voluntarily. Totally 54 identical bacterial isolates were identified both from urine and one or more skin sites from 43 (86%) of the patients. No identical bacterial isolates were obtained from seven (14%) of them. *Escherichia coli* being the commonest species, the majority of these isolates were Gram-negative (Table 1). The distribution of identical colonization of genital skin flora with urine were as follows: 30 in urethra, one in perineum, four in urethra and perineum, nine in urethra and labium/dorsum of penis, and 10 in both three skin sites. The relation between colonization of genital skin flora and bacteriuria in male and females is shown in Table 2. Identical colonization of both perineum and labium/dorsum of penis with urine were significantly higher in female patients than those of the males ($P = 0.037$, $P = 0.003$, respectively). No significant difference was found in the presence/distribution of colonization with respect to type of bladder management, educational status, and neurologic status ($P > 0.05$).

Discussion

The results of this study demonstrate that organisms causing urinary tract infection in spinal cord injured patients are also recoverable from the genital skin flora of the patients and suggest that urinary infection originates from organisms colonizing the genitalia.

Fawcett *et al*[1] showed that the colonization of the perineum and groins of the spinal cord injured patients by Gram-negative bacilli associated with urinary infection. In three of the patients, they isolated the organism causing urinary infection from the skin of the perineum before it appeared in the urine. It was shown that Gram negative uropathogens became a stable component of the skin flora after spinal cord injury.[1,2] Many studies have shown that *Klebsiella*

Table 1 Identical bacterial isolates

Organism	*Number*	*%*
Escherichia coli	24	44.4
Proteus mirabilis	8	15.8
Klebsiella pneumoniae	5	9.3
Providencia stuartii	5	9.3
Proteus rettgeri	2	3.7
Pseudomonas aeuruginosa	2	3.7
Serrative marcescens	2	3.7
Bacillus spp	2	3.7
Proteus vulgaris	1	1.85
Enterobacter agglemerans	1	1.85
Corynebacterium spp	1	1.85
Streptococcus faecalis	1	1.85

Table 2 Relation between colonization of genital skin flora and bacteriuria regarding sex

Place of identical colonization	*Female (%)*	*Male (%)*
Urine and urethral meatus	11 (35.5)	19 (82.6)
Urine and perineum	1 (3.2)	–
Urine and urethral meatus + perineum	3 (9.7)	1 (4.3)
Urine and urethral meatus + labium/penis	8 (25.8)	1 (4.3)
Urine and all skin sites	8 (25.8)	2 (8.7)

pneumonia and *Pseudomonas aeruginosa* commonly occur in the urinary tract of spinal cord injured patients.[3,7–10] In our study most of the organisms were also Gram negative bacilli. Among them *Escherichia coli, Proteus mirabilis, Klebsiella pneumoniae* and *Providencia stuartii* were the most predominant species.

Sanderson and Rawal[11] showed that various environmental sites (eg bed sheets, bath towels, locker surfaces and other sites) became contaminated with organisms indistinguishable from those causing bacteriuria in spinal cord injured patients. Their results indicated that contact with the immediate environment of spinal cord injured patients with urinary infection might lead to contamination of hands and confirmed the need for hand washing both by patients and staff. Sanderson and Weissler[12] examined the relationship between colonization by coliforms of the perineum and the incidence of bacteriuria and the contamination of bedclothes and other environmental sites with these organisms. They found that perineal colonization was significantly associated with bacteriuria and contamination of bedclothes. They concluded that the perinea might be an important source of contamination of the environment and indirectly of the hands of the patients and staff.

Taylor *et al*[13] compared the skin flora from the perineum, penis and urethra of spinal cord injured male patients with neurogenic bladder dysfunction with normal controls and showed that spinal cord injured patients had abnormal genital skin flora composed of high colony counts of Gram-negative uropathogens. Urine cultures were also obtained immediately after collection of skin cultures. Organisms isolated from urine were also present in one or more skin sites in every instance. These investigators accused the antibiotic usage, skin moisture, urine leakage, pH, skin temperature, personal hygiene, neurogenic bladder, and bowel management.

Montgomerie *et al*[14] studied the relationship of pH and moisture to *Pseudomonas aeruginosa* and *Klebsiella pneumonia* colonization of the perineal skin in male spinal cord injured patients and found a significant correlation between increased pH of the perineal skin and the presence of *Pseudomonas aeruginosa* but not in other bacterial species. Montgomerie *et al*[15] showed that *Klebsiella pneumonia* colonization was significantly associated with external condom catheter usage and increased with length of stay in the hospital.

In our study the distribution of colonization was different among male and female patients. Bennett *et al*[16] studied the urinary tract infections in female and male spinal cord injured patients and found a higher incidence of urinary tract infections in females with *Eschericia coli*.[16] They concluded that this difference could be related to the proximity of bowel/stool contamination. Supporting this conclusion we found a significantly higher identical colonization of perineum and labium/dorsum of penis with urine in female patients than those of males.

Organisms may enter the bladder through three ways in patients with indwelling catheter: (1) at the time of catheter insertion; (2) through the catheter lumen; or (3) along the catheter-mucosa interface.[17–20] Insertion of a catheter may push or drag urethral organisms into the bladder. The lumen and external surfaces of the indwelling catheter act as conduits for bacterial entry into the bladder. The tube offers a niche on its luminal and external surfaces for bacteria to develop a microenvironment. Another route for bacterial entry exists in the space between the external catheter and the urethral mucosa. The duration of catheterization is an important risk factor for the development of catheter associated bacteriuria.[21,22] For chronic urine retention of spinal cord injured patients with neurogenic bladder dysfunction, prolonged intermittent catheterization is useful.[23–25] Insertion of a catheter intermittently, drainage of urine, and immediate removal, of the catheter provide a periodic bladder emptying. Inserting the catheter seems to be the only way for bacterial entry in patients applying intermittent catheterization. Intermittent catheterization may provide a better hygenic care by the regular antiseptic procedures performed periodically. Moreover fecal contamination of the indwelling catheter may result in more favorable bacterial growth conditions. Therefore when comparing the identical colonization of the two groups we expected more identical colonization in patients with indwelling catheter but we found no statistically significant difference in presence/distribution of colonization between the patients with indwelling and intermittent catheterizations.

Educational status may be a factor affecting the personal hygienic care. The neurological level of the lesion and the extent of incompleteness are the major predictive factors for the functional outcome of spinal cord injured patients. The patients become more dependent in self care activities with higher neurological levels and more complete lesions. In our study patients having complications such as spasticity, contractures, decubitis ulcers which could effect the functional outcome were excluded in order to ensure standardization. We expected more identical colonization in patients with lower educational status, with higher neurological level, and with more complete lesion but we could not find any difference in the presence/distribution of colonization regarding these parameters. This could be related to standard nursery care in the hospital. In our opinion, performing a similar study to spinal cord injured outpatients and doing follow-up studies could be beneficial to show these relations.

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