

## EFFECT OF CLEAN INTERMITTENT CATHETERIZATION ON LOWER URINARY TRACT: AN EXPERIMENTAL STUDY

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**Objective** To investigate the effect of clean intermittent catheterization (CIC) on the lower urinary tract in experimental animals.

**Patients and Methods** Eight male spinalized cats were subjected to CIC for a period of 6 – 9 weeks. A urine specimen for culture was obtained weekly. A pathological examination of the proximal and distal urethra and the bladder was performed.

**Results** Urinary tract infection was detected in all cats starting from the second week. It responded to antibiotics but recurrence occurred after discontinuing the treatment. One animal died in the 4<sup>th</sup> week from fibrinopurulent peritonitis caused by necrotizing ulcerative cystitis. False passage occurred in another cat at the end of the 6<sup>th</sup> week. It was managed by fixation of a urethral catheter for a week, and CIC was then continued for another two weeks. Pathological examination showed a thickening of the urethral wall that progressed on continuation of CIC. Microscopic examination of the

urethra showed epithelial hyperaemia, ulceration and an inflammatory reaction with oedema as well as an inflammatory reaction of the lamina propria. The muscular layer showed progressive hypertrophy on continuation of CIC. The bladder wall showed epithelial ulceration, Brunn's nests and squamous metaplasia with islands of degenerated cells.

**Conclusion** Recurrent urinary tract infection, local traumatic reactions of the urethral and bladder wall, especially epithelial damage of the mucosa, and false passages are common complications occurring with CIC in the experimental animal. Although the situation in the experimental animal has no significant relevance in humans, yet, it may throw light on some aspects of possible complications of long-term CIC.

**Key Words** clean intermittent catheterization (CIC), experimental animal, urethral, spinal cord injuries

### INTRODUCTION

Clean intermittent catheterization (CIC) has been considered a well established procedure in the management of patients with neurogenic urinary retention and other voiding dysfunctions. It was first introduced by Guttman and Frankel<sup>1</sup> and popularized by Lapides and associates<sup>2</sup>. This technique is also part of the management of patients with other urologic disorders for the prevention of the recurrence of urethral stricture following urethrotomy<sup>3</sup> and after augmentation or substitution cystoplasty<sup>4</sup>. Nevertheless, CIC has been associated with several potential complications. Urinary tract infection is one of the major problems<sup>5</sup>. The other complications include urethritis<sup>6</sup>, trauma to the urethra including the creation of a false passage<sup>7,8</sup>, urethral stricture<sup>7</sup>, epididymitis<sup>7</sup>,

bladder stones and renal stones<sup>7,8</sup>, perforation of augmented segments<sup>9</sup>, and the psychosocial impact of daily urethral catheterizations<sup>8</sup>.

Since CIC is a lifelong treatment, especially for patients with neurogenic bladder dysfunction, this animal study was designed to evaluate the effects of long-term CIC on the urethral and bladder wall.

### MATERIAL AND METHODS

The study was conducted on 8 male mongrel cats, weighing between 2.8 and 3.4 kg. Spinal cord transection was performed under general anaesthesia (ketamine HCL 25mg/kg im.) through T5-6 laminectomy. The spinal cord was visualized, raised up on a hook and

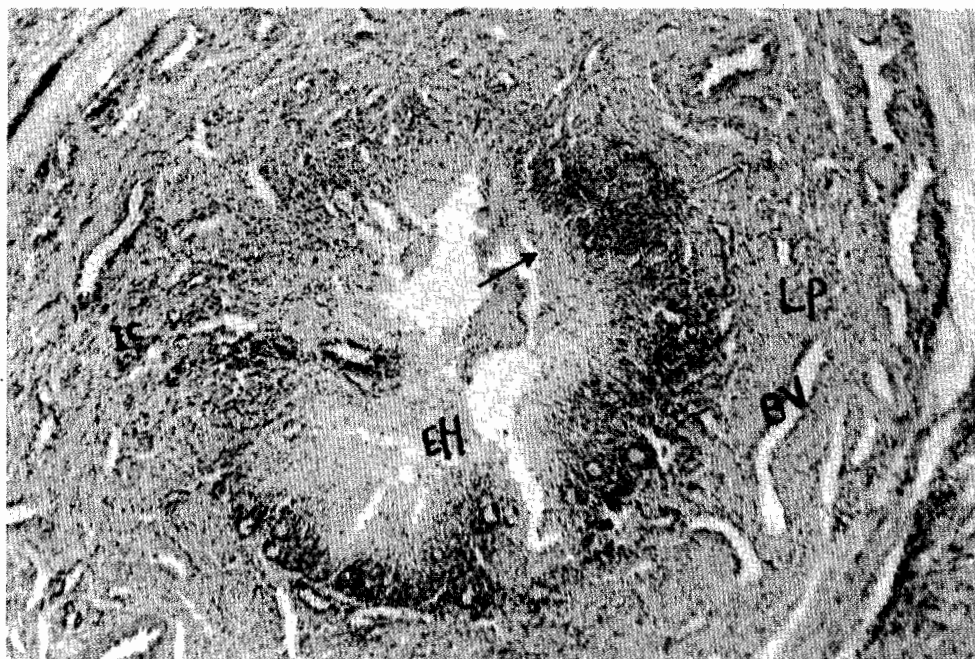


Fig. 1: Photomicrograph of a tissue section of the distal part of an adult male cat urethra after 7 weeks of CIC showing epithelial hyperaemia (EH) and ulceration (arrow). The lamina propria (LP) shows an inflammatory reaction in the form of engorgement with blood vessels (BV) and inflammatory cells (IC). (H & E x 250)

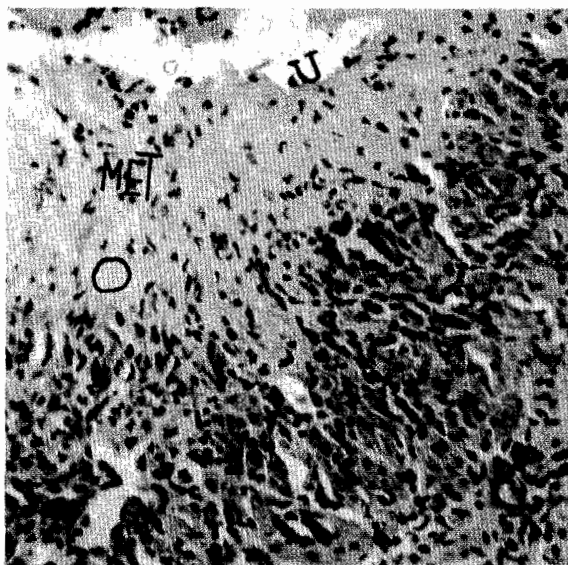


Fig. 2: Photomicrograph of a tissue section of the proximal part of an adult male cat urethra after 8 weeks of CIC showing epithelial ulceration (U), oedema (O) and metaplasia (MET). (H & E x 400)

possible sterile polyvinyl chloride catheter (3 Fr. Tom cat catheter) with a closed end and two side holes (Sherwood Medical, St. Louis, MO, USA) was used only once at a time. After retracting the prepuce and sterilization of the external urinary meatus with povidone iodine, a well lubricated catheter was inserted. Urine analysis and culture was performed weekly. Specimens were taken through suprapubic aspiration. A growth of 10<sup>5</sup> or more bacteria per cc urine was considered significant. Urinary tract infection was treated according to the sensitivity test. The cats were sacrificed after 6 to 9 weeks (2 cats every week). A gross examination of the lower urinary tract was done. The bladder, urethra, and surrounding organs were removed *en masse* and fixed in 10% formalin. The organs were dissected and each part of the urethra and bladder was identified. The tissues were blocked in paraffin, sectioned and stained with haematoxylin and eosin.

## RESULTS

Urinary tract infection was detected in all cats starting from the second week of CIC. It responded to antibiotics but recurrence occurred after discontinuing the treatment. The

completely transected. A piece of gelfoam was packed in the site of the transection for haemostasis. The wound was then closed in layers. The bladder was drained by clean intermittent catheterization twice a day. A dis-

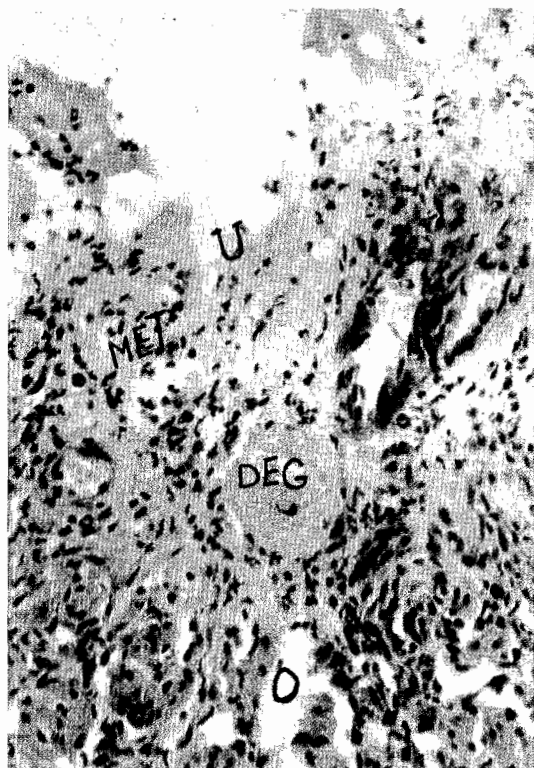


Fig. 3: Photomicrograph of a tissue section of the distal part of an adult male cat urethra after 9 weeks of CIC showing epithelial ulceration (U), oedema (O), degeneration (DEG and metaplasia (MET). (H & E x 400)

urine aspect became turbid between day 5 and 8, while the urine culture became positive between day 9 and day 17. *E. coli* was the causative organism in all cats except in one in which it was a mixed urethral flora with *E. Coli*. The cats were treated with trimethoprim (15 mg/Kg) combined with sulfamethoxazole (150 mg/Kg) for 7 days. One animal died in the 4th week from fibrinopurulent peritonitis caused by necrotizing ulcerative cystitis. False passage occurred in another one due to difficult catheterization at the end of the 6th week; it was managed by fixation of a urethral catheter for a week, and CIC was then continued for another two weeks. Pathological examination showed a thickened urethral wall that progressed with the continuation of CIC. Microscopic examination of the urethra showed epithelial hyperaemia (Fig. 1), ulceration with partial shedding of the epithelial layers (Fig. 2, 3), to complete shedding of all epithelial layers, even the basement membrane and superficial layer of the lamina propria (Fig. 4). The lamina propria showed an inflammatory reaction with oedema (Fig. 1, 3).

The preprostatic muscular layer of the urethra showed a progressive hypertrophy with continuation of CIC (Fig. 4). The bladder wall showed Brunn's nests, squamous metaplasia with islands of degenerated cells (Fig. 5) and epithelial ulceration (Fig. 6).

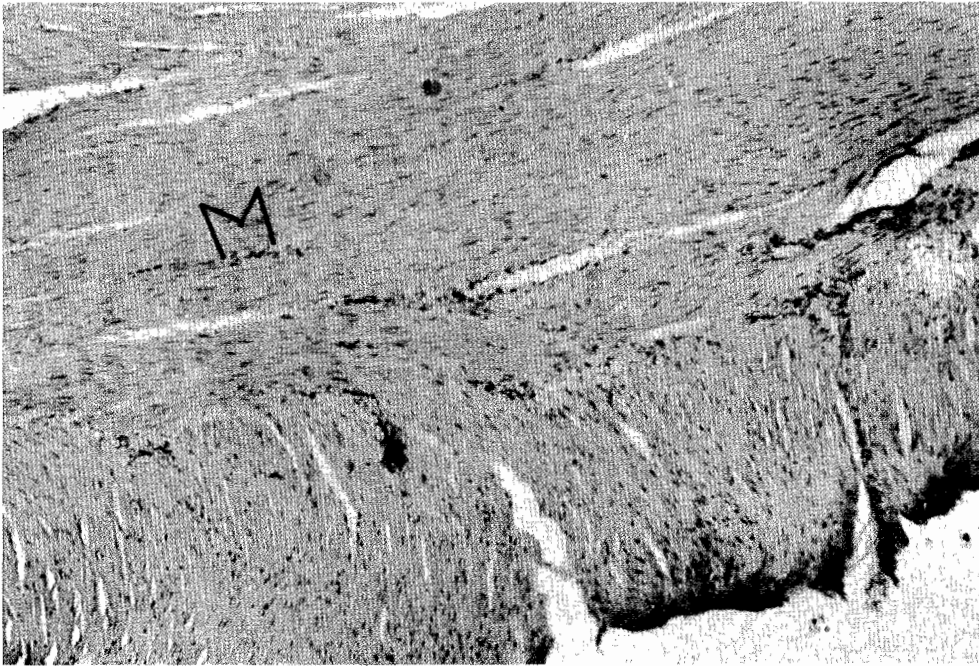
## DISCUSSION

This experimental work was done to detect the effect of repeated catheterization of a normal urethra on the urethral and bladder wall. The cats were spinalized to facilitate a repeated catheterization without sedation or anaesthesia.

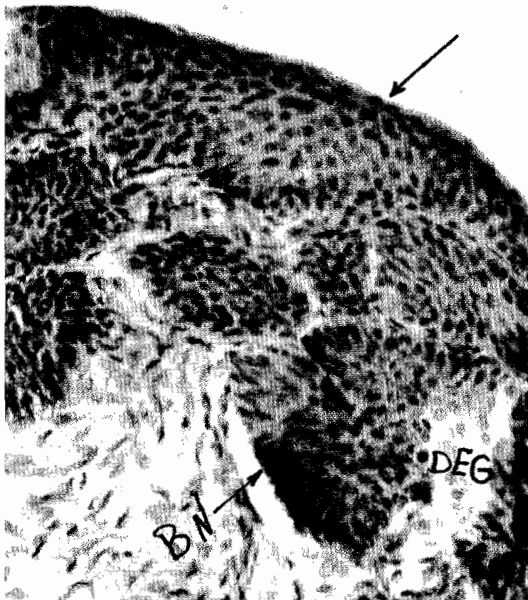
The male cat urethra is 8.5 to 10.5 cm long. It is divided into 5 parts, preprostatic, prostatic, postprostatic, bulbous, and penile urethra. The inner diameter ranges from 0.9 at the preprostatic urethra up to 5 mm at the prostatic urethra. The wall of the urethra is composed of epithelium, submucosa, and muscle layer. The latter is composed of three layers of smooth muscle at the preprostatic urethra similar to the bladder wall while distally to the prostate the striated muscle becomes prominent. The urethra bends ventrally at the bulbous urethra<sup>10</sup>. False passage occurred at this region in one of the cats.

Periodic significant bacteriuria associated with pyuria was detected in all animals. Urinary tract infection has been reported in several studies as a complication of CIC in humans with significant bacteriuria found in 50-86% of patients treated with CIC<sup>11,12</sup>. *E. coli* that is commonly found in CIC patients was also the dominating species found in the urine samples obtained from the cats. The majority of CIC patients with bacteriuria studied by Bakke and Digranes had no symptoms, and bacteriuria per se does not seem to be an indication for treatment in most of these patients<sup>13</sup>. Previous clinical studies of catheters with hydrophilic coating have, in some instances, shown a delay in the onset of significant bacteriuria<sup>14</sup>.

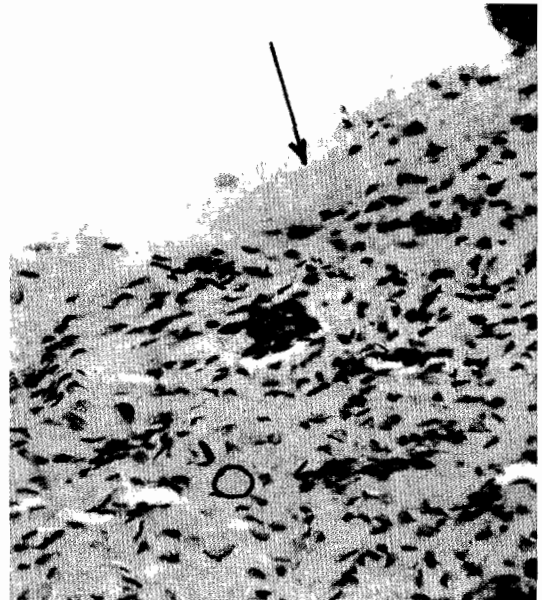
In the present study microscopic examination of the cat urethra and bladder showed oedema, epithelial ulceration, inflammatory reaction, muscle hypertrophy of the preprostatic part of the urethra that increased with the duration of CIC, squamous transformation of the epithelium of the bladder and Brunn's nests. These results confirm previous clinical observations that showed several urethral and blad-



**Fig. 4:** Photomicrograph of a tissue section of the muscle layer (M) of the preprostatic urethra of an adult male cat after 9 weeks of CIC showing progressive muscular hypertrophy. (H & E x 400)



**Fig.5:** Photomicrograph of a tissue section of the bladder of an adult male cat after 9 weeks of CIC showing Brunns nests (BN) and squamous metaplasia of the epithelium (arrow) with islands of degenerated epithelial cells (DEG) (H & E x 400)



**Fig. 6:** Photomicrograph of a tissue section of the bladder of an adult male cat after 8 weeks of CIC showing complete shedding of the epithelium (arrow) and oedema of the lamina propria. (H & E x 400)

der complications in patients on CIC. Urethritis, epithelial ulceration, and false passage were the most common complications. These complications tend to increase with the duration of CIC<sup>6,15-17</sup>. In spite of reports describing the use of hydrophilic small catheters and a liberal use of jelly to reduce local traumatic reactions of the urethral wall induced by repeated introduction of the catheters<sup>17-19</sup>, Wyndaele and Maes concluded that this did not seem to prevent urethral irritation and trauma in patients performing long-term CIC<sup>15</sup>.

In conclusion, clean intermittent catheterization which is an established option in the management of neurogenic voiding dysfunction is not without complications. Recurrent urinary tract infection, local traumatic reactions of the urethral and bladder wall, especially epithelial damage in its mucosa, and false passages are common complications occurring with CIC. Although the situation in the experimental animal has no relevance to the human situation, yet, it may throw light on some aspects of the complications of long-term CIC. Therefore, a periodic clinical follow up and a prophylactic suppressive dose of antimicrobial drugs are highly recommended to reduce such complications.

#### REFERENCES

- Guttmann L, Frankel H. The value of intermittent catheterization in the early management of traumatic paraplegia and tetraplegia. *Paraplegia* 1966, 4:63.
- Lapides J, Diokno AC, Silber AJ, Lowe BS. Clean, intermittent self catheterization in the treatment of urinary tract disease. *J Urol* 1972, 107:458.
- Robertson GSM, Everitt N, Lamprecht JR, Brett M, Flynn JT. Treatment of recurrent urethral strictures using clean intermittent self-catheterization. *Brit J Urol* 1991, 68:89.
- Singh G, Thomas DG. Intermittent catheterization following enterocystoplasty. *Brit J Urol* 1995, 76:175.
- Kass EJ, Koff SA, Diokno AC, Lapides J. The significance of bacilluria in children on long-term intermittent catheterization. *J Urol* 1981, 126:223.
- Lapides J, Diokno AC, Gould FR, Lowe BS. Further observations on self-catheterization. *J Urol* 1976, 116:169.
- Maynard FM, Diokno AC. Clean intermittent catheterization for spinal cord injury patients. *J Urol* 1982, 128:477.
- Klauber GT, Sant GR. Complications of intermittent catheterization. *Urol Clin N Am* 1983, 10:557.
- Elder JS, Snyder HM, Hulbert WC, Duckett JW. Perforation of the augmented bladder in patients undergoing clean intermittent catheterization. *J Urol* 1988, 140:1159.
- Wang B, Bhadra N, Grill WM. Functional anatomy of the male feline urethra: Morphological and physiological correlations. *J Urol* 1999, 161:654.
- Bakke A, Vollset SE. Risk factors for bacteriuria and clinical urinary tract infection in patients treated with clean intermittent catheterization. *J Urol* 1993, 149:527.
- Perkash I, Giroux J. Clean intermittent catheterization in spinal cord injury patients: a follow up study. *J Urol* 1993, 149:1068.
- Bakke A, Digranes A. Bacteriuria in patients treated with clean intermittent catheterization. *Scand J Infect Dis* 1991, 23:577.
- Roberts JA, Kaack MB, Fussell EN. Adherence to urethral catheters by bacteria causing nosocomial infections. *Urology* 1993, 41:338.
- Wyndaele JJ, Maes D. Clean intermittent self-catheterization: a 12-year follow up. *J Urol* 1990, 143:906.
- Waller L, Jonsson O, Norlen L, Sullivan L. Clean intermittent catheterization in spinal cord injury patients: long-term follow up of a hydrophilic low friction technique. *J Urol* 1995, 153:345.
- Hedlund H, Hjelmas K, Jonsson O, Klarskov P, Talja M. Hydrophilic versus non-coated catheters for intermittent catheterization. *Scand J Urol Nephrol* 2001, 35:49.
- Carlsten J, Bowald S, Sullivan L, Nilsson A. Effect of catheterization and surface osmolarity on urethral epithelium. An experimental study on dogs. *Pros Int Med Soc Paraplegia* 1985.
- Kaye MC, Levin HS, Montague DK, Pontes JE. Squamous cell carcinoma of the bladder in a patient on intermittent self-catheterization. *Cleve Clin J Med* 1992, 59:645.

**Editorial Comment:**

This paper describes the changes and complications of CIC in a spinalized cat model showing a lot of complications. It should be mentioned, though, that the situation of the cat does not represent the human situation. In the human, this line of therapy is now the *standard of care*, since the alternative of indwelling catheter is worse.

**Reply of the Author:**

We absolutely agree that CIC is now considered the standard management of patients with a weak detrusor power whatever the cause, and we want to emphasize that this work is not against this modality of treatment. However, the point is that it may throw some light on the side effects of the long-term use of CIC. Like other treatment options, it is not without complications. As for our using spinalized cats as an animal model, this has been done – and still is – in many centers for investigations on the neurogenic bladder, and many basic ideas in bladder neurophysiology and neuropathology have been established from the work on cats as an animal model. In our study we used spinalized cats mainly in order to facilitate the procedure of catheterization.

**RESUME**

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