



## Clean intermittent catheterization and prevention of renal disease in spinal cord injury patients

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Upper urinary tract complications have been reported in about 20–30% of spinal cord injury patients. Their pathogenesis is linked to the presence of high-pressure uninhibited detrusor contractions, high leak point pressure and low bladder compliance. The aim of this study was to evaluate the incidence of upper urinary tract complications in two homogeneous groups of spinal cord injury patients with different bladder emptying modalities (intermittent catheterization vs. tapping, abdominal straining, Crede's manoeuvre) and the relationship with clinic and urodynamic features. A total of 17 patients (22%) had upper urinary tract complications. The incidence of both urinary tract dilatation and vesicoureteral reflux was significantly lower in patients having intermittent catheterization ( $P=0.03$  and  $0.04$  respectively). Intermittent catheterization thus seems to be effective in preventing upper urinary tract disease in spinal cord injury patients requiring mechanical bladder emptying modalities. The finding of upper urinary tract complications also in patients having intermittent catheterization showing high intravesical pressures stresses the need of adding anticholinergic medications to the rehabilitation regimen of these patients.

**Keywords:** upper urinary tract dysfunction; spinal cord injury; intermittent catheterization; urodynamics

### Introduction

In spite of the progress made during recent years in the urological rehabilitation of Spinal Cord Injury (SCI) patients, upper urinary tract abnormalities remain frequent complications, and can lead to deterioration of renal function, thus being associated with a high risk of morbidity and mortality.<sup>1</sup> However no consensus exists regarding the real incidence of upper urinary tract involvement which varies from 0 to 33% of the patients.<sup>2,3</sup> Improvements in the management of bladder and sphincter dysfunctions in SCI patients have significantly decreased these risks. Several methods of urinary tract drainage exist for SCI patients; among these, intermittent catheterization, in the form of sterile or clean technique, is a well established emptying modality.<sup>4–6</sup>

The aim of this retrospective study was to define more clearly the role of clean intermittent catheterization in the prevention of vesicoureteral reflux and ultimate renal disease.

### Patients and methods

Between January 1992 and December 1995 we observed 215 SCI patients, of these, 78 post-traumatic

ones at their first urological assessment in our hospital were selected according to the following criteria: disease duration longer than 12 months after recovery from spinal shock, no previous medications, no urinary tract infection at the time of urological evaluation, no history of bladder and renal disease previous to the spinal cord lesion. All the patients underwent a complete neurological examination performed by a neurologist experienced in the disease according to the criteria of the American Spinal Injury Association.<sup>7</sup> There were 57 males and 21 females; mean age was  $35.1 \pm 13.2$  years and mean disease duration  $89 \pm 108$  months.

Patients were divided into two homogeneous groups (with regard to gender, age, disease duration, level and completeness of lesion) according to bladder emptying modalities: group 1, patients under clean intermittent catheterization (CIC) regimen; group 2, patients with other bladder emptying modality regimens (five under abdominal straining, 23 under tapping, three using Credè's manoeuvre, five with indwelling catheter and seven with spontaneous voiding).

Urodynamic investigation was performed in all patients, according to the standards of the International Continence Society<sup>8</sup> except when specifically noted. When urodynamic investigations were being done, no patient was having any type of pharmaco-

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logical treatment (anticholinergic or alpha blocking drugs) influencing bladder and sphincter behaviour; some of the patients have had such treatment for short periods in the past, but it was discontinued because of severe side effects or because of the absence of urinary incontinence. Patients who had a urinary infection were also excluded. Urodynamic evaluation consisted of cystometry with water at 37°C and a filling rate of 50 ml per min through a 6F double lumen catheter with the patients in the supine position. Abdominal pressure was measured with 10F intrarectal balloon catheter. Pelvic floor electromyography was recorded during cystometry with a bipolar wire electrode in the urethral sphincter.

The presence of detrusor hyperreflexia (DH), areflexia (DA), and sphincter dyssynergia (DSD) as defined by the standards of the International Continence Society,<sup>3</sup> was noted. DSD was classified into three classes according to Blaivas and Barbalias's criteria.<sup>9</sup> For patients with detrusor hyperreflexia leak point pressure was also noted.

Bladder capacity was assumed to be reduced if <200 ml, and increased if >500 ml. Bladder compliance was defined as the bladder volume vs intravesical pressure ratio (ml/cm water); it was assumed as reduced if <12.5 ml/cm water.<sup>10</sup>

Renal function was studied by means of BUN, creatinine and creatinine clearance evaluation. Lower (LUT) and upper urinary tract (UUT) were evaluated by ultrasound (US), intravenous excretory pyelogram (IVP) and/or voiding cystourethrography (VCUG). Upper urinary tract involvement was defined as the presence of pyelonephritis, hydronephrosis, renal stone formation or vesicoureteral reflux.

Statistical analysis was performed by means of  $\chi^2$  test or Fisher's exact test to assess contingency tables. Differences between means were assessed by the Student's t-test. Significance was assumed for  $P=0.05$  or less.

## Results

In the entire group of patients the mean duration of indwelling catheterization was  $77.1 \pm 78.2$  days.

The rate of symptomatic urinary infections was  $4.4 \pm 0.7$  infections/year (min 1, max 7) in group 1 and  $5.1 \pm 1.1$  (min 3, max 9) in group 2 ( $P=0.067$ ).

Group 1 was composed of 35 patients (26 males and nine females, mean age 33.2 years, mean disease duration 65 months, mean duration of indwelling catheterization  $67.9 \pm 54.1$  days); 25 patients drained their bladder by intermittent catheterization performed by themselves (included two of the tetraplegics). Group 2 was made of 43 patients (31 males and 12 females, mean age 36.7 years, mean disease duration 74 months, mean duration of indwelling catheterization  $75 \pm 63$ ); the clinical features of the two groups are described in Table 1. In group 1, 18 patients showed detrusor hyperreflexia with detrusor-sphincter dyssynergia and 14 only detrusor hyperreflexia, three patients showed detrusor areflexia; in group 2, 35 patients showed detrusor hyperreflexia (26 with detrusor sphincter dyssynergia) and eight detrusor areflexia (the urodynamic features are shown in Table 2); none of these differences were statistically significant; patients with detrusor hyperreflexia did not show any significant difference with regard to urodynamic parameters; although maximum amplitude of uninhibited contractions was higher in group 2, this difference did not reach statistical significance ( $P=0.154$ ). With regard to detrusor sphincter dyssynergia the two groups did not show any significant difference in the incidence of the three types of dyssynergia.

Bladder morphological abnormalities on ultrasonography or cystourethrography were present in 22 patients in group 1 (17 males, five females, mean age  $33.5 \pm 14$ , min 13, max 73, mean disease duration  $68 \pm 75$ , min 22, max 200) and in 36 patients in group

**Table 1** Clinical features

|                                | Group 1                          | Group 2                          | p     |
|--------------------------------|----------------------------------|----------------------------------|-------|
| <i>Patients</i>                | 35                               | 43                               |       |
| Males/females                  | 26/9                             | 31/12                            | 0.82  |
| Mean age (years)               | $33.2 \pm 12.8$<br>min/max 13/73 | $36.7 \pm 13.5$<br>min/max 19/68 | 0.064 |
| Mean disease duration (months) | $65 \pm 73$<br>min/max 20/236    | $74 \pm 87$<br>min/max 26/331    | 0.073 |
| <i>Lesion level</i>            |                                  |                                  |       |
| Cervical                       | 8                                | 14                               | 0.34  |
| Dorsal                         | 23                               | 22                               | 0.19  |
| Dorso-lumbar                   | 2                                | 1                                | 0.43  |
| Lumbo-sacral                   | 2                                | 6                                | 0.36  |
| <i>Completeness of lesion*</i> |                                  |                                  |       |
| ASIA A-B                       | 33                               | 35                               | 0.09  |
| ASIA C-D                       | 2                                | 8                                | 0.09  |

\*According to the American Spinal Injury Association Impairment Scale

**Table 2** Urodynamic features

|   | Group 1     | Group 2     | p     |
|---|-------------|-------------|-------|
| Detrusor hyperreflexia/areflexia                        | 32/3        | 35/8        | 0.20  |
| Detrusor sphincter dyssynergia                          | 18          | 26          | 0.066 |
| Uninhibited contractions threshold (ml)                 | 217 ± 136.4 | 183.5 ± 159 | 0.08  |
| Uninhibited contractions amplitude (cmH <sub>2</sub> O) | 73.8 ± 26.9 | 88.6 ± 31   | 0.154 |
| Uninhibited contractions duration (sec)                 | 127 ± 54    | 142 ± 48    | 0.092 |
| Leak point pressure (cmH <sub>2</sub> O)                | 68 ± 24.3   | 80 ± 38     | 0.13  |
| Bladder capacity (ml)                                   | 391 ± 187   | 279 ± 191   | 0.07  |
| Reduced bladder compliance                              | 12/35       | 14/43       | 0.87  |

2 (27 males, nine females, mean age 37.7 ± 13.8, min 20, max 68, mean disease duration 77 ± 20, min 30, max 331) ( $P=0.03$ ).

With regard to upper urinary tract damage in the entire group of patients, 17 (21.7%) showed morphological abnormalities of UUT: four patients in group 1 (three males, one female, mean age 33 ± 12.1 years, mean disease duration 79 ± 89 months) and 13 (seven males, six females, mean age 38.1 ± 13.7, mean disease duration 90 ± 87) in group 2 ( $P=0.03$ ); vesicoureteral reflux was present in a total of 12 patients (16.6%): two male patients in group 1 and 10 patients in group two (seven males, three females, mean age 36.6 ± 16.4, mean disease duration 80 ± 69 ( $P=0.04$ ); the features of upper urinary tract damage are shown in Table 3. With regard to urodynamic features one of the patients in group 1 with vesicoureteral reflux showed an areflexic bladder with reduced compliance and the other a hyperreflexic bladder with high intravesical pressures. In group 2 two patients with vesicoureteral reflux showed an areflexic bladder (one with reduced compliance) and all the others a hyperreflexic bladder (nine with detrusor sphincter dyssynergia, three with reduced compliance). Renal function was preserved in all of the patients.

## Discussion

Urinary tract abnormalities are quite common after spinal cord injuries and represent a cause of morbidity and mortality.<sup>11</sup> The incidence of these abnormalities varies in the different series from 0%<sup>2,12</sup> to 12%<sup>13</sup> up to 33%.<sup>3</sup> The occurrence of upper urinary tract involvement seems to be independent from gender, patients' age, disease duration, lesion level and completeness,<sup>11</sup> while there is no consensus on the relationship between urodynamic features, bladder management and upper urinary tract damage.<sup>11,14–19,20</sup>

The aim of this study was to examine the influence of bladder emptying modalities on the upper urinary tract; it is interesting because of the homogeneity of the two groups with regard to clinical and urodynamic features and most of all because none of the patients had responded usefully to pharmacological treatments (anticholinergic and/or alpha-blockers) which could have influenced bladder and sphincter behaviour and consequently the upper urinary tract; thus the bladder

**Table 3** Upper urinary tract abnormalities

|                       | Group 1 | Group 2 | p    |
|-----------------------|---------|---------|------|
| <i>Patients</i>       | 4       | 13      | 0.03 |
| Hydronephrosis        | 2       | 7       |      |
| Bilateral             | 1       | 5       |      |
| Monolateral           | 1       | 2       |      |
| Renal stones          | 2       | 6       |      |
| Bilateral             | 0       | 2       |      |
| Monolateral           | 2       | 4       |      |
| Vesicoureteral reflux | 2       | 10      | 0.04 |
| Bilateral             | 1       | 0       |      |
| Monolateral           | 1       | 10      |      |

emptying modality remains the only parameter that could significantly influence upper urinary tract involvement.

With regard to the incidence of upper urinary tract abnormalities our epidemiological data confirm what has been previously reported by other authors; and our data seems to confirm the independence of upper urinary tract involvement by gender, age, disease duration, completeness and level of lesion already reported.<sup>11</sup>

Our data also confirms the main role of clean intermittent catheterization for the prevention of vesicoureteral reflux and urinary tract abnormalities in SCI patients, as has been previously reported by the majority of authors:<sup>13,14</sup> the incidence of upper urinary tract abnormalities was significantly lower in patients having the clean intermittent regimen compared to patients with other bladder emptying modalities ( $P=0.03$ ). This difference does not depend upon different clinical features, and furthermore it does not depend upon different bladder and sphincter behaviours: in the two groups, indeed, the incidences of detrusor hyperreflexia and areflexia, detrusor sphincter dyssynergia, reduced bladder compliance and capacity were exactly the same in group 1 and group 2 (Table 2).

Finally there was no significant difference in the two groups with regard to urinary infection rates and the duration of indwelling catheter; two factors that could influence urinary tract outcome.

In our opinion clean intermittent catheterization helps to prevent upper urinary tract involvement because:

- (1) it allows regular rhythmic bladder emptying with a low bladder pressure, whereas most of the other modalities act by increasing the bladder pressure until it overcomes urethral pressure;
- (2) as already reported by many authors<sup>20,21</sup> if correctly performed it helps to prevent urinary tract infection: high residual volumes and bladder overdistension produce bladder wall ischemia and reduce host resistance to infections;
- (3) it allows complete bladder emptying; avoiding residual urine means to reduce the possibility to reach uninhibited contractions threshold and finally reduce exposure of bladder and upper urinary tract to high pressures.

Points 1 and 3 could also explain why patients with detrusor hyperreflexia in group 2 had the poorest urodynamic features (lower threshold and higher amplitude detrusor uninhibited contractions).

In our series we observed a high incidence of detrusor hyperreflexia and also in group 1 patients the presence of significant bladder abnormalities; vesicoureteral reflex was also present in two patients who performed clean intermittent catheterization and was associated with the presence of reduced bladder compliance or high amplitude uninhibited contractions; all of these data stress the need to have anticholinergic medications in the rehabilitation regimen of SCI patients: adding an anticholinergic drug (oxybutinine or propantheline *per os* or by bladder instillation) to clean intermittent catheterization may help to achieve continence and avoids high bladder pressures during urine storage and uninhibited detrusor contractions, thus helping to prevent bladder and upper urinary tract abnormalities.

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