The morbidity due to lower urinary tract function in spinal cord injury patients

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A review is given of 105 patients with a traumatic spinal cord injury. In 93 patients with a minimum follow up of one year the morbidity due to lower urinary tract function was evaluated, based on the situation at their last control visit. The relation was studied between bladder behaviour and the type of urine evacuation and their influence on upper urinary tract problems, urinary tract infections, stone formation and incontinence. Based on the results of this study the most appropriate method for control of bladder behaviour and urine evacuation in spinal cord injured patients is discussed in view of new treatment modalities such as dorsal rhizotomies and the implantation of an anterior sacral root stimulator.

Keywords: spinal cord injuries; neurogenic lower urinary tract dysfunction; morbidity.

Introduction

Great progress has been made during the last 25 years in the urological rehabilitation of patients with a spinal cord injury. Nevertheless these patients continue to develop complications such as urinary tract infections, stones of the upper and the lower urinary tract and deterioration of the bladder. Furthermore upper urinary tract problems can develop due to reflux and/or obstruction and these, with or without urinary tract infections as additional complications, can lead to deterioration of kidney function. Incontinence remains another important problem for these handicapped people.

However no consensus exists on the real incidence of morbidity due to lower urinary tract function in spinal cord injury patients. Although a number of interesting articles review the urological problems following spinal cord injury, most authors present a prospective study of consecutive patient groups that had a strict follow up. Such follow up is not always achieved and, even when the medical care is well organised, the

daily practice proves that the control of individual patients tends to be less scrupulous with time. Even in the published prospective series the incidence of urological problems varies much depending on the follow up, the composition of the patient groups and the treatment(s) that were proposed.

In an important study on the 25-year prospective mortality in veterans of the Korean and the second world war the mortality rate was 49% after 25 years, with renal disease as the major cause of death in 43% of those who died.¹ In this group, 44% of the patients had a Foley catheter at the time of evaluation. Vesicourethral reflux was present in 14.2% of the whole group and hydronephrosis in 14%. The group with the most important renal deterioration comprised patients with upper motor neuron lesions who were maintained on a Foley catheter. The high morbidity rate can probably be explained by the fact that in this study only 3 out of 175 patients were female.

A British study presents a survey of 406 traumatic spinal cord injury patients admitted from 1967 to 1982.² In this group

only 0.5% of the patients died from renal complications, being 5% of all deaths. At the last review 46% of the patients were appliance free and only 5.5% used permanent catheter drainage. Upper tract abnormalities were found in 14% of the patients and stones in 8%. In this series 84% were male and 16% female. The most striking feature of this study is the low incidence of death from renal failure.

Since there is a difference in the risk for upper tract problems between the male and the female population and since incontinence is a more difficult problem in women, some series deal especially with the female population with spinal cord injury.

In another British study a difference was found in the mortality between males and females.³ In a group of 86 females no single patient died from urological causes whereas 13 (1.7%) in a group of 775 males died from renal failure. In the female group 3 patients underwent a urinary diversion and 28 were managed with a permanent catheter drainage. In a group of 124 Irish women with a spinal cord injury, 22% had a permanent catheter drainage and 2 had undergone a urinary diversion because of intractable incontinence.⁴ Twenty-four patients (19%) underwent operative procedures on their urinary tract, mostly because of bladder stones.

The aim of the present study is to evaluate morbidity due to lower urinary tract function in consecutive patients with a spinal cord injury, controlled in a urology department. The incidence of urological morbidity was based on the rate of urinary tract infections, the presence of urinary tract stones, the importance of incontinence problems and the incidence of upper urinary tract deterioration.

Patients and methods

Between January 1985 and January 1992, 105 patients with a traumatic spinal cord injury were seen for urological evaluation. There were 78 males (74.3%) and 27 females (25.7%). The age at the moment of the spinal cord injury varied between 0 and 77 years, with a mean age of 31.5 years. Patients with a congenital spinal cord

Table I Follow up status of all patients

Years	Number	Control 1991
> 20	9	4
15–20	12	11
10–15	9	6
5–10	28	23
1–5	35	25
< 1	12	12
Total patients	105	81
Total > 1	93	69

problem were excluded from this study. However 7 patients with a spinal cord injury due to an arteriovenous malformation were included. The patient of 0 year at the moment of the injury had a birth injury but was controlled till the age of 20.

The mean follow up was 93.7 months (7.8 years) with a range between 1 and 456 months. In 12 patients (11.4%) the follow up was less than one year. An overview of the follow up is given in Table I.

Patients with complete and incomplete lesions at all different levels, from cervical to sacral, are represented in this series. However since the classification of the patients was based on the urodynamic behaviour of the lower urinary tract (bladder and urethra) no separate classification was done depending on either the degree or the level of the injury.

All patients had a complete urodynamic evaluation during the first screening. The urodynamic investigation was repeated whenever the clinical situation altered or in case of problems persisting after treatment. Videocystography was performed, usually in combination with the urodynamic investigation. In addition, an intravenous urogram was obtained at the initial screening. Further follow up of the urinary tract was based on regular ultrasonic examination of the kidneys. If any abnormalities appeared on the ultrasonic examination the intravenous urography was repeated. In case of suspicion of obstruction of the upper tract, renal scintigraphy with I-Hippuran or Tc-99m-Mag 3 was performed.^{5,6} This examination allows one to distinguish dilatation with or without obstruction based on the efflux curve of the radioisotope after the

injection of furosemide. Kidney function was estimated with a 24-hour creatinine clearance or with a Tc-99m-Mag 3 clearance.⁶

In the group of 105 patients, 4 died of nonurological causes (3 men, one woman). Of the total group of 105 patients 81 (77.1%) had a regular urological control and 93 patients (88.6%) had a minimum follow up of one year. In these 93 patients morbidity due to the function of the lower urinary tract was evaluated based on the situation at their last control visit.

The group of 93 patients with a minimum control of one year consisted of 70 males (75.3%) and 23 females (24.7%) of whom 69 (74.2%) had their last follow up control in 1991.

Results

Of 93 patients with a minimum follow up of one year, 48 (51.6%) presented a detrusor hyperreflexia with a coordinate sphincter mechanism, 14 (15.1%) had a detrusor hyperreflexia with a proven discoordinate sphincter mechanism and 31 (33.3%) presented a detrusor areflexia.

The method of evacuation of urine was noted as on the last follow up visit (Table II). Eight different forms of urine evacuation could be distinguished.

Suprapubic tapping was used during the whole follow up period by 18 patients (19.3%). All patients had a detrusor hyperreflexia, 3 with proven detrusor–urethral

dyssynergia and 15 without proven dyssynergia.

The Crd manoeuvre was performed by 22 patients (23.7%) of whom 6 had a detrusor hyperreflexia which generated too little pressure to empty the bladder with tapping and who refused intermittent catheterisation. The other 16 patients performing the Crd manoeuvre had detrusor areflexia and a weak pelvic floor, and could express urine with low intravesical pressure.

Clean intermittent catheterisation (CIC) was performed by 9 patients (9.7%), although 3 patients with a detrusor hyperreflexia and 2 of the 6 patients with a detrusor areflexia had used other evacuation methods previously.

A combination of different forms of urine evacuation was present in 22 patients. The combination of suprapubic tapping with clean intermittent catheterisation was used in 16 patients (17.2%) with a detrusor hyperreflexia, because of incomplete evacuation with tapping alone. For the same reason 4 patients used the combination of tapping with the Crd manoeuvre. In the group with a detrusor areflexia 2 patients (2.1%) emptied their bladder with a combination of Crd and intermittent catheterisation to reduce the number of catheterisations at their work.

Permanent catheter drainage, either suprapubic or transurethral, was present in 6 patients (6.4%). Four patients with a permanent catheter had a detrusor hyperreflexia and 2 a detrusor areflexia.

Table II Urine evacuation in relation to bladder behaviour

Urine evacuation	Bladder behaviour			Total
	Detrusor hyperreflexia	Detrusor hyperreflexia & dyssynergia	Detrusor areflexia	
Tapping	15	3	—	18
Cr��d��	4	2	16	22
ICC	1	2	6	9
Tapping + ICC	12	4	—	16
Tapping + Cr��d��	3	1	—	4
Cr��d�� + ICC	—	—	2	2
Catheter	4	—	2	6
Other ^a	9	2	5	16

^aBricker derivation, continent derivation, Brindley stimulator.

A surgical procedure that influenced the way of evacuation of urine was necessary in 16 patients. In 6 patients a urinary diversion following Bricker was performed during the follow up. This type of urinary diversion was necessary because of upper urinary tract problems in 4 patients (Table III) and because of severe and otherwise untractable incontinence in 2 other patients. Another 7 patients underwent intradural sacral posterior rhizotomies and the implantation of a Finetech-Brindley anterior sacral root stimulator.⁷ The indication for this procedure was mainly severe incontinence; often there were also recurrent urinary tract infections based on a large residual urine. A bladder augmentation with ileum (Clamcystoplasty) was performed in one patient and a supratrigonal bladder resection with a bladder replacement with ileum was necessary in another patient, because of low compliance bladder with severe incontinence. A male patient underwent a continent diversion with an Indiana pouch⁸ because of severe and progressive reflux, recurrent urinary tract infections, low bladder compliance and a scarred urethra due to recurrent urethral strictures.

Upper urinary tract problems

Since deterioration of the upper urinary tract is one of the most important medical problems in spinal cord injury patients, we tried to define in our series the patients at risk for upper tract problems. Upper tract

problems were divided into four categories: moderate dilatation without obstruction, severe dilatation without obstruction, dilatation with obstruction and reflux.

During the follow up 22 patients (23.7%) developed upper urinary tract problems (Table III). The time for the upper tract problems to appear varied from one month to 34 years (mean 10.6 years).

The group of patients with complications at the level of the upper urinary tract consisted of 15 males (68.2%) and 7 females (31.8%). Of the 22 patients, 17 had a detrusor hyperreflexia (10 without dyssynergia, 7 with dyssynergia) and 5 had a detrusor areflexia.

Moderate dilatation without proven obstruction was present in 14 patients (15.1%) of whom 7 had a detrusor hyperreflexia. Among these 7 there were 5 males (4 with a complete lesion and one with an incomplete lesion) and 2 females (one with a complete lesion and one with an incomplete lesion).

In 3 patients who developed moderate dilatation of the upper urinary tract without obstruction, all males (one with a complete lesion, 2 with an incomplete lesion), a detrusor hyperreflexia with dyssynergia was present. Another 4 patients with moderate dilatation without obstruction (2 males, 2 females, all with an incomplete lesion) had a detrusor areflexia.

In all of the patients with moderate dilatation without proven obstruction, the alterations of the upper urinary tract were

Table III Upper urinary tract problems (UUTP) in relation to bladder behaviour

Bladder behaviour	UUTP				Total
	Moderate dilatation without obstruction	Severe dilatation without obstruction	Dilatation with obstruction	Reflux	
Detrusor hyperreflexia	7 (5♂, 2♀)	—	2 (1♂ ^a , 1♀)	1 (♂ ^b)	10
Detrusor hyperreflexia & dyssynergia	3 (3♂)	2 (2♂)	1 (1♀ ^b)	1 (1♂ ^c)	7
Detrusor areflexia	4 (2♂, 2♀)	—	1 (1♀ ^b)	—	5
Total	14 (10♂, 4♀)	2 (2♂)	4 (1♂, 3♀)	2 (2♂)	22

^aTerminal kidney insufficiency, Bricker derivation, kidney transplantation

^bBricker derivation

^cContinent derivation

temporary and disappeared spontaneously or after changing the methods of urine evacuation.

Severe dilatation without proven obstruction appeared in 2 male patients with a detrusor hyperreflexia with dyssynergia. With an empty bladder no signs of obstruction were present on renal scintigraphy. One man performed the Crd manoeuvre for 3 years before dilatation appeared. Since he presented a reduction in the renal clearance, a suprapubic catheter was inserted for 6 months without any effect on the dilatation but with stabilisation of the clearance. A sphincterotomy was then performed. Two years after the sphincterotomy he had persistent dilatation but with a stable clearance. The other patient with severe dilatation without obstruction had emptied the bladder with suprapubic tapping for 9 years. He developed a retention and a transurethral catheter was put in place. After 3 months with partial recovery of the dilatation of the upper urinary tract, a sphincterotomy was performed. Four years after this his situation is stable without obstruction.

Severe dilatation with obstruction developed in 4 patients (one male and 3 females). The male patient had a detrusor hyperreflexia and developed a terminal kidney insufficiency due to progressive and irreversible dilatation of both upper urinary tracts 12 years after the spinal cord injury. In view of a future transplantation and due to the poor quality of the bladder, a Bricker diversion was performed. One year later a kidney transplantation was performed. Five years after the transplantation, the transplant kidney is functioning without any urological problems and with a stable kidney function.

A female patient with severe dilatation and obstruction of the upper urinary tract had a complete spinal cord injury and a detrusor hyperreflexia that was emptied with suprapubic tapping alone. She developed dilatation and obstruction 16 years after the injury and started intermittent clean catheterisation. At last follow up, 3 years after the initiation of the catheterisation, a slight dilatation without obstruction persists.

The second female patient with severe

dilatation and obstruction of the upper urinary tract had a complete lesion and a detrusor hyperreflexia with dyssynergia. She was seen with severe dilatation and obstruction 19 years after the injury. The bladder was emptied with the Crd manoeuvre and she refused to use intermittent catheterisation. Because of this and severe incontinence problems, a Bricker diversion was performed. The third female patient with severe dilatation and obstruction of the upper urinary tract had a partial lesion and a detrusor areflexia. She developed severe dilatation with obstruction due to alterations in the bladder quality 6 years after the spinal cord injury, in spite of a strict regime of intermittent catheterisation. Finally a Bricker diversion was performed. With a follow up of 6 months slight dilatation persists without obstruction.

Bilateral severe reflux (grade III–IV following Parkkulainen) developed in 2 male patients. One patient with a complete lesion and a detrusor hyperreflexia with high intravesical pressures developed bilateral reflux 3 years after the spinal cord injury and suffered from recurrent septic episodes. Six months later he underwent a Bricker diversion. At the last evaluation 6 years after the diversion, no infectious problems are present and his upper urinary tract is normal. Another male patient with an incomplete lesion and a detrusor hyperreflexia with dyssynergia developed severe dilatation due to the reflux and had recurrent infections 9 years after the lesion. In spite of maximal conservative treatment his kidney function deteriorated and finally 5 years later a continent diversion with an Indiana pouch was performed. This resulted in bilateral obstruction with the need for bilateral nephrostomies. Progressive decrease of his kidney function prohibits reconstructive surgery.

In total 5 patients needed major surgery to overcome the upper urinary tract problems which resulted in terminal kidney insufficiency in 2 of them.

Urinary tract infections

Urinary tract infections are another important cause of morbidity in patients with a spinal cord injury. Of the total group of 93

patients, recurrent and persistent urinary tract infections with fever or other clinical symptoms of infection were present in 21 patients (22.6%) (Table IV). Infection was defined as a combination of bacteriuria ($> 10^5$ per ml) and urinary leucocytosis (> 20 WBC/HPF of spun urine).⁹

The infections occurred in 19 males (91.3%) and only in 2 females (8.7%). The infections developed between one month and 17 years after the spinal cord injury with a mean of 6.3 years.

A detrusor hyperreflexia without proven dyssynergia was present in 9 patients, a detrusor hyperreflexia with proven dyssynergia in 5 and a detrusor areflexia in another 7 patients.

The group of 9 patients with a detrusor hyperreflexia were all male and had a complete lesion. Different types of urine evacuation were present. Tapping and tapping with Crd were used by one patient. Another patient had a permanent suprapubic catheter for 5 years. He presented with upper tract dilatation and overflow incontinence 12 years after the injury. Since he had severe autonomic dysreflexia on intermittent catheterisation and since he refused a sphincterotomy, a catheter drainage was his treatment of choice.

In total 3 patients with infections and a detrusor hyperreflexia emptied their bladder with the combination of suprapubic tapping and intermittent catheterisation. This means that 25% of the patients with a detrusor hyperreflexia that was emptied

with this combination presented recurrent infections. In the group with a detrusor hyperreflexia 3 patients underwent a surgical procedure. In 2 patients a Bricker diversion was necessary, also because of severe infections. In one patient infections started 6 years after the injury and at the last evaluation, 9 years after the Bricker diversion, no septic periods were present. In another patient a Bricker diversion was necessary because of decompensation of the bladder with large residuals and infections 2 years after the spinal cord lesion. However, because of persistent infections a secondary cystectomy was necessary another 2 years later. The third patient underwent sacral rhizotomies and implantation of a Finetech-Brindley stimulator 6 years after the injury because of recurrent infections and severe incontinence, although maximal conservative treatment was applied. With a follow up of one year he is continent and free of infections.

A detrusor hyperreflexia with dyssynergia was present in 5 male patients, 3 with a complete lesion and 2 with an incomplete lesion. Of this group of patients 2 empty their bladder with intermittent catheterisation, one with suprapubic tapping and 2 underwent surgery that changed the way of evacuation of urine. One patient underwent a Bricker diversion and developed kidney insufficiency that needed a kidney transplant later on. The other patient underwent a continent diversion with an Indiana pouch.

Table IV Bladder behaviour and method of urine evacuation in the patients with urinary tract infections

Urine evacuation	Bladder behaviour			Total
	Detrusor hyperreflexia	Detrusor hyperreflexia & dyssynergia	Detrusor areflexia	
Tapping	1	1	—	2
Cr��d��	—	—	3	3
ICC	—	2	1	3
Tapping + ICC	3	—	—	3
Tapping + Cr��d��	1	—	—	1
Cr��d�� + ICC	—	—	1	1
Catheter	1	—	—	1
Other	3	2	2	7
Total	9	5	7	21

Detrusor areflexia was present in 7 patients with infections (5 males, 2 females). The Crd manoeuvre was used by 3 patients with a partial lesion (2 males, one female). A man with a complete lesion performed intermittent catheterisation and in 2 patients surgery was performed. A female patient underwent a Bricker diversion 7 years after the injury because of infections and incontinence. In a male patient a Clam-cystoplasty was performed. He had a suprapubic catheter for 11 years but developed recurrent intractable infections and hydronephrosis during the year before surgery. With a follow up of 2 years he is without infections and has a normal upper urinary tract.

Urolithiasis

In total 11 patients (11.8%) (10 males, one female) developed urinary tract stones during the follow up (Table V). A detrusor hyperreflexia was present in 5 patients and a detrusor areflexia in 5 other patients. Only one patient with detrusor–sphincter dyssynergia developed a bladder stone whilst he had a permanent transurethral catheter.

Bladder stones were present in 5 patients and a concomitant bladder stone and kidney stone in only one patient. Symptomatic kidney stones developed in 5 other patients, in 3 of them together with changes of the upper urinary tract (dilatation).

Incontinence

Incontinence is, particularly in the female, one of the problems that causes most discomfort. Of the total group of 93 patients 32 (34.4%) had persistent severe incontinence, requiring absorptive or collecting devices, despite maximum conservative treatment (Table VI). Severe incontinence

was present in 18 out of 70 males (25.7%) and in 14 out of 23 females (60.8%). A detrusor hyperreflexia was present as the main cause of incontinence in 20 patients and a detrusor hyperreflexia with proven dyssynergia in 3. Although a detrusor areflexia was present, 9 patients in this group had severe incontinence problems.

In the group with a detrusor hyperreflexia, 11 males and 9 females suffered from incontinence. The majority (15) had a complete lesion.

Ultimately, surgery was necessary in 13 patients to overcome incontinence problems. In the group with a detrusor hyperreflexia, 7 patients (6 female, one male) underwent sacral rhizotomies and implantation of a bladder stimulator and one patient got a Bricker diversion. In the group with a detrusor areflexia, 5 patients underwent surgery mainly for incontinence problems. In 3 patients a Bricker diversion was performed and in 2 patients an augmentation cystoplasty was necessary.

Conclusions

In this study we evaluated the morbidity due to lower urinary tract function in patients with a spinal cord injury. An important percentage of patients developed upper

Table VI Overview of persistent incontinence in relation to bladder behaviour

Bladder behaviour	Incontinence (n)
Detrusor hyperreflexia	20
Detrusor hyperreflexia & dyssynergia	3
Detrusor areflexia	9
Total	32

Table V Bladder and kidney stones in relation to bladder behaviour

Bladder behaviour	Bladder stones	Kidney stones	Bladder & kidney stones
Detrusor hyperreflexia	1	3	1
Detrusor hyperreflexia & dyssynergia	1	—	—
Detrusor areflexia	3	2	—
Total	5	5	1

urinary tract problems. The incidence of these problems was very variable in time, could appear with every type of bladder dysfunction and was present both in males and in females. The incidence is equally distributed between incomplete and complete lesions.

Although the changes of the upper urinary tract appeared to be reversible after change of treatment in most of the patients, upper tract dilatation with obstruction, which was a reason for surgical correction, was present in the male as well as in the female. The method of urine evacuation as well as bladder behaviour had a definite influence on the upper urinary tract.

However no single method of urine evacuation can prevent upper urinary tract damage in all patients, since the change in bladder compliance alone can be responsible for upper urinary tract problems. Although deaths due to renal problems have decreased with renal replacement therapy and careful urological management, upper urinary tract problems can still occur and can be an important cause of morbidity.¹⁰ Moreover, as in our series, upper urinary tract problems can occur at any moment during the follow up and at every age. This confirms the need for a lifelong follow up of every patient with a spinal cord injury.¹¹ Since even with a careful follow up upper urinary tract problems can occur, we may conclude that the actual classical therapeutic modalities are insufficient. Therefore new treatment modalities such as complete dorsal rhizotomies of the sacral nerve roots could well become the treatment of choice for the protection of the upper urinary tract, due to the increase of bladder compliance.¹²

Modern treatment of spinal cord injury patients has reduced the risk of urosepsis.¹³ However the most frequent complication following spinal cord injury is still urinary tract infection.¹⁴ Furthermore urinary tract infection and its associated complications appear to be the most significant causes for renal function decrease.¹⁵

As in our series urinary tract infections are more common in males and their incidence varies in time.¹⁶ Infections can cause clinical problems in every type of bladder dysfunction and appear both in complete

and in incomplete lesions.¹⁷ Although the incidence of infections seems lower in those performing intermittent catheterisation,¹⁸ no single type of urine evacuation gives an absolute protection against infection. This important conclusion is confirmed in the literature.^{19,20} Experience with the sacral anterior root stimulator, however, indicates that the incidence of infections can be reduced significantly with this method.²¹ Therefore this technique could become the prime therapy in the treatment and prevention of urinary tract infections and their complications.

Stone formation is more frequent in males than in females.²² As in our series the type of bladder dysfunction does not seem to influence the incidence of urolithiasis, nor does the follow up period after the injury. The majority of symptomatic kidney stones, however, are found in patients with anatomic changes of the upper urinary tract.²³

About one third of our group of patients with a spinal cord injury presented with important incontinence even though maximal conservative therapy was applied. The incidence is higher and the amount of urine loss more important in the group with a detrusor hyperreflexia. Surgical therapy to prevent or overcome incontinence was more frequently needed in females than in males. Newer nonmutilating treatment modalities, such as sacral rhizotomies and implantation of a bladder stimulator are an important amelioration for selected patients.²⁴ However the actual available methods of electrostimulation are only optimal in patients with a complete lesion and further research in this field is necessary.

In general, urological complications seem to be more frequent and more serious in the chronic catheterisation group compared to those in patients treated by intermittent catheterisation.²⁵ This can be explained by the poorer general condition of patients with a permanent catheter drainage. For these patients the technique of bladder stimulation also seems to be an interesting alternative option.

As a general rule we advise a complete urological screening of every patient with a spinal cord injury as soon as the spinal shock period is passed. Even in patients without

any evidence of urological problems and a stable way of evacuation of urine, a follow up visit every 3 months during the first year can be defended. This control should include an ultrasound of the kidneys and control for infection. In case of infectious problems or a change in the ultrasound, further evaluation with renal scintigraphy is the only way to detect the risk for upper tract deterioration in an early phase. In the second year of follow up without any clinical problems or any abnormality on the previ-

ous controls, a new visit every 6 months is our present policy. From the third year a follow up visit once a year is in our view obligatory, even in the absence of any clinical problem. This follow up, in combination with the application of new treatment modalities such as complete dorsal rhizotomies of the sacral nerve roots eventually in combination with sacral anterior root stimulation, is the only way to diminish the incidence of morbidity, as we found in our series with a less consistent follow up.

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