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FUNCTIONAL RECOVERY OF THE BLADDER IN PATIENTS WITH SPINAL CORD INJURY

—PROGNOSTICATING PROGRAMS OF AN ASEPTIC INTERMITTENT CATHETERIZATION—

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Ninety patients with spinal cord injury were managed by aseptic intermittent catheterization program I (preventing the over-distension of the bladder) and program II (allowing overdistension) in which recovery of bladder function and the clinical effects were comparatively investigated.

Using program I, cases with positive BCR restored the automaticity of the bladder on average 8 weeks after injury. When urinary incontinence first occurs during aseptic intermittent catheterization, urinary training may be commenced since the bladder has then recovered from spinal shock. Cases with no BCR do not restore automatic bladder contraction. Program II delayed or weakened the recovery of bladder function considerably. Patients with incomplete lesions and sacral sparing, particularly those with urinary sensation, should be managed by program I which does not impair recovery of the bladder. It is possible to prevent urinary incontinence and infection, if paraplegics with complete lesions are managed by program II. The percentage of urinary infection was $22.6 \pm 16.0\%$ (N=90) during aseptic intermittent catheterization (non-touch technic) among whom no statistically significant difference between those with trigger voiding ($22.2 \pm 17.2\%$, N=57) and those with self-catheterization ($23.2 \pm 14.0\%$, N=33) was found.

Key words: Bladder recovery, Spinal cord injury, Aseptic intermittent catheterization, Over-distension of the bladder, Self-catheterization

Since it was introduced by Guttmann¹⁾, aseptic intermittent catheterization has been utilized as most appropriate for the urinary management in patients with spinal cord injury in the acute stage, and the clinical effectiveness of this method appears to be well established. Although the incidence of urinary tract infections is decreased and the automaticity of the cord bladder can be restored by this method of treatment, frequent urinary incontinence is a known disadvantage. It is now known that self-catheterization is effective in relieving urinary incontinence and complications in patients with neurogenic bladder dysfunction. We have introduced an aseptic intermittent catheterization method in the therapeutic program for acute urinary disorders of the patient with traumatic

spinal cord injury. The results, particularly on the recovery of bladder function, are presented in this report together with related clinical findings.

MATERIALS AND METHODS

Ninety patients who were hospitalized during the acute stage and treated for spinal cord injuries at The Iizuka Spinal Injuries Centre, Japan between June 1979 and December 1981 were included in this study (Table 1).

The time course of the recovery of bladder function was particularly investigated. Aseptic intermittent catheterization (non-touch technic) was carried out by the nursing staff. Considering that the urinary management should be changed depending upon differing levels and severity of the

Table 1. Program I was mainly used in tetraplegic males and those with sacral sparing, while program II was used in paraplegics without sacral sparing, especially in females

Patient	Initial management	Program I	Program II
Age	(Y/O)	6 - 72 (46)	11 - 63 (32)
Sex	male	46	31
	female	3	10
Paralysis	tetraplegia	38	5
	paraplegia	11	36
BCR	accelerated	38	30
	normal	6	2
	absent	5	9
Sacral sparing	present	32	4
	absent	17	37
Admission (days)		0 - 13 (2.2)	0 - 14 (3)
Observation (weeks)		12 - 79 (43)	9 - 79 (41)

spinal cord lesion at the steady therapeutic stage, two programs, I and II, were devised and aseptic intermittent catheterization was performed according to the programs described below.

Programs of aseptic intermittent catheterization:

Program I, which protects the bladder from distension, was mainly used in patients with incomplete cord lesions and male tetraplegics. Program II consisted of 3 catheterizations a day with unrestricted fluid intake, which therefore allows overdistension of the bladder more than 400 ml. was used for patients with complete cord lesions except male tetraplegics.

Remedies for urinary infections:

To monitor and control urinary infections, urine culture and sensitivity tests were done once a week. The rate of urinary infections was expressed as the ratio of the frequency of bacterial infections (bacterial number 10^4 /ml. or more was defined as infection) to the number of cultures. No preventive chemotherapy was used during the period of aseptic intermittent catheterization. Antibiotics were intramuscularly

injected at 8 hour intervals for 5 days or given orally for 5 days, according to the sensitivity tests only when urinary infection was observed.

Recovery of the bladder and bladder training:

During the course of aseptic catheterization, the ice water test (IWT)²⁾ was performed once a week, a positive IWT on 2 occasions was regarded as indicating recovery of the bladder from spinal shock. Bladder training was then started in patients in program I. The residual urine volume was measured to monitor the effect of bladder training. This was discontinued when the mean residual urine volume for 3 days was less than 50 ml. All patients were examined urodynamically to study the recovery process of the bladder³⁾. When a balanced bladder was not achieved, transurethral surgery for the sphincter was carried out in order to correct pathophysiological voiding conditions. In the patient group treated with program II, weekly IWT was also performed and aseptic catheterization by a nurse was discontinued when self-catheterization was thought to be possible.

Neurological findings :

Aseptic intermittent catheterization program I was usually started 2 or 3 days after spinal surgery which was performed immediately after admission. The level and severity of spinal cord lesion in each patient were neurologically determined soon after hospitalization and one week later in order to decide whether program I or II was suitable for each case. Since the recovery of the bladder depends largely on the severity; that is whether complete or incomplete paralysis, the neurological findings in the sacral region were carefully assessed. Sparing of sacral sensation and urinary sensation were looked for. Motor function was assessed by the voluntary and reflex contraction of the anal sphincter and the presence or not, of the bulbo-cavernosus reflex (BCR).

RESULTS

1. Recovery of bladder function

1) Ice water test and the bulbo-cavernosus reflex:

Sixty four cases became IWT positive,

while 26 remained negative throughout the test period. Sixty three of the 64 cases showed either an accelerated or normal BCR, indicating that they had an upper motor neuron lesion (UMN lesion). Of 13 IWT negative cases with UMN lesions, 8 were incomplete paralysis. They voided normally with no urinary incontinence. The remaining 5 had complete paralysis and had been managed by program II. Thirteen out of 14 cases which were found to have LMN lesion with no BCR were also IWT negative.

2) Programs and the onset of the positive IWT:

Of the 49 cases in the program I group, 37 cases became positive to IWT after 57.2 ± 56.9 days (66.1 ± 63.4 days, N=16 in those with a complete lesion, and 50.4 ± 50.5 days, N=21 in those with an incomplete lesion). There was no significant statistical difference between these two groups. Twenty seven out of 41 cases in program II became positive to IWT in 73.6 ± 52.7 days. Eight cases out of 14 IWT

IWT \ BCR	BCR	
	Present	Absent
Positive	 37	0
Negative	 7	 5
Positive	 26	 1
Negative	 6	 8

○ sacral sparing present
 ● Sacral sparing absent
 ⊙ female patient

Fig. 1. Patients with accelerated or normal BCR obtained positive IWT regardless incomplete or complete lesion

negative cases had no BCR, that is they had LMN lesion, while 6 cases had UMN lesion. These patients remained IWT negative for a mean test period of 226.8 ± 75.0 days. Treatment by program II of the latter 6 cases in the acute stage seemed to be responsible for the delay in or failure of induction of the positive IWT. In general, the IWT remained negative during the period of 97.6 ± 79.5 days, $N=33$ (the above mentioned 6 cases included). The recovery of the bladder was considerably delayed, when program II was employed during the spinal shock period (Fig. 1).

3) Recovery of the bladder and urinary incontinence:

Regardless of the program used, urinary incontinence was observed at about the period of conversion of the IWT. In 54 cases out of 90, which showed both a positive response to IWT and urinary incontinence,

the IWT became positive after 64.0 ± 55.9 days while the onset of urinary incontinence was seen after 64.0 ± 55.6 days in these 54 cases. There was no significant statistical difference (Fig. 2).

2. Therapeutic effectiveness

1) Status of urinary management:

The bladders of 27 out of the 49 patients in the program I group, became balanced, while 19 patients remained having unbalanced bladder function due to insufficient opening of the bladder neck and detrusor-sphincter dyssynergia which were diagnosed urodynamically. They required transurethral surgery (4 TUR-Bns, 12 anterior sphincterotomies and 4 TUR-Ps). Overall, 46 cases could void well and the remaining 3 could do self-catheterization. In the program II group, 25 of the 41 patients were able to do self-catheterization, while 5 patients still needed assisted intermittent catheterization. Eleven of the patients with positive IWT could not tolerate self-catheterization because of reflex urinary incontinence. Therefore, they were retrained for reflex voiding. Six of these 11 patients finally required transurethral surgery (2 TUI-Bns, 6 anterior sphincterotomies and TUR-P) because of insufficient voiding. In none of the cases was there a need for indwelling catheterization.

2) Urinary incontinence:

Of twenty one cases with urinary incontinence in the program I group, 15 had complete lesions among which 13 were treated by sphincter operations. Twenty six of the 28 patients without urinary incontinence had incomplete lesions among whom 27 had urinary sensation. In the program II group, all 10 cases with urinary incontinence had complete cord lesions with a positive IWT including 5 cases treated with sphincter surgery. Twenty nine of the 31 cases with no urinary incontinence required intermittent catheterization (25 on self-catheterization and 4 needed assisted catheterization) 5 times a day. Twelve out of 13 female patients were continent (6 on selfcatheterization, 4 on assisted catheterization and 2 on voiding). Two male patients with UMN lesions preferred the Credé maneuver. Urodynamic evaluation

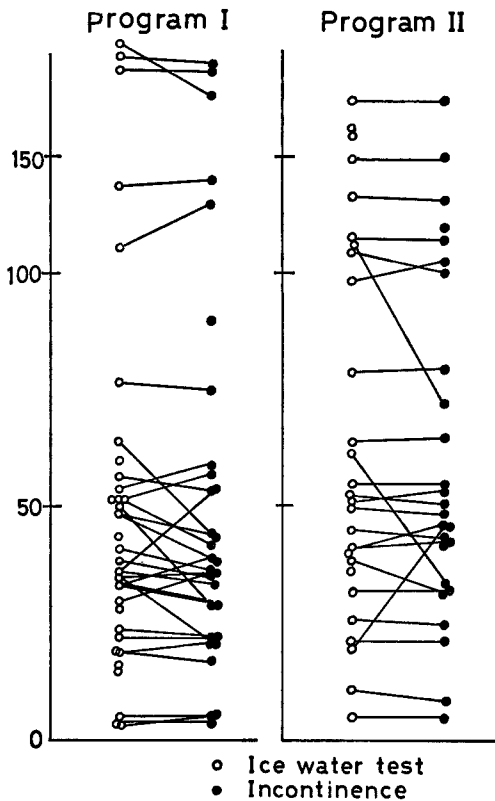
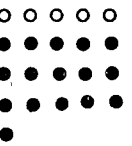
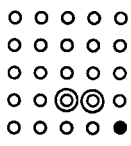
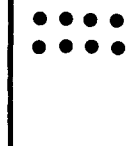


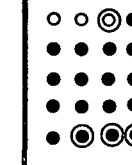




Fig. 2. The period of conversion of the IWT were correlated to that of urinary incontinence in both Program I and II

Initial management Incontinence Late management	Program I		Program II	
	Present	Absent	Present	Absent
Voiding	 21	 25	 9	 2
Self-catheterization	0	 3	0	 25
Assisted-catheterization	0	0	 1	 4

○ sacral sparing present
 ● sacral sparing absent
 ⊙ female patient

Fig. 3. Most of the patients with sacral sparing who were treated by program I obtained urethral voiding and those without sacral sparing who were treated by program II could perform self-catheterization. These patients achieved satisfactory social activity without urinary incontinence

of these 29 patients showed that the contractility of the bladder was very weak probably due to the effect of over-distension and so their sphincter pressure remained high. In 5 patients, urinary incontinence was controlled by the administration of anticholinergic drugs (Buscopan® 60 mg, and propantheline 90 mg t, i, d,) and by frequent catheterization. Two female patients, however, finally required permanent caudal nerve block with phenolglycerine for self-catheterization.

3) Urinary infection during hospitalization:

The rate of urinary infection in the patients managed with aseptic intermittent catheterization was found to be $22.6 \pm 16.1\%$, $N=90$ in acute stage. It was $21.2 \pm 16.3\%$ (for a period of 43 weeks) for group I, and $24.3 \pm 15.8\%$ for group II (41 weeks).

No statistically significant difference was noted in urinary infection rates between the 57 cases (42 observation weeks) under urethral voiding ($22.2 \pm 17.2\%$) and 33 cases (42 observation weeks) under self-catheterization ($23.2 \pm 14.0\%$).

4) Complication:

No complication such as pyelonephritis, hydronephrosis, reflux or disconfiguration of the bladder was noted in patients who were managed by program II.

DISCUSSION

When a patient with spinal cord injury recovers from spinal shock, it is necessary to train the patient for achieving efficient urination by taking advantage of the contractility of the urinary bladder. For this purpose, it has been thought desirable to

apply aseptic intermittent catheterization in order to prevent urinary infection and over-distension of the bladder during the acute stage. But when pathological voiding persists in spite of bladder training, it has been customary to either do resection or incision of the sphincter even at the risk of aggravating incontinence⁴⁻⁶. Our own experience has been that in cases with incomplete lesions, and in particular, central cord lesions nearly normal urination may be regained. The danger of lack of appropriate drainage during the phase of spinal shock, is such that the potential for recovery may be lost. This is because the distension of the paralysed bladder during the spinal shock period is thought to destroy the neuromuscular junction in the bladder wall, thus eliminating the contractility of the UMN bladder. However, we are of the opinion that patients with an over-distended UMN bladder can live without urinary incontinence by using self-catheterization. Clinical evaluation on the usefulness of the self-catheterization method in neurogenic bladder with complications has already been established^{7,8}. And we have demonstrated that using the SIC self-catheterization kit developed by us in cases with fresh spinal cord injury patients, prevents infection⁹. Because of this, cases showing complete loss of sacral sparing even one week after injury, including all female and male paraplegic patients, were managed by program II. Our results suggest that cases with an accelerated BCR, except those with very incomplete paralysis, may show a positive IWT; while those with no BCR may reasonably be expected not to regain reflex contraction of the bladder¹⁰. Therefore, those patients who had either an accelerated or normal BCR regained contractility of the bladder and became capable of performing trigger voiding, while those with no BCR could at best have Credé voiding or self-catheterization. Patients with incomplete cord lesions associated with sacral sparing or urinary sensation were able to control their voiding. Contrasted with patients with complete lesions who had persistent urinary incontinence, the findings in this study confirm the common concept that

cases with incomplete paralysis have a good prognosis, those with UMN lesion can have trigger voiding, while those with LMN lesion can achieve Credé voiding or self-catheterization. Eight weeks after injury, the bladders of patients on program I recovered from spinal shock, as shown by a positive IWT, and regained their automaticity of the bladder. The mean period of the recovery of the cord bladder has been variously reported by Abramson¹¹ (60 days), Perakash¹² (78 days), Herr¹³ (90 days), Firlit¹⁴ (90 days) and Comarr¹⁵ (6 months). Taking into account the practical difficulties in performing aseptic intermittent catheterization, Namiki et al¹⁶, proposed a closed cystostomy drainage system to obviate the disadvantage of indwelling catheterization. Pearman et al¹⁷ believe that aseptic intermittent catheterization is superior to indwelling catheterization. We found it worth-while to start bladder training when urinary incontinence first occurs, and that the IWT is not indispensable as a monitor of intermittent catheterization. Even a patient who has an indwelling catheter still requires regular IWT to detect bladder recovery. In patients with spinal cord injury, urinary incontinence which is critical in their daily lives is due to involuntary reflex contraction of the bladder. Even when perfect urination can be achieved in those with so-called balanced bladder¹⁸, reflex urinary incontinence may still occur if they have no urinary sensation. Comarr et al¹⁹ applied a self-catheterization method to patients with spinal cord injury in the acute and recovery phases of their bladder and reported good therapeutic results. They used this as a temporary remedy until a balanced bladder could be achieved. This is suggestive of their awareness that the majority of patients with spinal cord injury will, sooner or later, not tolerate self-catheterization because of reflex urinary incontinence. Several attempts have been made to overcome this, namely the administration of anti-cholinergic drugs²⁰, caudal blockade²¹, transection of the bladder²², multiple detrusor myotomy²³ and prolonged bladder distension therapy²⁴⁻²⁸ for the unstable bladder. The therapeutic results

so obtained have been variable. Ramsden et al²⁶⁾ used prolonged bladder distension as described by Helmstein²⁹⁾ and reported that 51 patients with unstable bladders showed a significant increase of the bladder capacity to become stable, and 41 cases were either cured or markedly improved. On the other hand, Delaere et al²⁸⁾ performed distension of the bladder under epidural anesthesia on 53 patients with unstable bladders, 8 of whom had spina bifida and/or spinal paralysis. Their results were discouraging because of a low success rate and a higher risk of recurrence and complications.

Sehn³⁰⁾ examined electromicroscopically the bladder wall of the rat and rabbit after 6 hours of distension, and searched for the presence of axonal degeneration. He attributed the clinical effect of bladder distension to the destruction and degeneration of pelvic neural junctions in the bladder. Why a cord bladder is not affected by over-distension after return of the reflex is not clear. Therefore, after conversion to a positive IWT, bladder training can be started without any risk of over-distension of the bladder. For this reason, it is difficult to control reflex urinary incontinence unless a nerve block is carried out. Nerve block, however, results in simultaneous impairment of bowel and sexual functions. We allowed distension of the bladder wall to over 400 ml using an aseptic intermittent catheterization regimen for paraplegics with complete cord lesions in this study. As a result, only 11 cases of 41 in program II group restored sufficient automaticity of the bladder; 6 out of 32 with an UMN lesion failed to recover, and 27 cases showed a delay in recovery. Sixteen of the 27 patients were capable of self-catheterization to controlling urinary incontinence. These results show that over-distending the bladder in an acute stage, later allows the patient to do urinary self-catheterization without the risk of urinary infection or incontinence.

In conclusion, it is possible and safe to prevent urinary incontinence if patients with incomplete lesions are managed by program I which prevents over-distension

of the bladder; and if paraplegics with complete lesions, and especially female, are managed by program II, which allows over-distension of the bladder by using an aseptic intermittent catheterization method in the acute stage.

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和文抄録

脊 損 患 者 の 膀 胱 機 能 回 復

—急性期無菌間歇導尿管管理法の違いによる尿路予後の検討—

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1979年6月から1981年12月の間に総合せき損センターで急性期収容治療された外傷性脊髄麻痺90例につき, 急性期無菌間歇導尿管管理法の違い(過伸展導尿と非過伸展導尿)による膀胱の回復状況と治療効果を検討した。

1. 急性尿閉期の神経学的所見, とくに球海綿体筋反射と冷水テストをおこなって膀胱回復の関係を調べたところ, 90例中, 64例は冷水テスト陽性(26例は冷水テスト陰性となった)となり, このうち63例は球海綿体筋反射が亢進, あるいは存在し, 核上損傷であった。球海綿体筋反射が亢進し核上損傷であることが分かった13例のうち, 不完全麻痺で尿失禁の無い正常排尿となった8例と, 膀胱過伸展管理したうちの5例は冷水テストが陰性であった。球海綿体筋反射が消失し核下損傷であることが判明した14例のうち13例は冷水テスト陰性であった。——『球海綿体筋反射が亢進または存在する例は, 膀胱を過伸展しない限り膀胱反射が出現〔冷水テスト陽性化〕する』

2. 膀胱非過伸展管理(仙髄領域の知覚残存を認めるものおよび頸損男子に適用)した49例のうち, 37例が冷水テスト陽性となり受傷後57.2±56.9日を要したのに比べ, 膀胱過伸展管理(仙髄領域の知覚残存なき脊損例に適用)した41例中球海綿体筋反射消失の8例(核下損傷例)を除く33例は受傷後, 97.6±79.5日まで冷水テストが陰性であった。——『過伸展すると膀胱の回復が遅れる』

3. 膀胱反射(冷水テスト陽性化)の出現と尿失禁の関係

90例中冷水テスト陽性化および無菌間歇導尿の合間の尿失禁とともに認めたのは54例で, それぞれ受傷後64.0±55.9日目および64.0±55.6日目に発現した。——『冷水テストが陽性化する時期に一致して尿失禁が発現する』

4. 非過伸展で管理した49例中27例は排尿訓練のみで, 19例はTUR併用によりバランス膀胱となり, 3例は自己導尿で排尿自立した。過伸展で管理した41例中25例は自己導尿, 5例は介助導尿で失禁の無い排尿管理ができたが, 11例は膀胱反射が強いため失禁性排尿を余儀なくされた。——『過伸展により自己導尿管理がしやすくなる』

5. 急性期無菌間歇導尿期間中の尿感染率は22.6±16.1%(N=90)で, 非過伸展の49例では21.2±16.3%(43週), 過伸展の41例では24.3±15.8%(41週)。回復期以後, 経尿道排尿となった57例の尿感染率22.2±17.2%(42週)と自己導尿となった33例の尿感染率23.2±14.0%(42週)との間に有意差を認めなかった。——『自己導尿でも感染の危険は少ない』

6. 過伸展による水腎症, 膀胱尿管逆流などの合併症は認めなかった。

以上の結果より, 将来反射性失禁排尿になる可能性が高い脊損完全麻痺(仙髄領域の知覚が無く, 球海綿体筋反射が亢進または存在する例)に限り, 尿失禁の少ない自己導尿向きの膀胱にするため, 過伸展でおこなう急性期無菌間歇導尿法も尿路管理法として意義があると考える。