

Investigation of the Afferent Nerves of the Lower Urinary Tract in Patients with 'Complete' and 'Incomplete' Spinal Cord Injury

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Summary

In 52 patients with a post-traumatic spinal cord lesion, both proprioception and exteroception in the lower urinary tract were investigated by determination of filling perception and with sensory threshold measurement towards electrical stimulation. Patients with incomplete lesions had one or both types of perception.

Of the 42 patients, with a lesion diagnosed clinically as complete, 15 perceived bladder filling, electrical stimulation or both stimuli, indicating the existence of a nervous afferent pathway between the lower urinary tract and the cerebral cortex.

Key words: *Neuropathic bladder; Spinal cord injury; Afferent innervation.*

The evolution after spinal cord injury (SCI) depends greatly on the completeness or incompleteness of the medullary lesion.¹

While a 10 years life expectancy has been found in 75 to 80% of complete tetraplegics surviving the first 3 months post-injury, the same prognosis was ascertained in 90% of those with an incomplete lesion.^{2, 3} In paraplegics a similar difference has been seen. Prognosis, however, also depends on age,⁴ level of injury,⁵ and sex.⁶

Medical treatment, rehabilitation and its outcome are influenced considerably by the extent of the lesion. Its impact on the urological history has been repeatedly described.^{7, 8}

The diagnosis of completeness of a spinal lesion can be made clinically^{9, 10} and/or with electrodiagnostic tests.¹¹

The management of the neuropathic bladder is very important.¹² Urological related complications are still amongst the leading causes of premature death after SCI.¹³

Urodynamic investigation is mostly needed to provide a clear urological diagnosis.¹⁴

In such urodynamic investigation, the main interest usually concerns motor

function evaluation.¹⁵ Few publications deal with the sensory function of the lower urinary tract, though the afferent innervation is of the upmost importance for motor function.^{16, 17}

Information about the afferent innervation of the lower urinary tract after SCI can also be important from a pathophysiological point of view, as the sensory pathway travels practically the entire length of the central nervous system.¹⁸

In this study we give the results of the investigations of the lower urinary tract sensation performed in a group of SCI patients with a 'complete' or an 'incomplete' lesion.

Methods

During an 8 months period, 52 consecutive patients with a SC lesion, all out of the phase of spinal shock, who came for urodynamic investigation had the sensation of the lower urinary tract investigated by two methods:

1. In the 48 patients, during a medium fill (30 ml/min) cystometry, the different subjective perceptions (first sensation, desire to micturate, sensation of full bladder) were noted. Patients were in the supine position on a Hydrajust uroradiological table. Bladder filling was performed through a urethral catheter 8 French at a constant flow with a JTL RM302 pump.

A filling solution of 700 ml sterile water and 200 ml Urografine 76% (Schering) was used at room temperature. The filling was stopped when full bladder sensation occurred or in the case of absent sensation at 600 ml. Only a local specific perception was accepted as a sign of bladder sensation.¹⁹ When perception occurred the volume of the fluid in the bladder was noted.

2. In 33 patients, the sensitivity threshold of bladder and urethra was determined with constant current electrical stimulation. A catheter with 2 ring electrodes (6 cm apart), was introduced into the empty bladder or urethra. Thresholds were determined with constant current stimulation (Dimed, Belgium) with square wave impulses of 0.5 msec length, 10 msec interval. The amplitude was gradually increased from 0 to 25 mA until perception occurred. All measurements were done at least three times. A maximum difference of 1.25 mA between thresholds was accepted for reproducibility.

During the same urodynamic investigation a clinical neurological examination was performed to confirm the neurological diagnosis to define the extent and completeness of the lesion. The existence of voluntary motor function and/or persisting sensation below a medullary level was used.

Results

In all patients the clinical neurological examination confirmed the previous findings suggesting completeness or incompleteness of the SC lesion.

Nine patients with an incomplete lesion had one or more perceptions during bladder filling. In 7 of these, electrical sensory threshold was preserved in at least one location of the lower urinary tract (Table I).

The results in the 42 patients with a complete lesion are given in Table II. Fifteen had some preserved sensation. Their data are given in detail in Table III.

In 1 patient with an 'uncomplete lesion' no reliable results could be obtained.

Table I Results of investigation of lower urinary tract sensation in 9 patients with incomplete SCI

Year SC injury	Level lesion	Clinical perception (ml)			Electrical threshold (mA)	
		FS	MS	BS	Bladder	Urethra
1984	L1	—	50	100	15·75	8·25
1978	L1	—	250	300	ND	ND
1978	D6	190	500	—	8·5	6·75
1988	D2	300	—	560	20	>25
1985	C8	120	350	—	12	2·5
1987	D4	—	—	480	ND	6·5
1987	C6	150	—	400	ND	ND
1985	L4	—	—	520	ND	4·5
1987	C5	—	—	555	>25	9·25

ND=not done; C=cervical; D=thoracic; L=lumbar; FS=first sensation; MS=desire to micturate; BS=full bladder sensation.

Table II Outcome of investigation of sensation in lower urinary tract in patients with 'complete' spinal cord lesion

		None	Electrical sensation		
			Present	Absent	Not done
Filling perception present		10	4	4	2
Filling perception absent		28	6	9	13
Filling perception not done		4	—	2	2

Table III Results of lower urinary tract sensation in 15 patients with 'complete' SCI and some preserved sensation

Year SC injury	Level lesion	Clinical perception (ml)			Electrical threshold (mA)	
		FS	MS	BS	Bladder	Urethra
1988	D12	—	220	260	>25	>25
1988	L1	—	500	—	>25	>25
1985	D11	—	350	—	>25	4
1965	L1	—	350	—	11	1·75
1981	L4	—	520	—	8·25	9·25
1984	D10	ND	ND	ND	>25	16·25
1988	D9	—	500	—	>25	>25
1988	D4	—	333	—	ND	ND
1988	D12	—	400	—	>25	>25
1987	D11	280	—	300	5·75	>25
1983	D3	—	240	300	ND	ND
1985	L4	—	—	340	>25	21
1987	C5	—	180	—	>25	15·5
1976	L1	250	300	—	>25	12·5
1988	C1	—	350	—	3·25	2·25

ND=not done; FS=first sensation; MS=desire to micturate; BS=full bladder sensation.

Discussion

In almost all patients with an incomplete lesion and in 15 of 42 patients with a complete lesion, the existence of an afferent nerve pathway from the bladder to the cerebral cortex was demonstrated.

The perceptions during bladder filling are elicited by proprioceptive stimuli on specific receptors in bladder wall, urethra and pelvic floor.²⁰ The sensory potentials run through the hypogastric, pelvic and pudendal nerves.²¹

Three different sensations have been described during cystometric bladder filling: first sensation, desire to micturate, and full bladder sensation.²²

The investigation of exteroceptive sensation in the lower urinary tract with constant current electrical stimulation was shown to give reproducible results. It has been used to determine sensation in the bladder and the urethra.^{23, 24}

Our data show that even in the presence of a clinically apparent complete SCI, sensory nerves from the lower urinary tract, for proprioception, exteroception or both may be preserved. Of the patients with complete SCI, in whom such nerve pathways were found, the majority had a lower thoracic or a lumbar lesion. In these patients, bladder sensation may be preserved through the hypogastric nerves.

The therapeutic usefulness of intact proprioception seems more evident than the preservation of exteroceptive nerves. Though the physiological role of exteroception is somewhat doubted,²⁵ findings of Mahony *et al.* (1977), show that exteroceptive stimuli from the bladder wall exert control of bladder filling while those from the urethra have a powerful facilitating action on the micturition reflex.

In a previous study,¹⁵ we demonstrated a good correlation between the clinical neurological investigation and the functional outcome of different parts of the lower urinary tract in 93% of 108 patients.

Our study shows that such a correlation does not exist between clinical neurological data and the sensory function of the lower urinary tract in SCI patients. Specific tests should be done to gain information on this important urological function.

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