Impaired Renal Function in Newly Spinal Cord Injured Patients Improves in the Chronic State—Effect of Clean Intermittent Catheterization?

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Purpose: We investigated renal function in spinal cord injured subjects in relation to the level and completeness of injury and bladder emptying regimen in the acute and chronic stages.

Materials and Methods: A retrospective chart review was performed of 169 spinal cord injured subjects treated at the Spinal Cord Injury Unit, Sahlgrenska Hospital between 1985 and 2002. Renal function based on glomerular filtration rate was evaluated by chromium ethylenediaminetetraacetic acid clearance 3 to 4 months after injury and at followup 3 to 5 years after injury.

Results: The glomerular filtration rate was lower than expected in the first investigation in the whole group (82% of the expected value). When divided according to level of lesion the figure was lower in the cervical (81%) and thoracic (88%) levels of the lesion and in the American Spinal Injury Association A group compared to the American Spinal Injury Association B-E group. In the second investigation we found a significant improvement in the whole group of 6%. When dividing the group according to bladder emptying regimen we found that in the group that emptied the bladder by clean intermittent catheterization glomerular filtration rate improved significantly (+7%).

Conclusions: Spinal cord injury affects renal function and has a deteriorating effect on glomerular filtration rate. The reduction is seen on the cervical and thoracic levels of injury and in complete injuries. Renal function improves with time after injury and improvement is seen most clearly in the group that uses clean intermittent catheterization as a bladder emptying method.

Key Words: spinal cord injuries, kidney function tests, urinary catheterization, glomerular filtration rate

Life expectancy for spinal cord injured patients is today almost the same as for able-bodied persons, which implies that the patients might live 40 to 60 years with a spinal cord injury. The previously dominant cause of death, renal dysfunction, has decreased from 45% to 50% [1–3] in the 1950s to 3% to 5% in recent decades.[3,4] The injury still has a huge impact on autonomic nervous system regulation of internal organs, including the upper and lower urinary tracts. The inability to empty the neurogenic bladder by voluntary control implies a risk of over distention and incomplete emptying with concomitant urinary tract infections. High intravesical pressure might generate renal reflux and dilatation, and irritations in the bladder could induce autonomic dysreflexia.[5] A balanced, low pressure bladder totally emptied at regular intervals without residual urine and leakage has for a long time been the goal and intermittent catheterization is held to be the gold standard. However, data are lacking that prove the importance, as revealed by a Cochrane review of catheter policies.[6]

Furthermore, systemized studies regarding the factors that have contributed to the total decrease in mortality related to renal dysfunction are lacking. Presumably the dramatic change has several causes. Clinical knowledge and skill in handling the patients have increased over the years through the creation of specialized SCI units. Systemizing clinical evidence into a science is an important issue. At our specialized SCI unit, spinal cord injured patients from the southwest of Sweden have been investigate by a structured program regarding the upper and lower urinary tracts, including cystometry, IVP and estimation of GFR by Cr-EDTA clearance. To systemize our clinical experience a retrospective database with neuro-urological findings in 249 SCI patients was created. We wanted to clarify the impact of renal function in SCI subjects according to level and degree of lesion and bladder emptying regimen in the acute and chronic phase. Furthermore, we wanted to investigate if renal function could be modified by treatment.

METHODS

A retrospective chart review was performed for neurourological status and investigations regarding bladder and renal function in 249 newly injured patients treated at the SCI unit in Gothenburg during 1982 to 2002. During this period approximately 500 to 600 newly injured patients were treated. The selection criteria were traumatic or nontraumatic spinal cord injury, length of stay more than 2 weeks,

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surviving the first stay at the SCI unit and that the records were available. Exclusion criterion was previous renal or urological disease. The majority of the patients included were injured during 1992 to 1999.

We present a report on the status of 169 newly SCI patients in whom renal function has been evaluated by Cr-EDTA clearance. All investigations by Cr-EDTA clearance were performed at the Department of Clinical Chemistry, Sahlgrenska University Hospital. GFR reference values are given related to age. To compare the total population without referring to age we recalculated Cr-EDTA clearance according to the formula for patients younger than 50 years: GFR = 115 − (0.4 × age) and older than 50 years GFR = 145 − age.[7] The measured value was then divided by the recalculated value and multiplied by 100, thus giving a percentage of the expected value.

Distribution for the group according to gender, age at injury, level and completeness of injury according to ASIA/International Medical Society of Paraplegia standards, and cause of injury (traumatic/nontraumatic) is shown in table 1.[8] Initially the patients were treated with indwelling catheters (CAD including suprapubic cystostomy) until urinary production was stable and less than 2,500 ml per day, approximately 2 weeks after injury. The bladder was then emptied by CIC 4 to 6 times daily using a hydrophilic, low friction catheter (LoFric®). Catheterization was performed by the staff or later, when possible, by the patients. Some patients were given an indwelling catheter because of the risk of over distention or permanently due to intractable urinary leakage, severe problems performing CIC due to urethral obstruction or older age and concomitant disease.

Some patients recovered normal control of micturition but usually had a period of emptying by CAD and CIC before recovery was stable. Normal control of micturition was clinically defined as voluntary, unstrained emptying of the bladder with less than 50 ml residual urine. Some patients were placed on a mixed regimen of bladder emptying, which included condom drainage combined with suprapubic tapping of the lower abdomen or Credé maneuver (emptying of the bladder by abdominal strain) and/or CIC performed less than 4 times daily. The method of bladder emptying is defined as the method of emptying that was present for more than half the time the patient was admitted. The urinary tract was evaluated by cystometry, IVP and measurement of GFR by Cr-EDTA clearance. The intention to perform the investigations differed over time, especially with regard to the patients who recovered normal control of micturition, more than 70% of whom were not evaluated. We report the GFR findings from the first investigation performed during the acute phase (169 patients) and compare it to a second (103) followup in the chronic phase 3 to 5 years later.

Statistical values are given as a mean with a 95% CI. Comparisons between and within groups are done using the t test for unpaired and paired data. A comparison has been made of the expected GFR value. Multivariant linear regression was used using SPSS®. Statistical significance is defined as $p < 0.05$.

TABLE 1. *Population characteristics*

Mean age at injury	40.9
No. cause of injury:	
Traumatic	151
Nontraumatic	18
No. gender:	
Female	43
Male	126
No. ASIA classification, completeness of injury:	
C:	
ASIA A	41
ASIA B-E	39
Th:	
ASIA A	34
ASIA B-E	23
L+S:	
ASIA A	6
ASIA B-E	26

TABLE 2. *GFR first investigation*

	Mean (95% CI)	
	GFR	% Expected Value
Total (169)	82 (80–85)	86 (83–89)*
Lesion level		
C (80)	76 (72–80)	81 (77–86)*,†
Th (57)	85 (80–89)	88 (84–92)*,‡
L+S (32)	94 (88–101)	96 (89–104)
Degree of injury:		
ASIA A (81)	79 (75–83)	80 (77–84)*,†
ASIA B-E (88)	86 (82–90)	92 (87–96)*

* Significantly lower than expected, $p < 0.01$.
† Significant difference C − Th, C − L+S, ASIA A − ASIA B, $p < 0.05$, $p < 0.01$.
‡ Significant difference Th − L+S, $p < 0.05$.

RESULTS

Newly Injured, First Investigation

GFR in the whole group showed a mean value of 82 ml per minute per 1.73 m^2, which was 86% (CI 83%–89%) of the expected value ($p < 0.01$ compared to expected). When dividing the group according to level of lesion there was a gradient with the lowest value in the highest injury group and with significant differences between the subgroups (table 2). The cervical and thoracic levels of the lesion showed lower values than expected. Almost half the group had a neurologically complete injury (ASIA A), and we found a significantly lower GFR in the ASIA A group compared to the pooled ASIA B-E group. Both groups had a lower value than expected (table 2). On multiple linear regression analysis sex, age, level and degree of lesion explained 15.6% of the variance in GFR. Level and degree of lesion were significant.

A total of 23 patients who recovered normal control of micturition were evaluted with Cr-EDTA clearance and GFR was normal. Of the patients with persistent neurogenic bladder dysfunction 90% were treated with CIC (130). The GFR was lower than expected in the CIC group and was significantly lower than in the group who recovered normal micturition. The mixed regimen group had a lower than expected value whereas it was normal in the CAD group (table 3).

Chronic Phase, Second Investigation

A second investigation was performed in 103 patients. A paired comparison revealed that the GFR in the entire group had improved by 6% ($p < 0.01$) (table 4). When divided according to lesion level there was a statistically significant improvement in the thoracic subgroup (40 patients), whereas the cervical (47) and lumbar sacral (16) subgroups showed no differences (table 4). The lumbar sacral group