

## ORIGINAL ARTICLE

# Incidence of symptomatic autonomic dysreflexia varies according to the bowel and bladder management techniques in patients with spinal cord injury

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**Study design:** A retrospective, multicenter study.

**Objectives:** To investigate the relationship between bowel and bladder management methods and symptomatic autonomic dysreflexia (AD) during hospitalization in patients with spinal cord injury (SCI).

**Setting:** Twenty-eight Rosai hospitals in Japan.

**Methods:** The study subjects were 571 patients with SCI who had been admitted to 28 Rosai hospitals between April 1997 and March 2007 for rehabilitation therapy and fulfilled the following criteria: (1) SCI at or above sixth thoracic level, (2) discharged from hospital after more than 4 months of admission for initial injury and (3) lack of pressure ulcers, deep venous thrombosis, ureteral and renal stones or heterotopic ossification throughout hospitalization to exclude possible influence of these complications on cardiovascular reflexes. The study subjects were examined for the incidence of symptomatic AD according to age, sex, ASIA Impairment Scale, injury level, bowel and bladder management techniques at discharge.

**Results:** The Rosai Hospital registry included 3006 persons with SCI during 1997–2007, and 571 patients fulfilled the above criteria. The highest incidence of symptomatic AD was diagnosed in subjects using reflex voiding and in those using manual removal of stool. By contrast, the lowest incidence of symptomatic AD was in those on continent spontaneous voiding and continent spontaneous defecation.

**Conclusion:** Medical staff should evaluate the presence of AD in patients with SCI at or above the T6 level under bladder and bowel management such as reflex voiding and manual removal of stool.

*Spinal Cord* (2011) 49, 49–54; doi:10.1038/sc.2010.94; published online 10 August 2010

**Keywords:** cardiovascular conditions; rehabilitation; neurogenic bladder; neurogenic bowel

## Introduction

Spinal cord injury (SCI) above the fifth to sixth thoracic level is sometimes associated with autonomic dysreflexia (AD),<sup>1</sup> although the latter has been noted to occur down to the tenth thoracic level on rare occasions.<sup>2</sup> Acute rise in blood pressure (BP) is the defining key event in AD and is a potentially dangerous condition with grave consequences such as stroke and seizure. Therefore, acute hypertension

must be monitored closely and treated as a medical emergency.<sup>3</sup> According to the International ASIA/ISCoS Autonomic Standards Committee, AD is defined as a rise of 20 mmHg above resting BP in subjects with SCI.<sup>4</sup> The AD reaction is provoked by peripheral afferent stimuli below the lesion level, which reach the isolated spinal cord.<sup>1</sup> The most common causes of AD are bladder distension, bowel distension and defecation.<sup>3</sup>

In patients with SCI, modern urologic teaching has supported the avoidance of indwelling urinary catheters<sup>5</sup> and recommended clean intermittent catheterization (IC) as the safest bladder management method in terms of urological complications,<sup>6</sup> although reflex voiding is used

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Received 23 March 2010; revised 28 May 2010; accepted 4 July 2010; published online 10 August 2010

in some cases. Improvement in the management of neurogenic bladder has dramatically reduced the number of deaths from urinary complications.<sup>5</sup> Conversely, little progress has been made in bowel management in patients with SCI because bowel-related problems are not usually life-threatening. Manual removal of stool could be associated with complications such as damage to the anorectal mucosa and anal sphincter in the anesthetized area.<sup>7</sup> In spite of these possible complications, the method is still followed in patients with SCI to help inadequate defecation. Indeed, Lynch *et al.*<sup>8</sup> reported that of 467 patients with SCI, manual evacuation was used regularly by 67% of patients with complete injuries and 25% of those with incomplete injuries.

A number of studies examined the AD reaction during urodynamic evaluation<sup>9,10</sup> and actual bowel program.<sup>11,12</sup> Our group previously investigated the AD responses before, during and after a bowel program involving manual removal of stool in lateral recumbency in patients with cervical SCI.<sup>11,12</sup> Manual removal of stool induced AD, with maximal increases in both systolic and diastolic BP.<sup>11,12</sup> Recently, Coggrave *et al.* used postal questionnaire to investigate the management of neurogenic bowel dysfunction in the community after SCI.<sup>13</sup> They received responses from 1334 persons with SCI (response rate: 48.6%) and reported that AD was a frequent complication of bowel care in 9.5% of those with injuries above T7.<sup>13</sup> Furthermore, significant associations were noted between AD and certain interventions such as manual evacuation in persons with cervical SCI, laxatives (stimulant) and chemical rectal stimulants.<sup>13</sup>

Prevention of AD is the best approach.<sup>14</sup> Therefore, patients with SCI should be advised to follow proper bowel and bladder management methods. However, to our knowledge, little is known about the incidence of AD in each bowel and bladder management method used by these patients. The purpose of this study was to investigate the relationship between the different bowel and bladder management methods and the incidence of AD during hospitalization in patients with SCI.

## Materials and methods

Twenty-eight Rosai hospitals participated in our study. The study protocol was approved by the Research Ethics Committee of our institution and all subjects were required to sign an informed consent form. In Japan, the group of Rosai hospitals maintains a registry database of all patients with traumatic SCI who undergo medical rehabilitation at these hospitals. In this study, all subjects with traumatic SCI who were discharged from Rosai hospitals between April 1997 and March 2007 were assessed retrospectively using the American Spinal Cord Injury Association (ASIA), the standard for neurological and functional classification of SCI.<sup>15</sup> Patients who were seen in the acute care setting but did not undergo rehabilitation were excluded.

The following criteria were used to select the subjects of the study: (1) history of SCI at or above T6; (2) discharge from each Rosai hospital after more than 4 months at initial injury. This cut-off time was selected because the majority of

patients who were discharged from the hospital at acute stage used indwelling urethral catheters; instead, we wanted to explore the relationship between bowel and bladder management methods, and AD at chronic stage. AD can occur at any time after injury even within the first few days<sup>16,17</sup> and commonly develops in patients with tetraplegia or high-level paraplegia at 3–4 months after the cord lesion;<sup>18</sup> (3) no pressure ulcerations, deep venous thrombosis, ureteral or renal stones or heterotopic ossification throughout hospitalization to exclude possible influence of these complications on cardiovascular condition.

As stated earlier, the criterion used for the definition of AD is a rise in BP of more than 20 mm Hg.<sup>4</sup> However, for the purpose of our investigation, which commenced in 1997, we defined AD as elevation of systolic BP as well as appearance of classical symptoms such as headache, sweating or flushing above the level of injury, nasal congestion, blurred vision and anxiety. Therefore, in this study, we investigated the relationship between the different bowel and bladder management methods and the incidence of symptomatic AD during hospitalization. The level of increase in systolic BP necessary for the diagnosis of symptomatic AD was defined by the attending physicians in each hospital.

Previous studies have reported various bowel and bladder management methods.<sup>8,19,20</sup> In this study, the bladder management methods were divided into six categories including continent spontaneous voiding, IC, indwelling supra-pubic catheterization, indwelling urethral catheterization, reflex voiding and others. The bowel management methods were divided into four categories including continent spontaneous defecation (with or without oral laxatives), rectal medication (enemas or suppositories without manual removal of stool), manual removal of stool (with or without rectal medication) and others.

## Statistical analysis

Data were expressed as mean  $\pm$  s.d. The percentage of persons with AD within different ASIA impairment scale (AIS), injury level, gender, age group, bladder and bowel management methods were analyzed using chi-square ( $\chi^2$ ) analysis. When  $\chi^2$ -test showed significant differences, the odds ratio was calculated between groups. Analysis of variance was used for comparison among AIS groups with respect to the duration of hospitalization (DH) and the groups with each bladder and bowel management with respect to the DH. When analysis of variance showed significant differences ( $P < 0.05$ ), Scheffe's test was used to determine differences between two groups. Statistical significance was defined as  $P < 0.05$ . All statistical analyses were performed using SPSS (version 11.5; SPSS Inc., Chicago, IL, USA).

## Results

The Rosai Hospital registry included 3006 persons with SCI registered between 1997 and 2007. Of these, 648 subjects fulfilled all three inclusion criteria described above. However, 77 patients were excluded because of insufficient data in their AIS or AD. Thus, the study group comprised 571

**Table 1** Demographic and clinical characteristics of the study subjects ( $n = 571$ )

Characteristics	n	%
<b>Sex</b>		
Males	466	81.6
Females	105	18.4
<b>Cause of injury</b>		
Motor vehicle collision	242	42.4
Falls	240	42.0
Sport-related accidents	32	5.6
Direct blunt injuries	21	3.7
Others	36	0.3
<b>Level of injury at discharge</b>		
C1–C4	181	31.7
C5–C8	346	60.6
T1–T4	27	1.7
T5–T6	17	3.0
<b>AIS at discharge</b>		
A	168	29.4
B	35	6.1
C	127	22.2
D	241	42.2
Mean $\pm$ s.d. age at discharge (years)		52.3 $\pm$ 18.8

Abbreviation: AIS, ASIA impairment scale.

**Table 2** The mean  $\pm$  s.d. duration of hospitalization ( $n = 571$ )

	Duration of hospitalization (days)
<b>AIS at discharge</b>	
A	286 $\pm$ 194*
B	282 $\pm$ 208*
C	262 $\pm$ 132*
D	207 $\pm$ 92
<b>Methods used for bladder management</b>	
Spontaneous voiding	201 $\pm$ 85
Intermittent catheterization	241 $\pm$ 141
Indwelling supra-pubic catheterization	311 $\pm$ 219 <sup>†</sup>
Indwelling urethral catheterization	233 $\pm$ 130
Reflex voiding	330 $\pm$ 143 <sup>†</sup>
Others	290 $\pm$ 128 <sup>†</sup>
<b>Methods used for bowel management</b>	
Continent spontaneous defecation	201 $\pm$ 87
Rectal medication	265 $\pm$ 145 <sup>§</sup>
Manual removal of stool	272 $\pm$ 192 <sup>§</sup>
Others	235 $\pm$ 106

Abbreviation: AIS, ASIA impairment scale.

\* $P < 0.05$ , compared with AIS D. <sup>†</sup> $P < 0.05$ , <sup>‡</sup> $P < 0.001$ , compared with spontaneous voiding. <sup>§</sup> $P < 0.001$ , compared with continent spontaneous defecation.**Table 4** Prevalence of symptomatic AD according to bladder management program ( $n = 571$ )

Bladder management	Prevalence of AD (%)	OR	95% CI	P
Continent spontaneous voiding	7.1 (14/196)	1	NA	NA
Intermittent catheterization	26.2 (32/122)	4.62	2.35–9.10	<0.001
Indwelling urethral catheterization	35.4 (28/79)	7.14	3.50–14.56	<0.001
Indwelling supra-pubic catheterization	40.0 (44/66)	8.67	4.46–16.84	<0.001
Reflex voiding	43.3 (13/30)	9.94	4.03–24.54	<0.001
Others	29.4 (10/34)	5.42	2.17–13.54	<0.001

Abbreviations: AD, autonomic dysreflexia; CI, confidence interval; NA, not applicable; OR, odds ratio.

patients. Table 1 summarizes the demographic and clinical characteristics of the participating subjects. Table 2 lists the mean DH for patients according to AIS, bladder and bowel management methods.

*Incidence of symptomatic AD according to age and gender*

Symptomatic AD was diagnosed in 24.7% (141/571) (in 24.2% (113/466) of men and 26.7% (28/105) of women). All age groups were prone to develop symptomatic AD and occurrence of this condition appeared equally in various age groups despite a trend of being more common among the younger patients ( $P = 0.06$ ). The incidence of symptomatic AD was not gender-dependent ( $P = 0.60$ ).

*Incidence of symptomatic AD according to injury level and AIS*

Symptomatic AD was diagnosed in subjects with SCI above the T5 segment. There was no significant difference in the incidence of symptomatic AD with respect to injury level ( $P = 0.06$ ). Table 3 lists the incidence of symptomatic AD by AIS. Symptomatic AD was most common among patients with AIS A lesion followed by those with B lesion.

The mean DH for patients with ASIA D was significantly shorter than those of other AIS groups ( $P < 0.05$ ). There were no significant differences in the mean DH among AIS A, B and C groups (Table 2).

*Incidence of symptomatic AD according to bladder management*

Among the 571 patients, the bladder management method used at discharge from the hospital was continent spontaneous voiding in 196 (34.3%), IC in 122 (21.4%), indwelling supra-pubic catheterization in 110 (19.3%), indwelling urethral catheterization in 79 (13.8%), reflex voiding in 30 (5.3%) and others in 34 (6.0%). The highest frequency of symptomatic AD was seen in patients who used reflex voiding, whereas the lowest incidence of symptomatic AD was in patients on continent spontaneous voiding followed by IC (Table 4).

**Table 3** Prevalence of symptomatic AD according to the AIS ( $n = 571$ )

AIS	Prevalence of AD (%)	OR	95% CI	P
A	43.5 (73/168)	7.7	4.5–13.1	<0.001
B	40.0 (14/35)	6.6	3.0–14.9	<0.001
C	25.2 (32/127)	3.4	1.9–6.1	<0.001
D	10.0 (22/241)	1	NA	NA

Abbreviations: AD, autonomic dysreflexia; AIS, ASIA impairment scale; CI, confidence interval; NA, not applicable; OR, odds ratio.

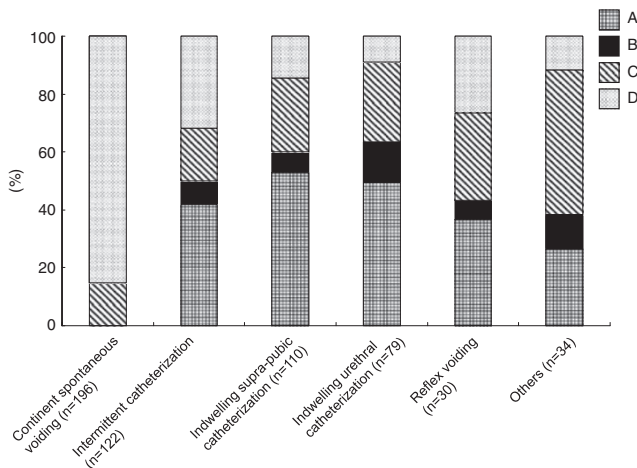
The mean DH was significantly shorter in patients with spontaneous voiding than those with reflex voiding ( $P < 0.001$ ), indwelling supra-pubic catheter ( $P < 0.001$ ) and others ( $P < 0.05$ ). There were no significant differences in the mean DH among other bladder management groups (Table 2).

Figure 1 shows the percentage of AIS A, B, C and D for each bladder management method. The percentage of AIS A was 52.7% in the indwelling supra-pubic catheterization group, 49.4% in indwelling urethral catheterization, 41.8% in IC, 36.7% in reflex voiding, 26.5% in others and 0% in spontaneous voiding.

#### Incidence of symptomatic AD according to bowel management

Among the 571 patients, the bowel management program at discharge from the hospital was continent spontaneous defecation in 164 (28.7%), rectal medication in 212 (37.1%), manual removal of stool in 170 (29.8%) and others in 25 (4.4%). The incidence of symptomatic AD was the highest in patients using manual removal of stool followed by those on rectal medication, whereas it was the lowest in continent spontaneous defecation (Table 5).

The mean DH was significantly shorter in patients with continent spontaneous defecation compared with those on rectal medications ( $P < 0.001$ ) and manual removal of stool ( $P < 0.001$ ). There were no significant differences in the mean DH among the other bowel management groups (Table 2).



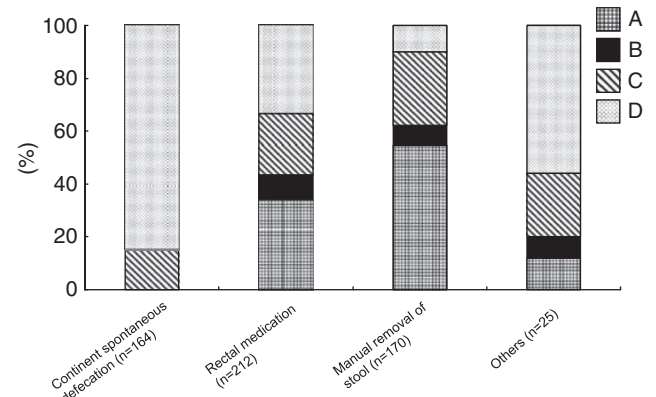
**Figure 1** Percentage of patients using each of the indicated bladder management method according to the AIS. (A) AIS A; (B) AIS B; (C) AIS C; (D) AIS D. AIS, ASIA impairment scale; ASIA, American Spinal Cord Injury Association.

Figure 2 shows the percentage of AIS A, B, C and D for each bowel management method. The percentage of AIS A was 54.7% in the manual removal of stool group, 34.0% in rectal medication, 12.0% in others and 0% in continent spontaneous defecation.

#### Discussion

This study is the first to evaluate the relationship between bowel and bladder management methods at discharge from hospital and the incidence of symptomatic AD during hospitalization in patients with SCI. The major finding of this study was that the highest incidence of symptomatic AD in bladder management was seen in patients with reflex voiding, whereas that of bowel management was found in patients practicing manual removal of stool.

Linsenmeyer *et al.*<sup>9</sup> examined the AD reaction during urodynamic evaluation and emphasized that the increase in BP in patients with uninhibited bladder contractions was not caused by bladder distension *per se*, but by bladder distension triggering an uninhibited bladder contraction. Among the bladder management methods for persons with SCI, reflex voiding is the only one that uses uninhibited bladder contraction. Furthermore, it has been reported that upper urinary tract complications, for example, urinary tract dilatation and vesicoureteral reflux, are more common in SCI patients with reflex voiding than those with IC.<sup>21</sup> With regard to the etiology, the pathogenesis of these complica-



**Figure 2** Percentage of patients using each of the indicated bowel management method according to the AIS. (A) AIS A; (B) AIS B; (C) AIS C; (D) AIS D. AIS, ASIA impairment scale; ASIA, American Spinal Cord Injury Association.

**Table 5** Prevalence of symptomatic AD according to bowel management program ( $n = 571$ )

Bowel management	Prevalence of AD (%)	OR	95% CI	P
Continent spontaneous defecation	7.9 (13/164)	1	NA	NA
Rectal medication	27.4 (58/212)	4.37	2.30–8.31	< 0.001
Manual removal of stool	39.4 (67/170)	7.56	3.97–14.40	< 0.001
Others	12.0 (3/25)	1.58	0.42–6.01	

Abbreviations: AD, autonomic dysreflexia; CI, confidence interval; NA, not applicable; OR, odds ratio.



tions is linked to high-pressure uninhibited detrusor contractions, high leak point pressure and low bladder compliance.<sup>21</sup> The presence of urinary tract dilatation and vesicoureteral reflux is not only likely to cause infection but also induces AD in patients with SCI at or above the T6 level. This background might explain our finding of the highest incidence of symptomatic AD in patients with reflex voiding despite the fact that the percentage of AIS A in these patients was not higher than those of IC and indwelling supra-pubic and urethral catheterization.

This study showed that the incidence of symptomatic AD in patients using indwelling supra-pubic catheterization was second highest. The indwelling supra-pubic catheter itself is expected to prevent AD reactions rather than induce them. This bladder management method is adapted to patients with SCI who cannot catheterize themselves because of impairment in upper extremities. Indeed, among our patients using indwelling supra-pubic catheterization, 77.3% (85/110) had C6 or above C6 lesions, and 52.7% (58/110) were AIS A. The incidence of AIS A was relatively high among patients using indwelling supra-pubic catheterization compared with those using other bladder managements. It has been reported that patients with more severe injury are more likely to develop AD.<sup>22</sup> In Japan, indwelling supra-pubic catheter management is usually introduced at the chronic stage, unlike other bladder managements. Accordingly, the AD reactions in such patients could develop before indwelling supra-pubic catheter management. Further research is needed to examine the timing of the development of AD.

In this study, the risk of symptomatic AD appearance in IC was the second lowest, although it was about five times as high as that of spontaneous voiding. There is strong argument regarding the safety and efficacy of IC for treatment of neurogenic bladder dysfunction in patients with spinal cord lesions.<sup>23</sup> IC is considered preferable to other forms of bladder emptying in neuropathic patients as it has less complications and associated with a better outcome.<sup>23</sup>

We investigated previously changes in BP, pulse rate and classic symptoms of AD before, during and after a bowel program involving manual removal of stool in lateral recumbency in patients with cervical SCI and AIS A or B grade.<sup>11</sup> The insertion of rectal medication induced a significant increase in systolic BP, which persisted during additional digital rectal stimulation. Furthermore, manual removal of stool induced AD, with maximal increases in systolic BP.<sup>11</sup> In addition, it has been reported that manual removal of stool may damage the anorectal mucosa and anal sphincter in the anesthetized area.<sup>7</sup> Injury of anorectal mucosa and sphincter might also induce AD in patients with SCI at or above the T6 level. This study also showed that the incidence of AIS A among patients who used manual removal of stool was relatively high compared with those using other bowel management methods. These findings might explain the highest incidence of symptomatic AD in manual removal of stool in this study. The results of our study are compatible with another study that reported significant associations between AD and manual evacuation.<sup>13</sup>

Manual removal of stool is the only method used by many patients with SCI especially those with complete lesion,<sup>8</sup> because of the lack of non-invasive and efficient bowel management methods for defecation. Furthermore, it has been reported that manual removal of stool is associated with low risk of unplanned bowel evacuation and short duration of evacuation time.<sup>24</sup> In this study, 29.8% of the patients used manual removal of stool. The use of this method by patients with SCI at or above the T6 level should require topical anesthesia to prevent AD reactions.<sup>12</sup>

One limitation of this retrospective study is the variable level of increased systolic BP used by each participating hospital for the diagnosis of AD. For a better comparison of the incidence of AD, there is a need to establish criteria for the diagnosis of AD including AD-related BP. Recently, AD was defined by the International ASIA/ISCoS Autonomic Standards Committee as a rise of 20 mm Hg above the resting BP.<sup>4</sup> It is also probable that we did not include some subjects who lacked the classical symptoms, that is, 'silent' AD,<sup>9</sup> because AD was defined as elevation of systolic BP and appearance of classical AD symptoms in this study. Further research is needed to examine 'silent' AD. Another limitation of the study is that we excluded patients with several other risk factors, apart from bowel and bladder problems, which can induce AD reactions. In reality, however, one cannot exclude all other risk factors for AD.

## Conclusion

The results of this study showed that the highest incidence of symptomatic AD was noted in patients using reflex voiding and in those using manual removal of stool. The medical staff should evaluate the presence of AD in patients with SCI at or above the T6 level, especially those using these bladder and bowel management techniques.

## Conflict of interest

The authors declare no conflict of interest.

## Acknowledgements

We thank the medical staff at Rosai hospitals for their assistance. We also thank Dr Faiq G Issa (Word-Medex Pty Ltd, Sydney Australia; [www.word-medex.com.au](http://www.word-medex.com.au)) for careful reading and editing of the paper.

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