

ORIGINAL ARTICLE

Effect of age on bowel management in traumatic central cord syndrome

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Study Design: A retrospective multicenter study.

Objectives: To investigate the characteristics of bowel dysfunction in elderly people with traumatic central cord syndrome (TCCS).

Setting: A total of 28 Rosai hospitals in Japan.

Methods: The Rosai Hospital registry included 3006 persons with spinal cord injury during 1997–2007. The study subjects were 186 patients with TCCS (160 men, 26 women; mean age, 61.7 ± 11.6 years, \pm s.d.). Patients were divided according to age into the young group (<50 years, $n=30$), the middle-age group (50–69 years, $n=112$) and the elderly group (≥ 70 years, $n=44$). We assessed the differences in bowel management techniques (spontaneous, rectal medications and manual emptying) and activity of daily living (ADL) with respect to bowel care at discharge among the three groups.

Results: Continent spontaneous defecation was the most common bowel management method (50%, 93/186). The percentage of elderly subjects on continent spontaneous defecation (36.4%) was significantly less than that of the young group (66.7%; $P<0.05$). Furthermore, the percentage of elderly patients who required no bowel care (18.2%) was significantly less than those of the young (53.3%) and middle-age groups (41.1%; $P<0.01$). However, few differences in bowel care-related ADL were recognized among the three groups in patients who required manual emptying.

Conclusion: The results identified significantly fewer patients aged ≥ 70 years with 'continent spontaneous defecation' or 'independent for bowel care' compared with younger patients. The results also highlighted the clinical importance of bowel dysfunction associated with TCCS especially in elderly people.

Spinal Cord (2012) 50, 51–56; doi:10.1038/sc.2011.90; published online 30 August 2011

Keywords: spinal cord injury; incomplete tetraplegia; rehabilitation; bowel dysfunction

Introduction

Traumatic central cord syndrome (TCCS) is considered the most prevalent incomplete spinal cord injury (SCI).¹ TCCS frequently occurs in elderly individuals with cervical spondylosis who sustain hyperextension injuries without spine fractures in falls, although the syndrome may occur in

persons of any age and may be associated with other etiologies, injury mechanisms or predisposing factors.²

Shingu *et al.*³ surveyed traumatic SCI registered across Japan between January 1990 and December 1992 in a nationwide epidemiological study. Their results demonstrated that the characteristic feature of SCI in Japan is the old age at the time of injury and that cervical cord injury constitutes 75% of the total SCI.³ Furthermore, they indicated that the high incidence of falls from a height and on level ground was another characteristic feature of SCI in Japan.³ In this respect, TCCS in Japan might be considered

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Received 22 March 2011; revised 23 June 2011; accepted 5 July 2011; published online 30 August 2011

more common especially in elderly people compared with other countries, although data on various clinical syndromes including TCCS were not made available in the above study.³

TCCS is generally considered to be associated with good prognosis and complete neurological and functional recovery.^{1,4-6} However, evidence suggests that the outcome is worse in the elderly than in younger people.^{2,7,8} Neurogenic bowel dysfunction is a major physical and psychological problem in individuals with SCI in association with abnormalities of bowel motility and sphincter control, coupled with impaired motility and hand dexterity, making bowel management a major problem.⁹ Persons with TCCS show some recovery of at least certain degree of ambulation, participation in daily life activities and bowel and bladder function.^{1,2,5-7,10-12} To our knowledge, however, there is little or no information on the differences in bowel dysfunction between the young and elderly people with TCCS. The purpose of this study was to clarify the bowel management techniques and bowel care-related activity of daily living (ADL) in elderly persons with TCCS.

Subjects and methods

The study protocol was approved by the Research Ethics Committee of our institution, and all subjects signed an informed consent form. A total of 28 Rosai hospitals participated in our study. 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 International Standards for Neurological and Functional Classification of SCI.¹³ Patients who were seen in the acute care setting, but did not undergo rehabilitation, were excluded.

There are no uniform or standardized diagnostic criteria for TCCS.¹⁴ In the European multicenter study of human SCI, van Middendorp *et al.*¹⁵ defined TCCS as total lower extremity motor score (LEMS) of ≥ 10 points higher than the total upper extremity motor score (UEMS). Recently, they also reviewed the currently applied TCCS diagnosis criteria and quantitative data regarding the 'disproportionate weakness' between the upper and lower extremities described in the original studies on TCCS subjects.¹⁴ The results of their study indicated an average of 10 motor points difference between the UEMS and LEMS as a possible TCCS diagnostic criterion.¹⁴ Therefore, we defined TCCS in this study as total LEMS of 10 or more points higher than the total UEMS at discharge.

The bowel management methods were divided into four categories as described previously,¹⁶ including continent spontaneous defecation (with or without oral laxatives), rectal medications (enemas or suppositories without manual removal of stool), manual removal of the stool (with or without rectal medication) and others.

In this study, bowel care-related ADL included toileting, bowel management, toilet transfer and locomotion. We also calculated the percentage of patients who were independent (with a score of 6 or 7) for all four Functional Independence Measure (FIM) items.

The neurological and functional outcomes of individuals with TCCS younger than 50 years of age are reported to be satisfactory.^{7,8} We, therefore, divided the patients by age into the young group (<50 years), the middle-age group (50-69 years) and the elderly group (≥ 70 years). We investigated the differences in bowel management techniques and bowel care-related ADL at discharge among the three age groups.

Statistical analysis

Data were expressed as mean \pm s.d. Differences in the rate of bowel management methods and persons with independent bowel care among the three groups were analyzed using the χ^2 test. Analysis of variance was used for comparison of three groups with respect to the ASIA motor score, sensory score and FIM score. When analysis of variance showed significant differences ($P < 0.05$), Scheffe's test was used to determine differences among the three groups. Statistical significant was defined as $P < 0.05$. All statistical analyses were performed using The Statistical Package for Social Sciences (version 11.5, SPSS Inc., Chicago, IL, USA).

Results

Our registry database included 3006 persons with SCI over the period of 10 years. Of these, 593 patients were excluded because of insufficient data (for example, age, gender, injury level, motor score, sensory score or bowel management method). Thus, the study subjects were 2413 patients with SCI consisting of 1707 patients with cervical lesions and 706 patients with thoracic or below thoracic lesions. On the basis of the above criteria of TCCS, 186 subjects had TCCS, with an incidence of 7.7% (186/2413).

Demographic and clinical characteristics

Table 1 shows the demographic and clinical characteristics of the TCCS subjects. The sample consisted of 160 (86.0%) men and 26 (14.0%) women with a mean age of 61.7 ± 11.6 years.

Table 1 Demographic and clinical characteristics of the study subjects with traumatic central cord syndrome ($n = 186$)

Characteristics	Young group ($n = 30$)	Middle-age group ($n = 112$)	Elderly group ($n = 44$)	P values
Sex				
Males	26	101	33	<0.05
Females	4	11	11	
Cause of injury				
Motor vehicle collision	16	41	10	<0.05
Falls	8	67	31	
Direct blunt injuries	3	2	1	
Sport-related accidents	2	1	1	
Others	1	1	1	
Duration of hospitalization (days) ^a	162 ± 133.2	166 ± 127.4	152 ± 94.1	NS

Abbreviation: NS, not significant.

^aData are mean \pm s.d.

Neurological characteristics

At discharge, the mean UEMS and the total motor score of the elderly group were significantly lower than those of the young group ($P < 0.05$; Table 2). There were no significant differences between the young and the middle groups with respect to UEMS, LEMS and total motor score at discharge in spite of a trend for higher values in the young group. No significant differences were found among the three groups with respect to the LEMS, light touch and pinprick score at discharge.

Table 3 lists the motor and sensory scores at discharge according to the methods of defecation. The UEMS, LEMS and total motor score of spontaneous defecation continent subjects were significantly higher than those of subjects who required rectal medications and manual removal of stool ($P < 0.001$). The pinprick score of continent patients with spontaneous defecation was significantly higher than that of patients who required manual removal of stool ($P < 0.05$). No statistical differences were found between the subjects who required rectal medications and those on manual removal of stool with respect to the motor and sensory scores.

Rehabilitation characteristics

Figure 1 shows the bowel management at discharge in the three age groups. Continent spontaneous defecation was the most common bowel management method for the entire sample and the percentage of patients using this method for the entire group was 50.0%. When the bowel management methods were divided into two categories including continent spontaneous defecation and others, the percentage of

elderly patients with continent spontaneous defecation (36.4%) was significantly smaller than that of the young group (66.7%, $P < 0.05$; Figure 1).

The total FIM scores at discharge for the young and middle-age groups were significantly higher than those of the elderly group ($P < 0.01$, Table 4). Table 4 shows the FIM scores according to the age groups. The FIM scores for toileting, toilet transfer and locomotion in the elderly group were significantly lower than those of the young and middle-age groups. Furthermore, the FIM scores of bowel management of the elderly group was significantly lower than that of the young group ($P < 0.05$).

Table 5 lists the FIM scores at discharge according to the defecation method and age groups. The FIM scores for toileting and toilet transfer of the elderly group with continent spontaneous defecation were significantly lower than those of the young and middle-age groups. In patients with TCCS who used rectal medications, the FIM score for toileting was significantly higher in the young group compared with the middle-age and elderly groups ($P < 0.05$). In contrast, in patients with TCCS who applied manual removal of stool, there were no differences among the three age groups in FIM scores for toileting, bowel management, toilet transfer and locomotion.

The percentage of patients whose discharge FIM scores for toileting, bowel management, toilet transfer and locomotion

Table 2 Mean motor and sensory scores on discharge in the three age groups

	Young group (n = 30)	Middle-age group (n = 112)	Elderly group (n = 44)
UEMS	29.5 ± 7.3*	26.8 ± 10.1	22.8 ± 11.5
LEMS	43.2 ± 7.4	41.3 ± 9.2	38.0 ± 10.4
TMS	72.6 ± 14.5*	68.1 ± 18.8	60.8 ± 21.4
Light touch score	74.0 ± 33.3	75.8 ± 26.5	81.1 ± 27.2
Pinprick score	73.1 ± 36.2	72.2 ± 29.2	77.3 ± 33.8

Abbreviations: LEMS, lower extremity motor score; TMS, total motor score; UEMS, upper extremity motor score.

Data are mean ± s.d.

* $P < 0.05$, compared with the elderly group.

Table 3 Mean motor and sensory scores on discharge according to the method used for defecation

	Continent spontaneous defecation (n = 93)	Rectal medications (n = 48)	Manual removal of stool (n = 32)	Others (n = 13)
UEMS	31.9 ± 5.5	19.2 ± 10.8****	19.4 ± 10.7****	29.6 ± 6.8
LEMS	45.7 ± 5.0	34.9 ± 10.8****	34.7 ± 9.5****	43.3 ± 6.0
TMS	77.6 ± 9.7	54.1 ± 21.2****	54.1 ± 19.8****	72.9 ± 12.5
Light touch score	79.7 ± 29.7	76.7 ± 25.4	67.1 ± 26.7	80.1 ± 23.1
Pinprick score	80.0 ± 30.9	69.7 ± 34.4	59.9 ± 27.4**	75.8 ± 21.2

Abbreviations: LEMS, lower extremity motor score; TMS, total motor score; UEMS, upper extremity motor score.

Data are mean ± s.d.

* $P < 0.001$, ** $P < 0.05$, compared with the continent spontaneous defecation group, **** $P < 0.001$, ***** $P < 0.01$, compared with 'others'.

■ continent spontaneous defecation
 ■ rectal medication
 ■ manual removal of stool
 □ others

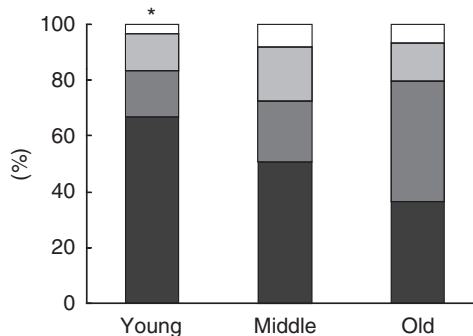


Figure 1 Discharge bowel management methods according to age. * $P < 0.05$, compared with the elderly group.

Table 4 Mean total and FIM scores according to bowel program in the three age groups

FIM scores	Young group (n = 30)	Middle-age group (n = 112)	Elderly group (n = 44)
Total	97.2 ± 30.0**	89.2 ± 30.0**	71.6 ± 27.5
Toileting	4.8 ± 2.5**	3.9 ± 2.6*	2.7 ± 2.2
Bowel management	5.1 ± 2.3*	4.3 ± 2.6	3.3 ± 2.5
Toilet transfer	5.5 ± 2.1**	4.8 ± 2.5*	3.7 ± 2.5
Locomotion	5.8 ± 1.8***	5.1 ± 2.0****	3.6 ± 2.3

Abbreviations: FIM, Functional Independence Measure.

Data are mean ± s.d.

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$, compared with the elderly group.

**** $P < 0.05$, compared with toileting.

were six or more points, that is, 'being independent of bowel care', in the young group was 53.3%, and that of middle-age group was 41.1%. On the other hand, that of the elderly group was 18.2% and significantly lower than those of the young and middle-age groups ($P < 0.01$). Among subjects aged ≥ 50 years, 30.1% were independent of ADL related to bowel care. Figure 2 plots the percentages of patients who were independent regarding bowel care at discharge according to the defecation method. The percentages of young and middle-age patients with continent spontaneous defecation 'independent of bowel care' were 75.0% and 65.5%, respectively. In contrast, the percentage of the same type of elderly patients with continent spontaneous defecation was 37.5% and significantly lower than those of the young and middle-age patients ($P < 0.05$). The percentages of young, middle-age and elderly patients who were 'independent of bowel care' and used rectal medications were 20.0%, 8.3% and 0%, respectively, with significantly lower percentage for the elderly patients compared with the young patients ($P < 0.05$). None of the patients who adopted manual removal of stool was independent with regard to bowel care at discharge.

At discharge, the scores of cognitive items were not significantly different between the elderly and younger groups (Table 6). Table 7 lists the rates of various complications recorded during hospitalization. The rates of heart disease, cerebral vascular attack and lung disease were higher in the elderly group than the middle-age group, and the rate of cerebral vascular attack was significantly higher in the elderly group than the young group.

Discussion

This study is the first detailed investigation of the effect of age on bowel management methods and bowel care-related ADL in individuals with TCCS. The major findings of this study were: (i) at discharge, only half of our subjects were on continent spontaneous defecation. (ii) The percentage of elderly subjects on continent spontaneous defecation was significantly less than that of the young group. (iii) The percentage of elderly patients independent of bowel care was significantly less than those of the young and the middle-age

Table 5 Mean discharge FIM scores according to age and method of defecation

	Toileting			Bowel management			Toilet transfer			Locomotion		
	Young	Middle	Elderly	Young	Middle	Elderly	Young	Middle	Elderly	Young	Middle	Elderly
Continent spontaneous defecation (n = 93)	5.9 ± 2.0*	5.5 ± 1.9*	4.0 ± 2.1	6.0 ± 1.7	6.1 ± 1.4	5.1 ± 2.0	6.5 ± 1.1*	6.4 ± 1.0**	5.4 ± 1.5	6.4 ± 1.2	6.0 ± 1.3	5.3 ± 1.8
Rectal medication (n = 48)	4.0 ± 2.3****	1.8 ± 1.6	1.6 ± 1.5	3.8 ± 1.8	2.4 ± 2.2	1.9 ± 2.0	4.6 ± 2.5	2.7 ± 2.3	2.6 ± 2.4	5.0 ± 2.3	3.7 ± 2.3	2.3 ± 1.9
Manual removal of stool (n = 32)	1.3 ± 0.5	1.4 ± 1.2	1.7 ± 1.0	2.3 ± 2.5	1.4 ± 1.0	2.2 ± 1.5	2.0 ± 2.0	2.3 ± 1.9	2.0 ± 1.3	4.3 ± 2.4	3.9 ± 2.0	2.8 ± 1.8
Others (n = 13)	2	5.5 ± 2.3	5.0 ± 3.5	4	5.4 ± 2.2	4.7 ± 3.2	5	6.3 ± 1.5	5.0 ± 3.5	4	6.3 ± 1.5	4.3 ± 2.9

Abbreviations: FIM, Functional Independence Measure.

Data are mean ± s.d.

* $P < 0.05$, ** $P < 0.01$, compared with the elderly group.

**** $P < 0.05$, compared with the middle-age group.

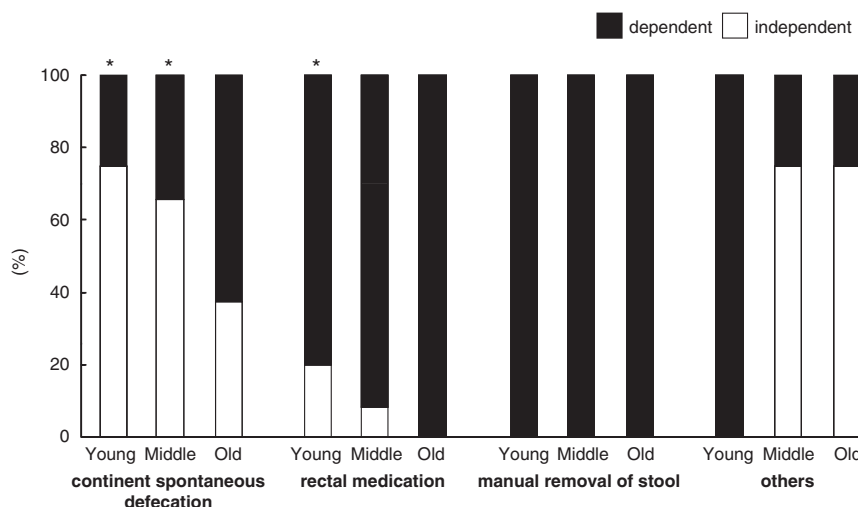


Figure 2 Percentages of patients who were independent and depended on bowel care according to age and method of defecation. * $P < 0.05$, compared with the elderly group.

Table 6 Mean scores of various cognitive items at discharge

	Young group (n = 30)	Middle-age group (n = 112)	Elderly group (n = 44)
Comprehension	6.7 ± 1.1	6.8 ± 0.8	6.5 ± 1.1
Expression	6.7 ± 1.1	6.8 ± 1.0	6.5 ± 1.0
Social interaction	6.7 ± 1.1	6.7 ± 1.0	6.3 ± 1.5
Problem solving	6.7 ± 1.1	6.7 ± 1.0	6.2 ± 1.6
Memory	6.8 ± 1.1	6.7 ± 1.0	6.3 ± 1.5

Data are mean ± s.d.

Table 7 Frequency of complications during hospitalization

	Young group (%)	Middle-age age group (%)	Elderly group (%)
Pressure ulcer	3.6	16.2	9.3
HO	3.4	2.8	2.3
DVT	0	0	0
Diabetes mellitus	3.4	11.0	14.0
Hypertension	0****	15.6	34.9
Heart disease	6.7	4.5**	21.4
CVA	0*	3.6*	13.6
Liver disease	6.7	5.6	5.0
Lung disease	3.3	0.9*	7.3
Renal disease	0	5.5	0

Abbreviations: CVA, Cerebral vascular attack; DVT, deep vein thrombosis; HO, heterotopic ossification.

Data are mean ± s.d.

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$, compared with the elderly group.

**** $P < 0.001$ compared with the middle-age group.

groups. (iv) Patients on manual removal of stool showed few differences in bowel care-related ADL among the three age groups.

A better neurological outcome has been described in younger people with TCCS compared with the elderly.^{2,8,10} This study also demonstrated significantly higher total motor score and UEMS on discharge in the young group

compared with the elderly group. Roth *et al.*² described that autonomic function tends to improve as well as, or better than, somatic muscle activity in TCCS. These findings could also explain the higher incidence of continent spontaneous defecation in the young group compared with the elderly. Although this study showed no differences among the three groups with respect to the sensory score, De Looze *et al.*,¹⁷ using radioopaque markers in individuals with SCI, proposed that the cause of constipation was prolonged transit time rather than loss of rectal sensation or dyssynergic pelvic floor contraction. Another reason is the age-related differences in bowel function, which have been reported in able-bodied person.¹⁸ In able-bodied person, it is commonly assumed that chronic constipation or changes in colonic function are natural consequences of the aging process,¹⁸ reflecting the tendency for a longer mean colonic transit time in the elderly.¹⁸ Furthermore, it is possible that the elderly group perform less favorably compared with young groups.

Our registry database does not include pre-morbid status of bowel care. Furthermore, there are only a few epidemiological studies on bowel dysfunction in able-bodied elderly people in Japan. Nakanishi *et al.*¹⁹ investigated the prevalence of fecal incontinence in a community-residing elderly population in Japan. Data on 1405 people aged 65 years and older living in the City of Settsu, Osaka, were reported in 1992.¹⁹ The authors reported a fecal incontinence prevalence rate of 7.5%.¹⁹ In this study, the proportion of elderly subjects with continent spontaneous defecation was 36.4% at discharge. These findings suggest that the majority of elderly subjects in our study seemed to have developed bowel dysfunction after cervical spine SCI.

Comparison of the young and elderly groups in this study showed that patients of the former were more likely to have independent of bowel care-related ADL. Penrod *et al.*⁷ demonstrated that 63% of subjects with TCCS aged < 50 years were bowel function-independent, compared with a few (24%) of the ≥ 50 years of age. Our results are in agreement

with those of the above study.⁷ A better neurological outcome is linked to a better functional recovery including bowel care-related ADL, and results in higher incidence of continent spontaneous defecation. Manual removal of the stool and use of rectal medications are difficult to perform by oneself especially in individuals with tetraplegia. In addition, people who engage in manual removal of stool or use of rectal medications experience bowel incontinence more often compared with ones with spontaneous defecation. For this reason, subjects of the elderly group tended to become dependent on bowel care-related ADL.

Penrod *et al.*⁷ indicated that the development of TCCS in advanced age is associated with poor outcome, because of the higher percentages of associated medical complications both before and after the injury. It is likely that such medical problems hinder the achievement of maximum function in these patients.⁷ In this study, medical complications were more frequent in patients of the elderly group than those of the middle-age and young groups. Thus, the coexistence of medical complications seems to enhance poor outcome of bowel care-related ADL in the elderly.

There is little or no information on bowel care-related ADL according to the defecation method in individuals with TCCS. The FIM scores for toileting and toilet transfer were significantly lower for the elderly group with continent spontaneous defecation than the young group. This finding might reflect the difference in UEMS between the two groups, because toileting and toilet transfer require the engagement of the upper extremities compared with bowel management and locomotion. In contrast, the FIM scores for toileting, bowel management, toilet transfer and locomotion were similar in patients with TCCS who used manual removal of stool irrespective of age, because all such patients had severe SCI-related disability.

Study limitation

One limitation of this retrospective study was the lack of long-term follow-up in relation to neurological and functional status and bowel management method. It is necessary to offer a sufficiently long period of intensive rehabilitation exercise to patients affected by motor incomplete spinal cord lesions.¹⁰ It is certainly possible to add further improvement to the above after discharge from the hospital. Despite the above limitations, the results of this study demonstrated differences in bowel management methods and ADL related to bowel care between the young and elderly patients.

Conclusions

The results of this study identified significantly fewer patients aged ≥ 70 years with 'continent spontaneous defecation' or 'independent for bowel care' compared with younger patients. The study results also highlighted the clinical importance of bowel dysfunction associated with TCCS especially in elderly people.

Conflict of interest

The authors declare no conflict of interest.

Acknowledgements

We thank the medical staff at the Rosai hospitals for their assistance. We also thank Dr Faiq G Issa (<http://www.word-medex.com.au>) for the careful reading and editing of the manuscript.

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