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Original Article

Effects on age on spinal cord lesion patients' rehabilitation

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Study design: The present study was undertaken to focus the age-related characteristics of a population of traumatic and nontraumatic spinal cord patients.
Objectives: to examine demographic, injury and outcome characteristics of older adults with spinal cord lesions as a result of trauma and nontrauma, and to compare these characteristics with those of younger patients in matched cohorts.
Setting: Spinal Cord Unit, Fondazione Santa Lucia IRCCS, a large rehabilitation hospital of the centre-south of Italy.
Methods: In total, 284 consecutive newly injured patients with traumatic and nontraumatic spinal cord lesions were retrospectively reviewed and divided according to age into two groups: under 50 years (group 1) and over 50 years (group 2). The following information was collected: onset of lesion to admission; injury variables: aetiology, level, associated injuries, medical complications and surgical intervention; length of stay; American Spinal Injury Association (ASIA) impairment and motor scores; Barthel Index (BI) and Rivermead Mobility Index (RMI) to assess independence in daily living; Walking Index for Spinal Cord Injury to assess ambulation; patients destination at discharge. In a subset of 130 subjects, a block design, matching procedure was used to control for the covariant effects of injury characteristics, time from lesion and aetiology on age effects.
Results: In the entire group of 284 patients, older subjects had a higher probability of having incomplete tetraplegia of nontraumatic origin; they also showed a shorter length of stay and a higher rate of complications. In the matched cohorts, younger patients showed better neurologic recovery (intended as ASIA impairment grade improvement and motor scores increase), significantly higher Barthel Index and RMI at discharge, a higher level of independence in spontaneous bladder and bowel management and a higher frequency of independent walking.
Conclusion: Older individuals with spinal cord injury and disease do well, but have a less favourable outcome in regard to walking, bladder and bowel independence than younger subjects and have more associated medical problems. Different rehabilitative strategies, therefore, are required for older subjects, which maximises the shorter length of stay and provides the necessary medical care and increased physical assistant resources following discharge.
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Keywords: spinal cord injury; age; outcome; rehabilitation; walking

Introduction

Spinal cord lesions are a devastating disease which produce severe functional impairment and psychosocial problems. Owing to the need of a prolonged rehabilitation stay, the risk of severe complications, the increased burden of care at discharge and the loss of productivity of these patients, spinal cord lesions result in extremely high costs to society.[1] Therefore, special efforts should be made to improve rehabilitation outcomes and to prevent complications and related medical problems.

Although most traumatic spinal cord lesions occur in young patients, approximately 20% of all spinal cord injuries occur in persons aged 65 years or older.[2] The progressive increase of age in the general population will probably produce an increased proportion of older patients and this has been seen in the USA.[3]

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It has been demonstrated that older patients with spinal cord injury have different features with regard to aetiology, sex ratio, neurological characteristics, complications, discharge placements and death after spinal cord lesions,[4] but the effects of age on spinal cord lesions is still a matter of disagreement. Some authors concluded that older patients have a higher risk of mortality and complications, while others suggested that these patients could obtain a better outcome as a result of the higher incidence of incomplete lesions in the elderly and yet others found no relation between age and functional outcome.[5,6] These differences relate, in large part, to the population of the subjects studied and the design and outcome measures utilised. Cifu *et al*[7] reported on the differences in outcome for three different age groups in a multicentre analysis of data from the model spinal cord injury centres and found significant differences between age categories with regard to American Spinal Injury Association (ASIA) motor index scores, rehabilitation length of stay and Functional Independence Measure scores.

Regardless of the differences in outcome, medical care systems will face greater challenges in efficiently and effectively treating older patients. Aged patients, with their multiple comorbidities, represent a special problem for physicians.[8] Furthermore, older adults who sustained a spinal cord injury have special functional and social issues which require specialised management and particular discharge accommodation.[9] Recently, McKinley *et al*[10] reported on the costs of caring for those with traumatic and nontraumatic spinal cord lesions. He found that younger and older subjects, when controlled for age, showed similar outcomes and rehabilitation efficiency between injury and noninjury cause of spinal cord injury. Such information about outcomes and costs of care for this growing population of spinal cord patients is necessary to formulate effective treatment plans and to justify the expenditure of rehabilitation funds. Otherwise 'ageism' has the potential to limit the accessibility of rehabilitation care to older patients.[11]

The present study was undertaken to define the characteristics of this population of aged traumatic and nontraumatic spinal cord diseases. The aims of the investigation were first, to describe the demographic, injury and complications characteristics of older adults with spinal cord lesions as a result of trauma and nontrauma and second, to compare outcome measures of older subjects with younger subjects in matched cohorts.

Patients and methods

Subjects

The sample consisted of 284 consecutive patients with recent onset of traumatic and nontraumatic spinal cord lesions, who were admitted to the spinal unit of a large rehabilitation hospital in Italy between 1997 and 2001. They were divided according to age into two groups: under 50 years (group 1) and over 50 years (group 2). Although geriatric patients are generally considered to be of age 65 years or older, those who were 50 years or older were considered as 'older adults'. The choice of age 50 years, although arbitrary, was made on the basis of previous reports.[12–14] Only patients who had the cognitive ability to participate in the rehabilitation programme were included. Whenever a patient was discharged or transferred for more than 3 weeks, the readmission was considered a second admission and the patient was excluded.

Measures

The following retrospective data were collected from a review of the charts:

- Onset of lesion to admission (LTA) to the hospital refers to time of trauma onset or disease onset to first acute hospital admission;
- injury variables: aetiology, associated injury, medical complications and surgical intervention;
- length of stay as in-patients in rehabilitation facility (LOS) (considered as an outcome measure as well as an independent determinant of other outcomes).

At admission and discharge patients were submitted to:

- Neurological examination was performed according to ASIA standards,[15] with evaluation of ASIA Impairment Scale, right and left motor and sensory levels. A subset of 200 subjects were evaluated for motor index scores. Neurological recovery was defined on the basis of improvement of motor scores and ASIA impairment grade.
- Barthel Index (BI),[16] according to standard protocols, scores ranging from 0 to 100 were assigned at admission and discharge, with higher score denoting greater levels of independence; BI subsets were also noted to identify areas of daily living more prone to be influenced by age (BI score was derived directly from the charts).
- Rivermead Mobility Index (RMI),[17] a 15 items mobility scale: the first three items of the scale evaluate patients' bed mobility and transfers, while the other 12 items assess patients' walking; the scores go from 0 to 15 (full autonomy in bed motility, walking and running). (RMI score was derived directly from the charts).
- Walking Index for Spinal Cord Injury (WISCI),[18] a new 0–20 levels scale that evaluates walking based on the need of physical assistance, braces and devices. The levels go from 0 (client unable to walk) to 20 (client walking without braces and/or devices and without physical assistance for at least 10 m). (The WISCI score was retrospectively derived based on the description of walking in the charts; such data were available only for 250 patients).
- Destination at discharge.

- Motor scores, BI and RMI score changes were calculated based on the difference between rehabilitation discharge versus admission.

Statistical analysis

- Descriptive data analysis: descriptive values, expressed as mean + SD, were supplied for all continuous clinical data. Data for 284 patients were analysed utilising Student's *t*-test for independent samples and χ^2 test.

Matching procedure and analysis
For outcomes evaluation a block design, matching procedure was used to control for the covariant effects of injury characteristics, time from lesion and aetiology on age effects. Four matching variables were selected: neurological level of injury (two levels: paraplegia and tetraplegia), ASIA impairment classification (two levels: A–D), time from lesion (two categories: <40 days and >40 days) and aetiology (two categories, traumatic and nontraumatic). Each patient was identified by an injury type/aetiology/time from lesion group and categorised based on age. Patients were selected from each age group to create matched dyads on the basis of their injury type/aetiology/time from lesion group classification. When multiple young and old patients were identified within the same classification, the patients were randomly matched until no more young/old dyads could be created. Patients without exact injury type/aetiology/time from lesion counterparts were excluded. This matching procedure produced 16 blocks (four injury type groups × two time from lesion groups × two aetiology groups). Overall 130 patients were selected, thus creating 65 dyads. Data for the dyads were analysed using paired *t*-test and McNemar's χ^2 test was applied to assess contingency differences.

Spearman's rank order correlation was performed to assess correlation between age and other parameters. Differences were taken as significant if $P<0.05$.

Results

Sample characteristics
There were 184 male and 100 female subjects, aged 12–86 years (mean 50. 4±19.3 years). Mean interval from lesion to admission was 56.9±43.9 days. The mean length of stay was 98.7±68.13 days. Most patients (179/284) had a spinal cord lesion of nontraumatic aetiology (inflammatory, vascular, neoplastic, degenerative), and the great majority of traumatic lesions were related to traffic accident (Table 1). Lesion level: 81 had a cervical lesion, 148 a thoracic one and 55 a lumbo-sacral one (including cauda equina damages). ASIA impairment: at admission 84 patients had an ASIA impairment A, 19 an ASIA B, 129 an ASIA C and 52 an ASIA D. At

Table 1 Lesion aetiology

Aetiology	*Under 50 years N=119*	*Over 50 years N=165*	*P*
Trauma	$N=79$	$N=28$	<0.001
Street accident[a]	48	5	<0.001
Falls	12	19	<0.001
Other causes[b]	19	4	0.3
Nontraumatic lesions	$N=40$	$N=137$	<0.001
Inflammatory	10	30	NS
Vascular	6	30	NS
Neoplastic	13	26	NS
Degenerative	11	51	NS

[a]Street accident: car and motorcycle accident
[b]Others: sport accidents, gunshot injuries, suicide attempts

admission, 75 patients presented complication related to spinal cord lesions (mostly pressure sores).

In all, 191 patients had surgery and 75 patients suffered from complications related to spinal cord lesion (mostly severe spasticity and pain syndrome) and concurrent disease that required 54 patients to be transferred to general hospitals.

Epidemiology
The characteristics of the two groups are shown in Tables 1 and 2.

Patients under 50 years have a higher probability of having a traumatic lesion if compared to patients over 50 years ($P<0.001$) (Table 1). Evaluating the level and completeness of lesion patients with incomplete tetraplegia (TI) were more frequent in the older group ($P=0.004$), patients with complete paraplegia (PC), than in the younger one ($P=0.002$) (Table 2).

The mean interval from LTA was 47.6±37.2 days in group 1 and 64.6±47.6 in group 2 ($P=0.008$). This difference was related only to patients with complete motor lesions, while ASIA C–D patients did not show a significant difference.

LOS was longer in patients under 50 years (111.3±63.88 versus 89±69.9, $P=0.008$) related to the higher incidence of incomplete motor lesions in the older group and to presence of complications at admission. It was however independent of aetiology, complications during hospitalisation, surgical interventions, etc.

Owing to the higher rate of complications and concurrent morbidities during hospitalisation, group 2 patients had a higher frequency of transfer to other hospitals ($P=0.02$). Younger patients had a higher frequency of admission to other rehabilitation facilities ($P=0.02$).

The percentage of patients who showed neurological recovery was higher in ASIA C group (4/86 ASIA A, 6/18 ASIA B, 63/127 ASIA C, 1/53 ASIA D). LTA

Table 2 Characteristics of young and old patients

	Group 1	Group 2	P
M/F ratio	79/40	105/60	0.63
Time from lesion	47.7±37.2	64.6±47.6	0.008
LOS	111.3±63.8	89±69.9	0.008
Associated lesions	41/79	10/28	0.14
Surgical intervention	96	91	<0.001
ASIA impairment			
A	46	39	0.01
B	9	8	0.34
C	47	81	0.1
D	64	117	0.08
Level			
C	28	53	0.11
T	52	96	0.015
L	39	16	<0.001
ASIA inpairment+level			
Complete paraplegia	42	37	0.0017
Incomplete paraplegia	48	73	0.5
Complete tetraplegia	13	9	0.09
Incomplete tetraplegia	16	46	0.004
Discharge			
Home	95	123	0.3
Other hospital	15	39	0.019
Other rehabilitation	9	3	0.02
Nursing home	0	0	1

interval was significantly longer in patients who did not improve (73±51.2 versus 47.2±38.4, $P=0.006$). Neurological recovery was more frequent in younger patients (41/119 patients in group 1 and in 33/165 in group 2, $P=0.006$).

At admission, there was no significant difference between the two groups with regard to the total number of complications and to the various complications (Table 3). The incidence of complications during hospitalisation, however, was significantly higher in patients over 50 ($P=0.033$), because of the significant higher incidence of respiratory insufficiency ($P=0.002$) and of concurrent morbidities: mostly surgical complications in young patients and cardiovascular diseases in old ones (Table 3).

Matched cohorts comparison (Table 4)
In the matched cohorts, time from lesion was not significantly different in the two groups (51.1±39.1 days in group 1 versus 67±47 in group 2, $P=0.07$). LOS was longer in younger patients, but this difference did not reach significance (110.2±66.1 versus 93.1±68.5, $P=0.15$).

Neurologic recovery In the younger group, ASIA impairment grade improvement occurred in 22/65 patients and in 12/65 of the older ones ($P=0.027$). Motor scores increase was higher in the young group too (Table 5).

Table 3 Complications and concurrent pathologies

Complications	Under 50 years	Over 50 years	P
Admission	30	43	NS
Pressure sores	27	38	NS
Paraosteoarthropathies	6	5	NS
Respiratory insufficiency	3	6	NS
Deep vein thrombosis	1	1	NS
Pulmonary embolism	0	0	NS
During hospitalization	24	52	0.033
Pressure sores	0	4	NS
Paraosteoarthropathies	2	0	NS
Respiratory insufficiency	0	12	0.002
Deep vein thrombosis	2	4	NS
Pulmonary embolism	0	3	NS
Urological	4	0	NS
Others	19	34	NS

Table 4 Injury level, ASIA impairment scale, time from lesion and aetiology composition of matched cohortsunder 50 and over 50 years groups (65 cohorts, 130 patients)

Neurologic level	AIS	Nontraumatic	Traumatic	Total
Tetraplegic	A-C	5	13	18
Tetraplegic	D	4	0	4
Paraplegic	A-C	25	12	37
Paraplegic	D	6	0	6
Total		40	25	65

Table 5 Main outcomes

	Age categories		
	Under 50 years	Over 50 years	P
Admission			
Motor scores	61.9±26.9	59.7±25	0.65
Barthel index	25.4±22.6	20.3±20.6	0.17
RMI	1.3±2.5	0.8±2	0.3
Discharge			
Motor scores	70.9±27.2	62.4±25.5	0.09
Barthel index	69.3±29.8	44.3±33.1	<0.001
RMI	6.8±4.9	3.5±4.5	0.001
Motor scores increase	11.2±10.8	3.2±6.8	<0.001
Barthel Index increase	43.9±27.3	24±21.1	<0.001
RMI increase	5.5±4.4	2.6±3.4	<0.001
WISCI increase	7.3±8.8	3.3±6.6	0.01
Motor scores efficiency	0.14±0.16	0.03±0.06	<0.001
Barthel index efficiency	0.5±0.3	0.3±0.3	0.002
RMI efficiency	0.06±0.06	0.03±0.05	0.004

Independence of daily living The BI and RMI were the same in both groups at admission, but significantly higher in group 1 at discharge ($P<0.001$) (Table 5). Significant differences were found for all BI items, with the exception of feeding (Table 6). Both BI and RMI

Table 6 Barthel index items

	Admission			Discharge			Increase		
	U 50	*O 50*	*P*	*U 50*	*O 50*	*P*	*U 50*	*O 50*	*P*
Feeding	7.4±4	6.3±4.3	0.14	8.8±2.9	8.1±3.5	0.4	1.4±2.9	1.8±3	0.4
Grooming	2.8±2.5	1.7±2.4	0.03	4.3±1.7	3.1±2.4	0.003	1.5±2.3	1.4±2.2	0.8
Bathing	0.8±0.6	0.8±0.6	1	1.9±2.4	0.7±1.7	0.005	1.8±2.4	0.6±1.6	0.003
Dressing	1.1±2.8	0.8±1.8	0.42	6.5±4.1	3.2±4	<0.001	5.4±4.2	2.4±3.6	<0.001
Bladder management	1.8±3.7	1.6±3.4	0.8	7.8±4	4.6±4.8	<0.001	6±4.7	2.9±4.3	<0.001
Bowel management	2.2±4.1	1.9±3.7	0.3	7.9±4	4.6±4.8	<0.001	5.3±4.8	2.7±4.2	<0.001
WC use	3.9±3.7	3.3±3.8	0.35	7.5±4.2	4.7±4.4	< 0.001	3.5±2.9	1.3±1.6	0.001
Transfers	4.2±3.9	3.5±3.9	0.4	12.5±3.9	8.1±4.8	<0.001	8.3±4.1	4.5±3.3	<0.001
Locomotion	2.3±4.1	2.2±3.8	0.8	9.2±5.2	6.2±5.2	0.003	6.9±4.9	4±3.5	0.001
Stairs climbing	0.2±1.1	0.1±0.9	0.5	3.5±4.2	1.7±3.4	0.02	3.2±4	1.5±3.2	0.02

Table 7 Frequency of independent walking (WISCI levels 9, 12, 13, 15, 16, 18, 19, 20)

	Under 50 years N=65	*Over 50 years N=65*	*P*
ASIA A-C	24/55	7/54	<0.001
ASIA A/B	4/27	0/27	0.04
ASIA C	20/28	7/28	<0.001
ASIA D	10/10	8/10	0.13
Total	34/65	15/65	0.004

increases are inversely correlated to age ($r = -0.44$ and -0.36, $P < 0.001$). BI increase was directly correlated to LOS ($r = 0.18$, $P = 0.04$), but not to LTA.

Bladder and bowel function In Group 1, 47/65 patients reached complete independence in spontaneous voiding or self catheterisation versus 35/65 in Group 2 ($P = 0.005$); the same difference was shown by BI bladder function item scores (Table 6). With regard to bowel function in Group 1, 47/65 patients were autonomous versus 31/65 in Group 2 ($P = 0.014$).

Mobility and walking In the matched cohorts, young patients (ASIA A/B and C) reach independent walking on the WISCI scale (levels 9, 12, 13, 15, 16, 18, 19, 20) more frequently than older patients ($P < 0.004$) (Table 7).This is true for all ASIA impairment grades with the exception of ASIA D. The respective BI and RMI scores are shown in Tables 5 and 6.

Discussion

The present study was undertaken to clarify the relation between age, spinal cord demographics and outcomes.

The demographic findings in our study are consistent with trends for the general traumatic and nontraumatic populations with spinal cord pathology.[19,20]

Traumatic lesions were more frequent among young persons (<50) and nontraumatic lesions in older ones (>50).[20] Older patients were significantly more susceptible to injury from falls.[21] According to some studies[19,22] motor vehicle accidents in young patients were the leading cause of SCI followed by falls, sport accidents, suicide attempts and acts of violence. These data are similar to those of other Italian statistics,[23] but different from USA data in which acts of violence have become the second cause of injuries[3] and the leading cause in paraplegic subjects.[7] The distribution of nontraumatic lesions is also comparable to McKinley's report[20] with vertebral degenerative disease as having the highest association with spinal cord disease.

Owing to the different causes of SCI and SCD, younger patients have a higher probability of sustaining complete motor lesions of the thoracic and lumbar levels, while older individuals have a higher frequency of incomplete tetraplegia.[5] This characteristic can significantly influence rehabilitation outcomes, since incomplete injury has a better neurologic prognosis.[24]

As expected, ASIA C patients have the best neurologic improvement. As previously reported, ASIA A and B patients have very low possibility to improve and ASIA D's suffer from ceiling effects (ie they do not have much to improve).[24] Patients who improved their ASIA impairment grade, however, had a significant lower LTA interval (47 days) as compared to those subjects, who did not improve (73 days). Since the most marked improvement of incomplete injuries occurs in the first two months,[25] comparisons where LTA is not controlled may be invalid.

In our series, older patients showed a higher frequency of complications and concurrent morbidities, a finding reported by Stover *et al*[4] that stresses the multiplicity of medical issues that face the older patients. Within complications related to spinal cord lesions, respiratory insufficiency is worth noting because it often required special assistance and transfer to other hospitals.

Younger subjects appeared to have a better neurological recovery, but the younger subjects had more trauma and the older subjects less severe injuries. Owing to the significant differences of severity and aetiology, we felt it necessary to control for these variables and decided to use a matching procedure similar to Cifu *et al*[21] and McKinley *et al*[10] in which patients who did not have their exact counterpart were excluded from the comparison. In this way we selected 65 cohorts and 130 patients.

With regard to LOS in our series, older patients had a significantly shorter LOS, a finding similar to Roth *et al*,[13] but opposite to Cifu's data[7] on paraplegic subjects. LOS could be influenced by a series of factors: the completeness of lesion (a high number of patients with incomplete tetraplegia in older group could justify the shorter LOS of this group); the higher frequency of comorbidities in older patients could interfere with the rehabilitation process, which could in turn affect the length of stay;[1] the discharge disposition and the increase likelihood of institutionalisation of older patients, which could affect the length of stay for awaiting placement. In our patients, the effects of level and motor completeness are weighted by the matched cohorts procedure: both groups have exactly the same number of complete/incomplete patients and para-tetraplegics. Owing to the Italian health policy that permits a more prolonged length of stay than reported in the USA, our guidelines are to discharge patients when they reach the maximum independence possible or when their scores of BI and RMI reach a plateau (same scores in two different evaluations at a distance of 20–30 days). Thus, in our opinion, the shorter LOS of older patients reflects reduced levels of function. This opinion is re-enforced by the significant difference of BI and RMI efficiency (used to better control for length of stay) which demonstrates that the difference of the two outcomes do not depend on LOS.

Our study demonstrates a significant difference in neurologic recovery, function and specific activities such as walking between younger and older subjects, irrespective of the cause. This is a new and important information for health-care planning. The need for predicting outcome based on expected neurologic recovery and associated functional recovery has been emphasised by one of the authors[26] as essential for health-care planning. This is the reason for carefully documenting neurological recovery and the specific functional correlations, so that clinical judgements are based on well-controlled studies.

In our series young patients recover better both in terms of ASIA impairment level and ASIA motor scores increase. We would like to suggest that this may be based on spinal cord recovery: it has been demonstrated that this recovery probably depends on various mechanisms. Immediately after the lesion, postsynaptic mechanisms (increased postsynaptic receptors excitability and receptors upregulation) have been postulated.[27] Later on, presynaptic mechanisms (synapse growth and formation of new circuits through collateral sprouting) may occur in cortical and subcortical centres and in the spinal cord.[28]

Data on the effect of age on SCI patient outcomes have already been reported in several studies,[7,12,14,21] but their methodologies differ from ours. Our results compare favourably with Penrod *et al*[12] and Burns *et al*[14] study on incomplete tetraplegic subjects, in regard to better outcomes for younger subjects in neurological recovery and walking although Penrod *et al*[12] utilised Frankel grades rather than the ASIA Impairment Scale to predict differences in ambulatory function, and did not define the grades for C and D. This is important, because the interpretation of 'functional muscles' for the C and D levels may change from one classification system to another. In Cifu's study[21] on tetraplegia, the younger subjects also show both neurological and improved functional outcomes, although the length of stay is equivalent. McKinley's study[20] on the comparison of traumatic and nontraumatic spinal cord causes also found lower FIM Motor scores for the older subjects, but he was unable to control for neurological severity. The nontraumatic spinal cord diseases had less severe neurological involvement similar to our descriptive results. In a subsequent study, when he[10] compared a match cohort of traumatic and nontraumatic subjects, in which he controlled for neurological level and ASIA Impairment scale, he also controlled for age, so he could draw no conclusions on the differences between young and old subjects.

With regard to function, we examined the differences between admission and discharge scores (change) and efficiency scores. On admission, there were no age group differences in BI and RMI scores.

Conversely significant differences in the three outcomes were noted at discharge; change scores and efficiency scores were different too. Furthermore, in our study we examined each item of the BI to discover areas of independence which could be particularly affected by age and found that young patients have a better outcome in all areas of daily living with the exception of feeding. In one of the few studies that considered single areas of daily living, Penrod *et al*[12] reported similar data, but the study examined only patients with central cord syndrome.

Young patients also have a better outcome in bladder and bowel management. With regard to the bladder, more patients in the young group reached independence in voiding. Interestingly, this difference included both the ability to perform clean intermittent catheterisation and to void spontaneously. According to Madersbacher[29] older patients have more difficulty performing intermittent catheterisation because of the decreased ability to cope with a new situation, because of higher impairment of balance and of hand functioning and because of pre-existing factors interfering with this technique such as prostatic hyperplasia. The improved bowel function is probably related to the better neurologic recovery of young patients.

Finally, special attention was paid to walking ability, because of the investigative interests of our hospital. Walking was examined with three scales which included the new WISCI, in addition to subscales of the BI and RMI. The WISCI is a new walking scale that integrates walking aids, braces and physical assistance in a hierarchical order[18] and was applied retrospectively. Two different distances were utilised: 10 m for the RMI and WISCI and 45 m for the BI. Younger patients in our study with traumatic and nontraumatic causes achieved better results than older ones as reported by Penrod *et al*[12] and Burns *et al*[14] in SCI. Walking outcome depends on age and ASIA impairment level at admission; and in the young group all (100%) the ASIA D patients at admission and 20/28 (71%) of the ASIA C at admission became ambulatory at discharge. In the old group, the respective results were 8/10 (80%) of ASIA D and 7/28 (25%) of ASIA C became ambulatory. In both groups, the percentages of patients who reached independent ambulation are lower than the ones of the above-mentioned studies, but this difference could be explained by different methodological approaches. Both Penrod *et al*[12] and Burns *et al*[14] took into account patients with only incomplete tetraplegia and in both studies patients were first evaluated within 1 week from the lesion, while our patients were evaluated in average 50–60 days after the lesion. It has been reported recently that a great amount of recovery in spinal cord injury patients occurs within 2 months from the injury,[25] thus it is possible that by the time our patients have been admitted to our hospital, a part of the recovery already occurred. Furthermore, in our series some ASIA A and B patients reached independent walking with appropriate braces and devices, but only in the young group. It is well known that walking with braces requires a high level of energy expenditure and good strength of the trunk and upper extremity muscles,[30] thus, patients over 50 years probably lack these requisites and are not candidates for bracing.

Independence in daily living is important for discharge planning. Our older patients' scores in BI items fell between incapacity to perform the activities and the need of moderate assistance, while in the younger group the same score was between moderate assistance and full independence. This suggests that older patients did not achieve enough independence for discharge to the community. Although in our series daily living outcome does not seem to influence discharge disposition (most of our patients returned home independent of age), older patients often require a high level of assistance at home and special social interventions would be necessary.

The present study has some limitations: (1) the sample consists of one European centre and may not be representative; (2) factors other than LTA, neurological severity and level were not controlled, which may have contributed to outcomes other than the age of patients and (3) while BI and RMI Scores were copied by the charts, the walking function defined by the WISCI was determined retrospectively, on the basis of the descriptions of walking in the charts.

Despite these limitations we think that our methodology effectively addresses some of the limitations of previous studies.[7,10,12,14,21] The matching procedure reduced the possible effects of lesion to admission interval, of level and completeness of lesion and the differences between traumatic and nontraumatic aetiology. Precise measures of motor recovery were used, correlated with walking recovery that was evaluated by BI, RMI and WISCI, rather than a global measure alone, such as the FIM. Clinicians should be better prepared to plan rehabilitation care based on these findings.

Conclusions

In conclusion, elderly individuals admitted to a regional rehabilitation centre with spinal cord injury and disease have generally less severe neurological deficit and are less frequently caused by trauma as compared to younger subjects. Medical complications are more common in older subjects, particularly respiratory insufficiency, often requiring transfer to acute hospitals. Neurological recovery appeared to be better in the younger population, but the younger and older groups were not similar. When severity, aetiology and time from onset are controlled, the older subjects fare well, yet have a shorter length of stay. They do not show, however, the same extent of neurological and functional recovery, such as walking, bladder and bowel independence as younger subjects. These factors are important considerations in the use of rehabilitation resources such as planning follow-up medical care for the comorbidities and physical assistance limitations.

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