ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2016;■:■■■-■■■

ORIGINAL RESEARCH

Influence of Age Alone, and Age Combined With Pinprick, on Recovery of Walking Function in Motor Complete, Sensory Incomplete Spinal Cord Injury

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Abstract

Objective: To determine if age, pinprick scores in the lower extremities, and neurologic severity of injury influence recovery of ambulation in persons with motor complete, sensory incomplete (American Spinal Injury Association Impairment Scale [AIS] grade B) spinal cord injury (SCI) 1 year after initial injury.

Design: This retrospective analysis examined subjects with AIS grade B from the Spinal Cord Injury Model System (SCIMS) database from 2006 to 2015. The baseline neurologic examination at rehabilitation admission (2−4wk postinjury) was used for comparison with 1-year outcome measures of locomotion.

Setting: Fifteen acute inpatient rehabilitation centers (participants in the SCIMS database).

Participants: Participants with AIS grade B SCI (N=249) were enrolled in the SCIMS database in 2 cycles (2006−2010 and 2011−2015).

Interventions: Not applicable.

Main Outcome Measures: Household ambulation at 1 year by FONE-FIM and by direct interview, as part of the annual neurologic exam; change in American Spinal Injury Association score 1 year postinjury.

Results: Findings demonstrate a statistically nonsignificant increase in likelihood of walking for those age <50 years compared with those age ≥50 years (relative risk [RR]=1.99; 95% confidence interval, 0.80−3.04). Presence of pinprick in at least one half of the lower-extremity dermatomes L2-S1 was associated with higher likelihood of walking (RR=5.57, P=.0023). Pinprick was significant for patients age <50 years (RR=4.58, P=.0090) but not for those age ≥50 years (P=.15).

Conclusions: Compared with younger individuals, participants age ≥50 years with AIS grade B SCI are less likely to achieve walking function 1 year postinjury. Likewise, preservation of pinprick sensation postinjury in the majority of lower-extremity dermatomes L2-S1 increases the chances of walking in individuals age <50 years.

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Predicting recovery of walking based on age and neurologic evaluation after traumatic spinal cord injury (SCI) is valuable in setting rehabilitation goals and in stratifying subjects for interventional trials.[1,2] Both the age and neurologic level of injury (NLI) of the individual at the time of traumatic SCI are essential components to consider when envisioning long-term function. Over the years, studies on the influence of age and severity of paralysis have demonstrated that younger individuals have a more favorable prognosis for recovery of walking function than do older persons.[3,4] In contrast with older individuals, persons age <50 years with sensory incomplete, motor complete SCI (American Spinal Injury Association Impairment Scale [AIS] grade B) may also have a different prognosis for recovery of household and independent community ambulation (walking 200ft [61m]). However, studies relating age to recovery of AIS grade B SCI based on age have been reported only recently.

One study[5] focused only on thoracic injuries and found that older individuals with AIS grade B SCI had less successful

Supported by the U.S. Department of Health and Human Services, National Institute on Disability, Independent Living, and Rehabilitation Research (grant nos. HHS 90SI5012-02-01 and NIDILRR H133N110021).

Disclosures: none.

0003-9993/16/$36 - see front matter © 2016 by the American Congress of Rehabilitation Medicine
http://dx.doi.org/10.1016/j.apmr.2016.01.024

walking outcomes than younger individuals. A pilot investigation[6] by our group showed that initial pinprick sensation favored a positive prognosis for walking in persons with AIS grade B SCI age <50 years. However, no individuals age ≥50 years with pinprick sensation walked independently at 1 year postinjury. Historical investigations[7-13] indicate that preservation of pinprick in the lowest sacral segments and in most lower-extremity dermatomes L2-S1 increases the likelihood of both household and community ambulation.[8] In 2 prior investigations,[7,8] subjects with AIS grade B were thought to have a 24% to 38% positive prognosis for walking, but the relation to age was not examined.

Based on findings of walking recovery in participants with AIS grade B from our single-center pilot study[6] and relevant past literature (table 1), we have chosen to examine a larger population drawn from the Spinal Cord Injury Model System (SCIMS) database. We hypothesize that age influences household walking in individuals with AIS grade B SCI and that age, in combination with initial pinprick sensation in dermatomes L2-S1, affects probability of eventual walking.

Methods

Data sources and evaluation measures

Compared with our pilot study[6] that used initial American Spinal Injury Association (ASIA) examination findings from the 72-hour evaluations, the earliest neurologic examinations with full sensory testing in the SCIMS database are at admission to rehabilitation (available since 2011). Although admission times varied between subjects, we limited our study population to individuals with AIS grade B SCI enrolled in the SCIMS database (appendix 1) within 30 days of injury, with most subjects arriving 2 to 4 weeks postinjury. Participants with cervical, thoracic, and lumbar NLI were included, whereas sacral NLI and participants <age 18 years were excluded. Main outcome measures were initial pinprick scores in dermatomes L2-S1 and NLI at or above L2 versus L2 and below. Analysis of the current investigation chose the age of 50 years to separate younger from older participants because this age had been used in 2 prior investigations on incomplete SCI.[3,4] The primary mode of locomotion at 1 year postinjury (walking vs wheelchair) was stratified according to age (<50 vs ≥50y).[6] This information was obtained by telephone interview (FONE-FIM), in cases where travel was not possible, or by in-person discussion at the annual neurologic examination at an SCIMS center. The FONE-FIM is a telephone version of the standard FIM that has demonstrated excellent construct validity in clinical testing.[14,15] Mode of locomotion at 1 year was evaluated by the same procedure previously described.

Ability to differentiate pinprick from dull sensation was tested according to the guidelines given in the International Standards for Neurological Classification of SCI.[16] Compared with pin appreciation in the face, each dermatome was graded as follows: 0 (absent), 1 (present but impaired), or 2 (present and normative). Pinprick preservation in the lower extremities was defined as pinprick/light-touch differentiation in a minimum of 5 of the 10 lower-extremity dermatomes from L2-S1,[8] which correspond to the lower-extremity myotomes tested in the International Standards for Neurological Classification of SCI.[16] In theory, if pinprick is preserved in a given dermatome, motor return in a corresponding myotome may be more likely, given the proximity of the corticospinal tract to the spinothalamic tract within the cord.[17]

The mode of locomotion according to age and the combination of age and pinprick were calculated separately, to determine if the 2 factors together were able to predict functional outcomes more accurately. In addition to age and pinprick at admission to rehabilitation, each participant's sex, ethnicity, and etiology of injury was obtained from the SCIMS database.

List of abbreviations:

AIS	**American Spinal Injury Association Impairment Scale**
ASIA	**American Spinal Injury Association**
NLI	**neurologic level of injury**
RR	**relative risk**
SCI	**spinal cord injury**
SCIMS	**Spinal Cord Injury Model System**

Verification and accuracy measures

A computer algorithm was used to confirm the accuracy of all ASIA examinations reported in the SCIMS database[18] at rehabilitation admission and 1 year postinjury. Discrepancies in ASIA scoring classification between the database and computer algorithm were further scrutinized and subsequently rescored by one of the authors through examination of all raw data points from the SCIMS database. In an attempt to best compare our results with earlier studies conducted at 72 hours postinjury, we limited inclusion to participants with full sensory (pinprick and light touch) and motor data available within 30 days of SCI.

Statistical methodology

Categorical variables were summarized using frequencies and percentages. Age was dichotomized as <50 versus ≥50 years. The association of age with demographic characteristics and outcomes was evaluated using the Pearson chi-square test. The risk ratio for <50 versus ≥50 years was estimated as the measure of effect of age at injury on walking function 1 year postinjury. Data were analyzed for the entire period from 2006 to 2015 and separately for the 2006 to 2010 and 2011 to 2015 cycles. Differences in the composition of the SCIMS, local referral patterns, and shorter lengths of stay in the acute care setting prompted the need to examine each cycle individually. All analyses were performed using SAS/STAT 13.2.[a]

Results

Walking outcomes at 1 year were available for 249 subjects who had ASIA grades of B at entry to rehabilitation. Demographic characteristics are summarized by age group in figures 1 through 3. No statistically significant differences were found in sex or race between the younger and older age groups; however, those age <50 years were more likely to be men and black. Etiology of injury differed between age groups ($P<.0001$), with participants aged <50 years more likely to have an SCI from motor vehicle collision and sports/recreation and those age ≥50 years more likely to have an SCI from falls or medical complications. Mean ages for younger and older participants were 29.8±9.9 and 59.8±7.3, respectively.

The association of age and walking outcomes is given in table 2. Overall, the relative risk (RR) of walking for age <50