Research Article

Is there any gender or age-related discrepancy in the waiting time for each step in the surgical management of acute traumatic cervical spinal cord injury?

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Context/Objective: Prior studies indicate that patient's gender and age can influence treatment choices during spine disease management. This study examines whether individual's gender and age at injury onset influence the waiting time for each step in the surgical management of patients with acute traumatic cervical spinal cord injury (atcSCI).
Design: Retrospective cohort study.
Setting: Quaternary spine trauma center.
Participants: This study included consecutive individuals with atcSCI admitted from August/2002 to October/2008 who were enrolled in the Surgical Trial in Acute Spinal Cord Injury Study (STASCIS).
Interventions: Spinal cord decompression.
Outcome Measures: Data on the periods of time for each step in the surgical management were analyzed to explore the potential effects of gender and age at injury onset.
Results: There were 64 individuals with atcSCI (17 women, 47 men; age range: 18–78 years; mean age: 50.5 ± 2.1 years). Older age was associated with longer stay in the acute spine center, but this association was cofounded by major pre-existing medical co-morbidities. Age did not significantly affect the waiting time for each step in the surgical management of these individuals with atcSCI. Women underwent surgical assessment earlier than men. Gender did not influence other key steps in the surgical management.
Conclusion: The study results suggest that older age at injury onset was associated with longer stay in the acute spine care center, and women had a shorter waiting time for surgical assessment than men. Nevertheless, no other age or gender bias was identified in the waiting times for the steps in the management of atcSCI.

Keywords: Spinal cord injury, Acute spine trauma, Neurotrauma, Age, Gender

Introduction

Changes in the epidemiology of traumatic spinal cord injury (SCI) were widely reported in the literature. As a consequence of the aging of the population, prior studies consistently documented an escalation of fall-related SCIs in the elderly population worldwide.[1–6] While the majority of prior investigations suggest there have been no significant changes in the proportion of men and women with SCI over the past two decades, the results of a few population-based studies suggest that the proportion of women has increased relative to the proportion of men over time.[1–6] Overall, the incidence and prevalence of acute traumatic SCI remains relatively modest, whereas the personal and societal burden is substantial.[5,7] The estimated lifetime costs per individual with traumatic SCI at the age of 25 years vary from $1.65 million for incomplete paraplegia to $4.7 million for complete high tetraplegia in the United States (in 2017 USD).[8]

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The 2003 report from the Institute of Medicine of the National Academies underlined broad healthcare disparities in the United States, despite controlling for disease severity, socioeconomic status, education, and access.[9] Elderly individuals and women are among the groups of Americans identified as receiving different or presumably lesser healthcare.[10] Age bias or ageism is generally defined as negative attitudes, stereotypes and behavioral discrimination based exclusively on a person's chronological age, that can be expressed by patients, their families and healthcare professionals.[11] Sex/gender bias or sexism is usually defined "as a belief in the intrinsic superiority of one sex over the other – typically men over women – and is associated with prejudice, discrimination and stereotyping".[12] Although there are several differences between men and women, an overestimation of the perceived implications of grouping people by their gender represents stereotyping that can be shared by either gender.[13]

Generally speaking, there is a paucity of studies in the literature assessing whether or not there is any potential, perceived or real age and sex bias in the management of individuals with trauma of the cervical spine and spinal cord. Therefore, we carried out this original study in order to examine whether gender and age at the time of injury are key determinants in the waiting times for the steps in the surgical management of individuals with acute traumatic cervical SCI (atcSCI).

Methods

Participants

This retrospective cohort study included consecutive individuals with atcSCI admitted to an acute spine trauma center in Canada from August 2002 to October 2008. All the cases were enrolled in the Surgical Trial in Acute Spinal Cord Injury Study (STASCIS) that was a prospective, observational study focused on the influence of the timing of surgical spinal decompression on outcomes after atcSCI. The results of STASCIS suggest that individuals who underwent early surgical decompression of the spinal cord (up to 24 h from the time of injury to surgical decompression) had better neurological recovery than the individuals who underwent late surgical spinal decompression (more than 24 h after atcSCI).[14] The individuals were asked to identify their gender using an open-ended question.

Pre-existing medical co-morbidities were quantified according to the degree as assessed using the Charlson Co-morbidity Index and Cumulative Illness Rating Scale, as well as the number of codes from the International Classifications of Diseases, 9th revision.[15–17]

Severity of SCI was classified according to the American Spinal Injury Association [ASIA] Impairment Scale (AIS) as follows: (i) motor and sensory complete SCI (AIS A); (ii) motor complete but sensory incomplete SCI (AIS B); (iii) motor incomplete SCI where the majority of the key muscles below the neurological level have muscle grade <3 (AIS C); and (iv) motor incomplete SCI where the majority of the key muscles below the neurological level have muscle grade ≥ 3 (AIS D).[18]

Health care process

Routine health care process steps during management of individuals with atcSCI are summarized in a flow chart (Fig. 1).[19] Delays in the management of SCI could occur due to: health care-related ("extrinsic") factors, or patient-related ("intrinsic") factors.[19] The extrinsic factors were comprised of any obstacle to the timely surgical decompression of the spinal cord related to the health care process related to the individual's management (e.g. barriers for transfer to spine trauma center, delayed specialist assessment, postponed imaging evaluation, anesthetic delay, unavailable operating room time).[19] These extrinsic factors are considered modifiable because, if changes in clinical practice guidelines, in hospital policy, and in health care processes and clinical care indicators are implemented, the health care processes would facilitate the generalization of early spinal cord decompression for all individuals with acute spine trauma. In contrast, the intrinsic factors include those unmodifiable conditions such as the individual's clinical condition (e.g. hemodynamically unstable patient) and health care process obstacles (e.g. geographic location of the emergency department, relative to where the individual is initially seen and assessed) (Fig. 1).

Data analysis

Data were analyzed using the Mann Whitney U test for continuous variables, and Fisher exact test for categorical variables. The potential effects of age and gender on the health care process steps according to univariate analyses were evaluated with regards to potential confounding effects of severity of SCI, major pre-existing medical co-morbidities (as assessed using the Charlson Co-morbidity Index, Cumulative Illness Rating Scale) and the number of pre-existing medical co-morbidities using multivariable regression analysis with ordinary least squares. All data analyses were performed using SAS version 9.4 (SAS Institute Inc., NC, USA).

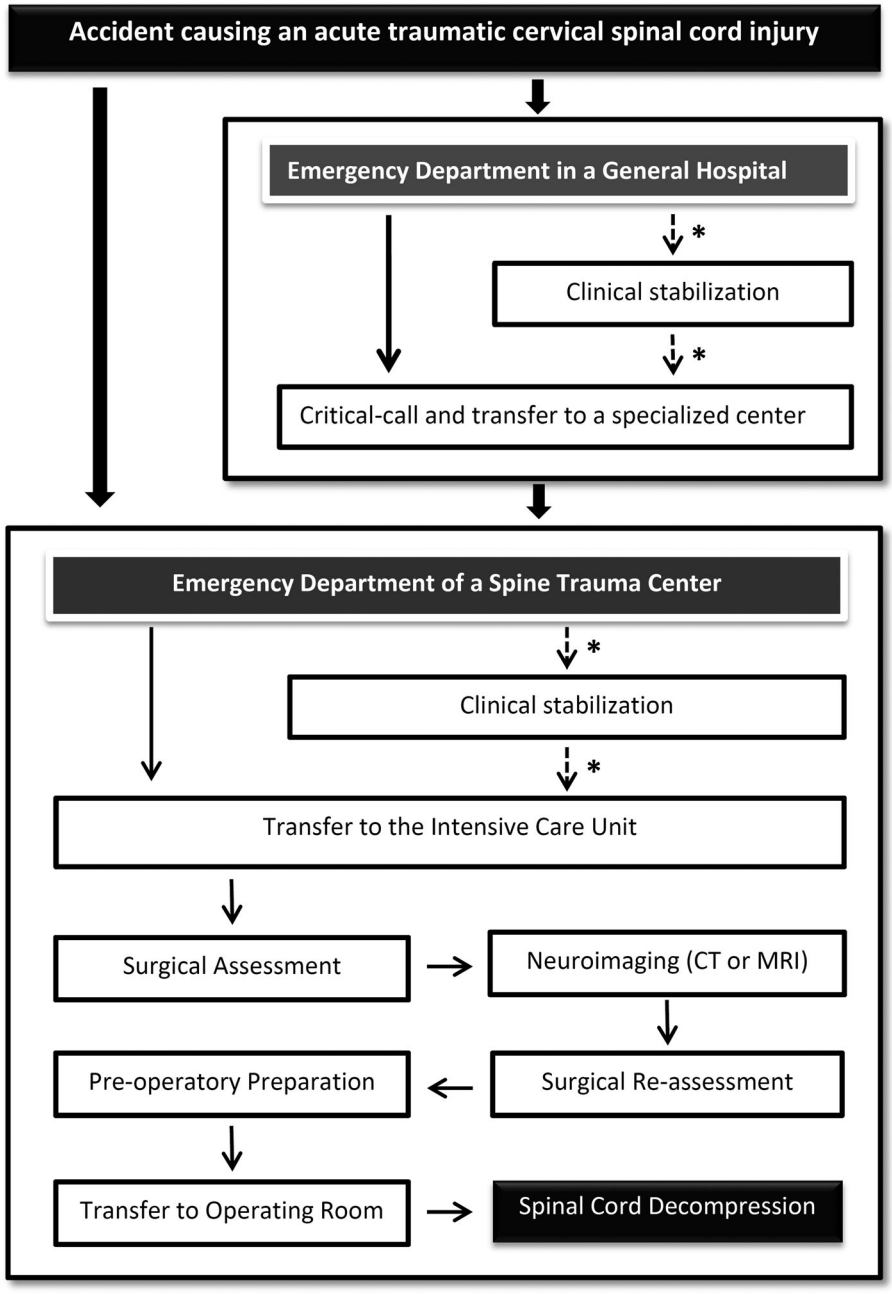

Figure 1 Flow chart of the management of patients from spinal cord injury to surgical decompression of spinal cord (asterisks identify the steps that involve intrinsic factors).

Results

There were 64 individuals with atcSCI (17 women and 47 men; aged 18–78 years with a mean age of 50.5 ± 2.1 years) who were admitted to the acute spine trauma care center. Of the 64 patients, there were 19 patients with complete (AIS A) SCI (29.7%), 9 patients with motor complete (AIS B) SCI (14.1%), 19 patients with incomplete, moderate impairment (AIS-C) SCI (29.7%), and 17 patients with incomplete, milder impairment (AIS-D) SCI (26.5%). While 41 individuals underwent late surgical spinal decompression (64.1%), 23 individuals underwent early surgical spinal decompression (35.9%).

Age as a potential determinant in the health care process

Age at the time of atcSCI was similar between men and women among the subgroups of patients with different degrees of severity of atcSCI as assessed using AIS, and between the group of individuals who underwent early spinal decompression and the group of patient who underwent late spinal decompression (Table 1).

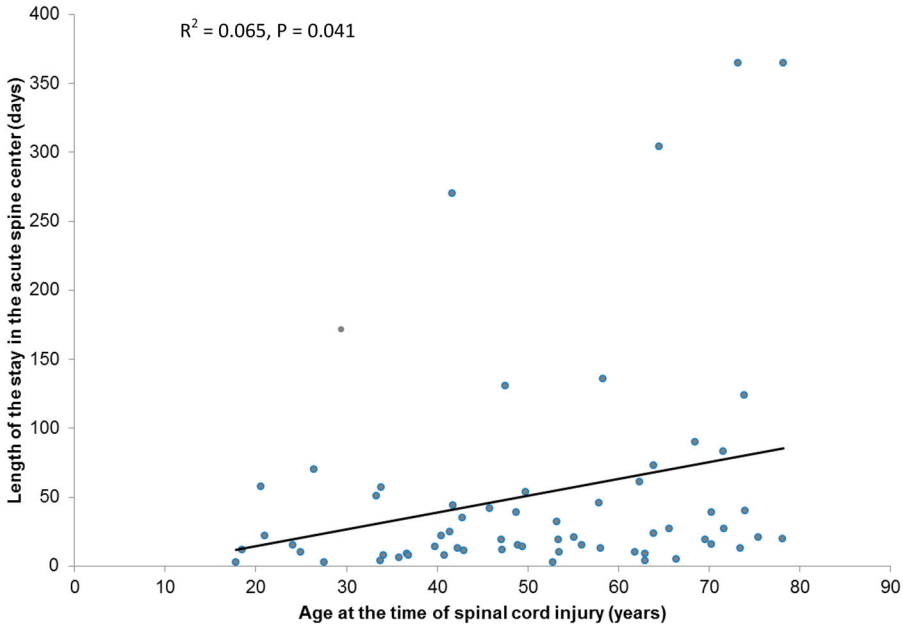

Figure 2 Results of the linear regression analysis comparing age at the time of spinal cord injury with length of stay in the acute spine trauma center.

Table 1 Results of the data analysis on age at the time of spinal cord injury (SCI).

Co-variants	Age (mean ± SEM) in years	P value
Gender		
Women	51.59 ± 4.41	
Men	50.13 ± 2.39	0.761
Severity of SCI on admission		
AIS A	48.74 ± 4.15	
AIS B	51.00 ± 5.99	
AIS C	56.00 ± 3.56	
AIS D	46.67 ± 3.90	0.383
Surgery Group		
Early spinal decompression	52.48 ± 3.78	
Late spinal decompression	49.42 ± 2.50	0.487
Charlson Co-morbidity Index		
0	45.66 ± 2.20	
1 or higher	63.94 ± 3.31	<0.001
Cumulative Illness Rating Scale		
1 or 2	42.68 ± 2.60	
3 or higher	59.40 ± 2.54	<0.001
Number of ICD codes		
None	40.87 ± 2.63	
1	55.00 ± 3.33	
2	59.78 ± 4.17	
3 or more	68.50 ± 3.65	<0.001

SEM: standard error of mean; ICD: International Classifications of Diseases

Table 2 Results of the multiple regression analysis on the potential effects of age at the time of injury and pre-existing medical co-morbidities on the length of stay in the acute spine center.

Model 1

Mean square: 16,427
F value = 2.70
R^2 = 0.081
P value = 0.075

Co-variants	Mean square	*F* value	P value
Age at the time of trauma	26,426	4.34	0.041
Number of ICD codes	6428	1.06	0.308

Model 2
Mean square: 16,577
F value = 2.73
R^2 = 0.082
P value = 0.073

Co-variants	Mean square	*F* value	P value
Age at the time of trauma	26,426	4.35	0.041
Cumulative Illness Rating Scale	6729	1.11	0.297

Model 3
Mean square: 13,755
F value = 2.23
R^2 = 0.068
P value = 0.116

Co-variants	Mean square	*F* value	P value
Age at the time of trauma	26,426	4.28	0.043
Charlson Co-morbidity Index	1083	0.18	0.677

ICD: International Classification of Diseases.

Table 3 Results of the data analysis on gender.

Co-variants	Women	Men	P value
Age			
Range	18–75 years	19–78 years	
Mean ± SEM	51.59 ± 4.41 years	50.13 ± 2.39 years	0.761
Severity of SCI on admission			
AIS A	2	17	
AIS B	2	7	
AIS C	6	12	
AIS D	7	11	0.209
Surgery group			
Early spinal decompression	5	18	
Late spinal decompression	12	29	0.570
Charlson Co-morbidity Index			
0	13	35	
1 or higher	4	12	1.000
Cumulative Illness Rating Scale			
1 or 2	10	24	
3 or higher	7	23	0.777
Number of ICD codes			
None	8	23	
1	6	10	
2 or more	3	14	0.466

SEM: standard error of mean; ICD: international classifications of diseases.

Older patients at the time of atcSCI significantly had a greater number of major pre-existing medical co-morbidities as assessed using Charlson Co-morbidity Index or Cumulative Illness Rating Scale (Table 1). Older individuals at the time of atcSCI also had a greater number of pre-existing medical co-morbidities as assessed using the codes from the International Classifications of Diseases (Table 1).

Age at the time of atcSCI was not associated with the length of stay in the acute spine trauma center, after adjusting for major pre-existing medical co-morbidities as assessed using Charlson Co-morbidity Index (Table 2). However, there was a trend for an association between older age and longer length of stay in the acute spine trauma center after adjusting for major pre-existing medical co-morbidities as assessed using Cumulative Illness Rating Scale (Table 2), or number of codes from the International Classifications of Diseases (Table 2).

Older age at the time of atcSCI was associated with longer stay in the acute spine trauma center (Fig. 2). However, age the time of atcSCI was not correlated to the pre-hospital period of time from injury to arrival at the first emergency department (P = 0.945), waiting period of time in the first care general hospital (P = 0.534), period of time in a second general hospital prior to transport to an acute spine trauma center (P = 0.267), period of time in the emergency department of the acute spine trauma center (P = 0.993), waiting time for assessment by a spine surgeon (P = 0.822), waiting time for a decision regarding surgical management (P = 0.344), and the overall period of time related to extrinsic factors (P = 0.344).

Gender as a potential determinant in the health care process

There were no significant differences between men and women with regards to their age at the time of injury, severity of atcSCI as assessed using AIS, and the number of individuals who underwent early decompression versus the number of individuals who underwent late decompression (Table 3). Additionally, there were no significant discrepancies between men and women with respect to the number of major pre-existing medical co-morbidities as assessed using Charlson Co-morbidity Index or Cumulative Illness Rating Scale (Table 3). Also, men and women were similar regarding the number of pre-existing medical co-morbidities as assessed using the codes from the International Classifications of Diseases (Table 3).

Table 4 Results of the data analysis on the potential effects of gender on the health care process.

Waiting time periods	Women (mean ± SEM)	Men (mean ± SEM)	P value
Length of stay in the acute spine trauma center (in days)	26.52 ± 6.53	60.83 ± 13.22	0.131
Pre-hospital time (*i.e.* period of time from injury to arrival at the first emergency department) (in minutes)	106.47 ± 19.78	190.67 ± 37.50	0.195
Waiting period of time in the first care general hospital (in minutes)	1009.31 ± 349.63	1605.41 ± 603.39	0.761
Period of time in the emergency department of the acute spine trauma center (in minutes)	216.80 ± 44.28	228.76 ± 29.08	0.820
Waiting time for assessment by a spine surgeon (in minutes)	78.90 ± 26.29	313.89 ± 81.33	0.050
Waiting time for a decision regarding surgical management (in minutes)	314.14 ± 75.79	512.05 ± 105.93	0.247
Overall period of time due to extrinsic factors (in minutes)	2978.88 ± 1220.41	3188.98 ± 605.88	0.867

SEM: standard error of mean.

Men and women with atcSCI showed similar length of stay in the acute spine trauma center, pre-hospital time (*i.e.* period of time from injury to arrival at the first emergency department), waiting period of time in the first care general hospital, period of time in the emergency department of the acute spine trauma center, waiting time for a decision regarding surgical management, and overall period of time due to extrinsic factors (Table 4). However, women had a significantly shorter waiting time for assessment by a spine surgeon than men after acute traumatic SCI ($P = 0.050$; Table 4). Of note, comparison between men and women regarding the period of time in a second general hospital prior to transfer to an acute spine trauma center was not performed due to insufficient data.

Discussion

The results of this retrospective cohort study using prospectively-accrued data suggest that older age at the time of atcSCI is associated with longer stay in the acute spine trauma center. This phenomenon can be, at least in part, explained by the relationship between the older age at the time of atcSCI and major pre-existing medical co-morbidities as assessed using Charlson Co-morbidity Index or Cumulative Illness Rating Scale. Nonetheless, the results of this study indicate that age at the time of injury is not a key determinant of the timing in the steps related to the management of atcSCI. Furthermore, the results of this study suggest that women with atcSCI were assessed by a spine surgeon earlier than men. Nevertheless, gender did not influence the other key steps in the management of atcSCI.

Age at onset of traumatic spinal cord injury

The results of our study suggest that older age at the time of atcSCI is associated with longer stay in the acute spine trauma center, even though more major pre-existing medical co-morbidities in the older patients had a confounding effect on that association. Similarly, Herren *et al.* showed that longer hospital of stay after lumbar spine surgery for spinal disc herniation, lumbar spinal stenosis and spondylolisthesis were associated with patient's older age at the time of the procedure.[20] Cummins *et al.* analyzed data from the Spine Patient Outcomes Research Trial (SPORT) that included three randomized and three observational cohort studies of surgical and non-surgical treatments for patients with intervertebral disc herniation, spinal stenosis, and degenerative spondylolisthesis with stenosis.[21] Their results indicated that patients younger than 60 years of age were more likely to be seen by a chiropractor and to have undergone manipulation for lumbar spine disease than older patients.[21] Nuno *et al* studied 9,077 patients surgically treated and 1,098 conservatively treated for idiopathic scoliosis from 1998 to 2007 in the United States.[22] Older patients were more likely to have a "non-routine" discharge (*i.e.* transfer, home health care, against medical advice, and death) than younger individuals with idiopathic scoliosis.[22] However, patient's age was not correlated with the probability of being surgically treated, or the risk of in-hospital complications.[22] While pre-existing medical co-morbidities were not correlated with the probability of surgical intervention, greater comorbidity scores were associated with a higher risk of in-hospital complications.[22]

The results of our study also suggest that age at the onset of atcSCI does not significantly affect the health care process during the management of atcSCI alone. Contrary to the notion that elderly patients are fated to poor recovery after traumatic SCI, the most recent clinical studies suggest that age at the time of injury is not necessarily associated with less favorable outcomes.[23,24] It is an established fact that survival in the geriatric population after SCI is lower than their younger adult counterparts, even though pre-existing medical co-morbidities appear to play a key role on the reduced survival in the elderly following SCI.[23–26] Nonetheless, among survivors, age at the onset of SCI did not significantly affect motor and sensory recovery or pain scores within the first year after acute traumatic SCI when data analyses were adjusted for major potential confounders.[23,24] The potential of older patients with SCI to neurologically improve within the first year post-injury did not translate into functional recovery similar to younger individuals.[23,24,27] Although the reasons for those age-related differences in terms of functional recovery remain under-studied, the influence of pre-injury functional status and ageism on functional recovery after neurotrauma has been recognized. In a recent qualitative study on the occupational therapists' perception in Canada, pre-accident functional status was consistently linked to patients' rehabilitation potential after acquired brain injury.[28] Ageistic attitudes can adversely affect recovery of patients with neurological disease or injury such as SCI and, hence, ageism should be avoided also in acute spine centers and rehabilitation facilities.[29] In reality, ageistic attitudes still exist among healthcare professionals including nurses caring for individuals with acute traumatic SCI.[29] Given that the nurses' attitudes were associated with their level of education, further research and knowledge dissemination activities for nurses caring for elderly with

SCI may have a substantial impact on patients' outcomes.[29] In a questionnaire-based survey of the member of the National Neurotrauma Society, clinicians showed significantly fewer negative attitudes towards old people in comparison with basic and clinical neuroscientists, and women gender was significantly associated with more positive attitudes toward old people compared to men.[30]

Therefore, the results of our single-institution study suggest that age at the onset of atcSCI do not influence the waiting times for the steps in the management of individuals with atcSCI. In the context of the elderly's potential to recover following SCI, the results of our study endorse a health care process for surgical management based on clinical and ancillary assessments regardless of patient's age.

Gender and traumatic spinal cord injury

The results of our study suggest that women had a surgical assessment earlier than men with atcSCI. Nonetheless, gender did not influence other key steps of management of atcSCI. Also, there were no observed gender-related disparities with regards to the length of stay in the acute spine trauma center for surgical management of atcSCI.

Prior studies suggest women may have less access to surgical treatment of lung cancer, vascular surgery and orthopedic surgery.[31,32] Likewise, Taylor *et al.* retrospectively studied 5,690 patients with degenerative lumbosacral pathologies with regards to potential patient gender bias in their management.[33] The authors reported that women were more likely to have imaging investigation requested than men, whereas men were significantly more likely to have surgery recommended than women.[33] McCutcheon *et al.* retrospectively analyzed data from 37,302 individuals with traumatic spinal vertebral fracture who have undergone a spinal decompression and/or fusion and were recorded in the Nationwide Inpatient Sample.[34] The authors found that women were less likely to undergo surgical treatment (odds ratio: 0.69, $P < 0.001$) when compared to men.[34]

There is growing evidence of physician gender-related disparities in the perception of patient's clinical information and its use in the health care process.[35–38] Unconscious bias in clinical decision making has been more intensively studied in American medicine since 1999 when Schulman *et al.* reported that patients' ethnicity and gender might have influenced physicians' management of chest pain and referral for catheterization.[39] Unconscious bias occurs when that physicians while making medical decisions are unconsciously influenced by stereotypes and prejudices.[40] Unconscious bias may result in medical errors and, hence, further research is required to improve quality and safe of neurosurgical care.[41] The patient gender bias observed in our study could not be explained by the confounding effects of the patients' age at injury, severity of SCI and pre-existing medical co-morbidities. The fact that all patients were managed by male surgeons in the acute spine trauma center did not allow analysis to refute or confirm a potential physician gender bias on the waiting time for patient's assessment by a spine surgeon.

There is a growing body of evidence that pre-existing medical co-morbidities can affect the clinical outcomes of patients with acute SCI.[42–44] Similar to our findings, a prior investigation reported that men with SCI did not differ from women with SCI in terms of the frequency of pre-existing medical comorbidities.[45]

Similar to our study, previous investigations on unmatched groups of patients with SCI showed no significant differences between men and women with regards to the mean length of stay.[45–48] Greenwald *et al.* documented that there were no gender-related differences in the length of stay in the acute care facility.[49] Mylotte *et al.* identified many predictive variables for a longer stay in the acute care unit, including SCI and development of a nosocomial infection, but gender was not associated with the length of stay in the acute care unit.[50] Scivoletto *et al.* found no significant differences between men and women subgroups regarding the length of stay in a Spinal Cord Unit for rehabilitation of individuals with traumatic or non-traumatic SCI.[51] In a multivariable regression analysis including 1,376 individuals with traumatic SCI, Craven *et al.* reported that length of stay in the rehabilitation centers was not significantly affected by the individuals' gender.[52]

The potential effects of patient gender on outcomes of spine surgery have been also reported in prior studies. Herren *et al.* documented that men had longer hospital of stay after lumbar spine surgery for spinal disc herniation, lumbar spinal stenosis and spondylolisthesis than women.[20] Using data from the SPORT, Cummins *et al.* reported that women were more likely to be seen by alternative health care providers and a pain specialist physician, and more frequently had visits to medical and physical therapists for lumbar spine disease (*i.e.* intervertebral disc herniation, spinal stenosis, and degenerative spondylolisthesis with stenosis) than men.[21] Nuno *et al.* found that more women underwent surgical treatment for idiopathic scoliosis, but the in-hospital complications rates in men and women were similar.[22]

Overall, the results of our study suggest that women had an earlier surgical assessment after atcSCI than men, even though there is no clear explanation for those gender-related disparities. Nonetheless, there were no other significant differences between men and women with regards to the key steps of management of patients with atcSCI.

Study limitations

This original work examined the potential effects of age at onset of SCI and gender on the health care process steps in the surgical management of individuals with atcSCI. However, there are some limitations to consider when interpreting and applying the enclosed results. First, selection bias may occur in any retrospective cohort study because data were collected before the research question when the current investigators did not have control on the number and characteristics of those potential study participants who declined to be enrolled in the STASCIS. Second, all spine surgeons who work in the participating acute spine trauma center were men. Third, all the spine surgeons involved in the management of those patients had prior education on the potential effects of ageism on the outcomes after SCI, which does not necessarily represent the experience of healthcare professionals in other jurisdictions. Finally, the sample size limited further data analysis including multiple co-variants in order to further clarify potential confounding effects. Also, negative results in some of the comparisons could be due to type-II error.

Conclusions

This retrospective cohort study using prospectively-accrued data, for the first time, examined whether age at the time of SCI and gender influence the key steps of the health care process in terms of the waiting time for each steps in the surgical management of individuals with atcSCI. Older age at the time of SCI was associated with longer stay in the acute spine trauma center, even though this association was cofounded by major pre-existing medical co-morbidities. Otherwise, age at onset of SCI did not significantly affect the health care process during surgical management of the individuals with atcSCI. The results of our study also suggest that women with SCI had an earlier surgical assessment than men. Yet, gender did not appear to influence the other key steps of surgical management of atcSCI. Further investigations are needed to determine if other factors such as ageism, patient gender bias and physician gender bias play a role in those age-related and gender-related discrepancies that were observed in this study.

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References

1 Chen Y, He Y, DeVivo MJ. Changing demographics and injury profile of new traumatic spinal cord injuries in the United States, 1972–2014. Arch Phys Med Rehabil. 2016;97:1610–19.
2 Jain NB, Ayers GD, Peterson EN, Harris MB, Morse L, O'Connor KC, *et al*. Traumatic spinal cord injury in the United States, 1993–2012. JAMA. 2015;313:2236–43.
3 McCammon JR, Ethans K. Spinal cord injury in Manitoba: a provincial epidemiological study. J Spinal Cord Med. 2011;34:6–10.
4 McCaughey EJ, Purcell M, McLean AN, Fraser MH, Bewick A, Borotkanics RJ, *et al*. Changing demographics of spinal cord injury over a 20-year period: a longitudinal population-based study in Scotland. Spinal Cord. 2016;54:270–76.
5 Furlan JC, Tator CH. Global epidemiology of traumatic spinal cord injury. In: Morganti-Kossman C, Raghupathi R, Maas A, editors. Traumatic brain and spinal cord injury: challenges and developments, 1st ed. Cambridge: Cambridge University Press; 2012. p. 216–23.
6 Berg M VD, Castellote JM, Mahillo-Fernandez I, de Pedro-Cuesta J. Incidence of traumatic spinal cord injury in Aragon, Spain (1972–2008). J Neurotrauma. 2011;28:469–77.
7 Furlan JC, Sakakibara BM, Miller WC, Krassioukov AV. Global incidence and prevalence of traumatic spinal cord injury. Can J Neurol Sci. 2013;40:456–64.
8 NSCIC. Spinal cord injury: facts and figures at glace. Birmingham (AL): National Spinal Cord Injury Statistical Center; 2016.
9 Nelson AR, Hill MN, Lavizzo-Mourey R, Betancourt JR, Bloche MG, Byrd WM, *et al*. Unequal treatment: confronting racial and ethnic disparities in health care. Washinton (DC): National Academy of Sciences; 2003.
10 Dykes DC, White AA. Getting to equal: strategies to understand and eliminate general and orthopaedic healthcare disparities. Clin Orthop Relat Res. 2009;467:2598–605.
11 Gershkoff AM, Cifu DX, Means KM. Geriatric rehabilitation. 1. Social, attitudinal, and economic factors. Arch Phys Med Rehabil. 1993;74:S402–5.
12 Radke HR, Hornsey MJ, Barlow FK. Barriers to women engaging in collective action to overcome sexism. Am Psychol. 2016;71:863–74.
13 Ellemers N. Gender stereotypes. Annu Rev Psychol. 2018;69:275–98.

14 Fehlings MG, Vaccaro A, Wilson JR, Singh A, Cadotte D, Harrop JS, *et al*. Early versus delayed decompression for traumatic cervical spinal cord injury: results of the surgical timing in acute spinal cord injury study (STASCIS). PLoS One. 2012;7:1–8.
15 Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol. 1992;45:613–9.
16 Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis. 1987;40:373–83.
17 Linn BS, Linn MW, Gurel L. Cumulative illness rating scale. J Am Geriatr Soc. 1968;16:622–6.
18 Furlan JC, Fehlings MG, Tator CH, Davis AM. Motor and sensory assessment of patients in clinical trials for pharmacological therapy of acute spinal cord injury: psychometric properties of the ASIA Standards. J Neurotrauma. 2008;25:1273–301.
19 Furlan JC, Tung K, Fehlings MG. Process benchmarking appraisal of surgical decompression of spinal cord following traumatic cervical spinal cord injury: opportunities to reduce delays in surgical management. J Neurotrauma. 2013;30:487–91.
20 Herren C, Aghayev E, Kaulhausen T, Roeder C, Meyer F, Siewe J, *et al*. Influencing factors on the length of stay in lumbar spine surgery: analysis of the German spine registry. Orthopade. 2014;43:1043–51.
21 Cummins J, Lurie JD, Tosteson TD, Hanscom B, Abdu WA, Birkmeyer NJ, *et al*. Descriptive epidemiology and prior healthcare utilization of patients in the spine patient outcomes research Trial's (SPORT) three observational cohorts: disc herniation, spinal stenosis, and degenerative spondylolisthesis. Spine. 2006;31:806–14.
22 Nuno M, Drazin DG, Acosta FL. Differences in treatments and outcomes for idiopathic scoliosis patients treated in the United States from 1998 to 2007: impact of socioeconomic variables and ethnicity. Spine J. 2013;13:116–23.
23 Furlan JC, Fehlings MG. The impact of age on mortality, impairment, and disability among adults with acute traumatic spinal cord injury. J Neurotrauma. 2009;26:1707–17.
24 Furlan JC, Bracken MB, Fehlings MG. Is age a key determinant of mortality and neurological outcome after acute traumatic spinal cord injury? Neurobiol Aging. 2010;31:434–46.
25 Kattail D, Furlan JC, Fehlings MG. Epidemiology and clinical outcomes of acute spine trauma and spinal cord injury: experience from a specialized spine trauma center in Canada in comparison with a large national registry. J Trauma. 2009;67:936–43.
26 Furlan JC, Kattail D, Fehlings MG. The impact of co-morbidities on age-related differences in mortality after acute traumatic spinal cord injury. J Neurotrauma. 2009;26:1361–7.
27 Furlan JC, Hitzig SL, Craven BC. The influence of age on functional recovery of adults with spinal cord injury or disease after inpatient rehabilitative care: a pilot study. Aging Clin Exp Res. 2013;25:463–71.
28 Lam Wai Shun P, Bottari C, Ogourtsova T, Swaine B. Exploring factors influencing occupational therapists' perception of patients' rehabilitation potential after acquired brain injury. Aust Occup Ther J. 2017;64:149–58.
29 Furlan JC, Craven BC, Ritchie R, Coukos L, Fehlings MG. Attitudes towards the older patients with spinal cord injury among registered nurses: a cross-sectional observational study. Spinal Cord. 2009;47:674–80.
30 Furlan JC, Fehlings MG. Attitudes toward the elderly with CNS trauma: a cross-sectional study of neuroscientists, clinicians, and allied-health professionals. J Neurotrauma. 2009;26:209–25.
31 Shugarman LR, Mack K, Sorbero ME, Tian H, Jain AK, Ashwood JS, *et al*. Race and sex differences in the receipt of timely and appropriate lung cancer treatment. Med Care. 2009;47:774–81.
32 Amaranto DJ, Abbas F, Krantz S, Pearce WH, Wang E, Kibbe MR. An evaluation of gender and racial disparity in the decision to treat surgically arterial disease. J Vasc Surg. 2009;50:1340–47.
33 Taylor BA, Casas-Ganem J, Vaccaro AR, Hilibrand AS, Hanscom BS, Albert TJ. Differences in the work-up and treatment of conditions associated with low back pain by patient gender and ethnic background. Spine. 2005;30:359–64.
34 McCutcheon BA, Chang DC, Marcus L, Gonda DD, Noorbakhsh A, Chen CC, *et al*. Treatment biases in traumatic neurosurgical care: a retrospective study of the Nationwide Inpatient sample from 1998 to 2009. J Neurosurg. 2015;123:406–14.
35 Nair BK, Attia JR, Bowe SJ, Mears SR, Hitchcock KI. Interns are from Venus, consultants are from Mars: differential perception among clinicians. Med J Aust. 2003;179:659–61.
36 Hershman DL, Buono D, McBride RB, Tsai WY, Joseph KA, Grann VR, *et al*. Surgeon characteristics and receipt of adjuvant radiotherapy in women with breast cancer. J Natl Cancer Inst. 2008;100:199–206.
37 Politi MC, Legare F. Physicians' reactions to uncertainty in the context of shared decision making. Patient Educ Couns. 2010;80:155–7.
38 Ferguson MK, Huisingh-Scheetz M, Thompson K, Wroblewski K, Farnan J, Acevedo J. The influence of physician and patient gender on risk assessment for lung cancer resection. Ann Thorac Surg. 2017;104:284–9.
39 Schulman KA, Berlin JA, Harless W, Kerner JF, Sistrunk S, Gersh BJ, *et al*. The effect of race and sex on physicians' recommendations for cardiac catheterization. N Engl J Med. 1999;340:618–26.
40 Santry HP, Wren SM. The role of unconscious bias in surgical safety and outcomes. Surg Clin North Am. 2012;92:137–51.
41 Fargen KM, Friedman WA. The science of medical decision making: neurosurgery, errors, and personal cognitive strategies for improving quality of care. World Neurosurg. 2014;82:e21–9.
42 Yekutiel M, Brooks ME, Ohry A, Yarom J, Carel R. The prevalence of hypertension, ischaemic heart disease and diabetes in traumatic spinal cord injured patients and amputees. Paraplegia. 1989;27:58–62.
43 Imai K, Kadowaki T, Aizawa Y, Fukutomi K. Problems in the health management of persons with spinal cord injury. J Clin Epidemiol. 1996;49:505–10.
44 Krassioukov AV, Furlan JC, Fehlings MG. Medical co-morbidities, secondary complications, and mortality in elderly with acute spinal cord injury. J Neurotrauma. 2003;20:391–9.
45 Furlan JC, Krassioukov AV, Fehlings MG. The effects of gender on clinical and neurological outcomes after acute cervical spinal cord injury. J Neurotrauma. 2005;22:368–81.
46 Charles ED, Fine PR, Stover SL, Wood T, Lott AF, Kronenfeld J. The costs of spinal cord injury. Paraplegia. 1978;15:302–10.
47 Fine PR, Stover SL, DeVivo MJ. A methodology for predicting lengths of stay for spinal cord injury patients. Inquiry. 1987;24:147–56.
48 Eastwood EA, Hagglund KJ, Ragnarsson KT, Gordon WA, Marino RJ. Medical rehabilitation length of stay and outcomes for persons with traumatic spinal cord injury 1990–1997. Arch Phys Med Rehabil. 1999;80:1457–63.
49 Greenwald BD, Seel RT, Cifu DX, Shah AN. Gender-related differences in acute rehabilitation lengths of stay, charges, and functional outcomes for a matched sample with spinal cord injury: a multicenter investigation. Arch Phys Med Rehabil. 2001;82:1181–7.
50 Mylotte JM, Graham R, Kahler L, Young BL, Goodnough S. Impact of nosocomial infection on length of stay and functional improvement among patients admitted to an acute rehabilitation unit. Infect Control Hosp Epidemiol. 2001;22:83–7.
51 Scivoletto G, Morganti B, Molinari M. Sex-related differences of rehabilitation outcomes of spinal cord lesion patients. Clin Rehabil. 2004;18:709–13.
52 Catharine Craven B, Kurban D, Farahani F, Rivers CS, Ho C, Linassi AG, *et al*. Predicting rehabilitation length of stay in Canada: It's not just about impairment. J Spinal Cord Med. 2017;40:676–86.