Annals of Physical and Rehabilitation Medicine xxx (2017) xxx–xxx

Available online at
ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com

Original article

Spinal cord injury associated with cervical spinal canal stenosis: Outcomes and prognostic factors

Y. Ronzi [a,b], B. Perrouin-Verbe [b], O. Hamel [c], R. Gross [b,*]

[a] Centre régional de rééducation et de réadaptation fonctionnelles Les Capucins, rue des Capucins, Angers, France
[b] Service de médecine physique et de réadaptation neurologique, centre hospitalier universitaire de Nantes, 85, rue Saint-Jacques, 44093 Nantes cedex 1, France
[c] Service de neurotraumatologie, centre hospitalier universitaire de Nantes, place Alexis-Ricordeau, 44093 Nantes cedex 1, France

ARTICLE INFO

Article history:
Received 16 October 2016
Accepted 25 September 2017

Keywords:
Spinal cord injury
Cervical spinal canal stenosis
Cord syndromes
Tetraplegia
Functional outcome

ABSTRACT

Objectives: To specify outcomes and identify prognostic factors of neurologic and functional recovery in patients with an acute traumatic spinal cord injury (SCI) associated with cervical spinal canal stenosis (SCS), without spinal instability.
Methods: A retrospective study was conducted using data from a Regional Department for SCI rehabilitation in France. A description of the population characteristics, clinical data and neurological and functional outcomes of all patients treated for acute SCI due to cervical trauma associated with SCS was performed. A statistical analysis provided insights into the prognostic factors associated with the outcomes.
Results: Sixty-three patients (mean age 60.1 years) were hospitalized for traumatic SCI with SCS and without instability between January 2000 and December 2012. Falls were the most frequent cause of trauma (77.8%). At admission, most patients had an American Spinal Injury Association Impairment Scale (AIS) grade of C (43.3%) or D (41.7%) and the most frequent neurological levels of injury were C4 (35.7%) and C5 (28.6%). Clinical syndromes were frequently identified (78.6%), with the most frequent being the Brown-Sequard plus syndrome (BSPS) (30.9%), followed by central cord syndrome (CCS, 23.8%). Almost 80% of survivors returned to the community, 60% were able to walk and 75% recovered complete voluntary control of bladder function. Identified prognostic factors of favourable functional outcomes were higher AIS at admission, age under 60 years and presence of BSPS or CCS.
Conclusion: Traumatic SCI, associated with SCS results mostly in incomplete injuries, can cause various syndromes and is associated with favourable functional outcomes.

1. Introduction

Cervical spondylosis affects up to 50% of persons over 40 years of age [1]. It often causes spinal canal stenosis (SCS), leading to neck pain, cervical radiculopathy and cervical myelopathy [1]. Subjects with cervical spondylosis have a higher risk of spinal cord lesions since the cord cannot move freely within the spinal canal, thus mild cervical trauma can cause devastating spinal cord injuries [2]. The anatomical features of such injuries usually include haematoma, oedema and myelomalacia, mostly affecting the central part of the spinal cord [3]. Schneider and Cherry provided the classical description of the symptoms that occur following cervical spinal cord injury (SCI) on an already compressed spinal cord [3]: weakness mostly affecting the upper limbs and various impairments of the lower limbs, including loss of bladder and bowel function. This clinical condition is today referred to as 'traumatic central cord syndrome' (CCS) and criteria for its diagnosis have recently been precisely defined [4]. Despite the generally older age of patients with CCS [5], this syndrome is associated with more favourable functional outcomes than other SCI-related syndromes [5–7].

CCS and traumatic SCI with CCS are frequently confused, probably because of the initial statement by Schneider and Cherry

Abbreviations: ACS, anterior cord syndrome; AIS, ASIA Impairment Scale; ASIA, American Spinal Injury Association; BSPS, Brown-Sequard plus syndrome; CCS, central cord syndrome; MRI, magnetic resonance imaging; NLI, neurological level of injury; SCI, spinal cord injury; SCS, spinal canal stenosis; TDM, tomodensitometry.

* Corresponding author.
E-mail address: raphael.gross@chu-nantes.fr (R. Gross).

http://dx.doi.org/10.1016/j.rehab.2017.09.003
1877-0657/

that CCS affects older patients with cervical spondylosis [3]. However, various situations may arise in subjects with acute SCI and concomitant cervical spondylosis [8]. Although this condition was first described more than 50 years ago, data relating to sociodemographic characteristics, clinical signs and symptoms and outcomes are lacking [8,9]. Such knowledge would help to determine appropriate management for this condition. One retrospective study investigated the clinical features and prognostic factors of CCS, however this was in a subset of patients who underwent surgical decompression [10].

The aims of this study were therefore:

- to describe the clinical features at the time of admission in patients with acute traumatic SCI associated with cervical CCS, without spinal instability;
- to identify outcomes and prognostic factors of neurologic and functional recovery in these patients.

2. Methods

2.1. Patients

A retrospective analysis of all patients referred to our SCI centre was conducted. This centre includes an acute care Neurotrauma unit and a Physical and Rehabilitation Medicine (PRM) department. All cases, admitted between the 1st of January 2000 and the 31st of December 2012, were reviewed. The inclusion criteria were:

- trauma to the cervical spinal cord with neurological impairment in the acute phase;
- no unstable spinal lesion, verified by computed tomography (CT) and magnetic resonance images (MRI) using the criteria defined by White and Panjabi [11] (all patients systematically underwent CT and MRI). Any patients with fracture, dislocation, disc lesion or vertebral sprain that was at risk of displacement or compromising the spinal canal were excluded. This choice is in accordance with many previous studies [9,10,12]: patients with radiological features of spinal instability were excluded because in many centres, including ours, these patients undergo immediate surgery to treat the cause of instability and reduce cord compression. Besides, it is not possible to differentiate between neurological involvement due to spinal stenosis and cord oedema and that due to acute cord compression by bony or disc elements;
- presence of cervical spinal canal stenosis. Cervical spinal canal stenosis was confirmed by the 'Pavlov' ratio on CT images [13]. A ratio < 0.8 at any level between C3 and C7 was considered as stenosis, with or without evidence of spondylosis.

All patients who met these three criteria were considered, whether they underwent surgery during the initial stages or not and regardless of corticosteroid administration.

2.2. Data collection

All applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research. This study conformed to the Helsinki Declaration of 1975, revised in 2013 and was approved by our institutional ethics board. Data were collected retrospectively, during the year 2015. The two-year delay between the end of the inclusion period and the beginning of data collection was necessary in order to obtain discharge data for all patients.

Two time points were considered:

- admission to the acute care unit;
- discharge from the PRM department.

The endpoint evaluation was performed at discharge since data at other time points (for instance, 6 months post-injury) were not available for all patients. Moreover, it is common practice to report data at discharge in epidemiological studies of patients with SCI [6,14,15].

All patients underwent standard neurological assessment. The neurological examination was performed according to the International Standards for Neurological Classification of Spinal Cord Injury [16]. The American Spinal Injury Association (ASIA) Impairment Scale (AIS), the neurological level of injury (NLI) and the presence of a clinical syndrome were evaluated. Clinical syndromes included central cord syndrome (CCS), Brown-Sequard plus syndrome (BSPS), transverse syndrome, anterior cord syndrome (ACS) and posterior cord syndrome. CCS was defined according to the criteria by the EM-SCI study group [4]: disproportionately more motor impairment of the upper than lower extremities, with a difference of at least 10 motor score points between the upper and lower extremities. BSPS was defined according to the description by Roth et al. [17]: asymmetric paresis with more marked hypoalgesia on the less paretic side. Transverse syndrome was considered as complete SCI. ACS was defined as loss of motor function and pain/temperature sensation at and below the injury level, with preservation of light touch and joint position sense [16]. PCS was defined as isolated loss of proprioception and vibration sense below the level of injury [6].

Data regarding function, including ambulatory status and lower urinary tract function on discharge and discharge mode were collected from the medical files. Level of ambulation was defined as the mode of locomotion for distances over 10 m (without gait aid, with gait aid, manual or electric wheelchair). Lower urinary tract function included bladder-emptying method (voluntary control, self-intermittent catheterization, hetero-catheterization, indwelling catheter or reflex micturition). Discharge mode included return home with or without any personal assistance for activities of daily living or hospital/institution care.

2.3. Data analysis and prognostic factors

For qualitative variables, data are provided as numbers and percentages. For quantitative variables, data are presented as means and/or medians and standard deviations. To search for explanatory factors relating to progression or stability of the AIS grade between admission and discharge (neurological prognosis), Fisher exact tests were performed with improvements in grade (yes/no) on one side and potential explanatory factors of improvement on the other side. The potential explanatory factors were:

- age (≥ 60 or < 60);
- cause of SCI;
- surgery (yes/no);
- the type of clinical syndrome caused by the SCI.

Three categories of clinical syndrome were considered to determine prognostic factors (BSPS, CCS and no, or other, identified syndrome) in order to have approximately similar numbers in each group.

Then, in order to search for explanatory factors of functional outcome, Fisher exact tests were performed with patients with or without favourable outcomes on one side and potential explanatory factors of outcomes on the other side. Three outcomes were assessed:

Please cite this article in press as: Ronzi Y, et al. Spinal cord injury associated with cervical spinal canal stenosis: Outcomes and prognostic factors (SCI with spinal canal stenosis). Ann Phys Rehabil Med (2017), http://dx.doi.org/10.1016/j.rehab.2017.09.003