Epidemiological Characteristics of Spinal Cord Injury in Northwest China: a single hospital-based study

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Abstract

Background: The northwest is relatively backward economically. Unfortunately, the epidemiological characteristics of SCI in Northwest China are rarely reported.

Methods: The SCI epidemiological survey software independently developed was used to sort out the data of patients treated with SCI from 2014 to 2018. Variables included age, sex, cause of injury, combined injury, severity of injury, ASIA scale, surgical treatment, complications, and rehabilitation.

Results: The enrolled 3487 patients were with a male to female ratio of 2.57:1 and an age of 39.50±11.20 years. SCI in 94.03% of patients was caused by falls and MCVs, which were the primary etiologies of SCI. There were 1786 patients, accounting for 51.22%, with other injuries. Asia D scale patients accounted for 41.12%. During hospitalization, pulmonary infection was the most common complication (437 cases, 32.59%), followed by hyponatremia (326 cases, 24.31%), bedsore (219 cases, 16.33%), urinary tract infection (168 cases, 12.53%), deep vein thrombosis (157 cases, 11.71%) and others (34 cases, 2.53%). Only 528 patients (15.14%) received long-term rehabilitation treatment.

Conclusion: The incidence of SCI in northwest China was on the rise with higher proportion in males, the MCVs and fall were the primary leading causes of injuries. The occupations most at risk from SCI are peasantries and workers. Pulmonary infection rate was the most common complication during hospitalization. Patients over the age of 50, especially the elderly, should pay attention to preventing falls and osteoporosis. Young people should pay attention to safe production and avoid falling from high places and falling objects.

Introduction

Spinal cord injury (SCI) not only causes serious functional and family financial burdens, but also poses a series of problems for patients' mental health and social stability(1). SCI is considered to be a major public health matter worldly, and the incidence of spinal cord injury vary widely around the world. SCI is considered a worldwide public health problem, but its incidence varies greatly from region to region(2). The average annual incidence of SCI in developed countries ranges from 10.4 per million to 83 per million (3, 4). In developing countries, SCI had a high incidence of 25.5 per million per year(5). Under the background that there is no effective rehabilitation method for spinal cord injury, primary prevention is particularly important.

There are few studies reported the epidemiological characteristics of SCI based on hospital in China, such as Beijing(6),Shanghai(7),Guangdong(8) and Chongqing(9). In terms of epidemiology, each region has its own characteristics in the occurrence of SCI, so it is of great significance to carry out epidemiological research on SCI at the local population level. However, we find that all these cities are highly developed and their medical care is at the forefront of China. The northwest is relatively backward economically, whose epidemiological characteristics of SCI are rarely reported. The study was aimed to investigate the epidemiological characteristics of patients with SCI in the backward areas of Northwest China; and

facilitate establishing the optimal allocation of medical resources and reducing the financial and social burdens.

Materials And Methods

As the tertiary trauma center in Northwest China, our hospital has collected the largest sample size of spinal cord injury patients. This study was approved by the Ethics Committee of our hospital. The inclusion criteria were patients with traumatic SCI or cauda equina injuries who were admitted to our hospital between 2014 and 2018. Patients with the following conditions were excluded from the study: vertebral body fractures without SCI, neurological deficit caused by degenerative spinal disease, fatal injuries, the medical records was incomplete. The SCI epidemiological survey software independently developed was used to sort out the data of patients. The variables studied were associated with the social demographic profile of patients (name, age, sex and occupation). Medical records consist of the cause, fracture part, associated injury and level of injury, which were determined by physical and radiographic examinations. Neurological levels of SCI were classified using the American Spinal Injury Association (ASIA) impairment scale. In addition, the treatment methods and complications during hospitalization were also documented.

The SCI epidemiological survey software independently developed was used to sort out the data of patients. The demographic information of patients (age, gender and occupation), the cause of injury and neurological levels were summarized. Neurological function were evaluated by the ASIA impairment scale. In addition, the treatment methods and complications during hospitalization were also included.

Statistical analysis

Mean values are presented as the mean ± SD. Analysis of variance (ANOVA) and Chi-square test have been used to find the significance of study parameters on enumeration data and categorical scale between groups respectively. A value of $p < .05$ was considered statistical signifcance. All statistical analyses were performed using Statistical Product and Service Solution Version 19.0 (SPSS, Inc, Chicago, IL, USA)

Results

General demographic characteristics of SCI patients from 2014 to 2018

A total of 3487 patients with SCI were identified in this study, the number of SCI patients is increasing year by year (Fig. 1). As shows in Table 1, the general demographic characteristics of SCI patients. Of the 3487 individuals with SCI, 2509 were male (71.95%) and 978(28.05%) were female, and male to female was 2.57:1. The patients' ages ranged from 18 to 87 years, with a mean age of 39.50 ± 11.20 years, males 36.60 ± 12.40 years, females 42.80 ± 11.80 years).

Table 1
demographic information, etiology of patients with SCI from 2014 to 2018

Years	2014	2015	2016	2017	2018	Total
Age	2	0	1	1	5	9
0–20	86	79	93	117	146	521
20–29	335	274	361	344	385	1699
30–39	114	107	143	198	228	790
40–49	67	85	70	83	109	414
50–59	13	5	8	11	17	54
≥ 60						
Gender	446	413	504	533	613	2509
Male	171	137	172	221	277	978
Female						
Occupation	387	354	401	442	491	2075
Farmer	155	138	179	213	258	943
Worker	43	37	58	61	68	267
Government-offices	8	6	8	15	36	73
Retired	15	10	18	13	19	75
Students	9	5	12	10	18	54
Other*						
Etiology	301	277	328	358	401	1665
Low fall	252	223	241	259	326	1301
High Fall	39	41	72	77	84	313
MVCs	15	4	24	47	63	153
Fall objects	8	4	6	9	13	40
Sports	2	1	5	4	3	15
Violence						
Total number	617	550	676	754	890	3487
Other* included unemployed individuals and self-employed individuals						
MVCs: motor vehicle collisions						

Injury etiologies and age distribution of patients with SCI

In this study, the primary cause of SCI was fall (low falls 47.75%, high falls 37.31%), followed by traffic accidents (8.98%), falling objects (4.39%). Furthermore, there were several uncommon causes, for instance sports injuries(1.15%), violence injuries(0.43%). The peak age distribution of patients with SCI was 30–49 years old, accounting for 80.99% of the total patients, and the incidence was negatively correlated with age. There are differences in the injury etiologies among different age groups (Table 2). The common etiologies in the 30–39 age group were fall (low fall and high fall) and motor vehicle collisions (MCVs). However, low fall was the primary cause of SCI in the 60-year-old group, which changed to motor injuries for the patients between the ages of 20 and 29.

Table 2
Analysis of the etiologies and age distribution among the spinal cord injury (SCI) patients

Etiologies	Age						Total
	0–20	20–29	30–39	40–49	50–59	≥60	
Low fall	0	213	733	420	262	37	1665
High fall	1	199	759	282	53	7	1301
MVCs	4	75	132	58	34	10	313
Falling objects	0	9	61	21	62	0	153
Sports	3	21	10	6	0	0	40
Violence	1	4	4	3	3	0	15

MVCs, motor vehicle collisions

Level injury and associated injuries

As shows in Fig. 2, the fracture took on a bimodal distribution. The first peak is cervical region, especially C4-C6, secondly is thoracolumbar region, especially T11-L3(34.82% and 38.40%, respectively).In this study, 1786 patients (51.22%) were complicated with other injuries, including craniocerebral injury (198,11.09%), frontofacial injury (407,22.79%), chest and abdominal injury (359,20.10%), pelvic injury (258,14.45%) and limb fracture (564,31.58%).

ASIA impairment scale

According to the ASIA impairment scale, the proportion of grade A, B, C and D injuries was 747(21.42%), 688(19.73%), 618(17.72%) and 1434(41.12%), respectively. The severity of injury caused by different causes, ASIA A grade patients were mainly by MCVs and high fall, B-C grades were mainly by low falls (Table 3). The different injury sites caused different injury grade. Injuries in the cervical cord and lumbar

cord, which was widely distributed in ASIA A-D, the thoracic cord injuries were mostly ASIA A-B, moreover, sacral cord injury mainly ASIA D. (Table 4).

Table 3
Comparison of causes of injury in different degrees of spinal cord injury

Etiologies	ASIA scale			
	A(%)	B(%)	C(%)	D(%)
Low fall	129(17.27)	267(38.81)	293(47.41)	976(68.06)
High fall	410(54.89)	277(37.08)	249(40.29)	365(25.45)
MVCs	136(18.21)	78(11.34)	51(8.25)	48(3.35)
Falling objects	57(7.63)	58(8.43)	14(2.27)	24(1.67)
Sports	8(1.07)	5(7.27)	7(1.13)	20(1.39)
Violence	7(0.94)	3(4.36)	4(0.65)	1(0.07)

Table 4
Analysis of the degrees and segment of the injury among the SCI patients

ASIA scale	The level of injury			
	Cervical cord(%)	Thoracic cord(%)	Lumbar cord(%)	Sacral cord(%)
A	516(31.29)	267(30.20)	96(10.29)	0(0.00)
B	249(15.10)	277(31.33)	198(21.22)	0(0.00)
C	121(7.33)	78(8.82)	167(17.90)	0(0.00)
D	763(46.27)	0(0.00)	472(50.59)	21(100)

Treatment of SCI and Clinical Complications

There were 2,763 patients (79.24%) who received surgical treatment and 724 patients (20.76%) who were conservatively treated. The hospitalization of patients with SCI was 1 to 378 days, with an average of 17.50 days. During the hospitalization period, a total of 1341 patients had complications, the incidence rate was 38.46%(Table 5). Of all the complications, pulmonary infection was the most common (437, 32.59%), followed by hyponatremia (326, 24.31%), bedsore (219, 16.33%), urinary tract infection (168, 12.53%), deep venous thrombosis (157, 11.71%) and others (34, 2.53%).

Table 5
Clinical Complications During the hospitalization

Complication	Number(%)
Pulmonary infection	437(32.59%)
Hyponatremia	326(24.31)
Bedsore	219(16.33)
Urinary tract infection	168(12.53)
Deep venous thrombosis	157(11.71)
Others#	34(2.53)
Others# include Cardiovascular diseases and Digestive system disease	

Discussion

Compared with other areas of China, there are several unique characteristics at northwest. The northwest is located in the hinterland of mainland China, mostly plateaus and basins. Compared with the economically developed areas in the eastern coastal areas, the level of economic and political are poor. In addition, the Northwest China is dominated by agriculture, with farmers accounting for the majority of the labor force, accompanied by lower levels of health insurance, education and lower household incomes. Our Hospital is the tertiary trauma center located in Xi'an, which is the economic and cultural centers of the Northwest China. Therefore, the SCI patients admitted by our hospital can objectively represent the epidemiological characteristics of SCI patients in northwest China.

Based on the epidemiological characteristics of SCI in our hospital over the past five years, we found that SCI not only causes abnormal sensory and motor functions below the injury level, but also causes many important organ dysfunction, including respiratory system, urinary system, digestive system and so on, which adds extra hospital costs. Thus, SCI should not be neglected in Northwest China, the prevention of spinal cord injury is particularly important, comprehensive and detailed epidemiological investigation is the basis of effective prevention countermeasures.

In this investigation, the male to female ration of SCI was 2.57:1, which was distinct with Beijing, Shanghai, Guangdong, Chongqing ,Anhui and Heilongjiang(6–11). This may have something to do with the different responsibilities and social division of labor between men and women in different provinces in China. Considering the reasons, the patients mainly come from the Northwest region, which is economically backward and resource-poor. Women's exposure to high-risk industries, such as construction and transportation, increases. At the same time, women are prone to osteoporotic fracture, which increases the proportion of women in SCI patients, there have the same true in South Africa (12).

The highest proportion of SCI in Northwest China was noted in the 30–49 years. In traditional Chinese culture, it is a unshirkable responsibility of the young and middle-age to support their parents and raise their children. Because of the large financial responsibility, they need to take a huge risk to raise their families. Meanwhile, the roads in northwestern China are rugged and complicated. Various reasons increase the possibility that they suffer from work-related SCI, making people aged 30–49 a high-risk group. China's aging population is increasing, with more elderly people suffering from SCI. For the elderly patients, SCI may coexist with degenerative spine disease and/or osteoporotic compression fractures. Therefore, attention should be paid to the needs of the elderly in SCI rehabilitation(13). In this study, the proportion of farmers and laborers was as high as 59.51% and 27.04%, respectively. It is different with previous reports in Guangdong(8), Turkish(14) and México(15). Differences may rooted from the diversity of economic and political environments. Northwest China has a high proportion of the population engaged in agriculture-related occupations; and the probability of SCI occurrence is higher than that of any other occupation.

The causes of SCI include, falls (high fall and low fall), MVCs, fall objects, sports and violent injuries. there are also some differences among countries or regions. We found that falling (high fall and low fall) was the mainly cause of SCI, followed by MVCs, which happened at almost all ages. An epidemiological survey in Canada in 2006 showed that MVCs were the main cause of SCI, but the fall became the mainly cause in 2009(16, 17). The incidence of violence in the various countries or regions were also distinct, the cause of this injury is only 0.40% in Beijing(6), while 11.90% in Brazil(18). Like violent injuries, gunshot wounds were rare in our country, mainly because the state strictly manages social security and strictly controls guns. Similar to other developing countries, the per capita car ownership in China is increasing, meanwhile, the improvement of transport safety measures and the increase in traffic safety awareness, those made the proportion of SCI related to traffic injuries has declined.

Similar to the finding of previous studies (9, 19), the damaged region in this study showed a bimodal distribution, with C4-C6 and T11-L3 being the most common levels of injury; and the incidence of cervical SCI was the highest (47.29%). Additionally, we also found an association between the severity of spinal cord injury and the cause of the injury. MCVs and high fall injuries mostly led to complete SCI, mainly grade A. However, the grade D spinal cord injuries are mostly caused by low falls, which are mostly manifested as incomplete SCI. Williams et al(20) and Thietje et al(21) reported that patients with grade A spinal cord injuries are more likely to suffer from depressive disorders and suicide, and doctors and their families should give more care and help to prevent the occurrence of suicide caused by depression.

The results of this study showed that there were 1341 patients with complications, the incidence rate was 36.49%. Of all the complications, respiratory diseases were the most common (30.7%). This is associated with long-term bed rest, basic lung disease caused by smoking before incidence and rib fractures. Cervical spinal cord injury can reflect the function of diaphragm or intercostal muscle, weaken the strength of respiration and cough, and the sputum was not easy to cough out, which were also related to respiratory complications(22). The higher the level of SCI, the higher the incidence of pulmonary infection. The incidence of pulmonary infection can reach more than 90% when the SCI located above the

level of C5 and causing diaphragm movement dysfunction (23). The results also showed that the average hospitalization time of SCI patients was 10.70 days, the longest was 94 days, and the hospitalization cost was 4,352 yuan to 45,6320 yuan (average 37,850 yuan). It is pointed out that the hospitalization period of SCI patients is long, the cost is high, and the income of most patients is low and the ability to pay is limited, so it is difficult to get comprehensive and effective treatment. However, it is a pity that there were only 15.14% of the SCI patients received rehabilitation. Although this may be related to the low overall SCI rehabilitation level in Northwest China, it also reflects our insufficient attention to SCI postoperative rehabilitation.

Our study has several limitations:(1) This study is a hospital-based descriptive SCI study that only identified a small proportion of all SCI patients in Northwest China. (2) We only collected the information who admitted to hospital with SCI, leaved out the information on patients who died in hospitals before admission. (3) The number and cycle of studies subjects were restively limited. (4) We lack systematic training and there are omissions in the process of collecting data.

Conclusion

Through the investigation and analysis of the epidemiological characteristics of SCI in Northwest China, it is suggested that the understanding of SCI should be improved. We need to strengthen safety education and protection for high-risk groups to reduce the incidence of catastrophic spinal cord injuries. Respiratory complications are important factors leading to death after SCI, especially when the injury is located in the cervical spinal cord. Meanwhile, the significance of the rehabilitation of spinal cord injury should be addressed.

Abbreviations

Spinal cord injury (SCI)

American Spinal Injury Association (ASIA)

Analysis of variance (ANOVA)

motor vehicle collisions (MCVs).

Declarations

Ethics approval and consent to participate: The study was approved by the ethical committee of Honghui Hospital, Xi'an Jiaotong University. The patient gave written consent to for research applications of their clinical data. The patient data was anonymised in this study.

Consent for publication: Consent to publish was obtained from the patients detailed in this study.

Availability of data and materials: The datasets generated during the current study are public at the email dingjun.hao@qq.com.

Competing interests: The authors declare no conflict of interests.

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Authors' contributions: Conceived and designed the experiments: Hao DJ and Yang JS. Performed the experiments: Zou P and Song LL. Collected the data:Zou P Lu Y, Guo H, Zhao YT and Liu TJ. Contributed reagents/materials/analysis tools: Liu TT. Wrote the paper: Yang JS and Wang ZM.

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References

1. Mirzaeva L, Gilhus NE, Lobzin S, Rekand T. Incidence of adult traumatic spinal cord injury in Saint Petersburg, Russia. Spinal cord. 2019;57(8):692-9.
2. Hagen EM, Rekand T, Gilhus NE, Gronning M. Traumatic spinal cord injuries–incidence, mechanisms and course. Tidsskrift for den Norske laegeforening : tidsskrift for praktisk medicin, ny raekke. 2012;132(7):831-7.
3. Wyndaele M, Wyndaele JJ. Incidence, prevalence and epidemiology of spinal cord injury: what learns a worldwide literature survey? Spinal Cord. 2006;44(9):523-9.
4. Skolasky RL, Thorpe RJ, Jr., Wegener ST, Riley LH, 3rd. Complications and mortality in cervical spine surgery: racial differences. Spine. 2014;39(18):1506-12.
5. Rahimi-Movaghar V, Sayyah MK, Akbari H, Khorramirouz R, Rasouli MR, Moradi-Lakeh M, et al. Epidemiology of traumatic spinal cord injury in developing countries: a systematic review. Neuroepidemiology. 2013;41(2):65-85.
6. Li J, Liu G, Zheng Y, Hao C, Zhang Y, Wei B, et al. The epidemiological survey of acute traumatic spinal cord injury (ATSCI) of 2002 in Beijing municipality. Spinal cord. 2011;49(7):777-82.
7. Chang FS, Zhang Q, Sun M, Yu HJ, Hu LJ, Wu JH, et al. Epidemiological study of Spinal Cord Injury individuals from halfway houses in Shanghai, China. The journal of spinal cord medicine. 2018;41(4):450-8.
8. Yang R, Guo L, Huang L, Wang P, Tang Y, Ye J, et al. Epidemiological Characteristics of Traumatic Spinal Cord Injury in Guangdong, China. Spine. 2017;42(9):E555-e61.

9. Ning GZ, Mu ZP, Shangguan L, Tang Y, Li CQ, Zhang ZF, et al. Epidemiological features of traumatic spinal cord injury in Chongqing, China. The journal of spinal cord medicine. 2016;39(4):455-60.
10. Wang HF, Yin ZS, Chen Y, Duan ZH, Hou S, He J. Epidemiological features of traumatic spinal cord injury in Anhui Province, China. Spinal cord. 2013;51(1):20-2.
11. Chen R, Liu X, Han S, Dong D, Wang Y, Zhang H, et al. Current epidemiological profile and features of traumatic spinal cord injury in Heilongjiang province, Northeast China: implications for monitoring and control. Spinal cord. 2017;55(4):399-404.
12. Pefile N, Mothabeng JD, Naidoo S. Profile of patients with spinal cord injuries in Kwazulu-Natal, South Africa: Implicactions for vocational rehabilitation. The journal of spinal cord medicine. 2018:1-10.
13. Kudo D, Miyakoshi N, Hongo M, Kasukawa Y, Ishikawa Y, Ishikawa N, et al. An epidemiological study of traumatic spinal cord injuries in the fastest aging area in Japan. Spinal cord. 2019;57(6):509-15.
14. Guzelkucuk U, Kesikburun S, Demir Y, Aras B, Ozyoruk E, Yilmaz B, et al. Demographic and clinical characteristics of patients with traumatic cervical spinal cord injury: a Turkish hospital-based study. Spinal cord. 2015;53(6):441-5.
15. Zarate-Kalfopulos B, Jimenez-Gonzalez A, Reyes-Sanchez A, Robles-Ortiz R, Cabrera-Aldana EE, Rosales-Olivarez LM. Demographic and clinical characteristics of patients with spinal cord injury: a single hospital-based study. Spinal cord. 2016;54(11):1016-9.
16. Pickett GE, Campos-Benitez M, Keller JL, Duggal N. Epidemiology of traumatic spinal cord injury in Canada. Spine. 2006;31(7):799-805.
17. 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. The Journal of trauma. 2009;67(5):936-43.
18. Leal-Filho MB, Borges G, Almeida BR, Aguiar Ade A, Vieira MA, Dantas Kda S, et al. Spinal cord injury: epidemiological study of 386 cases with emphasis on those patients admitted more than four hours after the trauma. Arquivos de neuro-psiquiatria. 2008;66(2b):365-8.
19. Fredo HL, Rizvi SA, Lied B, Ronning P, Helseth E. The epidemiology of traumatic cervical spine fractures: a prospective population study from Norway. Scandinavian journal of trauma, resuscitation and emergency medicine. 2012;20:85.
20. Williams RT, Wilson CS, Heinemann AW, Lazowski LE, Fann JR, Bombardier CH. Identifying depression severity risk factors in persons with traumatic spinal cord injury. Rehabilitation psychology. 2014;59(1):50-6.
21. Thietje R, Pouw MH, Schulz AP, Kienast B, Hirschfeld S. Mortality in patients with traumatic spinal cord injury: descriptive analysis of 62 deceased subjects. The journal of spinal cord medicine. 2011;34(5):482-7.
22. Jiang F, Jaja BNR, Kurpad SN, Badhiwala JH, Aarabi B, Grossman RG, et al. Acute Adverse Events After Spinal Cord Injury and Their Relationship to Long-term Neurologic and Functional Outcomes:

Analysis From the North American Clinical Trials Network for Spinal Cord Injury. Critical care medicine. 2019.

23. Fehlings MG, Vaccaro A, Wilson JR, Singh A, D WC, 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(2):e32037.

Figures

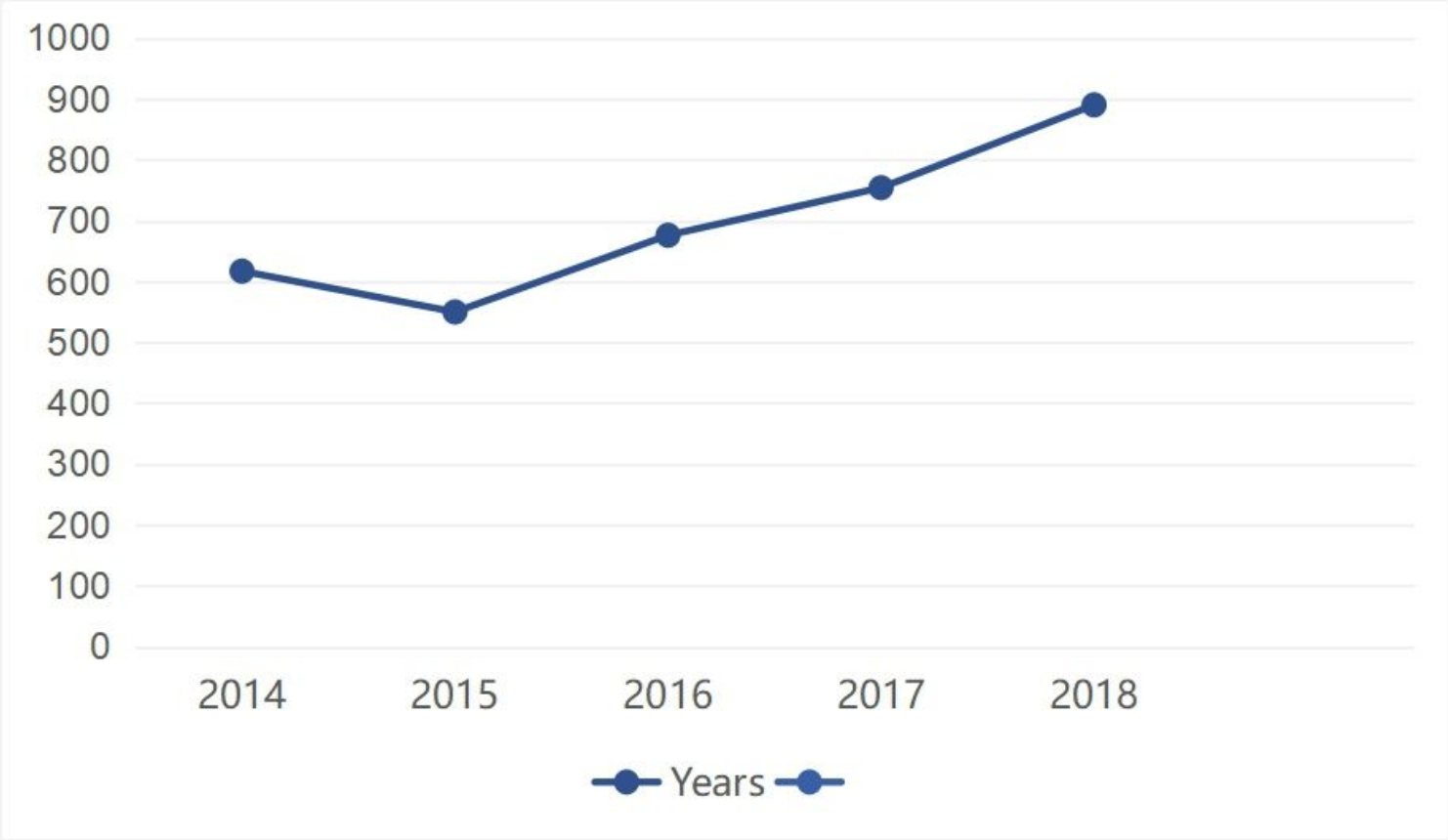

Figure 1

The trend of SCI patients during 2014-2018

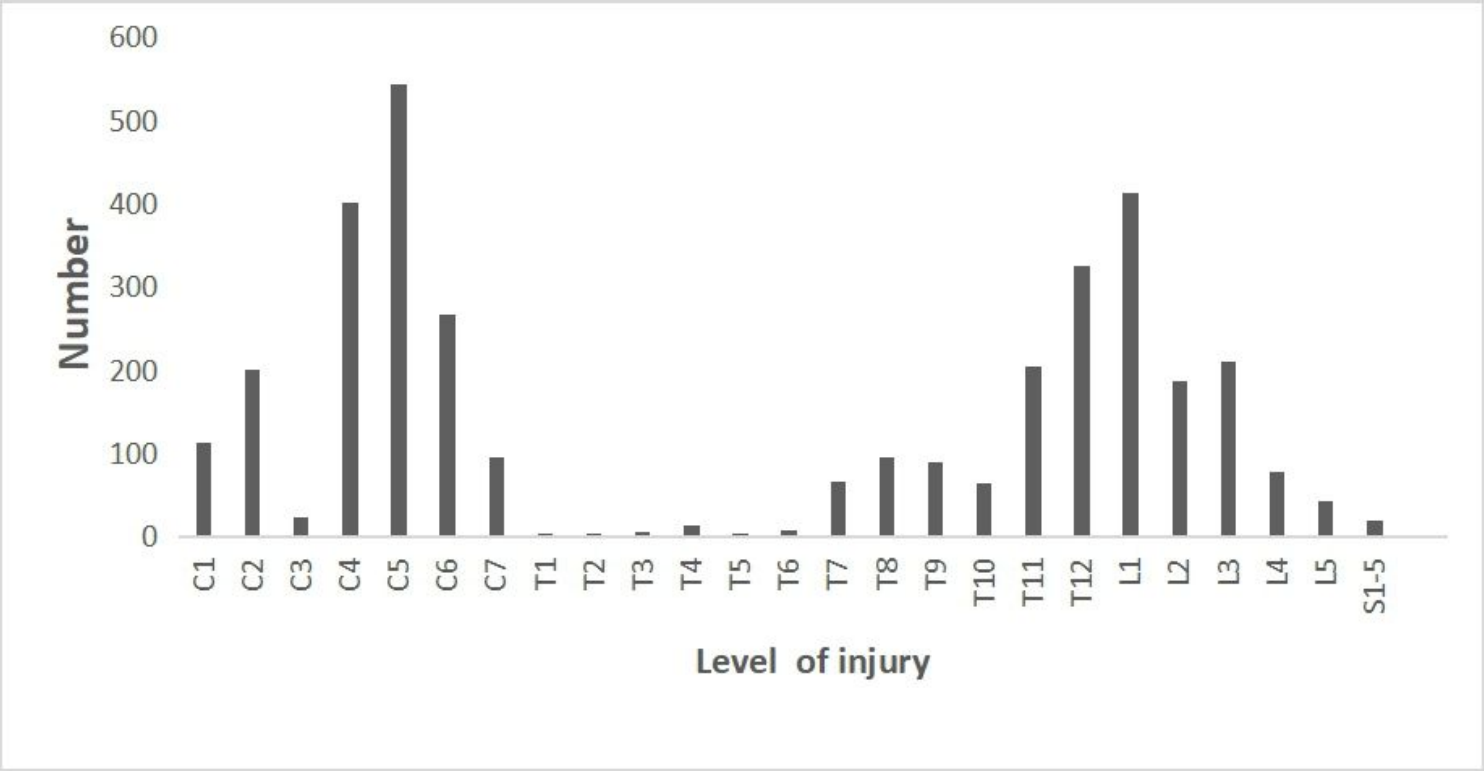

Figure 2

Distribution of spine level injuries for SCI patients by the severity of injury