

# Neurological Outcome in Road Traffic Accidents with Spinal Cord Injury

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## ABSTRACT

*The aim of the study was to investigate neurological outcome in road traffic accidents (RTA) with spinal cord injury (SCI). The study was undertaken in National Spinal Unit of Special Medical Rehabilitation Hospital, in Varaždinske Toplice, Croatia. Hospital records of 154 inpatient RTA SCI patients, in years 1991–2001 were reviewed. Six groups of patients were formed: car drivers, co-drivers, back seat passengers, motorcycle drivers, bicycle drivers and pedestrians. Neurological assessments at admission to rehabilitation and before discharge were done according to American Spinal Injury Association (ASIA) impairment scale. Methods of descriptive statistics were used. Overall 49% of RTA SCI patients presented with complete injury (ASIA A) at admission to rehabilitation, 93% of initially complete spinal cord injured patients remained complete at discharge and 72% previously non-ambulatory incomplete (ASIA B-E) patients achieved ambulation. Complete injury was acquired more often in motorcycle drivers and car drivers group (67% and 54%, respectively). Road traffic spinal cord injuries are, and will remain the leading cause of traumatic SCI, with high proportion of complete injury at rehabilitation onset, especially in motorcycle drivers and car drivers groups.*

**Key words:** road traffic accident, spinal cord injury, neurological outcome

## Introduction

Road traffic accidents (RTA) resulting in spinal cord injury (SCI) have been well documented as the most prevalent type of traumatic SCI with increasing incidence, affecting predominantly young individuals in the most productive period of life, bringing significant, life-long burden on the family, community and health-care system<sup>1</sup>. Croatia is a south-eastern European country with 4.4 million inhabitants, diverse landscape, increasing traffic, with gross domestic product per capita of 10 000 \$ and 1.6 million registered vehicles (roughly 1 per every 3 persons) and the incidence of 14 deaths in traffic/100.000 inhabitants<sup>2</sup>. Laws encouraging traffic safety have been improved and increasingly implemented in the course of time, leading to slow but steady decrease of mortality in road accidents. In Croatia, RTA with SCI account for 0.3% of all road accidents involving personal injury, and represent approximately 40% of all traumatic SCI in the overall yearly incidence of 20 SCI cases/million. These data are well within limits of European Union statistics. Recently, Tchvaloon et. al. published a study of overall survival, neurological recovery and mor-

bidity after spinal cord injuries following road accidents in Israel<sup>3</sup>. Authors concluded that road accident victims with SCI have a somewhat higher survival rate but lower neurological recovery than the general SCI population. The aim of our study was to investigate overall neurological outcome of patients with SCI acquired in RTA, and with respect to the position of the participant in the accident.

## Subjects and Methods

Records of 154 RTA SCI patients rehabilitated in national Spinal Unit of Special Medical Rehabilitation Hospital in Varaždinske Toplice, Croatia in years 1991–2001 were reviewed. This Spinal Unit admits all Croatian RTA SCI patients for rehabilitation. Patients were treated by immobilisation at the scene of accident and transferred to Traumatology clinic. Majority of patients were unstable and treated surgically and some of them were given at the time less controversial methylprednisolone treat-

ment according to NASCIS scheme<sup>4</sup>. All patients underwent through standardised yet individually tailored comprehensive rehabilitation programme, with the length of stay depending of the neurological level and completeness of injury. Neurological assessments at admission to rehabilitation and before discharge were done according to American Spinal Injuries Association (ASIA) impairment scale, whereas ASIA A represents total motor paralysis and sensory (both light touch and pinprick) loss below the injury level and is referred to as complete injury, while ASIA B, C, D and E represent incomplete injury with preservation of at least some sensory (B) and/or motor function (C, D, E) below the injury level<sup>5,6</sup>. Ambulatory status can be obtained when ASIA scale reaches D and E status, with sufficient leg motor power to sustain own body weight, which is still not the case with ASIA B and C incomplete status. We classified our patients into six groups: car drivers, co-drivers, back seat passengers, motorcycle drivers, bicycle drivers and pedestrians. Data were organised into a Microsoft® Excel SR-1 file (Microsoft, Redmond, WA, USA) and descriptive statistics methods were used.

**Results**

During 11 – years (1991–2001) period, there were 154 RTA SCI patients (93 paraplegic and 61 tetraplegic) undergoing rehabilitation in the Unit, their numbers and percentage shown in Table 1. Their rehabilitation commenced at approximately 14th day post-injury, with an average length of stay of 3–6 months. ASIA impairment scale at rehabilitation onset and its changes in course of rehabilitation until discharge from the centre are shown in Table 2. Completeness of neurological injury at rehabilitation onset in each of the 6 group is shown in Table 3. Persistence of complete SCI in each group is presented in Table 4.

**Discussion**

Road traffic accidents are leading cause of traumatic spinal cord injury, often complete and resulting in per-

**TABLE 1**  
ROAD TRAFFIC ACCIDENTS WITH SPINAL CORD INJURY: PATIENTS ADMITTED TO REHABILITATION

	n	%
Car drivers	63	41
Co-drivers	34	22
Pedestrians	19	12
Motorcycle drivers	18	12
Back seat passengers	15	10
Bicycle drivers	5	3
Total	154	100

n – number of patients in each group, % – percentage of patients in each group

**TABLE 2**  
NEUROLOGICAL OUTCOME IN ROAD TRAFFIC ACCIDENTS WITH SPINAL CORD INJURY

Admission			Discharge	
ASIA = n	%	⇒	ASIA = n	%
A = 76	49	⇒	A = 71	93
			C = 4	5
			D = 1	1
B = 13	8	⇒	B = 5	38
			C = 4	31
			D = 3	23
			E = 1	8
C = 33	21	⇒	A = 1	3
			C = 3	9
			D = 22	67
			E = 7	21
D = 19	12	⇒	D = 5	26
			E = 14	74
E = 13	8	⇒	E = 13	100
Total = 154	100			

From left: ASIA = n – number of patients according to American Spinal Injury Association (ASIA) impairment scale at rehabilitation onset, % – percentage of patients in the group, ⇒ – neurological changes during rehabilitation, ASIA = n – number of patients according to ASIA impairment scale at discharge from rehabilitation, % – percentage of patients in each ASIA subcategory at discharge

manent disability. We investigated neurological status at admission and during rehabilitation in RTA SCI patients, in an attempt to relate the impact of position of the participant in the accident to the severity of SCI measured by the ASIA impairment scale. In our study car drivers group was represented with 63 patients, understandably representing majority (41%) of subjects in the study (Table 1). Overall, 93% of 76 initially complete (ASIA A) SCI patients remained complete at discharge (Table 2), comparable to published data<sup>1,3</sup> (92.7% in the study presented by Tchvaloon et. al.)<sup>3</sup>, in our sample ranging from 97% in car drivers group to 88% in back seat passengers group, not taking into account single complete bicycle driver who remained complete (Table 4). The remaining 5% (4 patients) converted to ASIA C, and 1% (one patient) to ASIA D (Table 2). Ambulatory status (ASIA D and ASIA E) at admission were noted in 32 (20%), while 33 out of 46 (72%) previously non-ambulatory incomplete patients (ASIA B and ASIA C) achieved ambulatory status (ASIA D and ASIA E) in course of rehabilitation; the results encouraging both for patients and involved health professionals, but generally expected outcome (Table 2). Almost half of patients (49%) presented with complete SCI at admission to Spinal unit (41% in sample by Tchvaloon et. al.)<sup>3</sup> approximately 14th day post injury (Table 2), with the range of 20% (bicycle drivers) to 67% (motorcycle drivers) (Table

**TABLE 3**  
COMPLETE INJURY AT ADMISSION TO REHABILITATION IN EACH GROUP

	ASIA A/n	%
Motorcycle drivers	12/18	67
Car drivers	34/63	54
Back seat passengers	8/15	53
Pedestrians	9/19	47
Co-drivers	12/34	35
Bicycle drivers	1/5	20

ASIA A/n – number of complete – American Spinal Injury Association (ASIA) A (total motor paralysis and sensory loss below the injury level) patients in each group, % – percentage of complete patients in each group

**TABLE 4**  
COMPLETE INJURY AT DISCHARGE FROM REHABILITATION IN EACH GROUP

	ASIA A/n	%
Car drivers	33/34	97
Motorcycle drivers	11/12	92
Co-drivers	11/12	92
Pedestrians	8/9	89
Back seat passengers	7/8	88
Bicycle driver	1/1	100

ASIA A/n – number of complete – American Spinal Injury Association (ASIA) A (total motor paralysis and sensory loss below the injury level) patients in each group, % – percentage of complete patients in each group

3). Understandably, and despite compulsory wearing of helmets, motorcycles are the most dangerous method of

transportation, and injuries are often severe and complicated. Driver's seat (54% of ASIA A at admission) is not very safe place either, with steering wheel in front and the driver exposed to the traffic coming from the opposite or the side. Back seat passengers (53% ASIA A at admission) probably do not wear seat belts as regularly, although it is compulsory to all passengers in the vehicle. On the contrary, co-drivers (35% ASIA A at admission) with their seat belts on, and bicycle drivers (20% ASIA A at admission) with considerably smaller speed than bikers, seem to be generally more protected from complete injury. The limitations of the study include sample size that prevents us to verify certain differences among groups statistically; furthermore ASIA impairment scales are not taken immediately following injury but at rehabilitation onset approximately 14th day post-injury and, we could not measure the impact of countless variables of every accident concerning speed, forces of the collision, car features etc.

## Conclusion

Forty-nine percent of patients presented with complete injury at admission to rehabilitation, 93% of initially complete SCI patients remained complete at discharge and 72% previously non-ambulatory incomplete patients achieved ambulation. Among groups, motorcycle drivers and car drivers groups of patients appear to be the most susceptible to complete injury initially (67% and 54%, respectively). Road traffic accident spinal cord injuries are, and will remain the leading cause of traumatic SCI. It would be of further interest to observe outcomes of injury in specific groups, especially with respect to preventive measures taken on them.

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## NEUROLOŠKI ISHOD KOD PROMETNIH NESREĆA S OZLJEDOM KRALJEŽNIČKE MOŽDINE

### SAŽETAK

Cilj studije bio je ispitati neurološke ishode kod prometnih nesreća s ozljedom kralježničke moždine (OKM). Ispitivanje je provedeno u nacionalnom Spinalnom odjelu Specijalne bolnice za medicinsku rehabilitaciju, u Varaždinskim Toplicama, Hrvatska. Pregledana je medicinska dokumentacija 154 bolničkih pacijenata s OKM zadobivenom u prometnoj nesreći, u godinama od 1991. do 2001. Oformljeno je šest skupina pacijenata: vozači automobila, suvozači, putnici na stražnjem sjedalu, motoristi, biciklisti i pješaci. Neurološki pregled kod prijema na rehabilitaciju i prije otpusta učinjen je sukladno American Spinal Injury Association (ASIA) skali neurološkog deficita. Korištene su metode deskriptivne statistike. Ukupno je 49% bolesnika s OKM zadobivenom u prometnoj nesreći kod prijema na rehabilitaciju imalo potpunu ozljedu, 93% početno potpunih ozljeda ostalo je takvima i kod otpusta, a 72% početno nepokretnih bolesnika s nepotpunom OKM je prohodalo. Potpuna je ozljeda bila učestalija kod motorista i vozača automobila (67% i 54%). Prometne ozljede jesu i bit će vodeći uzrok traumatske OKM, s visokim udjelom potpune ozljede na početku rehabilitacije, osobito u skupinama motorista i vozača automobila.