ORIGINAL ARTICLE

Spinal Cord Injury and Co-Occurring Traumatic Brain Injury: Assessment and Incidence

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ABSTRACT. Macciocchi S, Seel RT, Thompson N, Byams R, Bowman B. Spinal cord injury and co-occurring traumatic brain injury: assessment and incidence. Arch Phys Med Rehabil 2008;89:1350-7.

Objectives: To examine prospectively the incidence and severity of co-occurring traumatic brain injury (TBI) in persons with traumatic spinal cord injury (SCI) and to describe a TBI assessment process for SCI rehabilitation professionals.

Design: A prospective, cohort design to collect and analyze clinical variables relevant for diagnosing co-occurring TBI.

Setting: An urban, single-center National Institute of Disability and Rehabilitation Research Model Spinal Cord Injury System in the Southeastern United States.

Participants: People (N=198) who met inclusion criteria and provided consent within an 18-month recruitment window.

Interventions: Not applicable.

Main Outcome Measure: FIM cognitive scale.

Results: Based on participants' presence and duration of posttraumatic amnesia, initial Glasgow Coma Scale total score, and presence of cerebral lesion documented by neuroimaging, 60% of our traumatic SCI sample also sustained a TBI (n=118). Most co-occurring TBIs were mild (34%). Co-occurring mild complicated (10%), moderate (6%), and severe TBI (10%) were less common but still occurred in a significant percentage (26%) of persons with traumatic SCI. Persons with traumatic SCI who were injured in motor vehicle collisions and falls were more likely to sustain a co-occurring TBI. Cervical level traumatic SCI was associated with greater rates of TBI but not more severe injuries. Tree analyses established a practical algorithm for classifying TBI severity associated with traumatic SCI. Analysis of variance established criterion validity for the algorithm's TBI severity classifications.

Conclusions: Findings from our prospective study provide strong support that TBI is a common co-occurring injury with traumatic SCI. Incomplete acute care medical record documentation of TBI in the traumatic SCI population remains a considerable issue, and there is a significant need to educate emergency department and acute care personnel on the TBI clinical data needs of acute rehabilitation providers. A systematic algorithm for reviewing acute care medical records can yield valid estimates of TBI severity in the traumatic SCI population.

Key Words: Brain injuries; Diagnosis; Incidence; Rehabilitation; Spinal cord injuries.

THE CAUSES OF SCI VARY depending on age, race and ethnicity, and sex, but most SCIs are caused by trauma sustained during MVCs, falls, assaults, and sports participation. Epidemiologic studies indicate approximately 10,000 persons sustain a traumatic SCI each year.[1] Although some persons who sustain a traumatic SCI do not survive, the overwhelming majority of persons with traumatic SCI who do survive require extended inpatient rehabilitation. Similar to traumatic SCI, TBI can be a significantly disabling event. Not surprisingly, depending on injury etiology, many persons sustain both a traumatic SCI and TBI.[2,3] A co-occurring TBI would be expected to significantly impact traumatic SCI rehabilitation outcome.[4,5] Consequently, diagnosing a co-occurring TBI early in the traumatic SCI rehabilitation process may facilitate treatment planning and enhance eventual rehabilitation outcome.

Investigators began to examine the incidence of traumatic SCI and co-occurring TBI 4 decades ago. Published incidence rates vary widely, ranging from 16% to 59% (table 1).[6-20] In studies in which nosology was provided, at least 50% and as many as 82% of TBIs were considered minor or mild. Most investigations used retrospective clinical metrics to identify co-occurring TBI in persons hospitalized for traumatic SCI rehabilitation. By using acute care medical records, investigators typically retrieved LOC, TBI ICD-9 code, neuroimaging, and less frequently PTA data to establish a diagnosis. Studies that exclusively used TBI ICD-9 codes or positive neuroimaging for TBI diagnosis had lower incidence rates (16%–34%) than studies that included measures of altered consciousness (28%–59%). In many studies, investigators found clinical information critical for diagnosing TBI after traumatic SCI was absent or embedded in acute care records and difficult to

List of Abbreviations

ANOVA	analysis of variance
ASIA	American Spinal Injury Association
CT	computed tomography
GCS	Glasgow Coma Scale
ICD-9	*International Classification of Disease–9th Revision*
LOC	loss of consciousness
MVC	motor vehicle collision
NIDRR	National Institute of Disability and Rehabilitation Research
PTA	posttraumatic amnesia
SCI	spinal cord injury
TBI	traumatic brain injury

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Table 1: Chronological Review of Studies Reporting Incidence of Co-Occurring TBI in Persons With SCI

Study and Year	Sample Size	SCI Level/Etiology	Design and Setting	TBI Diagnostic Criteria	Incidence TBI (%)	TBI Nosology
Harris[6] (1968)	150	Tetra 45%, NR	Retrospective, TC	Minor = LOC for minutes and PTA <12h	33	60% minor; 40% major
Meinecke[7] (1968)	595	NR, MVC 8%	Retrospective, TC	NR	25	74% concussion; 15% skull fx or brain contusion
Shrago[8] (1973)	50	Tetra 100%, NR	Retrospective, TC	Contusions, abrasions, lacerations, or skull fracture	34	NR
Silver et al[9] (1980)	100	Tetra 51%, MVC 41%	Retrospective, TC	LOC, PTA, contusions	50	82% minor; 18% serious
Rimel[10] (1981)	253	NR, MVC 46%	Prospective, CNS registry	NR	47	NR
Young et al[11] (1982)	1615	Tetra 54%, MVC 46%	Prospective, SCI registry	ICD codes	16	60% concussion; 20% skull fx; 20% brain injury
Davidoff et al[12] (1985)	88	C1-T6 = 76%, MVC 38%	Retrospective, TC, AR	LOC or PTA	42	NR
Richards et al[13] (1988)	150	Tetra 51%, MVC 58%	Prospective, AR	LOC	59	NR
Steudel et al[14] (1988)	59	Tetra 100%, MVC 63%	Retrospective, TC	Tunnis and Loew classification; GCS	56	45% mild; 30% moderate/severe; 25% NR
Davidoff et al[15] (1988)	82	Tetra 44%, MVC 56%	Prospective, TC, AR	PTA (LOC, 44%)	49	PTA duration: 40% <1h; 18% 1–12h; 16% 12–72h; 24% >72h
Michael et al[16] (1989)	92	Tetra 100%, NR	Retrospective, TC	ICD code for TBI or positive head CT scan	24	81% mild/moderate; 19% severe
Saboe et al[17] (1991)	508	Tetra 24%, multilevel 50%, MVC 56%	Retrospective, TC	NR	26	NR
Pagni and Massaro[18] (1991)	225	NR, NR	Retrospective, TC	Mild = LOC <1h; small fx or contusion; severe = LOC >1h	54	60% mild; 40% severe
Go et al[19] (1995)	4107	NR, MVC 45%	Prospective, SCI registry	LOC; head injury = "significant dysfunction" secondary to TBI	28–40	28% LOC; 12%; head injury (some group overlap)
Strubreither et al[20] (1997)	322	NR, NR	Retrospective, AR	Cerebral lesion	20	27% none; 42% minor/moderate; 31% severe

Abbreviations: AR, acute rehabilitation center; CNS, central nervous system; fx, fracture; NR, not reported or could not be determined; TC, trauma center; Tetra, tetraplegia.