Motor recovery following spinal cord injury caused by stab wounds: a multicenter study

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A prospective multicenter study was conducted by centers participating in the National Model Spinal Cord Injury System program to examine neurological deficit and recovery patterns following spinal cord injury (SCI) resulting from stab wounds. Thirty two patients were evaluated. Sixty three percent presented with motor incomplete lesions on initial examination. In addition, four of seven who initially presented with motor complete paraplegia were motor incomplete at follow-up. Furthermore, 50% of those with motor incomplete lesions had asymmetrical motor patterns indicative of a Brown-Séquard Syndrome. Although the percentage of patients sustaining an incomplete SCI injury following a stab injury to the spine is higher than the percentage of incomplete lesions associated with other etiologies, the amount of motor recovery when controlling for level and completeness of injury is no greater than previously reported for other etiologies.

Keywords: spinal cord injury; tetraplegia; paraplegia; motor recovery; penetrating trauma; stab wounds

Introduction

With the exception of South Africa, reports of stab wounds which result in spinal cord injury (SCI) are relatively rare.^{1–3} Peacock⁴ and Lipschitz⁵ retrospectively reviewed two series of South African individuals with SCI caused by stabs. Peacock reported on 450 patients who sustained stab wounds to the spine with ensuing SCI. These patients accounted for approximately 25% of all cases with SCI in this series. Lipschitz reported on 314 individuals with SCI caused by stab wounds.

In developed countries having a plethora and ready access to guns, SCI due to stab wounds is relatively infrequent and most reports of SCI due to stab wounds consist of one or two cases or a small series.^{6–9} In the period from 1980 to 1993, 1736 individuals with SCI began and completed rehabilitation in the Regional Spinal Cord Injury Care System of Southern California. Although intentional violence accounted for 810 of these cases (42.8%), most were due to gunshot wounds, 760 cases (40.2%) and relatively few resulted from stab wounds, 50 cases (2.6% of the entire sample or 6.2% of those due to violence). Similarly, the National Spinal Cord Injury Statistical Center, the repository of data generated by the Model Spinal Cord Injury Care Systems, reports that only 1.1% of the 16024 cases on file were due to penetrating injuries other than gunshot wounds.¹⁰

The purpose of this investigation was to prospect-

ively determine the characteristics of neurological deficit and quantify motor recovery in individuals who have sustained SCI due to stab wounds. Since the prevalence of SCI caused by stab wounds in the United States is low, it is difficult for one institution prospectively to collect sufficient data in a reasonable time period. Therefore, a collaborative investigation among the Regional Model Spinal Cord Injury Systems, which are sponsored by the National Institute on Disability and Rehabilitation Research, was undertaken.

Methods

The locations of the nine SCI systems which participated in this study are listed in Table 1.

Detailed motor examinations were conducted upon admission to the system and approximately 1 year from the date of injury. If patients did not return for a 1 year follow-up examination, the most recent examination was recorded as the follow-up. Examinations were performed according to the American Spinal Injury Association Standards for Neurological and Functional Classification of Spinal Cord Injury.¹¹ Each of 10 key

Table 1 Locations of participating Model Spinal Cord Injury Systems

Downey, California	Englewood, Colorado
Atlanta, Georgia	Chicago, Illinois
Ann Arbor, Michigan	Detroit, Michigan
New York, New York	Philadelphia, Pennsylvania
Houston, Texas	

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muscles/muscle groups representing myotomes from C5 to S1 was tested bilaterally on a standard six-point manual muscle testing scale. Bladder control status and ambulatory status were also assessed upon admission and at annual follow-up. Ambulation status was graded on a three point scale (1: non-walker, 2: assisted walker, 3: independent walker). Patients who were able to ambulate 150 feet without physical assistance from a helper with or without orthoses and/or crutches were classified as 'independent'. If an individual required assistance from a helper, they were classified in the 'assisted' category.

Data collection for this sample of patients commenced prior to the American Spinal Injury Association's acceptance of the sacral sparing definition of the completeness of SCI in 1992.^{11,12} In addition no sensory data were collected. Consequently, patients could not be classified according to completeness of neurological injury. Patients were classified according to the motor completeness of injury. A motor complete injury was defined as one in which there was no preservation of motor function more than three segments below the most caudal segment with motor grades of 3 bilaterally. A motor incomplete injury was one in which some preservation of motor function existed more than three segments below the most caudal segment with motor level of 3 bilaterally.

Results

Initial examination

Thirty two patients from nine regional Model SCI Systems constituted the study sample. There were 22 males and 10 females with an average age of 26.8 years. The initial examination upon admission to the system was conducted at an average of 10 days following injury.

The distribution of level and completeness upon initial examination was: seven presenting with motor complete paraplegia; 12 with motor incomplete paraplegia; five with motor incomplete tetraplegia; and eight with motor complete tetraplegia. Ten (50%) of those with motor incomplete lesions had asymmetrical patterns of motor deficit indicative of a Brown-Séquard Syndrome.

There was a significant difference ($P < 0.01$) in the American Spinal Injury Association (ASIA) Motor Score (AMS) between the four groups of patients at the initial examination. Subjects with motor incomplete paraplegia demonstrated the highest AMS (63.7) followed by those with motor complete paraplegia (50.1), those with incomplete tetraplegia (43.0), and those with complete tetraplegia (15.0 points). Twenty five subjects were unable to ambulate, three were able to ambulate with assistance, and three were able to ambulate independently. Ambulatory status was unavailable for one subject. The majority of subjects (24 of 32 cases) did not have volitional bladder control. Seven subjects demonstrated volitional bladder function and bladder status was unavailable for one additional subject.

Twelve of 14 patients (86%) in whom sacral sparing was tested at the time of initial examination had a neurologically incomplete SCI based on the sacral sparing definition.

Follow-up examination

The distributions of level of injury, initial AMS and, when available, follow-up AMS for all patients are tabulated in Table 2. Four individuals did not return for follow-up. Sixteen of the 28 individuals who returned for follow-up had their follow-up examinations a minimum of 10 months or more (≥ 299 days) after injury. There were significant differences between the four groups for both the initial and the follow-up AMS (Table 3). The average change in AMS from initial to follow-up exam was 16.9 ± 11.5 points. Those with motor complete tetraplegia demonstrated the least improvement with an AMS change of only 6.0 ± 2.8 points and those with motor incomplete tetraplegia the most improvement, 22.7 ± 19.6 points.

Seven of the 16 (44%) patients with a follow-up longer than 299 days were independent ambulators. An additional six patients with a follow-up of less than 299 days were also able to ambulate independently. All of these six patients were motor incomplete. Similarly, 10 of 14 (71%) subjects had volitional bladder control at follow-up. Only one of 10 patients who initially presented as motor complete and had adequate follow-up was able to walk independently or volitionally void at follow-up.

Discussion

Lipschitz⁵ found that the majority of spinal injuries due to stab wounds were located in the thoracic spine (74%) followed by the cervical spine (18%) and the lumbar spine (8%). He reported that if the SCI was neurologically complete over 24 h after injury neurological recovery was rare, and if present, negligible. If, however, the individual sustained an incomplete injury, more than half of all patients returned to their former employment and 14% demonstrated total recovery within 3 to 9 months.

Peacock⁴ reported that 25% of all SCI patients admitted to the Spinal Cord Injury Centre in Cape Town between 1963 and 1976 had SCI due to stab wounds. Again, the most common site of the stab wound was in the thoracic spine (63%), followed by the cervical spine (30%) and the lumbar spine (7%). Eighty percent of injuries were incomplete. Of those with incomplete injuries, 69% (248 cases) had a Brown-Séquard type of lesion. Peacock assessed recovery based on ambulatory status. Good recovery, defined as ambulating without an assistive device or with only an ankle-foot orthosis, was observed in 66% of the group. Fair recovery was designated as ambulation with 'major support' and was noted in 17% of the group. No recovery was observed in 17% of the group and 4% of the patients died.

Our results were comparable to those reported by Lipschitz⁵ and Peacock⁴. Sixty three percent were

Table 2 Asia Motor Score (AMS) at initial and final examination

Case No.	Initial exam (days)	Final exam (days)	Initial AMS (points)	Final AMS (points)	Walking status ^a
<i>Motor complete paraplegia (initial exam)</i>					
2	11	116	50	50	1
3	19	354	50	71	1
7	1	303	50	50	1
11	1	205	51	57	1
15	1	418	50	82	1
16	1	317	50	80	3
24	10	836	50	50	1
<i>Motor incomplete paraplegia (initial exam)</i>					
1	11	497	81	97	3
5	1	337	77	96	3
9	1	367	82	100	3
13	10		68		
17	1	508	69	92	3
22	27		53		
26	16	391	54	62	1
28	1	344	58	72	2
29	4		59		
30	3	160	53	64	3
34	11		55		
36	1	32	55	61	
<i>Motor complete tetraplegia (initial exam)</i>					
6	1	344	4	8	1
8	12	146	0	0	1
18	1	321	11	19	1
19	40	151	24	30	1
33	8	29	36	36	1
<i>Motor incomplete tetraplegia (initial exam)</i>					
4	8	98	54	65	3
12	23	97	76	88	3
14	32	299	42	85	3
20	13	157	41	68	3
21	47	417	10	14	1
31	13	31	42	70	3
32	22	391	32	53	3
35	13	135	47	79	3

^aKey to codes: 1 = non-walker, 2 = assisted walker, 3 = independent walker

Table 3 Asia motor scores in patients with ≥ 299 days follow-up

	Number	ASIA motor score		
		Initial	Follow-up	Change
Motor complete paraplegia	5	48.0 $\pm$ 4.5	66.6 $\pm$ 15.7	18.6 $\pm$ 13.6
Motor incomplete paraplegia	6	70.2 $\pm$ 12.0	86.5 $\pm$ 15.6	16.3 $\pm$ 5.1
Motor complete tetraplegia	2	7.5 $\pm$ 4.9	13.5 $\pm$ 7.8	6.0 $\pm$ 2.8
Motor incomplete tetraplegia	3	28.0 $\pm$ 16.4	50.7 $\pm$ 35.6	22.7 $\pm$ 19.6
Total	16	47.5 $\pm$ 24.2	64.4 $\pm$ 30.0	16.9 $\pm$ 11.5

paraplegic. Fifty percent of those with motor incomplete lesions at the initial examination had asymmetrical motor patterns indicative of a Brown-Séquard syndrome. Of those with ≥ 299 days follow-up, 44% were able to walk independently and 71% had volitional bladder control.

The relatively high percentage of motor incomplete injuries following stab wounds accounts for the relatively favorable outcome compared to injuries due to other causes with respect to motor recovery and the fact that the majority of patients could void volitionally and ambulate independently at follow-up.^{13,14}

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