ORIGINAL ARTICLE

NEUROLOGICAL RECOVERY IN TRAUMATIC SPINAL CORD INJURIES AFTER SURGICAL INTERVENTION

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Background: Spinal injuries are the most devastating injuries and affect every aspect of patients' lives. This may cause lifelong disability due to spinal cord injury. Recovery of neurological functions is highly desirable. Early or late surgical intervention is still debatable, but majority recommend early intervention. The result of late surgical intervention in term of neurological recovery is not clear. This study focuses on neurological recovery after late surgical intervention. The objective of this study was to assess neurological recovery in term of ASIA grading in patients with traumatic spinal cord injury. **Methods:** This descriptive cross-sectional study was performed from June 2013 to June 2016. All patients treated for spinal trauma with spinal cord injury, operated after 24 hrs of injury were included in the study. Neurology was assessed according to ASIA scale preoperative and at 6 months. Data was analysed with the help of SPSS. **Results:** Total of 149 patients, 32 (21.5%) were female and 117 (78.5%) male were included. mean age was 32±13.11 years. Ninety-six (64.4%) patients presented with fall while 53 (35.6%) presented with motor vehicular accidents (MVA). according to AO comprehensive classification 76 (51.1%) patients were type C, 47 (31.5) were type B and 26 (17.4%) were type A. preoperative neurology was ASIA A 65 (43.6%), B12 (8.1%), C 59 (39.6%) and D 13 (8.7%). Mean delay in surgery was 3.6±1.8 days with minimum of 1 and maximum 14 days. ASIA grading on 6 months was ASIA "A" 61 (40.9%), B4 (2.7%), C 26 (17.4%), D 33 (22.1%) and E 25 (16.8%). the overall improvement in neurology was in 67 (45%) of patients. improvement by one grade was documented in 49 (32.9%) patients, by two grades in 17 (11.4%) and by three grades in one patient (.7%). **Conclusion:** fall from height is a major cause of spine injuries in our set up followed by RTA. Preventive measures need to be instituted to lessen the devastating outcome.

Keywords: Spinal injuries; Spinal cord injury; ASIA scale; Decompression

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INTRODUCTION

With the advancement in technology, urbanization and industrialization of society, traumatic spine and spinal cord injuries are increasing day by day, and affect the most productive young adult population of the society.[1] Globally, it is the leading cause of mortality & morbidity in the first four decades of life. Worldwide 5.8 million people die from different kind of trauma, which is expected to reach 8.4 million annual deaths by the 2020.[2,3] Socio-economically, traumatic spinal cord injuries, which are very much preventable, put huge burden on the society at large too. Spinal injuries are one of the most disabling injuries and often leads to permanent lifelong disabilities in the patients, and directly/indirectly affects adversely the society too.[4] The reported incidence of spinal injuries is between 13–30%.[5,6] A Canadian study with a sample size of over 12 thousand patients reported 23.3% incidence of spinal injuries with 5.4% spinal cord injury.[7] The most common cause of spinal injuries were Motor Vehicular Accidents (MVA) and then falls.[8] The most injured in the spine is thoracolumbar segment of the spine and followed by cervical spine injuries in 2–10%.[9] In Pakistan, studies carried out on spinal injuries reports 76–91.6% spinal cord injury in these patients with spinal injuries, and falls were the commonest cause in these nationally conducted studies were which is quite contrary to the Studies' reports in the developed mentioning MVA as the most common cause of spinal injuries.[10,11] However nationally conducted studies reports were based on facts and figures from tertiary care hospitals due to lack of established trauma centres in the country. Traumatic Spinal Cord Injuries (SCI) has impact on every aspect of patient life. Management of SCI require a lot of financial resources with subsequent a lot of economic burden on the affected families in specific and the society at large. The costs incurred from injuries are inclusive of those needed for initial acute phase hospital treatment of the affected patient, and the management of followed on complications associated with these SCI.[12] The economic burden of SCI is enormous. The life time economic burden for

single partial paraplegic patient in Canada is Estimated to be around $1.47 million while for complete paraplegia it is around $3.3 million.[13] Cost effects of SCI in developed countries are mostly borne by the state and associated insurance agencies whereas no support like those in developed world is barely available to SCI affected patients in Pakistan and treatment costs are far beyond the reach of our local population.

It is obvious that recovery of neurological function in SCI is the most desirable outcome from professional and patients' prospective. After the initial injury and assault to spinal cord, secondary spinal cord compression may go on due to pressure from accumulating hematoma, and continued displaced bony fragments.[14] Understandably, it is important to relieve this ongoing compression by stabilizing the spine and decompressing it. Studies have been done and majority reported improvement in neurology after prompt decompression within 24 hours of spinal injuries.[15] While studies carried out on SCI patients wherein surgical intervention and decompression was carried out after 24 hours after the SCI, showed no additional advantage.[16]

Logistically speaking and for many other reasons, it is almost impossible for most of our SCI patients to reach hospitals, where care for these SCI patients is available, within 24 hours in our setup. At the earliest, most such patients get operated at/ after 3 days on the closest available operation list. Despite this, many of our patients improve have shown improved neurology even after delayed surgical intervention. In this study, we will review neurological recovery in our patients with traumatic spinal cord injuries operated after 24 hours from the time of injury.

MAERIAL AND MEHODS

The objective of this stud was to assess neurological recover in term of ASIA grading in patients with traumatic spinal cord injury, who had undergone spinal surgery 24 hours after the injury. This descriptive cross-sectional study was performed from June, 2013 to June, 2016 at Spine Unit, Department of Orthopaedic & Spine Surgery, Hayatabad Medical Complex/ Khyber Girls Medical College, Peshawar.

This study includes those patients: a) who had traumatic spinal cord injury with completed preoperative assessment, b) and in whom surgical intervention was performed 24 hours the injury. Only those patients were included who had complete neurological assessment according to ASIA scale preoperatively and then repeated at 6months from treatment time. In all patients, initial routine stabilization according to ATLS protocol was done [17] followed by later complete neurological examination had been performed. All patients were graded according to ASIA scale in to A, B, C, D and E accordingly after ruling out spinal shock.[18] Biplane X-rays were done routinely while MRI and CT scans were done on case to case basis. Spinal fractures were classified according to comprehensive AO classification into type A, B and C.[19] Preoperative steroids were no used in these patients. Informed consent and preoperative work up was carried out, stabilization with decompression was performed by senior author(s)/ surgeon (s). Patients were routinely either discharged home or referred to rehabilitation centre around third postoperative day provided patients are sable and have no complication. Follow up done at 2 weeks, 6 weeks ,3 months, 6 months, 12 months and thereafter yearly. Biplane x-ray and ASIA grading was done on each follow up. Changes in neurology according to ASIA grade were recorded at 6 months. All demographic parameters, ASIA grading preoperatively and at 6 months postoperatively were recorded. SPSS 20 were used for statistical analysis.

RESULTS

In the study duration, total of 326 patients were operated for spinal injuries at the Spine Unit, Department of Orthopaedic and Spine Surgery, Hayatabad Medical Complex/ Khyber Girls Medical College, Peshawar. Out of these 326, 167 patients had spinal cord injuries. On further scrutiny 149 patients fulfilled the criteria for inclusion in our study. Out of these 149 patients, 32 (21.5%) were female while 117 (78.5%) were male. The mean age of the group was 32±13.11 years with minimum of 9 and maximum of 66 years.

The most common cause of spine injury and SCI in our series was falls followed by motor vehicular accidents (MVA). In our series, 96 (64.4%) patients presented with falls' history while 53 (35.6%) presented with history of MVA as the cause. Although less in number, those patients who were involved in MVA had more sever spinal injuries. In patients with MVA as cause, majority of patients were with type B and C fractures. Out of total 53 patients 34 (64.2%) were type C, 16 (30.2%) type B and 3 (5.7%) were types "A" fractures. Patients who had sustained spinal injuries from falls in our study, 42 (43.8%) were type C, 31 (32.3%) type B, and 23 (24.0%) were type A (Table-1). In our study, the correlation between MVA and severity of injury was statistically significant with *p*-value of .009 (Table-2). In our study, both the dorsal and lumbar regions were equally involved with 58 (38.9%) patients having dorsal spine injuries, and 56 (37.6%) patients having lumbar spine injuries. Thirty-five (23.5%) patients had cervical spine injuries. In cervical spine

injured patients, C5-6 was the most common level involved followed by C6-7 injuries, i.e., 15 (10.1%) patients, followed by C6-7in 8 (5.4%) patients respectively. In thoracolumbar spine, the most common injury level was L1 23 (15.4%) patients. Majority of the fractures/ injuries were concentrated around thoracolumbar junction. In 72 (48.3%) patients the level of spinal injury falls between D10 and L2. The most common type of fracture was type C according to AO comprehensive classification. In this study 76 (51.1%) patients were type C, 47 (31.5) were type B and 26 (17.4%) were type A.

In our study, according to ASIA scale the preoperative neurology was as follow: A 65 (43.6%), B12 (8.1%), C 59 (39.6%) and D 13 (8.7%) (Figure-). Majority of patients 42 (64.6%) out of 65 with ASIA A neurology had sever type C spinal injury. In patients with ASIA C neurology, type C and B type fractures were the most common,25(42.4%) and 18(30.5%) out of 59 patients respectively. (Table-3) The severity of SCI was directly related to type of spinal fracture in our series with *p*-value of 0.041.

Mean time elapsed before any surgical intervention was 3.6±1.8 days with minimum of 1 and maximum 14 days. The most common type of surgery performed was posterior spinal fixation (PSF) with decompression. In thoracolumbar region 102 patients underwent PSF with decompression while 5 patients underwent pedicle subtraction osteotomy while vertebral body resection was done in 7 patients. In cervical spine, anterior cervical discectomy and fixation in 20 patients, anterior cervical corpectomy and fixation in 9, in 5 patients PSF with decompression while in one patient combine anterior posterior procedure was performed. The ASIA grading on 6 months was as follow: A 61 (40.9%), B4 (2.7%), C 26 (17.4%), D 33 (22.1%) and E 25 (16.8%) (Figure-2). As evident that there were no changes in patients with complete neurology while partial neurology patients recovered significantly. Four patients with ASIA A neurology improved at 6 months, but all were in cervical spine. Three improved by 2 grades to ASIA C while 1 by three grades to ASIA D. The overall improvement in neurology occurred in 67 (45%) of patients. In majority of patients the improvement was by one grade 49 (32.9%), while in 17 (11.4%) by two grades and in one patient (.7%) was by three grades. Comparing improvement of neurology with region in cervical spine 24 (68.6%) out of 35 patients had some neurological improvement. In thoracic spine, only 14 (24.1%) and in lumbar spine 29 (51.8%) patients had neurological improvement. (Table-4). The neurological recovery rate was directly dependant on the region of SCI in our series with *p*-value of .000.

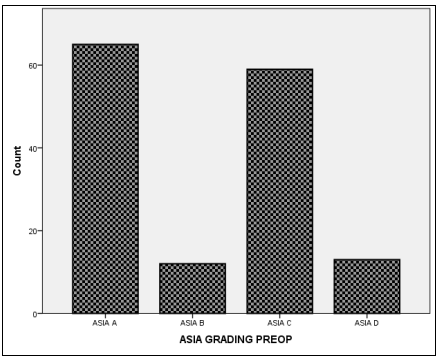

Figure-1: **Preoperative ASIA grading of neurological injuries**

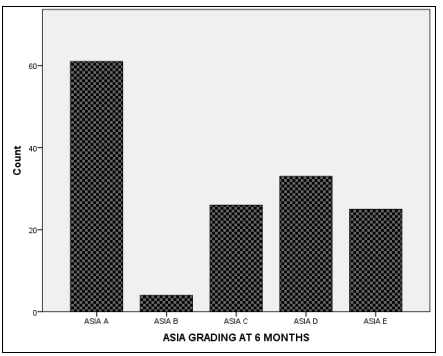

Figure-2: 6 Month's Postoperative ASIA Grading

Table-1: cause of spine injury *type of fracture crosstabulation

		Type of fracture			Total
		Type A	Type B	Type C	
Cause of spine injury	Count	23	31	42	96
	Expected Count	16.8	30.3	49.0	96.0
	Fall % within cause of spine injury	24.0%	32.3%	43.8%	100.0%
	Count	3	16	34	53
	Expected Count	9.2	16.7	27.0	53.0
	% within cause of spine injury	5.7%	30.2%	64.2%	100.0%
Total	Count	26	47	76	149
	Expected Count	26.0	47.0	76.0	149.0
	% within cause of spine injury	17.4%	31.5%	51.0%	100.0%

Table-2: Symmetric measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.251	.009
	Cramer's V	.251	.009
N of Valid Cases		149	
a. Not assuming the null hypothesis.			
b. Using the asymptotic standard error assuming the null hypothesis.			

Table-3: ASIA grading preop *type of fracture crosstabulation

			Type of fracture			Total
			Type A	Type B	Type C	
ASIA grading preop	ASIA A	Count	5	18	42	65
		Expected Count	11.3	20.5	33.2	65.0
		% within Asia grading preop	7.7%	27.7%	64.6%	100.0%
	ASIA B	Count	2	6	4	12
		Expected Count	2.1	3.8	6.1	12.0
		% within Asia grading preop	16.7%	50.0%	33.3%	100.0%
	ASIA C	Count	16	18	25	59
		Expected Count	10.3	18.6	30.1	59.0
		% within Asia grading preop	27.1%	30.5%	42.4%	100.0%
	ASIA D	Count	3	5	5	13
		Expected Count	2.3	4.1	6.6	13.0
		% within Asia grading preop	23.1%	38.5%	38.5%	100.0%
Total		Count	26	47	76	149
		Expected Count	26.0	47.0	76.0	149.0
		% within Asia grading preop	17.4%	31.5%	51.0%	100.0%

Table-4: Improvement in neurology *region of spine injury crosstabulation

			Region of spine injury			Total
			Cervical	Dorsal	Lumbar	
Improvement in neurology	No improvement	Count	11	44	27	82
		Expected Count	19.3	31.9	30.8	82.0
		% within region of spine injury	31.4%	75.9%	48.2%	55.0%
	Improvement by one grade	Count	11	11	27	49
		Expected Count	11.5	19.1	18.4	49.0
		% within region of spine injury	31.4%	19.0%	48.2%	32.9%
	Improvement by two grades	Count	12	3	2	17
		Expected Count	4.0	6.6	6.4	17.0
		% within region of spine injury	34.3%	5.2%	3.6%	11.4%
	Improvement by three grades	Count	1	0	0	1
		Expected Count	.2	.4	.4	1.0
		% within region of spine injury	2.9%	0.0%	0.0%	0.7%
Total		Count	35	58	56	149
		Expected Count	35.0	58.0	56.0	149.0
		% within region of spine injury	100.0%	100.0%	100.0%	100.0%

DISCUSSION

The drastic effects of spinal cord injury on patient's life cannot be overemphasized. The aim of every intervention is to reduce initial mortality and morbidity of the patient and improve neurological outcome later. Along with other factors, the main stay of improving neurological outcome is operative decompression and stabilization to reduce secondary spinal cord injury. But the time of surgical intervention is highly controversial. Some advocate the benefits of early decompression while other report no additional benefits and recommend surgical intervention when the patient condition is stabilized.[20] Early stabilization and decompression is also been advocated for early mobilization of the patient, reducing hospital stay and secondary pulmonary and thrombo-embolic complications, and hence reducing overall mortality.[21] Even in one multi-institutional study, Marshell *et al* reported that no further neurological deterioration has occurred when surgery was done after 5 days as compared to early surgery.[22]

Rahimi Movaghar V *et al* in their randomized control trial compared results of early versus late decompression in patients with thoracolumbar spine injuries at one-year time from surgery.[23] In 19 patients, late decompression had been performed and they reported 44% overall improvement rate with majority improving by one grade. The same authors have also reported improvement of ASIA A grade in one patient from late surgical intervention and 2 patients benefitting from early decompression group by one grade. All of

their patients recovered in terms of sensations without any motor recovery. In our study, the overall improvement rate was 37.7% for thoracolumbar fractures. In our series, there was no improvement in ASIA "A" patients' neurology in thoracolumbar region. It may be well be because of the factor that their follow up time was double when compared to our study. But still complete neurology is a bad prognostic factor for recovery regardless of the time of surgery. Rath SA *et al* reported neurological improvement in 30 (71%) out of 42 patients by one to three grades in patients with thoracolumbar spine fractures at 8 months follow-up.[24] 13 patients out of 20 with initial insignificant motor power recovery to final useful recovery with these 13 patients able to walk with support. They strongly recommend early decompression in spinal cord injuries with thoracolumbar fractures. Our recovery rates are lower compared to their overall recovery rates and specifically in regard to ASIA "A" recovery. This may well be due to spinal injuries' patients presenting late to the hospital and subsequent late surgical intervention carried out in our series.

Umerani MS *et al* reported the outcome of late versus early decompression in cervical spine fractures with spinal cord injury. In 64 patients operated after 24 hours of surgery, they reported only 5 (8.7%) with two grade improvements.[25] In our study the overall neurological improvement in patients with cervical spine injuries was in 68.6% patients. In 12 (34.2%) patients out of 35, improvement was by 2 grades. This may well be partially explained by the fact that even surgery was delayed in our series but all these patients with severe type C injuries had been applied early cervical traction in our department with consequent indirect decompression resulting in better outcome inspite of late surgery. These results were published in one of early study on the treatment of sub axial cervical spine fractures.[26] Similar study done by Gupta *et al* have reported 59% overall improvement rates in patients operated after 3 days of injury with 32% improvement by two grades.[27] Although the rates of neurological recovery in both groups was comparable but the advantages in terms of mortality and morbidity were far less in the early intervention group.

Functional walking along with bowel and bladder control are top priorities of patients. The most important prognostic factor in term of ambulation is reported to be initial ASIA grading. Complete neurology has a very less chance of ambulation while partial neurology ASIA "C" and "D" has the best prognosis.[28]

In our study, it is clear that the recovery of ASIA "A" in thoracolumbar fracture surgery is zero, while in cervical spine injury patients, there was some improvement in 4 patients. Out of them, 3 improved to ASIA "C" which is still not useful for functional ambulation and one to ASIA "D". So practically at 6 months postoperatively, there was only one patient who had improved from ASIA "A" in terms of functional ambulation. The worst prognosis in term of neurological recovery put a big question mark on the surgical management of these patients. There are studies which even report better outcome with conservative treatment in these patients.[29] Similarly, another study done by Rahimi-Movaghar V on patients with complete neurological injury in thoracic spine reported no benefit of surgical decompression.[30] On other hand, Bourassa-Moreau E *et al* in their study reported improvement in neurological grades in 15 (28%) out of 53 patients. The patients who had improved, most of the patients were with cervical spine injuries, and had been operated within 24 hours.[31] In our opinion, majority of these patients are with sever type of spinal injuries with mechanical instability and do require surgical stabilization. Similarly, no one can deny these patients the smallest possible beneficial effect of surgery specially so in cervical spine. Decompression may be done in selected patients where it is needed for the reduction of type "C" fractures.

CONCLUSIONS

Early surgical intervention though desirable, delayed surgical intervention can produce comparable results in term of neurological recovery.

Combination of Initial ASIA "A" grade, type "C" fractures and thoracolumbar spine caries the poorest prognosis in term of neurological recovery.

Surgical stabilization may be recommended in patients with ASIA "A" neurology though routine decompression may be not required and need further studies.

AUTHORS' CONTRIBUTION

MNUR: Study conception & Data analysis. BA: Data collection. ZK: Data collection. AS: Data processing & paper writing. MW: Data processing. MAK: Paper editing

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