

Epidemiology of Distribution and Patterns of Blunt Traumatic Cervical Spine Injury: A Retrospective Cross-sectional Observational Study

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ABSTRACT

Introduction: Quadriplegia due to spinal cord injury is a devastating consequence of trauma to the cervical spine, involving numerous functional, psychosocial, and economic ramifications. Identification of unstable CSI is therefore an essential aspect of the trauma evaluation in preventing subsequent neurological damage. We retrospectively analysed the cases presented with cervical spine injury. In this study, we evaluated the frequency and risk factors for different types of cervical spine injury.

Material and Methods: We retrospectively analysed the data of trauma patients admitted in the emergency room (ER) of S.C.B Medical College and Hospital, Cuttack and Govt. Medical College and Hospital, Balasore, Odisha, India, during the period from July 2017 to June 2018. The primary outcome was Cervical Spine fracture (CSfx) and dislocations, or cervical SCI.

Results: Among the polytrauma patients undergone cervical CT, 68 (10.6%) cases have cervical spine fracture. Incidence of cervical spine fracture is significantly more in male patients in compare to females (69.1% vs 30.9%, 2.2:1). There is a steady increase in incidence of cervical spine fracture across the age from 15 to 60 yr old. Most common type of neurological injury observed was incomplete SCI in 7 (10.3%) cases. Road traffic accident was the most common mode of trauma causing cervical spine fracture seen in 39 (57.3%) cases

Conclusion: This retrospective study demonstrated that most victims of cervical spine injury in our region are 46 to 90 years old and the incidence increases with rising age with male predominance and road traffic accidents being the most frequent mechanism leading to cervical spine injury,

Keywords: Cervical Spine Fracture, Spinal Cord Injury, Road Traffic Accident, Multidetector Computed Tomography

primary function of the atlas and axis, three quarter of their total rotation of the cervical spine takes place between them.³ Quadriplegia due to spinal cord injury is a devastating consequence of trauma to the cervical

spine, involving numerous functional, psychosocial, and economic ramifications.^{4,5,6} Identification of unstable CSI is therefore an essential aspect of the trauma evaluation in preventing subsequent neurological damage.^{7,8} This task is especially difficult in patients who are not clinically evaluable because of intoxication or concomitant head injury, respiratory or metabolic disturbances, brain injury and has led to the use of advanced imaging techniques such as CT and MR imaging for radiological clearance.⁹

Cervical spine fractures are frequently seen in association with trauma, particularly among younger individuals.¹⁰ These injuries, which exist on a spectrum from minor avulsion fractures to significant fractures in association with spinal instability and spinal cord injury (SCI), can exert an enormous direct financial toll on the health care system. The even greater significance of these injuries is because of the indirect losses including time off work and lost productivity, especially in young patients who sustain complete SCIs.¹¹

However, the epidemiology of spinal injuries and cervical spine fractures, in particular, remain incompletely explored. A recent search of the medical literature reveals that no prior investigation has attempted to quantify the incidence of cervical spine fractures or characterize risk factors for these injuries, among a large and diverse population base. Although some studies have attempted to address other subsets of spinal trauma^{10,12}, or spinal injuries as a whole, most of these investigations are limited in scope and frequently rely on populations already exposed to trauma.

INTRODUCTION

Spinal injuries specifically those involving cervical region are often feared by common because of their association with paralysis and death. "One having a crushed vertebra of his neck, he is unconscious of his two arms and legs and he is speechless – an ailment not to be treated". (2500 B.C) has been quoted in various literature.¹ Earlier days patients were tied upside down to a ladder which was violently shaken, the presumption being that any dislocation might be reduced by this method.² Anatomically, physiologically and clinically cervical spine may be divided into two distinct areas. The first two vertebra have a different shape from the remainder, the movement taking place between them is different from that in the lower segments. Rotational movement is the

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Based on the results of these prior investigations, male sex, white race, lower socioeconomic or educational status, high-risk behaviours, and age 15 to 30 years have all been postulated as potential risk factors for spinal fracture and/or SCI.¹³ Determinations of the incidence of SCI or spinal fractures made using trauma-based populations, or those presenting to a single practice or center, likely result in overestimations. Furthermore, available data regarding the epidemiology of spinal fractures or SCI are not necessarily translatable to the cervical spine, and calculations for select populations in trauma centers or regional locations should not be assumed to apply to the population as a whole.

Cervical spine injuries occur in 5%–10% of patients with blunt polytrauma. Among all the spinal cord injuries that are diagnosed each year, 55% involve the cervical spinal cord.¹⁴ Multidetector computed tomography (CT) is used throughout major trauma centers as the initial screening examination for high-risk patients who are suspected of having cervical spine trauma, and multidetector CT is increasingly incorporated into whole-body CT protocols in the evaluation of blunt polytrauma.

In case where there is no clear indication of cervical spine injury, however, patients still need to be evaluated for cervical spine injuries because an unstable cervical spine injury could be delayed and result in devastating neurological deterioration. Also in advert use of cervical collar for long duration may cause pressure sore. Which can ultimately lead to infection and need for debridement other reported complication of collar are elevated intra cranial pressure, ventilator associated pneumonias. There is difficulty in airway maintenance, difficulty in

MATERIAL AND METHODS

This study was a retrospective analysis of data of trauma patients admitted in the emergency room (ER) of S.C.B Medical College and Hospital, Cttack and Govt. Medical College and Hospital, Balasore, Odisha, India, during the period from July 2017 to June 2018. The primary outcome was Cervical Spine fracture (CSfx) and dislocations, or cervical SCI. All trauma patients with CSfx and/or spinal cord injuries were included in the study. Patients with nontraumatic brain injury, minor blunt and penetrating injuries, and single uncomplicated limb injuries were excluded. Also, injuries to the brachial plexus; trauma to other parts of the vertebral column except cervical were excluded. All demographic data was gathered from the data bank. The time of the trauma, mechanism of trauma, injury position, detailed anatomic description and existence of SCI in patients were also recorded.

Study design and setting

This study was a part of the Traumatic Head and Spine Injury Study. The patient sample in the registry included all consecutive patients (n=640) with HI who underwent head CT during the period from July 2017 to June 2018. The patients were prospectively enrolled from the ED and the data were retrospectively recorded.

Clinical data

Data was collected from the registry included subject- and injury-related data, clinical information from the ED, the mechanisms of injury were recorded. In retrospect, the medical records of all these patients (n=640) were carefully reviewed to select those individuals whose cervical spine was CT-imaged due to a clinical suspicion of a CSI within one week after primary head CT. Cervical CT was performed primarily according to the National Emergency X-Radiography Utilization Study (NEXUS) recommendations.¹⁶ On arrival, multitrauma patients underwent whole-body CT (comprising cervical spine) according to international recommendations.¹⁷ A total of 68 (10.6%) cervical spine CT-imaged patients with some fracture were identified and included in the current study. Of the CSI patients, the presence of possible spinal cord injury and radiculopathy were recorded.¹⁸ The study included all patients with blunt trauma who underwent cervical spine radiography in the participating EDs at the discretion of the treating physician. The study collected demographic information (age, sex), presence or absence of low-risk criteria, and interpretations from all radiographic studies obtained on the enrolled patients. We determined whether injuries were present or absent by reviewing the final interpretations of all radiographic studies obtained on each enrolled patient.

Imaging data

As part of the trauma protocol, the whole spine is screened by radiographs in all multi-trauma

Individuals (figure 1-7). This includes three views for cervical spine; anteroposterior, lateral with swimmers and an open mouth view for odontoid. All head CT scans were analyzed and systematically coded by two neuroradiologists using a structured data collection form. Acute traumatic intracranial lesions included subdural hematoma and effusion (SDH), epidural hematoma and effusion (EDH), diffuse axonal injury (DAI) lesions, edema, compression of the cerebrospinal fluid spaces, midline shift, contusions, pneumocephalus, skull fracture, and traumatic subarachnoid hemorrhage were also noted.

CSI was defined as a fracture or subluxation of any of the cervical vertebrae. Whiplash injuries without radiological findings were not included in the analysis. The injured cervical spine level, including occipital condyle (C0) fracture, together with a detailed anatomic description of each vertebra and CT-detectable ligament injury, was recorded systematically. On clinical basis, magnetic resonance imaging was performed on the patients with spinal cord injury.

RESULTS

Among the polytrauma patients who undergone cervical CT, 68 (10.6%) cases have cervical spine fracture. Incidence of cervical spine fracture is significantly more in male patients in compare to females (69.1% vs 30.9%, 2.2:1). (Graph 1) There is a steady increase in incidence of cervical spine fracture across the age from 15 to 60 yr old. The maximum number [15 (22.1%)] of fracture is observed in the age group

Neurological status at the time of diagnosis	n=68	%
Normal	54	79.4
Root injury	3	4.4
Incomplete SCI	7	10.3
Complete SCI	1	1.4
Unknown	3	4.4

Table-1: Distribution of cases according to neurological status at the time of diagnosis

Etiology	n=68	%	SCI, n=8	Root injury, n=3
Road traffic accident/MVC	39	57.3	5(62.5%)	2(66.7%)
Fall from height	16	23.5	3(37.5%)	1(33.3%)
Interpersonal violence	4	5.9	-	-
Bicycle	5	7.3	-	-
Pedestrian	1	1.5	-	-
Diving	2	2.9	-	-
Others	1	1.1	-	-

Table-2: Distribution of cases according to mechanism of trauma

Age	Road traffic accident/MVC, n=39	Fall from height, n=16	Interpersonal violence, n=4	Bicycle, n=5	Pedestrian, n=1	Diving, n=2	Others, n=1
< 15	1 (2.5%)	1 (6.2%)	-	-	-	-	-
16-30	12 (30.8%)	2 (12.5%)	3 (75%)	1 (20%)	-	-	-
31-45	9 (23.1%)	3 (18.7%)	1 (25%)	2 (40%)	1 (100%)	2 (100%)	1 (100%)
46-60	5 (12.8%)	4 (25.0%)	-	2 (40%)	-	-	-
61-75	7 (17.9%)	5 (31.2%)	-	-	-	-	-
76-90	5 (12.8%)	1 (6.2%)	-	-	-	-	-
> 90	Nil	-	-	-	-	-	-

Table-3: Distribution of cases according to mechanism of trauma vs age group

Neurological status	C0 – C2 fracture, n=26 (38.2%)	Subaxial fracture, n=38 (55.9%)	Both CO – C2 fracture and Subaxial fracture, n=4 (5.9%)
Normal	23 (88.5%)	28 (73.7%)	3 (75%)
Root	0	3 (7.9%)	0
Incomplete SCI	1 (3.8%)	5 (13.2%)	1 (25%)
Complete SCI	0	1 (2.6%)	0
Unknown	2 (7.7%)	1 (2.6%)	0

Table-4: Neurological status at time of diagnosis for patients with C0–C2 vs subaxial fractures. 4 (5.9%) patients out of 68 have both C0–C2 and Subaxial fracture

Site	Total number of fractures, n= 88 in 68 patients	%
C0	5	5.9
C1, Atlas	6	6.8
C2, Axis	21	23.9
C3	7	7.9
C4	8	9.1
C5	18	20.4
C6	13	14.8
C7	10	11.3

Table-5: Distribution of cases according to site of fracture

Spine Interspace Level	No of injuries, n=88 in 68 patients	%
No dislocation	17	33.3
Atlanto-occipital	1	1.9
C1 – C2	5	9.8
C2 – C3	4	7.8
C3 – C4	6	11.8
C4 – C5	8	15.7
C5 – C6	13	25.5
C6 – C7	12	23.5
C7 – T1	2	3.9

Table-6: Distribution of dislocations and subluxations by cervical spine level

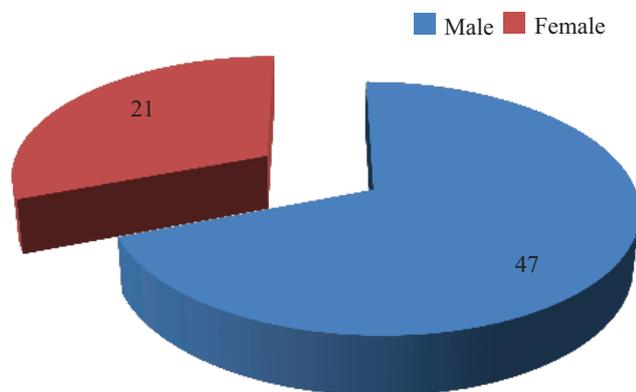
76-90 yr. (Graph 2)

Majority of the cases, 54 (79.4%), presented with no neurological deficit. Most common type of neurological injury observed was incomplete SCI in 7 (10.3%) cases followed by root injury in 3 (4.4%) and complete SCI in 1 (1.4%). (Table 1)

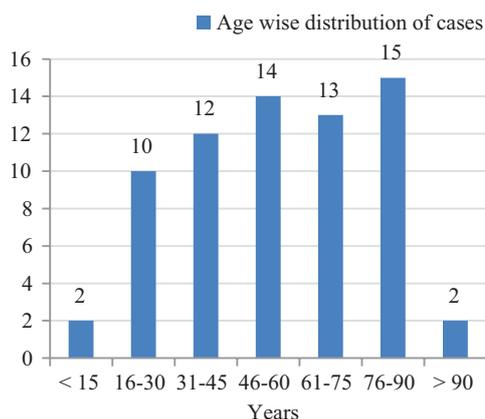
38 (55.9%) cases shows minimal Head Injury Severity Score. 7 (10.3%) cases have no head injury and 5 (7.3%) cases have severe Head Injury Severity Score. (Graph 3)
Road traffic accident was the most common mode of trauma

Number of levels injured	n=68	%
1	52	76.5
2	13	19.1
3	2	2.9
4	1	1.5
Total no of fractures	88	100

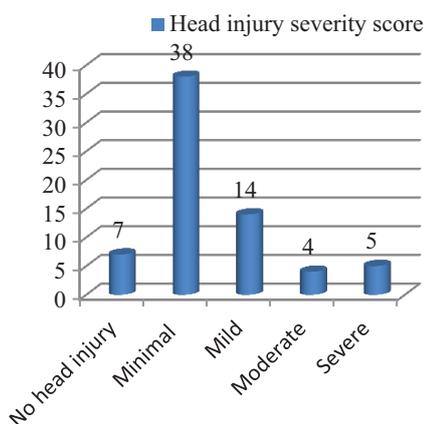
Table-7: Distribution of cases according to number of levels injured



Graph-1: Gender wise distribution of cases



Graph-2: Age wise distribution of cases



Graph-3: Distribution of cases according to Head Injury Severity Score

causing cervical spine fracture seen in 39 (57.3%) cases followed by fall from height 16 (23.5%). The commonest cause of SCI was road traffic accident in 5 (62.5%) followed by fall in 3 (37.5%) cases. But patients with road traffic

accident have 12.8% incidence of SCI while patients with fall have 18.7% incidence of SCI. (Table 2)

In 16-45 yr age group road traffic accident was the common mechanism of trauma and in 46-75 yr age group it was fall from height. (Table 3)

Among 88 fractures high cervical spine fracture (C0-C2) was seen in 32 (36.4%) cases and subaxial fractures (C3-C7) in 56 (63.6%) cases. Spinal cord injury and root injuries are more common in case of subaxial fractures (15.8%, 7.9%) in compare to C0-C2 fracture (3.8%, 0%) (9:1). SCI seen in 8 cases were more common when level of injury was at C4 in 4 (44.4%) cases followed by C5 in 2 (22.2%) cases. Root injuries are common in age group 31-45 yr, incomplete SCI are commonly seen in 61-75 yr age group while complete SCI is seen only in a 38 yr old patient. (Table 4)

Maximum number of fractures are in C2 vertebra in 21 (23.9%) cases followed by C5 in 18 (20.4%) cases. (Table 5) Dislocation was not seen in 17 (33.3%) cases. Dislocations and subluxations are more common at C5-C6 intervertebral interface 13 (25.5%) followed by C6-C7 interspace 12 (23.5%) while least at atlanto-occipital joint in 1 (1.9%) case. (Table 6)

Majority of cases have one level of injuries 52 (76.5%) and only one (1.5%) case has 4 levels of injuries. (Table 7)

DISCUSSION

In this study we observed 10.6% of patients presented with head injury have cervical spine fracture. In contrast to us William Goldberg et al²⁰ observed radiographic cervical spine injury in 2.4% of blunt trauma patients. Tuomo Thesleff et al²⁵ observed cervical spine fracture in 6.6% of their study population.

In our study we observed that the incidence of cervical spine fracture is significantly more in male in compare to females (2.2:1). Similar results were seen by Hege Linnerud Fredo et al¹⁹, 68% male and 32% female, (2:1). VSSV Prasad et al²¹ also found male gender constituted 66% of their study population. Mahnaz Yadollahi et al²² observed a male predominance among their study population (78.5%). This could mostly be due to the engagement of the male gender in more hazardous vocations; their tendency to do their handwork themselves at home or work, even if they do not have the expertise required; or the fact that males constitute more vehicle riders than females in Iran. Langston T. Holly et al²³ had also observed more prevalent in male in compare to female (2.4:1).

In this study we observed a steady increase in incidence of cervical spine fracture from 15 to 60 yr old and maximum cases observed in the age group 76-90 yr. Hege Linnerud Fredo et al¹⁹ also found the relative incidence of CS-fx increased significantly with age and median age was 56 yr. In contrast William Goldberg et al²⁰ studied most common age group with cervical fracture was 20-30 yr (18.1%) followed by 30-40 yr (17.3%). VSSV Prasad et al²¹ observed seventy-five per cent of the CSI involved a young population aged less than 50 years and nearly 30% were in the third decade with 16% each in 2nd and 4th decades. Mahnaz Yadollahi et

al²² in their study revealed the highest frequency of cervical spine fracture among those aged 16 - 40 years. In contrast to us they observed a decreasing incidence with increasing age. Langston T. Holly et al²³ observed the mean age of patients with cervical injury was 39 years (range 18-64 years). H. Ersmark et al²⁴ found the age distribution showed a peak at around 25 years for all subgroups of traffic accidents. The age distribution of injuries from falls revealed a greater incidence in older ages in contrast to traffic accidents.

We observed no neurological deficit in majority of the cases (79.4%). Among the cases of neurological deficit, incomplete SCI was most common (10.3%) followed by root injury (4.4%) and complete SCI (1.4%). SCI were most commonly observed in patients with road traffic accident (75%). In accordance with us Hege Linnerud Fredo et al¹⁹ had studied no neurological deficit in 79% followed by incomplete SCI in (8.5%), root injury (4.7%) and complete SCI (1.9%). VSSV Prasad et al²¹ noted spinal cord injury (SCI) in 27%; complete in 16% and incomplete in 11% cases. They also studied MVC as the most common cause of SCI. Langston T. Holly et al²³ observed complete SCI in 12.5% cases, incomplete SCI in 45.8% and no SCI in 41.7% cases.

In this study we observed that 55.9% have minimal Head Injury Severity Score and 7.3% cases have severe Head Injury Severity Score. Langston T. Holly et al²³ observed the mean Injury Severity Score to be 32 ± 14 . H. Ersmark et al²⁴ observed the concomitant injuries were not usually serious (Injury Severity Score < 25), except for a minor group of multitraumatized patients (Injury Severity Score > 25), where the cervical spin injury was just part of a multiple injury complex.

In our study we found the most common mode of trauma causing cervical spine fracture was road traffic accident seen (57.3%) cases followed by fall from height (23.5%). In younger age group (<45 yr) road traffic accident was the common mechanism while in elder age group (>46) it was fall from height. We also observed that, the most common cause of SCI was injury due to road traffic accident while fall from height was most commonly associated with SCI in compare to RTA (18.7% vs 12.8%), In contrast to us Hege Linnerud Fredo et al¹⁹ observed trauma mechanisms were fall from height as the most common mechanism of trauma in 60% followed by motorized vehicle accidents in 21%, bicycling in 8%, diving in 4% and others in 7%. But similar to us they found Patients with fall related injuries tended to be older, while patients injured in motorized vehicle-, bicycle- or diving accidents tended to be younger. VSSV Prasad et al²¹ also observed traffic accidents accounting for 71%, followed by pedestrian trauma in 10%, sport injuries in 7% and 5% each by fall and work related trauma. They also found the commonest cause of SCI was MVC (74%). However, only 28% of MVC had a SCI while 32% of fall and industrial accidents had an associated SCI. Mahnaz Yadollahi et al²² in their study showed that, motor vehicle collisions were the most frequent trauma mechanism leading to cervical spine injury, with falls the second most frequent. Among motor vehicle accidents, the most common mechanisms of trauma

was car rollover (46.78%), followed by car-to-car accidents (24.93%) and car to motor accidents (14.65%). Similar to our study Langston T. Holly et al²³ have also observed the most common mechanism of injury was MVA (29.3%), followed by automobile versus pedestrian accidents (20.6%), falls (16.6%) and assaults (10.7%). H. Ersmark et al²⁴ found road traffic accidents were most numerous (50%), next came injuries from falls (37%), and third diving accidents (5%). Other accidents constituted 8%.

We observed spinal cord injury and root injuries more common in subaxial fractures (15.8%, 7.9%) in compare to C0-C2 fracture (3.8%, 0%) (9:1). Also studied SCI were more common when level of injury was at C4 (44.4%) followed by C5 (22.2%). Complete CSI was seen in patient with C4 level injury. Similar to our study VSSV Prasad et al²¹ observed SCI in 57% of C4 and 24% of C6 level spinal trauma. Nearly 50% of the complete SCI had a C5 level followed by 23% at C4. They also found only 5% of C2 and 6% of C7 spinal injuries had neurological deficit and proportion of complete SCI was also higher at C4 through C6 levels. Thus, risk of SCI with C4 and C5 level injury was significantly high compared with injuries at C1 and C2.

We studied root injuries commonly in the age group 31-45 yr, incomplete SCI are in 61-75 yr age group while complete SCI in only case of 38 yr old. VSSV Prasad et al²¹ observed 34% of the SCI in third decade of age and nearly 70% of all SCI involved persons under the age of 40 years. Only 17% were seen after the age of 70 years. With increasing age the incomplete SCI was more frequently observed. Sixty to ninety per cent of the SCI was complete in the young population. H. Ersmark et al²⁴ studied primary neurological impairment like paresthesiae, numbness, transient muscular weaknesses in 18% cases and tetraparesis in 5%.

We observed high cervical spine fracture (C0-C2) in 36.4% and subaxial fractures (C3-C7) in 63.6% of fractures and both types in 5.9% of patients. We studied median age for patients with C0-C2 fractures was 63 yr (54% were males) and that for subaxial fracture was 44 yr (68% were males). Hege Linnerud Fredo et al¹⁹ observed high CS-fx (C0-C2) and subaxial fractures in 35% and 65% of fractures respectively and combination of both in 5.3% of cases.

They observed the median age for patients with C0-C2 fractures was 66 years (range 16-101), and 58% were males, the median age of patients with subaxial fracture was 49 (range 4-94), and 74% were males. In contrast to us Langston T. Holly et al²³ observed the most frequently injured region was between the occiput and C-3, demonstrated in 58.3% of patients. H. Ersmark et al²⁴ observed fractures at the C2 level were the commonest followed by C5.

In this study we found maximum number of fractures are in C2 vertebra (23.9%) followed by C5 (20.4%) cases. Similar to us Hege Linnerud Fredo et al¹⁹ had studied most common site of fracture at C2 (23.3%) but according to them 2nd most common site was C6 (21.2%). Similarly William Goldberg et al²⁰ observed C2 (including the odontoid) was the most common site of fracture, accounting for 23.9% of all injuries, followed by C6 (20.25%) whereas the C3 vertebra was the

structure least likely to be injured. VSSV Prasad et al²¹ have also studied the commonest level of spinal injured was C2 (27%) followed by C5 (22%).

We observed dislocations and subluxations most commonly at C5-C6 interface (25.5%) followed by C6-C7 (23.5%) while least common at atlanto-occipital joint (1.9%). In accordance to us William Goldberg et al²⁰ studied dislocations and subluxations most commonly at C5-C6 interface (25.1%) followed by C6-C7 (23.3%) while least common at atlanto-occipital joint (2.1%). H. Ersmark et al²⁴ observed the frequency of dislocation injuries with and without fractures was most common at level C6-C7, followed by C5-C6, then C2-C3.

We observed single level of injuries in 76.5% cases and multiple level injuries in 23.5% cases. Hege Linnerud Fredo et al¹⁹ have also observed multiple level injuries in 26% cases.

CONCLUSION

Our retrospective study showed numbers of cervical spine fracture cases in the one year. This data demonstrated that most victims in our region are 46 to 90 years old and the incidence increases with rising age. A male predominance was observed, and road traffic accidents were the most frequent trauma mechanism leading to cervical spine injury, with falls the second most frequent. The rate of SCI in our study was 11.7% of all cases.

ABBREVIATIONS

1. CSfx - Cervical Spine fracture
2. CT - Computed tomography
3. CSI - Cervical spine injury
4. SCI - Spinal cord injury

REFERENCES

1. Power, Sir D' Arcy, The Edwin Smith Papyrus. British Journal of Surgery 1934;21:385.
2. Eastwood, W. J. Discussion of Fractures and Dislocations of the Cervical Vertebra. Proceedings of the Royal Society of Medicine (Section of Orthopedics), 1940;33:651.
3. Durbin F. C. Fracture Dislocation of the Cervical spine. The Journal of Bone and Joint Surgery 1957;39:.
4. Cardenas DD, Hoffman JM, Kirshblum S, et al. Etiology and incidence of rehospitalization after traumatic spinal cord injury: a multicenter analysis. Arch Phys Med Rehabil 2004;85:1757-1763.
5. Harvey LA, Batty J, Jones R, et al. Hand function of C6 and C7 tetraplegics 1 - 16 years following injury. Spinal Cord 2001;39:37-43.
6. McKinley W, Santos K, Meade M, et al. Incidence and outcomes of spinal cord injury clinical syndromes. J Spinal Cord Med 2007;30:215-224.
7. Piatt JH Jr. Detected and overlooked cervical spine injury in comatose victims of trauma: report from the Pennsylvania Trauma Outcomes Study. J Neurosurg Spine 2006;5:210-216.
8. Poonnoose PM, Ravichandran G, McClelland MR. Missed and mismanaged injuries of the spinal cord. J Trauma 2002;53:314-320.
9. Antevil JL, Sise MJ, Sack DI, et al: Spiral computed tomography for the initial evaluation of spine trauma: a new standard of care? J Trauma 2006;61:382-387.
10. Ryan MD, Henderson JJ. The epidemiology of fractures and fracture dislocations of the cervical spine. Injury 1992;23:38-40.
11. Tator CH, Duncan EG, Edmonds VE, et al. Complications and costs of management of acute spinal cord injury. Paraplegia 1993;31: 700-14.
12. Price C, Makintubee S, hernodon W, Istre GR. Epidemiology of traumatic spinal cord injury and acute hospitalization and rehabilitation charges for spinal cord injuries in Oklahoma, 1988-1990. Am J Epidemiol 1994;139:37-47.
13. Jackson AB, Dijkers M, Devivo M, Poczatek RB. A demographic profile of new traumatic spinal cord injuries: change and stability over 30 years. Arch Phys Med Rehabil 2004;85:1740-8.
14. Vaccaro AR, Hulbert RJ, Patel AA, et al. The subaxial cervical spine injury classification system: a novel approach to recognize the importance of morphology, neurology, and integrity of the disco-ligamentous complex. Spine (Phila Pa 1976) 2007;32: 2365-2374.
15. Dunham CM, Brocker BP, Collierr BD, et al. Risks associated with magnetic resonance imaging and cervical collar in comatose, blunt trauma patients with negative comprehensive cervical spine computed tomography and no apparent spinal deficit. Critical Care. 12:R89. Epub, 2008.
16. Hoffman JR, Wolfson AB, Todd K, Mower WR. Selective cervical spine radiography in blunt trauma: methodology of the National Emergency X-Radiography Utilization Study (NEXUS). Ann Emerg Med 1998; 32:461-469.
17. Linsenmaier U, Krotz M, Hauser H, Rock C, Rieger J, Bohndorf K, Pfeifer KJ, Reiser M. Whole body computed tomography in polytrauma: techniques and management. Eur Radiol 2002;12:1728-1740.
18. Kirshblum SC, Burns SP, Biering-Sorensen F, Donovan W, Graves DE, Jha A, Johansen M, Jones L, Krassioukov A, Mulcahey MJ, Schmidt-Read M, Waring W. International standards for neurological classification of spinal cord injury (revised 2011). J Spinal Cord Med 2011;34:535-546.
19. Hege Linnerud Fredo, Syed Ali Mujtaba Rizvi, Bjarne Lied1, Pål Rønning and Eirik Helseth. 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. William Goldberg, Charles Mueller, Edward Panacek, Stefan Tigges, Jerome R. Hoffman, William R. Mower. Distribution and Patterns of Blunt Traumatic Cervical Spine Injury. Annals of Emergency Medicine 2001 38:1.
21. VSSV Prasad, A Schwartz, R Bhutani, PW Sharkey and ML Schwartz. Characteristics of injuries to the cervical spine and spinal cord in polytrauma patient population: experience from a regional trauma unit. Spinal Cord 1999;37:560-568.
22. Mahnaz Yadollahi, Shahram Paydar, Haleh Ghaem,

- Mohammad Ghorbani, Seyed Mohsen Mousavi, Ali Taheri Akerdi, Eimen Jalili, Mohammad Hadi Niakan, Hossein Ali Khalili, Ali Haghnegahdar, and Shahram Bolandparvaz. *Epidemiology of Cervical Spine Fractures*. *Trauma Mon*. 2016; 21:e33608.
23. Langston T. Holly, Daniel F. Kelly, George J. Counelis, Thane Blinman, David L. McArthur, And H. Gill Cryer. Cervical spine trauma associated with moderate and severe head injury: incidence, risk factors, and injury characteristics. *J Neurosurg Spine* 2002; 31 96:285-291.
 24. H. Ersmark, MD, N. Dalen, R. Kalen. Cervical Spine Injuries: A Follow-up of 332 Patients. *Paraplegia* 1990;28:25-40.
 25. Tuomo Thesleff, Anneli Kataja, Juha Öhman, Teemu M. Luoto. Head Injuries and the Risk of Concurrent Cervical Spine Fractures. *Acta Neurochirurgica*. 2017; 159:907-914.

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