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IMAGING FACTORS IN MRI FOR PREDICTING RESPIRATORY DISTRESS IN CERVICAL SPINAL CORD INJURY- A RETROSPECTIVE ANALYSIS

Orthopedics

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ABSTRACT

Background: Acute cervical spinal cord injury (CSCI) is an important cause of morbidity and mortality in adults due to respiratory distress and can prove fatal. Such patients may need definitive airway support. In this study, we analyzed MRI imaging factors in such patients that may suggest risk of respiratory failure.

Methods: Thirty-seven patients with CSCI over 18months were studied. Respiratory failure was considered when mechanical ventilation was required. Neurological function was assessed using ASIA scoring. Cervical spine MRI features were evaluated. Statistical analysis was done using SPSS.

Results: There were 35males and 2females. Mean age was 45.5years. Most common mechanism of injury was fall from height(28/37 pts). Spinal cord injury level was C2 in 3, C3 in 17, C4 in 15 and C5 in 2patients. Upper level of cord edema was at C2-3 in 20/37patients. Respiratory failure occurred in 21/37(56.7%) patients. All patients with respiratory failure had a neurological level of C5 or above.

Conclusion: MRI can accurately localize CSCI and identify patients at-risk of respiratory failure. Cord edema extending to C2-3 strongly predicts respiratory involvement. Bony level correlates poorly with respiratory distress. Definitive airway may be established early in high-risk patients.

KEYWORDS

cervical spine, cord injury, respiratory failure, MRI

INTRODUCTION

Cervical spine injuries are one of the gravest life threatening injuries encountered in accident and trauma centers. Respiratory system related complications are the most common cause of morbidity and mortality associated with acute cervical spine injuries; atelectasis, pneumonia and ventilator failure are the most common complications encountered in decreasing order.(1) With the advent of magnetic resonance imaging (MRI) it is now easy to confirm the diagnosis of cord contusion, edema and hematomyelia.(2)

MRI evaluation of anatomic structures helps in the determination of cause and extent of neurological deficit, mechanism of spinal injury and presence of spinal instability if any.(3,4) Present study was carried out to study the level of cord insult, bony injury level determined by MRI and radiological imaging and its correlation with respiratory distress in patients with acute cervical spinal cord injury (ACSCI).

MATERIAL AND METHODS:

The present study is a prospective-retrospective study conducted in Department of Orthopaedics and Trauma Center, Institute of Medical Sciences, Banaras Hindu University, Varanasi from December 2015 to June 2017. Thirty-seven patients presenting to accident and trauma department with ACSCI were included in the study.

Inclusion criteria:

i)The definition of respiratory failure consisted of the requirement of a definitive airway and the assistance of mechanical ventilation. ii)Both the sexes between the age group of 18 to 70 years. iii) Patients with acute cervical spine cord injury and presenting within one week of injury.

Exclusion criteria:

i) Patients with altered mental status or head injuries. ii) Patients in whom MRI is contraindicated i.e. patients with metallic implants, claustrophobia, pacemakers, and cochlear implants in situ.

Initial stabilization of the neck was done with Philadelphia cervical collar and other injuries were ruled out. Patients with stable vital parameters were then shifted for radiological and MR imaging. Patients were segregated according to the American Spinal Injury Association (ASIA) classification. (4)

RESULTS:

Out of thirty-seven patients, thirty-five were males and two females with the mean age of 45.47 years and range of 18 to 70 years. Most common mode of trauma was fall from height (28/37) followed by road traffic accident (6/37) and trivial fall (3/37). Trivial fall as the cause of ACSCI was seen in elderly people with pre-existing spinal disease.

Respiratory distress was defined as requirement of definitive airway and assisted mechanical ventilation. In our study respiratory distress was observed in 21 out of 37 patients. All the patients with distress had the insult to the cord extending up to C-4 level of the cord and above; higher the upper level of the insult to the cord higher was the incidence of respiratory distress ($p<0.0001$) (Table 1).

Table 1- Cord edema levels and respiratory distress

			Respiratory distress		Total	
			YES	NO		(p-value)
Cord edema (upper level)	C2	level	3	0	3	<0.0001
	C3	level	15	2	17	
	C4	level	3	12	15	
	C5	level	0	2	2	
Total			21	16	37	

The level of bony injury in patients with ACSCI had no correlation with the incidence of respiratory distress ($p=0.156$) (Table 2).

Table 2- Level of bony injury and respiratory distress

		Respiratory distress		Total	
		Yes	No		p-value
Bony injury level	C4-5	5	2	7	0.156
		13.5%	5.4%	18.9%	
	C5-6	9	4	13	
		24.3%	10.8%	35.1%	

	C6-7	6	5	11	
		16.2%	13.5%	29.7%	
	No Bony Injury	1	5	6	
		2.7%	13.5%	16.2%	
Total		21	16	37	
		56.8%	43.2%	100.0%	

It was also observed that higher the number of cervical segments involved higher was the incidence of respiratory distress especially if the number of involved segments were more than three. (Table 3)

Table 3- Segments involved and respiratory distress

		Respiratory distress		Total	
		YES	NO		(p-value)
No. of segments involved	1.00	2	8	10	
		5.4%	21.6%	27.0%	0.001
	2.00	3	7	10	
		8.1%	18.9%	27.0%	
	3.00	10	0	10	
		27.0%	0.0%	27.0%	
	4.00	5	1	6	
		13.5%	2.7%	16.2%	
	5.00	1	0	1	
		2.7%	0.0%	2.7%	
Total		21	16	37	
		56.8%	43.2%	100.0	

The information collected regarding all the selected cases were recorded in a Master Chart. Data analysis was done with the help of computer using Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, version 22.0 for Windows). Pearson Chi-Square was used to test the significance of difference and p value less than 0.05 was considered as significant.

DISCUSSION:

Based on the signal patterns observed in saggittal T2- weighted sequences of MR imaging four patterns are commonly used in the literature as described by Bondurant *et al.* pattern 1 shows a normal MRI signal in the cord; pattern 2 represents single-level edema; pattern 3 is multi-level edema; and pattern 4 is mixed hemorrhage and edema.(6) Spinal shock resulting because of traumatic ACSCI results in flaccid paralysis of respiratory muscles of rib-cage and diaphragm; this results in mechanical imbalance and less efficient ventilation leading to respiratory distress.(7,8,9)

A patient with ACSCI with complete cord injury above the C5 level is likely to have impairment of diaphragmatic muscle leading to respiratory distress whereas of the upper extent of the insult is at or below the level of C5 the patient is likely to breathe independently without any respiratory assistance.(10) In our study, thirty-five patients had upper level of cord insult at C4 or above out of these twenty-one patients had respiratory distress and higher the level of cord insult more was the incidence of distress; below C5 level, distress was not observed in any patient.

H Yamamoto *et al.* (1994) studied MRI findings and respiratory problems in 12 patients of complete cervical injury accompanied by respiratory distress and concluded that in three severe cases complicated by respiratory difficulty, the spinal cord injury was above the C4-5 level.(4) Yu-Hua Huang *et al.* (2014) studied 108 patients diagnosed with ACSCI and concluded that MRI can accurately localize ACSCI and identify those patients at risk of respiratory failure. (11) Imaging level of injury at C3 and presence of spinal cord edema are both predictors. To prevent secondary cord injury from prolonged hypoxia and facilitate pulmonary care, definitive airways should be established early in high risk patients.

Patients with American Spinal Injury Association (ASIA) grade A and grade B showed less improvement in neurological function as compared with grade C and above. The level of bony injury at or below C4-5 does not correlate with the incidence of respiratory distress (p=0.156); as for bony injury at any given level the insult to the spinal cord is usually higher level and there was statistically significant correlation between the upper level of cord injury and respiratory distress (Figure 1 and 2).

Figure 1. C6-C7 level injury with cord edema extending till C3 vertebral body- this patient developed respiratory distress

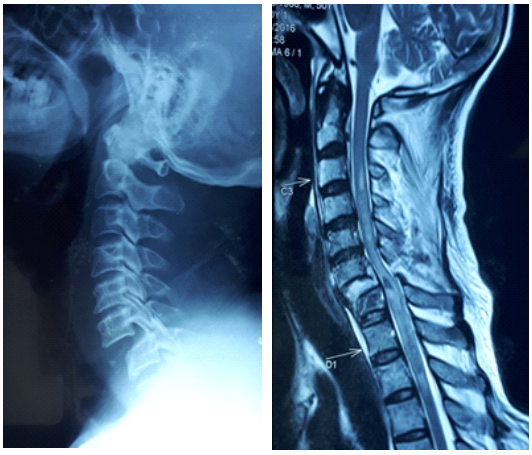
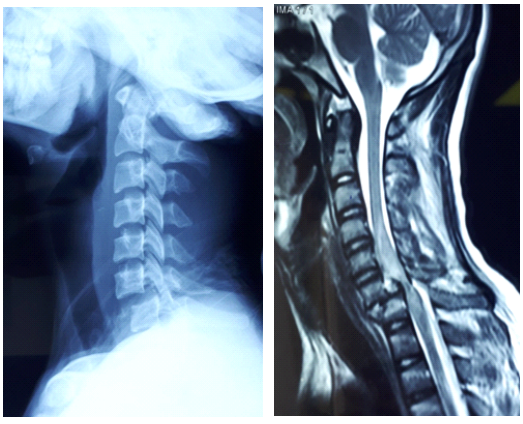


Figure 2. C6-C7 level injury with cord edema extending till upper border of C4- this patient did not develop respiratory distress



The edema extent involving one or two segments had better initial neurological status and less incidence of distress (p=0.001) as this denoted less severe injury and the edema usually subsided over a period of time; these patients also had better improvements in ASIA grades when compared to patients involving three or more segments.

CONCLUSION:

MR imaging can be used as an effective tool in localizing ACSCI and identifying those patients who pose the risk for respiratory failure; the upper most level of cord edema at C4 or above and more than three level of edema extent are both predictors of respiratory distress. Bony injury level C4-5 or below does not predict respiratory failure. Thus proper pulmonary care and definitive airway can be established in those patients with risk of respiratory distress and incidence secondary cord injury, which results from hypoxia, can be mitigated.

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