

Original Article

When to suspect head injury or cervical spine injury in maxillofacial trauma?

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ABSTRACT

Background: The global status report of the World Health Organization (WHO) on road safety suggested that India is leading in road traffic accidents in the world. According to the report on road accidents in India in 2010 by the Transport Research Wing, Ministry of Road Transport and Highways, New Delhi, Kerala ranked third in accidents per lakh population and second in persons injured per lakh population. As the face, brain, and cervical spine are in close proximity with one another, associated injuries can be suspected. The aim of this study was to determine the relationship between the severity of head, cervical spine, and facial injury and incidence of facial injury in patients with head and/or cervical spine injury.

Materials and Methods: A prospective cohort study was conducted over a period of one year. The study population included all patients having computed tomography (CT)-demonstrable head injury, radiographic evidence of cervical spine injury, and associated head or cervical spine injury with facial injury. Data were analyzed using the chi-square test using statistical package SPSS. A *P* value less than 0.05 was considered statistically significant.

Results: Of 124 patients, 59 (47.6%) had facial injuries. As severity of head injury increased, the number of facial injuries decreased. Statistically, no significant association between facial and head injury was seen. A statistically significant association between dentoalveolar involvement and cervical spine injury was seen ($P < 0.001$). The proportion of injuries in patients with cervical spine injuries alone was significantly lower in the frontal ($P = 0.001$) and orbital ($P = 0.004$) regions and higher in the mandibular region ($P = 0.010$).

Conclusion: Midface injuries were more commonly associated with head injuries. Decreased facial involvement leads to increased severity of head injury. Simple injuries of the cervical spine were more commonly associated with facial injuries.

Key Words: Cervical spine injury, head injury, maxillofacial injury

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INTRODUCTION

The study of trauma has a very important role these days. Due to the increase in economic strength of our society, the number of people owning different varieties of vehicles has increased, resulting in an

increased number of automobiles on our roads. Further, due to bad roads and nonadherence of traffic rules, road traffic accidents has emerged as one of the principle causes of morbidity and mortality. As the face is the most exposed part of the body, it is very prone to sustaining injuries during these accidents. Frequently, patients having facial injuries have other associated injuries especially to the brain and cervical spine. Several studies suggest that facial fracture dissipates a lot of force during trauma, in effect protecting the brain.^[1,2] In contrast to this, the literature also suggests that facial fracture increases the risk of brain trauma.^[3] Frequently, it

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is also thought that cervical spine injury should be considered in a maxillofacial trauma patient until proved otherwise. Recently, Jamal *et al.*^[4] in their study also supported this belief. Further, some studies suggest no association between facial and cervical spine injuries.^[5,6] Others show a small but real possibility of the face being injured in cervical spine injuries.^[7,8,9] Likewise, association of head injury with facial injury has been emphasized.^[10,11,12,13]

The global status report of the World Health Organization (WHO) on road safety^[14] suggests that India has one of the highest road traffic accidents in the world. Also, in the report on road accidents in India 2010 by the Transport Research Wing, Ministry of Road Transport and Highways, New Delhi, Kerala ranked third in the number of accidents/100,000 population and second in the number of persons injured/100,000 population.^[15] Hence, a study to consider any association between head, cervical spine, and facial injury is pertinent. The present study was planned for this purpose.

MATERIALS AND METHODS

The aims and objectives were to determine the incidence of facial injury in patients presenting with head injury and cervical spine injury and the relationship between the severity of head and cervical spine injury and facial injury.

A prospective cohort study design was adopted to assess the incidence of facial trauma in patients sustaining head or cervical spine injury.

Study population

The study population consisted of all patients admitted in the Department of Neurosurgery-Head Injury Intensive Care Unit and Department of Surgery having computed tomography (CT)-demonstrable head injury and patients admitted in the Department of Orthopedics having radiographic evidence of cervical spine injury. It also included patients having associated head or cervical spine injury along with facial injury, reporting in the Department of Oral and Maxillofacial surgery.

Patients who did not have X-ray and CT proved injury and patients who died were excluded from the study. All patients included in the study had CT of head if head injury was present and X-ray of the cervical spine if cervical spine injury was present. Findings of CT and X-rays were reported from the same unit of the Radiology Department of the Medical College.

This study was conducted from January 2008 to January 2009.

A standard form was designed to record age, sex, and etiology of injury, and associated features of head or cervical spine injury and facial injury of the patient.

Head injuries were classified as mild, moderate, and severe according to the Glasgow Coma Scale (GCS) score.

Cervical spine and facial injury were classified as simple and severe. Demonstrable straightening of the cervical spine in the radiograph was considered simple. All other injuries like luxation, subluxation, or dislocation were considered severe. Facial injuries involving only soft tissue were called as simple and any injury involving bone or dentoalveolar segment were considered severe. Available CT, magnetic resonance imaging (MRI), and X-ray findings were also recorded. Data were analyzed by chi-square test; *P* values less than 0.05 were considered statistically significant. The statistical package SPSS (SPSS Inc., Chicago, IL, USA) was used for all analyses.

RESULTS

During the study period, a total of 124 cases were assessed of which 59 patients (47.6%) had facial injuries.

Age, sex, and etiology

Maximum patients were seen in the age range of 21 to 40 years in all the groups [Figure 1]. In all the groups, males outnumbered females. Genderwise, there was no significant difference in the proportion of patients with facial injuries [Table 1].

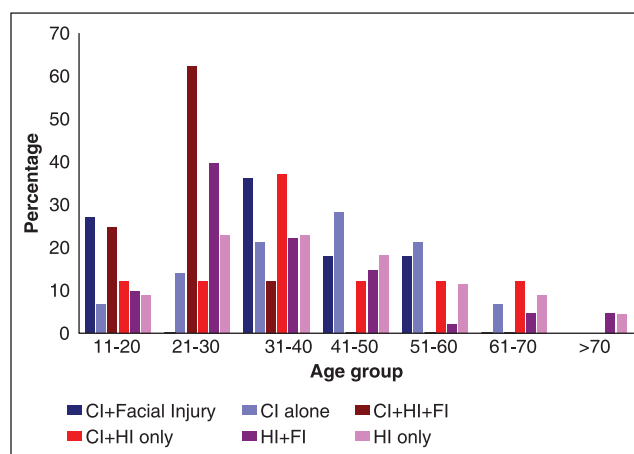


Figure 1: Different types of injuries and age groups (n = 124), HI: head injury; CI: Cervical injury

Overall, maximum cases were of road traffic accidents followed by falls [Table 2]. There was one case of sports injury and eight cases had other etiological causes. Among patients with facial injuries, the proportion of those with injuries from light motor vehicles and heavy motor vehicles were higher as compared to pedestrian, assault, fall, and other injuries.

Different clinical features of head injury were assessed in the study like skull fracture, contusion, subdural hematoma (SDH), extradural hematoma (EDH), and so on. Statistically, no significant association of facial injuries was seen with any of the clinical features. However, SDH ($P = 0.018$) and cerebrospinal fluid otorrhea (CSF-O) ($P = 0.048$) was significantly less prevalent among cases with facial injuries [Table 3].

Table 1: Gender distribution of facial injuries

Gender	Cervical spine injury alone (n = 25)		Head injury + cervical injury (n = 16)		Head injury alone (n = 83)		Total (n = 124)	
	Present (n = 11)	Absent (n = 14)	Present (n = 8)	Absent (n = 8)	Present (n = 40)	Absent (n = 43)	Present (n = 59)	Absent (n = 65)
Male	9	10	8	7	36	37	53	54
Female	2	4	0	1	4	6	6	11
χ^2	0.365		1.067		0.306		1.192	
P	0.546		0.302		0.580		0.275	

Table 2: Etiology

Etiology	Cervical spine injury alone (n = 25)		Head injury + cervical injury (n = 16)		Head injury alone (n = 83)		Total (n = 124)	
	Present (n = 11)	Absent (n = 14)	Present (n = 8)	Absent (n = 8)	Present (n = 40)	Absent (n = 43)	Present (n = 59)	Absent (n = 65)
LMV	7	2	6	3	22	19	35	24
HMV	2	0	1	0	11	7	14	7
Pedestrian			0	1	3	6	3	7
Assault			1	0	0	1	1	1
Fall	2	9	0	4	2	6	4	19
Sports					0	1	0	1
Others	0	3			2	3	2	6
χ^2	12.046		8.000		6.208		18.520	
P	0.007		0.092		0.400		0.005	

LMV: Light motor vehicle; HMV: Heavy motor vehicle

Table 3: Clinical features of head injury: Facial injury

Feature	Head injury + cervical injury (n = 16)		Head injury alone (n = 83)		Total (n = 99)		Statistical significance (overall)	
	FI Present (n = 8)	FI Absent (n = 8)	FI Present (n = 40)	FI Absent (n = 43)	FI Present (n = 48)	FI Absent (n = 51)	χ^2	P
Open head injury	5	8	39	39	44	47	0.008	0.929
Skull fracture	5	3	20	19	25	22	0.794	0.373
Contusion	4	5	19	24	23	29	0.794	0.373
SDH	0	2	7	16	7	18	5.619	0.018
EDH	2	2	7	9	9	11	0.122	0.727
ICH	1	1	9	11	10	12	0.104	0.747
CSF-R	1	0	2	1	3	1	0.006	0.939
CSF-O	0	0	0	4	0	4	3.923	0.048
Pneumocephalus	3	2	11	7	14	9	1.840	0.175
SAH	3	3	23	23	26	26	0.101	0.751

SDH: Subdural hematoma; EDH: Extradural hematoma; ICH: Intracerebral hemorrhage; CSF-R: Cerebrospinal fluid rhinorrhea; CSF-O: Cerebrospinal fluid otorrhea; SAH: Subarachnoid hemorrhage; FI: Facial injury

Severe facial injuries were more common in all the three groups. There was no significant association between type of injury and type of facial injury ($P = 0.229$).

Soft and hard tissue were both involved in majority of the patients ($n = 35$; 59.32%). Involvement of soft tissue was seen in 19 patients (32.2%) and dentoalveolar involvement was seen in 11 (18.64%) patients. Statistically, a significant association between dentoalveolar involvement and cervical spine injury alone was seen ($P < 0.001$) [Table 4].

The maxilla was the region most commonly involved, followed by frontal, orbital, zygomatic, mandible, and nasal regions. The proportion of injuries in patients with cervical spine injuries alone was significantly lower in the frontal ($P = 0.001$) and orbital ($P = 0.004$) regions, whereas its proportion was significantly higher in the mandibular region ($P = 0.010$) [Table 5].

Statistically, a negative association between subluxation and facial injuries was seen ($P = 0.032$). For fracture and dislocation of the spine, no significant

association could be seen. No case of luxation was reported in the present study [Table 6].

Among patients with cervical spine injury alone, the incidence of simple injuries was significantly higher among patients with facial injuries; however, no such association was seen among patients with head injury along with cervical injury. Overall, no significant positive association between facial injury and severe cervical injury was seen ($P < 0.001$) [Table 7].

It was noticed that as severity of head injury increased as per the GCS score, the number of facial injuries decreased [Table 8].

Subluxation was seen in the C4-C5 region in 50% of the patients. Dislocation and fractured spine were seen mostly in the C5 region of the cervical spine.

Comparing the incidence of fractures in different bones of the cranium, it was found that the most frequently fractured bone was the temporal bone followed by the frontal bone [Figure 2].

Table 4: Features of facial injury

Features	Cervical spine injury alone (n = 11)	Head injury + cervical injury (n = 8)	Head injury alone (n = 40)	Total (n = 59)	χ^2	<i>P</i>
Involvement of soft tissue	1	3	15	19	3.308	0.191
Involvement of hard tissue	0	0	0	0	—	—
Soft and hard tissue both	9	4	22	35	2.905	0.234
Dentoalveolar	7	1	3	11	18.155	<0.001

Table 5: Facial regions involved

Region	Cervical spine injury alone (n = 11)	Head injury + cervical injury (n = 8)	Head injury alone (n = 40)	Total (n = 59)	χ^2	<i>P</i>
Frontal	1	7	25	33	13.726	0.001
Orbital	1	4	26	31	10.839	0.004
Nasal	2	2	8	12	0.142	0.932
Zygomatic	4	4	17	25	0.354	0.838
Maxilla	8	5	23	36	0.850	0.654
Mandible	7	3	7	17	9.294	0.010

Table 6: Features among cervical spine patients

Feature	Cervical spine injury alone (n = 25)		Head injury + cervical injury (n = 16)		Total (n = 41)		Statistical significance (overall)	
	FI present (n = 11)	FI absent (n = 14)	FI present (n = 8)	FI absent (n = 8)	FI present (n = 19)	FI absent (n = 22)	χ^2	<i>P</i>
Fracture spine	1	3	1	2	2	5	1.072	0.301
Subluxation	1	6	0	1	1	7	4.578	0.032
Dislocation	1	4	0	1	1	5	2.489	0.115
Luxation	0	0	0	0	0	0	—	—

FI: Facial injury

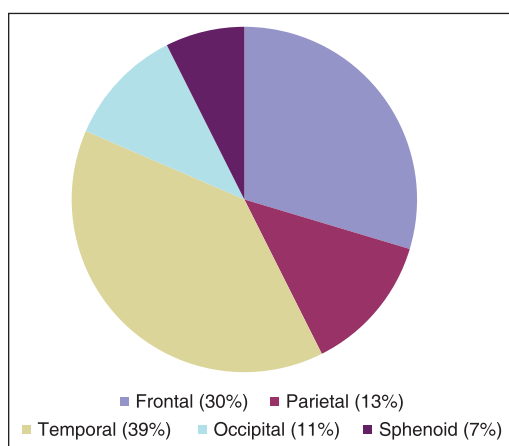
Table 7: Type of cervical injury

Type of cervical injury	Cervical spine injury alone (n = 25)		Head injury + cervical injury (n = 16)		Total (n = 41)	
	Present (n = 11)	Absent (n = 14)	Present (n = 8)	Absent (n = 8)	Present (n = 19)	Absent (n = 22)
Simple	8	0	7	5	15	5
Severe	3	14	1	3	4	17
χ^2	14.973		1.333		12.897	
P	<0.001		0.248		<0.001	

Table 8: GCS score

Etiology	Cervical spine injury alone (n = 25)		Head injury + cervical injury (n = 16)		Head injury alone (n = 83)		Total (n = 124)	
	Present (n = 11)	Absent (n = 14)	Present (n = 8)	Absent (n = 8)	Present (n = 40)	Absent (n = 43)	Present (n = 59)	Absent (n = 65)
Normal	11	14	—	—	—	—	11	14
Mild	—	—	6	5	13	11	19	16
Moderate	—	—	1	0	11	14	12	14
Severe	—	—	1	3	16	18	17	21
χ^2	—		2.091		0.537		0.904	
P	—		0.352		0.765		0.825	

GCS: Glasgow coma scale

**Figure 2: Regions of skull fracture (n = 47)**

DISCUSSION

Head injury and facial injury

Injuries affecting the maxillofacial region are complex, especially because of the proximity of vital structures like the cranium containing the brain and cervical spine. In many cases, head injury accounts for a significant portion of mortality and morbidity. Keenan *et al.*^[3] and Martin *et al.*^[16] found facial fracture to be highly associated with head injury. Many studies^[7,11,17] indicated that the frequency of neurologic injuries associated with facial fracture was as high as 82%. Recently, Mulligan *et al.*^[18] found 21.7% incidence of

facial fractures in head injury patients. In this study, we found that the frequency of maxillofacial injury was 48.48% in patients with some sort of head injury. If we consider a combination of cervical spine injury and head injury, the frequency of facial injury was 47.58%.

In almost all studies, there is a male predominance^[10,19,20,21,22] and we also found that males are involved in over 80% of the cases [Table 1]. In patients having facial injury including the entire group, we see that the male-to-female ratio is nearly 9:1. Perhaps this is because in a country like India having a male-dependent society, the movement of males outside their homes is more; hence, there is a greater likelihood of them sustaining trauma.

The age of patients ranged from 13 to 90 in our series. Most of the patients fell in the range of 21-40 [Figure 1]. Keita *et al.*^[22] in their series in Mali studied maxillofacial trauma and found that most of the patients were young, with a mean age of 27 years. This pattern is similar to almost all other studies studying the relationship between facial fracture and concomitant neurological injuries.^[10,20,21,23-25]

Light motor vehicles were the most frequent cause of injury, accounting for 59.32% [Table 2]. This finding is similar to Subhasraj *et al.*^[24] who studied maxillofacial injuries and reported an incidence

of 62 and 23 % involving two wheelers and four wheelers, respectively. Keita *et al.*^[22] found 93% road traffic accidents as the cause of maxillofacial injuries. This can be attributed to local conditions like bad roads and lack of restraints, and so on. Recent trends in the western world have been toward a reduction in road traffic accident cases and increased maxillofacial fracture cases because of sports injuries and interpersonal violence.^[26] This is perhaps because of the respect for traffic rules and application of restraint while driving. In an Indian setting with bad roads and lack of respect for traffic rules especially in smaller cities and towns, road traffic accidents seems to be the most common cause for maxillofacial injuries.

In our study group, severe injury of the facial region was seen in all three groups of patients. This indicates that the involvement of bony tissues of the face is most of the time associated with head injury or cervical spine injury. The maxilla (61%) is the region most frequently involved [Table 5]. This is followed by frontal, orbital, zygomatic, mandible, and nasal region. In the study by Pappachan and Alexander,^[10] involvement of zygoma was the most frequent. In the series by Sinclair *et al.*,^[27] association between facial fracture and head injury was 85%. They also found maxillary bone involvement to be more common. Recently, Mithani *et al.*^[28] found that midface fractures were associated with basilar skull fractures and several intracranial injuries. They looked for an association between unilateral midface and head injury and bilateral midface and head injury and suggested that concomitant injuries should be investigated closely with distinct types of facial fractures.

The cranial bone most frequently fractured was the temporal bone (39%) followed by the frontal bone (30%) [Figure 2]. Compared to the study by Haug *et al.*,^[29] in which frontal bone involvement was 38% and temporal bone 22%, we had a slightly lesser involvement of the frontal region and greater involvement of the temporal bone. In the study conducted by Pappachan and Alexander,^[10] temporal bone involvement was 18.52%. Further, it was noticed that when the temporal bone was fractured, the most common region of hard tissue involvement was the zygomaticomaxillary complex.

Contusion (52%) and subarachnoid hemorrhage (52%) were the most common injuries seen in

patients having head injury followed by skull fracture (47.47%).

In neurologic injuries, various studies have shown that concussion is more frequently associated with facial fracture.^[3,10,19,22,30] Keenan *et al.*,^[3] in a case control study, found more concussion (9%) than intracranial injury (4%). In this study, facial injuries were mostly seen in patients having subarachnoid hemorrhage followed closely by skull fracture and then contusion [Table 3].

In this study, we observed that when the severity of head injury increased as per the GCS score, the number of facial injuries decreased [Table 8]. This may mean that facial injury dissipates forces so that a less serious cranial injury would be sustained by the victim. Similar findings were reported by Lee *et al.*^[11] They suggested that facial bones act as a protective cushion for the brain, explaining the fact that injuries that crush the facial bones frequently cause no apparent brain damage. Chang *et al.*^[2] suggested that the maxilla, together with the neighboring bones, is capable of absorbing considerable impact force, thus protecting the brain from direct collision. They further concluded that there should be a direct correlation between the severity of maxillary fracture and that of the initial head injury. Other investigators like Davidoff *et al.*,^[30] and Keenan *et al.*^[3] found facial fracture to be highly associated with traumatic brain injury. Mulligan *et al.*^[18] also found increased number of head injury (71.5%) patients in their series of 2.7 million trauma cases having combined facial fracture and cervical spine fractures.

The mandible was involved in only 17 cases (28.81%) out of the total injuries seen in the series [Table 5]. If we compare this to the total number of head injury patients, it decreases to 17.17%. The mandible was involved in three cases (5.5%) of the total skull fractures (n = 54) in our series. This is in contrast to other investigators who found a significant association of mandibular fracture with cranial injury.^[19,21,23,27] In patients having head injury associated with facial injury (n = 48), the region most commonly involved was the middle third of the face; the lower third was less frequently involved. This is similar to the observation of Haug *et al.*^[19,29] that midfacial fractures had more than twice the chance of sustaining cranial fractures and neural injuries.

Cervical spine injury and facial injury

In this study, 41 patients had cervical spine injuries (isolated cervical spine and combined with head injury). Of this, 19 (46.34%) patients had some sort of facial injury [Table 7]. Most of the literature describes the incidence of cervical spine injury in association with injury to the facial skeleton ranging from 0.3 to 19.3%.^[5,12,23,31-34] Most of these studies looked for cervical spine injuries in maxillofacial-injured patients. Our study looked for the incidence of maxillofacial injuries in a group of cervical spine injury patients and we found quite a high association; almost 46.34% had some sort of facial injury. This is in contrast to what McCabe and Angelos^[7] concluded. This is also higher compared to the study by Lewis *et al.*,^[31] in which they found 19.6% incidence of facial injury. Hills and Deane^[5] concluded that there is a lack of significant correlation between maxillofacial and cervical spine injuries.

In our series, 53.65% of the patients belonged to the age group of 31-60 years. We also noticed that patients with a facial injury in association with both cervical spine and head injury were usually young, mostly younger than 40 years [Figure 1].

The male-to-female ratio was approximately 5:1 in overall cervical spine-injured patients. But if we consider patients with facial injury also, this ratio increases to 8.5:1 [Table 1].

Road traffic accidents were the most common cause of cervical spine injury [Table 2]. In patients having concomitant facial injury, this was the most common cause. But when we assess cervical spine injury where the etiology is a fall, the percentage of facial injuries is only 13.33%. Hence, we can conclude that in patients having cervical spine injury on account of road traffic accidents, facial injuries were more common.

Majority of the conscious patients (n = 25) with facial injury (75%) presented with simple injuries to the cervical spine. But in patients with severe injury to the cervical spine, the percentage with facial injury was only 19% [Table 7]. Hence, we noted that when severity of cervical spine injury increases, the incidence of facial injury decreases.

Assessment of fully alert trauma patients has shown that possible cervical spine injuries can be satisfactorily screened by etiology, patient symptoms, and physical examination. However, in patients in whom reliable examination and symptoms

are missing, there is a difficulty. This can lead to delayed diagnosis either because of the effects of the head injury or other concomitant injury. Recently Jamal *et al.*^[4] suggested that cervical spine injury is present in a maxillofacial trauma patient until proved otherwise. Of 41 cervical spine injury patients, 41.02% of patients in our series had concomitant head injury.

It was seen that the proportion of injuries in patients with cervical spine injuries alone was significantly lower in the frontal ($P = .001$) and orbital ($P = .004$) regions, whereas its proportion was significantly higher in the mandibular region ($P = .010$) [Table 5]. It was also seen that the midface and lower face was involved in almost equal proportion when they were associated with cervical spine injury. Elahi *et al.*^[35] found that a combined facial fracture pattern, involving multiple facial regions, accounted for the greatest number of cervical spine injuries in their series. Further, in our study, it was noted that of four cases of severe cervical spine injury, the lower third of the face was involved, and the involvement of the upper cervical spine (C1-C4) was seen in severe injury associated with the lower third. This finding is consistent with those of Lalani and Bonanthaya^[8] and Lewis *et al.*^[31] who concluded that when the lower third of the face is involved, injuries to the upper cervical spine are seen.

In this study, subluxation was seen in the C4-C5 region in 50% of the patients. Dislocation and fractured spine were seen more than 50% of the times in the C5 region, which is considered as the most mobile portion of the cervical spine. This is in agreement with the studies of Davidson and Birdsell^[32] and Hackl *et al.*^[9] Statistically, a negative association between subluxation and facial injury was seen ($P = .032$) in this study.

In the facial injury group, soft and hard tissue both were involved in majority of the patients (n = 35; 59.32%). Involvement of soft tissue was seen in 19 patients (32.2%); dentoalveolar involvement was seen in 11 (18.64%) patients. Statistically, a significant association between dentoalveolar involvement and cervical spine injury alone was seen ($P < 0.001$) [Table 4]. This is in contrast to the study Bayles *et al.*^[36] who found no significant association between cervical spine trauma and isolated mandibular trauma. However, our finding further stresses the point that when the lower third of

the face is involved, cervical injury should be ruled out. As a result, it has long been advocated that as patients with facial trauma are at a higher risk of cervical spine trauma, they should undergo cervical spine radiography as a routine investigative procedure.^[9,36,37]

CONCLUSION

In our series, approximately 50% of the patients had some facial injury. Though overall there was no significant association between the three types of injuries in this study, it appears that motor vehicle accident patients suffer injuries in which multiple forces from different directions act at the same time on the patient. Hence, when examining the road traffic accident patient, a high level of care should be practiced so that significant injuries to other head and neck regions may not be missed.

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