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Published online 2015 August 1. **Research Article**

A Study to Analyses Pattern and Treatment of Upper Cervical Spine Injuries Experience From Developing World

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Background: The literature regarding the different patterns of upper cervical spine injuries, their appropriate management, and management development of such injuries is scarce in the world.
Objectives: The current study aimed to present the experience regarding the high velocity trauma of upper cervical spine injuries.
Patients and Methods: Thirty patients (22 males, 8 females) with upper cervical spine injuries were treated and followed-up for an average of 24 months. The corresponding data were analyzed with respect to various types of injuries and different treatment modalities used to treat such patients keeping the basic healthcare facilities in view.
Results: The clinical as well as radiological outcomes of the treatment of such injuries were mostly achievable with minimum facilities in India, with only few complications.
Conclusions: Managing such patients needs a proper transport facility, proper care during transport, appropriate evaluation in the hospital and prompt conservative or operative treatment. Treatment is usually safe and effective by well trained professionals with good clinical and radiological outcomes.

Keywords: Upper Cervical Spine Injury; Dense Fracture; Hangamans Fracture

1. Background

Cervical spine starts just below the skull and ends above thorax. Upper cervical spine injuries are about 24% of the fractures and dislocations of the cervical spine injuries (1). Specific joint articulations allow the movement in the plane of flexion, extension, lateral bending and rotation. Injury occurs when forces applied to head and neck result in loads that exceed the ability of the supporting structures to dissipate energy. Jefferson (2) found that injuries to the cervical spine involve two particular areas C1 to C2 and C5 to C7. There is very limited muscular support around cervical spine area and it supports the weight of head (12 - 15 pounds), placing it at higher risk of sudden movements and whip-lash injuries, that can cause damage to bones, ligaments, arteries and more seriously to the cervical cord and the exiting nerve roots. Injuries to the cervical spine lead to neurological damage in approximately 40% of the patients; 10% of traumatic spinal cord injuries have no obvious roentgenographic evidence of vertebral injury (3).

Injuries of the upper cervical spine are the injuries between occipital condyles to C2 vertebra (4). They are:

1. Fractures of occipital condyles;
2. Dislocation of atlanto-occipital joint;
3. Fractures of atlas (jafferson fracture);
4. Rupture of transverse ligament at level C1 and C2;
5. Rotatory subluxation of C1 and C2;
6. Fractures of dens;
7. Traumatic spondylolisthesis of axis (Hangman's fracture);

Spine injuries may be associated with the cord injuries, complete or incomplete, which can manifest as total motor or sensory loss distal to the injury level or presence of some such functions, respectively. Occipitocervical dislocations often results in death (5). The latter may present as Brown-Sequard syndrome, central cord syndrome, anterior cord syndrome, and posterior cord syndrome or rarely as monoparesis of upper or lower extremities.

Although urbanization and industrialization have increased the incidence of spine trauma, developing countries are not lagging in this regard. Other common causes of injuries of spinal cord in tropical and subtropical countries like India include personal violence and falling from height. The paraplegic and quadriplegics in economically poor countries with complete motor and sensory loss die within few months or remain permanently bed ridden because of various complications associated with such injuries.

However, there must be at least limited place for the treatment of such patients in local hospitals and a reasonably well equipped centre in the teaching hospitals. The expensive western methods of management need to be realistically adopted to a community with weak economy.

2. Objectives

The current study aimed to:

1. Highlight the magnitude of this problem and its demographic distributions in the urban and suburban areas of Jammu city.
2. Study the various modes of trauma responsible for such spine injuries.
3. Critically evaluate the results of the existing methodology of management of such patients.
4. Make the study as the basis to promote the guidelines and create creating new facilities for the total management of such patients within the resources.

3. Patients and Methods

All the patients with upper cervical spine injuries attending either the emergency or out patient department (OPD) of the department of orthopedics during a period of one year from October 2009 formed the study group. A total of 30 patients of upper cervical spine injury were included in the study, there were nine patients with atlas fractures, three patients with atlanto-axial subluxation, two patients with Jefferson fracture, twelve patients with dense fracture, and four patients with Hangman's fracture. No patients with occipital condyle fracture or occipitocervical dissociation were received during the study period.

All atlas fractures (n = 9) received were of stable type, therefore, all were treated conservatively by putting them on bed rest and on Philadelphia collar for a period of eight to twelve weeks. One case with burst fracture of atlas, stable type without neuro deficit was conservatively managed in Philadelphia collar and strict bed rest for a period of 12 weeks. Another patient with burst atlas fracture and unstable variety with central cord syndrome presentation was managed by halo vest immobilization (HVI) for a period of 12 weeks.

A patient with atlanto-axial subluxation (type I) was managed by traction followed by Philadelphia collar for a period of 12 weeks. Another patient of atlanto-axial subluxation (type II) with neurodeficit was managed by posterior C1-C2 fusion followed by Minerva jacket immobilization for a period of 12 weeks. Another patient of atlanto-axial subluxation (type II) without neurodeficit was managed by traction followed by HVI for a period of 12 weeks.

A patient of type I dense fracture not associated with craniocervical dissociation with neurodeficit (quadriparesis) was managed by strict bed rest and Philadelphia collar for 8 weeks. All the four patients with type III dense fracture were without neurodeficit and were managed conservatively, two by Halovest, one by SOMI brace and one by Philadelphia collar and strict bed rest. Two patients refused HVI. There were seven patients with type II dense fracture, four patients were fixed anteriorly by a cannulated screw, a patient referred late and the fracture was displaced and managed by posterior C1-C2 arthrodesis. A patient who was not fit for surgery was treated conservatively by HVI for a period of 12 weeks. A patient of type II dense facture refused both HVI and surgery and was managed by Philadelphia collar and strict bed rest for a period of 12 weeks. Dens access device and 4 mm cannulated titanium screw were used to fix dens anteriorly by two image intensifiers. The patient was kept supine, neck hyper extended and mouth open with sterilized gauze and the image intensifier technician was trained to take alternatively lateral and open mouth x-rays of upper cervical spine per-operatively.

There were four patients with Hangman's fracture in the study, three of them with type I Hangman fracture without neurodeficit and all were managed conservatively on Philadelphia collar and strict bed rest for a period of 12 weeks. A patient with type IIA Hangman fracture was managed by HVI for a period of 12 weeks.

Postoperatively antibiotic cover was given for a week. The patients were allowed to turn horizontally on the 1st postoperative day and sit upright with proper collar on the 2nd postoperative day. Patients were assisted to walk on the 4th postoperative day. They received daily physiotherapy. Check radiographs were taken to confirm reduction, vertebral height, graft position (when used) and any change in kyphotic angle. Periodic neurological and general physical examinations were conducted. Postoperative complications were taken care of. Stitches were removed on the 7th postoperative day and patients were discharged with collar. Psychological counselling was given throughout the treatment and vocational guidance was given at the time of discharge from the hospital.

The follow-up examinations were done for an average period of one year, with the patient reporting at intervals of three weeks, six weeks, three months, six months, and one year. The Halovest was removed after 12 weeks in the OPD department. Serial radiographs were obtained at one week, three weeks, six weeks, three months, six months, and one year.

4. Results

Thirty patients with upper cervical spine injury received in various units of orthopedic department of State Medical College, Jammu, India, during a period of one year from October the first 2009 formed the subject s of the current study; the mean follow up was 24 months and the following observations were made.

4.1. Incidence

The patients attending the orthopedic department were 13.9% (41,581) of the total patients (299,112) attending the hospital during the study period and the orthopedic admission was 13.2% (5,000) of the total hospital admission (37,648) during the study period.

Total spinal injuries constituted 4.24% (212) of the total admission in the orthopedic department (5,000), and cervical spine injuries constituted 51.8% (110) of the total spine injuries (212) during the study period. Upper cervical spine injuries constituted 27.2% (30) of the total cervical spine injuries (110) and 14.15% (30) of the total spine injury patients (212) during the study period. There were 22 (73%) males and 8 (27%) females.

Most of the patients, 8 (27%), belonged to the age group 61 - 70 years, followed by 7 (23%) 41 - 50 years, 6 (20%) 31 - 40 years, 5 (17%) 21 - 30 years, 3 (10%) 51 - 60 years, and 1 (3%) 11 - 20 years.

RTA was the commonest mode of injury in 21 (70%) patients followed by fall from height in 7 (23%), fall of heavy object over the head in 1 (3.5%) patient, and 1 (3.5%) patient had train accident.

Twenty-six (86.6%) were without neurodeficit while four (13.3%) patients were associated with neurodeficit. Majority of patients 19 (63%) were from rural areas whereas 11 (37%) patients belonged to urban areas.

Almost every kind of transport were used with majority of taxi 17 (56.6%), ambulance 4 (13.3%), bus 4 (13.3%), three wheeler 3 (10%), and 2 (6.6%) came on foot.

Four patients were associated with head injury and four with scalp injury, two with chest trauma, one with other spine injury and one patient with limb injury.

Different modalities of treatment were used in the patients of upper cervical spine injuries, 24 (80%) patients received conservative treatment while 6 (20%) received operative treatment; 13 (43.3%) patients were admitted within 24 hours after the injury, 13 within 24 hours to one week, one patient was admitted within one to two weeks, 2 (6.66%) within two weeks to one month, and one (3.33%) patient was admitted one month after the injury.

4.2. Site of Involvement

Table 2 shows the distribution of patients as per their pattern of injury; the majority of the patients, 12 (40%), were of dens fracture, followed by 11 (37%) with atlas fracture, 4 (13%) with Hangman fracture and 3 (10%) with atlanto-axial subluxation. Incidence of the different types of spine injuries in our hospital is given in Table 1.

4.3. Complications of Treatment Modalities

various complications associated with different types of treatment modalities of upper cervical spine injuries are mentioned in Table 3. Different types of upper cervical injuries with X-rays, CT scan, preoperative and postoperative clinical photos are given subsequently in Figures 1 - 3.

Table 1. Incidence of Spine Trauma in Our Hospital

S. No.	During the Study Period	No. of Cases
1	Total patient admitted to the hospital	299,112
2	Total patient admitted to the orthopedics department	41,581
3	Total admission in the hospital	37,648
4	Total admission in the orthopedics department	5,000
5	Total spine injury patients	212
2	Total cervical spine injury patients	110
3	Total upper cervical spine injury patients	30

Table 2. Number and Types of Upper Cervical Spine Injuries Received During Study Period

Type of Injury	No. Of Cases	Age, %
Occipital condylar fractures	0	0
Craniocervical dissociation	0	0
Atlas fractures	11	37
Atlanto-axial subluxation	3	10
Dense fracture	12	40
Hangman's fracture	4	13
Total	30	100

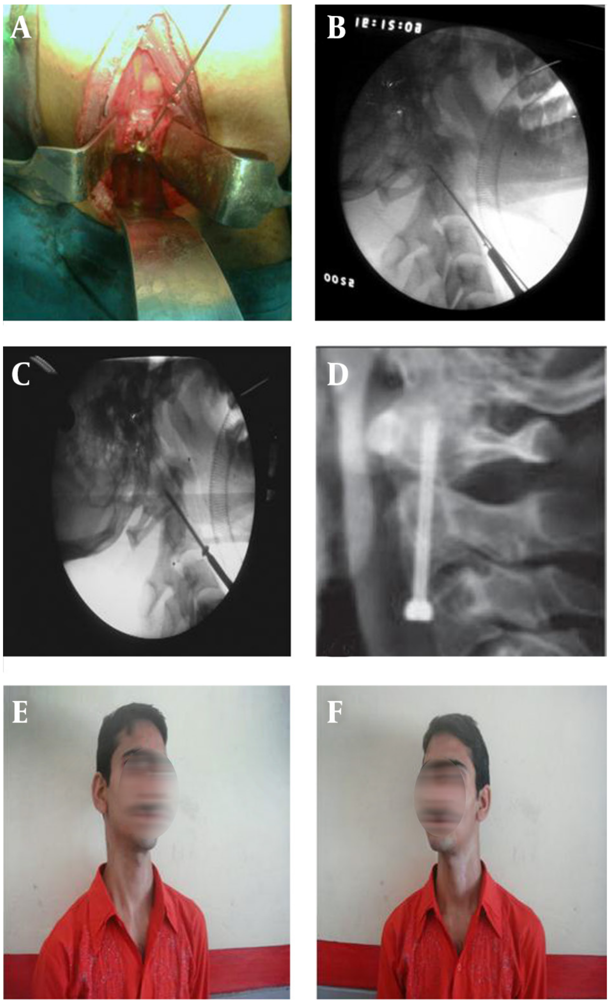
Table 3. Complications Related to Treatment Modalities

S No.	Complications	No of Cases
1	Neck stiffness	6
2	Residual neck pain	1
3	Decreased neck movements	2
4	Torticollis	1
5	Seizures	1
6	Pin site scar	1
7	Pin tract infections	1
8	Pin loosening	1
9	Occipital hypoesthesia	1
10	Dysphagia	1
11	Implant failure	1
12	CSF leak	1
13	Loss of reduction	1

Figure 1. Atlanto-Axial Dislocation.

CT shows atlanto-axial dislocation and post OP X-ray show posterior fusion; post-operative photographs show Minerva jacket immobilization and surgical scar. Follow up X-rays show atlanto-axial fusion; follow up photographs show neck movements.

Figure 2. Type II Dens Fracture



CT shows undisplaced type II dens fracture; per-operative photographs and X-rays show guide wire in place. Per-operative and follow up X-rays show screw in place; follow up photographs show neck movements.

Figure 3. Type II Dens Fracture

X-ray and CT show displaced type II dens fracture; post-operative X-ray and patient on halo vest immobilization. Follow up X-rays shows atlanto-axial posterior fusion; follow up photographs show neck movements.

5. Discussion

Acute injuries of the spine and spinal cord are among the common causes of severe disability and death following trauma. Upper cervical spine injuries constitute one quarter of the cervical spine injuries (6). It is a great challenge for a physician to treat such patients to a level that they can be independent. Increasing the incidence and changing patterns of spinal trauma is the result of mechanization and industrialization.

The significant difference in presentation of this problem in the developing countries as compared to more advanced nations lies in the epidemiological factors mode of injury, gender incidence, mode and time of referring to the hospital, socioeconomic status and virtually nonexistent paraplegic centers or spinal units, thereby, making the management of these patients far from satisfactory.

Upper cervical spine injury was 27.2% (30) of the total cervical spine injuries (110) and 14.15% (30) of the total spine injury patients (212) during the study period. The results were consistent with the available literature (5).

There were 22 (73%) males and 8 (27%) females in the study. Since males have a more dynamic personality and are more involved in daily activities, they are more frequently vulnerable to get injuries, including spinal injuries. The figures in the present study were consistent with those of the authors in the Indian as well as western literatures (6).

Mean age of the patients in the present series was 46.13 years ranging from 11 to 70 years, majority of the patients 8 (27%) belonged to age group of 61 - 70 years. The mean age of the males was 43.72 years while the mean age for females was 52.75 years (7).

Most of the patients in the current study were from rural areas 19 (63%) compared to urban areas 11 (37%). The current study concluded that the higher incidence of spinal injuries in rural and low socioeconomic group is due to social, cultural, and geographic factors. The poor make a living by hard physical labor in the construction activities and in the process, sustain trauma by falls.

Road traffic accident was a mode of injury in 21 (70%) patients, followed by fall in 7 (23%). falling used to be the most common mode of injury, now road traffic accidents are the commonest cause of such spinal injuries, it is due to many fold increase in the vehicles on the congested roads and more hilly regions lead to more accidents. It was consistent with the studies conducted in India or western countries. Extension of the cervical spine leads to the anterior longitudinal ligament tension and compression across the facet joints. Cadaveric experiments revealed that hyperextension trauma leads to tensile failure of the anterior longitudinal ligament however this may not occur before posterior element completion (8, 9).

In the current study 13 patients were admitted within 24 hours after their injury, while 13 patients were admitted within one week after their injury. A patient referred to hospital after two weeks, two patients within one month while as one patient reported after one month. The current study observation of delayed hospitalization was different from the ones in the developed countries; the reason is multifactorial like poor socioeconomic status, low knowledge and poor transport facility, delayed or improper referral and most importantly less symptoms of motor deficits, bowl, and bladder symptoms associated with upper cervical spine injuries. Due to low expertise these injuries were likely missed by general practitioners: therefore the patients referred late to the tertiary hospitals.

Mode of transportation to the hospital from the site of injury varied and all means of transportation such as ambulance 13.3%, bus 13.3%, taxi 56.6%, three-wheeler 10% were used, and two patients came on foot. There was no spine-care during transportation. Even the patients who referred were not advised regarding the proper spine care, and adequate immobilization was not applied to such patients. This is due to lack of training among the medical and paramedical staff initially handling these patients, lack of awareness in general population who usually handle such patients at the site of accident regarding spine injuries, and more important lack of well trained staff and equipped transportation service available to transfer such critically injured patients from the site of accident to the hospitals. Even the application of Philadelphia is found to provide less motion at fracture site (10). In the field application of Gardner-Well's tongs traction is an effective means of immobilizing the cervical spine (11). In the developed countries well equipped ambulances with trained crew members, aircrafts, motor boats and helicopter services are available to transport such patients to specialized centers for proper management.

Among the current 30 patients, 11 (37%) had atlas fractures, 3 (10%) atlanto-axial subluxation, 12 (40%) dens fractures, and 4 (13%) Hangman fractures. Atlas fractures are more common and are usually treated conservatively. Lateral mass fractures or Jefferson fractures may involve a rupture of the transverse ligament especially if the lateral translation of the C1/C2 joint is more than 7 mm (12). Most of the literature suggests that odontoid fracture type II is most common (13). During the study no patients with occipital fracture or craniocervical dissociation were received. All received atlas fractures were stable. A case of atlas burst fracture was of stable type and without neurodeficit, while another patient of burst fracture with unstable variety presented central cord syndrome. One patient of atlanto-axial subluxation were of type I while as another two were of type II and both type II atlanto-axial subluxation were associated with neurodeficit. A patient of type I dens fracture was associated with neurodeficit (quadriparesis), all the four patients of type III dens fracture were without neurodeficit. There were seven patients of type II dens fracture and all were without neurodeficit. The management of type II dense fracture remains controversial when displacement of the fracture, age of the patient, and degree of communication comes into play and depending upon the presentation time and presence or absence of the neurodeficit. Neural injury in dense fracture occurs in those with small diameter canal (14). However progressive myelopathy may develop in untreated and displaced fractures (15). There were four patients with Hangman fracture in the study, three patients were type I Hangman fracture without neurodeficit and one patient with type IIa Hangman facture. Hangman's fracture angulated and displaced is usually treated surgically with more focus on type IIa (16). Fixation may be done by posterior trans-pedicular fixation or anterior discectomy and fusion.

Dens fracture was the most common upper cervical spine injury and the common type of dens fracture was type II, the current study put in single odontoid screws and found that putting two screws was technically more difficult and less feasible.

The biomechanical and clinical studies revealed ample efficacy of the same fixation (17, 18). Comminuted non reducible and late presenting type II dense fractures were treated with posterior fusion.

Among the 30 patients under study, 26 (86.6%) were without neurodeficit while 4 (13.3%) were associated with neurodeficit. These results were consistent with those of other studies. A patient with atlas burst fracture presented central cord type of neurodeficit. Two patients with C1-C2 rotatory subluxation presented quadriperesis, one patient of type I dens fracture was associated with quadriparesis. It is known that most of the ligamentous injuries present as instabilities, therefore they should be treated (13).

Associated injuries were present in 40% of cases in the current study. Eight patients were associated with head and scalp injury. One patient was associated with other spine injury, while one patient was associated with limb injury.

Among the 4 patients with neurodeficit associated with upper cervical spine injury, two patients recovered from Frankel grade C to Frankel grade D, one patient improved from Frankel grade D to Frankel grade E while one patient with neurodeficit was not followed up. No death or worsening of the neurodeficit of the patients was observed in the study during the follow up.

5.1. Complications Following the Treatment

Six of the patients treated by Halovest developed neck stiffness and two patients treated by post atlanto-axial fusion developed decreased rotatory neck movements. Reported incidence of fusion was about 98% (19) and the incidence of vertebral artery injury was about 2.2% per screw with the incidence of neurological complications of about 0.1% (20). There was one complication of residual neck pain, torticollis, seizures, pin site scar, pin site infection, pin loosening, occipital hypoesthesia, dysphagia, implant failure, cerebrospinal fluid (CSF) leak, and loss of reduction. Up to 38% of the patients developed skin complications after prolonged use of cervical collar (21).

Thorough understandings of the common types of upper cervical spine injuries help in picking them up early. A detailed clinical and radiological workup including X-rays, CT scans, and MRI is mandatory for a complete analysis of the injury. Most of them need good conservative care and few require surgery, which is sometimes technically demanding. The results of the conservative and surgical treatment were good and the complication rate was not high. Late presentation is often associated with secondary complications especially persistent pain and myelopathy. Early presentation and diagnosis is the key to successful treatment and is vital to prevent secondary complications especially with neural deficit.

Specialized spinal injury centers with all modern amenities at each tertiary hospital are ideal and desirable for patients with spinal trauma which should be the aim and part of the health policy of the country. Awareness about spine injuries and their careful handling at the accident site should be created in general population through social and government agencies including media. Social and vocational rehabilitation require special attention and there is great scope for the further improvement in this direction.

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Authors' Contributions

Study concept and design: Younis Kamal, Dara Singh; acquisition of data: Hayat Ahmad Khan, Younis Kamal, Naseemul Gani, and Snobar Gul; analysis and interpretation of data: Dara Singh, Anil Gupta; drafting of the manuscript: Snobar Gul, Hayat Ahmad Khan, and Younis Kamal; critical revision of the manuscript for important intellectual content: Naseemul Gani, Hayat Ahmad Khan. Study supervision: Anil Gupta, Dara Singh.

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