Incidence And Radiography Of Upper Cervical Spine Injury In Blunt Head Injury In A Rural Hospital Setting

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Citation

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Abstract

Objective: The purpose of this study is to look at the incidence and determine whether standard plain cervical spine radiographs are adequate in detecting C1 and C2 fractures in patients with blunt head injury.
Materials and Methods: We prospectively studied 112 patients admitted to our hospital with blunt head trauma from whatever cause. All patients with blunt head trauma reffered for CT scan of the cranium had a routine CT scan of C1 and C2 Vertebra. The plain x-ray of cervical spine, CT scan of C1 and C2 vertebra were read by consultant radiologist who was not involved in the patient management. The author then compared the relative abilities of plain films and compared with CT scans as referenced standard to detect fractures of C1 and C2 vertebrae.
Results: A total of 2 (1.7%) fractures of C1 and a total of 9 (8.0%) fractures of C2 were demonstrated, with a total of 11(9.8%) fractures. For C1 fracture, plain radiograph has a sensitivity of 100.0%, specificity of 98.2%, positive predictive value of 50.0%, negative predictive value of 100.0% and correctly classified of 98.2%. For C2 fracture, plain radiograph has a sensitivity of 33.3%, specificity of 98.1%, positive predictive value of 60.0%, negative predictive value of 90.5% and correctly classified of 93.1%. For C1 and C2 fracture in combination, plain radiograph has a sensitivity of 45.4%, specificity of 98.2%, positive predictive value of 55.5%, negative predictive value of 97.3% and correctly classified of 95.6%.
Conclusion: The overall results of the study suggest that plain cervical spine radiographs are still reliable if used as the sole screening modality in the detection of C1 and C2 fractures in rural setting where availability of CT is scarce.

INTRODUCTION

Early and accurate detection of cervical spine fracture is essential in the work-up of patients and head injury, due to possibility of neurologic damage. In these patients, acquisition of lateral and anteroposterior plain x-rays is considered to be standard.

Computed tomography (CT) of the cervical spine is usually reserved for the evaluation of patients with equivocal or suspicious finding at plain radiography ([1]). The sensitivity of plain radiographs is not as high as CT scan in detecting cervical spine injuries ([1,2,3]). Hence, early clearance of cervical spine in acutely injured blunt trauma patients by plain x-rays alone is not always possible ([4]). This leads to a delay in diagnosis and patient management, even though it is well known that prompt recognition and management of cervical spine injuries in acutely injured patients is critically important to prevent neurologic damage, which may be as high as 50% ([1, 4, 5]). Radiological errors have been shown to contribute to miss diagnoses of spinal cord injury ([6]).

The ability of CT scan to directly affect patient's management by providing a safe, rapid and easily interpretable information about the traumatic lesions of the spine had been agreed upon by many authors ([7]). Despite this, in most centres including ours of a rural setting, the cervical CT scan has been reserved for the evaluation of patients with equivocal or suspicious standard views suggesting cervical spine injury. The aim of this study is to determine the incidence and relook at the role of radiography in upper cervical spine injury in blunt head injury in a rural hospital setting.

MATERIALS AND METHODS

A total of 112 consecutive patients with blunt head trauma in whom plain cervical spine radiographs and routine CT scan of C1 and C2 performed were included in this study. All patients included in this study were patients who had GCS < 13, symptoms and signs of head injury. Patients with CT scan of C1 and C2 were included in this study to compare the relative abilities of plain films with CT scans as referenced standard to detect fractures of C1 and C2 vertebrae. The inclusion criteria are patients of all ages admitted for blunt head trauma requiring CT scan of the cranium, in whom CT of C1 and C2 was performed.

The exclusion criteria are patients who did not have the anteroposterior and lateral cervical spine radiographs (taken after injury) available during the study.

Routine anteroposterior and lateral radiographs of the cervical spine were done using a GE Compax static x-ray (General Electric, Milwaukee, Wisconsin) with a focus-film distance of 100 cm except for the lateral where it was 180 cm, kVp range from 55-70 and mAs of 40-100 with no grid. The CT scan was performed with Somatom Hi-Q version B2 scanner (Siemens AG, Germany). The C1 and C2 area were scanned with the patient in supine position using zero gantry angulation, continuous sections of 2mm using a kVp of 133 and mAs of 350 and acquisition time of 2 seconds per slice. The images were then printed and reviewed in soft tissue and bone window.

The CT scan of C1 and C2 and plain cervical spine radiograph were prospectively read by an experienced consultant radiologist who was not involved in the original patients work-up. To avoid biasness, the plain cervical spine radiographs and CT scan were read independently of each other, with the plain radiographs series being read first. The total number, type, portion of the vertebra involved and anatomic level of the fracture(s) of C1 and C2 and plain radiographs were determined.

Statistical analysis was done using SPSS for Windows version 13.0 software program. Descriptive analysis was used to the socio-demographic data: age, sex and ethnicity. By using cross tabulation and using CT scan as the reference standard, the findings of C1 and C2 fractures on plain radiographs were then analysed for sensitivity, specificity, positive predictive value, negative predictive value and overall accuracy.

The association between findings of plain cervical radiographs and CT scan were measured using Fisher's Exact Test. For the analysis of statistical significance, was taken as 0.05. Therefore, if p > , the results were considered not statistically significant, and if p < , the results were considered statistically significant.

RESULTS

Over the period of 25 months during which the study was carried out, a total of 300 subjects were evaluated and only 112 subjects who met the inclusion criteria. There were 86 (76.8%) males and 26 female (23.2%). The age ranges from 2 to 71 years old with a mean 26.1 years old. The race distributions were 103 Malays (92%); Chinese 8 (7.1%); Siamese 1 (0.9%). The causes of blunt head injury were motor vehicle accident 96 (85.7%), fall 13 (11.6%), assault 2 (1.8%) and others 1 (0.9%).

All subjects had AP and lateral radiographs done. There were a total of 13 subjects who had fractures, of whom 11 (9.8%) fractures seen on CT. There were 9 (8.0%) C2 fractures, 2(1.7%) C1 fractures and 1(0.89%) had C1 and C2 fracture together.

Figure 1

Table 1: Summary of fractures detected by plain and CT scan

Sample No.	Plain C1	CT C1	Plain C2	CT C2
7	1	0	0	0
17	1	1	0	0
18	0	0	0	1
33	0	0	1	0
47	1	1	1	2
51	0	0	1	1
57	0	0	1	1
58	0	0	0	1
65	0	0	0	1
76	1	0	0	0
106	0	0	1	0
108	0	0	0	1
110	0	0	0	1
Total fracture	4	2	5	9

Comparison of C1 and C2 fractures was made between plain radiographs and CT scan as in table 2 and 3.

Figure 2

Table 2: Comparison of detection of C1 fractures by plain radiographs and CT scan

		CT		Total
		Positive	Negative	
Plain radiograph	Positive	2	2	4
	Negative	0	110	110
Total		2	112	114

Figure 3

Table 3: Comparison of detection of C2 fractures by plain radiographs and CT scan

		CT		Total
		Positive	Negative	
Plain radiograph	Positive	3	2	5
	Negative	6	105	111
Total		9	107	116

For the detection of C1 fracture, the sensitivity was 100.0%, the specificity was 98.2%, the positive predictive value was 50.0%, the negative predictive value was 100.0% and correctly classified as 98.2%. The Fisher's Exact test p value= 0.001. For C2 fracture, the sensitivity was 33.3%, the specificity was 98.1%, the positive predictive value was 60.0%, the negative predictive value was 90.5% and correctly classified was 93.1%. The Fisher's Exact test p value= 0.003. For C1 and C2 fracture together, the sensitivity was 45.4%, the specificity was 98.2%, the PPV was 55.5%, the NPV was 97.3% and correctly classified was 95.6% with Fisher's Exact test p value <0.001.

DISCUSSION

The unproven axiom that head injury implies a risk of cervical spine injury is one that has been accepted widely ([8]). The American College of Surgeons teaches that “trauma occurring above the clavicle should raise the suspicion for potential cervical spine injury”.

Several authors had estimated that incidence of cervical spine injury among surviving head-injured patients to be between 10% to 20%. However, none of these publications had cited references for the source of their data ([8], [9]). Post-mortem and clinical studies that investigated this relationship demonstrate conflicting results. Research on fatal accident victims showed that as many as 16% had a concurrent incidence of head trauma with cervical injury. Nevertheless, the majority of post-mortem studies confirmed that many of the traumatic fatalities had sustained upper cervical (C1 and C2) spine and cord injuries, which most likely caused immediate death. Hence clinical studies of surviving trauma patients may be influenced by the exclusion of this group of patients.

This study with the incidence of 9.8% of fracture of C1 and/or C2, supports the estimation of 5 to 20% of cervical injuries in patients surviving from head trauma in the literature. This figure would be higher and fall within the 10 to 20% bracket if fractures at other cervical levels were included.

There were altogether 2 fractures of C1 (1.7%) and 9 fractures of C2 (8.0%) and 11(9.8%) had fracture of both C1 and C2. This is somewhat similar to findings by Link et al, 1995.

Combined C1 and C2 fractures produce a higher incidence of neurological morbidity than seen in isolated fractures ([10]). However, in the sole patient in this study with concurrent C1 and C2 fractures, no neurological abnormality was noted. Interestingly, most of the patients with C1 and C2 fractures are mostly young adults. This to some degree conforms to the observation that the atlanto-axial segment is particularly vulnerable in children especially those who are younger than 12 years old ([10],[11],[12]). No patient in this series had any neurological deficit. This is in keeping with review of the literature which reveals that neurological deficit in fracture of C1 and C2 is uncommon. Those that do have neurological involvement in C1 and C2 injuries usually do not survive due to the nature of the injuries and hence does not make it into study population ([7], [12],[13],[14]). This results in a few number of patients with neurological involvement in those surviving patients with C1 and C2 fracture.

This study had an overall sensitivity and specificity of plain radiographs in detecting C1 and C2 fractures – 33.3% and 100% respectively. These figures are comparable to other studies.

Although under ideal situations, i.e. with technically adequate and complete films, the sensitivity of the three views has been shown to be between 92% to 95%, there is good evidence that as an initial screening tool in the emergency cases, plain radiography is often inadequate ([15]). The reasons for this is multifactorial and includes the inability to adequately visualise the cranio-vertebral junction, poor quality of portable films taken in difficult environment in the casualty and the need to prioritise other diagnostic studies or therapeutic interventions before complete evaluation of the cervical spine. This is particularly true in the case of C1 and C2 fractures which are often obscured by either patients injury (e.g. mandibular injury), endotracheal tube or lack of cooperation from the patient ([16]). In addition, open mouth views can be intrinsically difficult and time consuming to obtain in these patients. In a study by Borock et al ([4]), 52 (42%) of 123 patients could not be image at the cranio-vertebral junction by conventional radiography, thus prompting CT at this level. Acheson et al ([6]) scanned the C1 and C2 level because of the tubes obscuring the conventional views in 32 patients. Daffner ([16]) reported that in 74% of patients with suspected cervical spine injuries, the open mouth view had to be repeated, ranging from 1 to 4 repeat films and averaging 1.4 repeat film per patient. This made the open mouth view the most difficult to obtain and required repitition most often. The reasons for repeated radiographs were positioning errors, over-penetration, large patient size and uncooperative patients. He concluded that it is illogical and non-cost effective to repeat plain radiographs when CT is available for a faster and more definitive means of diagnosis.

Limitations of this study is having small subject numbers and larger well defined study need to be undertaken in this field. Not all with blunt head injury are scanned as scan was limited to those meeting the hospital head injury algorithm. There might be higher number of fractures.

CONCLUSION

The overall results of the study suggest that plain cervical spine radiographs are still reliable if used as the sole screening modality in the detection of C1 and C2 fractures in rural setting where availability of CT is scarce.

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