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The use of forced flexion/extension views in the obtunded trauma patient

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Abstract *Objective:* To determine whether forced flexion/extension (F/E) films for "clearing" the cervical spine in unconscious or semiconscious patients are useful or actually dangerous. *Design and patients:* Of 810 patients admitted for blunt trauma over a 5-year period, 479 patients whose films and charts were available received passive F/E film views of the cervical spine. Of these, 447 were reviewed retrospectively in masked fashion for any exacerbation of neurological changes subsequent to the procedure and with respect to the final neurological status at discharge. *Results:* Twenty-nine patients (6%) had various abnormalities including fractures and ligamentous injuries seen on the initial films. Following forced F/E films no change was made in the diagnosis of 23 patients. Of the remaining six patients, two required no treatment, two only required the use of a collar but two did have surgical intervention, this decision being based on the findings seen in the initial films. However, 285 films (59%) were judged inadequate due either to inadequate F/E (150 patients, 31%) or poor visualization (194 patients, 40%). There were three false positives all subsequently cleared by other studies and there were no false negatives. From the chart review, there were no complications or deaths attributable to the procedure. *Conclusion:* Although we were unable to find any complication or deaths directly attributable to the procedure, the clinicians abandoned passive F/E views in obtunded patients on the grounds of expense. Our present method of "clearing" a cervical spine in an obtunded patient is a cross-table lateral radiograph followed by a high-resolution thin-slice CT scan with sagittal and coronal reconstruction. We are against the use of routine MRI studies and of a forced F/E view in these patients.

Keywords Cervical spine · Cervical fractures · Cervical trauma · Forced extension · Flexion views

Introduction

The technique used for "clearing" cervical spines in patients who are either unconscious or semiconscious has been controversial for years. With the advent of fast CT scanning with sagittal and coronal reconstruction, some authors would now recommend a cross-table lateral radiograph to exclude major injury to the cervical spine followed by a CT scan from the base of the skull down to T2 [1, 2, 3, 4, 5].

However, when the senior author first arrived at the University of Missouri in Columbia, the trauma surgeons, as well as the orthopedists and neurosurgeons, were bringing the unconscious patient down to the Radiology Department once they had been stabilized and were performing forced flexion/extension (F/E) views either under digital fluoroscopy or by using films [6, 7, 8]. The radiologists had been objecting to this procedure for years on the grounds that if a patient was unable to feel

Table 1 Mechanism of injury

64%	Motor vehicle crash
13%	Fall
3%	ATV (all-terrain vehicle)
2%	Bicycle Boat Struck by falling object Hanging Pedestrian Farm accident
1%	Assault Burn/fireworks Diving Found down Gunshot Motorcycle
<1%	Sports injury Hypothermia Near drowning Plane crash Struck by lightning

pain, forced F/E films might inflict actual harm. So we decided to do a study to determine whether the procedure was useful or not and whether in fact it was actually dangerous. Incidentally, when we were about halfway through collecting our data the surgeons stopped requesting forced F/E films and instead started ordering CT scans [9]. The term "forced" is probably more correct than "passive" since the patient was positioned with the head over the edge of the table. A surgical resident "forced" the neck into as marked a flexed and then as marked an extended position as possible. The term "obtunded" refers to the fact that the patient was either unconscious, semiconscious or under chemical paralysis.

Materials and methods

The records and films of 810 patients who were admitted with blunt trauma and who received F/E views of their cervical spines between 1994 and 1999 were reviewed (Table 1). The University of Missouri Hospital is a level 1 trauma center and deals with many patients who have sustained a high-speed or other major accident. Eighty of the films were not found and we thus viewed 730 film sets in 691 patients (39 repeat examinations). The films were reviewed by an experienced musculoskeletal radiologist who was masked to the clinical findings. The films were assessed with respect to any abnormal findings, whether they were done actively or passively and whether they were adequate or inadequate (Table 2). The term "inadequate" implied either that the whole of the cervical spine was not visualized or that the amount of motion was not adequate to determine whether there were any abnormalities on F/E. Two hundred and fifty-one studies were excluded because it was determined that the F/E series was performed actively on a conscious patient (Table 2). This left us with 479 sets of films in patients who had received passive F/E films.

A review of the medical records was also undertaken for all these patients. Twenty-two patients had duplicated examinations and 10 charts were unobtainable (often because of impending litigation), so that 447 charts were reviewed. The charts were searched for any obvious complications of the procedure, for any evidence of alterations in the neurological status following the procedure, as well as for the eventual outcome, particularly with respect to the patient's neurological status at discharge. Although it was a masked radiographic and chart review study, IRB permission was obtained.

Table 2 The total number of films which were found inadequate and the explanation

	Passive	Active
No. of films	479	251
No. abnormal	29 (6%)	25 (10%)
F/E inadequate	150 (31%)[a]	76 (30%)
Total inadequate visualization	194 (40%)[a]	
See only down to:		
C_4	1	1
C_5	12	2
C_6	46	18
C_7	135	57
Total inadequate films	285 (59%)	116 (46%)

[a] Some patients had both inadequate F/E as well as inadequate visualization

Table 3 Abnormalities found on a radiographic and chart review

	Radiographically	Chart review
Fractures	7	31
Subluxation	9	11
Ligamentous injury	13	16
Fractures:[a]		
Compression of body	4	10
Compression of teardrop	2	3
Spinous process	2	7
C1/2	1	6
Jefferson	–	2
Lateral mass	–	5
Facet	–	2

[a] Because some patients had multiple fractures, the numbers add up to more than the seven found radiographically and 31 found on chart review

Results

There were 479 sets of F/E films in the radiographic study. Twenty-nine (6%) were considered abnormal on the original films and following forced F/E studies (Table 3). There were seven fractures (which were mainly anterior compression fractures), nine patients had subluxation (three of whom had fixed subluxation suggesting an old injury) and 13 patients developed kinking on flexion similar to that seen in whiplash injuries (see Table 3). Following forced F/E, no change was made in the diagnosis of 23 patients (4%) whereas the procedure

revealed new findings in six patients. Two patients required no further treatment: one had a clay- shoveller's fracture of C7 and the other had a mild anterior compression fraction of C6. Two patients, one with subluxation at C3–4 and one with kinking at C4–5, were placed in collars. However, two patients did require operative intervention: one had posterior fixation for significant subluxation at C6–7 which was seen on the initial films but was exaggerated on F/E; the other had posterior fixation for a known fracture at the base of the dens whose known instability only became more obvious on forced F/E, although we do not understand how the procedure came to be performed on this particular patient. It is of interest that our surgeons reviewing the same material concluded that there were no cases of ligamentous instability requiring surgical stabilization in this group of patients. In subsequent follow-up studies, usually with CT scanning, eight of these patients were found to have significant subluxation or additional fractures such as lateral mass fractures in two, and a Jefferson fracture in one. CT scanning also confirmed four other fractures.

On reviewing the films, 150 patients (31%) were considered to have had an inadequate amount of motion between the F/E views. A further 194 patients (40%) had inadequate visualization. It was possible to see down only to the C4 vertebral body in one patient, C5 in 12, C6 in 46 and C7 in 135 patients. Thus the total number of inadequate studies was 285(59%). Incidentally, of the 251 active F/E studies, 25 (10%) were considered abnormal, 76 (30%) had inadequate F/E and 78 (31%) had inadequate visualization (i.e., C4 in 1 patient, C5 in two, C6 in 18 and C7 in 57 patients), with the total number of inadequate studies representing 116 studies (46%). This supports the thesis that performing the procedure on obtunded patients results in a higher rate of inadequate studies.

Of the 447 charts reviewed, 58 had cervical spine injuries that were documented clinically: 31 patients sustained fractures including 11 of the vertebral body (three teardrop fractures), six fractures of the C1/2 complex, two Jefferson fractures and six spinous process fractures (Table 3);11 patients had subluxation at various levels but mainly C4–5–6 and 16 patients had ligamentous injury or "cervical strain". One patient with bony injury had a spinal cord contusion, which was diagnosed on MRI. Using the Glasgow Coma Score (GCS), five patients had a normal GCS and normal F/E films; seven patients had a normal GCS and abnormal films but most of these were only minor ligamentous injuries (Table 4). As the GCS increased, so did the severity of the cervical spine injury and in fact no patients with a GCS of less than 15 had any operative intervention: they were all treated with either nothing or a collar. Of the 37 patients with a GCS of 15, seven had surgical fixation of their cervical spine. At discharge the neurological status of these 58 patients was normal in 48, two died of respiratory complications, three were paralyzed and five had some minor weakness. No correlation could be found between the radiographic findings and the clinical findings or the ultimate outcome in these patients. We were also unable to find any complications attributable to the passive F/E series in the 457 patients who underwent the procedure and there were no deaths attributable to the procedure.

Table 4 The degree of injury as assessed by the Glascow Coma Score

GCS	Number	Percent
3	101	23%
4	9	2%
5	7	2%
6	27	6%
7	26	6%
8	7	2%
9	16	4%
10	9	4%
11	22	5%
12	6	1%
13	18	4%
14	43	10%
15	142	32%
Not documented	4	1%

Finally, in the overall group of 837 flexion/extension series, we were only able to find three false positive results and no false negative. One of the false positive results (possible widening of C5–6 and C6–7 disk spaces) was cleared by a better repeat F/E series 2 weeks later. A second patient with suspected ligamentous injury C4–5 had a negative MRI examination subsequently and the third patient, who was thought to have a possible C1–2 fracture on F/E, was cleared with a negative CT scan.

Discussion

Our results are interesting from a number of points of view. Firstly it appears that forced F/E did no actual harm and that not one patient had their injury exacerbated by the procedure or died as a result of it. Parenthetically one would have thought that because of this finding, the clinicians would continue to perform forced F/E views on obtunded patients. However, they decided to stop performing these procedures primarily because they found them not to be cost-effective: nearly one third of the series were inadequate to rule out instability and of 837 patients only four were identified with decreased admission GCS, normal plain films and/or CT scan and positive or suggestive findings on F/E [9]. The actual cost of the procedure is also probably in the region of $3,000 because the patient has to be moved from the ICU with a nurse anesthetist, at least one resident, at least one other nurse as well as various assistants. The

actual price of the film and 1 h of fluoroscopy time is only $240 at our institution, which represents a minor part of the overall cost of the procedure.

Another interesting point is the lack of false negatives. There were three false positives all of whom had their necks subsequently cleared. We did 39 repeat examinations and were unable to find any false negatives on the first reading, however inadequate the original study was. With the advent of routine CT scanning, it is obvious that many patients with neck injuries have additional discrete but non-life-threatening fractures of their spine (laminar fractures, facet fractures and spinous process fractures for example) than are seen on the plain film series [10, 11]. However, all 837 of the patients had intensive well-documented clinical and radiographic follow-up and we were unable to identify any false negative result and there were no further false positives.

From the radiological point of view it is interesting to look at the consequences of the more serious fractures [11, 12]. We identified six patients with C1/2 fractures and two patients with Jefferson fractures, out of whom only one patient had any neurological damage (a right hemiparesis). It is also interesting to note how many of these studies were considered inadequate even with the use of digital imaging and fluoroscopy. Many of these were due to the size of the patient but many more were due to the fact that the patient was unconscious so someone had to hold the patient under the axilla and someone else pull the arms downwards as well as having to have a radiologist in the room to supervise. Since the radiologists involved all considered the procedure hazardous to the health of the patient, in retrospect the authors think that often the radiologist was willing to accept frankly inadequate films just to get the patient back to the ICU.

For the moment, the controversy of how to clear the cervical spine in obtunded patients seems to have died down [1, 2, 12]. Although a recent leading article by Mirvis [13] seems to suggest otherwise, he personally advocates the use of plain films and spiral CT to clear the cervical spine in obtunded patients. Mirvis quotes a number of articles, mainly from Great Britain, which support his contention. For instance Gupta and Clancy [14] state that normal plain films and a normal CT scan excludes unstable injuries of the cervical spine likely to produce cervical neurological injury in most patients. On the other hand Davis et al. [6] proposed using forced F/E on obtunded patients following a study of 116 patients in whom they found two facet fractures and a 2 mm subluxation. Although none of their patients required surgical intervention, these authors recommend forced F/E since they state that it can be safely and effectively used to clear the cervical spine in obtunded patients. Ultimately in his review article Mirvis [13] asks nine theoretical questions on forced F/E and comes out against it. Based on an apparently normal plain film series and normal spiral CT scan, if only one patient undergoing forced F/E becomes paralyzed or dies as the result of the procedure, that is one patient too many. So we would like to state that we are also categorically against forced F/E.

The other controversy that Mirvis [13] discusses is the place of MRI in obtunded patients with cervical spine injury. D'Alise et al. [15] studied 121 patients with negative radiographs who did not receive CT scans but who had limited MRI of the cervical spine including two sagittal sequences. Thirty-one patients were shown to have significant prevertebral soft tissue injuries, herniated disks and other ligamentous damage. Eight of these patients required surgical intervention. These authors state that one of the advantages of this procedure is that it can clear 75% of these patients and spinal precautions can be safely discontinued. Another comment about this paper is that the decision to operate on these patients was actually based on F/E views performed once the patient had regained consciousness. The senior author did an informal survey of over 20 level 1 trauma centers in the United States and found that none of them did routine cervical spine MRI on obtunded patients with suspected cervical spine injuries. Obviously there are specific indications for an emergency MRI including worsening neurological status and advancing levels of neurological damage. Routine MRI will significantly add to the cost without altering the clinical management of the vast majority of these patients. In fact in our own group of patients, since we had no true false negatives, MRI would have added no significant findings but would have added significant cost to the whole process (over $700,000), not counting moving the patients once again from the ICU to the MRI suite and back.

Conclusion

Based on our findings in 479 in obtunded patients, we now advocate the use of an adequate plain film series (particularly an adequate lateral view) and a spinal CT scan with sagittal and coronal reconstructions to "clear" the cervical spine in obtunded patients. We are against the use of routine MRI studies and of the forced F/E view in these patients.

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