ORIGINAL ARTICLE

Computed tomography vs. magnetic resonance imaging in unstable cervical spine injuries

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ABSTRACT

BACKGROUND: This study aimed to investigate the role of computed tomography (CT) in identifying missed unstable blunt cervical injuries.

METHODS: Patients admitted to the emergency department between June 2014 and June 2018 with a diagnosis of blunt cervical trauma were included in this study. All participants underwent cervical magnetic resonance imaging (MRI) after an initial cervical CT investigation. All imaging results were reviewed, and decisions were taken by the consensus of a team consisting of an emergency medicine specialist, a neuroradiologist, and a neurosurgeon. Other variables included age, sex, the Glasgow Coma Scale, medical comorbidities, multi-trauma, neurological deficits, accompanying intracranial hemorrhage, extremity fractures, and the mechanism of the injury.

RESULTS: Data for 195 patients were analyzed. The mean (±standard deviation) age of the participants was 47.34±21.90 years, and 140 (71.8%) were males. Eighteen patients (9.2%) were below age <18. The most frequent mechanism of injury was fall from height (n=100; 51.3%). Using MRI as the gold standard, the sensitivity of CT in diagnosing unstable cervical injury was 77.7% (95% CI [67.1–86.1]), while its specificity was 100.0% (95% CI [59.0–100.0]).

CONCLUSION: Although computed tomography is relatively good in diagnosing unstable cervical injuries, its sensitivity in detecting positive cases is not as successful. Thus, the use of MRI in patients with an unstable injury seems to be warranted.

Keywords: Cervical vertebrae; computed tomography; magnetic resonance imaging; neck injuries; sensitivity and specificity.

INTRODUCTION

Background/Rationale

Cervical spine injuries (CSI) are rare in blunt trauma but may lead to devastating morbidity and mortality. They constitute approximately 1–3% of all blunt trauma cases[1] and 0.2% of all emergency service applications.[2] Spinal cord injuries accompany 0.07–0.26% of this group.[3,4] Early diagnosis is critical because delayed or undiagnosed unstable injuries may have serious consequences.[5]

Studies of both the National Emergency X-Radiography Utilization (NEXUS)[6] and Canadian C-Spine Rule (CCR)[7] are landmarks in the management of suspected cervical trauma. Both tools are decision rules to guide the use of cervical-spine radiography in patients with trauma. Computed tomography (CT)[8] and magnetic resonance imaging (MRI)[9] are longstanding methods as diagnostic screening tools to clear unstable injury in blunt cervical trauma cases. However, there is some disagreement regarding the use of imaging after a negative CT.[10,11]

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The majority of cervical spine injuries are fractures; ligamentous and combined injuries are less frequent.[12] However, the MRI is superior to CT for diagnosing soft tissue and spinal cord injuries. Thus, the MRI may target isolated, unstable ligamentous injuries when screening blunt trauma cases for unstable CSI with negative CT.[9] In light of this, we may hypothesize that "edema," "sprain," and "contractures" missed following a negative CT can be detected and reported by the MRI.

Objectives

This study aims to assess the utility of MRI after a CT, and examine findings on MRI and assess their effects on the treatment and outcome of stable and unstable injuries.

MATERIALS AND METHODS

Study Design

This study was conducted in a cross-sectional plan. Study reporting was prepared following the STROBE guidelines.[13] The study protocol was approved by the Local Ethics Committee at Ege University Medical Faculty (IRB number: 18-4.1/39; Date: 17 April 2018).

Setting

This study was approved and conducted in the Department of Emergency Medicine at Ege University Faculty of Medicine. This tertiary health care center annually serves around 200 thousand patients in Izmir, Turkey.

Participants

Data collection was performed using the hospital's electronic medical records. The registry was searched between 01.06.2014 and 31.06.2018 for the ICD-10 codes S17 (Crushing injury of the neck) and S12 (Fracture of cervical vertebra and other parts of the neck). All files registered with these codes were revised. Of the 14850 cases retrieved, 112 were excluded from this study because of some other diagnoses. From the remaining 14738 patients, 198 who underwent a CT scan followed by MRI within 48 hours of admission were included in this study. Patients with non-diagnostic CT results and/or incomplete medical records were excluded at this stage (Fig. 1, patient flow diagram).

Variables

The primary outcome variables of this study were the presence or absence of any pathology in the CT and MRI. Data were collected for other variables, such as age, sex, the mechanism of injury, intensity of trauma (Low energy trauma (LET) vs. High energy trauma (HET), discharge location, and treatments about the CS. HET was defined per the Dutch National Ambulance Protocol, version 7.2, on triage criteria.[14] Clinical data collected consisted of the Glasgow Coma Scale, medical comorbidities, neurological deficits, accompanying intracranial hemorrhage, and extremity fractures.

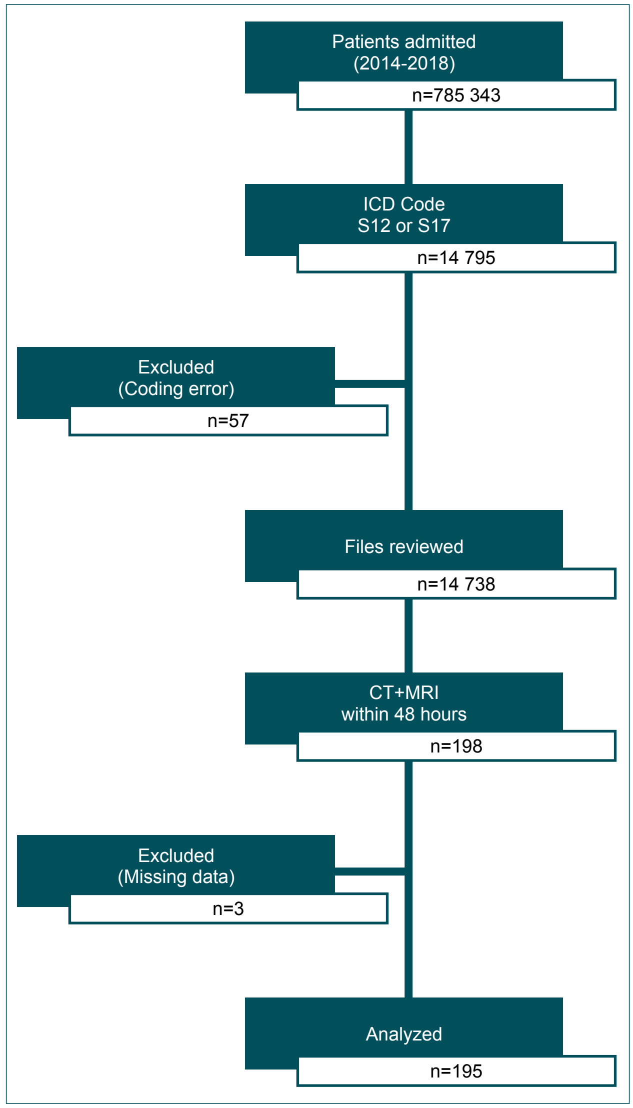

Figure 1. Patient flow diagram.

All CT scans were performed with a GE Discovery HD 750 (GE Healthcare, Milwaukee, WI). The MRI scans were performed with either a 1.5 Tesla Siemens Symphony or 3 Tesla Siemens Avanto CMR scanner (Siemens Medical Solutions, Erlangen, Germany).

All CT and MR images were assessed by an emergency medicine specialist, a neuroradiologist, and a neurosurgeon to classify interpretations as 'negative' or 'positive' for acute traumatic injury patients. Studies interpreted unequivocally as negative for CSI were classified as 'Negative CT.' The results were classified as 'Positive CT' if impressions included any of the following features: major fractures of vertebrae, disc space widening, vertebral subluxation, epidural hematoma, and prevertebral or paravertebral edema/hematoma. Patients were classified as having a 'Positive MRI' if they had any of the following features: ligamentous injury, posttraumatic spinal cord pathological signal changes or hemorrhage, epidural/subdural hematoma, new or acute disc herniation, and prevertebral edema or hematoma. MRI studies interpreted unequivocally as negative for any of the above findings were classified as 'Negative MRI.'

As a result of the file investigations, the patients categorized as having "stable" or "unstable" injury. The definitions of unstable injury were based on the neurological status of the patient, the degree of spinal canal stenosis, and the degree of instability. The commonly accepted, Denis' 1983 delineation was used in the definition of unstable CSI as a single-level ligamentous injury extending to two or three columns.[15]

Of the more modern classification systems, the SLIC (Sub axial injury classification system)[16] proposed by the Spinal Trauma Study Group was used. The system is based on the injury morphology, competency of the discoligamentous complex (DLC), and the neurological status of the patient. Conservative treatment is indicated for a score of 3 or less, whereas a score of 5 or higher suggests operative intervention.

Bias

All the retrieved files were inspected by two emergency medicine specialists. All imaging results were reviewed and decisions were taken by the consensus of a team consisting of an emergency medicine specialist, a neuroradiologist, and a neurosurgeon. To prevent bias, error checking and debugging were done after the data was entered into the computer.

Study Size

The post-hoc sample size was calculated based on a 0.2%[2] expected prevalence of cervical spine injuries among emergency service applications. Given a finite population of 785 343, an expected prevalence of 0.2%, and a margin of error of 3%, a sample size of 146 cases is required to estimate cervical spine injuries in the study population with a confidence interval of 99%.[17]

Statistical Analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 25.0 software (SPSS Inc., Chicago, IL, USA). The results were presented as frequencies, percentages, means, and standard deviations (SD). The Kolmogorov–Smirnov test was performed to test if the numerical variables were normally distributed. The independent samples t-test was used to compare numerical data, and the Chi-square test was used for categorical variables. The sensitivity and specificity of CT were calculated considering MRI as the gold-standard. A p-value of <0.05 was considered statistically significant.

RESULTS

Participants

Results for 195 blunt cervical trauma patients were analyzed in this study. The patients had a mean age of 47.34±21.90 years (min 1, max 90). Of the patients, 140 patients (71.8%) were male, 55 (28.2%) were female, and 18 (9.2%) were under the age of 18 years. Sixty-one patients (31.3%) had some comorbidities.

Descriptive Data

Of the 785 343 patients admitted to the emergency unit, 14738 (1.8%) were due to blunt cervical trauma. Of these cases, on the other hand, 145 (0.9%) was identified as cervical injuries, whereas 88 (0.6%) of them was unstable cervical injuries confirmed by CT and MRI.

Fall from high accounted for the most common mechanism of injury (51.3%; n=100). Ninety-nine patients (50.8%) had multiple trauma. One hundred five patients (53.8%) had high energy trauma, while 90 (46.2%) patients had low energy trauma (Table 1). There was no difference between males and females concerning the mechanism of injury or patient outcomes (p>0.05). Most of the patients (97.9%; n=191) had a Glasgow Coma Scale of above 13 and were alert (98.5%; n=192). Surgical intervention was required for 39 patients (20.0%) and one patient (0.5%) died.

Outcome Data

Twenty of the 131 cases (15.2%) in the total population and

Table 1. Distributions of the trauma mechanisms and patient outcomes

	No		Yes	
	n	%	n	%
Mechanism of injury				
Fall from height	95	48.7	100	51.3
Motor vehicle accident	130	66.7	65	33.3
Pedestrian	178	91.3	17	8.7
Assault	190	97.4	5	2.6
Other mechanisms of injury	186	95.9	8	4.1
Unknown mechanism	192	98.5	3	1.5
Patient outcome				
Neurologic deficit	171	87.7	24	12.3
Conscious	3	1.5	192	98.5
Intracranial hemorrhage	181	92.8	14	7.2
Extremity fracture	163	83.6	32	16.4
Any bony fracture	117	60.0	78	40.0
Spinal cord injury	175	89.7	20	10.3
ALL injury	165	84.6	30	14.4
Suboccipital ligament injury	185	94.9	10	5.1
Unstable injury	107	54.9	88	45.1
Operation	156	80.0	39	20.0
Exitus	194	99.5	1	0.5

ALL: Anterior longitudinal ligament.

18 of the 25 cases (72%) among the unstable CSI cases with a negative CT had positive findings in the MRI. Besides, the mean ages of the CT-positive (54.55±21.77), as well as MRI-positive (54.29±22.28) cases, were significantly higher (t and p, -3.292; 0.001 and -3.955; <0.001, respectively) compared to the negative cases (43.82±21.17 vs. 42.19±20.22, respectively). When CT and MRI were compared for positive results in different conditions, it was observed that they had similar

Table 2. Comparison of the CT and MRI results concerning different mechanisms of injury and patient outcomes

	CT					MRI				
	Negative		Positive			Negative		Positive		
	n	%	n	%	χ^2, p	n	%	n	%	χ^2, p
Fall from height										
No	71	54.2	24	37.5	4.799, 0.028	66	58.9	29	34.9	10.981, 0.001
Yes	60	45.8	40	62.5		46	41.1	54	65.1	
Motor vehicle accident										
No	85	64.9	45	70.3	0.570, 0.450	69	61.6	61	73.5	3.031, 0.082
Yes	46	35.1	19	29.7		43	38.4	22	26.5	
Pedestrian										
No	117	89.3	61	95.3	1.945, 0.163	100	89.3	78	94.0	1.318, 0.251
Yes	14	10.7	3	4.7		12	10.7	5	6.0	
Assault										
No	126	96.2	64	100.0	2.507, 0.113	107	95.5	83	100.0	3.803, 0.051
Yes	5	3.8	0	0.0		5	4.5	0	0.0	
High energy trauma										
No	86	95.5	4	4.4	61.039, <0.001	84	93.3	6	6.7	88.102, <0.001
Yes	45	42.9	60	57.1		28	26.7	77	73.3	
Neurologic deficit										
No	116	88.5	55	85.9	0.272, 0.602	99	88.4	72	86.7	0.120, 0.729
Yes	15	11.5	9	14.1		13	11.6	11	13.3	
Extremity fracture										
No	112	85.5	51	79.7	1.058, 0.304	95	84.8	68	81.9	0.291, 0.590
Yes	19	14.5	13	20.3		17	15.2	15	18.1	
Any bony fracture										
No	96	82.1	21	17.9	29.341, <0.001	88	75.2	29	24.8	37.814, <0.001
Yes	35	44.9	43	55.1		24	30.8	54	69.2	
Spinal cord injury										
No	127	72.6	48	27.4	22.498, <0.001	110	62.9	65	37.1	20.512, <0.001
Yes	4	20.0	16	80.0		2	10.0	18	90.0	
ALL injury										
No	119	72.1	46	27.9	11.879, 0.001	106	62.4	59	35.8	20.325, <0.001
Yes	12	40.0	18	60.0		6	20.0	24	80.0	
Suboccipital ligament injury										
No	131	70.8	54	29.2	21.575, <0.001	112	60.5	73	39.5	14.223, <0.001
Yes	0	0.0	10	100.0		0	0.0	10	100.0	
Operation										
No	119	90.8	37	57.8	29.312, <0.001	104	92.9	52	62.7	27.186, <0.001
Yes	12	9.2	27	42.2		8	7.1	31	37.3	
Unstable										
No	106	80.9	1	1.6	109.333, <0.001	105	93.8	2	2.4	160.616, <0.001
Yes	25	19.1	63	98.4		7	6.3	81	97.6	
SLIC score										
0	17	36.2	30	63.8	4.765, 0.092	6	12.8	41	87.2	3.403, 0.182
1	5	31.3	11	68.8		0	0.0	16	100.0	
2	3	12.0	22	88.0		7	8.0	81	92.0	
GCS score										
≤13	3	75.0	1	25.0	0.113, 0.736	3	75.0	1	25.0	0.515, 0.473
>13	128	67.0	63	33.0		109	57.1	82	42.9	

CT: Computed tomography; MRI: Magnetic resonance imaging; SLIC: Subaxial Cervical Spine Injury Classification; GCS: Glasgow Coma Scale; ALL: Anterior longitudinal ligament.

Table 3. Performance of computed tomography compared to MRI in the detection of all cervical injuries and unstable cervical injuries

All cases	**MRI**		
	Negative	**Positive**	**Total**
Computed tomography			
Negative	111	20	131
Positive	1	63	64
Total	112	83	195
Unstable cervical injuries	**MRI**		
	Negative	**Positive**	**Total**
Computed tomography			
Negative	7	18	25
Positive	0	63	63
Total	7	81	88

MRI: Magnetic resonance imaging.

significances (Table 2). However, the MRI yielded somewhat more positive results compared to CT. Neither CT nor MRI showed the importance in differentiating between different SLIC score categories.

The sensitivity and specificity of CT in detecting any cervical injury was calculated as 75.9% (95% CI [65.2–84.6]) and 99.1% (95% CI [95.1–99.9]), respectively (Table 3), whereas the sensitivity and specificity of CT in detecting unstable cervical injuries were calculated as 77.7% (95% CI [67.1–86.1]) and 100.0% (95% CI [59.0≠100.0]), respectively.

While 6.5% (n=7) of the stable injuries were operated, 36.4% (n=39) of the unstable patients got operated (Chi-Square=26.839; p<0.001). The CT and MR images of one representative case are presented in Figure 2.

As seen in the images, vertebral dislocation and narrowing of the spinal canal can be identified in both the CT and MRI. However, myelopathic signal changes at the spinal cord can only be detected on the MR images.

DISCUSSION

Key Results

The prevalence of blunt cervical trauma among patients admitted to the emergency department was found at 1.8%. On the other hand, the frequency of unstable cervical injuries confirmed by CT and MRI was calculated as 0.6%. Besides, this study confirms that CT alone is not sufficient in eliminating cervical spinal injuries in patients with blunt trauma. A

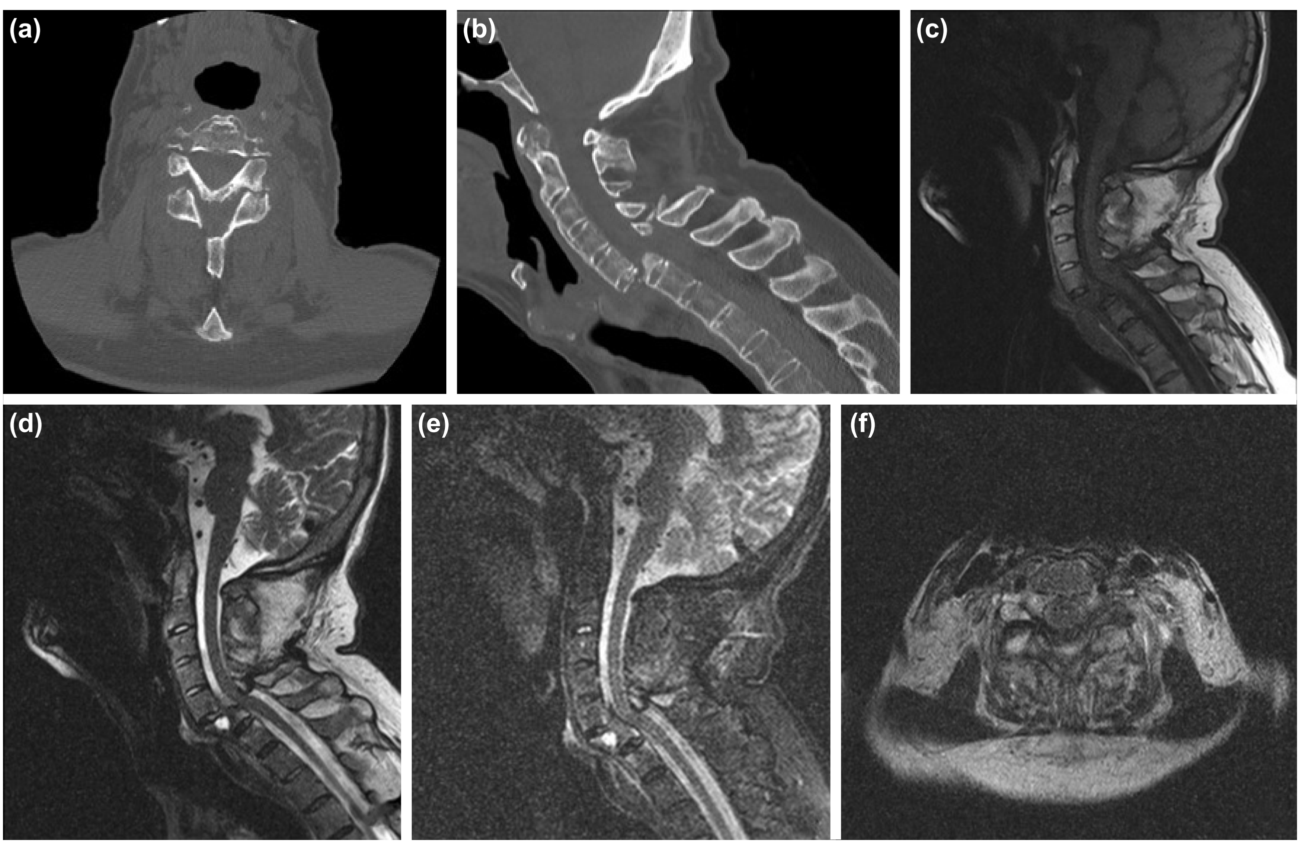

Figure 2. Axial **(a)** and reformatted sagittal **(b)** and coronal **(c)** CT images of the cervical spine. Multiple fractures and dislocation are seen at the level of C5 and C6 vertebrae. Sagittal T2 **(d)**, sagittal TIRM **(e)**, and axial T2 **(f)** MR images of the cervical spine and spinal cord show myelopathic signal changes at the level of C5 vertebrae in the spinal cord

significant proportion of unstable CSI cases missed by the CT could be identified using MRI.

Limitations

This is a retrospective study carrying the general limitations of file studies. Beyond the issues related to the robustness of the recorded data, the study population has a wide age range, with demonstrated diversities between children and adults.[18] Additionally, it would be valuable to receive the interpretations of the treating surgeons on the radiological images as well. Furthermore, the study lacks information about long-term follow-up and complication rates. It is possible that there are missed cases in the emergency ward, who experienced some complications. On the other hand, the study hospital receives a significant number of referrals from other institutions. Thus, the high number of the patient influx in the study center can be regarded as an advantage of this study.

Interpretation

Demographic differences are observed in many disease entities, including cervical spine injuries. Among patients undergoing cervical spine radiography in the emergency department, cervical spine injury was more common among the elderly, male subjects.[18] However, we did not observe any difference concerning sex.

Obtunded patients need special attention due to their difficulty in obtaining a reliable physical examination. Although different GCS cut-off levels were proposed to describe obtunded, per the suggestion of Tomycz et al.,[19] we have chosen the threshold as less than 13 and 13 and above. In our sample, only four patients had a GCS score of 13 or less.

Algorithms, such as the Canadian C-spine Rule (CCR) and the NEXUS criteria, have been developed to reduce the rates of unnecessary radiography.[20] However, given the significant morbidities and mortalities associated with cervical trauma, it is understandable that clinicians are cautious in overlooking injuries. In blunt injury patients, assessment of possible instability and avoidance of secondary injury is the primary goals of cervical spine clearance protocols. After a missed spinal injury, the incidence of avoidable neurological deterioration has been reported as high as 60%.[21] Thus, it is usual to observe high tech laboratory investigations in the context of emergency services.

In awake and alert patients who are neurologically intact and without distracting injury, the NEXUS low-risk criteria and the CCR study have proposed that imaging is not necessary.[22,23] However, especially in patients with continuous and persistent cervical tenderness, the use of such criteria is inconsistent.[24] Although for the patients with blunt trauma, where CT has been approved as the standard first step diagnostic tool, the sufficiency of a normal CT result alone, has been observed with doubt. As to one report, the deviation from NEXUS led to the diagnosis of significant injuries in two patients, which would otherwise have been missed.[24] Malhotra et al.[9] reported 15% of the MRI abnormalities consequent a negative CT. Menaker et al.[25] found 9% abnormal MRI results after an initial CT scan and, thus, advocated the continued use of MRI.

The MRI has been preferred for further imaging in unconscious or clinically unevaluable patients.[26] However, the MRI is used frequently, even in alert and awake patients. As to the study of Inaba et al.,[27] 19% of alert and awake patients with a Glasgow Coma Scale Score of 14 to 15 failed the NEXUS low-risk criteria and necessitated CT authorization. Besides, the definition and clinical significance of unstable injury vary between studies and individual doctors. The most commonly used definition of "significant injury" is the three-column model based on NEXUS,[28] which were also utilized in our study. On the other hand, some studies have stressed that MRI is unnecessary. Hogan et al.[29] diagnosed 3.3% injuries by MRI that were not evident on CT; however, none of those injuries were radiographically unstable. Como et al.[30] reported that they removed MRI from their treatment algorithm and did not observe any cases of new neurologic deficits on a 2-year follow-up. Also, Tomycz et al.[19] defended that MRI was not necessary to clear the cervical spine. As reported by Khanna et al.,[31] 49% of the patients without diagnostic clues in the CT scans had injuries identified on MRI, but they all were deemed insignificant. Despite the agreement that the MRI is superior in identifying ligamentous and soft-tissue injuries, the objections for its routine use rely on the relatively low clinical importance of these soft tissue injuries that may not necessitate treatment.

Factors affecting the diagnostic capability of MRI should be considered as well. MRI is sensitive in demonstrating acute edema of the soft tissues within the first 72 hours of the event.[6] Short after this period, soft tissue edema decreases and injury may no longer be visualized by the MRI. In this study, we included only imaging results within the first 48 hours. On the other hand, MRI may be risky, particularly in severely injured unstable patients, because the patient has to be transported from the intensive care unit to a less safe site. Also, the supine position of patients in the gantry of the MRI may lead to increased intracranial pressure, aspiration, and hypoxia. Additionally, the MRI cannot be performed for patients with ferric implants.[32]

On their arrival, many of the trauma patients have a cervical collar. The routine practice in the study institution in such cases is combined ordering of MRI and CT. The MRI is expensive compared to CT. However, this difference is negligible for Turkey. As to the current official communiqué of the Turkish Social Security Institution, a cervical CT costs 63.23 TL (12.14 USD), while an MRI costs 74.72 TL (14.35 USD).[33] Although there are discussions on the cost-effectiveness of MRI, its utility in diagnosing CSI is well-established.[9,11] We consider that from the standpoint of the devastating and irreversible nature of missed CSI, the expenses of MRI obviously counterbalance the upkeep of a quadriplegic in our context.

Conclusion

Interpreted in the light of the heterogeneous literature, our results suggest that the use of MRI to diagnose unstable CSI injury in patients with negative CT findings depends on the decision of emergency physicians, consultant neurosurgeons and neuroradiologists in charge. Even after neurological evaluation and a well-performed negative CT in unstable injuries, obtaining an MRI seems to be justified. Given the serious consequences, all efforts should be made to reach 100% sensitivity in detecting CSI and strive to avoid neurological complications. The authors advocate the continued use of MRI in the detection of unstable CSI.

Ethics Committee Approval: The study protocol was approved by the Local Ethics Committee at Ege University Medical Faculty (IRB number: 18-4.1/39; Date: 17 April 2018).

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Conflict of Interest: None declared.

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REFERENCES

1. Martin MJ, Bush LD, Inaba K, Byerly S, Schreiber M, Peck KA, et al; WTA C-Spine Study Group. Cervical spine evaluation and clearance in the intoxicated patient: A prospective Western Trauma Association Multi-Institutional Trial and Survey. J Trauma Acute Care Surg 2017;83:1032–40. [CrossRef]
2. Zakrison TL, Williams BH. Cervical spine evaluation in the bluntly injured patient. Int J Surg 2016;33:246–50. [CrossRef]
3. Reid DC, Henderson R, Saboe L, Miller JD. Etiology and clinical course of missed spine fractures. J Trauma 1987;27:980–6. [CrossRef]
4. Plackett TP, Wright F, Baldea AJ, Mosier MJ, Thomas C, Luchette FA, et al. Cervical spine clearance when unable to be cleared clinically: a pooled analysis of combined computed tomography and magnetic resonance imaging. Am J Surg 2016;211:115–21. [CrossRef]
5. Harris MB, Kronlage SC, Carboni PA, Robert KQ, Menmuir B, Ricciardi JE, et al. Evaluation of the cervical spine in the polytrauma patient. Spine (Phila Pa 1976) 2000;25:2884–91; discussion 2892. [CrossRef]
6. Hoffman JR, Wolfson AB, Todd K, Mower WR. Selective cervical spine radiography in blunt trauma: methodology of the National Emergency X-Radiography Utilization Study (NEXUS). Ann Emerg Med 1998;32:461–9. [CrossRef]
7. Stiell IG, Wells GA, Vandemheen KL, Clement CM, Lesiuk H, De Maio VJ, et al. The Canadian C-spine rule for radiography in alert and stable trauma patients. JAMA 2001;286:1841–8. [CrossRef]
8. Holmes JF, Akkinepalli R. Computed tomography versus plain radiography to screen for cervical spine injury: a meta-analysis. J Trauma 2005;58:902–5. [CrossRef]
9. Malhotra A, Wu X, Kalra VB, Nardini HK, Liu R, Abbed KM, et al. Utility of MRI for cervical spine clearance after blunt traumatic injury: a meta-analysis. Eur Radiol 2017;27:1148–60. [CrossRef]
10. Malhotra A, Wu X, Mahalingam S. Cervical spine magnetic resonance imaging in blunt cervical trauma patients. J Trauma Acute Care Surg 2017;83:748–9. [CrossRef]
11. Maung AA, Johnson DC, Barre K, Peponis T, Mesar T, Velmahos GC, et al; ReCONECT MRI C-SPINE Study Group. Cervical spine MRI in patients with negative CT: A prospective, multicenter study of the Research Consortium of New England Centers for Trauma (ReCONECT). J Trauma Acute Care Surg 2017;82:263–9. [CrossRef]
12. Young AJ, Wolfe L, Tinkoff G, Duane TM. Assessing Incidence and Risk Factors of Cervical Spine Injury in Blunt Trauma Patients Using the National Trauma Data Bank. Am Surg 2015;81:879–83.
13. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Version 2. PLoS Med 2007;4:e296. [CrossRef]
14. van Laarhoven JJ, Lansink KW, van Heijl M, Lichtveld RA, Leenen LP. Accuracy of the field triage protocol in selecting severely injured patients after high energy trauma. Injury 2014;45:869–73. [CrossRef]
15. Denis F. The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. Spine (Phila Pa 1976) 1983;8:817–31. [CrossRef]
16. Vaccaro AR, Hulbert RJ, Patel AA, Fisher C, Dvorak M, Lehman RA Jr, et al; Spine Trauma Study Group. The subaxial cervical spine injury classification system: a novel approach to recognize the importance of morphology, neurology, and integrity of the disco-ligamentous complex. Spine (Phila Pa 1976) 2007;32:2365–74. [CrossRef]
17. Lenth R. Java Applets for Power and Sample Size [Computer software] 2009. Available from: https://homepage.divms.uiowa.edu/~rlenth/Power/. Accessed May 24, 2018.
18. Lowery DW, Wald MM, Browne BJ, Tigges S, Hoffman JR, Mower WR; NEXUS Group. Epidemiology of cervical spine injury victims. Ann Emerg Med 2001;38:12–6. [CrossRef]
19. Tomycz ND, Chew BG, Chang YF, Darby JM, Gunn SR, Nicholas DH, et al. MRI is unnecessary to clear the cervical spine in obtunded/comatose trauma patients: the four-year experience of a level I trauma center. J Trauma 2008;64:1258–63. [CrossRef]
20. Stiell IG, Clement CM, McKnight RD, Brison R, Schull MJ, Rowe BH, et al. The Canadian C-spine rule versus the NEXUS low-risk criteria in patients with trauma. N Engl J Med 2003;349:2510–8. [CrossRef]
21. Todd NV, Skinner D, Wilson-MacDonald J. Secondary neurological deterioration in traumatic spinal injury: data from medicolegal cases. Bone Joint J 2015;97-B:527–31. [CrossRef]
22. Griffith B, Bolton C, Goyal N, Brown ML, Jain R. Screening cervical spine CT in a level I trauma center: overutilization?. AJR Am J Roentgenol 2011;197:463–7. [CrossRef]
23. Duane TM, Wilson SP, Mayglothling J, Wolfe LG, Aboutanos MB, Whelan JF, et al. Canadian Cervical Spine rule compared with computed tomography: a prospective analysis. J Trauma 2011;71:352–5; discussion 355–7. [CrossRef]
24. Morrison J, Jeanmonod R. Imaging in the NEXUS-negative patient: when we break the rule. Am J Emerg Med 2014;32:67–70. [CrossRef]
25. Menaker J, Philp A, Boswell S, Scalea TM. Computed tomography alone for cervical spine clearance in the unreliable patient--are we there yet?. J Trauma 2008;64:898–904. [CrossRef]

26. Hadley MN, Walters BC, Grabb PA, Oyesiku NM, Przybylski GJ, Resnick DK, et al. Radiographic assessment of the cervical spine in asymptomatic trauma patients. Neurosurgery 2002;50:S30–5. [CrossRef]
27. Inaba K, Byerly S, Bush LD, Martin MJ, Martin DT, Peck KA, et al; WTA C-Spine Study Group. Cervical spinal clearance: A prospective Western Trauma Association Multi-institutional Trial. J Trauma Acute Care Surg 2016;81:1122–30. [CrossRef]
28. Fisher BM, Cowles S, Matulich JR, Evanson BG, Vega D, Dissanaike S. Is magnetic resonance imaging in addition to a computed tomographic scan necessary to identify clinically significant cervical spine injuries in obtunded blunt trauma patients?. Am J Surg 2013;206:987–94. [CrossRef]
29. Hogan GJ, Mirvis SE, Shanmuganathan K, Scalea TM. Exclusion of unstable cervical spine injury in obtunded patients with blunt trauma: is MR imaging needed when multi-detector row CT findings are normal?. Radiology 2005;237:106–13. [CrossRef]
30. Como JJ, Leukhardt WH, Anderson JS, Wilczewski PA, Samia H, Claridge JA. Computed tomography alone may clear the cervical spine in obtunded blunt trauma patients: a prospective evaluation of a revised protocol. J Trauma 2011;70:345–51. [CrossRef]
31. Khanna P, Chau C, Dublin A, Kim K, Wisner D. The value of cervical magnetic resonance imaging in the evaluation of the obtunded or comatose patient with cervical trauma, no other abnormal neurological findings, and a normal cervical computed tomography. J Trauma Acute Care Surg 2012;72:699–702. [CrossRef]
32. Dunham CM, Brocker BP, Collier BD, Gemmel DJ. Risks associated with magnetic resonance imaging and cervical collar in comatose, blunt trauma patients with negative comprehensive cervical spine computed tomography and no apparent spinal deficit. Crit Care 2008;12:R89. [CrossRef]
33. Communique on the changes in the Social Security Institution [Sosyal Güvenlik Kurumu sağlık uygulama tebliğinde değişiklik yapılmasına dair tebliğ]. Off Gaz Repub Turkey 2018;July 5. Available from: https://www.resmigazete.gov.tr/eskiler/2018/07/20180705M1-1.htm.

ORİJİNAL ÇALIŞMA - *ÖZET*

Anstabil servikal yaralanmalarda bilgisayarlı tomografi ve manyetik rezonans görüntüleme bulgularının karşılaştırılması

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AMAÇ: Bu çalışmanın amacı atlanabilen anstabil servikal yaralanmaların belirlenmesinde bilgisayarlı tomografinin (BT) rolünü araştırmaktır.
GEREÇ VE YÖNTEM: Bu çalışmada acil servise Haziran 2014 ile Haziran 2018 arasında künt servikal travma tanısı ile başvuran olgular yer almaktadır. Tüm olgular ilk önce yapılan bir BT incelemesini takiben servikal manyetik rezonans görüntülemesine (MRG) tabi tutulmuşlardır. Tüm görüntüleme sonuçları gözden geçirilmiş ve kararlar acil tıp uzmanı, nöroradyolojist ve beyin cerrahından oluşan bir ekip tarafından fikir birliği ile alınmıştır. Diğer değişkenler arasında yaş, cinsiyet, Glasgow koma skalası, ek morbidite, çoklu travma, nörolojik defisitler, intrakraniyal hemoraji, ekstremite kırıkları ve yaralanmanın mekanizması yer almaktadır.
BULGULAR: Çalışmaya alınan 195 hastanın bilgileri analiz edildiğinde; hastaların ortalama yaşı (±standart sapma) 47.34±21.90 yıl olup 140'ı erkek (%71.8) 18'i (%9.2) 18 yaşın altında idi. En sık görülen yaralanma mekanizması yüksekten düşme idi (n=100; %51.3). Altın standart olarak MRG kullanılmış olup, anstabil servikal travma tanısında BT'nin duyarlılığı %77.7 (%95 GA [67.1–86.1]) iken, özgüllüğü %100.0 (%95 GA [59.0–100.0]) saptanmıştır.
TARTIŞMA: Her ne kadar BT anstabil servikal yaralanmaların tanısında rölatif olarak iyi olsa da duyarlılığı yeterli değildir. Bundan dolayı anstabil yaralanması olan olgularda MRG çekilmesi daha uygundur.
Anahtar sözcükler: Bilgisayarlı tomografi; boyun yaralanmaları; manyetik rezonans görüntüleme; sensivite ve spesifite; servikal vertebra.

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