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Evaluation of the diagnostic efficacy of computed tomography imaging in trauma patients

Furkan Soy[1], Ozan Pehlivan[2], Ayşe Didem Çakır[3], Sinan Oğuzhan Özsan[4]

[1]Department of Orthopedics and Traumatology, Kahramankazan State Hospital, Ankara, Turkiye
[2]Department of Orthopedics and Traumatology, Beytepe Murat Erdi Eker State Hospital, Ankara, Turkiye
[3]Infection Control Nurse, Kahramankazan State Hospital, Ankara, Turkiye
[4]Department of Emergency Medicine, Kahramankazan State Hospital, Ankara, Turkiye

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Corresponding Author: Furkan Soy, dr.furkansoy@gmail.com

ABSTRACT

Aims: The objective of this study was to assess the efficacy of computed tomography imaging tests ordered for trauma patients in the emergency medicine service and to identify pathologies in the imaging.

Methods: A retrospective evaluation was conducted on trauma patients who applied to our hospital's Emergency Medicine Department between 01 January 2023 and 01 October 2023 and underwent diagnostic computed tomography imaging (CT).

Results: A total of 4193 CT scans were analysed in 3641 patients. Falls were the most common etiological cause (n=3451, 82.3%). Pathology was detected in 25.87% of CT orders. The most frequently used CT type was cranial CT (n=1687, 40.22%). The highest rate of pathology was found in scapula CT (75%), while the lowest rate was observed in cervical spine CT (13%). The most common pathology was detected in cranial CT (n=457).

Conclusion: The accessibility of relevant specialists to emergency physicians reduces the number of unnecessary CT imaging orders. In the emergency department, physicians should adhere to internationally accepted guidelines when ordering advanced imaging studies.

Keywords: Emergency department, computed tomography, efficiency, consultation, trauma

INTRODUCTION

Emergency departments are areas where diagnostic tests and treatments are carried out simultaneously. In evaluating patients, it is important to take an adequate medical history, perform a thorough physical examination, and conduct necessary diagnostic tests. However, in busy emergency departments, it may not always be possible to obtain an adequate patient and family history, and physical examinations may be limited to the affected system. To prevent unnecessary radiation exposure and reduce the cost of unnecessary examinations, it is important for physicians to determine the appropriate examinations that will lead to a diagnosis and order the necessary diagnostic tests. This will also help to prevent time loss.[1,2]

On the other hand, one of the most critical issues affecting emergency departments is the problem of crowding. This issue of crowding is a multifaceted problem affecting emergency services.[1] In this challenging environment, emergency physicians have increasingly relied on advanced technology rather than their clinical skills to minimise errors in clinical diagnoses. This approach aims to ensure objectivity and precision in the diagnostic process.[3]

In recent years, radiological imaging methods have become increasingly important for diagnosing patients and diseases. Conventional radiographs and computed tomography (CT) imaging are particularly accessible in almost every emergency department. However, this easy accessibility has led to a significant increase in the number of unnecessary radiological imaging examinations without appropriate indications. The increasing number of off-label investigations has led to a rise in health expenditures, raising concerns about cost-effectiveness.[4]

The use of high-level imaging methods, particularly CT, has increased in emergency departments due to the growing significance of imaging in diagnosis and the ease of access to imaging techniques such as CT and magnetic resonance imaging (MRI). Consequently, patients and healthcare personnel are exposed to higher levels of radiation. Requests for investigations should only be made when appropriate indications are present. Failure to do so can lead to increased length of stay for patients in the emergency department, which in turn contributes to overcrowding and increased healthcare expenditures and personnel utilisation.[5,6]

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Providing an efficient, safe, and effective imaging service in emergency departments requires attention to three main factors: awareness, compliance, and control. Healthcare professionals and patients must be informed about the harmful effects of radiation. Guidelines and compliance criteria should be followed when requesting imaging, and routine clinical audits should be conducted to ensure control. Excessive imaging can be prevented by analyzing the underlying factors. This approach can protect patients and healthcare workers from the harmful effects of radiation, while also reducing emergency department density and health expenditures to some extent.[5]

The study evaluated CT imaging of patients admitted to the emergency department of Kahramankazan State Hospital due to trauma with various etiological factors during the first 9 months of 2023. The objective of our study was to analyse the demographics of CT imaging requests in the emergency department, including the presence or absence of pathology in the imaging, the time of day during which CT orders were requested, and the distribution of speciality areas among requesting physicians.

METHODS

This is a retrospective cross-sectional study conducted in the Emergency Medicine Department of Kahramankazan State Hospital. The study received ethics committee approval from Ankara Etlik City Hospital No. 1 Clinical Research Ethics Committee (Date: 22.11.2023, Decision No: AEŞH-EK1-2023-702) and was carried out in accordance with the principles of the Declaration of Helsinki.

This study included patients aged 12 years and older who were admitted to the Emergency Department of Kahramankazan State Hospital between 01 January 2023 and 01 October 2023 for trauma and underwent CT scans for diagnostic purposes. Patients without radiological imaging despite a CT order, patients with CT imaging that was not reported by the radiology clinic, and patients with missing imaging data were excluded from the study.

The patient files and hospital information system contain age and gender information, as well as the type of CT requested, which may include cranial CT, maxillofacial CT, cervical spine CT, scapula CT, shoulder CT, elbow CT, hand-wrist-arm CT, thorax CT, thoracic spine CT, lumbar spine CT, pelvis CT, hip CT, or knee CT, and foot-ankle CT. The study investigated the physician who requested the CT examinations, the time period during which the CT examination was requested, the results of the CT reports, the body region in which pathology was observed in patients with pathology, and the type of pathology observed.

The study divided the examination results into two categories: those with pathology (+) and those without pathology (-). The primary objective was to determine the rate of pathology detection in the requested CT scans. The study also analyzed the demographics of the requested CT scans, the distribution of the ordering physician's branch, and the comparison of working hours.

The analysis compared patients who had CT scans ordered based on their socio-demographic data, pathology in imaging results, study period, and the physician's branch. Patient ages were grouped and recorded. Patients who had CT scans ordered were analyzed within their respective age and CT type groups.

Statistical Analysis

Statistical analyses were conducted using SPSS version 21.0 (IBM®, Chicago, USA). Descriptive statistics were presented as mean and standard deviation for normally distributed numerical data, median and lower-upper value for non-normally distributed data, and number and percentage for nominal data. Two-group comparisons of normally distributed variables were performed using an independent samples t-test, while non-normally distributed variables were compared using the Mann-Whitney U test. The study analysed nominal data between the two groups using the Chi-square test and Fisher exact test. Statistical analyses considered comparisons with a p-value below 0.05 as statistically significant.

RESULTS

The study included 3,641 patients who underwent a total of 4,193 CT scans. The mean age of the patients was 42.97±22.66 years (range 12-99 years), with the most common age group being 22-45 years (37.1%). Of the patients, 56.6% (n=2061) were male (Table 1).

Table 1. Demographic characteristics of study participants

		n	%	n	
Gender	Female	1580	43.4	3641	100
	Male	2061	56.6		
Age	12-21	731	20.1	3641	100
	22-45	1350	37.1		
	46-60	659	18.1		
	61 and older	901	24.7		
	Min. 2	Max. 99	Average 42.97	SD 22.66	

Min: Minimum, Max: Maximum, SD: Standart deviation

Among patients who underwent CT imaging, falls (n=3451, 82.3%) were the most common cause, followed by traffic accidents (n=339, 8.06%) (Table 2). Table 2 also provides information on other causes. 60.4% of the patients (n=2534) presented to the emergency department outside of working hours as the time period in which radiological examination was performed.

Table 2. Reasons for admission to the emergency department and the time period of admission

		n	%	n	
Diagnosis	Fall	3451	82.3	4193	100
	Traffic Accident	338	8.06		
	Assault	186	4.44		
	Work accident	156	3.72		
	Other	62	1.48		
Time period of radiological examination	Working hours	1659	39.6	4193	100
	Off-hours	2534	60.4		

The most frequently requested CT scans from patients were cranial CT (n=1687, 40.22%) and pelvis CT (n=1237, 29.49%). The other CT types were thorax CT (n=548, 13.07%), lumbar spine CT

(n=187, 4.46%), cervical spine CT (n=156, 3.72%), thoracic spine CT (n=156, 3.72%), maxillofacial CT (n=58, 1. 38%), foot-ankle CT (n=39, 0.93%), hip CT (n=29, 0.69%), hand-wrist-arm CT (n=27, 0.67%), shoulder CT (n=25, 0.62%), knee CT (n=25, 0.60%), elbow CT (n=14, 0.33%), scapula CT (n=4, 0.10%). No pathology was observed in 74.13% (n=3108) of the patients, while pathology was observed in 25.87% (n=1085)(Table 3). The CT type with the highest percentage of pathology was scapular CT (n=3, 75%). The CT type with the second highest percentage of pathology was hand-wrist-arm CT (n=20, 71%).

Table 3. Distribution of the types of CT requested and the presence of positive findings

Requested CT type	CT count	CT ratio	Number of CTs with positive pathological findings	Pathological finding positive CT rate
Cranial CT	1687	40.22%	457	27%
Pelvis CT	1237	29.49%	279	23%
Thorax CT	548	13.07%	123	22%
Lumbar spine CT	187	4.46%	47	25%
Cervical spine CT	156	3.72%	21	13%
Thoracic spine CT	156	3.72%	34	22%
Maxillofacial CT	58	1.38%	22	38%
Foot-ankle CT	39	0.93%	24	62%
Hip CT	29	0.69%	19	66%
Hand-wrist-arm CT	27	0.67%	20	71%
Shoulder CT	25	0.62%	18	69%
Knee CT	25	0.60%	10	40%
Elbow CT	14	0.33%	8	57%
Scapula CT	4	0.10%	3	75%
Total	4193	100%	1085	% 25.87

CT: Computed tomography

Imaging tests were ordered by general practitioners in 49.2% of cases (n=2063), by emergency medicine specialists in 30.6% (n=1283), and by consultant specialists in 20.2% (n=847) (Table 4). Consultation procedures were performed during off-hours 56.6% of the time (Table 5).

Table 4. Distribution of the specialty of the physician who requested the CT imaging

	n	%
General practitioner	2063	49.2
Specialist in emergency medicine	1283	30.6
Specialist consultant	847	20.2

CT: Computed tomography

Table 5. Distribution of consultation time

Time period consulted with consultant physician	n	%
Working hours	368	43.4
Off-hours	479	56.6
Total	847	100

The frequency of pathology in CT imaging ordered by consultant physicians was significantly higher than that ordered by general practitioners or emergency specialists ($p<0.001$). Statistically significant differences were observed for wrist-arm CT, hip CT, cranial CT, maxillofacial CT, shoulder CT, pelvis CT, cervical spine CT, trochal spine CT and thorax CT. There was no statistically significant difference found between consultant specialists and general practitioners in foot-ankle CT, elbow CT, and knee CT imaging. The study did not include CT imaging requested by emergency medicine specialists in these three CT imaging groups. Additionally, no statistically significant difference was found between the three physician branches in CT imaging of the lumbar spine ($p=0.0516$)(Table 6).

Table 6. Distribution of the presence of pathology according to CT imaging types according to the requesting physician's branch

CT Type	Presence of pathology	Specialist consultant n	Specialist consultant %	Specialist in EM n	Specialist in EM %	General Practitioner n	General Practitioner %	Total n	Total %	Statistical analysis
Foot-foot ankle CT	+	15	1.80	-	-	9	0.44	24	0.6	X^2:0.488 p:0.485
	-	11	1.30	-	-	4	0.20	15	0.4	
Elbow CT	+	7	0.80	-	-	1	0.04	8	0.2	X^2:0.884 p:0.347
	-	4	0.50	-	-	2	0.10	6	0.1	
Knee CT	+	9	1.10	-	-	1	0.04	10	0.22	X^2:1.22 p:0.3269
	-	10	1.20	-	-	4	0.20	14	0.3	
Hand-wrist-arm CT	+	19	2.20	-	-	1	0.04	20	0.5	X^2:14.9 p<0.001
	-	2	0.20	-	-	6	0.30	8	0.2	
Hip CT	+	16	1.90	-	-	3	0.14	19	0.5	X^2:3.83 p:0.04
	-	5	0.60	-	-	5	0.24	10	0.23	
Cranial CT	+	46	5.40	164	12.8	247	12.00	457	10.90	X^2:5.107 p<0.001
	-	31	3.70	597	46.5	602	29.18	1230	29.31	
Lumbar spine CT	+	5	0.60	15	1.17	27	1.30	47	1.12	X^2:1.325 p:0.516
	-	8	0.90	48	3.7	84	4.10	140	3.33	
Maxillofacial CT	+	6	0.70	7	0.55	9	0.44	22	0.50	X^2:7.904 p:0.01
	-	1	0.10	13	1.53	22	1.10	36	0.90	
Shoulder CT	+	2	0.20	4	0.31	11	0.60	18	0.43	X^2:2.215 p:0.033
	-	1	0.10	4	0.31	3	0.14	8	0.20	
Pelvis CT	+	147	17.40	4	0.31	128	6.20	279	6.70	X^2:15.873 p<0.001
	-	445	52.50	76	5.9	437	21.10	958	22.80	
Cervical spine CT	+	4	0.50	2	0.16	15	0.70	21	0.50	X^2:11.541 p:0.003
	-	6	0.70	54	4.2	75	3.60	135	3.20	
Thoracic spine CT	+	7	0.80	14	1.1	13	0.60	34	0.80	X^2:12.182 p:0.002
	-	4	0.50	59	4.6	59	2.90	122	2.90	
Thorax CT	+	16	1.90	39	3.04	72	3.50	127	3.02	X^2:13.221 p<0.001
	-	20	2.40	183	14.3	222	10.80	425	10.14	
Total		847	20.2	1283	30.6	2063	49.2	4193	100	X^2:6.724 p<0.001

CT: Computed tomography, EM: Emergency medicine

DISCUSSION

The rise in the use of imaging techniques in emergency medical services has garnered global attention. Some studies analyzing this increase have found no significant change in the profit/loss ratio despite increased use of CT.[7,8] However, data suggests that the rate of emergency department admissions has doubled in about 15 years. An increase in the number of admissions leads to a linear increase in the number of investigations ordered.[9]

The use of advanced imaging modalities and its effectiveness and results are important research topics. According to the European Union (EU) Health Statistics Report, Turkiye ranked first in MRI scans and eighth in CT scans between 2011 and 2014. While the EU average saw a 49% increase in CT utilization, Turkey experienced a 60% increase.[10]

In the field of emergency medicine services, Oğuz et al.[11] observed a 3.6% increase in the number of patients admitted to the emergency department in 2000 compared to 1998. Additionally, the frequency of CT requests increased by 69%. The study found that normal results in cranial, maxillofacial, and cervical CT imaging increased in 2000, while major and minor findings decreased. The main objective of our study was to demonstrate the frequency of pathology observed in CT imaging studies ordered in emergency medicine services. We did not investigate the number of investigations requested by year. However, our findings indicate that the majority (74.13%) of diagnostic imaging studies ordered in emergency departments did not reveal any pathological findings.

Yıldız et al.[12] analysed 1700 patients admitted to the emergency department of a secondary care hospital who underwent CT scans. The study found that cranial CT was the most frequently requested scan for patients admitted due to trauma. Pathology was observed in 7% of patients who underwent cranial CT and 10.7% of patients who underwent thoracic CT. Furthermore, it was reported that 98.5% of cranial imaging studies conducted on childhood trauma patients showed no signs of pathology. Similarly, in our study, cranial CT scans were the most commonly requested type (40.22%). We found pathology in 27% of cranial CT results, indicating a higher rate of positive pathological findings compared to the aforementioned study.

Yıldız et al.[12] conducted a study which found that pathology was detected in approximately 71% of patients who underwent CT of the spine. The rates of pathology detection in maxillofacial CT and extremity CT were 53.8% and 65.1%, respectively. These CT imaging modalities, especially for the affected trauma site, increased the frequency of pathology detection. This suggests that CT imaging of the trauma focus, after careful examination, would be more effective in multiple trauma patients. The study found that the incidence of pathological findings on CT imaging of the cervical, thoracic, and lumbar spine was 13%, 22%, and 25%, respectively. These results suggest that a more detailed examination of the spine should be performed in patients presenting to the emergency department. Routine pan-spine CT imaging should be avoided in multitrauma patients, even if no positive findings are present.

Arslan et al.[13] conducted a study evaluating 2012 CT scans ordered for trauma patients admitted to a tertiary emergency medicine service. The study found that 23.9% of CT orders showed pathology, with cranial CT being the most frequently ordered type (64.3%). Our study, which parallels Arslan et al.'s findings, showed a 25.87% rate of positive pathological findings in CT orders. Similarly, the most commonly ordered type of CT in our study was cranial CT.

In our study, the type of CT with the highest percentage of positive pathology was scapular CT (n=3, 75%). However, we believe that this result may be due to the low number of isolated scapular CT orders. The CT type we use to detect scapular pathology in trauma patients is thoracic CT, which is generally useful in revealing accompanying costal pathologies. Therefore, we believe that a certain proportion of patients with scapular pathology may be included in the thorax CT request type.

Swartzberg and Goldstein[14] evaluated CT orders in patients admitted to the adult emergency department over a 4-month period in 2018. The study found that CT was requested in only 4.6% of admitted patients, with the majority of requests coming from trauma patients. Of the cranial CTs performed, 53.8% yielded positive results. This rate was 47.1% in trauma patients and 61.8% in non-trauma patients. Based on these findings, it can be concluded that imaging modalities ordered in the emergency department yield a high rate of negative results not only in our country but also in other countries. This issue is not limited to a specific region or nation, but rather a global problem. To address this, it is crucial to implement diagnostic and clinical decision-making algorithms when using these diagnostic methods in the emergency department. This will help prevent unnecessary imaging requests.

Our study found a higher rate of positive pathology in extremity and maxillofacial CT types compared to spine and cranial CT types. This may be attributed to the fact that our hospital had 3 orthopaedic surgeons and 2 ENT specialists during the study period, but no spine surgeon or neurosurgeon. In daily emergency department consultation procedures, the general practitioner or emergency medicine specialist can easily consult the relevant specialist physician. Conventional radiographs and CT scans are ordered only after the patient has been examined by the specialist physician. This approach significantly reduces the number of unnecessary CT scans. It has been concluded that improving access to relevant specialist physicians can reduce the number of unnecessary CT scans. With this aspect of our study, it is concluded that the number of unnecessary CT imaging will decrease in cases where access to the relevant specialist physician becomes easier.

Several measures have been proposed to reduce the number of unnecessary requests for CT imaging. The 'New Orleans' and 'Canadian CT HeadRule' criteria have been shown to have high sensitivity in central nervous system imaging for trauma patients. Similar guidelines have also been established for non-traumatic patients.[15] In a 2015 study by Kanzaria et al.,[16] 435 emergency physicians were evaluated. The study found that 85% of physicians believed that too many diagnostic tests were being requested in their emergency department. Additionally, almost all physicians reported that some of the advanced imaging tests requested were medically unnecessary. Physicians have suggested that reducing the number of unnecessary imaging tests could be achieved through malpractice reform, patient education, providing feedback to physicians on test requests, and educating physicians on diagnostic imaging tests.

Limitations

The study has some limitations. Firstly, we only evaluated CT orders for admissions within a 9-month period, which may have limited the comprehensiveness of our results. Secondly, due to the retrospective nature of the study, we were unable to evaluate the clinical findings of the patients. Instead, we considered the reason for ordering the examination and the presence or absence of pathology in the examination results. Another limitation of our study is that we did not evaluate the frequency of CT orders and the density of patients in the emergency department according

to the number of patients and the increase in the number of patients according to the years.

Further studies, which will include the clinical findings of the patients and emergency department patient density data, can evaluate the frequency of CT ordering in emergency departments, the reasons for CT ordering by emergency department physicians, the fear of malpractice and the extent of defensive medicine.

CONCLUSION

The high frequency of requests for cranial and pelvic CT scans, coupled with the high rate of negative results, highlights the need for caution when ordering these scans. It is important to conduct a thorough physical examination of the patient before ordering these scans and to carefully analyze the reasons for the request. As a result of our study, we found that easier access to relevant specialist physicians increased the rate of positive pathology in CT imaging. To reduce the number of examination orders and healthcare costs, physicians should use internationally accepted guidelines when ordering radiological imaging.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of Ankara Etlik City Hospital No. 1 Clinical Researches Ethics Committee (Date: 22.11.2023, Decision No: AEŞH-EK1-2023-702).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Rasouli HR, Aliakbar Esfahani A, Abbasi Farajzadeh M. Challenges, consequences, and lessons for way–outs to emergencies at hospitals: a systematic review study. *BMC Emerg Med*. 2019;19(1):62.
2. Hinson JS, Martinez DA, Cabral S, et al. Triage performance in emergency medicine: a systematic review. *Ann Emerg Med*. 2019;74(1):140-152.
3. Larson DB, Johnson LW, Schnell BM, Salisbury SR, Forman HP. National trends in CT use in the emergency department: 1995–2007. *Radiol*. 2011;258(1):164-173.
4. Griffey RT, Jeffe DB, Bailey T. Emergency physicians' attitudes and preferences regarding computed tomography, radiation exposure, and imaging decision support. *Acad Emerg Med*. 2014;21(7):768-777.
5. Azman RR, Shah MNM, Ng KH. Radiation safety in emergency medicine: balancing the benefits and risks. *Korean J Radiol*. 2019;20(3):399.
6. Tung M, Sharma R, Hinson JS, Nothelle S, Pannikottu J, Segal JB. Factors associated with imaging overuse in the emergency department: a systematic review. Am J Emerg Med. 2018;36(2):301-309.
7. Korley FK, Pham JC, Kirsch TD. Use of advanced radiology during visits to US emergency departments for injury-related conditions, 1998-2007. *Jama*. 2010;304(13):1465-1471.
8. Wiener RS, Schwartz LM, Woloshin S. Time trends in pulmonary embolism in the United States: evidence of overdiagnosis. *Arch Intern Med*. 2011;171(9):831-837.
9. Raja AS, Ip IK, Sodickson AD, et al. Radiology utilization in the emergency department: trends of the past 2 decades. *Am J Roentgenol*. 2014;203(2):355-360.
10. Demir MC, Akkas M. Awareness of risks associated with the use of plain X-Ray, computed tomography, and magnetic resonance imaging among emergency physicians and comparison with that of other physicians: a survey from Turkey. *Med Sci Monitor: International Med J Experiment Clin Res*. 2019;25:6587-6597.
11. Oguz KK, Yousem DM, Deluca T, Herskovits EH, Beauchamp NJ. Effect of emergency department CT on neuroimaging case volume and positive scan rates. *Acad Radiol*. 2002;9(9):1018-1024.
12. Yıldız ÖÖ, Eraybar S, Kaya H, Armağan, E. Acil serviste yapılan bilgisayarlı tomografi görüntüleme istemleri ne kadar etkin? *J Contemp Med*. 2019;9(3):249-254.
13. Arslan E, Aydın İ, Lök U, et al. Acil servisten istenen radyolojik görüntüleme incelemelerinin etkinliğinin değerlendirilmesi. *Adıyaman Üniv Sağ Bil Derg*. 2021;7(2):136-145.
14. Swartzberg K, Goldstein LN. High positive computed tomography yields in the emergency department might not be a positive finding. *South African Med J*. 2018;108(3):230-234.
15. Stiell IG, Wells GA, Vandemheen K, et al. The Canadian CT head rule for patients with minor head injury. *Lancet*. 2001;357(9266):1391-1396.
16. Kanzaria HK, Hoffman JR, Probst MA, Caloyeras JP, Berry SH, Brook RH. Emergency physician perceptions of medically unnecessary advanced diagnostic imaging. *Acad Emerg Med*. 2015;22(4):390-398.