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Research Article

Whole-body computed tomography after major blunt trauma: is it necessary?

Majör künt travma sonrası rutin tüm vücut bilgisayarlı tomografi: Gerekli mi?

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Abstract

Introduction: Trauma is a significant health problem today. Also, it is the foremost reason for death among people ages 1-45; for this reason, the economic and social effect is more articulated. The whole-body CT scans have become a standard procedure in managing trauma patients in many trauma centers. We think that whole body CT will be beneficial in patients with blunt trauma. Thus, we aimed to examine patients with blunt trauma who applied to the emergency department and had whole-body CT scans.
Methods: Patient who applied to blunt trauma and had whole-body CT scans to the emergency department of a tertiary training and research hospital between Jan 1, 2021, and Jan 1, 2022, were examined in this single-center, retrospective study. The study population was established based on inclusion and exclusion criteria. ISS, GCS, and whole-body CT scans were compared for mortality.
Results: Cranial bone fracture (p= 0.001), epidural hemorrhage (p= 0.001), traumatic subarachnoid hemorrhage (p= 0.001), cerebral edema (p= 0.003), and thoracic contusion (p= 0.046) were significant for mortality. Also, the number of pathological regions in whole-body CT scans was not associated with mortality (p= 0.587). ISS (p=0.001) and GCS (p= 0.001) predicted mortality in patients who experienced whole-body CT scans.
Conclusion: Based on our findings, we can detect organ and tissue injuries quickly and in detail using whole-body CT scanning after major blunt trauma. In addition, various protocols are needed in multiple trauma patients to reduce the number of unnecessary WBCT scans. Therefore, whole-body CT scans may be helpful for selection, as ISS and GCS are markers of mortality.
Keywords: Whole-body Tomography, Trauma, Trauma Imaging

Öz

Giriş: Travma günümüzde önemli bir sağlık sorunudur. Ayrıca 1-45 yaş arası kişilerde en önde gelen ölüm nedenidir; bu nedenle ekonomik ve sosyal etkisi daha belirgindir. Tüm vücut BT taramaları, birçok travma merkezinde travma hastalarının tedavisinde standart bir prosedür haline geldi. Künt travmalı hastalarda tüm vücut BT'nin faydalı olacağını düşünüyoruz. Bu nedenle acil servise künt travma ile başvuran ve tüm vücut BT çekilen hastaları incelemeyi amaçladık.
Yöntem: Bu tek merkezli, retrospektif çalışmada, üçüncü basamak bir eğitim ve araştırma hastanesinin acil servisine 1 Ocak 2021-1 Ocak 2022 tarihleri arasında künt travma nedeniyle başvuran ve tüm vücut BT görüntüleri çekilen hasta incelendi. Çalışma popülasyonu, dahil etme ve hariç tutma kriterlerine göre oluşturulmuştur. ISS, GKS ve tüm vücut BT taramaları mortalite açısından karşılaştırıldı.
Bulgular: Kafa kemiği kırığı (p= 0,001), epidural kanama (p= 0,001), travmatik subaraknoid kanama (p= 0,001), beyin ödemi (p= 0,003) ve toraks kontüzyonu (p= 0,046) mortalite açısından anlamlıydı. Ayrıca tüm vücut BT taramalarında, patolojik bölge sayısı mortalite ile ilişkili bulunmadı (p= 0,587). ISS (p=0,001) ve GKS (p= 0,001)mortalite ilişkiliydi.
Sonuç: Bulgularımıza dayanarak, major künt travma sonrası tüm vücut BT taraması kullanarak organ ve doku yaralanmalarını hızlı ve ayrıntılı bir şekilde tespit edebiliriz. Buna ek olarak gereksiz WBCT taramasının sayısını azaltmak için çoklu travma hastalarında çeşitli protokellere ihtiyaç vardır. Bu nedenle, ISS ve GKS mortalite belirteçleri olduğundan, tüm vücut BT taraması seçimi için yardımcı olabilir.
Anahtar Kelimeler: Tüm vücut tomografisi, travma, travma görüntülemesi

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Key Points

1. Due to ISS and GCS are markers of mortality, whole-body CT scans may be helpful for selection.
2. The number of pathological regions in whole-body CT scans may not be associated with mortality.
3. Pathologic cranial CT findings may be associated with mortality.

Introduction

Trauma is one of today's pertinent health problems. More than 5 million people die from damages associated with trauma annually, accounting for 9% of global mortality [1]. Trauma is one of the most important causes of death worldwide, especially in the young population. For these reasons, it has obvious economic and social effects on society [2].

Trauma patient management is determined by the advanced trauma life support (ATLS) guidelines' principles. This guideline suggests pelvis and chest radiographs and chest and abdomen ultrasonography (focused assessment with sonography in trauma, FAST) for initial evaluation [3]. This initial imaging may be supplemented by computed tomography (CT) scans of body regions selected based on clinical suspicion. However, whole-body CT (WBCT) has become standard practice in the management of trauma patients in many trauma centers [4]. In more than one study, it has been advocated that the management of patients exposed to severe trauma should be evaluated with WBCT, independent of the injured body region [5, 6]. Despite the critical role of WBCT in the management of trauma patients, concerns remain about the risk of radiation exposure [7].

WBCT consists of imaging the head, neck, chest, abdomen, and pelvis. WBCT provides rapid detection of the vast majority of head and neck, thorax, abdomen, and pelvis injuries with high sensitivity [8]. Especially when using WBCT in the emergency room, radiation exposure to the patient should always be considered, as trauma patients are often at a young age. The radiation dose from WBCT is 10–20 mSv, with a lifetime cancer mortality risk of 0.08% for this dose [9]. Studies have shown that WBCT scans in blunt trauma increase the likelihood of survival. However, its diagnostic accuracy is restricted [10, 11].

We think that WBCT will be beneficial for patients with blunt trauma. Thus, we aimed to examine patients with blunt trauma who applied to the emergency department and had WBCT scans.

Methods

Study Design

Patients who applied to blunt trauma and had whole-body CT scans at the emergency department of a tertiary training and research hospital between January 1, 2021, and January 1, 2022, were examined in this single-center, retrospective study. Approval was obtained before study from the local committee (Decision No. 2022/209, E-40465587-050.01.04–539).

All trauma patients were evaluated in accordance with the advanced trauma life support (ATLS) protocol at the first admission to the emergency department. As a result of the evaluation of the patients, the decision for whole-body CT scan imaging was taken by the emergency medicine physicians within appropriate indications.

Patients who applied to the emergency department for blunt trauma and had whole-body CT scans without meeting the exclusion criteria were enrolled in the study. Patients rejecting diagnosis and treatment, transferred to another institution, with deficient whole-body tomographic scans, child patients (under 18 years old), patients with penetrating trauma, and patients who were dead at the time of presentation to the emergency department were excluded. Our study design is presented in Figure 1.

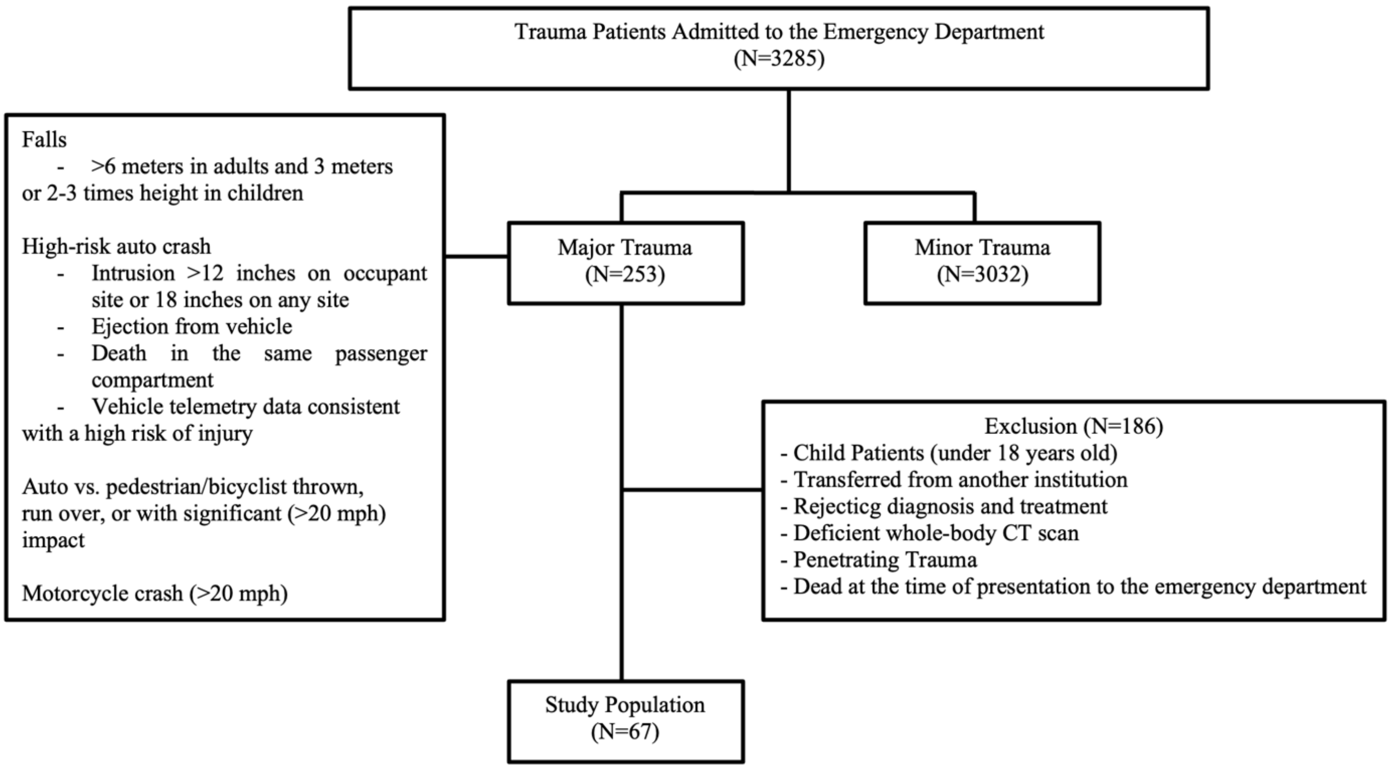

Figure 1. Flow Chart

Study Protocol

The patients' data and whole-body CT at the time of presentation to the emergency department were retrieved from the hospital's digital archive. These included patients' age, gender, mechanisms of injury, whole-body CT findings, mortality, and hospitalization time. Whole-body CT scans were evaluated separately based on their pathologies. In addition, we included patients' Glasgow Coma Score (GCS) and Injury Severity Score (ISS) at the time of the first admission.

All the CT scans were obtained by the 16-slice CT scanner (Toshiba Alexion™, Toshiba Medical Systems Corporation, Nashu, Japan) with a 3-5 mm section thickness. Per ATLS guidelines, all trauma patients needing CT imaging undergo cranial, cervical, thoracic, and abdominal CTs. Radiology experts reported these CTs.

The patients' data included in the study were categorized and compared according to their mortality status after hospitalization.

Endpoints

The endpoint of this study was the analysis of whole-body CT scans of blunt trauma patients.

Statistical Analysis

All analyses were performed on Jamovi v.1.6 statistical software (The Jamovi Project (2021) computer software, version 1.6, Sydney, Australia). Categorical data were expressed in frequency (n) and percentage. Normally distributed continuous variable data were described as mean plus standard deviation (SD) and non-normally distributed data as median and interquartile range (IQR). The normality of the distribution was evaluated using the Shapiro-Wilk test. The t-test was applied in the comparison of continuous variables in cases of normal distribution and the Mann-Whitney U test in cases of non-normal distribution. The chi-square test was used to compare categorical variables between the groups.

Results

Of the 67 patients included in the study, 51 (76.1%) were male and 16 (23.9%) were female. The mean age of the patients was 51.5, with a minimum age of 18 and a maximum age of 84. The most common trauma mechanism was fall and roll in 43 (64.2%) and in-vehicle traffic accidents in 10 (14.9%). Head 29 (43.4%) and chest 26 (39.4%) pathologies were the most common pathologies in whole-body CT scans. The median GCS of the patients was 15, and the interquartile range was 14–15. The median ISS of the patients was 6, and the interquartile range was 4–12. The demographic data, trauma mechanisms, hospitalization, whole-body CT scan data, GCS, and ISS data are summarized in Table 1.

Table 1. The patients' demographic data, trauma mechanisms, hospitalization, whole-body CT scan data, GCS, and ISS data

	All patients (n=67)	No mortality (n=60)	Mortality (n=7)	p value
Gender				
Male	51 (76.1%)	46 (68.6%)	5 (7.5%)	0.758
Female	16 (23.9%)	14 (20.9%)	2 (3.0%)	
Age (Year)	51.5 ± 16.1 (18-84)	50.2 ± 15.6 (18-84)	62.4 ± 17.9 (25-80)	0.056
Trauma mechanisms				
In-Vehicle Traffic Accident	10 (14.9%)	8 (11.9%)	2 (3.0%)	
Non-Vehicle Traffic Accident	5 (7.5%)	4 (6.0%)	1 (1.5%)	0.462
Fall and Roll	43 (64.2%)	39 (58.2%)	4 (6.0%)	
Accident by Object Falling on	9 (13.4%)	9 (13.4%)	0 (0.0%)	
Pathology in whole-body CT scans				
Head	29 (43.3%)	22 (32.8%)	7 (10.5%)	**0.001**
Neck	9 (13.4%)	8 (11.9%)	1 (1.5%)	0.944
Chest	26 (39.4%)	23 (25.8%)	3 (13.6%)	0.843
Abdomen	4 (6.0%)	4 (6.0%)	0 (0.0%)	0.481
Pelvis	6 (9.0%)	7 (9.0%)	0 (0.0%)	0.381
Hospitalization	55 (82.1%)	48 (71.6%)	7 (10.5%)	0.192
Glasgow coma score (GCS)	15 (IQR 14-15)	15 (IQR 15-15)	7 (IQR 7-7.5)	**0.001**
Injury severity score (ISS)	6 (IQR 4-12)	5 (IQR 3.5-10)	42 (IQR 40-51)	**0.001**

IQR. Interquartile Range

Note 1. Normally distributed data are expressed as Mean ± SD (Min.-Max.), Abnormally distributed data as Median (IQR 25-75). Categorical data were expressed in frequency (n) and percentage.

Note 2. Student's t-test was used for normally distributed data and the Mann Whitney U test for abnormally distributed data. The chi-square test was used to compare categorical variables.

Cranial bone fracture (p = 0.001), epidural bleeding (p = 0.001), traumatic subarachnoid hemorrhage (p = 0.001), cerebral edema (p = 0.003), and thorax contusion (p = 0.046) were statistically associated with mortality. Subdural bleeding (p=0.468), pneumocephalus (p=0.427), cervical bone corpus fracture (p=0.726), cervical bone transverse process fracture (p=0.731), cervical bone spinous process fracture (p=0.731), pneumothorax (p=0.517), hemothorax (p=0.468), rib fracture (p=0.488), pneumomediastinum (p=0.731), sternum fracture (p=0.481), spleen laceration (p=0.731), kidney laceration (p=0.624), bladder injury (p=0.731), pelvis bone fracture (p=0.381), orbital bone fracture (p=0.185), maxillary bone fracture (p=0.326), mandibular bone fracture (p=0.731), nasal bone fracture (p=0.545), scapula fracture (p=0.481), clavicle fracture (p=0.185), and femoral neck fracture (p=0.624) were statistically associated with no mortality. The number of pathological regions in whole-body CT scans was 0 (15–22.4%), 1 (26–38.8%), 2 (20–29.9%), 3 (5–7.5%), 4 (1–1.5%), and 5 (0%). The statistics of patients' detailed whole-body CT scans are summarized in Table 2.

Table 2. Patients' detailed whole-body CT scan data

	All Patients (n=67)	No Mortality (n=60)	Mortality (n=7)	P Value
Number of pathological regions in whole-body CT*				
0	15 (22.4%)	15 (22.4%)	0 (0.0%)	
1	26 (38.8%)	23 (34.3%)	3 (4.5%)	
2	20 (29.9%)	17 (25.4%)	3 (4.5%)	0.587
3	5 (7.5%)	5 (6.0%)	1 (1.5%)	
4	1 (1.5%)	1 (1.5%)	0 (0.0%)	
5	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Pathology in whole-body CT				
Cranial Bone Fracture	20 (29.9%)	14 (19.9%)	6 (9.0%)	**0.001**
Epidural Bleeding	4 (6.0%)	1 (1.5%)	3 (4.5%)	**0.001**
Subdural Bleeding	5 (7.5%)	4 (6.0%)	1 (1.5%)	0.468
Traumatic Subarachnoid Hemorrhage	12 (17.9%)	7 (10.4%)	5 (7.5%)	**0.001**
Pneumocephalus	5 (7.5%)	5 (7.5%)	0 (0.0%)	0.427
Cerebral Edema	1 (1.5%)	0 (0.0%)	1 (1.5%)	**0.003**
Cervical Bone Corpus Fracture	7 (10.4%)	6 (9.0%)	1 (1.5%)	0.726
Cervical Bone Transverse Process Fracture	1 (1.5%)	1 (1.5%)	0 (0.0%)	0.731
Cervical Bone Spinous Process Fracture	1 (1.5%)	1 (1.5%)	0 (0.0%)	0.731
Pneumothorax	13 (19.4%)	11 (16.4%)	2 (3.0%)	0.517
Hemothorax	5 (7.5%)	4 (6.0%)	1 (1.5%)	0.468
Thorax Contusion	11 (16.4%)	8 (11.9%)	3 (4.5%)	**0.046**
Rib Fracture	21 (31.3%)	18 (26.8%)	3 (4.5%)	0.488
Pneumomediastinum	1 (1.5%)	1 (1.5%)	0 (0.0%)	0.731
Sternum Fracture	4 (6.0%)	4 (6.0%)	0 (0.0%)	0.481
Spleen Laceration	1 (1.5%)	1 (1.5%)	0 (0.0%)	0.731
Kidney Laceration	2 (3.0%)	2 (3.0%)	0 (0.0%)	0.624
Bladder Injury	1 (1.5%)	1 (1.5%)	0 (0.0%)	0.731
Pelvis Bone Fracture	6 (9.0%)	6 (9.0%)	0 (0.0%)	0.381
Orbital Bone Fracture	3 (4.5%)	2 (3.0%)	1 (1.5%)	0.185
Maxillary Bone Fracture	4 (6.0%)	3 (4.5%)	1 (1.5%)	0.326
Mandibular Bone Fracture	1 (1.5%)	1 (1.5%)	0 (0.0%)	0.731
Nasal Bone Fracture	3 (4.5%)	3 (4.5%)	0 (0.0%)	0.545
Scapula Fracture	4 (6.0%)	4 (6.0%)	0 (0.0%)	0.481
Clavicle Fracture	3 (4.5%)	2 (3.0%)	1 (1.5%)	0.185
Femoral Neck Fracture	2 (3.0%)	2 (3.0%)	0 (0.0%)	0.624

*It refers to the number of pathological regions from the imaging of the head, neck, chest, abdomen, and pelvis in whole-body CT scans.
Note 1. Categorical data were expressed in frequency (n) and percentage.
Note 2. The chi-square test was used to compare categorical variables.

Discussion

Trauma is a significant health problem today. It also affects the society economically and socially, as it is one of the most important causes of death, especially in people aged 1–45 [2]. Trauma patient management is decided by the advanced trauma life support (ATLS) guidelines' principles. This guideline suggests pelvis and chest radiographs and chest and abdomen ultrasonography (focused assessment with sonography in trauma, FAST) for initial evaluation [3]. The decision to have a CT scan following conventional post-traumatic imaging is less clearly defined in the ATLS guidelines and is tied to national guidelines and protocols. Also, patients injured after major trauma often require CT scans of many parts of the body after conventional imaging. In the last few years, whole-body imaging has become a possible alternative to the traditional imaging strategy. Modern multi-detector CT scanners, which have started to be used with increasing technological advances, can perform imaging of the head, cervical spine, chest, abdomen, and pelvis in a single examination (a "whole-body CT scan") [12]. The number of trauma centers using whole-body CT for the early evaluation of major trauma is increasing [4]. Studies have displayed that whole-body CT scans in blunt trauma increase the possibility of survival [10, 11].

In the study conducted by Harntaweesup S et al., the usefulness and outcomes of whole-body computed tomography in trauma patients were investigated. Whole-body CT has been shown to detect significant unexpected organ injuries such as skull base fractures, occult pneumothorax, small intestine, and retroperitoneum [13]. Our study showed that whole-body CT scans made many major and minor diagnoses without being missed. Among these diagnoses, cranial bone fracture, epidural hemorrhage, traumatic subarachnoid hemorrhage, cerebral edema, and thoracic contusion were significant for mortality. Also, subdural bleeding, pneumocephalus, cervical bone corpus fracture, cervical bone transverse process fracture, cervical bone spinous process fracture, pneumothorax, hemothorax, rib fracture, pneumomediastinum, sternum fracture, spleen laceration, kidney laceration, bladder injury, pelvis bone fracture, orbital bone fracture, maxillary bone fracture, mandibular bone fracture, nasal bone fracture, scapula fracture, clavicle fracture, and femoral neck fracture were not significant for mortality.

The study made by Yoong S et al., assessed the sensitivity of whole-body CT for major trauma and observed that whole-body CT in trauma has high sensitivity and a low rate of missed injuries (2.4%) [14].In addition, Salim et al showed that WBCT performed in major trauma patients resulted in treatment change in 19% of 1000 patients without obvious external signs of injury [15]. Our study number of injuries detected per body region is that head 29 (43.3 %), neck 9 (13.4 %), chest 26 (39.4 %), abdomen 4 (6.0 %), and pelvis 6 (9.0 %). Also, no pathological finding was detected in 15 (22.4 %) whole-body CT scans, and no injuries were overlooked in the whole-body CT scans. The presence of head pathology on whole-body CT scans was associated with mortality. However, the number of pathological regions in whole-body CT scans was not associated with mortality.

In the study by Kaya FB et al., the location of whole-body CT scans in trauma patients was investigated, as were the factors affecting mortality. ISS and GCS were found to predict mortality in patients undergoing whole-body CT scans [16]. Our study found that ISS and GCS predicted mortality in patients who experienced whole-body CT scans.

The meta-analysis published by Chidambaram et al. provides evidence suggesting that WBCT is associated with a lower mortality rate. They also noted that WBCT could detect undiagnosed injuries [17]. Arruzza et al., on the other hand, observed that WBCT reduced emergency room times in all studies included in their meta-analysis. Thus, they stated that it would have a faster diagnosis time for definitive treatment and minimize the effect of overcrowding in the emergency room [18]. Despite the benefits of WBCT, a cancer-related death rate of 1 in 1250 has been attributed to CT scans. However, whether morbidity and mortality due to radiation exposure with imaging outweigh "overlooked injuries" is another highly controversial issue [17]. In line with this information, there is a clear need for comprehensive and explanatory studies on whether recent developments show that the risk of not performing WBCT outweighs the risk associated with the examination.

Limitations

There are some limitations to this study. The first is that the nature of the single-center, retrospective study limits the generalizability of our results. Second, due to the study design, the limitation is that pediatric patients and patients with penetrating trauma were omitted. Finally, our data did not include patients' vital signs or whether FAST was performed. This situation caused limitations in discussion and comparison. A large population and multicenter studies are needed to investigate this subject.

Conclusion

Based on our findings, we can detect organ and tissue injuries quickly and in detail using whole-body CT scanning after major blunt trauma. In addition, various protocols are needed in multiple trauma patients to reduce the number of unnecessary WBCT scans. Therefore, whole-body CT scans may be helpful for selection, as ISS and GCS are markers of mortality.

Conflicts of interest: No conflict of interest in this study.

Author Contributions		Author Initials
SCD	Study Conception and Design	MMY, GA
AD	Acquisition of Data	GA
AID	Analysis and Interpretation of Data	MMY, GA
DM	Drafting of Manuscript	MMY
CR	Critical Revision	MMY, GA

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