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ORIGINAL ARTICLE

CT SCANNING WITH POLYTRAUMA PROTOCOL: IS THE PATIENT OVER-SCANNED?

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Abstract

Trauma is the leading cause of death in individuals under 45 years old. CT scan with polytrauma protocol plays a crucial role in the rapid assessment of trauma patients. However, its routine usage may result in unnecessary imaging, increased radiation exposure and higher healthcare costs.

This study aimed to evaluate the overuse of CT scans performed with polytrauma protocol based on clinician's request.

Materials and Methods: A retrospective review of 138 trauma patients referred to polytrauma CT scans between March and May 2025, that was conducted using PACS data from two institutions. The average patients' age was 46.3 years (range: 4–89 years), with 79% being male.

Inclusion criteria were trauma patients referred to CT with polytrauma protocol. The number of injured body parts was compared to the number of parts scanned to assess scan necessity.

Results: Out of 138 patients 49 (35.5%) had positive CT findings. Out of 49 patients 32 (65.3%) met polytrauma criteria. Only 4 patients (8.2%) had indication for CT scan with polytrauma protocol. 45 (91.8%) of the patients were over-scanned. 75% excess scanning had 17 patients (37.7%), 50% over-scanning had 20 patients (44.4%), and 25% over-scanning was done in 7 patients (15.5%). The most unnecessary examinations were performed to neck in 85.7% and abdomen in 46.6%, in comparison to chest (33.3%).

Conclusion: A significant number of patients underwent unnecessary CT scanning, particularly involving the neck and abdomen. These findings underscore the importance of clinical guidelines to reduce over-scanning, minimize radiation, lower costs and improve trauma care efficiency.

Key Words: *CT polytrauma protocol; over-scanning.*

Introduction

Trauma has become the leading cause of death in young patients under the age of 45 years (1). The management of trauma patients should be focused on identifying and resolving life–threatening injuries. Polytrauma is defined as traumatic injuries that involve at least two body parts or systems, such as the head, chest, abdomen, or one or more extremity, with one of those or the combination of them potentially fatal for the patient (2).
After clinical examination of the traumatized patient, according to the body systems affected, the imaging protocol starts with X-rays (cervical, thoracic and pelvic), focused assessment with trauma sonography (FAST), and eventually Computed Tomography (CT) (3,4). CT should be done only if indicated, not by default, and should be selective for specific body regions (3).

Imaging modalities should be taken in consideration, as well as radiological workflow, in order to chronologically define the protocol, and avoid overlooking life–threatening diagnosis (5). MDCT has indisputable role and is set as the most important imaging modality according to submillimeter isotropic data acquisition. Mainly, CT is used in patients with multiple injuries that do not allow exclusive evaluation of each of them, such as combined brain, thoracic injuries, thoraco-abdominal injuries or multiple abdominal injuries, and in case of vessel injury.
The trauma management algorithm recommends CT scan with polytrauma protocol for "polytrauma" patients (6). The main standard is an immediate interpretation of CT scan on the first images available, and then reassessment and making reconstructions, at least in the three standard planes (axial, coronal and sagittal) (7). Post-processing reconstructions, such as three-dimensional (3D) multiplanar reconstructions (MPR) and volume rendering reconstructions, are also helpful in identifying and characterizing the exact location of some injuries, such as vascular, skeletal, etc. However, currently no agreement on the optimal CT-protocol is achieved (8-11). But non-enhanced CT has become a single polytrauma protocol, which consists of CT scans of the head (including facial skeleton), neck, chest and abdomen/ pelvis (12), when possible, a 'feet first' patients' position is preferred to allow better visualization of weight-bearing structures.

The aim of the study was to assess the unnecessary CT scanning with polytrauma protocol according to the diagnosed injuries.

Materials and Methods

Retrospectively, an initial CT scans of 138 patients with clinical indication for polytrauma were analyzed in a three-months period from March to May in 2025, using PACS system from two institutions. Patients' mean age was 46.3 years old (range from 4 to 89 years), and 79% were

male. Inclusion criteria were trauma patients sent by the clinicians for CT scans with polytrauma protocol, suspected of having more than one body system injured.

In all patients a single polytrauma CT scan protocol was performed, non-contrast enhanced, with thin slices, followed by thinner slice reconstructions in three planes. In some cases, when clinically visceral or vascular injury was suspected, post-contrast CT scanning was obtained. Post-processing reconstructions, such as three-dimensional (3D) multiplanar reconstructions (MPR) and volume rendering reconstructions were done to identify and characterize the exact location of some injuries, such as vascular, skeletal, etc. CT images were reported by radiologists at emergency departments in both institutions. Non-enhanced CT polytrauma protocol consists of scanning of the head with scanning the brain, skull, facial bones, then neck, chest, abdomen and pelvis. The head images were evaluated for skull and facial bones fracture and for brain injury; neck - for spine and soft tissue trauma, chest CT was assessing the lung injury, presence of pneumothorax, hemothorax, mediastinal structures injury or thoracic spine, and chest wall injury as well; abdomen /pelvis CT scans were assessed in order to identify injuries to abdominal, retroperitoneal or pelvic organs injury, as well as skeletal injury. CTs of the extremity were performed when injury was suspected by the clinicians.

On CT scans the types of injuries were analyzed, focusing in dependance on which body parts were affected, in comparison to body parts that were scanned, to exclude the ones that do not correlate to the indication for scanning. The over-scanned body region/s were recognized, and the percentage of unnecessary performed CT examinations was calculated.

Results

Out of 138 patients scanned with polytrauma indication, in 49 patients (35.5%) positive results on CT scans were identified, out of which 32 cases (65.3%) were positive for polytrauma, and in 17 cases (34.7%) only one body part was affected.

Out of the 32 patients that were positive on polytrauma, 13 patients (40.6%) had pulmonary and skeletal trauma (Figure 1), 11 patients (34.3%) had neural and skeletal trauma (Figure 2), and abdominal and skeletal trauma was found in only one patient (3.1%). Neural, lung and skeletal trauma were diagnosed in 3 patients (9.3%), whereas in one patient (3.1%) neural, abdominal and skeletal trauma were found, and in another one (3.1%) all four systems were affected – neural, lung, abdominal and skeletal trauma were found. On the other hand, out of 17 patients with trauma in only one body part, 15 patients (88.2%) had skeletal trauma, 5 patients (33.3%) were with fractures in 2 bones; 1 patient (6.67%) with fractures in 6 bones; 2 patients (13.3%) with serial rib fracture, and in 2 patients (13.3%) spine injury was detected. One patient (5.9%) was identified with only neural trauma, presented as subdural hematoma and in 1 patient (5.9%) was found only lung contusion.

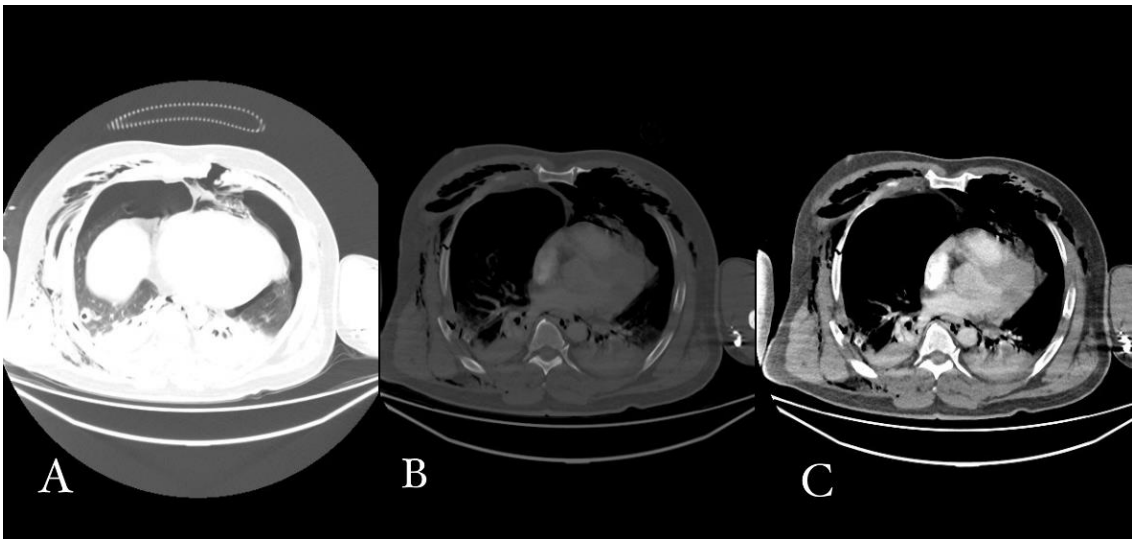

Figure 1. CT scan with polytrauma protocol in patient after car accident. Clinically, he was positive on chest injury and skeletal trauma. There is a sign for bilateral lung contusion with partial pneumothorax and bilateral subcutaneous emphysema, more pronounced at the right side (A, B) with rib fractures at several ribs on the right hemithorax (C)..

Out of all patients sent for CT scanning, that had been reported positive on trauma (49 patients), only 4 patients (8.2%) were confirmed positive for the indication for scanning. 45 patients (91.8%) were over-scanned, according to the indication, with **over-scan rate ranging from 25% to 75% per patient.** 17 patients (37.7%) had 75% excess in scanning, 20 patients (44.4%) had 50% excess in scanning, and 7 patients (15.5%) had 25% excess in scanning. The most unnecessary examinations were performed to the neck in 85.7% (42 cases), then head CT scans 40% (18 cases), whereas abdomen CT over-scanning was more often performed (in 46.6%) than in the thorax CT scans (33.3%).

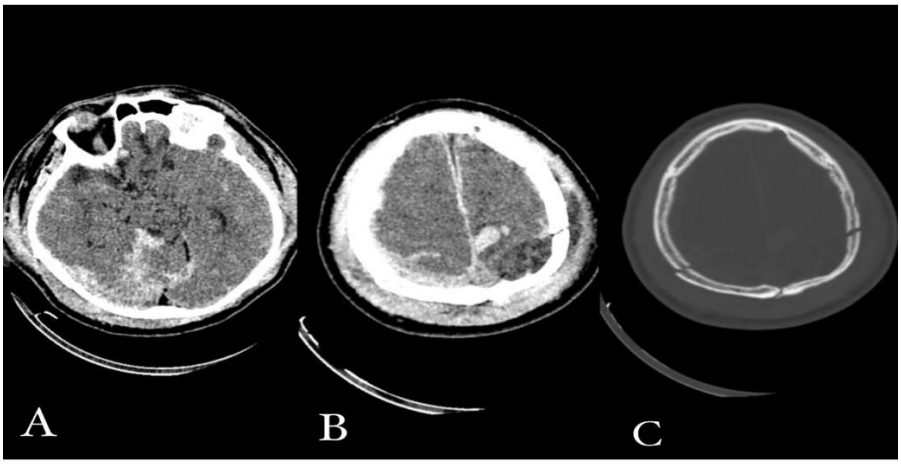

Figure 2. CT scan performed with polytrauma protocol, non-contrast scans. Patient injured in car accident. CT scans show two systems affected, brain and skeletal trauma. Subarachnoid hemorrhage supratentorially and temporally was seen (A) with intracerebral hemorrhage in the parietal left lobe (B) and hemorrhage in parafalx area. Axial plane at bone window shows parietal bone fracture (C).

Discussion

The CT scanning with polytrauma protocol remains a cornerstone in the rapid evaluation of trauma patients, especially in the presence of altered mental status or multiple suspected injuries. However, the results in our study demonstrate that a large proportion of patients, 91.8% underwent scanning of more body regions than ultimately warranted by injury patterns. The findings of this study highlight a significant rate of over-scanning **in** the application of the polytrauma CT protocol.

This discrepancy between clinical suspicion and actual findings **is** not unique. Prior studies have raised similar concerns. For instance, Salim et al. and Linsenmaier et al. (13,14), have shown that polytrauma CT protocol frequently identifies incidental or clinically irrelevant findings, while less than a half of the scans detect true polytrauma**.** In our study, out of 138 patients, asked by the clinician for CT scan with polytrauma protocol, only 23.2% of the cases had injuries affecting more than one body system, and even among those, 78.1% had trauma confined to just two parts. This suggests that routine CT polytrauma protocol may result in over-scanning, particularly when applied indiscriminately.

In our study the highest rates of over-scanning were observed in neck CTs (85.7%), followed by the abdominal CTs (46.6%) and thoracic CTs (33.3%). This pattern reflects the common inclusion of these regions in default trauma protocols, despite the absence of focal signs or symptoms. Notably, head CT was also over-scanned in 40% of cases, often without intracranial findings. Such over-scan not only increases radiation exposure but also contributes to higher healthcare costs**,** scanner overload and potential delays in reporting**.** According to Huber-Wagner et al., the application of CT polytrauma protocol in hemodynamically stable patients with minor mechanisms of injury should be reconsidered, as clinical examination combined with selective imaging often suffices (5). The over-scan rate in our study, ranging from 25% to 75% per patient, strongly supports this more tailored approach. Clinical decision tools, such as the REACT-2 protocol or NEXUS criteria (for cervical spine), may help in limiting unnecessary imaging without compromising diagnostic accuracy (Priti Kharel (16)).

Interestingly, only 8.2% of the patients had trauma findings that fully matched the indication for CT scanning in polytrauma protocol, indicating a low predictive value of clinical suspicion in this setting. This could stem from a combination of factors: limited initial assessment in unstable

patients, defensive medicine practices, or institutional reliance on pre-set trauma imaging protocols.

Nevertheless, it is important to recognize the value of negative findings in trauma imaging. In patients who are unconscious, intoxicated or intubated, polytrauma protocol CT scanning can rule out life-threatening injuries quickly, and can guide safe early mobilization or surgical planning. Thus, over-scanning must be balanced with the risk of under diagnosis**,** especially in high-energy trauma.

This study demonstrates a significant rate of over-scanning in the use of whole-body CT protocols for trauma patients, with significantly exceeding the necessary diagnostic scope based on injury patterns. While CT scans with polytrauma protocol remain essential for the rapid assessment of severely injured or unresponsive patients, our findings underscore the importance of more selective imaging strategies. These highlight the need for greater adherence to clinical decision-making tools and tailored imaging protocols to minimize unnecessary radiation exposure, reduce healthcare costs, and streamline trauma care.

Limitation of the study is being a retrospective one, and that includes only two centers, which may limit generalizability. Data on long-term patients' outcomes or how imaging influenced management decisions were not included. Furthermore, although excess scanning was quantified, we did not assess cumulative radiation dose, which would offer additional insight into the clinical implications of over-imaging.

Implications for practice are that more selective approach to polytrauma imaging, guided by clinical judgment and validated triage tools, may significantly reduce unnecessary scans, limit radiation exposure and optimize resource use. Additionally, protocol review and interdisciplinary communication between radiologists, emergency physicians and trauma surgeons, could further refine imaging strategies.

Conclusion

This study demonstrates a significant rate of over-scanning with CT scan with polytrauma protocol in trauma patients. Majority of the patients did not fully match the indication for scanning. Over-scanning was the most prevalent in neck and abdominal CTs, reflecting the routine application of full protocols even when not clinically justified. These findings highlight the need for greater adherence to clinical decision-making tools and tailored imaging protocols to minimize unnecessary radiation exposure, reduce healthcare costs and streamline trauma care. Future prospective studies should further evaluate the impact of protocol adjustments on clinical outcomes and resource utilization.

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