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Routine Chest Computed Tomography and Patient Outcome in Blunt Trauma

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Background: Computerized Tomography (CT) scan is gaining more importance in the initial evaluation of patients with multiple trauma, but its effect on the outcome is still unclear. Until now, no prospective randomized trial has been performed to define the role of routine chest CT in patients with blunt trauma.

Objectives: In view of the considerable radiation exposure and the high costs of CT scan, the aim of this study was to assess the effects of performing the routine chest CT on the outcome as well as complications in patients with blunt trauma.

Patients and Methods: After approval by the ethics board committee, 100 hemodynamically stable patients with high-energy blunt trauma were randomly divided into two groups. For group one (control group), only chest X-ray was requested and further diagnostic work-up was performed by the decision of the trauma team. For group two, a chest X-ray was ordered followed by a chest CT, even if the chest X-ray was normal. Injury severity, total hospitalization time, Intensive Care Unit (ICU) admission time, duration of mechanical ventilation and complications were recorded. Data were evaluated using t-test, Man-Whitney and chi-squared test.

Results: No significant differences were found regarding the demographic data such as age, injury severity and Glasgow Coma Scale (GCS). Thirty-eight percent additional findings were seen in chest CT in 26% of the patients of the group undergoing routine chest CT, leading to 8% change in management. The mean of in-hospital stay showed no significant difference in both groups with a P value of 0.098. In addition, the mean ICU stay and ventilation time revealed no significant differences (P values = 0.102 and 0.576, respectively). Mortality rate and complications were similar in both groups.

Conclusions: Performing the routine chest CT in high-energy blunt trauma patients (with a mean injury severity of 9), although leading to the diagnosis of some occult injuries, has no impact on the outcome and does not decrease the in-hospital stay and ICU admission time. It seems that performing the routine chest CT in these patients may lead to overtreatment of nonsignificant injuries. The decision about performing routine CT scan in a trauma center should be made cautiously, considering the detriments and benefits.

Keywords: Trauma; Computerized Tomography Scan; X-Ray; Thorax

1. Background

Trauma is the leading cause of death in young people in our country. Radiologic evaluation including Computerized Tomography (CT) scan is gaining more importance in the initial management of multiply injured trauma patients, but considering the large burden of patients with trauma and limited resources in many trauma centers, any algorithm in diagnosis and treatment of these patients should be cost-effective and based on sufficient data. Evaluation of thoracic cavity is of great importance in blunt trauma. Some injuries are evident on clinical examination, needing no further diagnostic workup before treatment; for example, tube thoracostomy in a patient with respiratory distress and obvious unilateral absent breathing sound. On the other hand, some potentially life-threatening injuries might be missed until proper radiologic work-up is performed. Radiologic evaluation of chest injuries in patients with blunt trauma begins usually with a simple chest X-ray at the admission time. Unfortunately, chest X-ray has limited sensitivity in detecting thoracic injuries. Many thoracic injuries such as contusions, diaphragmatic injuries, pneumothoraces and hemothoraces are missed on chest X-ray (1). For pulmonary contusion, the sensitivity of chest X-ray compared to chest CT is only 69% (2). In many trauma centers, chest CT-scan, or even whole body CT-scan, is routinely used for patients with severe trauma. The whole-body CT scan is assumed to decrease mortality and shorten hospitalization time in patients with severe trauma (3). These

benefits are especially more significant in patients with head trauma and decreased consciousness (4, 5). On the other hand, this diagnostic algorithm leads to considerable radiation exposure and high costs and some have questioned the benefit of performing whole-body CT scan routinely (6, 7). Until now, no prospective randomized trial has been performed to define the role of performing routine chest CT in severe blunt trauma

2. Objectives

The aim of this study was to evaluate the effect of performing routine chest CT and its complications on mortality and duration of hospitalization in patients with blunt trauma.

3. Patients and Methods

After approval by the ethics board committee and according to the Helsinki protocol, 100 hemodynamically stable patients with severe blunt trauma were enrolled in the study. Severe trauma was defined as motor vehicle accident with a speed more than 50 km/h, falls from a height more than three meters, or any pedestrian accident and direct hit to the thorax. Hemodynamic stability was considered the main inclusion criterion, defined as blood pressure of at least 90 mmHg and the pulse rate below 100/minute. Children (age $\leq$ 16 years) and pregnant women were not included in the study. Informed consents were taken from the patients or their relatives and block randomization (four and six blocks) was used to divide the patients into two groups. For group one (control group), only chest X-ray was requested and no other intervention was made in the diagnostic work-up of the patient. Further management was guided only by the decision of the trauma team, which might be observation, repeating the chest X-ray, or chest CT. For group two, a chest X-ray was ordered followed by chest CT, even if the chest X-ray was normal. Other radiologic investigations such as abdominal, pelvic or brain CT scan were requested by the trauma team according to the trauma mechanism and clinical judgment and no intervention was made in both groups. Injury severity was assessed using injury Severity Score (ISS). Duration of mechanical ventilation and observation in the Intensive Care Unit (ICU), total hospitalization time, organ failure, pulmonary complications, and required thoracic operations such as tracheostomy, tube thoracostomy and thoracotomy were recorded. The relationship between the two groups, background characteristics and subsequent outcomes were assessed. For the background characteristics and outcomes, differences in means between the two groups were determined using the t-test or Man-Whitney test and are reported as mean ± SD or median (fifth and 95th quantiles) and chi-squared test was used for comparison of categorical data. All the analyses were conducted with the SPSS and all of the reported P values were two-sided. A P value < 0.05 was considered statistically significant.

4. Results

One hundred patients with severe trauma (according to the trauma mechanism) and stable hemodynamic status were enrolled in the study. Although severe trauma was defined as an inclusion criterion, many of these patients could not be included due to hemodynamic instability, explaining the relatively low ISS score of 9. The mechanism of trauma was motor-vehicle accident in 73 patients (73%), pedestrian trauma in 5 (5%), falls in 13 (13%), and direct hits to the thorax in 9 (9%). The mean age was 38.48 ± 15.35 in the control group (group one, n = 50) and 33.08 ± 13.22 in the group undergoing routine CT scan (group two, n = 50), which showed no significant difference (P value = 0.404). Thirty-six patients (72%) in group one and 40 (80%) in group two were male, which presented an equal gender distribution (P = 0.349). The mean ISS was 9.72 ± 7.31 in group one and 8.30 ± 6.20 in group two, which revealed no significant difference (P = 0337). The mean Glasgow-Coma-scale (GCS) was also similar in both groups with mean GCS scores of 15 ± 0 in group one and 14.82 ± 0.72 in group two (P = 0.08) (Table 1). In group one (selective CT scan), rib fractures were seen in chest X-ray in 5 (10%) and clavicular fracture in 3 (6%) patients. A serial chest X-ray was requested for 5 (10%) patients and one hemothorax was identified, leading to chest tube insertion. For one patient with rib fractures and suspicious hemothorax on the serial chest X-ray, a chest CT was requested which confirmed the diagnosis and chest tube insertion had been performed. In group two, rib fractures were seen in 6 (12%) patients on chest X-ray, leading to immediate chest tube insertions.

Chest CT led to 19 additional findings in 13 (26%) patients: nine hemothoraces, four pneumothoraces, five lung contusions, and one pericardial effusion. Additional investigations or interventions were made only in 4 (8%) patients including three chest tube insertions and one echocardiography (revealing no additional diagnosis and no change in management). Finally, tube thoracostomy was required in eight patients: 2 patients (4%) in group one and 6 patients (12%) in group two, which revealed no significant difference. Table 2 shows the outcome of patients in the two groups. The mean in-hospital stay showed no significant difference in both groups with a P value of 0.098. In addition, the mean ICU stay and ventilation time revealed no significant differences (P values = 0.102 and 0.576, respectively). Organ failure was observed in 18 patients (36%) in group one and in 12 patients (24%) in group two, which showed no significant difference in both groups (P = 0.19). One death occurred in group two due to respiratory failure; thus, the mortality rate was 0% in group one and 2% in group two, which showed no significant difference with a P value of 1.0. The additive costs for chest CT in group two was 583.756 Rials (approximately 22 $) for each patient.

Table 1. Demographic Characteristics of Patients in the Two Groups [a,b]

	Group 1, Control	Group 2, Routine CT	Total	P Value
Age, Mean ± SD	38.48 ± 15.35	36.08 ± 13.22	37 ± 14.2	0.404
Male, No. (%)	36 (72)	40 (80)	76 (76)	0.349
ISS, Mean ± SD	9.72 ± 7.31	8.30 ± 6.20	9 ± 6.7	0.337
GCS median, (5th/95th percentile)	15 (15/15)	15 (14/15)	15 (14/15)	0.08

[a] Abbreviations: CT, computed tomography; GCS, Glasgow coma scale.
[b] Demographic characteristics showed no significant difference, confirming correct randomization.

Table 2. Outcome of Patients in Two Groups [a]

	Group 1, Control	Group 2, Routine CT Scan	Total Patients	P Value
In-hospital admission time, d	3.3 ± 2.77	3.3 ± 2.01	3.3 ± 2.4	0.098
ICU admission time, d	0.16 ± 0.51	0.22 ± 1.55	0.19 ± 1.02	0.102
Ventilatory support, d	0.40 ± 0.19	0.22 ± 1.55	0.31 ± 0.71	0.576
Tube thoracostomy	2 (4)	6 (12)	8 (8)	0.421
Organ failure	18 (36)	12 (24)	30 (30)	0.19
Death	0	1 (2)	1 (1)	1

[a] Data are presented as mean ± SD or No. (%).

5. Discussion

Many large studies have been performed to define the impact of CT scan on detection of chest injuries and outcome of patients; unfortunately, none have been randomized controlled studies. Trupka et al. performed a retrospective study on 103 patients with chest trauma, all of whom underwent chest CT. In comparison with chest X-ray, the sensitivity of CT scan was higher and resulted in the diagnosis of 67 (65%) additional injuries which would be missed on simple chest X-ray. The injuries included lung contusions, hemothoraces and pneumothoraces, two diaphragmatic ruptures and one myocardial rupture, leading to change in management in 42 patients (41%) (1). Brink et al. reported similar data in a prospective cohort study on 464 patients with severe blunt trauma. Routine chest CT resulted in 43% additional diagnoses and 17% change in management. Most missed injuries were lung contusions (n = 94), pneumothoraces (n = 85) and thoracic cage fractures, and in addition, potentially life threatening injuries such as aortic injuries (n = 2) were found (8). Another study on 443 patients with blunt chest trauma who underwent chest CT revealed 81% additional diagnoses on chest CT in those with an initially normal chest X-ray (9). Barrios et al. showed similar results in retrospective analysis of 200 patients with blunt trauma; chest CT resulted in the diagnosis of 25% more injuries and 6% change in management (10). In our study, 19 additional diagnoses (38%) were found on chest CT scans in 13 patients (26%), confirming the higher sensitivity of chest CT for detecting thoracic injuries. As also seen in the previous studies, these occult injuries are mostly contusions and hemothoraces or pneumothoraces and one was pericardial effusion without clinical significance. Although in some studies depicted above life threatening injuries were occasionally encountered, in our study none of the injuries were serious or life threatening. According to these data, there is no doubt that chest CT will lead to better detection of injuries, but the question is: "does routine chest CT really improve the outcome in patients with trauma or leads it only to over-diagnosis of nonrelevant injuries?" Detecting more injuries with a more sensitive diagnostic tool must not always lead to better outcomes. Insertion of a chest tube in a small hemothorax or pneumothorax leads to higher morbidity for the patient, longer hospitalization time, and higher costs. There are few studies that evaluated the outcome of patients who underwent chest CT. In a cohort study performed by Weninger et al. two groups of patients with trauma were compared. The first group included patients admitted before 2002, managed according to a selective CT scan algorithm based on clinical examination and suspected injuries. Group two included all patients with trauma after 2002, when routine whole-body CT scan was incorporated in the algorithm of trauma care. They demonstrated that routine whole-body CT scan led to more accurate and faster diagnosis, reduction in mechanical ventilation, shorter ICU and hospital stays, and decreased organ failure rate (3). However, the better outcome observed in group two may be also due to better care and changes in patient management after 2002, not only due to performing routine CT scan. Another study with a similar design showed that whole-body CT scan shortened the interval to start emergency surgery, but had no effect on

mortality. The authors hypothesized that an improvement in outcome might be assumed, as the group undergoing CT scan was more seriously injured (11). Sierink et al. showed decreased 30-day mortality (but not overall mortality) in patients undergoing whole body CT scan in comparison to matched patients from a historical cohort who underwent standard radiologic work-up (12). Only a randomized controlled study can definitely confirm the effect of performing routine CT scan on patient outcome; unfortunately, they are lacking in the literature. Three recent meta-analyses highlighted the need for randomized controlled trials in this field (13-15). Our study is the first randomized controlled study on patients with trauma, showing no significant effect of performing routine chest CT on ventilation time, ICU and in-hospital stay, complications and mortality. An interesting finding was that those who underwent CT scan showed a higher rate of chest tube insertion (six patients in comparison with two patients in the control group), although showing no statistical significance. Some investigators have tried to assess which subgroup of patients with trauma would benefit the most by undergoing CT scan. Traub et al. in a retrospective study on 141 trauma patients showed that performing CT scan in patients with chest wall tenderness, reduced air-entry and abnormal respiratory effort is more likely to provide further diagnostic information for management. They proposed to perform routine chest CT in intubated patients and selective use in asymptomatic patients (16). The presence of chest wall tenderness was also defined as the most important criterion to detect high-risk patients for chest trauma in the study performed by Khoshdel et al. They proposed a risk assessment model based on clinical and radiologic findings to select high-risk patients for occult chest injuries (17). In addition, patients with decreased consciousness probably benefit from performing CT scan. Kimura et al. reported decreased mortality in patients with moderate to severe consciousness-disturbance who underwent whole body CT scan in comparison to those who did not undergo CT scan in a retrospective study (4). Self et al. found 38% unexpected injuries and 26% change in management after performing whole body CT scan in patients who were sent for cranial CT scan (5). The population in our study represented patients with high-energy trauma mechanism and a mean ISS of 9 and mean GCS of 15. Although the inclusion criteria for the study were defined as severe trauma, the distance between the radiology unit and emergency ward in our institution resulted in exclusion of the most severe patients with trauma with questionable hemodynamic stability. Most of the mentioned studies reported higher ISS scores. Weninger et al. reported a mean ISS of 27.1 and in the study performed by Yeguiayan, 60% of the patients revealed an ISS score of 25 or more (3, 18). This difference in trauma severity could explain the more obvious effect of performing CT scan in their patients. Performing routine chest CT in patients with high-energy blunt trauma (with mean ISS of 9), although leading to diagnosis of additional injuries, has no impact on outcome and does not decrease the in-hospital and ICU admission times. It seems that performing routine chest CT in these patients, beside its costs and radiation exposure, may lead to over-diagnosis and overtreatment. Decision about performing routine CT scan in a trauma center should be made cautiously, considering the detriments and benefits, the costs and radiation burden; but bearing in mind that occasionally, routine CT scan may lead to diagnosis of an occult life threatening injury such as aortic dissection. The results of this study should not be extended to more severely injured patients with higher ISS and unconscious trauma patients, as there are many studies supposing the benefit from performing chest or whole body CT scan in these patients. Another randomized controlled study on more severely injured trauma patients with a higher ISS should be conducted to delineate the impact of performing routine chest CT (or whole body CT scan) on the outcome of these patients.

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