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## Is whole-body trauma MDCT justified in patients in good clinical condition but with dangerous trauma mechanism?

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### Summary

**Background:**

To assess whether whole body MDCT is justified in patients in good clinical condition yet with dangerous trauma mechanism.

**Material/Methods:**

The study included 81 patients who were examined between January and July 2008 with whole-body trauma CT protocol. Inclusion into the study was based on a dangerous trauma mechanism and the possibility of an unbiased calculation of the weighted revised trauma score (RTSw). All examinations were performed with 16 row MDCT scanner located in emergency department. The cut off of the RTSw over 6.0 was used to separate the patients in good clinical condition. The CT examinations and medical records of patients were reviewed to assess the number of significant injuries, the need for emergency surgery and other types of medical treatment, the number of negative CT examinations, the number of patients admitted to hospital, and mortality.

**Results:**

28 life-threatening injuries were found in 21 of 61 patients with RTS over 6.0 (34.4%). Only two of those patients required emergency surgery (laparotomy). CT studies were negative for traumatic injuries in 22 patients from this group (36.0%).

**Conclusions:**

Whole-body MDCT may detect injuries in patients in good clinical condition, with some of them demanding medical treatment. Still, further studies are required to balance the advantages of MDCT and potentially harmful effects of radiation dose, especially better triage systems and low-dose protocols are needed.

**Key words:**

polytrauma • whole-body MDCT • Revised Trauma Score

**PDF file:**

<http://www.polradiol.com/fulltxt.php?ICID=879249>

### Background

Multidetector row computed tomography has established itself as an excellent tool to detect traumatic injuries. Especially, it has proved useful in polytraumatic patients suffering from high energy accidents [1,2]. Multidetector row scanners have become a part of a standard equipment in Emergency Departments worldwide and some authors advocated a liberal use of MDCT in patients with macroenergetic trauma, even to the degree of substituting physical examination [1,3–6]. On the other hand, the growing use of MDCT has caused concern about effects of exposure to high

doses of ionizing radiation [7]. The purpose of this study was to assess the diagnostic yield of MDCT in patients in good clinical condition yet with the dangerous mechanism of injury.

### Material and Methods

The study included 81 patients (49 men, 32 women, aged 16-90 years, mean age 42 years, SD 20,48 years) who were examined between January and June 2008 with whole-body trauma CT protocol. Inclusion into the study was based on a dangerous trauma mechanism (motor vehicle

**Table 1.** Whole-body MDCT protocol.

Anatomical Region	Contrast Medium*	Slice Thickness	Reformats
Head	–	5 mm	–
Cervical Spine	–	1.25 mm	Coronal and sagittal
Thorax	Arterial phase (25s after iv CM administration)	2.5 mm	Coronal and sagittal
Abdomen and pelvis with the inclusion of the femoral necks	Portal venous phase (55s after iv CM administration)	2.5 mm	Coronal and sagittal

\*For thoracic and abdominal scan, 150 mL of contrast medium was administered with automatic injector at the rate of 3 mL/s.

**Table 2.** Demographic characteristics of patients in both study groups.

	RTSw $\geq 6.0$	RTSw $< 6.0$
Number of patients	61	20
Men	35	14
Age:	range	17–90
	mean $\pm$ SD	41 $\pm$ 20

accident in 62 patients, fall from height in 11 patients, crushing injury in 8 patients) and the possibility of an unbiased calculation of the weighted revised trauma score (RTSw) (all necessary data available prior to medical therapy, intubation, etc).

All whole-body CT examinations were performed with 16-row multidetector scanner (BrightSpeed, GE, US) located in Emergency Department. The imaging protocol included native scans of the head and cervical spine and contrast enhanced scans of the body. The detailed imaging protocol is presented in Table 1. Dose length products (DLPs) for each study automatically calculated by the scanner were recorded.

Initial evaluation of patients' clinical condition was performed with the RTSw calculated from Glasgow Coma Scale, systolic blood pressure, and respiratory rate. The cut off value of the RTSw equal to or higher than 6.0 corresponding to survival probability over 90 per cent was set to select patients in good clinical condition. Patients were divided into two groups: Group A with the RTSw  $\geq 6.0$  and Group B with the RTSw  $<$  than 6.0. The detailed characteristics of both groups are presented in Table 2.

The CT examinations and medical records of all patients were reviewed to assess the number of significant injuries, the need for emergency surgery and other types of medical treatment, the number of negative CT examinations, the number of patients admitted to hospital, and mortality.

The injuries we classified as significant included: any intracranial lesions capable of producing mass effect (dural hematoma, intracerebral hematoma, pneumocephalon), any pneumothorax, any thoracic or abdominal arterial injury, grade III or higher injury to abdominal solid organs, bowel perforation, any active arterial bleeding, unstable pelvic fractures, and unstable cervical spine fractures.

**Table 3.** Distribution of significant injuries in both study groups.

Type of injury	Group A	Group B	Total
Pneumocephalon	0	2	2
Subdural hematoma	2	6	8
Unstable C-spine fracture	4	2	6
Pneumothorax	9	7	16
Brachiocephalic trunk injury	0	1	1
$\geq$ Grade III liver injury	1	1	2
$\geq$ Grade III spleen injury	1	0	1
$\geq$ Grade III kidney injury	0	1	1
Mesentery laceration	0	1	1
Unstable pelvic fracture	9	3	12
	<b>26</b>	<b>24</b>	<b>50</b>

All statistical analyses were performed using the STATISTICA (version 8.0) software package (StatSoft, Tulsa, UK). Data were analyzed using an unpaired t test; p-value  $< 0.05$  indicated a statistically significant difference.

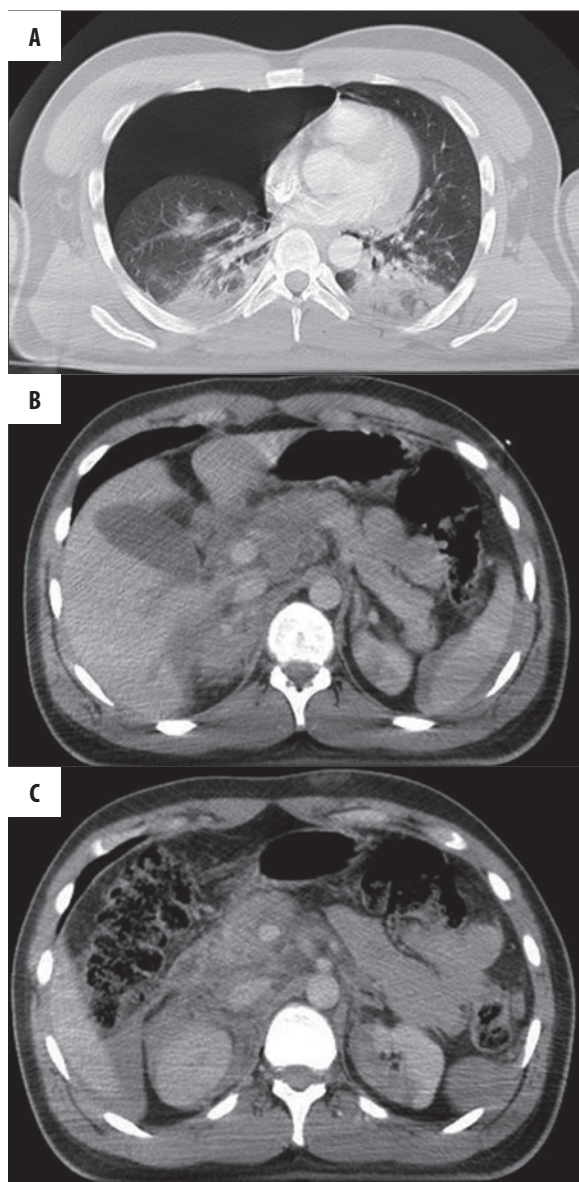
## Results

Overall, 50 significant injuries were detected by CT in 36 of all patients (44.4%). Twenty six significant injuries were found in 21 patients from the Group A with the RTSw  $\geq 6.0$  (34.4%). Among the patients with RTSw  $< 6.0$  (Group B), 15 patients (75.0%) were diagnosed with 24 significant injuries. Table 3 presents the types and distribution of significant injuries in both groups.

Emergency surgery was needed in 2 patients from Group A (3.3%), who underwent laparotomy. In Group B, emergency surgery was performed in 9 patients (45.0%) including 4 craniotomies, 1 thoracotomy, and 4 laparotomies.

A chest tube placement was needed for 4 of 9 pneumothoraces (44.4%) detected in Group A and for all 7 pneumothoraces in Group B.

CT was negative for any injuries in 22 patients (36.0%) from Group A and only in 1 patient (5.0%) from Group B. All



**Figure 1.** A 21-year old male after fall from height. RTSw 6.085. (A) Tension pneumothorax on the right. (B) Two deep lacerations on the visceral surface of hepatic segments 6 and 7, hematoma of the right adrenal, hypodense area in the pancreatic neck. (C) Contusion of the upper pole of the left kidney.

patients from Group B were admitted to hospital, while 37 patients (60.6%) from Group A required hospital stay.

The difference between both groups as regards incidence of serious injuries, number of emergency surgical procedures, number of negative CT examinations and number of patients admitted to hospital was found to be statistically significant (*p* values of 0.0007, 0.000001 and 0.005 respectively).

The mortality in both groups was not statistically different (*p* 0.4188) with 3 patients deceased (5.0%) in Group A and 2 patients (10.0%) in Group B.

The average radiation dose from the whole-body MDCT expressed in terms of DLP was 3472.54 mGy/cm (range 1824.50–4863.46 mGy-cm, SD 693.78 mGy-cm).

## Discussion

The liberal use of whole-body CT in patients after high-energy trauma has been advocated by many authors, recently most notably by Salim and coworkers who studied prospectively 1000 patients admitted to academic level I trauma center [4]. Inclusion criteria were defined in the manner which allowed scanning patients without obvious physical signs of injury but with dangerous trauma mechanism, which was done in 592 patients. The authors reported the 20% incidence of significant findings in patients without obvious evidence of injury in physical examination. In addition, the treatment plan was changed on the basis of CT result in as much as 19% of all patients, however the authors also took into account alternations based on a negative CT scan, such as early hospital discharge.

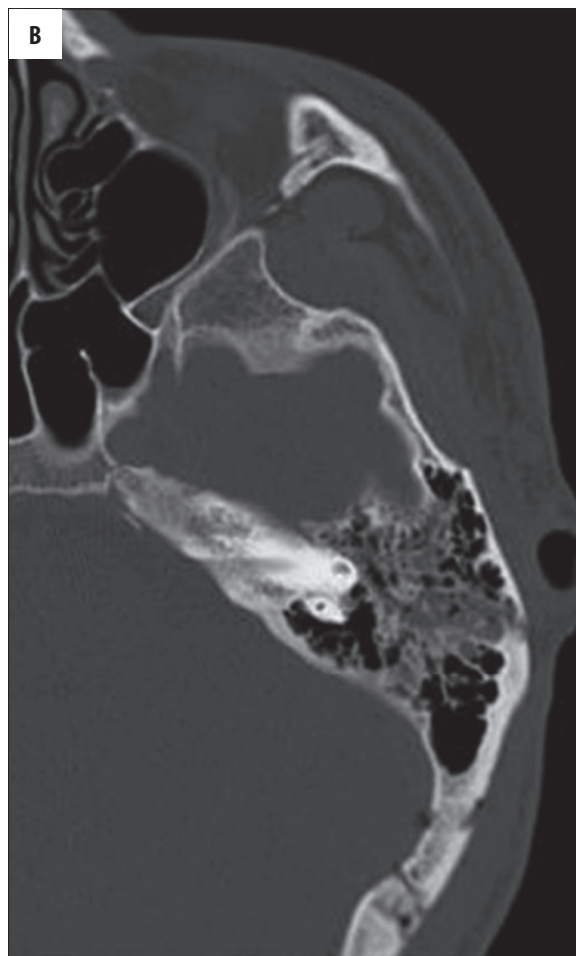
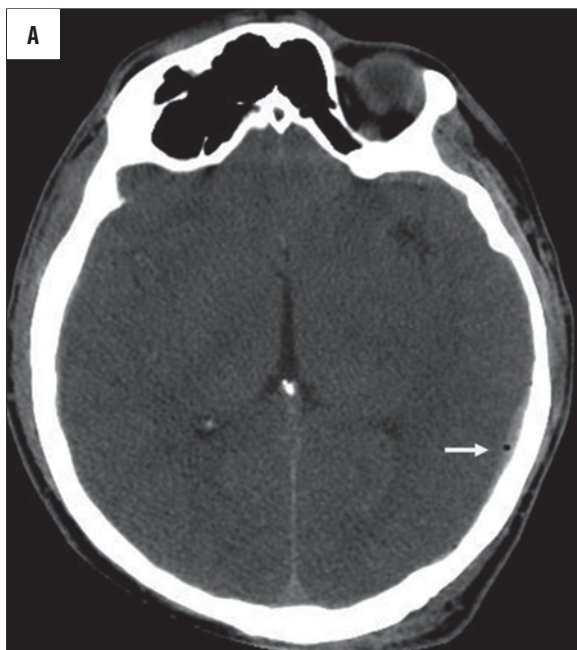
Similarly, we also found a high incidence (34.4%) of significant injuries in patients whose vital signs and level of consciousness were not significantly deteriorated (Figure 1). However, the exact importance of those findings is not clear.

First, only two patients from this group required emergency surgery (3.3%). Other medical procedures included chest tube placement which was done in 4 of 9 patients with pneumothorax. None of subdural hematomas detected in patients from Group A required neurosurgical intervention (Figure 2). This data suggests that the high sensitivity of MDCT in detecting traumatic injuries may in part of the patients lead to diagnosis of abnormalities that would in the other case not have surfaced clinically. Similar conclusions were reached by Fried et al who reported the 38% incidence of abnormal CT findings in patients after blunt abdominal trauma and no clinical findings suggesting injury, but did not find any effect of those on clinical course [8]. Rizzo and coworkers found traumatic lesions in 38% of patients undergoing trauma CT, however in one third of cases they had no influence on treatment plan [1].

Surgery was performed within 48 hours in 3 other patients due to unstable cervical spine fractures and in 5 patients due to unstable pelvic fractures. Taking into account a good clinical condition of those patients, the role of whole-body CT in detecting skeletal injuries also seems questionable, since the use of radiography or CT scans limited to area of interest could be diagnostic as well, with the advantage of lower radiation dose.

The obvious benefit from MDCT was shown by two cases of patients scheduled for surgery in whom small pneumothoraces were detected which allowed chest tube placement to prevent the increase in size of pneumothorax during anesthesia and mechanical ventilation. The MDCT also allowed early diagnosis of splenic fragmentation in a patient with completely normal vital signs (Figure 3). The benefit from MDCT in such patients lies in the possibility of performing early surgery before their clinical condition deteriorates bringing an increased risk of complications [4]. The role of





**Figure 2.** A 21-year old male. Motor vehicle accident. RTSw 7.841. (A) A small subdural hematoma with gas bubbles (arrow). (B) A longitudinal fracture of the petrous bone.



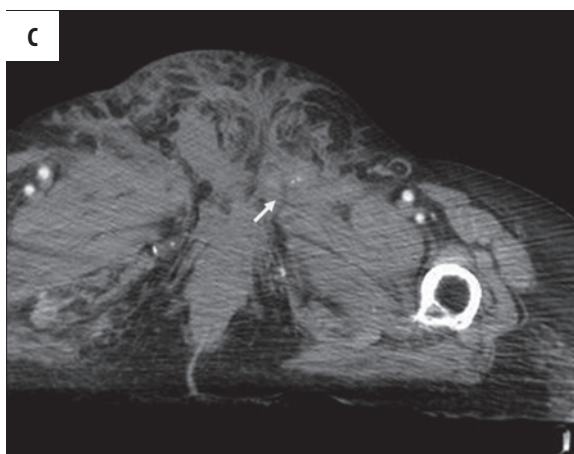
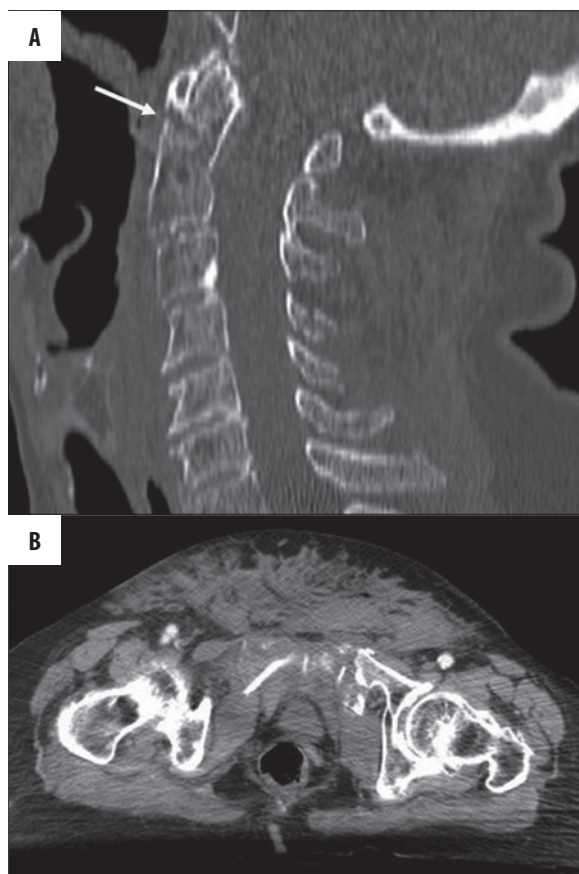
**Figure 3.** A 21-year old female after fall from a horse. RTSw 7.841. The fragmentation of the spleen with a small focus of active CM extravasation (arrow).

MDCT in demonstrating multiple injuries in distant sites is unquestionable as well (Figure 4) [2].

What was also shown by our results are the difficulties with triage of patients in Emergency Department. The Revised Trauma Score is a physiological scoring system, which consists of Glasgow Coma Scale, Systolic Blood Pressure and Respiratory Rate [9,10]. The RTS has been widely accepted as a tool to triage polytraumatic patients and to assess their outcome, however some papers question its actual value [11]. Recent analyses show that there is a lack of definitive evidence supporting its use as a primary triage tool and even if some studies shown the RTS to be a reliable predictor of prognosis for polytraumatized patients, its weakness is demonstrated in patients having severe injury involving a single anatomical region, especially if the anatomical region other than the head is concerned [10,12]. Our results confirm those observations. Even if,

the incidence of severe injuries was significantly higher in the group with the RTSw less than 6.0, performing MDCT only in those patients will miss injuries requiring medical therapy in some patients. With a faster transportation of patients to Emergency Department and a better field care, the initial clinical condition of patients may mask the actual severity of injury. In addition, the RTSw failed to predict mortality in our study population. The ability of the RTS to predict mortality has also been questioned by a large statistical study on a group of 22,388 patients [13].

Altogether, high sensitivity of MDCT in detecting traumatic lesions and difficulties with assessing severity of injury and prognosis using initial vital signs encourage the use of whole-body CT. On the other hand, the number of completely negative CT scans (28.0%) in our study population and the percentage of patients that were discharged on the same day (29.0%) seems worrisome. The DLPs from our whole-body studies roughly corresponded to the effective doses in the range of 11–15 mSv and are similar to other studies [14,15]. The surveys of atomic bomb victims has shown that the risk of cancer is significantly increased by the radiation dose over 5 mSv [16,17]. The risk of cancer mortality from whole-body scan was estimated to be 1 in 1250 for a 45-year old male [15]. Taking into account a young age of trauma patients and still growing number of CT examinations performed both in emergency setting and from other indications, the effects on the health of a



**Figure 4.** A 90-year old female. Fall from height. RTSw 6.94. (A) Minimally displaced type II odontoid fracture (arrow). (B) Fracture of both pubic rami. Large hematoma in the pelvis and subcutaneous fat. (C) Foci of active bleeding are seen below the left pubic ramus (arrow).

population in a long-term perspective may be significant. Whether earlier discharge of those patients is a substantial benefit seems controversial, as the actual medical costs has not been assessed as yet and the short-term savings may be outweighed in the future by cancer treatment expenses. Those problems are also aggravated by the fact that the awareness of CT radiation dose and associated risks, both among patients and physicians, remains surprisingly low

[18]. If whole-body CT is to be viewed as a screening examination in polytrauma, low dose protocols must be developed.

## Conclusions

Whole-body MDCT may detect injuries in patients in good clinical condition, yet only some of them will require medical treatment. Further studies are still required to balance the advantages of MDCT and potentially harmful effects of radiation dose. It is important to assess the actual impact of MDCT findings on patients' treatment and prognosis, especially in relation to patients' initial clinical condition and results of other studies, which could help to optimize indications for the whole-body CT examination and develop effective patient triage system. At the same time the effort should be put into diminishing the radiation dose from whole-body MDCT, while preserving high image quality and diagnostic efficacy.

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