European Journal of Trauma and Emergency Surgery (2019) 45:489–492
https://doi.org/10.1007/s00068-018-0926-7

ORIGINAL ARTICLE

Assessment of sensitivity of whole body CT for major trauma

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Received: 23 June 2017 / Accepted: 23 February 2018 / Published online: 8 March 2018

Abstract

Introduction Whole body computed tomography has become standard practice in many centres in the management of severely injured trauma patients, however, the evidence for it's diagnostic accuracy is limited.

Aim To assess the sensitivity of whole body CT in major trauma.

Method Retrospective review of all patients with injury severity score (ISS) > 15 presenting with blunt trauma to a UK Major Trauma Centre between May 2012 and April 2014. Injuries were classified as per ISS score—1 = head and neck 2 = face 3 = chest 4 = abdomen. The authors reviewed patient's electronic charts, radiological results; interventional procedure records, discharge letters and outpatient follow up documentation and referenced this with Trauma Audit and Research Network data.

Results 407 patients with ISS > 15 presented to the Trauma centre during May 2012 and April 2014. Of these, 337 (82.8%) had a whole body CT scan. 246 pts were male, 91 were female. 74 (21.9%) were due to a fall from > 2 m, 41 (12.2%) due to a fall from < 2 m, 208 (61.7%) were due to motor vehicle crashes, 1 (0.3%) due to a blast injury, 5 (1.5%) due to blows, and 8 (2.4%) due to crush injuries. Sensitivity for Region 1 was 0.98, Region 2 = 0.98, Region 3 = 0.98 and Region 4 was 0.95. Overall sensitivity was 0.98. 15 injuries (2.4%) were not identified on initial CT (false −ve). These injuries were: colonic perforation = 1, splenic contusion = 1, pneumothorax = 1, liver laceration = 1, intracranial haemorrhage = 1, cerebral contusions = 1, spinal injuries = 7, canal haemorrhage = 1, maxilla fracture = 1.

Conclusion These results show that whole body CT in trauma has a high sensitivity and a low rate of missed injuries (2.4%). However, our study only evaluated a subgroup of patients with ISS > 15 and further work is required to assess the use of this investigation for all major trauma patients.

Keywords Major Trauma · Whole Body CT · Sensitivity

Introduction

Trauma is one of the leading causes of morbidity and mortality in the UK and is the commonest cause of death in the under 40 population [1]. Major Trauma Networks were initiated in the UK in 2010 following the publication of the National Audit Office Report which recommended centralisation of Major Trauma Services [2]. The East Midlands Major Trauma Centre (EMMTC) is a large, urban Major Trauma Centre which went live in April 2012 and sees approximately 1400 patients per annum with around 98% of these sustaining blunt trauma. Whole body computed tomography (CT) or Pan-scan has become standard practice in many trauma centres in the management of severely injured patients, however concerns remain regarding the risk of radiation exposure [3]. The radiation dose from whole body CT is 10–20 mSv which equates to an estimated lifetime cancer mortality risk of 0.08% for 45 year olds [4]. Studies have shown that whole body imaging in blunt trauma increases the probability of survival [5, 6]; however, the evidence for its diagnostic accuracy is limited. Over reliance on CT scan may lead to unnecessary or delayed intervention [7] and there is debate as to whether Pan-scanning in Trauma is cost effective in the current era of modern health care with limited financial resources [8].

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s00068-018-0926-7) contains supplementary material, which is available to authorized users.

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Aim

To assess the diagnostic accuracy in terms of sensitivity for whole body CT scan in patients with major trauma.

Method

We performed a retrospective data review of all patients with Injury Severity Score (ISS) > 15 presenting with blunt trauma to a large UK Major Trauma Centre between May 2012 and April 2014 who underwent a whole body CT scan. Paediatric patients, patients with penetrating trauma and secondary transfer patients were excluded. All patients were received by a Trauma Team which was activated as per the EMMTC trauma triage protocol and resuscitated as per ATLS and EMMTC guidelines. Decision to CT by the Trauma Team Leader was based on mechanism of injury and clinical assessment.

CT protocol

Patients were scanned using a Philips Brilliance 256 iCT, using a dose of 120 kV (fixed) and variable mAs. Plain head (vertex to skull base) and plain cervical spine (skull base to T4) was acquired. 100 mL of Niopam 270 contrast was administered at 4 mL/second. A 25 s post-contrast chest and abdomen (apices to pubic symphysis) was acquired, followed by a 65 s post-contrast abdomen (diaphragm to pubic symphysis).

The scan was read initially by the Radiology Registrar and a provisional report was issued immediately. The report was then verified by three consultant radiologists within a maximum of 16 h, with a subspecialty Consultant each separately verifying neuro, musculoskeletal and intrathoracic/intraabdominal components of each study.

Injuries were classified into categories as per the ISS score—1 = head and neck 2 = face 3 = chest 4 = abdomen. Injuries to the pelvis and extremities were not considered as the extremities were not always included in the initial CT scan. The presented results therefore refer to injuries of the head and torso. The authors reviewed all patient's electronic charts, radiological results, interventional procedure records, discharge letters and outpatient follow up documentation and referenced this with Trauma Audit and Research Network (TARN). Sensitivity rates were calculated on an injury basis for each body region and overall.

Results

407 adult patients with ISS > 15 (mean ISS 32.5) presented with blunt trauma as a primary transfer to the Trauma centre during May 2012 and April 2014. Of these, 337 (82.8%) had a whole body CT scan. In total 601 injuries were detected on initial whole body CT scan (Table 1). 336 patients had injuries detected on initial CT and one patient had no injuries detected on initial CT. 246 patients were male, 91 were female. The mean age was 42 years. 74 (21.9%) were due to a fall from > 2 m, 41 (12.2%) due to a fall from < 2 m, 208 (61.7%) were due to motor vehicle crashes, 1 (0.3%) due to a blast injury, 5 (1.5%) due to blows, and 8 (2.4%) due to crush injuries (Table 2). The mean time from Emergency Department presentation to CT scan was 34.4 min. Sensitivity for Region 1 was 0.98, Region 2 = 0.98, Region 3 = 0.98 and Region 4 was 0.95. Overall sensitivity was 0.98 (Table 3). 12 out of 337 patients (3.5%) had one or more missed injuries with 15 out of 616 injuries in total (2.4%) not identified on initial CT (Fig. 1). These injuries were: colonic perforation = 1, splenic contusion = 1, pneumothorax = 1, liver laceration = 1, intracranial haemorrhage = 1, cerebral contusions = 1, spinal injuries = 7, canal haemorrhage = 1, maxilla fracture = 1. Two out of 12 patients had missed injuries with clinically significant consequences requiring intervention (see Table 4). The commonest category of missed injury on initial CT was spinal fractures, but none of these had clinically significant consequences. 39 incidental findings were

Table 1 Number of injuries detected per body region

Region	Number of injuries	Prevalence (%)
1. Head and neck	154	45.7
2. Face	64	19.0
3. Chest	241	71.5
4. Abdomen	142	47.8

Table 2 Baseline characteristics of patients undergoing whole body trauma CT scan

Characteristic	*n*	%
Sex		
Male	246	73
Female	91	27
Age		
0–20	32	9.5
20–40	109	32.3
40–60	112	33.2
60–80	56	16.6
80–100	28	8.3
Mechanism of injury		
Fall > 2 m	74	21.9
Fall < 2 m	41	12.1
RTC	208	61.7
Crush	8	2.4
Blow	5	1.5
Blast	1	0.3

Table 3 Sensitivity per body region

Region	No. of true +ve results/total no. of injuries	Sensitivity	95% CI
1. Head and neck	154/157	0.980	0.958–1.002
2. Face	64/65	0.984	0.954–1.014
3. Chest	241/245	0.983	0.967–0.999
4. Abdomen	142/149	0.953	0.942–0.964
Overall	601/616	0.975	0.963–0.987

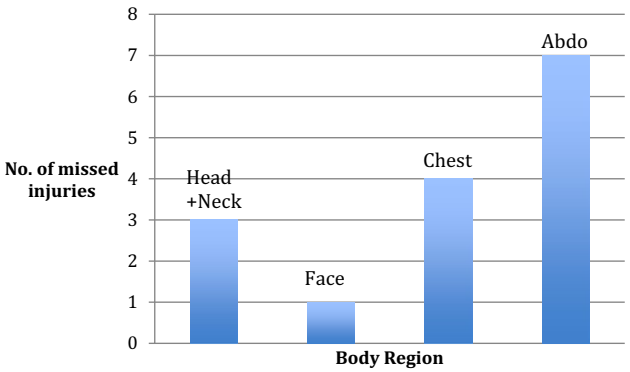

Fig. 1 Missed injuries per body region

detected (11.5%) (See Appendix 1). 10 (3%) of incidental findings were highly clinically significant requiring further intervention during admission, 9 (5.9%) were of moderate clinical significance requiring further management post-discharge from hospital, and 9 (2.7%) were of low clinical significance requiring no further follow-up.

Discussion

These results show that whole body CT in major trauma has a high sensitivity and a low rate of missed injuries (2.4%). Smith et al. [9] reported similarly high sensitivity for CT in the detection of intraabdominal injury in battlefield trauma. Stengel et al. [10] reported variable rates of sensitivity of whole body CT scan per body region (79.6–86.7%) for all major trauma patients; however, they reported a higher sensitivity rate (85.3–92.1%) in a subgroup of patients similar to our cohort with an ISS greater than 15. 12 (3.5%) of our patients had injuries which were not detected on initial CT however only two patients had missed injuries which were clinically significant and required a change in treatment strategy. This may be due to the fact that some injuries, e.g., colonic perforation may develop over time. Stengel et al. reported a higher rate of missed injuries (6.3%), however our patients were scanned using a 256 slice CT scanner, whereas Stengel's group used a 64 slice scanner which may have lowered the diagnostic accuracy of the images. We did not specifically study the impact of positive pan scan findings on need for further intervention, however, all patients required admission for clinical observation.

We identified incidental findings in 11.5% of patients who underwent a whole body CT scan for Trauma which is much lower than was reported by Fakler et al. who detected incidental findings in 43.3% of patients [11]. However, unlike our patient cohort, they analysed patients with both blunt and penetrating trauma and included patients with ISS less than 15 making the results less applicable to our centre. Development of a protocol is required for follow-up of incidental findings such as referral for specialty multidisciplinary team discussion.

Table 4 Outcomes of missed injuries

Type of injury	AIS[a]	Method of detection	Consequence
Colonic laceration/perforation	3	Subsequent CT	Colectomy
Splenic contusion	2	Subsequent CT	Conservative Mx
Pneumothorax	3	CXR	Conservative Mx
Liver laceration	4	Laparotomy	Liver packing
Intracranial haemorrhage	4	Subsequent CT	No change in Mx
Spinal #	2	X ray	No change in Mx
Spinal #s	2	MRI	No change in Mx
Spinal #s	2	Subsequent CT	No change in Mx
Spinal #	2	Subsequent CT	No change in Mx
Spinal #	2	MRI	No change in Mx
Bifrontal contusions	4	Subsequent CT	No change in Mx
Canal haemorrhage	4	Subsequent MRI	No change in Mx
Maxilla fracture	3	Subsequent CT	No change in Mx

[a]Abbreviated injury scale

Our review has some limitations in that data collection was retrospective and it was performed in a single centre which may limit its generalizability to other centres. Paediatric patients and patients with penetrating trauma were not included. Our reference standard for the initial whole body CT was all data pertaining to the patient during their admission and this may have been a potential source of bias as this was not standardised between patients, e.g., some patients may have had further plain X-rays for subsequent imaging, whereas others may have had an MRI for further evaluation. We evaluated a subgroup of patients with ISS greater than 15 and further work is required to assess the use of this investigative modality for all major trauma patients.

Conclusion

Whole body CT has a high diagnostic accuracy in terms of sensitivity in the evaluation of patients with severe blunt trauma.

Compliance with ethical standards

Conflict of interest Susan Yoong, Ravi Kothari and Adam Brooks declare they have no conflict of interest.

Informed consent For this type of study formal consent is not required.

Human and animal right statement This article does not contain any studies with human participants or animals performed by any of the authors.

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