Original Research Article

New Indian Journal of Surgery
Volume 11 Number 4 / October–December 2020
DOI: https://dx.doi.org/10.21088/nijs.0976.4747.11420.11

Early Total Body CT for Trauma Patients: A Randomized Cohort Study

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How to cite this article:
Shaurav Ghosh. Early Total Body CT for Trauma Patients: A Randomized Cohort Study. New Indian J Surg. 2020;11(4):515–522.

Abstract

Introduction: The purpose of our study was to compare Total-Body Computed Tomography (TBCT) with selective scanning in adults with poly-trauma and assess outcomes as a function of scan time, cost, radiation exposure and length of hospital stay.

Methodology: A retrospective analysis was performed with data derived from the trauma registry of the Emergency department of a Quaternary care hospital. Admissions from January, 2017 to December, 2017 were considered. Patients were selected based on their Injury Severity Score (ISS). Descriptive and inferential statistical analysis was done using this data.

Results: Outcomes were independent of gender and age distribution. Most patients belonged to the Young Adult (18–35 years) age group. The average time for scanning was 43.88m. Radiation Exposure was found to be increased after TBCT imaging compared with selective imaging. Scan-time and cost of investigation were less for the TBCT group. In the case of the selective scanning group, cost increased as re-imaging and further extended imaging was used. LOS was less for the TBCT imaging group. Subsequent re-visits post hospitalization were more in the case of the selective imaging group.

Conclusions: The results from this study suggest that application of Total Body CT significantly reduces overall time spent in the emergency department, with higher exposure to radiation, but with an overall benefit in terms of lower cost.

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Keywords: Total Body CT; Whole Body CT; Pan scan; Poly-trauma; Time; Cost; Radiation.

Introduction

Trauma is the leading cause of death among people aged 1 to 45 years.[5,7,8] The National Crime Records Bureau (NCRB) of India, reported an increase in accidental deaths over the past decade. Early diagnosis and treatment are key elements to trauma management.[1] Advanced technology enabled high-speed, low-dose, short scanning time and high-sensitivity imaging in an acute care setting. Trauma centers are increasingly using Total Body CT (TBCT) (defined as a CT scan including the head, neck, chest, abdomen, pelvis, and spine) as an early evaluation tool in poly-trauma.[2] Guidelines recommend that time elapsed between injury and operation should be minimized.[1,3] Primarily, selective CT scans were performed as supplement to conventional imaging.[1,2] Diagnostic superiority and less scanning-time are recognized advantage of TBCT.[2,3,17] Integration of TBCT into early assessment protocol significantly increases the probability of survival in those who are severely injured.[4,5,7] Though proportion of TBCT has increased since 2014, greater radiation exposure has been cited as major risk factor hence it remains inconclusive whether TBCT should be used as initial assessment tool.[7,13–17] Primary aim of this study was to assess the value of immediate Total Body computed tomography (CT) during the primary survey of injured patients compared with conventional radio graphic imaging supplemented with selective CT.

Objective

The purpose of our study was to compare Total Body computed tomography (TBCT) with selective scanning in adults with poly-trauma and access outcomes of scan time, cost, radiation exposure and length of hospital stay.

Materials and Method

A retrospective analysis performed with data derived from the trauma registry of the Emergency department, for admissions from January, 2017 to December, 2017. More than 229 admissions were identified during this one-year period for the study. The inclusion criterion considered all trauma patients with Injury Severity Score (ISS) ≥ 15 on arrival at the hospital. The exclusion criteria applied considered age ≤18, pregnancy, low energy trauma with blunt injury mechanism, isolated penetrating injury to 1 body region (not including gunshot wounds), and any patient too unstable to undergo CT scan or required CPR or immediate operation due to risk of imminent death. 85 of 229 (37.12%) patients were selected.

Statistical Analyses

Descriptive and inferential statistical analyses were performed. Results on continuous measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented as a ratio (%). Significance assessed at 5 % level of significance. Chi-square/ Fisher Exact test has been used to find the significance of study parameters on categorical scale between two or more groups, non-para metric setting for qualitative data analysis. Fisher exact test used when cell samples are very small. Suggestive significance for P value: 0.05<P<0.10), moderately significant for P value: 0.01<P ≤ 0.05 and strongly significant for P value: P≤0.01.

Results

Table 1: Gender distribution of patients studied.

Gender	No. of patients N=229	%(100)
Female	57	24.9
Male	172	75.1
Total	229	100.0

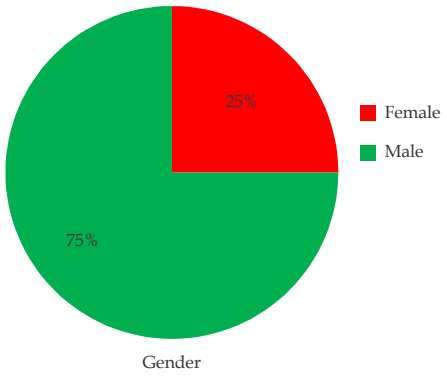


Fig. 1: Gender distribution of patients studied.

Table 2: Distribution of patients by Investigation Category.

Investigation Category	No. of patients N=229	%(100)
Selective	185	80.8
Total Body	44	19.2
Total	229	100.0

Fig. 2: Distribution of patients by Investigation Category.

Table 3: Length of Stay, LOS (number of days).

Length of Stay (No. of days)	No. of patients N=229	%(100)
0	19	8.3
1–7	144	62.9
8–14	42	18.3
15–21	12	5.2
21–28	3	1.3
>28	8	3.5
NA	1	0.4
Total	229	100.0

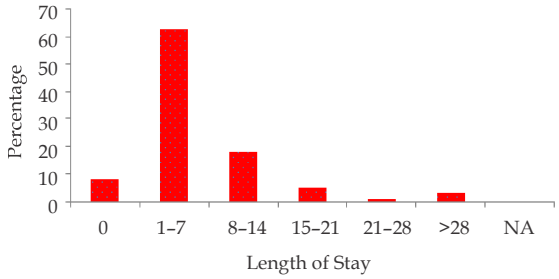


Fig. 3: Length of Stay, LOS (number of days).

Table 4: Investigation Category of patients studied by gender and imaging / scanning type.

Investigation Category	No. of patients N=85	% (100)
Female	N=23	
Selective imaging	13	56.5
Total Body CT	10	43.5
Male	N=62	
Selective imaging	31	50.0
Total Body CT	31	50.0

P value = 0.593 and not significant. Chi-Square Test

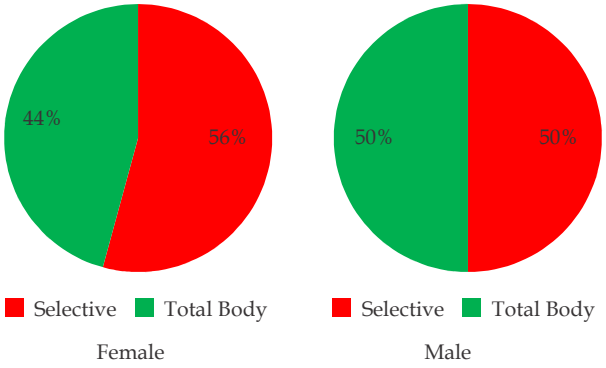


Fig. 4: Investigation Category.

Table 5: Age distribution of patients studied in relation to gender.

Age in years	Gender	
	Male (62)	Female (23)
Young Adult (18– 35 years)	40(64.5%)	9(39.1%)
Middle Age (36–55 years)	11(17.7%)	6(26.1%)
Older Adult (more than 55 year)	11(17.7%)	8(34.8%)
Total	62(100%)	23(100%)

p=0.098+, Significant, Chi-Square Test.

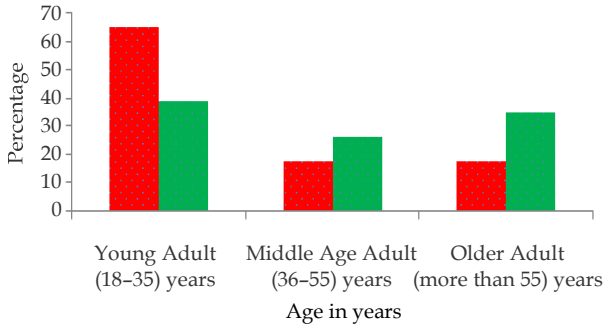


Fig. 5: Age distribution of patients studied in relation to gender.

Table 6: Gender distribution of patients in relation to investigation.

Investigation category	Gender	
	Male (62)	Female (23)
Selective imaging	31(50%)	13(56.5%)
Total Body CT	31(50%)	10(43.5%)
Total	62(100%)	23(100%)

p=0.593, Not Significant, Chi-Square Test.

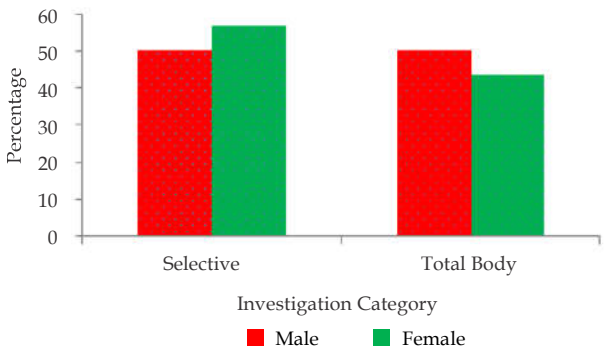


Fig. 6: Gender distribution of patients in relation to investigation.

Table 7: Cost distribution of patients studied in relation to investigation.

Cost	Investigation category	
	Selective imaging (44)	Total Body CT (41)
0–5,000	0(0%)	0(0%)
5,001–10,000	20(45.5%)	0(0%)
10,001–15,000	15(34.1%)	38(92.7%)
15,001–20,000	8(18.2%)	1(2.4%)
20,001–25,000	0(0%)	1(2.4%)
25,001–30,000	1(2.3%)	1(2.4%)
More than –30,001	0(0%)	0(0%)
Total	44(100%)	41(100%)

p<0.001**, Significant, Fisher Exact Test.

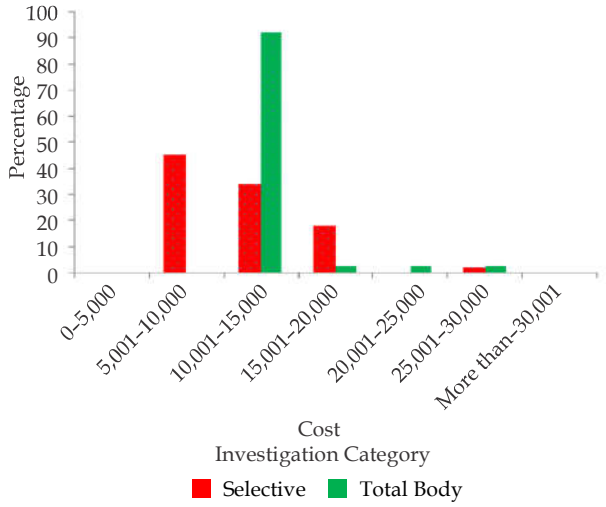


Fig. 7: Cost distribution of patients studied in relation to investigation.

Table 8: Radiation distribution of patients studied in relation to investigation category.

Radiation	Investigation category	
	Selective Imaging (44)	Total Body CT (41)
≤ 10.0 rad	27(61.4%)	3(7.3%)
>10.0 rad	17(38.6%)	38(92.7%)
Total	44(100%)	41(100%)

p<0.001**, Significant, Chi-Square Test.

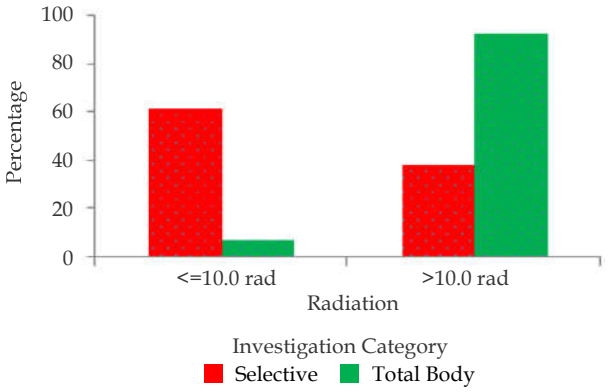


Fig. 8: Radiation distribution of patients studied in relation to investigation category.

Table 9: Investigation category distribution of patients studied in relation to Reimaging category.

Investigation category	Reimaging	
	Yes (50)	No (35)
Selective imaging	26(52%)	18(51.4%)
Total Body CT	24(48%)	17(48.6%)
Total	50(100%)	35(100%)

p=0.959, Not Significant, Chi-Square Test.

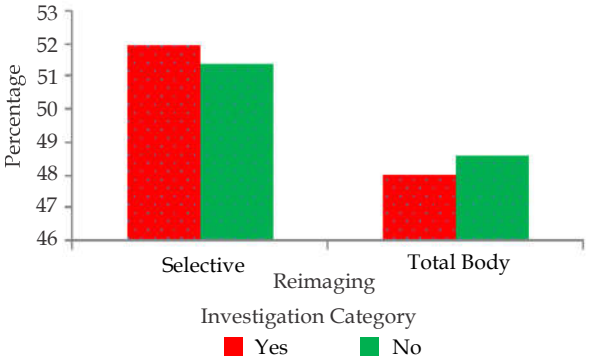


Fig. 9: Investigation category distribution of patients studied in relation to Reimaging category.

Table 10: Revisits distribution of patients studied in relation to investigation category.

Investigation category	Revisit	
	Yes(51)	No(34)
Selective imaging	27(52.9%)	17(50%)
Total Body CT	24(47.1%)	17(50%)
Total	51(100%)	34(100%)

p=0.790, Not Significant, Chi-Square Test.

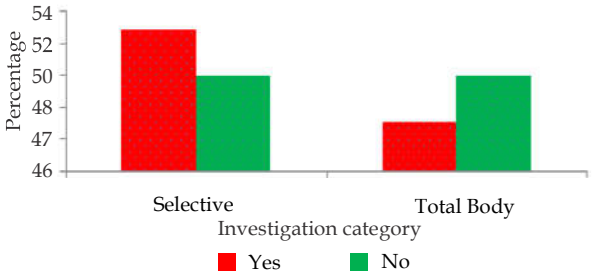


Fig. 10: Revisits distribution of patients studied in relation to investigation category.

Table 11: LOS distribution of patients studied in relation to investigation category.

Length of Stay, LOS (days)	Investigation category	
	Selective imaging (44)	Total body CT(41)
0–5 days	20(45.5%)	19(46.3%)
6–10 days	9(20.5%)	12(29.3%)
11–15 days	8(18.2%)	3(7.3%)
15–20 days	4(9.1%)	2(4.9%)
More than 20 days	3(6.8%)	5(12.2%)
Total	44(100%)	41(100%)

p=0.451, Not Significant, Fisher Exact Test.

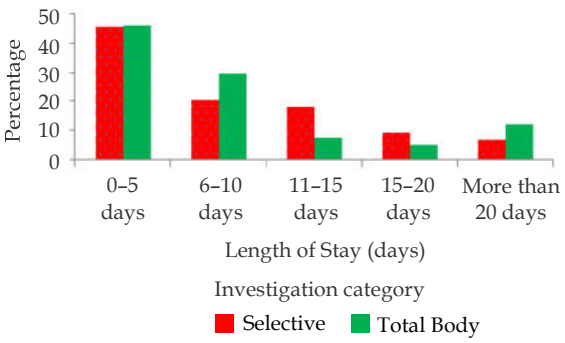


Fig. 11: LOS distribution of patients studied in relation to investigation category.

Table 1, Fig. 1 shows the gender distribution of the 229 patients that were considered in the study: 172 (75.1%) males and 57 (24.9%) females.Table 2, Fig. 2 Distribution of patients by Investigation Category shows that out of the 229 (100%) patients considered in the study, 185 (80.8%) underwent selective imaging and 44 (19.2%) underwent TBCT scanning. Table 3, Fig. 3: Length of Stay, LOS

Table 12: Descriptive statistics of quantitative measurements of patients studied.

Variables	Minimum	Maximum	Mean	Median	SD
Age in years	19.00	81.00	39.02	33.00	18.56
LOS	0.0	123.00	10.19	6.00	15.25
scan time (min)	10.00	70.00	43.88	50.00	12.13
Cost (Rs)	5220.00	30700.00	13438.00	15000.00	4324.00

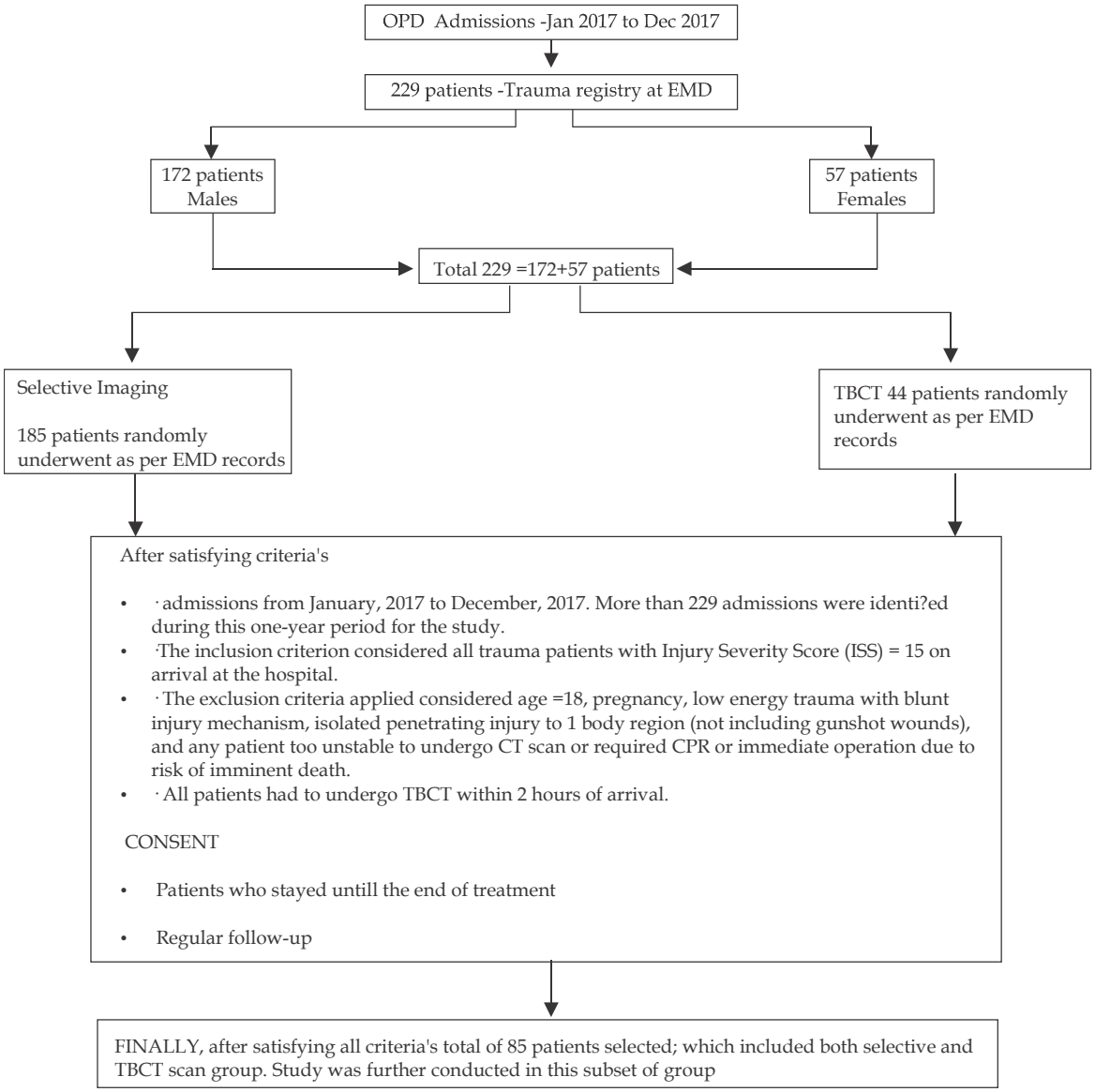
(number of days) shows number of patients split by their respective lengths of stay: 19 (8.3%) of the 229 patients got discharged within the first 24 hours of admission. 144 (62.9%) patients stayed for up to 7 days. 42 (18.35%) stayed for up to 14 days. Only 8 (3.5%) stayed for ≥ 28 days. Only 85 (37.1%) of 229 patients were selected for the study.Table 4, Fig. 4: Investigation Category further breaks up the sample of patients studied by gender and imaging / scanning type: out of 85 patients, 62 (72.9%) males and 23 (27.1%) females met the selection criteria; had at least a single diagnostic CT performed within 2-hours of arrival and constituted the study group. 31 (50%) males and 13 (56.5%) females underwent selective imaging whereas 31 (50%) males and 10 (43.5%) females underwent TBCT.P value = 0.593 and not significant.Table 5, Fig. 5: Age distribution of patients (n=85) studied in relation to gender. Majority of the patients are in the age group Young Adult (18–35 years) with males 40(64.5%) and females 9(39.1%).p=0.098+, Significant. Table 6, Fig. 6: Gender distribution of patients in relation to investigation. Total of 85 patients, 31(50%) males and 13(56.5%)Females underwent selective imaging.p=0.593, Not Significant. Table 7, Fig. 7: Cost distribution of patients studied in relation to investigation shows 35 (79.6%) of the 44 patients in Selective imaging group, showed expenditure up to Rs15000. However, 38(92.7%) of 41 patients, in the TBCT group showed expenditure up to Rs15000. p<0.001**, Significant. Table 8, Fig. 8 : Radiation distribution of patients studied in relation to investigation category shows 27 (61.4%) of 44 patients in selective group and 3 (7.3%) of 41 patients received radiation ≤ 10.0 rad.17 (38.6%) patients in selective category and 38(92.7%) in the TBCT group received >10.0 rad. 15 (36.6%) patients received radiation up to 30 rad (300 mSv). p<0.001**, Significant.Table 9, Fig. 9: Investigation category distribution of patients studied in relation to Re-imaging category shows 26(52%) of 50 patients in selective group and 24(48%) in the TBCT scan group underwent re-imaging. p=0.959, Not Significant. Table 10, Fig. 10: Revisits distribution of patients studied in relation to investigation category shows 27(52.9%) of 51 patients in the selective scanning group and 24(47.1%) in the TBCT group revisited after discharge. Of the remaining 34; 17(50%) patients in selective scanning group and 17(50%) in TBCT group showed poor compliance with post- hospitalisation follow-up visits in- spite of giving patients written appointments at the time of discharge. p=0.790, Not Significant. Table 11, Fig. 11: LOS distribution of patients studied in relation to investigation category. Of 44 patients, in selective imaging group: 20 (45.5%), 9(20.5%) and 8(18.2%) had LOS up to 5, 10 and 15 days respectively. Amongst 41 patients in the TBCT scan group, 19 (46.3%), 12 (29.3%) and 3 (7.3%) had LOS up to 5, 10 and 15 days respectively. 3 (6.8%) patients in the selective group and 5 (12.2%) in the TBCT scan group stayed >20 days.p=0.451, Not Significant.

From the data analyzed (Table 12), the average age (years) range of participants (n=229) was 39.02±18.56 (19 – 81) years. Mean Average Length of hospital stay (days) for participants (n=229), 10.19±15.25(0.0–123) days. Of the 85 patients (n=100) meeting the inclusion criteria, average scan time (min) 43.88 SD ±12.13(10.00– 70.00 min) and average cost Rs. 13438.00±4324.00 (Rs. 5220.00 – Rs. 30700.00).

Table 13: Outcome of our studies compared to other landmark studies.

Reference	Year	Country	Type	N	Conclusion
Huber-Wagner et al[19]	2009	Germany, Austria and Switzerland	Non-randomized cohort	4621	Increased in WBCT
Weningeret al[20]	2007	Austria	Non-randomized cohort	370	Accurate, faster diagnosis, reduced time intervals, ventilation, ICU, hospital days, and organ failure rates in TBCT group
Wurmb et al[21]	2009	Germany	Non-randomized cohort	161	Short time interval for intervention in TBCT group
Wurmb et al[22]	2011	Germany	Non-randomized cohort	318	WBCT shortens time interval for surgery with mortality unchanged
Sierink JC et al[17]	2016	Netherlands, Switzerland	Randomized Multicenter cohort, REACT-2	5475	does not reduce in-hospital mortality. increased radiation dose, focus on the selection of patients
Hutter et al[23]	2011	Germany	Non-randomized cohort, PATRES study group	1144	survival advantage in Pan scan
Our studies	2017	India	Non-randomized cohort	85	Increased radiation dose, short time scan, cost and LOS

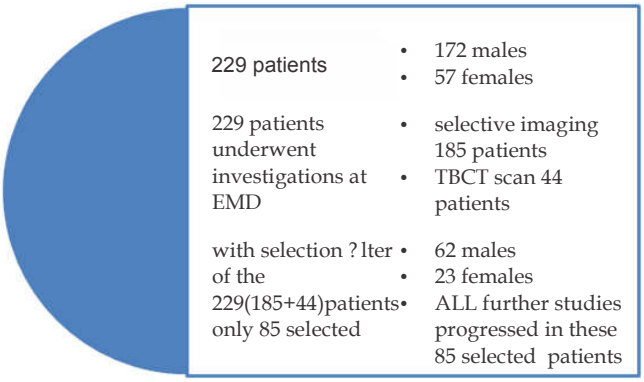
Addendum to comments / explanation above



In my opinion it is necessary to mention about the genesis of the selection of the subset of patients. Hence I started from the 229 patients that arrived at the EMD following trauma. As and when study progressed and selection filters were put in place; we were finally left with 85 patients which included both groups.

All further studies were then done in 85 patients; some of which underwent selective Scan and others TBCT.

It is my humble request if the following facts are considered.



Discussion

According to the EAST Practice Management Guidelines Work Group, CT is recommended (level 1) for evaluation of hemodynamically stable patients with equivocal findings on physical examination, associated neurologic injury, or multiple extra-abdominal injuries. Under these circumstances, patients with negative CT are admitted for observation. CT is diagnostic modality of choice for non-operative management of solid visceral injuries. Sensitivity between 92% and 97.6% and specificity as high as 98.7%[2] has been reported in patients undergoing emergency CT. Stengel, Dirk et al found the sensitivity of the initial pan-scan was 85.7% for abdominal injuries and Specificity was 97.5% for abdominal injuries.[2]

Huber-Wagner et al (2009)[19] published a retrospective analysis of a subset of data (2002-2004) from the German Trauma Registry showing an increase in probability of survival in patients receiving a Total Body CT scan (n=1494) compared to those who received no CT scan or a selective CT scan (n=3127). The authors conclude that TBCT is recommended as a standard diagnostic method during the early resuscitation phase. Subsequent six systematic reviews agreed on time benefit of TBCT scan but no consensus was obtained on survival benefit.[9-17] Presently TBCT scan is used either as supplement to or replacement for conventional imaging. TBCT may increase radiation and incidental findings when used without considering pre-test probability of actionable traumatic injuries. These might result in increased patients' anxiety and health care costs.[7]

The recent REACT-2 trial concluded median radiation exposure was higher in patients with total body scan: 20.9 mSv in total body scan group vs. 20.6mSv in selective imaging group.[17] Median time to end of imaging was less in total body scan group: 30 min in total body scan group vs. 37 min in selective imaging group. Median time to diagnosis was less in total body scan group: 50 min in total body scan group vs. 58 min in selective imaging group. Time in trauma slot (including CT scanner) was shorter for patients in the total body scan group: 69 min versus 82 min. Hospital cost was pretty much the same between the two groups: 25–27,000 Euros, but this was only calculated in the Netherlands. Readmission within 6 months higher in total body scan group: 17% vs. 11%.[17] Guidelines for the management of bleeding and coagulopathy recommend that the time elapsed between injury and operation should be minimized. In this context, TBCT scan can significantly speeded up the diagnosis and treatment process and increased the probability of survival.[18]

In our studies, there was significant reduction in the scan-time in the TBCT group(table 12). TBCT may reduce the number of patient recalls for completion imaging (Table 10, Fig. 10).

Whereas patients in selective imaging group may require further CT at a later stage to reassess injuries. (Table 9 and Fig. 9) Scheduling a repeat computed tomography (CT) scan for stable patients with poly-trauma is unnecessary, given that it rarely changes management. Scheduling a repeat CT scan within 24 hours is done to rule out secondary changes that might warrant intervention, even if patients are stable. Considering this practice delays diagnosis, increases length of hospital stay, radiation exposure and cost, evidence-based rules should be implemented. Re-visits post hospitalization within 6 months higher in selective group. TBCT in trauma patients is associated with high radiation dose of ≥30 Rads. Whereas in the selective imaging group, majority of patients are exposed to 10Rads. However, TBCT in the initial work-up of trauma patients results in fewer additional CT examinations, and time for completing trauma -related imaging is shorter. Incidental (trauma-related) findings were more in case of TBCT scans. Also diagnosing patients with an immediate TBCT scan does not change the length of hospital stay as compared to selective scanning group.

Conclusions

Results of the study were independent of gender and age distribution. Most patients involved in the study belonged to the Young Adult (18– 35 years) group. The average time for scanning was 43.88m. Radiation Exposure was found to be increased after TBCT imaging. Scan-time and cost of investigation was less in TBCT group. Length of hospital was less in TBCT in comparison to the selective imaging. Subsequent re-visits post hospitalization was more in selective imaging group.

Further studies are needed to study the long -term complications resulting from TBCT scan with the need to establish a standard protocol for doing TBCT scans to reduce the radiation exposure.

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