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Cohort Study

Usefulness and outcome of whole-body computed tomography (pan-scan) in trauma patients: A prospective study

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ABSTRACT

Background: Severe trauma can cause multi-organ injuries, and the mortality rate may increase if significant organ injuries are missed. This study was performed to determine whether whole-body computed tomography scan (pan-scan) can detect significant injury and leads to proper management, including alteration the priority of management.

Methods: This prospective study was conducted from January 2019 to March 2021 and involved trauma patients level 1, level 2, and dangerous mechanism of trauma. Additionally, the data of trauma patients who had selective computed tomography scan were retrospectively reviewed to compared the clinical benefits.

Results: Twenty-two patients were enrolled in the prospective study. The pan-scan detected significant organ injury in 86% of the patients. Prioritization of organ injury management changed after performance of the pan-scan in 64% (major change in 64.29% and minor change in 35.71%). Skull base fracture, small bowel injury, retroperitoneal injury, kidney and bladder injury, and occult pneumothorax were the majority of injuries which was not consider before underwent pan-scan ($p < 0.05$). The door-to-scan time tended to be shorter in the pan-scan group than in the selective scan group without a significant difference [mean (SD), 59.5 (34) and 72.0 (86) min, respectively; $p = 0.13$]. Pan-scan contribute 100% confidence for trauma surgeon in diagnosis of specific organ injuries in severe injured patients.

Conclusions: The pan-scan facilitates timely detection of significant unexpected organ injuries such as the skull base, occult pneumothorax, small bowel, and retroperitoneum. It also helps to prioritize management and increases the diagnostic confidence of trauma surgeons, leading to better outcomes without delay.

1. Introduction

Trauma has become a substantial problem in healthcare systems. In Thailand, trauma had a mortality rate of 32 per 100,000 population in 2019 [1]. In emergency and urgently care settings, early detection of organ injuries is the key to successful management of trauma patients. Emergency physicians and general surgeons currently manage trauma patients according to the Advanced Trauma Life Support (ATLS) protocol [2]. The gold standard diagnostic work-up includes a head-to-toe clinical examination, focused abdominal sonography for trauma (FAST), and plain X-rays of the chest and pelvis followed by selective computed tomography (CT) of body regions with suspected injury or followed by whole-body CT scan. However, there may still be hidden areas of injury in patients with severe trauma, and prediction of such injury is unreliable by clinical judgment and assessment of the mechanism of injury alone. Single-pass CT or whole-body CT or pan-scan protocols for trauma patients has been developed include scans of the brain, cervical spine, and facial bones as well as intravenous contrast arterial, venous, and delayed phases imaging of the neck vessels, chest, abdomen, and pelvis. A pan-scan can be used to diagnose additional injury, resulting in a change in management, priority, or the order of

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Abbreviations

ATLS	Advanced Trauma Life Support
FAST	focused abdominal sonography for trauma
CT	computed tomography
ICU	intensive care unit
LOS	length of hospital stay
ISS	Injury Severity Score

management [3,4]. Pan-scans are associated with better outcomes, including decrease in overall and 24-h mortality rates [4,5]. The pan-scan has many advantages, including a time-saving benefit, detection of hidden organ injuries such as retroperitoneal injuries or major vascular injuries, changes in management, a potential survival benefit, and a decreased rate of missed injury. Although the use of a pan-scan clearly decreases in-hospital mortality, the additional injuries detected by a pan-scan might be only minor injuries [3–5]. The pan-scan protocol is now commonly used to supplement standard radiologic imaging after primary assessment of patients with severe trauma according to the ATLS protocol, but a pan-scan is not mandated in every case. The use of a pan-scan have some disadvantages such as a high radiation dose [7]. Therefore, a standard indication for a pan-scan has not yet been established. From previous study, trauma surgeons are encouraged to schedule their patients for a pan-scan as the primary imaging tool after resuscitation, a brief physical check-up, and FAST examination because of pan-scan facilitates accurate and early detection of lesions caused by severe or high-energy trauma and prevents clinicians from missing occult lesions, thus helping to decrease mortality [1–7].

This study was performed to determine the usefulness of the pan-scan in detecting unsuspected organ injury and its effect on patients management. The findings of this study could serve as a guide for decisions regarding whether to perform a pan-scan in trauma patients.

2. Methods

2.1. Study protocol

The protocol of prospective study is shown in Fig. 1. All patients who presented for treatment of trauma from January 1, 2019 to December 31, 2020 and met the eligibility criteria were included. The eligibility criteria were an age of ≥15 year-old, a trauma triage level of 1 or 2, and

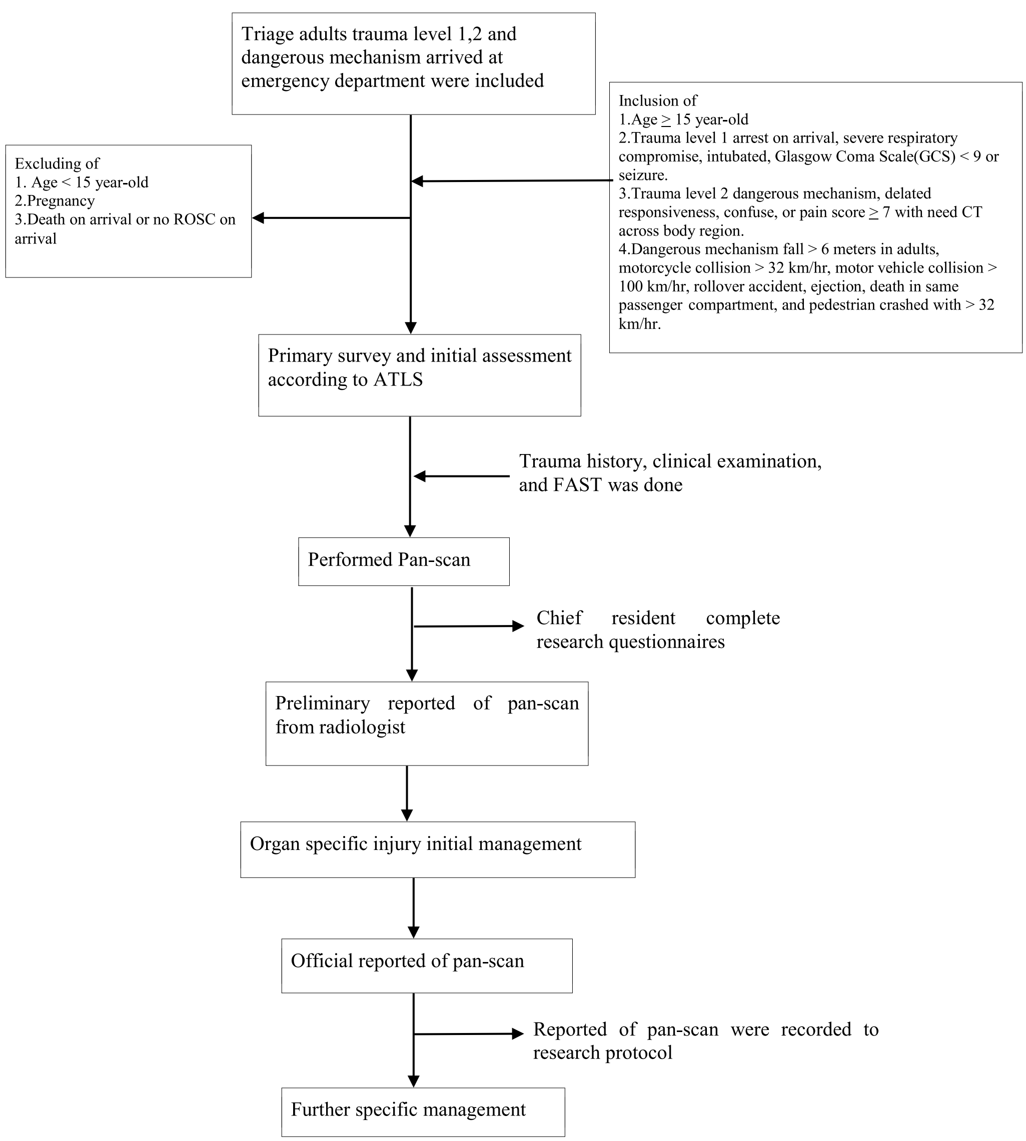

Fig. 1. A prospective protocol flow chart.

trauma in dangerous mechanism with arrival at the resuscitation room of the emergency department. The exclusion criteria were pregnancy, and arrest with no return of spontaneous circulation (ROSC) on arrival. The primary survey and initial assessment according to the ATLS protocol were performed by a trauma team consisting of trauma staff members, a well-trained surgical team leader (chief of general surgery residents), junior surgical residents, and emergency physicians. After the primary survey and initial assessment of the trauma mechanism, clinical examination, and rapid bedside ultrasonography (FAST or E-FAST) of eligible patients, a fast track pan-scan for trauma was performed. The chief resident completed the research questionnaires regarding suspected organ injuries, and the pan-scan results were then reported by the radiologist. The chief resident also predicted the patient's disposition after treatment in the emergency department, such as immediate to operating room or intervention, admission to the trauma ward, admission to the intensive care unit (ICU), referral, or discharge home. The pan-scan was performed with a 64-slice multidetector-row CT scanner and included non-contrast imaging of the brain, cervical spine, and face followed by contrast-enhanced imaging of the neck vessels, chest, abdomen, and pelvis in the arterial, venous, and delayed phases that performed in selected cases. The slice thickness was 2.5 mm for axial, coronal, and sagittal reconstruction. These patients in the prospective protocol were defined as the "pan-scan group". The chief resident performed questionnaires regarding the suspected organ injury diagnosis according to the clinical examination, mechanism of injury, and FAST or E-FAST results before underwent pan-scan, and these findings were compared with the preliminary pan-scan diagnosis. All scans were preliminarily reported in a timely manner by the radiology residents and then validated to produce the finalize report by staff radiologist.

2.2. Retrospective data collection

We retrospectively reviewed data of trauma patients during the 5-year period before implementation of the pan-scan protocol in our hospital, 10 years retrospective before 2021 (additional cases could not be collected because patients data were deleted every 10 years according to hospital policy). These patients were defined as the "selective CT scan group." The same inclusion criteria used for the prospective protocol were used in the selective CT scan group to compare the clinical benefits with respect to length of hospital stay (LOS), mortality, door-to-scan time, and total contrast usage. The patients age of <15 years, pregnancy, and arrest with no return of spontaneous circulation (ROSC) on arrival has been excluded from retrospective historically control. The trauma leader decided whether a CT scan of a selective body region should be performed in patients with suspected organ injury based on the clinical examination findings and mechanism of injury. The patients' demographic data, selective CT scan findings, organ injury diagnosis, time to the preliminary report were also collected.

2.3. Definitions

Level 1 trauma triage in our hospital was defined as arrest on arrival with return of spontaneous circulation (ROSC), severe respiratory compromise, need endotracheal intubation, a Glasgow coma scale (GCS) score <9, or seizure. Level 2 trauma triage was defined as a dangerous trauma mechanism, delayed responsiveness, confusion, a pain score of ≥7, and the need for a CT scan across a specific body region. A dangerous trauma mechanism was defined as a fall of >6 m in adults, motorcycle collision at speed >32 km/h, motor vehicle collision at > 100 km/h, rollover accident, ejection, or a crash with a pedestrian at speed >32 km/h. Significant injury was defined as a specific organ injury requiring treatment with surgery, percutaneous intervention, or embolization. The door-to-scan time was defined as the duration of time from when the patient arrived at the emergency room to when he or she underwent a pan-scan or selective CT scan. The time to the preliminary report was defined as the duration of time from when the patient underwent the pan-scan to the time when the radiology resident reported detection of organ injury to the trauma team. Prioritization or priority management of organ injury was defined as the order of organ injury management according to the severity of organ-specific injury.

2.4. Outcomes

The primary outcomes were agreement of diagnosis of significant organ injury and detection of specific organ injury by a pan-scan. The secondary outcomes were 30-day mortality, level of confidence in management based on the pan-scan, changes in priority of management after underwent pan-scan, time of investigation as a door to scan time, time to the preliminary report, intravenous contrast dosage, and clinical benefits compared with a selective CT scan (e.g., LOS).

The work has been reported in line with the STROCSS criteria [8].

2.5. Statistical analysis

The statistical analysis was conducted using Stata 14.2 software (StataCorp LLC, College Station, TX, USA). Continuous variables are summarized using mean, standard deviation, and median. Categorical variables were analyzed by the chi-square test and are presented as a percentage. Agreement regarding suspected organ injury before and after performance of the pan-scan was assessed using Cohen's kappa correlation coefficient, where ≤0.00 indicated no agreement, 0.01 to 0.20 indicated slight agreement, 0.21 to 0.40 indicated fair agreement, 0.41 to 0.60 indicated moderate agreement, 0.61 to 0.80 indicated substantial agreement, and 0.81 to 1.00 indicated almost perfect agreement. The McNemar test was used to identify differences in dichotomous dependent variables between two related groups. A p-value of <0.05 was considered statistically significant.

3. Results

The prospectively collected data of 22 patients (pan-scan group) were compared with the retrospectively collected data of 15 patients (selective CT scan group) to compare the clinical benefit of performing a pan-scan (Table 1). The selective CT scan group consisted of 86.67% men and the prospective pan-scan group had 81.82% men (p = 0.999). The average age was 54 and 45 year-old in the selective CT scan group and pan-scan group, respectively (p = 0.151). The mean Injury Severity Score (ISS) was significantly higher in the pan-scan group than in the selective CT scan group [mean (SD), 24 (9.1) and 17 (6.8), respectively; p = 0.014]. The 30-day mortality rate was 0.00% and 9.09% in the selective CT scan group and pan-scan group, respectively (p = 0.505). The rate of level 1 trauma triage was 13.33% in the selective CT scan group

Table 1
General demographic data of trauma patients before and after implement of whole-body CT scan.

		Before (N = 15)	After (N = 22)	p-value
Gender: N(%)	Male	13(86.67)	18(81.82)	0.999
	Female	2(13.33)	4(18.18)	
Age: years	Mean(SD)	54(5)	45(4)	0.151
ISS score	Mean(SD)	17(6.8)	24(9.1)	***0.014***
Death: N(%)		0	2(9.09)	0.505
Initial GCS	Mean(SD)	14(2.55)	12(3.80)	0.109
LOS: days	Mean(SD)	15(15.3)	10(9.5)	0.307
LOS in ICU: days	Mean(SD)	7(5.76)	7(7.17)	0.915
Door to scan time: mins	Median (IQR)	72(86)	59.5(34)	0.130
Scan to preliminary report time: mins	Median (IQR)	127(182)	186.5 (215)	0.194
Total contrast use for CT scan per admission: ml	Median (IQR)	90(100)	80(20)	0.977

ISS; severity injury score, GCS; Glasgow coma score, CT; computed tomography.

and 50.00% in the pan-scan group ($p = 0.022$). The mean (SD) initial Glasgow coma scale score on arrival was 14 (2.25) and 12 (3.8) in the selective CT scan group and pan-scan group, respectively ($p = 0.109$). The LOS tended to be longer in the selective scan group, but the difference was not statistically significant [15 (10.3) and 10 (9.5) days, respectively; $p = 0.307$]. The length of ICU stay was not significantly different between the two groups [7 (5.76) and 7 (7.17) days in selective CT scan group and pan-scan group, respectively; $p = 0.915$]. The door-to-scan time tended to be shorter in the pan-scan group, but the difference was not statistically significant [72.0 (86) and 59.5 (34) min in selective CT scan group and pan-scan group, respectively; $p = 0.13$]. The time from the scan to the preliminary report tended to be longer in the pan-scan group, but the difference was not statistically significant [127.0 (182) and 186.5 (215) min, respectively; $p = 0.194$]. The total intravenous contrast usage for each scan per admission was lower in the pan-scan group, but the difference was not statistically significant [80 (20) and 90 (100) mL, respectively; $p = 0.977$].

Diagnoses of specific organ injuries by pan-scan are shown in Fig. 2. Small bowel injury occurred in 3 (13.64%) patients, lung contusion and laceration in 6 (27.27%), occult pneumothorax in 5 (22.73%), hemothorax in 3 (13.64%), cervical spine injury in 1 (4.55%), skull base fracture in 1 (4.55%), facial bone fracture in 4 (18.18%), kidney injury in 2 (9.09%), bladder injury in 2 (9.09%), thoracic aortic injury in 1 (4.55%), abdominal aortic injury in 1 (4.55%), liver injury in 1 (4.55%), splenic injury in 2 (9.09%), thoracolumbar spine fracture in 6 (27.27%), lumbosacral spine injury in 3 (13.64%), pelvic fracture in 3 (13.64%), and no organ injury detected in 4 (18.18%).

Th role of pan-scan in patients management is shown in Table 2. The pan-scan helped to detect specific organ injuries in 19 (86%) patients. Management of organ injuries detected by the pan-scan comprised admission for clinical observation in 8 (36%) patients, minimally invasive intervention (such as intercostal drainage, percutaneous drainage, or embolization) in 6 (27%), a need operation in 5 (23%), and no further management after the pan-scan in 3 (14%). The management of organ injury changed in 55% of patients after the pan-scan. Prioritization of management changed after the pan-scan in 14 (64%) patients. A major change in priority management occurred in 9 (64.29%) patients and a minor change in priority management occurred in 5 (35.71%). Details of the prioritization changes in organ injury management after performance of the pan-scan are shown in Table 3. The major priority of management changes after the pan-scan occurred in patients with traumatic brain injury (such as skull base fracture and intracranial hemorrhage), thoracic aortic injury, hollow viscus organ injury, and concurrent pelvic injury with solid organ abdominal injury.

Table 2
Summary role of pan-scan for trauma patients.

Parameter		N(%)
Pan-scan help detect significant injury		19(86)
Management of injury detected from pan-scan	Need admission for observation	8(36)
	Need intervention (Embolization, PCD, ICD)	6(27)
	Need operation	5(23)
	No further management/ Discharge home	3(14)
Management change after pan-scan		12(55)
Priority management change after pan-scan[a]		14(64)
	Major priority change	9 (64.29)
	Minor priority change	5 (35.71)

PCD; percutaneous drainage: ICD; intercostal drainage.
[a] Details in Table 3.

Table 4 shows the results of a subgroup analysis of agreement between suspicion of injury before performance of the pan-scan and the pan-scan findings. For both skull base fracture and occult pneumothorax, there was no agreement between suspicion of injury before the pan-scan and detection of injury by the pan-scan ($p = 0.317$, kappa $= -0.073$ and $p = 0.025$, kappa $= -0.084$, respectively). However, statistically significant agreement was found between suspicion of injury before the pan-scan and detection of injury by the pan-scan for small bowel injury, retroperitoneal injury, kidney and bladder injury, and occult pneumothorax ($p = 0.025$, 0.045, 0.014, and 0.025, respectively).

Table 5 shows that most surgeons had an increased level of

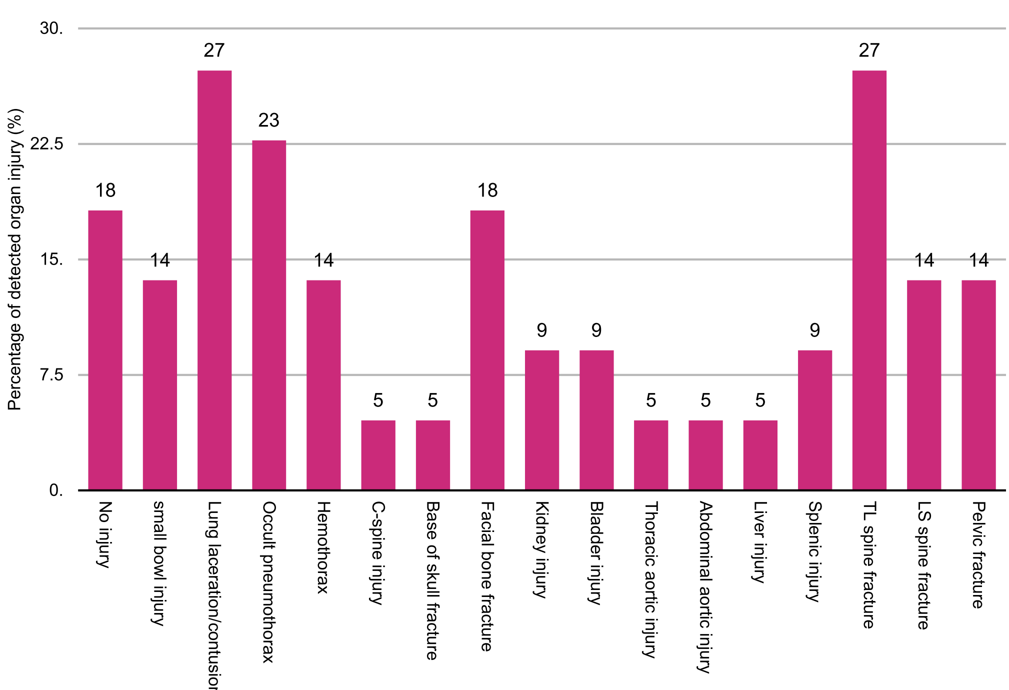

Fig. 2. The pan-scan diagnosis of specific organ injury.

Table 3
Details of priority change in organ injury management after underwent pan-scan.

Patients	Priority management before underwent pan-scan	Priority management after underwent pan-scan	Priority change (major/minor)=
1	1st TBI 2nd Pneumothorax	1st C-spine fracture 2nd TBI 3rd Pneumothorax	Major
2	1st Maxillofacial fracture 2nd TBI	1st Brain herniation	Major
3	1st Hemothorax 2nd Pelvic fracture	1st Pelvic fracture with hemorrhagic shock 2nd Small lung laceration with minimal hemothorax	Major
4	1st Extremities long bone fracture	1st Abdominal solid organ injury 2nd Extremities long bone fracture	Major
5	1st Extremities long bone fracture 2nd Ribs fracture	1st TBI 1st Extremities long bone fracture	Minor
6	1st Abdominal solid organ injury 2nd Pneumohemothorax 3rd Open fracture of extremities	1st Pneumohemothorax 2nd Splenic injury without shock 3rd Open fracture of extremities	Minor
7	1st Pneumothorax 2nd TBI	1st Base of skull fracture and TBI 2nd Occult pneumothorax	Major
8	1st Pneumothorax 2nd Pelvic fracture	1st Pelvic fracture with internal iliac artery injury 2nd Pneumothorax 3rd Bladder injury	Major
9	1st Hemothorax	1st Thoracic aortic injury 2stHemothorax 3rd Perinephric hematoma	Major
10	1st Pneumothorax 2nd TBI	1st C-spine fracture 2nd Pneumothorax 3rd Maxillofacial fracture	Major
11	1st Maxillofacialfracture 1st TBI	1st TBI and DAI 2nd Maxillary and orbital floor fracture	Minor
12	1st TBI 2nd Hemothorax	1st C-spine fracture 2nd Lung laceration	Minor
13	1st Pneumothorax 2nd Abdominal solid organ injury	1st Hallow viscus organ perforation 2nd Pneumohemothorax 3rd TBI	Major
14	1st Abdominal solid organ injury 2nd Pelvic fracture 3rd Retroperitoneal hematoma	1st Pelvic fracture 2nd Retroperitoneal hematoma	Minor

TBI; traumatic brain injury.
DAI; diffuse axonal injury.
Major priority change is change order of organ injury management if missed cause mortality.
Minor priority change that if missed this injury is not cause mortality.

confidence in diagnosis of specific organ injury (from 50% to 100%) after performance of the pan-scan.

4. Discussion

In our hospital, patients with severe trauma undergo a pan-scan after the primary survey and initial assessment for the purpose of timely detection and management of potential life-threatening organ injuries. The pan-scan room is located nearby the trauma resuscitation room, and patient management involves co-ordination among trauma surgeons, emergency physicians, and radiologists. The current prospective data of our hospital show that a pan-scan plays an important role in detecting significant organ injuries that can be missed if only clinical judgment and the mechanism of injury are considered. The significant injuries detected in our prospective study were skull base fracture, small bowel injury, retroperitoneal injury, kidney and urinary bladder injury, and occult pneumothorax. These injuries are often in hidden areas, are difficult to diagnose, and mostly require operative management; additionally, special precaution is needed for occult pneumothorax in terms of whether intercostal drainage is needed. In a previous study, the incidence of occult lesions such as thoracic and head injuries ranged from 3% to 14%, while the incidence of such injuries found by pan-scan in the present study was 86% [9]. Thus, a pan-scan can effectively detect hidden areas of injury and facilitate timely and proper management, including appropriate patient disposition. In our study, the pan-scan detected organ injury in 86% of cases. A previous study on the accuracy of pan-scan showed that the sensitivity of diagnosis of significant injury ranged from 83.8% to 88.3%, which is consistent with our data [15]. Mistral et al. [9] reported that the sensitivity and specificity of clinical judgment of suspected organ injury after severe trauma was 82% and 49%, respectively. This use of clinical judgment and assessment of the mechanism of injury alone is not enough for reliable and sufficient diagnostic performance compared with pan-scan in the detection of serious to critical lesions or significant organ injury in patients with high-energy blunt trauma [9]. The area under the curve, sensitivity, and specificity of clinical judgment in their study were 0.7 (95% confidence interval, 0.64–0.75), 86%, and 49%, respectively [9]. In a retrospective study of the clinical use of imaging in the acute trauma setting, nearly 52% of patients had no clinically significant injuries seen on radiography [9]. This finding and our data indicate that in patients with severe trauma, clinical judgment, assessment of the mechanism of injury, and basic investigation are not enough to decide to omit a pan-scan, which can detect injuries that are in hidden areas or difficult to diagnose.

A pan-scan can help to improve surgeons' decision-making regarding patient management. After a pan-scan, cases may be altered from

Table 4
A subgroup agreement of organ injury before and after underwent pan-scan.

Organ injury before underwent pan-scan		Organ injury detected from pan-scan		*P-value*	Cohen's kappa
		No	Yes		
Base of skull fracture	No	18 (85.71)	1(100)	0.317	−0.073
	Yes	3(14.29)	0		
Small bowel injury	No	17 (77.27)	5 (22.73)	***0.025***	–
	Yes	0	0		
Retroperitoneal injury[a]	No	18 (81.82)	4 (18.18)	***0.045***	–
	Yes	0	0		
Kidney and urinary bladder injury	No	16 (72.73)	6 (27.27)	***0.014***	–
	Yes	0	0		
Occult pneumothorax	No	15 (93.75)	6(100)	***0.025***	−0.084
	Yes	1(6.25)	0		

[a] Retroperitoneal injury is including of retroperitoneal hematoma, psoas muscle hematoma, and vascular injury.

Table 5
Physician's level of confidence to pan-scan diagnosis.

Parameter		N(%)
Before panscan level of confidence of diagnosis	0	2(9.09)
	50%	17(77.27)
	100%	3(13.64)
After panscan level of confidence of diagnosis	0	0
	50%	0
	100%	22(100)

operative to non-operative management (NOM)/intervention or from non-operative to operative management; our prospective data showed that such alterations in management occurred in about 55% of cases. A pan-scan can also increase the trauma team's confidence in patient disposition to the trauma ward, ICU, or home. Salim et al. [16,17] reported that the treatment plan was altered according to the pan-scan results in nearly 19% of patients. In the present study, this rate was 64%. Most of the changes in the priority of management after the pan-scan occurred in patients with traumatic brain injury, which requires a time-critical intervention or operation. Therefore, a pan-scan has an effect on the order of management of organ injury.

A randomised controlled trial (RCT) and previous published data from our hospital showed no difference in the in-hospital mortality rate between patients who underwent a pan-scan and those who underwent a selective CT scan with a trend toward selection bias of the patients in the pan-scan group [13,14]. However, a meta-analysis showed a lower mortality rate in the pan-scan group than in the selective CT scan group (16.9% and 20.3%, respectively) [10]. Chidambaram et al. [6] also reported a significantly lower overall mortality rate (odds ratio = 0.79, 95% confidence interval = 0.74–0.83, $p < 0.05$) and 24-h mortality rate (odds ratio = 0.72, 95% confidence interval = 0.66–0.79, $p < 0.05$) in trauma patients who underwent a pan-scan than in those who underwent a selective CT scan. Jiang et al. [5] also reported a lower mortality rate in the pan-scan group (pooled odds ratio = 0.66, 95% confidence interval = 0.52–0.85). A prospective study by Yeguiayan et al. [15] also revealed a lower mortality rate in the pan-scan group than selective CT scan group (16% vs. 22%, respectively; $p = 0.02$). In contrast, our prospective study showed that the mortality rate was higher in the pan-scan group than in the selective CT scan group. This can be explained by the greater severity of trauma (higher ISS) in the pan-scan group. However, although our mortality rate was higher in the pan-scan group than selective CT scan group, it was still lower than previously reported mortality rates [5,6,16]. The higher ISS in the pan-scan group might have been a result of higher detection of organ injury by pan-scan because we selected the patients using the same inclusion criteria. Caputo et al. [10] also reported a significantly higher ISS in the pan-scan group than in the selective CT scan group (29.72 vs. 26.46, respectively; $p < 0.001$, $n = 23{,}172$) with some selective bias might be effect increasing of mortality in pan-scan group.

In the present study, the door-to-scan time was shorter in the pan-scan group than in the selective CT scan group, but the difference was not statistically significant. This lack of significance occurred because of the effective flow of trauma patients among the emergency department, trauma surgeons, and radiologists. Many studies have also shown that a pan-scan can significantly reduce the time interval from patient arrival to the emergency room and patient management, leading to better outcomes [11,12]. The time from the pan-scan to the preliminary report was longer than the time from the selective scan to the preliminary report, but the difference was not statistically significant because more specific part of CT needed to be interpreted in the pan-scan group. This process was not a cause of delayed management. A previously published RCT also showed a time benefit of pan-scan in terms of less time required to perform the scan and to attain a diagnosis after patient arrival [13]. Although one concern for pan-scan in contrast-induced nephropathy, our study showed that contrast use in pan-scan is lower than that in selective CT scan accumulated on the same admission. One meta-analysis showed no significant difference in the LOS or ICU stay between the pan-scan and selective groups [5]. In our study, the ICU stay was not significantly different between the two groups, but because of the more severe trauma (higher ISS) in the pan-scan group, patients who underwent a pan-scan tended to have a slightly longer ICU stay. The LOS was also not significantly different but tended to be shorter in the pan-scan group.

According to our study, a pan-scan can help to improve the level of confidence by about 50% among trauma surgeons or emergency physicians in terms of achieving a timely diagnosis of organ injury in patients with severe trauma. Thus, the pan-scan has benefits with respect to timely detection of organ injury, priority of management, and increased confidence of trauma surgeons in organ injury diagnosis, leading to better outcomes.

5. Strength and limitation

The main strength of our study is that it was a prospective cohort study comparing suspected injury with pan-scan results. The evaluation of level of confidence to pan-scan is accurate according to assess in real situation. Our study showed that prioritization of management can change after a pan-scan because of detection of additional injury. The main limitation of our study is the low number of participants in both the prospective and retrospective review. The low number of participants in the prospective review was due to the city lockdown during the COVID-19 pandemic, resulting in a lower overall incidence of trauma. The low number of participants in the retrospective review was due to our hospital's practice of deleting patient information every 10 years, preventing collection of data before 2010.

6. Conclusion

A pan-scan facilitates timely detection of significant organ injury, especially in hidden areas (e.g., skull base fractures, small bowel injury, retroperitoneal injury, and occult pneumothorax), leading to proper management. A pan-scan also helps to prioritize management and increases the confidence of trauma surgeons in organ injury diagnosis, leading to better outcomes without delay.

Ethics approval and consent to participate

This study was approved by the ethics committee.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Ethical approval

Ethics approval was permitted from Mahidol University.

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Sitthichart Harntaweesup is contribution for data collection, literature search, writing the paper.

Chonlada Krutsri is contribution for conception and design of the study, literature search, revising article, final approval.

Preeda Sumpritpradit is contribution for revising article, literature search, final approval.

Pongsasit Singhatas is contribution for acquisition of data, final approval.

Tharin Thampongsa is contribution for acquisition of data.

Pinporn Jenjitranant, Sirote Wongwaisayawan, Nitima Saksobhavivat, and Rathachai Kaewlai is contribution for conception and design of the study and final approval.

Registration of research studies

1. Name of the registry: Thai Clinical Trails Registry.
2. Unique Identifying number or registration ID: TCTR20220108001.
3. Hyperlink to your specific registration (must be publicly accessible and will be checked): https://www.thaiclinicaltrials.org/show/TCTR20220108001.

Guarantor

The Guarantor is Dr. Chonlada Krutsri who is the corresponding author of this manuscript.

Consent

Ethics approval was permitted from Mahidol University for consent of retrospective review patients data.

Patients' names, initials, or hospital numbers should not be used.

Declaration of competing interest

The authors declare that they have no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amsu.2022.103506.

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