# SELECTIVE NON-OPERATIVE MANAGEMENT OF BLUNT ABDOMINAL TRAUMA USING COMPUTED TOMOGRAPHY

**Nittaya CHAMADOL, MD.,[1] Siwanit OJONGPHIAN, MD.,[1]**
**Chaiyut THANAPISAN, MD.[2]**

## ABSTRACT

**OBJECTIVE:** To determine the accuracy of computed tomography (CT) scan in the evaluation and grading of the severity of blunt abdominal organ injury for the purpose of selecting patients who can be managed conservatively. To compare the CT grading system (using organ injury scaling of the American Association for Surgery of Trauma: AAST) with the trauma score : abbreviated injury score and injury severity score (AIS, ISS) and clinical outcome in patients who were treated by conservative and surgical management.

**MATERIALS AND METHODS:** Twenty-two patients suspected of intraabdominal organ injury who underwent complete CT scan study from January 1994 to October 1999 were analyzed and graded according to organ injury scale (OIS) grading system (Table 1-7). The clinical records of these patients were reviewed and correlated with the CT grading system, trauma score and clinical outcome.

**RESULTS:** Seven patients had liver injury, four of them (58%) received conservative treatment, mean OIS=II, mean ISS=12.25. Three patients (42%) were treated by surgery, mean OIS=III, and ISS=30. One of them was operated due to jejunal perforation that was missed on initial CT scan. Four patients had splenic injury, 1 case (25%) had successful conservative treatment, OIS=II, ISS=9, and 3 cases (75%) underwent surgery, OIS ranged from III-IV, ISS=21.3. Three patients had pancreatic injury, 2 in the three patients (67%) had conservative treatment, OIS range II-III, ISS=9, and in the remaining one patient (33%) underwent surgery due to duodenal perforation that was missed on CT scan, OIS=II, ISS=10.Two patients in renal injury group, mean OIS ranged from I-III, ISS=7.5, had successful conservative treatment. One patient who had bladder injury, OIS=IV, ISS=21 underwent surgical management without complication. One patient with clinical suspicion of renal injury had only abdominal wall hematoma, ISS=9. Two cases were negative CT scan, had very low ISS (ISS=1). One patient with retroperitoneal hematoma received percutaneous drainage with good result.

**CONCLUSION:** CT scan is the investigation of choice, having high accuracy in the diagnosis and grading of the severity of blunt abdominal trauma particularly in solid organ injury. There are difference of trauma score (OIS, ISS) between patients who underwent conservative and surgical management that can be used for prediction and evaluation in the selection of non-operative management of blunt abdominal trauma.

**AIS** = Abbreviated Injury Score, **ISS** = Injury Severity Score, **OIS** = Organ Injury Scale

[1] Department of Radiology
[2] Department of Surgery Faculty of Medicine, Khon Kaen University, Khon Kaen, 40002 Thailand Telephone, Fax 043-348389

## INTRODUCTION

CT scan can now provide rapid and accurate diagnosis of abdominal trauma in detection of hemoperitoneum and solid organ injury.[1] Non-operative approach is becoming the standard of practice for hemodynamically stable patients.

The purposes of this study were to determine the accuracy of CT scan in the evaluation and grading of the severity of blunt abdominal organ injury for the purpose of selecting patients who can be managed conservatively, and to compare the CT grading system using organ injury scale (OIS) with the trauma score (AIS, ISS) and the clinical outcome in patients who were managed by conservative and surgical treatment.

## MATERIALS AND METHODS

The records of the patients suspected of intraabdominal organ injury admitted to Srinagarind Hospital from January 1994 to October 1999 were reviewed retrospectively. Forty two patients were examined with CT scan, but only 22 patients with complete study were included in this review. There were 16 male, and 6 female patients, age ranged from 3 to 50 years. All of them underwent abdominal CT scan for evaluation of their injury prior to any surgical intervention. They were considered hemodynamically stable, or were quickly and easily resuscitated on admission.

The examinations were performed with either conventional CT scanner (GE 9800 Quick, Milwaulkee), or spiral CT scanner (Toshiba, Exvision) taken at 60 seconds after starting a bolus of contrast medium (100 ml, 300% contrast medium) by mechanical injector at the rate of 3 ml/sec or bolus hand injection. All abdominal CT scans were reviewed by experienced radiologists. The serial section of the scans were evaluated with scoring system reported by the AAST known as organ injury scale (OIS) (Table 1-7) and correlated with trauma score (AIS, ISS).[15-17]

## RESULTS

The patients were classified according to organs injury, such as liver injury (7 patients), splenic injury (4 patients), pancreatic injury (4 patients), renal injury (2 patients), bladder injury (1 patient) , retroperitoneal hematoma (1 patient), abdominal wall hematoma (1 patient), and negative study (2 patients).

The data of organ injury, CT grading system (OIS) compared with mean ISS and clinical outcome was shown in table 8.

In liver injury group, 4 of 7 patients (53%) were managed by conservative treatment successfully, OIS= II, and mean ISS=12.25 (Fig.1). Three patients (47%) were operated, OIS I-II, mean ISS=30. Jejunal injury was missed on initial CT scan in one patient. ISS in the surgical group is markedly higher than in the non-surgical group.

In splenic injury , the OIS in surgical group ranged from III to V, which was higher than in non-surgical group (OIS=2), and ISS was also higher (Fig.2,3).

In pancreatic injury, the OIS in non-surgical group ranged from II to IV, that was higher than in surgical group. However the patient in surgical group went to surgery because of associated duodenal perforation (Fig.4).

In renal injury, the OIS ranged from I-III, mean ISS=7.5 All of them had successful non-surgical management (Fig.5).

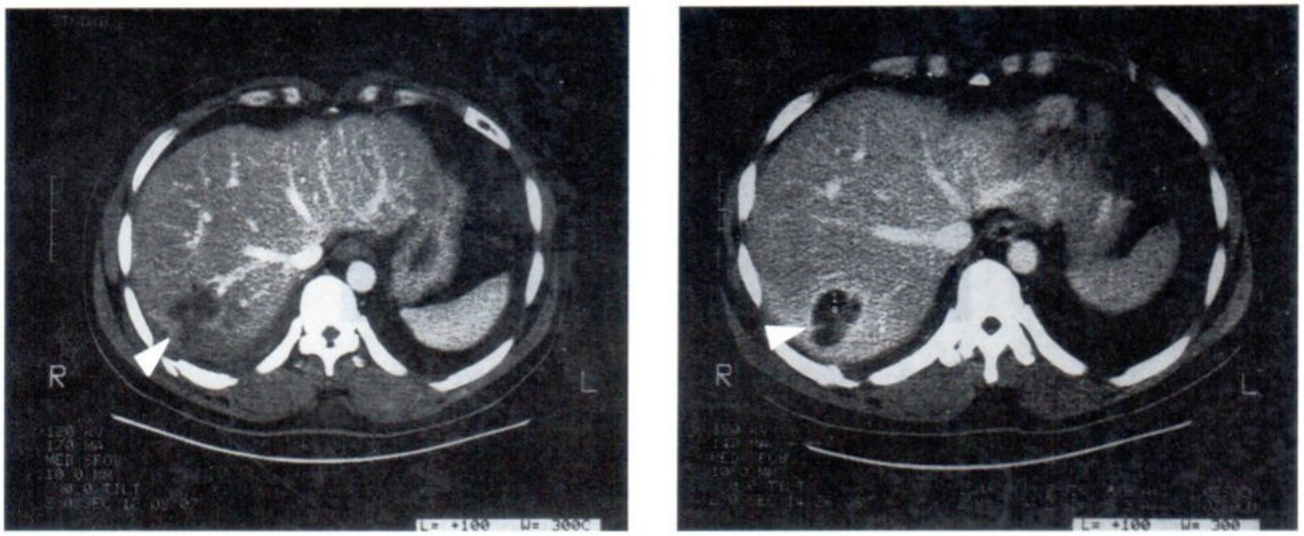
One patient with bladder injury had OIS grade IV, ISS=21, underwent surgical treatment without complication ( Fig.6).

One patient with suspected renal injury had only abdominal wall hematoma, ISS=9. One patient with retroperitoneal hematoma without identifiable organ injury received percutaneous drainage with good results.

**OIS** = Organ Injury Scale, **AIS** = Abbreviated Injury Score, **ISS** = Injury Severity Score

Two cases with negative CT scan had very low ISS.

There was high accuracy in predicting solid organ injury by CT scan. The diagnosis was correct in all patients at surgery. But bowel injury was missed on initial evaluation.




1A 1B

**Fig 1** Liver injury grade II. There is contusional hematoma at posterior segment of right lobe liver. (arrow)A The patient underwent conservative treatment and follow up CT scan shows resolved hematoma.(arrow) B.

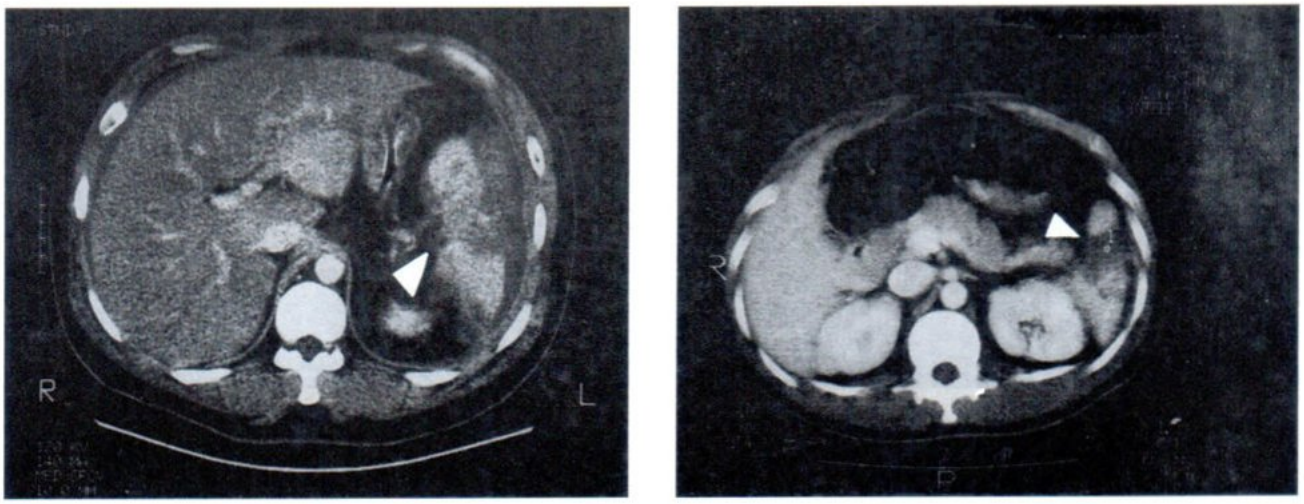



**Fig 2** Splenic injury grade V. The CT image shows shattered spleen with hilar vessel injury. (arrow) He underwent splenectomy and no complication.

**Fig 3** Splenic injury grade II. There is splenic laceration at lower pole of spleen (arrow) with intraparenchymal hematoma less than 5 cm. He received conservative management.

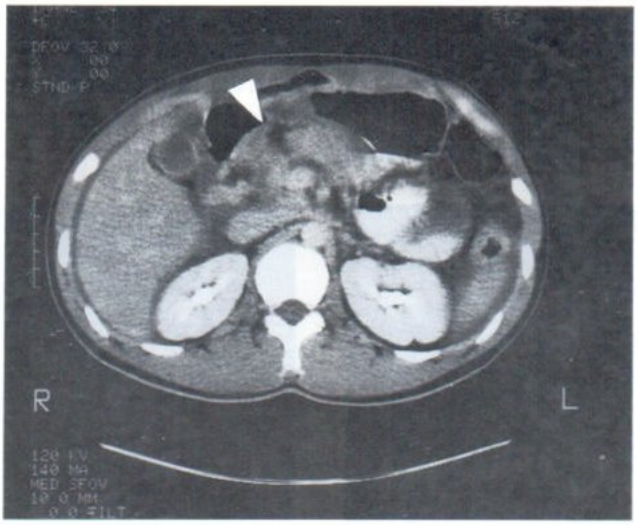
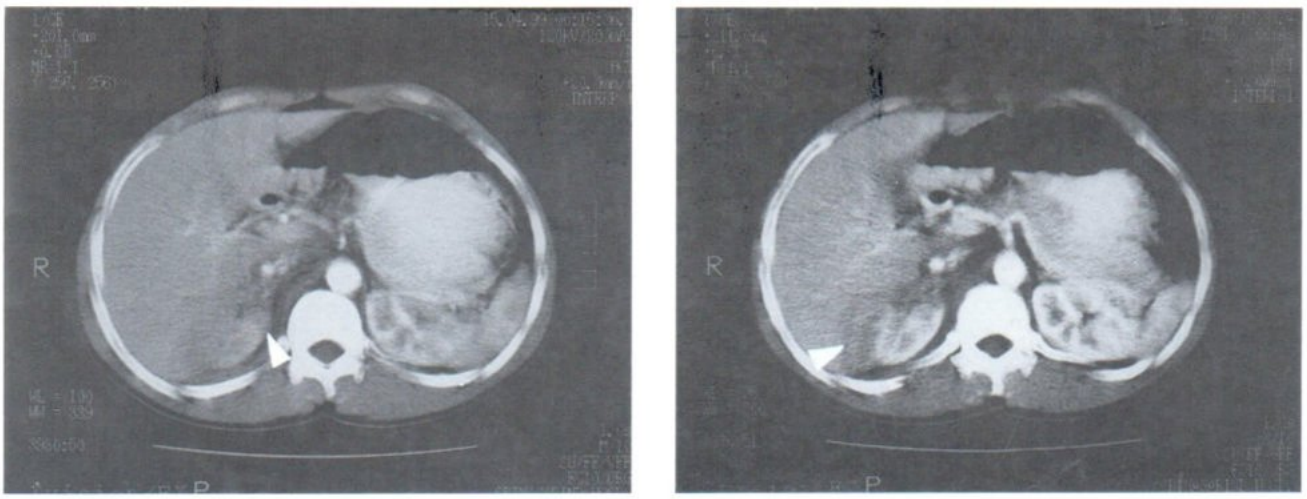



**Fig 4** Pancreatic injury grade IV. There is fracture at the neck of pancreas with blurring of retroperitonea fat plane. (arrow) He underwent conservative treatment, l ater developed pancreatic pseudocyst.




**5A** **5B**

**Fig. 5** Renal injury grade II. There is laceration at medial aspect of upper pole of right Kidney. (arrow) A Evidence of minimal subcapsular and perinephric hematoma as shown in B. (arrow) He underwent conservative treatment with good result.

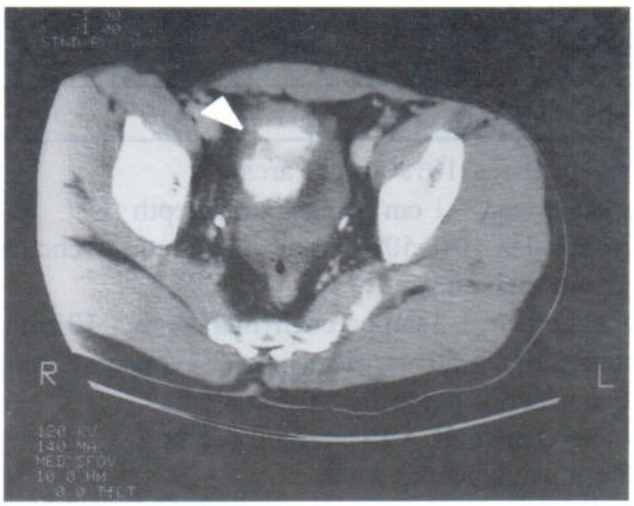



**Fig. 6** Bladder injury grade IV. This image shows rupture bladder (intraperitoneal type). There is hematoma at dome of urinary bladder with intraperitoneal hematoma. He underwent surgery and without complication.

**Table 1.** Spleen injury scale

| | Grade* | Injury Description | AIS |
|---|---|---|---|
| I | Hematoma | Subcapsular, < 10% surface area | 2 |
| | Laceration | Capsular tear, < 1 cm parenchymal depth | 2 |
| II | Hematoma | Subcapsular, 10%-50% surface area; intraparenchymal, < 5 cm in diameter | 2 |
| | Laceration | Capsular tear, 1-3 cm parenchymal depth which does not involve a trabecular vessel | 2 |
| III | Hematoma | Subcapsular, > 50% surface area or expanding; ruptured subcapsular or parenchymal hematoma; intraparenchymal, < 5 cm or expanding | 3 |
| | Laceration | > 3 cm parenchymal depth or involving trabecular vessel | 3 |
| IV | Laceration | Laceration involving segmental or hilar vessels producing major devascularization (>25% of spleen) | 4 |
| V | Laceration | Completely shattered spleen | 5 |
| | Vascular | Hilar vascular injury which devascularizes spleen | 5 |

* Advance one grade for multiple injuries up to grade III.

Modified from journal of trauma: Moore EE, Cogbill TH, Jurkovich GJ, Shackford SR, Malangoni MA, Champion HR. Organ injury scaling: Spleen and Liver (1994 revision). J Trauma 1995;38:323 24.

**AIS** = Abbreviated Injury Score

**Table 2.** Liver injury scale

| | Grade* | Injury Description | AIS |
|---|---|---|---|
| I | Hematoma | Subcapsular, < 10% surface area | 2 |
| | Laceration | Capsular tear, < 1 cm parenchymal depth | 2 |
| II | Hematoma | Subcapsular, 10%-50% surface area; intraparenchymal, < 10 cm in diameter | 2 |
| | Laceration | Capsular tear, 1-3 cm parenchymal depth < 10 cm in length | 2 |
| III | Hematoma | Subcapsular, > 50% surface area or expanding; ruptured subcapsular or parenchymal hematoma; intraparenchymal, > 10 cm or expanding | 3 |
| | Laceration | > 3 cm parenchymal depth | 3 |
| IV | Laceration | Parenchymal disruption involving 25%-75% of hepatic lobe or 1-3 Couinaud's segments within a single lobe | 4 |
| V | Laceration | Parenchymal disruption involving > 75% of hepatic lobe or > 3 Couinaud's segments within a single lobe | 5 |
| | Vascular | Juxtahepatic venous injuries; i.e., retrohepatic vena cava/central major hepatic veins | 5 |
| | Vascular | Hepatic avulsion | 6 |

* Advance one grade for multiple injuries up to grade III.
Modified from journal of trauma: Moore EE, Cogbill TH, Jurkovich GJ, Shackford SR, Malangoni MA, Champion HR. Organ injury scaling: Spleen and Liver (1994 revision) 1995;38:323-24.

**AIS** = Abbreviated Injury Score

**Table 3.** Pancreatic injury scale

| | Grade* | Injury Description + | AIS |
|---|---|---|---|
| I | Hematoma | Minor contusion without duct injury | 2 |
| | Laceration | Superficial laceration without duct injury | 2 |
| II | Hematoma | Major contusion without duct injury or tissue loss | 2 |
| | Laceration | Major laceration without duct injury or tissue loss | 3 |
| III | Laceration | Distal transection or parenchymal injury with duct injury | 3 |
| IV | Laceration | Proximal* transection or parenchymal injury involving ampulla | 4 |
| V | Laceration | Massive disruption of pancreatic head | 5 |
| .81, .91 = Head; .82, .92 = Body; .83, .93 = Tail | | | |

* Proximal pancreas is to the patients' right of the superior mesenteric vein. * Advance on grade for multiple injuries to the same organ. + Based on most accurate assessment at autopsy, laparotomy, or radiologic study.

**Table 4.** Duodenal organ injury scale

| | Grade* | Injury Description + | AIS |
|---|---|---|---|
| I | Hematoma | Involving single portion of doudenum | 2 |
| | Laceration | Partial thickness, no perforation | 3 |
| II | Hematoma | Involving more than one portion | 2 |
| | | LacerationDisruption <50% of circumference | 4 |
| III | Laceration | Disruption 50-75% circumference of D2 | 4 |
| | | Disruption 50-100% circumference of D1, D3, D4 | |
| IV | Laceration | Disruption > 75% circumference of D2 | 5 |
| | | Involving ampulla or distal common bile duct | |
| V | Laceration | Massive disruption of duodenopancreatic complex | 5 |
| | Vascular | Devascularization of duodenum | 5 |

D1 = 1st portion duodenum, D2=2nd portion duodenum, D3=3rd portion duodenum, D4=4th portion duodenum.

* Advance on grade for multiple injuries to the same organ.

+ Based on most accurate assessment at autopsy, laparotomy, or radiologic study.

**Note:** Table3,4 modified from journal of trauma: Moore EE, Cogbill TH, Malangoni MA, Champion HR, Shackford SR, Pachter HL, et al: Organ injury scaling, II: Pancreas, Duodenum, Small bowel, Colon, and Rectum. J Trauma 1990;30:1427-9.

**Table 5.** Small bowel organ injury scale

| | Grade* | Injury Description + | AIS |
|---|---|---|---|
| I | Hematoma | Concusion or hematoma withour devasculari zation | 2 |
| | Laceration | Partial thickness, no perforation | 2 |
| II | Laceration | Laceration < 20% of circumference | 2 |
| III | Laceration | Laceration ≥ 50% of circumference without transection | 3 |
| IV | Laceration | Transection of the small bowel | 4 |
| V | Laceration | Transection of the small bowel with segmemal tissue loss | 4 |
| | Vascular | Devascularization segment | 4 |

* Advance on grade for multiple injuries to the same organ.

+ Based on most accurate assessment at autopsy, laparotomy, or radiologic study.

Modified from journal of trauma: Moore EE, Cogbill TH, Malangoni MA, Champion HR, Shackford SR, Pachter HL, et al: Organ injury scaling II: Pancreas, Duodenum, Small bowel, Colon, and Rectum. J Trauma 1990;30:1427-9.

**Table 6.** Renal injury scale

| | Grade* | Injury Description + | AIS |
|---|---|---|---|
| I | Contusion: | Microscopic or gross hematuria; urologic studies normal | 2 |
| | Hematoma: | Subcapsular, nonexpanding without parenchymal laceration | 2 |
| II | Hematoma: | Nonexpanding perirenal hematoma confined to renal retroperitoneum | 2 |
| | Laceration: | <1.0 cm parenchymal depth of renal cortex without urinary extravasation | 2 |
| III | Laceration: | >1.0 cm parenchymal depth of renal cortex without collecting system rupture or urinary extravasation | 3 |
| IV | Laceration: | Parenchymal laceration extending through the renal cortex, medulla and collecting system | 4 |
| | Vascular: | Main renal artery or vein injury with contained hemorrhage | 4 |
| V | Laceration: | Completely shattered kidney | 5 |
| | Vascular: | Avulsion of renal hilum which devascularizes kidney | 5 |

* Advance on grade for multiple injuries to the same organ.
+ Based on most accurate assessment at autopsy, laparotomy, or radiologic study.

Modified from journal of trauma: Moore EE, Shackford SR, Pachter HL, Champion HR, Malangoni MA, McAninch JW, et al: Organ injury scaling: Spleen, Liver and Kidney. J Trauma 1989;29:1664-6.

**Table 7.** Bladder organ injury scale

| | Grade* | Injury Description | AIS |
|---|---|---|---|
| I | Hematoma | Contusion, intramural hematoma | 2 |
| | Laceration | Partial thickness | 3 |
| II | Hematoma | Extraperitoneal bladder wall laceration < 2 cm | 4 |
| III | Laceration | Extraperitoneal (> 2 cm) or intraperitoneal (<2 cm) bladder wall lacerations | 4 |
| IV | Laceration | Intraperitoneal bladder wall laceration > 2 cm | 4 |
| V | Laceration | Intra or extraperitoneal bladder wall laceration extending into the bladder neck or ureteral orifice (trigone) | 4 |

* Advance on grade if multiple lesions exist.

Modified from journal of trauma: Moore EE, Cogbill TH, Jurkovich GJ, Champion HR, Malangoni, MA, Shackford SR, et al: Organ injury scaling III:Chest wall, Abdominal vascular, Ureter, Bladder, and Urethra. J Trauma 1992;33:337-9.

**AIS** = Abbreviated Injury Score

**Table 8.** Relationship between organ injury, CT grading (OIS), injury severity score (ISS),and management

| Organ | Number of patient (n) | Non-Surgery | | | Surgery | | | Accuracy by CT Vs Surgery |
|---|---|---|---|---|---|---|---|---|
| | | OIS | No(n) | mean ISS | OIS | NO(n) | mean ISS | |
| Liver | 7 | Gr II | 4 | 12 .25 | Gr I | 1 | 30 | correct |
| | | | | | Gr II | 1 | | missed iejunal |
| perforation | | | | | | | | |
| | | | | | Gr III | 1 | | correct |
| spleen | 4 | Gr II | 1 | 9 | Gr III | 1 | 21.3 | correct |
| | | | | | Gr V | 2 | | |
| Pancreas | 4 | Gr II | 1 | 9 | Gr II | 1 | 10 | missed duodenal |
| perforation | | | | | | | | |
| | | Gr III | 2 | | | | | |
| Renal | 2 | Gr II | 2 | 7.5 | - | - | - | |
| Bladder | 1 | - | - | - | Gr IV | 1 | | correct |
| Abdominal wall hematoma | 1 | - | - | 9 | - | - | - | |
| Retroperitoneal hematoma | 1 | - | - | 9 | - | - | - | |
| Negative Study | 2 | - | - | 1 | - | - | - | |

**OIS** = Organ Injury Scale, **ISS** = Injury Severity Score

## DISCUSSION

CT scan is recommended for blunt abdominal trauma patients with clinical suspicion of intraabdominal organ injury who are hemodynamically stable. The procedure was reported as possessing great accuracy in the diagnosis of both hemoperitoneum and organ damage.[2-7] The CT scan is graded according to organ injury scale in the prediction of successful selective non-operative management of blunt abdominal organ injury. The previous study by Wing et al[9] reported 97.6% accuracy in the diagnosis of organ damage. In our study, the accuracy in the diagnosis of solid organ injury was 100%.

The study by Umlas et al[8], showed unclear severity of splenic injury as described by CT when compared to the clinical outcome, but our study found it to be completely accurate in grading the diagnosis of splenic injury.

In our study, the bowel injury was missed in 2 cases ( duodenal and jejunal injury). The limitation of interpretation is probably caused by inappropiated technique for window width setting and bowel opacification. In one prospective study of blunt trauma, CT scan showed a sensitivity of only 25% in the detection of duodenal and small intestine injuries.[10]

There were many reports on CT grading in surgical and conservative management of solid organ injury.[11-14] The OIS grade I to III were treated with conservative treatment while OIS grade III to V had surgical treatment. Similar result was found by us. The patients with OIS grade III will go to surgery or not, depend on clinical evaluation and associated injury.

Our study showed that all patients in non-surgical group have ISS less than twenty, and in surgical group, most patients (91%) have ISS more than twenty, except in two patients who were operated because of bowel injury. Furthermore, patients with high grade OIS, also had high ISS, but patients with low grade OIS may had either low ISS or rather high ISS, depending on associated other organ injury. The negative study patients had very low ISS.

## CONCLUSION

CT is the investigation of choice for the diagnosis of solid organ injury with high accuracy in evaluation and grading of severity of blunt abdominal trauma. The difference in OIS and ISS in patients who underwent conservative and surgical management can be used for prediction and evaluation in selective non-operative management of blunt abdominal trauma.

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