



**ORIGINAL RESEARCH PAPER**

**Radiodiagnosis**

**RELATION BETWEEN INFERIOR VENA CAVA DIAMETER AND OCCURRENCE OF HYPOTENSION, SEVERITY OF SOLID ABDOMINAL ORGAN INJURY AND HEMOPERITONEUM IN CASES OF BLUNT TRAUMA OF ABDOMEN.**

**KEY WORDS:**

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**ABSTRACT**

**OBJECTIVE:** The purpose of this study was to evaluate the clinical significance of the "flattened vena cava" sign on abdominal contrast enhanced ct scans in venous phase imaging.

**MATERIALS AND METHODS:** CT scan abdomen of 50 patients imaged with history of blunt trauma to abdomen were retrospectively reviewed for a flat cava sign. The medical records of the patients with a flattened cava sign--defined as a maximal transverse-to-anteroposterior ratio of 3:1 or greater were reviewed for evidence of low blood pressure or hypovolemia.

**RESULTS:** Out of total 50 patients evaluated 30 had flattened IVC (FIVC). Of these 30 patients all had higher incidence of hypotension, higher grade of solid organ injury, hemoperitoneum.

**CONCLUSION:** Of the 50 inpatients, 60% had flattened vena cava sign on abdominal CT scans. The majority of patients with flattened vena cava sign had increased chance of occurrence of hypotension or evidence of hypovolemia after trauma.

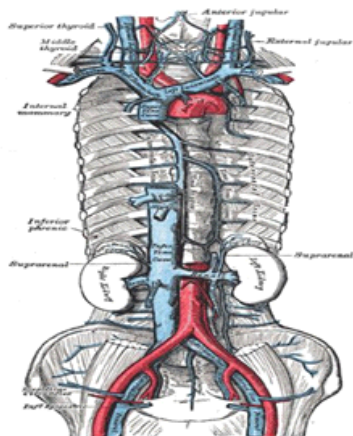
**INTRODUCTION-**

Blunt abdominal traumas have become very common due to increased road traffic accidents in recent years(1). After a patient is brought to a hospital Focused Assessment with Sonography (FAST) / CT scan of abdomen and pelvis is usually done on the patient(2). It has been observed that blunt trauma of the abdomen with visceral injury of solid abdominal organs usually leads to low blood pressure(3) which in turn may lead to cardiovascular shock due to hypovolemia(4,5). In such cases blood pressure is continuously monitored. Blunt trauma of the abdomen usually leads to internal bleeding leading to hemoperitoneum and loss of intravascular fluids leading to collapse of IVC(6) . This can be shown on contrast enhanced CT scan in the venous phase as flattening of IVC (FIVC) by measuring the reduced diameter.

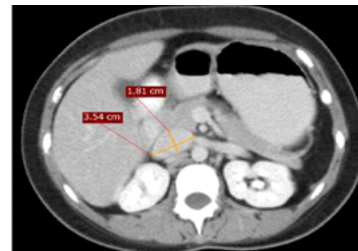
Hence in this study we intend to correlate the occurrence of IVC flattening and decreased blood pressure (hypotension) and severity of blunt trauma to abdomen as per American association for the surgery of trauma (AAST) guidelines.

**AIMS-**

›To assess the diameter of IVC on axial section of CT scan of abdomen at midway between the renal veins and the vena caval bifurcation portion as the predictor of hypotension in blunt abdominal trauma.



**Figure 1- Normal anatomy of inferior vena cava.**



**Figure 2- Transverse/anteroposterior diameter ratio of IVC at the level of midpoint between renal veins and vena caval bifurcation.**

**MATERIALS AND METHODS**

**Type of study:**

Retrospective cohort study.

**Inclusion Criteria:**

- Patients who have suffered blunt trauma to the abdomen.
- Patients who have undergone contrast enhanced CT scan in arterial venous and delayed phases.

**Exclusion Criteria-**

- Patients who underwent only non contrast CT.

**Sample size:**

50 patients with history of blunt trauma to the abdomen.

CT scans of 50 patients with blunt trauma to the abdominal were studied retrospectively over a period of three years (2015-2018) at our tertiary care teaching Hospital – ACPM HOSPITAL.

A 16 SLICE CT scan machine with urografin injection for intravenous contrast was used to perform contrast enhanced CT scan of abdomen and pelvis.

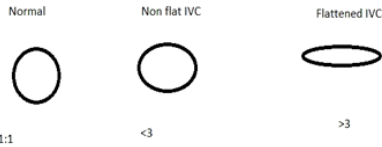
› Imaging was performed in arterial phase and venous phase. Delayed excretory phase was performed in cases of renal injury(8,9,10).

**The images were reviewed for signs of:-**

1. Diameter of IVC in venous phase was measured in both AP and transverse dimension at midway between the renal

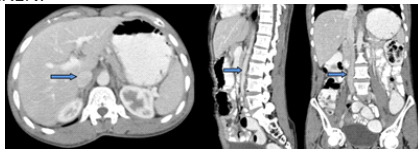
- veins and the vena caval bifurcation.
- 2. AAST grading was done for solid viscera injury.
- 3. Hemoperitoneum

>In view to assess diameter of IVC which acts as predictor of hypotension (11,12,13), the diameter of IVC was measured at midway between the renal veins and the vena caval bifurcation. >  
The ratio of TRANSVERSE:ANTEROPOSTERIOR diameter of IVC was measured at midway between the renal veins and the caval bifurcation part.

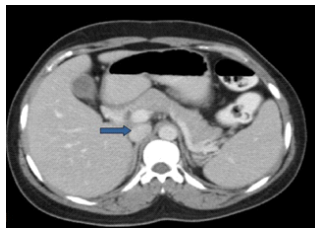


**Figure 3- LINE DIAGRAM SHOWING NORMAL IVC, NFIVC AND FIVC.**

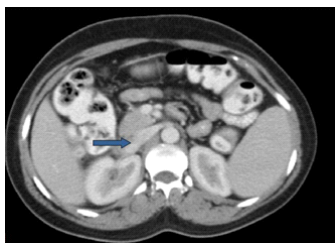
RATIO OF TRANSVERSE:ANTEROPOSTERIOR DIAMETER OF IVC  
FLATTENED IVC (FIVC) = TRANSVERSE: ANTEROPOSTERIOR :>/=3  
NON FLATTENED IVC = TRANSVERSE: ANTEROPOSTERIOR :</=3  
BASE ARTICLE FROM WHICH TR:AP RATIO OF IVC i.e. 3 CUT OFF WAS TAKEN.



**Figure 4- POST CONTRAST OF VENOUS PHASE OF MDCT ABDOMEN SHOWING IVC IN ALL THREE PLANES**



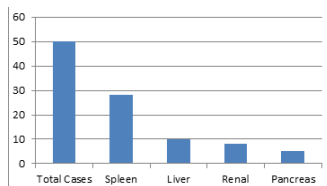
**Figure 5- POST CONTRAST OF VENOUS PHASE OF MDCT ABDOMEN SHOWING NON flat IVC.**



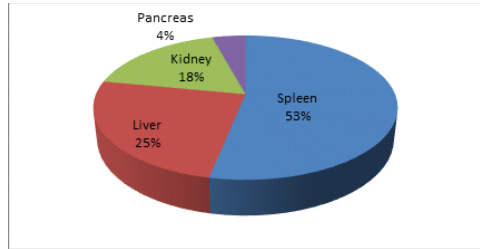
**Figure 6- POST CONTRAST OF VENOUS PHASE OF MDCT ABDOMEN SHOWING NON flat IVC.**

**RESULTS-**

In our review of 50 cases which were studied retrospectively, considering the age group between 15-70 years, 28 (56%) patients had splenic injury, 10 (20%) patients had liver injury, 4 (16%) patients had renal injury, 4 (8%) patients had pancreatic injury



**Figure 10- BAR GRAPH SHOWING NUMBER OF INJURED ORGANS WITH FIVC.**



**Figure 11- BAR GRAPH SHOWING NUMBER OF PATIENTS WITH HYPOTENSION WITH SEVERE GRADE OF DIFFERENT ORGAN INJURIES, HEMOPERITONEUM AND FIVC.**

Sr. No.	Organ injured	Grade of injury	TR/AP ratio of IVC
1	Spleen	Grade1	2.9
2	Spleen	Grade2	3.0
3	Liver	Grade3	3.1
4	Spleen	Grade3	3.3
5	Kidney	Grade3	3.7
6	Spleen	Grade4	3.2
7	Spleen	Grade3	3.6
8	Liver	Grade3	3.8
9	Spleen	Grade4	4.1
10	Spleen	Grade3	3.2
11	Kidney	Grade3	3.6
12	Liver	Grade3	3.5
13	Spleen	Grade3	4.2
14	Liver	Grade3	4.3
15	Kidney	Grade2	3.7
16	Spleen	Grade4	3.3
17	Pancre-as	Grade2	3.1
18	Spleen	Grade3	3.1
19	Kidney	Grade2	0.8
20	Liver	Grade2	1.0
21	Spleen	Grade3	3.7
22	Spleen	Grade4	3.6
23	Spleen	Grade4	3.9
24	Liver	Grade2	2.5
25	Spleen	Grade4	4.0
26	Liver	Grade2	1.9
27	Spleen	Grade3	3.4
28	Spleen	Grade4	3.2
29	Spleen	Grade3	3.1
30	Kidney	Grade1	0.5
31	Spleen	Grade2	2.3
32	Spleen	Grade1	2.2
33	Liver	Grade2	2.8
34	Pancre-as	Grade3	3.3
35	Spleen	Grade2	2.9
36	Spleen	Grade1	2.6
37	Spleen	Grade2	2.3
38	Liver	Grade2	2.1
39	Kidney	Grade1	2.5
40	Spleen	Grade1	2.2
41	Pancre-as	Grade2	2.1
42	Spleen	Grade1	1.5
43	Spleen	Grade2	1.0
44	Spleen	Grade1	1.5
45	Spleen	Grade2	3.1
46	Spleen	Grade1	2.1
47	Liver	Grade2	3.2
48	Kidney	Grade1	3.0
49	Pancre-as	Grade3	3.3
50	Kidney	Grade1	3.3

So out of 50 patients, 30 patients had Flattened IVC at the level midway between renal veins and caval bifurcation with severe

grade of organ injury and severe degree of hemoperitoneum with increased incidences of mortality and morbidity as was reviewed from their medical records. Remaining 20 patients Non flattened IVC had low grade organ injury and minimal hemoperitoneum and decreased morbidity and mortality.

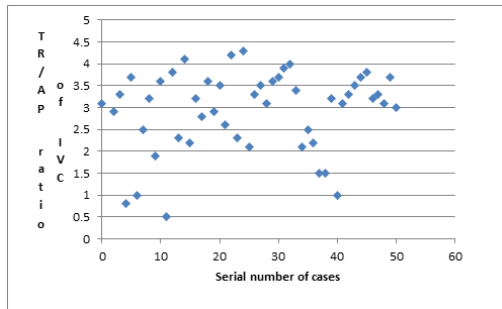


Figure 12- SCATTER DIAGRAM SHOWING TR/AP RATIO OF IVC in cases OF 50 ABDOMINAL BLUNT TRAUMA. 30 PATIENTS OUT OF 50 HAD FIVC WITH RATIO OF >3.0.

Y AXIS REPRESENTS THE TR/AP RATIO OF IVC AND X AXIS SHOWS CASES OF ABDOMINAL TRAUMA IN OUR STUDY(n=50).

Thus, in cases of those Patients showing flattened IVC (FIVC) there was increased incidence of hypotension/ hemorrhagic shock; and it also correlated with severity of involved organ injury and hemoperitoneum.

**CONCLUSION:**

So the above study shows significance of assessing the IVC diameters of the patient with history of blunt trauma abdomen.

Hence it is can be said that patients with a flattened IVC had increased incidences of low blood pressure, solid abdominal organ injuries and free blood in peritoneum.

Thus it can be said the venous phase diameter of IVC on CT axial section can be used to determine low blood pressure and severity of solid abdominal organ injuries and free blood in peritoneum in cases of blunt trauma of the abdomen.

The ratio of TR/AP diameter of IVC at the level midway between renal veins and caval bifurcation is more objective measurement and sound indicator, which correlates with severity of low blood pressure, grade of solid organ injury and hemoperitoneum. So it is recommended this TR/AP ratio of IVC to be reported in all CT scan reports of abdominal trauma patients.

**Limitations-**

Sample size is small. Results need to be test for larger sample size and across multiple centers to reduce different confounding factors.

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