MDCT In Blunt Abdominal Trauma, A Good Predictor For Surgical Management

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Abstracts: **Aim:** The aim of our study was to analyze the role of Multidetector computed Tomography (MDCT) in the classification and management of high energy blunt abdominal trauma. **Material And Method:** A Prospective study of 140 patients of all age groups was conducted from October 2010 to October 2012. Rectal and IV contrast were used. Angiography was performed in cases of suspected vascular trauma. Three dimensional reconstructions were done. CT findings were correlated and confirmed by either operative findings or follow-up CT. **Result:** 140 cases of blunt abdominal trauma were included in this study. Abdominal USG (Ultrasound) and MDCT were performed. Abdominal injuries were more common in males seen in 119 cases (89%). Spleen was the most common organ to be injured, affected in 40 patients (23%). Liver injury was seen in 36 cases, renal involvement in 30 cases, bowel in 20 cases, urinary bladder in 7 cases, a pancreatic injury in 3 cases and retro peritoneum involvement in 2 cases. Out of 140 patients 135 had free intraperitoneal fluid. USG findings and MDCT findings were compared with per operative findings. Patients managed conservatively were compared with repeat follow up CT findings. USG showed a sensitivity of 55 % and specificity of 75 % in solid organs injury and sensitivity of 95 % and specificity of 99 % in free fluid detection. MDCT showed a sensitivity of 97 % and specificity of 98 % in solid organs injury and 100%in hemoperitoneum. **Conclusion:** MDCT is the modality of choice to evaluate abdominal injury when there is doubt in clinical and USG findings, and to offer patient conservative management. [Vaishnav K et al NJIRM 2014; 5(2) :19-26]
Key Words: Multidetector computed tomography, blunt abdominal trauma.

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Introduction : Imaging in abdominal trauma has seen a quantum leap with Multi Detector CT Scan (MDCT) with its three dimensional reconstruction, angiography techniques and scanning times being progressively decreased and image resolution has increased reducing motion artifacts. High resolution ultrasound (usg) being cost effective can detect the solid organ injury and free fluid but had limitation in evaluating injuries to pancreas, bowel, kidney, adrenal, mesentry, diaphragm , vascular and spine injury. While MDCT detect these injuries better and also detects lower thoracic injury. It also allows high quality two-and three-dimensional multiplanar reformatted images to be obtained, which aid in the diagnosis of the complex multisystem traumatic injuries and guiding the management of patients. The primary advantage of CT scanning is its high specificity and use for guiding nonoperative management of solid organ injuries.

In addition, a CT scan of the abdomen can reveal other associated injuries, notably vertebral and pelvic fractures and injuries in the thoracic cavity.

Aims:-To diagnosis the injuries to the organs which are difficult to evaluate by usg. To grade the solid organ injuries which are of prognostic significance. Comparison of usg and CT scan findings with operative findings.

Material and Methods: This prospective study was carried out in 140 patients, clinically suspected of having internal abdominal injuries at our institution from October 2010 to October 2012.

Detailed history and clinical examination was carried out. USG was done in all patients. MDCT is done in patients having hemoperitoneum with normal appearance of solid organs and positive history of trauma suspecting pancreas, vascular and bowel injury. No gender and age prediliction was considered. The usg and MDCT findings in the patients requiring operative management were compared with intra-operative findings.

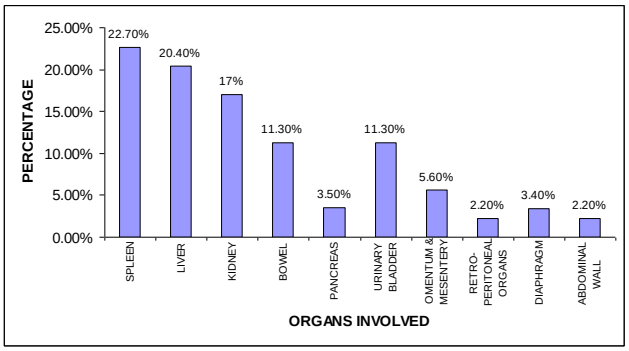
MDCT examinations were carried out with standard abdominal trauma protocol using intra venous non ionic contrast media and oral/rectal contrast as and when required (for bowel trauma). Protocol included plain study, followed by intra venous contrast study (2 ml/kg with flow rate of 2-3 ml/second) in arterial phase (bolus tracking) and venous phase(70-80 seconds delay) with delayed full bladder scan was performed when required. CT angiography was done for suspected vascular

injury. Penetrating injuries were excluded in this study.

Results: MDCT findings were compared with operative results; follow up CT scan/USG. Specificity and sensitivity of the MDCT findings were obtained. Patients of all age group were included in our study; out of which abdominal injuries were more common in the age group of 21-40 yrs (53%). In our study, 38 patients had multiple organ injuries. Out of them 123 were male patients (87.85%) and 17 were female patients (12.14%). Of 3 patients having pancreatic trauma on MDCT, pancreatic laceration (3) was most common finding followed by intrapancreatic hematoma (2) and peripancreatic hematoma (2).

Retroperitoneal hematoma was noted in 2 patients and psoas hematoma in 2 patients. 135 patients having free fluid, spleen is most commonly injured organ followed by liver and kidney. Free fluid is most consistent finding (20/20) in patient with bowel injury. Results are shown in following tables.

Table 1:- Organs Involved



In this study of 140 cases splenic injury was most common -40 cases (22.7%) followed by liver cases -36 (20.4%) and kidney 30 cases (17.0%).

Table 2:- MDCT IN SPLENIC TRAUMA

NO	MDCT FEATURES	True Positive	True Negative	False Positive	False Negative
1	Splenic Contusion	12	26	00	02
2	Splenic Laceration	30	10	02	00
3	Intraparenchymal Haematoma	14	26	00	00
4	Subcapsular Haematoma	04	36	00	00
5	Perisplenic Haematoma	32	10	00	00
6	Splenicartery Pseudoaneurysm	00	00	00	00
7	Splenicartery Thrombosis	00	00	00	00
8	Splenicvein Thrombosis	02	38	00	00
9	Total	94	146	02	02

Perisplenic hematoma (80%) was most common finding followed by splenic laceration (75%) and splenic contusion (30%).

Table 3:- MDCT IN LIVER TRAUMA

NO	MDCT FEATURES	True Positive	True Negative	False Positive	False Negative
1	Liver Contusion	22	12	00	02
2	Liver Laceration	20	16	00	00
3	Intraparenchymal Haematoma	22	14	02	00
4	Subcapsular Haematoma	02	22	00	00
5	Perihepatic Haematoma	08	28	00	00
6	Portal Vein Thrombosis	00	00	00	00
7	Hepatic Vein Thrombosis	00	00	00	00
8	Total	74	92	02	02

Liver contusion (61%) and intraparenchymal hematoma (61%) was most common finding followed by liver laceration (55%). Pnemoperitoneum (100%) was most common finding followed free fluid (90%).

Table 4:- MDCT IN BOWEL TRAUMA

NO.	Mdct Features	True Positive	True Negative	False Positive	False Negative
1	Pneumoperitoneum	20	00	02	00
2	Free Fluid	18	00	02	02
3	Localized Haematoma (Sentinel Clot)	02	16	00	02
4	Loclized Thickened Bowel Wall	02	16	02	02
5	Total	42	32	06	06

TABLE 5 :- MDCT IN PANCREATIC TRAUMA

NO.	MDCT FEATURES	True Positive	True Negative	False Positive	False Negative
1	Pancreatic Laceration	03	00	00	00
2	Intraparenchymal Haematoma	02	00	00	01
3	Peripancreatic Haematoma	02	01	00	00
4	Total	07	01	00	01

Discussion: Blunt abdominal trauma in isolation represents 5% of the trauma mortality and further contributes 15 % to mortality as part of polytrauma [1]. Total numbers of organs involved are shown in Table 1. In our study, abdominal USG was performed as the initial imaging modality. MDCT was perfomed only when usg alone was not helpful for management of patients. Operative results were compared with MDCT and USG findings. Patients with conservative management were regularly followed up with MDCT/USG. The most widely used injury grading system is the American Association for the Surgery of Trauma (AAST) scale [2]. USG is a portable, economical, easily available, and fast and a bed side procedure. Though it gives lot of valuable information in trauma patients, it has its own pitfalls. USG gives basic idea regarding haemoperitoneum and organ injury, but has limitation for retroperitoneal organs, pelvic, vascular and bony injuries. In polytrauma patients timely management is very important and thus with MDCT we get complete evaluation regarding number of organs injured and grading of injuries. Thus MDCT proves to be a boon for surgeons in the management of the patient whether surgical or conservative is to be undertaken. In cases where operative management is required, it aids in planning the surgery well and vascular surgeon can be informed beforehand if the MDCT findings point towards the need for any vascular intervention.

Hemodynamically stable patients with positive usg findings may require a CT scan for defininig the nature and extent of injuries. Thus high laprotomy rate can be reduced with only CT findings. Hemodynamically stable patients with negative usg findings require close observation, serial abdominal examinations, and a follow up examination. However MDCT is strongly recommended in the patients with other associated injuries. Hemodynamically unstable patients with negative usg findings are a diagnostic challenge. Options include diagnostic peritoneal lavage, exploratory laparotomy, and noninvasive and prefered CT scan in almost all cases after aggressive resuscitation

Splenic Trauma: Spleen is most commonly injured organ following blunt abdominal injury. Spleen is the most vascular organ of the body containing 500 to 600 ml of blood. Splenic injury is commonly associated with other organ injuries. CT is modality of choice for imaging of splenic injuries [3] . More than 70% of the patient of splenic injury are teated with conservative management. Surgical intervention is required when large perisplenic hematoma and splenic vascular injury. Splenic contusion is seen as nonenhancing hypodence area within spleen. Perisplenic hematoma seen as large hyperdence collection with hemoperitoneum. MDCT feature of splenic trauma as shown in table 2. CT classification of splenic trauma is shown below.

Over all ultrasound has sensitivity of 63% and specificity of 80%, MDCT has sensitivity of 97% and specificity of 98%.

LIVER TRAUMA : The liver is the second most frequently injured solid abdominal organ after spleen. The right lobe is injured more frequently

and severely than left, posterior segments are more frequently injured than anterior [3]. Blunt hepatic injuries in hemodynamically stable patients without other indications for exploration are best served by a conservative, nonoperative approach [4, 5, 6] . Some small laceration s were easily controlled by sutures and hemostatic agents. Deep lacerations should not be simply closed beacause of the risk of abscess formation and hemobilia. Liver contusion seen as illdefined hypodence area without enhancement and laceration seen as linear non enhancing hypodense tract from liver parenchyma to surface. In case of act ive extravasation of contrast from the veesel is indicative of surgical exploration. The CT classification of liver trauma is shown below. MDCT feature of liver trauma as shown in table 3.

Classification Of Spleen Trauma

Grade I	Capsular avulsion ,superficial lacerations or sub capsular hematoma less than 1 cm
Grade II	Parenchymal lacerations 1-3cm deep, central Sub capsular hematoma less than 3 cm
Grade III	Laceration more than 3 cm deep, central sub capsular hematoma more than 3 cm
Grade IV	Fragmentations in 3 or more sections or devascularized non enhanced spleen

CT CLASSIFICATION OF LIVER TRAUMA

Grade I	Capsular avulsion, superficial lacerations less than 1cm deep. Subcapsular hematoma less than 1 cm thickness, periportal blood tracking.
Grade II	Laceration 1-3cm deep, central/sub capsular hematoma 1-3 cm diameter
Grade III	Laceration more than 3cm deep ,central subcapsular hematoma more than 3 cm deep
Grade IV	Massive central subcapsular hematoma >10 cm, lobar destruction or devascularization
Grade V	Bilobar tissue destruction or devascularization

Over all ultrasound has sensitivity of 48% and specificity of 75%, MDCT has sensitivity of 97% and specificity of 98%.

RENAL TRAUMA : Renal injury is common occurring in 8-10% of cases of blunt and penetrating trauma. About 90% of renal injuries result from blunt force injury. CT has become the primary diagnostic tool for the rapid and accurate assessment of acute traumatic genitourinary injuries, as well as for the diagnosis of related complications. Injuries involving renal hilum are seldom primarily and in most of the cases total nephrectomy. Blunt trauma involved minor includes contusion 85% and mostly treated with conservative manangment and major includes deep cortico medullary lacerations with extravasation, large perinephric hematoma, and renal pedicle injury. The CT classification of renal trauma is shown below. Over all ultrasound has sensitivity of 63% and specificity of 78%, MDCT has sensitivity of 97% and specificity of 97%.

CT CLASSIFICATION OF RENAL INJURY

Grade I	Contusion or non expanding subcapsular hematoma without laceration.
Grade II	Non expanding perirenal hematoma or cortical laceration (<1 cm) without urinary extravasation.
Grade III	Laceration (>1 cm) without urinary extravasation, larger perinephric haematomas.
Grade IV	Laceration through the corticomedullary junction and into collecting system or segmental renal artery or vein with contained haemorrhage.
Grade V	Shattered kidney or avulsion of the renal pedicle.

BOWEL TRAUMA: The diagnosis of intestinal injury is one of the most difficult and controversial aspects of trauma care. A delay in diagnosis of bowel injury of only 8 hours has been shown to increase morbidity and mortality [7, 8] . A delay may result in peritonitis, ongoing hemorrhage, bowel ischemia, and necrosis. Rupture of a hollow viscus may produce free air either in the peritoneal cavity, but may also occur following pneumothorax and mechanical ventilation [9] . Additional findings of free intraperitoneal fluid may be seen. Contrast studies employing water soluble contrast media are useful in detecting perforation and intraluminal obstruction in stable patients. MDCT is the

diagnostic modality of the choice for detection of bowel and mesenteric injuries and has been shown to be more sensitive and specific than clinical examination, diagnostic peritoneal leavage and abdominal ultrasound. Negative abdominal CT results are inadequate to safely rule out a perforated small bowel injury [7] . The sign of bowel injury are frequently subtle. The most specific sign of bowel injury are.

-Pneumoperitoneum or Pnuemo-retroperitoneum
-Extravasation of oral contrast material
-Low attenuation fluid between loops
-Bowel wall discontinuity

MDCT is very helpful when retroperitoneal bowel is perforated, which is masked by x-ray and usg. Clinical suspicion about such injury is many times diagnosed by oral and rectal contrast CT scan. Early evaluation of colon injury much more important to prevent ischemia. Mesenteric tear may or may not associated with bowel injury. Hemoperitoneum without any solid organ injury suggest possibility of mesenteric injury.

The sensitivity of CT to traumatic bowel injury varies from 69% to 92% and CT is 94%–100% specific for the diagnosis of bowel and mesenteric injuries. CT findings can include focal bowel wall thickening, mesenteric infiltration, free air, the presence of intraperitoneal fluid without solid organ injuries and extravasated contrast material. Free air adjacent to bowel segment is more sensitive for perforation of that segment of bowel. MDCT feature of bowel trauma as shown in table 4. Sensitivity of MDCT in detecting bowel trauma is 87% and specificity is 84% in this study while sensitivity of 97.7% and specificity of 98.5%, as shown in Archieves of surgery 2002.

PANCREATIC TRAUMA : The pancreas is the least commonly injured solid organ, accounting for 3-12% of all abdominal injuries. This injury occurs after a sudden force that compresses the pancreatic neck against lumbar spine, e.g. in motor vehicle accidents in adults and bicycle accidents in children. Pancreatic injuries are difficult to diagnose [3]. Initial CT findings may be normal, even with pancreatic transaction, because the elastic pancreatic parenchyma resumes its normal contour. A repeated CT abdominal scan at 24 to 48 hours can help reveal evolving injuries . A delay in diagnosis can often result in recurrent pancreatitis, pseudocyst, fistula or abscess formation . CT classification of pancreatic injury as shown below. MDCT features of pancreatic trauma as shown in table 5. [Figure 5]

CT CLASSFICATION OF PANCRATIC INJURY

Grade I	• Minor contusion or laceration without duct injury
Grade II	• Major contusion or laceration without duct injury or tissue loss.
Grade III	• Distal transection or parenchymal injury with duct injury.
Grade IV	• Proximal transection or parenchymal injury involving ampulla.
Grade V	• Massive disruption of pancreatic head.

Over all ultrasound has sensitivity of 38% and specificity of 25%, MDCT has sensitivity of 88% and specificity of 99%.

URINARY BLADDER TRAUMA : Bladder injuries may be due to blunt, penetrating or iatrogenic trauma. Majority of the patients of bladder trauma have associated fracture of pelvis most commonly of the anterior pubic arch. A distended bladder is more prone to injury. The patient presents with suprapubic pain or tenderness and/or hematuria.Differentiation between intraperitoneal and extraperitoneal rupture is very important for management. Extraperitoneal rupture is mostly managed by conservative approach or in some cases operative mangement was done after patient stable. While in case of intraperitoneal rupture operative management is required. A classification of bladder injury after blunt abdominal trauma has been described by sandler et al [10] . CT classification of bladder trauma as shown below.

CT CLASSIFICATION OF URINARY BLADDER INJURY

TYPE 1	Bladder contusion
TYPE 2	Intra peritoneal rupture
TYPE 3	Interstitial injury
TYPE 4	Extra peritoneal rupture
TYPE 5	Combined injury

Fig.1a- Splenic contusion, Fig 1b- Splenic laceration with perispleic hematoma

Fig 2a- Liver contusion, Fig 2b- Liver laceration with haemoperitoneum

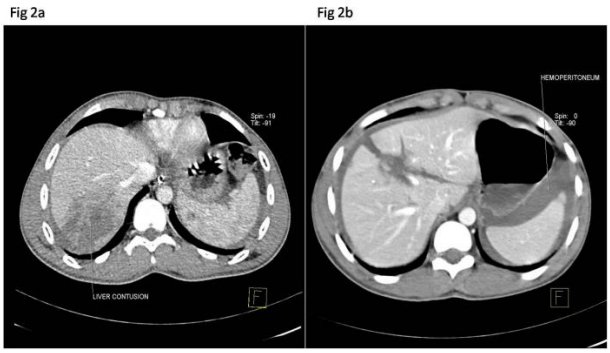
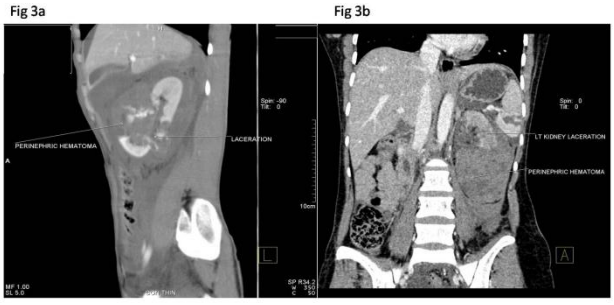


Fig 3a and 3b- Kidney laceration with perinephric hematoma



Over all ultrasound has sensitivity of 81% and specificity of 77%, MDCT has sensitivity of 92% and specificity of 90% in UB trauma.

FREE FLUID : The dependent portions of the abdomen and pelvis should be scrutinized thoroughly in trauma patient to detect small quantities of fluid that may indicate a subtle intraperitoneal injury [11].

CT has high sensitivity and specificity for the detection of blood in the peritoneal cavity.

Fig 4a and 4b– Free intraperitoneal air with haemoperitoneum in case of bowel perforation

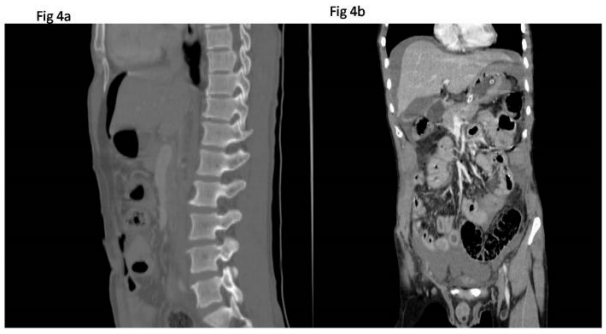


Fig 5a- Laceration at the head of pancreas, Fig5b- Fracture of pancreas at body region with haemoperitoneum

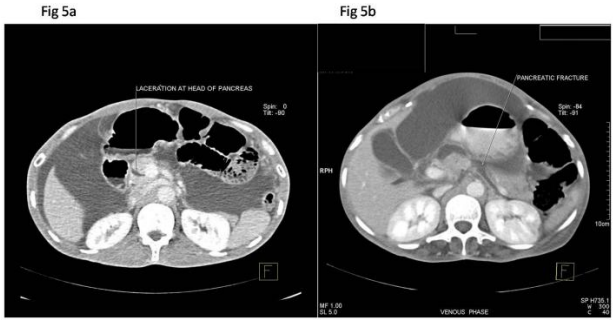


Fig 6a- Psoas hematoma, Fig 6b- Adrenal gland hematoma with renal laceration

Hemoperitoneum starts near the site of injury and spreads along the expected anatomic pathways.

Out of 140 patients of abdominal trauma 135 patients had free fluid, USG has detected free fluid in 130 patients in which 115 patients had free fluid with echoes and 25 patients had free fluid without echoes. [Figure 7]

20 out of 20patients of mesenteric and bowel injury showed free fluid with echoes, thus free fluid with echoes without any solid organ injury points towards omentum or mesenteric injury. Over all

ultrasound has sensitivity of 95% and specificity of 100% in free fluid detection these is comparable with study by K. A. Lentz, M. G. Mc Kenney, D. B. Nunez which shows sensitivity 85% and specificity 95%.

Fig 7- Gross haemoperitoneum

Fig 8a and 8b- Diaphragmatic tear

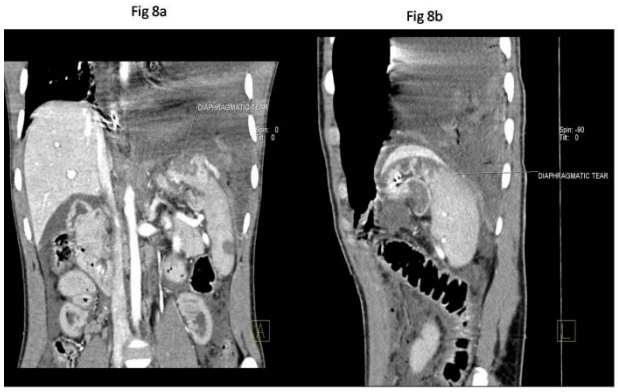
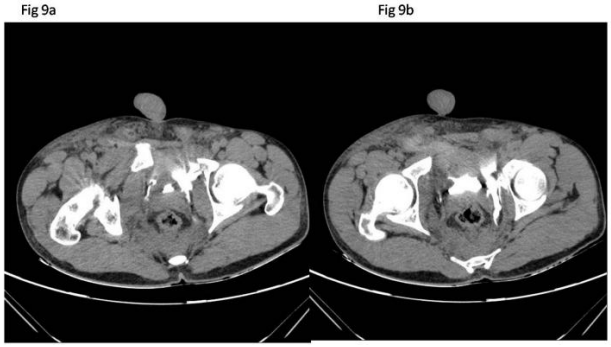


Fig 9a and 9b- Extra peritoneal rupture of bladder with leakage of dye



RETROPERITONEAL INJURY: The most commonly injured structures are the adrenals, pancreas, major vessels, gastrointestinal tract, genitourinary tract and musculoskeletal system [12] . Over all ultrasound has sensitivity of 50% and specificity of 50%, MDCT has sensitivity of 98% and specificity of 67%.

DIAPHRAGMATIC INJURY : Blunt trauma and penetrating wounds of the chest are the most frequent causes of traumatic diaphragmatic rupture. In blunt trauma, the tear is left sided in 70-90 percent of all cases and right sided in 10-30 percent. This is probably due to the protective function of the liver [13]. The stomach is the most commonly herniating organ, but bowel, spleen, liver, and omentum can also herniated into the chest. Out of 3 patients having diaphragmatic injury USG has detected tear in 1 patient and missed hernia in 2 patients where as MDCT has detected tear in 3 out of 3 patients and hernia in 2 out of 3 patients.

ABDOMINAL WALL TRAUMA : Abdominal wall injuries are easily overlooked if not specifically seen. Intramuscular hematomas appear as collection with expansion of intramuscular plane of abdominal wall. Subcutaneous hematoma and occasionally bowel herniation can occur [14].

The most important concern of nonoperative management is the potential for missed injuries, particularly hollow viscus perforations. Delay in diagnosing a hollow viscus injury is associated with significant morbidity and increased mortality [15] .

Conclusion: MDCT is the modality of choice for blunt abdominal trauma management as sensitivity and specificity is very high with MDCT than USG. Availability and cost is only limiting factor in developing countries, but for better management of patients having bunt abdominal trauma MDCT is very helpful.

Take home message: MDCT is must for trauma of abdomen. Though is expensive but for proper management of patients it is necessity.

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