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Radiodiagnosis

"IMAGING OF NAXALITE ATTACK INJURIES IN CHHATTISGARH STATE, INDIA: ORIGINAL ARTICLE".

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ABSTRACT

Objective: To present the imaging features of the injury victims of Naxalite attacks in Chhattisgarh state, India and to stress upon the value of imaging.

Methods: It is a retrospective study of 100 patients who were brought in Triage room after the Naxalite attack in the span of 1 year between 2015 & 2016. Imaging tests in the form of X rays, Ultrasounds, Doppler, CT scan and MRI were done depending upon the need. The injuries were evaluated to know the mechanism of injury, categorizing the type, determining the Triaging and to know its severity by Injury Severity Score (ISS).

Results: Injuries had variable modes of mechanisms, of which most common was gunshot attacks. Numerable injures were blunt injuries. Few were injured in bomb blast forces.

Discussion: Modes of injuries in Naxalite attack were direct gunshot, pellets of gunshot, object like Arrow, Rods, Stone, wooden stick, knife and bomb blasts [6]. These can either cause penetrating injuries or blunt trauma. Blunt injuries had internal derangements secondary to mechanical energy transfer. Majority of the injuries were of penetrating type. Bomb blast injuries results either from flying fragments, like metallic (shrapnels or pellets); or can occur when the victim body is thrown away by the intense pressure changes or least likely by burns, toxic inhalation.

Conclusion: Our study revealed that Bomb blast was the most common mechanism followed by Gun shot. Pattern was penetrating injury. The chest and abdomen were the most commonly injured body parts. Knowledge of such injuries is essential for the Radiologists since they can make a difference in triaging and management of such cases.

KEYWORDS : Imaging, Naxalism, CT scan, Radiology

INTRODUCTION:

Naxalite movement in India had its origin initially from West Bengal state. In later years, it got spread into less developed areas of rural southern and eastern India, such as Chhattisgarh, Odisha, Andhra Pradesh and Telangana through the activities of underground groups like the Communist Party of India (Maoist). Other states affected are Jharkhand and Bihar. Chhattisgarh state is getting regular and repeated attacks. Usual victims (95 %) are state police and paramilitary officers and 5% were civilians. In this article, we present the radiological features of blast-related injuries of 100 victims which we faced between 2015 & 2016.

METHODS AND MATERIALS:

We included all the victims in all Naxalite attack cases brought to the hospital in emergency department and were subsequently investigated radiologically. Patients who were brought dead or not investigated by imaging were excluded from the study group.

Since, these victims come in mass causalities, it is difficult to Triage each and every patient by routine protocol. Hence, we categorized the number of organ system injured [3]. External injuries were noted. And it was assumed to have deeper injuries from the external injuries. Such suspected injuries were imaged. Severity of injury was determined by the basic vitals, external injuries and number of organ system involved. Injuries were graded by ISS depending upon the clinical and radiological findings into stage 1, 2 and 3.

Following modalities were used for imaging:

1. X rays - either bedside and in radiology department for stable haemodynamically patients.
2. USG - bedside FAST for critical patients to see collections in pericardial, pleural and peritoneal spaces. Complete ultrasound studies were done in radiology department or ICU to evaluate the solid organs in details. Few scanning were done for IVC to look haemodynamic status by collapsibility of IVC walls in triage and ICU. Doppler's were usually done bedside in triage room
3. CT scans - most preferred imaging in majority of patients for CT head, chest , abdomen (including cystogram) and extremities (peripheral angiograms).
4. MRI scan - After excluding metallic objects by X rays, MRI for Joints, spine and brain (follow up) were done.
5. Guided procedure - drainage of collections from peritoneal, pleural cavities, to remove blocked Foleys catheters, for venous access.
6. DSA was done in a victim with suspected left renal ischaemia.

CT imaging is useful for anatomic and pathologic evaluation. Angiography should be done if ischaemia is suspected. Radiography is for detection of foreign bodies and fractures [8].

CT scan was the most commonly used modality in acute chaotic setting of naxalite victims [5]. Single pass spiral CT protocols were used. This was to shorten the time for diagnosis and quicker patient mobility. CT was initiated with Full length AP topograms were taken to look for major fractures, FB and surgical emphysema and to modify the scan, to assess need for contrast / angiogram/ Cystogram. It was very helpful tool to start with. When contrast was required, high iodine containing contrast medium was used with slow flow rate which improved the quality of contrast scan [14].

Spiral CT scan from head to pelvis were made in our study in cases where more than 3 organ involvements was found during initial triaging.

Depending on the Topogram and plain sections, further decisions of contrast or angiogram were made.

Bedside radiographs were done in many patients to detect metallic fragments and fractures as part of triaging.

FAST ultrasound was given importance in all critical patients to help in triaging of patient in less time.

The images were assessed retrospectively to know the mechanism of injury, severity of injury, organs injured, condition of patient and plan of action.

Mechanism of injuries are shown in:

1. Penetrating injury by Bullet, arrow, rod, knife can affect any body part
2. Blunt trauma can affect targeted area.
3. Bomb blast explosion –

- Injury due to pressure changes (Primary injury) or flying objects like shrapnel or pellets which can affect any body part (secondary injury)
- due to thrown away of body by the blast wind (tertiary injury) or
- Indirect trauma such as smoke or heat (quaternary injury)

For grading of injuries, Injury severity scale (ISS) was used.

Calculation of ISS:

It is an anatomically based injury severity scale which scores each injury from 1 to 6 within six body regions. Three most severely injured ISS body regions (A, B and C), and add the three squared numbers for an ISS (ISS = A2 + B2 + C2 where A, B, C).

There are six body regions:

a) Head / Neck
b) Face
c) Thorax
d) Abdomen / Pelvis
e) Extremities
f) External

The ISS scores ranges from 0 to 75. ISS was categorized into three severity levels;

1. Mild= 9,
2. Moderate =9–15 and
3. Severe >15.

In order to describe and analyze the distribution of injuries, the body was divided into six anatomical regions: head–neck; face, thorax; abdomen–pelvis; extremities; and external. The ISS, types and distribution of the injuries were described as frequency and percentage.

Follow up imaging by were done for assessing the status after treatment. Done for head injuries, pelvic trauma and post-operative abdominal injuries. This was because the injuries were mainly penetrating type and region involved were Trunk.

RESULTS:

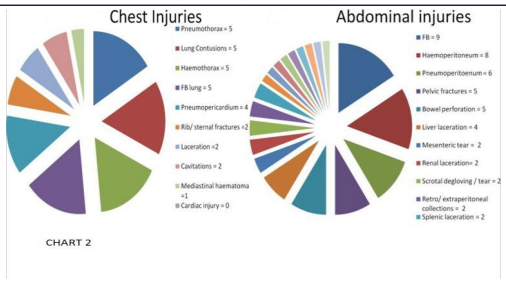
All of 100 patients were males, which were studies who visited in emergency department. The mean patient age was 32.5 years (range 20–45 years).

Most common modality used was CT scan followed by X-rays. Out of 80 CT scans, 9 had whole-body CT scans. There were 15 affected cranial CTs, 25 thorax CTs, 2 cervical spine CTs, 15 maxillofacial CTs, 15 abdominal CTs and 5 lower extremity CT scans. 75 patients had plain radiographs. 25 patients underwent MRI to evaluate spine, joint and brain. ultrasound studies was done either bedside- FAST for critical patients to see collections in pericardial, pleural and peritoneal spaces or complete- done in radiology department or ICU to evaluate the solid organs in details. Few USG scanning were done for IVC to look haemodynamic status by collapsibility of IVC walls in triage and ICU. Doppler's were usually done bedside in triage room. USG guided procedures like thoracocentesis, aspiration of retroperitoneal collection; Jugular venous access and puncture of Foleys bulb in stuck catheters were done. DSA was done in a victim with suspected left renal ischaemia in cathlab.

The most common mechanism of trauma was penetrating injury of bullets, shrapnels and pellets, that to resulting in trunk injuries [1, 7, 48].

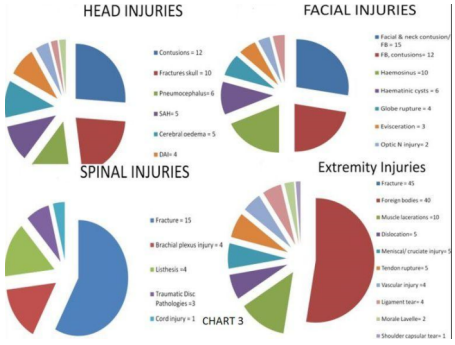
75 patients had one or more penetrating injury including both superficial and deep. Of which, 55 patients had superficial penetrating injury.

Superficial FBs were found in majority of patients in facial, thoracic, abdominal, pelvic soft tissues, sacrum and extremities.



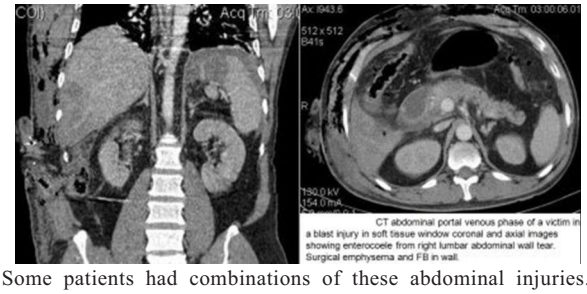
14 patients had severe head injuries. 12 had cerebral contusions, 5 had cerebral oedema, 4 had DAI, 2 had hematomas, 1 had encephalocoele, 1 with cerebellar ischaemia. One had complication of CSF Rhinorrhoea.

Facial injuries were mostly superficial penetration of the fragments. Two had scalp lacerations. Intraocular foreign bodies and globe rupture were noted secondary to ocular injuries, vitreal hemorrhage and retinal detachments were observed



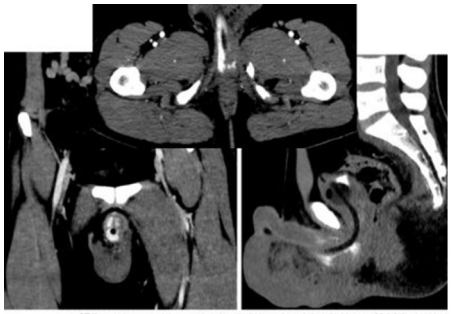
There were pellets penetrating the peritoneal or pleural space with solid and viscous organ injuries in 15 patients. 9 patients had deep intraabdominal injuries and 6 in thorax. Few had mediastinal Foreign bodies.

4 patients with hepatic injuries, 2 with splenic injuries, 2 had mesenteric injuries, 5 had bowel perforations, 1 Splenic artery aneurysm, one had left renal ischemic injury, one had GB perforation, 1 had UB and 1 with urethral injury.



CT abdominal portal venous phase of a victim in a blast injury in soft tissue window coronal and axial images showing enterocoele from right lumbar abdominal wall tear. Surgical emphysema and FB in wall.

Some patients had combinations of these abdominal injuries. Intraoperative additional finding was 1 patient having gastric perforation. Complications detected in 4 patients, 1 had colo-cutaneous fistula, 1 ischiorectal abscess, 1 patient with rebleed and 1 bowel ischaemia. One patient had penile bulb tear with leak in corpus spongiosum.



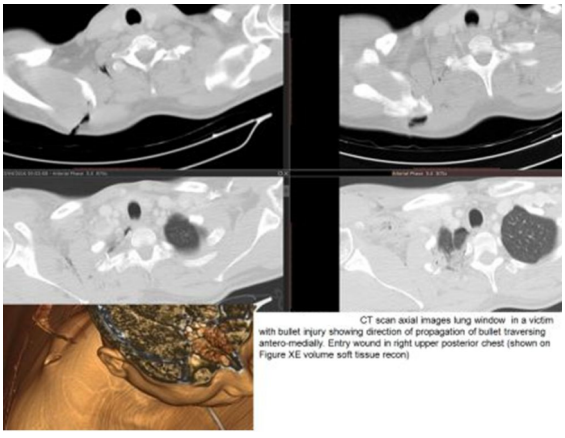
CT iliac angiogram axial, coronal and sagittal planes in a victim with history of fall following blast injury showing left lateral margin penile bulb with contrast extravasation in anterior corpus spongiosum.

Splenic injuries were due to bomb blasts and both had associated left haemothorax.

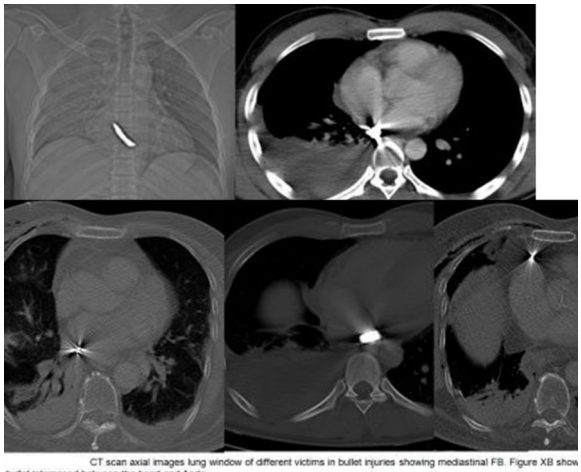
Renal injury happened by bullet entered from left posterior trunk resulted in left renal arterial occlusion and renal contusions along with bladder clots.

Perineal tear, urethral and UB injury presented secondary to bullet injuries.

Of 6 thoracic injuries, 5 had pneumothorax with or without haemothorax. Lung contusions and lacerations were frequent in penetrating chest injuries. No patients in our study had cardiac injury. In few patients, we could assess the direction of travel of bullet /pellet, apart from with entry and exit wounds on clinical examination.



CT scan axial images lung window in a victim with bullet injury showing direction of propagation of bullet traversing antero-medially. Entry wound in right upper posterior chest (shown on Figure XE volume soft tissue recon)

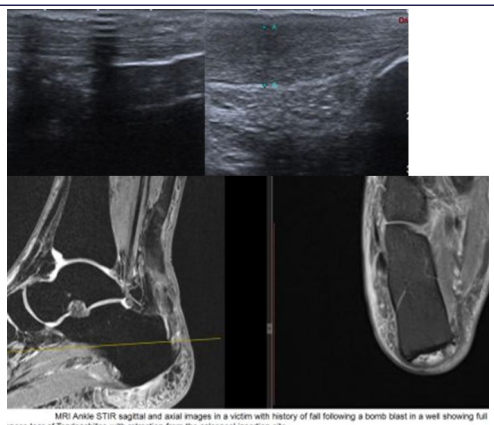


CT scan axial images lung window of different victims in bullet injuries showing mediastinal FB. Figure XB show bullet interposed between the heart and Aorta.

One patient had come with assault by arrow, which flew from right side first lacerating the flexor muscles of forearm and occluding the Ulnar artery and then it got stabbed in right lung parenchyma resulting in haemopneumothorax and lacerations of right lung

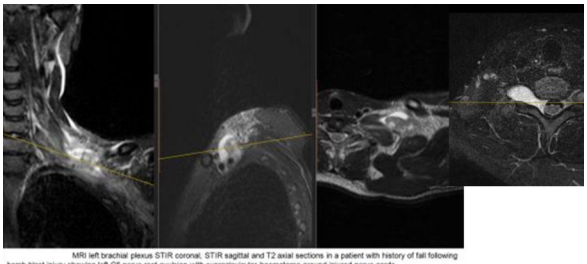
CT scan topogram and colour photograph of a victim with Arrow injury showing large radio-opaque linear FB in right chest.

Few patients had muscle tear, tendon injuries. Few patients were fortunate to escape from vascular injuries due to penetrating foreign bodies as close as to its wall.



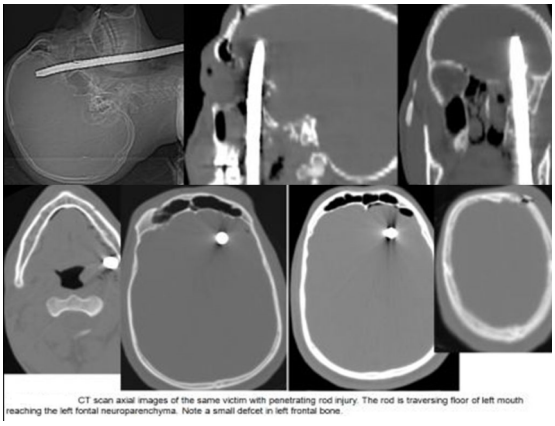
MRI Ankle STIR sagittal and axial images in a victim with history of fall following a bomb blast in a well showing full ness tear of Tendoachilles with retraction from the calcaneal insertion site.

10 patients were thrown away in the high pressure blast wave and fell down resulted in spinal injuries, brachial plexus injury, pelvic fractures, extremity fractures, and dislocations. In brachial plexus injuries, contusions, root avulsion and traumatic meningocoeles were observed.



MRI left brachial plexus STIR coronal, STIR sagittal and T2 axial sections in a patient with history of fall following bomb blast injury showing left C6 nerve root avulsion with supraclavicular haematoma around injured nerve cords.

One patient was assaulted by rod which went up to the brain parenchyma from floor of mouth across the left maxillary antrum and left orbit.



CT scan axial images of the same victim with penetrating rod injury. The rod is traversing floor of left mouth reaching the left fontal neuroparenchyma. Note a small defcet in left frontal bone.

Most complicated head injury was frontal bone shattering and encephalocoele. He was with frontal lobes out of his skull and right globe rupture. Overlapped with it, he had DAI along with other 3 patients. Later, this patient went into CSF rhinorrhea.

Four patients with head injury had diffuse axonal injury suggesting the high pressure injury following blast. One had encephalocoele from frontal aspect, frontal lobe hemorrhagic contusions, right sided subdural haematoma. One patient with skull base fracture had CSF Rhinorrhoea.

Summarizing the Organ injuries, most common finding was cerebral contusion in head, FB/ haemo-pneumo-peritoneum in abdomen, Pneumothorax in chest, FB/ contusions in face and fractures in extremities and spine.

25 patients underwent immediate surgical procedures as a life saving interventions [6]. 4 patients were operated after 2 days due to delayed presentation. Two were re-explored due to rebleed. There were strong relation between the ISS, organs injured and operative interventions for such patients.

Chart 1 indicates that number of immediate surgical interventions increased with number of organs injured. Also, majority of the patients had 1 to 2 organ injuries. Only 25 patients had 3 or more organ injuries.

Metal fragments were identified in 73 patients on plain radiographs and CT scans. Non-metallic fragments were not detected.

Injury Severity Score (ISS):

1. grievous risk (ISS > 15) - 19
2. Moderate risk (ISS =9-15) - 35
3. Mild risk (ISS <9) - 51

Mean ISS = 12(range 0–75).
Maximum ISS was 50 in our group.

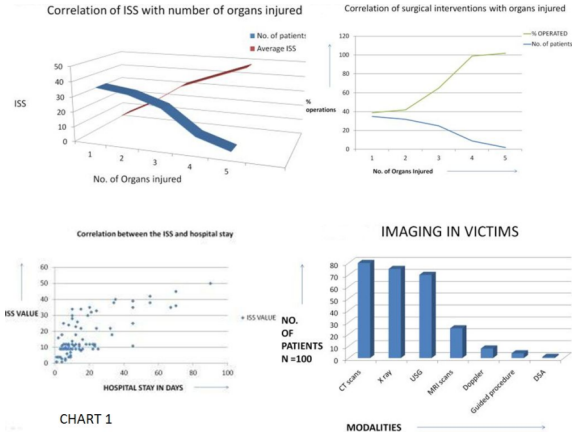


CHART 1

Mild risk ISS (stage 3) was most common injury found [15]. Higher ISS was observed when more than 4 organ system involvement [3].

Correlation of ISS with number of Organs injured is shown in: [Chart 1]. Chart showed that ISS is increased with increasing number of organs injured. Also, the majority of patients had ISS in stage 2 & 3 (<15)

ISS with stage 1 had higher length of stay, higher ICU admissions and increased mortality rates [2]. Mortality in hospital: 4 % (ISS stage 1=3, stage 2 =1). Major cause was severe head injury, hypovolemic shock, cardiac arrest, ARDS, pulmonary embolism and sepsis [16]. Average Hospital stay was 10 days (varying from 1 day to 3 months). It correlated with ISS in our study since majority of patients were in Type 2 and 3 of ISS scale [3]. Superficial FB patients with stage 3 ISS were discharged early, as early as in 1 day. Maximum stay was 3 months, observed in 2 patients with Type 1 ISS, one with head injury and another with GI re-bleed which later got complicated and went into sepsis.

Correlation of ISS with hospital stay of patients in days is shown in- [Chart 2].Chart indicated the direct relationship of ISS with the hospital stay of patients. Also, majority of patients are custered in the area with ISS < 15. Also, mean stay clustering is at around 10 days.

DISCUSSION:

Naxalite attack victims can have wide variety of injuries affecting multiple body regions and organ systems. Number of patients reaching to the hospital is Tip of The Iceberg, those who luckily escape from the vital organ injuries, otherwise majority of primary blast injury victims die before reaching to the hospital [17].

Effect of such injuries depends on following factors: Object used, organ involved, type of injury, degree of penetration, the number and location of pellets, and nature of the explosive material in blast injury. Also, closed-space explosions cause higher mean ISSs, higher mortality and higher incidence of primary blast injuries than open air blasts [18]. Almost all of our blasts were in open space.

Results of this study showed that the majority of the severely injured patients had CNS, thoracic and abdominal injuries. This result is corroborated by the results of previous Studies [1, 16] in which the Torso was the most common injuries among high ISS. Also, higher mortality and morbidity rate of severely injured patients (15%), due to involvement of multiple systems.

Head injury resulted in higher morbidity and major cause of mortality of patients [16]. No cardiac injury was diagnosed in our study.

There were increased abdominal, vascular and neurosurgical procedures were required in cases of torso penetrating injuries and blast injuries. No injuries came due to burns or toxic inhalation in bomb blasts.

CT features of penetrating lung injury are characterized by ground-glass opacities, pneumothorax, haemothorax, pneumomediastinum and air or fat embolism can be observed as well. Consolidation with typical butterfly distribution similar to adult respiratory distress syndrome.

CT features of penetrating abdominal injury are pneumoperitoenum, haemoperitoneum, retroperitoneal haematoma, bowel and bladder perforation, GB perforation. They had characteristic entry and/ or exit wounds. These features are typical of penetrating injuries which one should be aware of [23].

One patient with caecal perforation had secondary hemorrhage for which re-exploration was done and drain tube was kept. It complicated into the colo-cutaneous fistula. CT Angiography was performed in suspected ischaemia for extremities & abdomen and pulmonary angiogram in suspected fat embolism in polytrauma. Naxalite vascular injuries tend to be more complex than nonterror attack injuries [4]. Also, entrapment and compartment syndrome can magnify the primary inflicted cause [10].

Hence, keen examination and imaging observation can improve the outcome of the patient and save the limb in cases of peripheral injuries.

MRI was done in 25 patients for spinal injuries; joints and follow-up brain in suspected ischemia or rebleed. Follow up MRI brain as an advanced Neuroimaging were done in few patients to assess the finer details of reversible and irreversible lesions which in turn will determine long-term functional impairment [9]. One patient had cerebellar ischemic secondary to post traumatic dissection of right vertebral artery. Four patients had diffuse axonal injuries which were not evident on CT scans. 15 patients had spinal fractures, most common area was lumbar spine, involving spinous, transverse processes and vertebral bodies; of which 4 had spondylolisthesis. Two patients had spinal cord injuries. One had caudal nerve compression. Few nerve root and trunk avulsions involving brachial plexus. 5 patients had internal knee derangements, 3 meniscal and 2 ACL tear. 2 patients had haemolymphatic cysts (Morale Lavelle syndrome) and 1 had right shoulder posterior capsular tear.BJR

Facial injuries were explained and its impact on reconstructive in the series following the suicide bombing attacks of Jerusalem [25].

The majority of the injuries in our study group were penetrating injuries, accounting for 75% of all injuries [1].

Penetration of pellets fragments in the abdominal viscera was seen in 5 patients all of which underwent emergency surgery. One had GB perforation.

Compared with other studies, there was a considerably higher rate of chest and abdominal injuries [22]. Abdominal and thoracic injuries were seen in 25% of our patients. Unlike in a previously published report by [article: 21] which found extremities to more common, our study has shown that the distribution of majority of severe injuries was predominant in the trunk.

On the other hand, the rate of severe extremity injuries was low in this study compared with that in the Boston Marathon bombings, where explosive devices were positioned on the ground.

High velocity flying objects can have apparent minimal injury at the entry site, but can lead to a catastrophic internal injury. Hence, importance was given to all the metallic foreign bodies, even a small

pellet and focused reading was done to evaluate the direction of travel, organs involved and possible injuries might have happened [19].

comparison of Imaging versus Operative findings for Internal organ injury.

INTERNAL INJURY	OPERATIVE FINDINGS			
		+ ve	- ve	Total
IMAGING	+ ve	22 TP	3 FP	25
	- ve	4 FN	71 TN	75
	TOTAL	26	74	100

Sensitivity = 84 %
Specificity = 95 %
PPV = 88 %
NPV = 94 %

N= 100
Internal injuries suspected in 25 patients on imaging.
29 patients were operated in all, 25 patients immediately and 4 patients after 2 days due to late presentation, missed on imaging.

Radiological investigations were much helpful in diagnosing injuries, staging the severity and deciding the plan of action. Sensitivity of 84 %, Specificity of 95 %, PPV of 88 % and NPV of 94 % were observed.

Sensitivity and PPV of imaging are slightly less due to occult injuries by flying objects as well as due to late presentation. High Specificity and NPV indicates good correlation between the external and internal injuries since CT were tailored by guessing internal injuries by looking at the external injuries and number of organs injured. Also, operations were planned looking at the location of FB and ISS score on CT scans. Hence, CT proves to be accurate in proportion to the severity of injuries and location Fbs.

96 % of patients were handled at our hospital. 4 patients were referred to higher centre by air lift of which 2 were in coma, 1 non-responding ARDS and 1 non responding sepsis patient.

The primary limitation of this study is that we have sampled only small number of patients at random. This can vary with frequency of attacks. Brought dead patients were not included in our study. This has underestimated the impact of overall Naxal attack. Also, our data consisted of a group of victims admitted to our emergency department. We were unable to investigate victims referred to other hospitals. Hence, exact incidence is difficult to be estimated since the numbers were incomplete.

CONCLUSION:

An analysis of the patterns of Naxalite attack injuries from our experience showed a higher rate of penetrating injuries caused by pellets. In addition, the most commonly injured body region was the trunk. Even a tiny pellet can cause disastrous internal injuries in an organ or at a distant site [20]. Knowledge of such characteristics & patterns should be kept in mind for a practicing radiologist [1, 22]. Quick imaging by FAST ultrasound as well as by single pass spiral CT scanning and prompt diagnosis can make lot of difference in triaging and management of patients, thereby improving the outcome and hospital stay. Hence, radiologist plays an essential role [12]. Team work of Intensivist, EMS staffs, Nursing staffs, Emergency medical doctors, GI, Vascular and Neurosurgeons, Orthopaedicians, Dermatologist and Radiologists play a key role in assessment of such injuries. However, in chaotic scene, concerns of poor triage and missed diagnosis of injuries are still challenging. More studies are required to standardize the protocols for evaluation and imaging so as to reduce the morbidity and mortality in such casualties of terror attack victims [8, 13].

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