

Pattern of Emergent Head Computed Tomography Findings in a Tertiary Care Hospital during off Working Hours: Retrospective Analysis

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ABSTRACT

Introduction: Emergency head computed tomography (CT) is rising exponentially during off working hours due to evidence-based medicine, patient's expectation and desires, easy availability and apprehension of medico-legal cases, thereby raising health-care cost. There is huge gap in demand and supply of radiologist, especially during off working hours. There is need to know the pattern of emergency head findings. **Materials and Methods:** A retrospective analysis of all emergent noncontrast CT head during off working hours in the Department of Radiodiagnosis of a Tertiary Care Hospital, Mumbai, India, which were performed from June 2017 to May 2018. CT findings of 308 patients were analyzed. **Results:** About 63.6% of total head CT showed no significant abnormality. The most common abnormality was intracranial hemorrhage which was just 9.1% followed by acute infarct which was 6.2%. Extradural hemorrhage, subdural hemorrhage, and subarachnoid hemorrhage was only 1% each of total head CT findings. No significant abnormality was detected in 74.65%, 70.21%, 89.13%, 31.37%, 100%, and 69.09% in cases of head injury, seizure, giddiness/dizziness/syncope, cerebrovascular accident, transient ischemic attack, and altered sensorium, respectively. **Conclusion:** Pattern analysis of emergent head CT reveals that most of the emergent CT head shows no significant abnormality. There is a need for stringent guidelines for emergent head CT, training of emergency physician as well as CT technician for common findings to bridge the radiologist demand-supply gap for providing effective health care in peripheral hospitals.

KEYWORDS: Emergency computed tomography, head computed tomography, head injury, noncontrast computed tomography head, seizure, syncope

INTRODUCTION

Computed tomography (CT) scan has changed the outlook of radiology and health-care system.^[1] These days, CT scan of the entire body can be acquired in seconds, and resolution has improved due to advancement in hardwares and softwares.^[2] In the United States, approximately 70 million CT scans are performed annually, and the requisition for CT is rising exponentially.^[3,4] Various factors responsible for rise in CT in emergency patients are its easy availability, noninvasive nature, less cost, higher resolution, efficacy, patient's expectations and their desires, and apprehension of medico-legal cases.^[5-9] About 14% of all patients entering

the Emergency Department in the United States underwent CT in 2007 which was six-fold rise as compared to 1995.^[5] The analysis of the rise in number of CT scan showed that approximately 80% of annual increase is due to increase in the frequency of CT scans while only 20% can be attributed to increase in number of emergency patients.^[5]

Policy makers, insurance companies, and various stakeholders are increasingly concerned about the

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rise in number of CT scan as it is causing rise in the treatment cost apart from significant radiation exposure.^[10] Noncontrast head CT accounts for approximately 70%–80% of emergency CT referrals.^[11,12] As per 2008 National Center for Health Statistics, there were approximately 6.1 billion expenditure on emergency CT head in the United States.^[5]

Although in an emergency department, many noncontrast CT (NCCT) head are requested for cases without any history of trauma, but existing studies have shown that the diagnostic importance of NCCT in these patients varies from 0% to 15% depending on the study population such as cases with giddiness or vertigo, dizziness, delirium, or syncope.^[13-21] Furthermore, it has been found that most of cases with positive-NCCT findings in a nontrauma cases had abnormal neurological examination findings, and majority of them were above 65 years of age.^[19-21]

The emergency physicians are not skilled enough for image interpretation of urgent head CT, due to lack of emphasis on radiology during their undergraduate course. Furthermore, in spite of the availability of CT machines in remote places, there is a lack of proper care due to lack of qualified doctor for emergent head CT interpretation. The number of radiologist is very less as compared to requirement and very few radiologists are available to interpret images during off working hours. In recent years, there has been a surge in artificial intelligence in CT scanner for identification of emergent CT findings. Hence, it is the need of the hour to know the pattern of CT findings in emergent head CT and their relative prevalence to formulate guidelines and policies for effective healthcare. This prompted us to do a retrospective analysis of emergent head CT during off working hours in a tertiary care hospital.

MATERIALS AND METHODS

It was a retrospective analysis of all the NCCT head records in the Department of Radiodiagnosis of a Tertiary Care Hospital, Mumbai, India, during off working hours as an emergency request. The NCCT head examinations that were performed from June 2017 to May 2018 were retrieved from the database and were evaluated. The CT scans were carried out on 16-slice Siemens multidetector CT scanners; 5-mm contiguous slices were taken from vertex to foramen magnum, followed by reconstruction to 1.2 mm in soft tissue and bone window.

The CT findings were grouped under 11 categories: no significant abnormality, extradural hemorrhage (EDH), subdural hemorrhage (SDH), subarachnoid hemorrhage (SAH), intracranial hemorrhage (ICH), acute ischemic infarct, subacute ischemic infarct,

infections, encephalomalatic/gliotic changes, significant fractures, and miscellaneous group. The cases under the category miscellaneous mainly include neurosurgical follow-up case/complications/postoperative evaluation which was done on urgent request.

The first category of no significant abnormality includes normal study, no significant abnormality, diffuse cerebral atrophy, age-related changes, intracranial vascular calcifications, and chronic lacunar infarcts. These findings were taken as no significant abnormality for our study because most of these abnormalities are detected as incidental findings on NCCT head, and their presence on emergency CT has no significant impact on the emergency management of the patient. The remaining eight groups were taken as positive-CT findings for our study purpose.

These findings were tabulated and were analyzed using Statistical Package: IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.

RESULTS

There were total of 308 emergent head CT during the study out of which 204 were males with mean age of 50.16 years and 104 were females with mean age of 60.45 years. The clinical indication for CT requisition and their gender distribution is shown in Table 1. There were 196 cases with no significant abnormality while 112 cases were with positive-CT findings. The distribution of total number of cases has been depicted in Table 2. The number of cases with head injury, seizure, dizziness/giddiness showing various CT findings has been shown in Table 3 and the distribution of cases with CT findings with cerebrovascular accident (CVA), transient ischemic attack (TIA), and altered sensorium has been shown in Table 4. Three cases had multiple positive findings and have been included in their predominant CT finding heading.

Table 1: Clinical indication and their gender distribution

Symptoms	Males	Females	Total (n=308), n (%)
Head injury	55	16	71 (23.05)
CVA	32	19	51 (16.56)
TIA	10	5	15 (4.87)
Seizures	32	15	47 (15.26)
Dizziness/giddiness/syncope	26	20	46 (14.94)
Altered sensorium	36	19	55 (17.86)
Neurosurgical postoperative/ miscellaneous	13	10	23 (7.47)
Total	204	104	308

CVA: Cerebrovascular accident, TIA: Transient ischemic attack

DISCUSSION

CT scan is the modality of choice for evaluation of head in the emergency department due to its easy availability,

noninvasive nature, less cost, higher resolution, efficacy, patient’s expectations and their desires, and apprehension of medico-legal cases by referring clinicians. Most of the emergent findings can be evaluated by CT scan with fair accuracy or can be at least said it is normal or with significant finding and referred.

Table 2: Computed tomography findings on emergent head computed tomography (n=308)

CT findings	n (%)
NSA	196 (63.6)
EDH	4 (1.3)
SDH	4 (1.3)
SAH	2 (0.7)
ICH	28 (9.1)
Acute infarct	19 (6.2)
Subacute infarct	7 (2.3)
Infection	1 (0.3)
Encephalomalatic/gliotic/ICSOL	17 (5.5)
Significant fracture	10 (3.2)
Miscellaneous	20 (6.5)

NSA: No significant abnormality, EDH: Extradural hemorrhage, SDH: Subdural hemorrhage, SAH: Subarachnoid hemorrhage, ICH: Intracranial hemorrhage, ICSOL: Intracranial space occupying lesion, CT: Computed tomography

In due course of time, there has been rapid increase in CT request in working hours as well as off working hours due to emergence of evidence-based medicine, easy availability of CT scan, requirement of clientele satisfaction, and multiple legal issues.

There is scarcity of radiologist in India. There is approximately one radiologist per lakh population in India, while in the United States, there is one radiologist per ten thousand population.^[22] The relative distribution of radiologist in cities and rural areas varies with scarcity of radiologist in rural areas. Most of the emergency departments are staffed 24 × 7, but due to limited radiology staff, the radiology department is not staffed round the clock. The liberal imaging recommendation

Table 3: The distribution of computed tomography findings in cases with head injury, seizure, dizziness/giddiness

	Head injury (n=71), n (%)	Seizure (n=47), n (%)	Dizziness/giddiness/syncope (n=46), n (%)
NSA	53 (74.65)	33 (70.21)	41 (89.13)
EDH	3 (4.23)	-	-
SDH	3 (4.23)	-	1 (2.44)
SAH	-	-	-
ICH	6 (8.45)	2 (4.25)	1 (2.44)
Acute infarct	-	-	1 (2.44)
Subacute infarct	1 (1.4)	-	-
Infection	-	-	-
Encephalomalatic/gliotic/ICSOL	-	12 (25.53)	2 (4.35)
Significant fracture	5 (7.04)	-	-
Miscellaneous	-	-	-

NSA: No significant abnormality, EDH: Extradural hemorrhage, SDH: Subdural hemorrhage, SAH: Subarachnoid hemorrhage, ICH: Intracranial hemorrhage, ICSOL: Intracranial space occupying lesion

Table 4: The distribution of computed tomography findings in cases with cerebrovascular accident, transient ischemic attack, and altered sensorium

	CVA (n=51), n (%)	TIA (n=15), n (%)	Altered sensorium (n=55), n (%)
NSA	16 (31.37)	15 (100)	38 (69.09)
EDH	-	-	1 (1.82)
SDH	-	-	-
SAH	-	-	2 (3.64)
ICH	10 (19.6)	-	9 (16.36)
Acute infarct	18 (35.29)	-	-
Subacute infarct	6 (11.76)	-	-
Infection	-	-	1 (1.82)
Encephalomalatic/gliotic/ICSOL	-	-	3 (5.45)
Significant fracture	-	-	-
Miscellaneous	1 (1.96)	-	1 (1.82)

NSA: No significant abnormality, EDH: Extradural hemorrhage, SDH: Subdural hemorrhage, SAH: Subarachnoid hemorrhage, ICH: Intracranial hemorrhage, ICSOL: Intracranial space occupying lesion, CVA: Cerebrovascular accident, TIA: Transient ischemic attack

for minor ailments increases the workload of radiologist as well as economic burden on the patient and country as a whole.

The aim of emergency imaging is to diagnose the cause of the symptoms of the patient for urgent patient management by medical or surgical measures. The common CT findings in emergent head CT in our institution was EDH, SDH, SAH, ICH, acute ischemic infarct, subacute ischemic infarct, encephalomalatic/gliotic changes, and significant fractures. Few cases associated with neurosurgical complication also form the part of urgent neuroimaging by CT head. There are many findings such as chronic lacunar infarcts, age-related cerebral atrophy; nonspecific. White matter hypodensities which were seen on emergent head CT but as these findings will not affect the management of emergent patient, we have grouped these findings as no significant abnormality for our study purpose.

Our study shows that 66.23% patients for emergent CT are males. Number of males is more than females for all clinical indications of emergent CT. This may be due to relative predominance of male population around the hospital area. The higher proportion of head injury in males may be because in Indian scenario, females generally take household chores while male are involved in outdoor activities giving more prone to head injury.

Table 1 shows that head injury and altered sensorium are major indications for emergent CT. CVA, seizures, and dizziness/giddiness/syncope also forms major indication for emergent CT. Table 2 shows that 63.6% of total head CT shows no significant abnormality. The most common abnormality is ICH which is just 9.1% followed by acute infarct which is 6.2%. EDH, SDH, and SAH form only 1% each of total head CT findings.

As per the report by The Institute of Medicine, approximately \$750 billion of the United States spent annually on health care without any benefits to patients.^[23] Minor head trauma is a common cause for patients reporting to emergency department, and it has been estimated that approximately 75% of traumatic brain injuries are considered mild.^[24] Our study also shows that 74.65% of total head injury shows no significant findings. There were 8.45% patients with ICH. Few patients had ICH in addition to SDH/SAH, thus total ICH cases were 12.68%. In a study by Michaela Cellina in 2016, in Italy, 52.8% CT examinations were not indicated according to the National Institute for Health and Care Excellence guideline, and approximately 76.4% of the CT examinations were not indicated as per the Canadian CT Head Rule.^[25] The study by William showed that 649 out of 716 total head CT showed no significant abnormality.^[26]

Our study shows that 70.21% of total patients with seizure indication show no significant findings. About 25.53% cases showed encephalomalatic/gliotic changes, and 4.25% cases showed ICH as cause of seizures in off working hours. In a large cohort study by Kotisaari *et al.*^[27] it was found that NCCT is positive in only 12% of cases. They also found that positive findings were more in cases with a history of focal motor signs, headache, altered mental state, or history of malignancy. They also found that the presence of at least one of these associated features was associated with 84% positive findings while the absence of these findings in emergent CT head had a high negative predictive value (96%). Their study also revealed that use of contrast did not improve sensitivity of CT in these cases. As per Salinsky *et al.*,^[28] there is increased chance of getting positive findings on NCCT head in cases of seizure if there is associated acute head trauma, focal neurological deficit, and prolonged alteration of consciousness while the absence of any of these will lead to true positive yield almost zero.

Our study shows that 89.13% cases with dizziness/giddiness/syncope showed no significant findings. The study by Mitsunaga and Yoon^[29] in 2015 concluded that most patients with dizziness/giddiness/syncope will not benefit from CT unless they are ≥ 60 years of age, have focal neurological deficit or have recent head injury. Their study showed only 7.1% of cases of dizziness and 6.4% of cases of syncope had positive findings.

The use on NCCT for CVA is highly recommended to detect acute infarct or to rule out ICH as only 31.37% cases had no significant findings which may be in the early stage of infarction. There is doubtful role of emergent NCCT in TIA cases, as all cases in our study showed no significant abnormality. These CT scans can be planned later by contrast enhanced CT or magnetic resonance imaging.

Shin *et al.*^[30] in their study found that the presence of focal neurological deficit, C-reactive protein level < 2 mg/dl, and Glasgow Coma Scale < 9 is associated with positive findings on brain CT in patients with altered sensorium. Our study showed that 69.09% of had no significant findings which was consistent with Shin *et al.* findings in which 39.8% had shown positive results.

Our study had showed the pattern of findings in various indications of emergent head CT and has revealed high percentage of no significant abnormality. There are existing guidelines for various indications for urgent CT demand, but there is recent upsurge in advising

urgent head CT and many times these guidelines are not being followed. Although our results are consistent with developed nations, India has poor health infrastructure and cannot afford unwanted burden of health-care cost. Each investigation adds up to the poverty of our rural population. There is a need to streamline the assessment of patients presenting with minor ailments, adherence to guidelines to avoid unnecessary CT thereby reduction of health-care spending.

CONCLUSION

A retrospective analysis of emergent head CT reveals that most of the emergent CT head shows no significant abnormality. There is a need for stringent guidelines for emergent head CT to avoid unnecessary radiation and cost of medical care. Furthermore, the emergency physician as well as CT technician should be trained to interpret common positive-CT findings, and there is need to develop scanners with artificial intelligence to identify common emergent CT findings to bridge the radiologist demand-supply gap for providing effective health care in peripheral hospitals.

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Conflicts of interest

There are no conflicts of interest.

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