Observational Study

Intracerebral changes detected by CT scan of brain in eclampsia

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To evaluate the different neurological changes in brain in eclampsia by CT scan in relation to neurologic symptoms. This is prospective observational study in a tertiary hospital. CT scan of brain is performed within 48 hours of eclampsia after confinement of fetus and after stabilising the mother with standard $MgSO_4$ protocol. The CT scans of brain are performed with 5mm and 10mm section in the axial plain. CT scan of brain shows, 31.6% has cerebral edema, 23.7% have cerebral infract, 7.9% have cerebral haemorrhage, while 36.8% have no detectable findings. Parietal region of the brain is affected in 67% followed by parieto-occipital area (17%), occipital area (8%) and brain stem (8%). 68.4% mothers have headache, 18.4% have visual disturbances, 34.2% have altered sensorium with hyper-reflexia and 36.6% have coma. CT scan of brain in eclampsia can provide useful intracerebral information and should be done in cases with severe neurologic manifestations, if possible for every eclamptic mother.

[*J Indian Med Assoc* 2018; **116:** 20-3]

Key words **: Computed tomography, eclampsia.**

Eclampsia is defined as occurrence of generalised seizures, not caused by any co-incidental neurological disorder (eg, epilepsy) in a woman whose condition also meets the criteria for preeclampsia[1] which is a complex multi-organ disorder characterised by pregnancy induced hypertension and proteinuria after 20 weeks of pregnancy (exception –gestational trophoblastic disease or multiple pregnancy).

Cerebral complications are the major cause of deaths in eclampsia; still the neuropathophysiology of eclamptic seizure is mostly unknown. There are two distinct but related types of cerebral pathology in the patients of eclampsia[1]. The first is gross haemorrhage due to ruptured arteries caused by severe hypertension of any cause, not necessarily only by preeclampsia or eclampsia. The second type of post-mortem lesions are edema, hyperaemia, ischemic microinfarcts and petechial haemorrhages. The neurologic manifestations of severe eclampsia are identical to those of hypertensive encephalopathy[2], which is clinically manifested as generalised tonic-clonic seizure and usually preceded by neurological symptoms like hyper-reflexia, altered sensorium, headache, visual changes and even coma.

The recent advances in radiologic imaging including the use of computed tomography (CT) scans and magnetic resonance imaging (MRI), have greatly enhanced our understanding about the correlation between neurologic manifestations and neuro-anatomic and pathological characteristics of eclampsia[3]. Harandou M *et al*[4]; showed that 73.68% cases of eclamptic mothers who are still symptomatic after 24 hours have cerebral edema and 10.5% have cerebral hemorrhage and 15.7% have normal CT scan study.

The aim of the study is to evaluate the different neurological changes in brain by CT scan in eclampsia and their relation with different neurologic symptoms. In this study, CT scan methodology has been adopted because it is less expensive and easily available.

Methodology :

This is a prospective study of CT scan finding of brain on cases of eclampsia admitted in a tertiary hospital. The study population are chosen by random samplings who are patient of eclampsia admitted through emergency and also indoor patients who develop eclampsia after admission. The study protocol is approved by institutional ethics committee.

Inclusion Criteria :

(1) Patients with Eclampsia (at least one episode of seizure in women with more than 20 weeks gestation or less than 06 weeks postpartum with blood pressure more than 140 mm of Hg systolic and 90 mm of Hg diastolic with urine albumin of more than 0.3gm/L). both antepartum and postpartum

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Exclusion Criteria :

(1) Women who are known case of Hypertension, Epilepsy.

(2) Seizures due to metabolic disturbances, space occupying lesions or intracerebral infections.

Total 38 eclamptic mothers are chosen according to inclusion criteria. Basic information including age, parity and gestational age, previous medical or obstetric history is taken. Detailed history of convulsion like duration, time, number of convulsion and presence of premonitory symptoms are sought; followed by detailed neurological examination (specially level of consciousness, pupilary reaction and reflexes) including fundoscopy is performed. Basic investigations like blood pressure, urine for proteinuria (by dipstick) are measured and complete hemogram, platelet count, serum uric acid, serum creatinine, liver enzymes are sent. Standard $MgSO_4$ protocol is given to all eclamptic mothers.

If the mother is not already delivered, assessment of cervix and delivery of the fetus is done accordingly either by induction of labour or Caesarean section. CT scan of brain is performed within 48 hours of eclampsia after confinement of fetus and after stabilising the mother. The CT scans of brain are performed with plain and intravenous (non-ionic) contrast enhancement (if necessary) with 5mm and 10mm section in the axial plain. The CT scan findings are evaluated with neurological characteristics. Level of consciousness is classified according to Glasgow coma scale (<8 severe, 9-12 moderate and >13 minor)[5]. Statistical analysis is performed with aid of Statistical Package for the Social Sciences (SPSS 16, SPSS Inc., Chicago, IL, USA). P value <0.05 is considered for statistical significance. Follow-up CT scan is not performed as it is not included in the study protocol.

Results :

Total 38 eclamptic mothers are included in this study. Median age of the mothers is 23 years with standard deviation (SD) of 3.8years. In 47.4% eclamptic mothers are primigravida and 52.6% eclamptic mothers are multigravida. Among them 28.9% have postpartum eclampsia, 39.8% have intrapartum eclampsia and 31.6% have antepartum eclampsia. 39.47% mothers delivered by normal delivery and 60.53% mothers have undergone LSCS.

CT scan of brain shows, 31.6% have cerebral edema (diffuse white matter low density areas, patchy area of low density, loss of normal cortical sulci) 23.7% have cerebral infract (hypo attenuating brain tissue), 7.9% have cerebral haemorrhage (intraventricular/parenchymal hemorrhage, subarachnoid hemorrhage, subdural hematoma), while 36.8% have no detectable findings. Parietal region of the brain is affected in 67% followed by parieto-occipital area (17%), occipital area (8%) and brain stem (8%) (Table 1).

Among different neurologic symptoms 68.4% mothers have headache, 18.4% have visual disturbances, 34.2% have altered sensorium with hyper-reflexia and 36.6% have coma (Table 2). Eclamptic mother who presented with visual disturbances (7/38) mostly have brain lesions in parieto-occipital and occipital region (6/7), which is statistically significant (p<0.005). Similarly, mothers presented with coma (14/38) mostly have lesions in parietal cortex (10/14) also, significant (p 0.002). But no association is found with area of lesions and other symptoms like headache. Hyperreflexia indicates pyramidal syndrome involving CNS but has no correlation with type of lesions.

In 53.3% eclamptic mothers are preterm (<37 weeks completed gestational age); among them 42.9% have cerebral edema, 28.6% have cerebral infarction, 14.3% have cerebral haemorrhage and 14.3% have no CT scan findings. 44.7% eclamptic mothers are term (>37 weeks completed gestational age); among them 17.6% have cerebral edema, 17.6% have cerebral infarction, but 67.4% have no CT scan findings (p<0.05).

In this study there is no difference between blood pressure distributions between those who have CT scan findings than those who have not positive CT scan findings (Table 3).

Eclamptic mother whose number of episode of convulsion is less than 5; among them 61.9% have no finding in CT scan, 28.6% cerebral edema, 9.5% have cerebral infarction. On the other hand whose number of episode of convulsion is more than 5, among them 35.3% develop cerebral edema, 41.2% develop infarction and 17.6% develop cerebral haemorrhage (P 0.001).

Table 1 — *Different areas of brain involvement by CT scan*

	Cerebral edema	Cerebral haemorrhage	Cerebral infract	Total
Basal ganglia and internal capsule	4.1%	0%	4.1%	8.2%
Cerebral cortex: occipital	8.3%	0%	0%	8.3%
Cerebral cortex: parietal	37.5%	8.3%	20.8%	66.6%
Cerebral cortex: both parieto-occipital	0%	4.1%	12.5%	16.6%

Table 2 — *CT scan findings among different neurologic symptoms*

	CT Scan of brain			
Neurologic symptoms	Normal CT findings	Cerebral edema	Cerebral infarction	Cerebral haemorrhage
Altered sensorium and hyper-reflexia	38.5%	46.2%	15.4%	0%
Headache	26.9%	30.8%	30.8%	11.5%
Visual disturbances	14.3%	28.6%	42.9%	14.3%
Coma	7.1%	35.7%	35.7%	21.4%

Table 3 — *BP distribution among eclamptic mothers*

	CT scan features (edema/ hemorrhage/infarction)	No CT scan finding	P value
Systolic BP (mean±SD)	166.25±17.64mmHg	155.71±17.85mmHg	0.086
Diastolic BP (mean±SD)	113.33±14.09mmHg	107.14±9.94mmHg	0.156

In 55.3% eclamptic mothers have Glasgow coma scale <8 during admission; among them 33.3% develop cerebral edema, 33.3% develop infarction, 14.3% develop cerebral haemorrhage and 19% have no CT scan findings. 44.7% eclamptic mother whose Glasgow coma scale is >8; among them 29.4% develop cerebral edema, 11.8% develop infarct and 58.8% have no CT scan finding (p <0.05).

Of the eclamptic mothers who recovered within 24 hours to fully oriented state (N=13) 76.9% have no CT scan findings, only 15.4% develop cerebral edema and 7.7% develop infarction. Eclamptic mother who recovered over 48 hours (N=13); only 7.7% have no CT scan finding in CT scan, 46.2% develop edema, 30.8% develop infarction and 15.4% develop hemorrhage (p<0.019).

Discussion :

In this study cerebral edema is most common lesion (31.6%) detected by CT scan, but most importantly 37.8% eclamptic mothers have no CT scan finding. These finding is corroborative with the findings of Harandou M *et al*[4] and Akan H *et al*[21] (Table 4).

In patients with a normal CT scan, MRI is indicated but has not been made because of cost and non-availability in our institute. 50% of the Posterior reversible encephalopathy syndrome (PRES) patients (revealed by MRI) show normal initial CT scans. MRI investigation would have revealed more brain lesions.

Regarding area of distribution parietal and occipital area is the most frequent site of brain lesions in CT scan; supported by observation of Naidu *et al*[6]. They found parieto-occipital involvement in 97.4% of cases. Sometimes diffuse brain edema is associated with compression or dilatation of 3rd and 4th ventricles. There are two such cases in our study. One rare case of lacunar infarct and another rare subarachnoid haemorrhage is found in this study.

The CT scan findings observed in this study is similar to that observed in patients have severe hypertensive encephalopathy[7] or more similar to its variant Posterior reversible encephalopathy syndrome (PRES)[8]. PRES is characterized by headache, altered mental status, visual disturbances, and seizures. Although hypertensive encephalopathy can arise in patients with conditions in which there is acute systemic hypertension alone, it most commonly occurs in patients also having pre-existing endothelial dysfunction or damage. The combination of acute hypertension and endothelial damage results in hydrostatic edema (hyperperfusion) – a specific form of vasogenic edema characterised by the forced leakage of serum through capillary walls and into the brain interstitium- which, if severe enough, will be radio-graphically evident[8,9]. Vasogenic edema is most common finding in eclampsia which explain the reversible nature of most eclampsia. The patients which show no significant finding in CT scan may have very mild vasogenic edema not enough for radiologic detection. The CT scan findings of cerebral infarction are originating from anoxia and cytotoxic edema. This may represents the spectrum of eclampsia ranges from an initially reversible phase of vasogenic edema formation to a later phase of ischemic damage and hemorrhage, which carries a worse prognosis with residual neurologic effect[10]. In fact, laboratory studies of hypertensive encephalopathy, suggest that as vasogenic edema progresses, local tissue pressure increases. This causes a decrease in regional perfusion pressure and a reduction of blood flow to ischemic levels. Subsequently, areas surrounding marked vasogenic edema may progress to infarction and cytotoxic edema[10].

Table 4 — *CT scan findings of brain in eclampsiadifferent study*

	Normal finding	Edema	Infarction/ Thrombosis	Haemo-rrhage
Harandou *et al*[4] (2006)	15.78%	73.68%	15.78%	10.53%
Akan H *et al*[21] (1993)	18.18%	50%	13.63%	9.09%
Milliez J (1990)	59%	34%		6.8%
Richards AM[15] (1988)		63.79%		9.3%
Naidu K[6] (1997)		58.5%		

Brain perfusion is maintained by an auto regulatory system of small arteries and arterioles that has myogenic and neurogenic component[9]. In PRES cases direct toxic effect on endothelium or vessel distension decrease the effect of myogenic mechanism. Then neurogenic mechanisms take over regulation of cerebral perfusion. The perivascular sympathetic nerves travel in the adventitial layer of cerebral blood vessels and are relatively protected from agents that cause endothelial damage. Since the vertebra-basilar system and posterior cerebral arteries are sparsely innervated by sympathetic nerves[11]; the occipital lobe and other posterior brain regions may be particularly susceptible to breakthrough of auto-regulation with elevated systemic pressure. Vasoconstriction induced by sympathetic innervations, moderately protects anterior circulation areas from over perfusion.

Headache is most common neurologic symptoms in this study (68.4%). Akutsu T *et al* (1992)[12] and Chang WN *et al* (1996)[13] also get similar results. Eclamptic mothers with visual symptoms and coma have more lesions in parieto-occipital region and parietal region respectively is corrobo-

rative with the findings of Chakravarty A, Chakrabarty SD (2002)[14] and Chang WN *et al* (1996)[13]. Mothers who have develop coma with Glasgow coma scale <8 and with recurrent episode of convulsion (>5 times in number) develop more findings in CT scan. This finding is correlated to study of Richards *et al*[15] showing severity of edema is related to duration of intermittent seizures. Also, mothers who become fully oriented within 24 hours have significantly less chance of having brain lesions in CT scan. As cerebral mass effect along with diffuse white matter hypodensities is associated significantly more with coma (p 0.034); these mothers recovered later from their eclamptic episodes[16]. In this study preterm eclamptic mother are significantly having pronounced CT scan finding than term mother ($p<0.05$); as preterm mothers are more severely affected in respect to more prodromal symptoms, multiple seizures, major maternal complication[17]. In our study, there is no statistical significant difference in blood pressure values between cases of positive CT scan findings and cases with normal CT scan findings. Acute increase in blood pressure in the later half of pregnancy from the mid pregnancy blood pressure nadir called 'Delta Hypertension' may signify preeclampsia even if absolute pressure may still be <140/90 mmHg. Some of these patients may develop eclamptic seizure whose blood pressure have stayed below 140/90 mmHg[18]. Brain edema detected in preeclampsia/eclampsia is thought to be secondary to endothelial injury, rather than hyperperfusion (acute hypertension) alone. This is also the reason of seizure occasionally found in normotensive eclampsia, where cerebral autoregulation is disrupted due to endothelial factor resulting in vasogenic edema. This finding is correlated with the findings of Schwartz *et al*[19].

Conclusion :

It is evident from this study that cerebral edema is most common cerebral lesions followed by infarction and hemorrhage and parieto-occipital regions of brain is the most common affected area. Although almost 38% eclamptic mothers do not have cerebral lesions, those who have lesions are significantly related to level of consciousness, number of convulsive episode and time taken to recover fully oriented state. Most common neurological finding is headache followed by altered sensorium and hyperreflexia, visual disturbances and coma.

CT scan of brain can provide useful intracerebral information to detect different brain lesions in eclampsia which may have different prognosis with residual effect and may need specific modification in management protocol to prevent long term neurologic sequels and reduce maternal mortality and morbidity; although these parameters are not included in this study. Hira B and Moodley J (2004) have shown that CT scan does change management in 27% of eclamptic mothers which is statistically significant[20].

Conflict of interest: None

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