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# Correlation Between the Degree of Midline Shift in Computed Tomography Scan of Brain and Level of Consciousness of the Patients with Acute Spontaneous Intracerebral Haemorrhage

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**Key words:**
Midline shift, computed tomography, brain, consciousness, acute spontaneous intracerebral haemorrhage.

## Abstract

***Background:*** *Intracerebral hemorrhage (ICH) is the second most common cause of stroke, following ischemic stroke, but accounts for a disproportionate amount of cerebrovascular mortality and morbidity. The extent of midline shift, observed on computed tomography (CT) scans, has been recognized as an important radiological finding associated with the severity of ICH.*

***Objective:*** *To evaluate correlation between the degree of midline shift in computed tomography scan of brain and level of consciousness of the patients with acute spontaneous intracerebral haemorrhage.*

***Material and method:*** *This cross-sectional study was carried out in 100 patients, out of this 50 had spontaneous intracerebral hemorrhage with mass effect and 50 had spontaneous intracerebral hemorrhage without mass effect taken as the control group, the age range from 30-75 years. These patients were purposively collected from the Department of Radiology and Imaging in collaboration with Department of Medicine, Neuromedicine and Neurosurgery of Dhaka Medical College Hospital, Dhaka. All the patients were evaluated by CT findings. On admission Glasgow Coma Scale (GCS) score were recorded from participant's treatment sheet and reviewed by the senior Neurologist after taking permission of the authority.*

***Results:*** *This study shows there is significant inversely correlation of the GSC score with degree of midline shift measure using septum pellucidum shift ($P<0.05$). The GCS score of <10 mm of septum pellucidum shift compared to greater than 10 mm of septum pellucidum shift is significantly different ($P<0.05$). The GCS score of SICH with mass effect compared to the GCS score of SICH without mass effect is significantly different ($P<0.05$).*

***Conclusion:*** *Radiologist should carefully and elaborately interpret the spontaneous intracerebral hemorrhage with midline shift at CT-scan brain and help clinicians to evaluate the level of consciousness which is significant predictor of outcome of our valuable patients.*

## Introduction

Spontaneous intracerebral haemorrhage (SICH) or haemorrhagic stroke is a blood clot/hematoma that arises in the brain parenchyma in the absence of trauma or surgery, commonly due to hypertension, vascular anomalies, tumors, amyloid angiopathy, eclampsia and various drugs. Hypertension, however, remains the single greatest risk factor for SICH. Spontaneous intracerebral haemorrhage

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accounts for strokes and is associated with a highest mortality and morbidity rate of any stroke subtype.[1]

On average, in every 45 seconds someone in the United States has a stroke. Each year about 7000,000 people experience a new or recurrent stroke. Several European countries and Japan have strikingly higher rates of 3 per 1000. There is also a higher outcome at midline shift greater than 1.5 cm were observed (Brain Trauma foundation, 2000). Patients with shift of 5mm or more are more likely to have neurological deficit requiring long term supervisions.[2]

Computerized Tomography scanning is the initial diagnostic procedure of choice in acute stroke. Hematomas, even just a few millimeters in diameter, are rapidly and accurately identified on CT scan. The changes in the CT scan appearance of intracerebral haematoma over time has been well studied.[2] CT is the imaging modality of choice in patients with critical illness due to its speed and virtually no interference on other medical equipments such as ventilator and infusion pump. CT provides a substantial amount of information, including the size & location of haemorrhage and presence of intra-ventricular, subarachnoid & subdural blood.[3]

Manual measurement of midline shift is usually done on an axial slice. There are a number of methods of measuring a midline shift. Cisternal, sellar/suprasellar obliteration, vertical displacement of cerebral masses and midline shifts using the falx, pineal gland and septum pellucidum shift etc. But simple and easy method in the cerebral midline shift is measuring the displacement of the third ventricle and septum pellucidum from midline. It is an easily determined criterion in CT scan with spontaneous intracerebral haematoma. It is found that a midline third ventricle shift correlates with septum pellucidum shift in SICH. These associations were compared by the Glasgow Coma Scale score in respect to the magnitude of the midline shifts.[4]

Haemorrhagic stroke due to spontaneous intracerebral haemorrhage is one of the fatal non-communicable diseases, having higher mortality and morbidity rate in our country, and CT scan is widely used for diagnosis of SICH. Midline shift (MLS) in CT scan is the most important quantitative feature clinicians use to evaluate the severity of brain compression by haemorrhage volume. A few studies have been done in this regards and so far no study has been done in our country. This study has been designed to observe, the third ventricle midline shift & septum pellucidum shift: their consequences on Glashow Coma Scale score and their correlation in patients with SICH and to compare the result with available previous studies. The Glasgow Coma Scale (GCS) score was recorded just before CT scanning based on provisional diagnosis of the patient. So, this study may have a positive role in diagnostic and therapeutic aspect of the management of haemorrhagic stroke patients. It is expected that this study finding will help clinicians to formulate treatment strategy for the patients having SICH.

**Materials and Methods**

This cross-sectional study was carried out in 100 patients, out of this 50 had spontaneous intracerebral hemorrhage with mass effect as 'case' group and 50 had spontaneous intracerebral hemorrhage without mass effect taken as the 'control' group, the age range from 30-75 years. These patients were purposively collected from the Department of Radiology and Imaging in collaboration with Department of Medicine, Neuromedicine and Neurosurgery in Dhaka Medical College Hospital, Dhaka during the period of 1st January 2013 to 31st December 2013. All the patients were evaluated by CT findings. On admission Glasgow Coma Scale score were recorded from participants treatment sheet and reviewed by the senior Neurologist after taking permission of the authority.

The cerebral midline shift was measured using septum pellucidum shift in mm between the anterior horn of the lateral ventricles on the CT slice containing the third ventricle and/or pineal gland. Septum pellucidum shifts were divided into two groups: shift of 10mm or less and >than 10 mm. The admission GCS score of patient in each group were noted. After taking permission from the relevant authority data were collected from the patients and their attendants. Prior consent were taken form their attendants after explaining to them the beneficial aspects of the study. All other needed data were collected from the history sheet, CT reports and they were recorded in a data collection sheet.

**Results**

This study shows almost equal number of patients belonged to the age group of 51-60 years (32%) and 61-70 years (40%) followed by patients of above 70 years of age (12%) in the group who had mass effect and in the control group were almost the same. Out of 100 clinically diagnosed hemorrhagic stroke 50 had spontaneous intracerebral hemorrhage with mass effect, 38(76%) were male and 12(24%) were female. Other 50 had spontaneous intracerebral hemorrhage without mass effect purposively taken as a control and 34(68%) were males and 16(32%) were female (Table 1). Among 100 subject (case plus control) following sites had hemorrhage in CT scan: supratentorial (85%) and infratentorial (15%) (Table II). It is evident that majority (76%) of the SICH occurred due to rupture of MCA branch followed by anterior and posterior cerebral artery (case plus control) (Table III). The Glasgow Coma Scale Score, 13-15 had 06(12%) patients of ISCH with mass effect, 9-12 had 17(34%) and low GCS score 3-5 had 27(54%) patients respectively of same group. On the other hand, in the group of without mass effect 24% had 13-15 score and 60% had 9-12 and 8(16%) had 3-5 score (Table IV). Septum pellucidum shift in CT scan were divided into two groups: shifts of 10 mm or less 30(60%) patients and greater than 10 mm was observed in 20(40%) patients who had SICH with mass effect (Table V). Out of this 50 had spontaneous intracerebral hemorrhage with mass effect as case group and 50 had spontaneous intracerebral hemorrhage without mass effect taken as the control group (Table VI). Septum pellucidum shift in CT scan were divided into two group: sift of 10 mm or less 60% (n=30) and greater than 10 mm had observed in 40%(n=20) of the patients who had SICH with mass effect. The GSC scores of patients in each group were noted. The group of 10 or less had 5-15 score, mean±SD 10.32±2.89 and greater than 10 mm group had 3-9, mean±SD 6.46±1.85 (Table VII). The septum pellucidum shift of 50 intracerebral hemorrhage with mass effect participant were correlated with the Glasgow Coma Scale Score. A significant negative correlation was found between these two participants. The septum shift were range from 02 mm to 22 mm (mean±SD, 10.44±5.11) and the GCS score were from 3-15 (mean±SD 8.12±3.61) (Table VIII). The septum pellucidum shifts of 50 intracerebral hemorrhage with mass effect participants were correlated with the Glasgow Coma Scale Score. A significant negative correlation was found between these two parameters. The value of Spearman's Correlation Coefficient *r* was -0.760 and $p<0.01$ (Figure 1).

**Table I.** Sociodemographic characteristics of the study subject (n=100)

| Characteristics | Case (n=50) | | Control (n=50) | |
|---|---|---|---|---|
| | No | Percentage (%) | No | Percentage (%) |
| Age in years | | | | |
| 30-40 | 2 | 4 | 2 | 4 |
| 41-50 | 6 | 12 | 6 | 12 |
| 51-60 | 16 | 32 | 19 | 38 |
| 61-70 | 20 | 40 | 18 | 36 |
| >70 | 6 | 12 | 5 | 10 |
| Sex | | | | |
| Male | 38 | 76 | 34 | 68 |
| Female | 12 | 24 | 16 | 32 |

**Table II:** Distribution of site of intracerebral hemorrhage as detected in CT (n=100)

| Site | Number of ICH | Percentage (%) |
|---|---|---|
| Supratentorial | | |
| Deep | | |
| Basal ganglia | 38 | 38 |
| Thalamus | 3 | 3 |
| Intraventricular | 11 | 11 |
| Paraventricular | 22 | 22 |
| Internal capsule | 3 | 3 |
| Lobar | | |
| Temporoparietal | 3 | 3 |
| Temporal | 5 | 5 |
| Infratentorial | | |
| Cerebellar | 9 | 9 |
| Pontine | 6 | 6 |

**Table III.** *Arterial territory of hemorrhage as detected in CT scan (n=100)*

| Artery territory | Number of ICH | Percentage (%) |
|---|---|---|
| Anterior cerebral artery | 9 | 9 |
| Middle cerebral artery | 76 | 76 |
| Posterior cerebral artery | 6 | 6 |
| Cerebellar artery | 9 | 9 |

**Table IV.** Distribution of the participants according to Glasgow Coma Scale Score between SICH with or without mass effect (n=100)

| Group of patients | Mild (13-15) | Moderate (9-12) | Severe (3-8) |
|---|---|---|---|
| With mass effect: Case (n=50) | 6(12%) | 17(34%) | 27(54%) |
| Without mass effect: Control (n=50) | 12(24%) | 30(60%) | 8(16%) |

**Table V:** Distribution of the study subjects according to mass effect measured using septum pellucidum shift in mm (n=50)

| Types of lesion | Septum pellucidum shift (10 mm or less) | Septum pellucidum shifts (Greater than 10 mm) | Total |
|---|---|---|---|
| SICH with mass effect | 30(60%) | 20(40%) | 50 |

**Table VI:** Comparison between SICH with mass effect and SICH with no mass effect (n=100)

| Group | Mild to moderate (9-19) | Severe (3-8) | Total | P value |
|---|---|---|---|---|
| SICH with mass effect | 23 | 27 | 50 | 0.001 |
| SICH with no mass effect | 42 | 8 | 50 | |

**Table VII:** Relationship between septum pellucidum shift 10 mm or less and greater than 10 mm with GCS score (n=50)

| Septum pellucidum shift | N | Minimum | Maximum | Mean±SD | P value |
|---|---|---|---|---|---|
| 10 mm or less | 30 | 5 | 15 | 10.31±2.89 | 0.001 |
| Greater than 10 mm | 20 | 3 | 9 | 6.46±1.85 | |

**Table VIII:** *Relationship between septum pellucidum shift with Glasgow Coma Scale Score*

| | N | Minimum | Maximum | Mean±SD | P value |
|---|---|---|---|---|---|
| Septum pellucidum shift | 50 | 02 | 22 | 10.44±5.78 | 0.001 |
| GCS | 50 | 3 | 15 | 8.12±3.14 | |

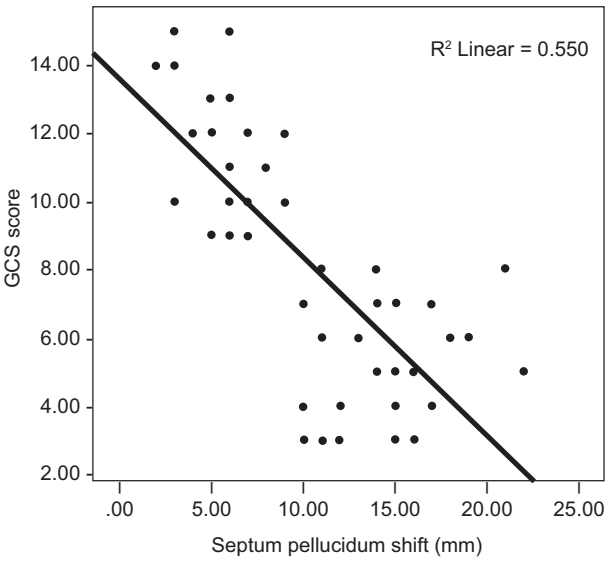


**Figure- 1:** *Scatter diagram showing the significant negative relationship (rs -0.760) between Septum Pellucidum shift and Glasgow Coma Scale Score.*

## Discussion

A study of the literature on SICH reveals a consensus that the level of consciousness is the single most important prognostic factor concerning prognosis and outcome. The main goal of my study was to evaluate the degree of midline shift at CT brain correlates well with Glasgow Coma Scale Score.

This cross-sectional study was carried out in 100 patients, out of this 50 had spontaneous intracerebral hemorrhage with mass effect and 50 had spontaneous intracerebral hemorrhage without mass effect taken as the control group.

These patient were purposively collected from the Department of Radiology and Imaging in collaboration with Department of Medicine, Neuromedicine and Neurosurgery in Dhaka Medical College Hospital, Dhaka. All the patients were evaluated by CT findings. In the present study, 50 had spontaneous intracerebral hemorrhage with mass effect, 38 (76%) were male and 12 (24%) were female. Other 50 had spontaneous intracerebral hemorrhage without mass effect purposively taken as a control and 34 (68%) were male and 16 (32%) were female, which shows a definite preponderance of males with a male: female ratio of approximately 2.57:1.

The age range from 30-75 years and the mean age of the patients were 63.3±11.1 years. These findings are not far from another study Bashar et al.[5] In the present study, the male preponderance was noted, which is consistent with another study.[6]

The septum pellucidum has been used as a dynamic landmark in determining midline shift by Ross et al..[7] The septum pellucidum shift has been correlated with level of consciousness. It is a relatively simple method of measuring brain shift because of easy identification of the septum pellucidum in most scans. Septum pellucidum shifts in CT-scan were divided into 2 groups: shifts of 10 mm or less (60%, n= 30) had GCS Scores ranging form 5-15 with an average GCS of 10-11 (actual value 10.32) and grater than 1Omm septum pellucidum shift (40%, n= 20) had a GCS score range of 3 to 9, with a substantially lower mean GCS score of 6 (actual value 6.46). These two group had highly significant difference $p<0.01$ which is closely resemble to the study of Carlos Francis A. Santiago

et al.[8] They observed 65.6% (n= 21) had shift of 10 mm or less, GCS score range 11-12 and 35.4% (n= 11) had greater than 10mm septum pellucidum shifts with GCS Score range 3-9 and these two group had significant difference in means. Carlos Francis A. Santiago et al.[8] further found that, the degree of midline shift measured using septum pellucidum shift correlated with GCS score at the time of CT-scan, with an r of - 0.6753. Quattrochi et al.[9] found in the study of 75 patients used septum pellucidum lateral shift and found that it was a significant predictive factor for poor outcome especially when out of proportion to the extent of intracranial hemorrhage. These studies have shown that significant midline shift correlates with high intracranial pressure, abnormal posturing and low admission GSC score. Saks et al.[10] reported seventy-six patients underwent 235 scans (3.1±1.3 per patient). Midline shift of 2.1 mm was present in 88.2% if patients on initial CT, including 36 of 39 (92.3%) basal ganglia hematomas, 17 of 18 (94.4%) thalamic hematomas and 14 of 19 (74%) lobar hematomas. Septum pellucidum shift was a more sensitive measurement of initial mass effect at all hematoma locations.

Among 100 study subjects (Case plus Control) following sites have been observed at CT-scan. Supratentorial 85% and infratentorial 15%. Supratentorial site were also classified as deep (77%) and lobar (8%) and infratentorial sites were divided into cerebellar (9%) and potine (6%). These findings are almost consistent with that of Basar et al.[5] But Sakas et al.[10] shows 61.2% were lobar, basal ganglia (13.8%), ventricles (12.5%), cerebellum (7.5%) and pontine (5%).

In this study, comparison between septum pellucidum shift with GCS score shows the septum pellucidum shifts of 50 intracerebral hemorrhage with mass effect participants were correlated with the Glasgow Coma Scale Score. A significant negative correlation was found between these two parameters. The value of Spearman's Correlation coefficient *r* was -0.760 and it was very significant ($p<0.001$).

Ross et al.[7] in their study showed both septum pellucidum and pineal gland shift and correlated them with level of consciousness. A correlation was found between a decrease in the level of consciousness and significant increase in the mean lateral brain displacement at the pineal gland (from 3.8 to 7.0 mm) and septum (5.4 to 12.2 mm). When outcome was examined in patients who were stupors or comatose on admission, a significant increase in septal shift was found and significant relationship between outcome and degree of pineal or aqueductal shift was observed.

This study was carried out in 100 patients, out of this 50 had spontaneous intracerebral hemorrhage with mass effect and 50 had spontaneous intracerebral hemorrhage without mass effect at CT-scan taken as the control group.

The Glasgow Coma Scale Score of each group were expressed as mild (13-15), moderate (9-12) and severe (3-8). The association is very significant ($P=0.001$). So, the level of consciousness correlates with the degrees of midline shift.

## Conclusion

This study shows the cerebral midline shift is measured using the septum pellucidum shift is an easily determined significant criterion which is used to gauge the neurological status of patients with spontaneous unilateral intracerebral hematoma. There is significant inversely correlation of the GCS score with degree of midline shift measure using septum pellucidum shift. The GCS score of ≤10 mm of septum pellucidum shift compared to greater than 10mm of septum pellucidum shift is significantly different. The GCS score of SICH with mass effect compared to the GCS score of SICH without mass effect is significantly different. Thus radiologist should carefully and elaborately interpret the spontaneous intracerebral hemorrhage with midline shift at CT-scan brain and help clinicians to evaluate the level of consciousness which is significant predictor of outcome of our valuable patients.

**Conflict of interest:** None declared

**Ethical approval:** The study was approved by the Institutional Ethics Committee of Dhaka Medical College, Dhaka.

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