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Original Article

Association Between Hypertensive Retinopathy and Intracerebral Haemorrhage: Evaluation of Retinal Findings as Predictive Markers in Hypertensive Emergencies

Patel Meet Bharatbhai[1], Dr Ronak Prakashkumar Shah[2], Dr Mittal Sindhav[3]

[1]Resident, Department of Emergency Medicine, Smt B k Shah medical institute and research centre.
[2]Associate Professor, Department of Medicine, Smt B k Shah Medical Institute and Research Centre.
[3]Assistant Professor, department of Emergency Medicine. Smt B k Shah Medical Institute and Research Centre.

Corresponding Author:

Patel Meet Bharatbhai
Resident, Department of Emergency Medicine, Smt B k Shah medical institute and research centre.
Email. Meetb99@gmail.com

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ABSTRACT

Introduction: Hypertension is one of the most significant modifiable risk factors for both cardiovascular and cerebrovascular diseases worldwide.
Aim: To investigate the association between hypertensive retinopathy and intracerebral haemorrhage (ICH) in hypertensive patients, and to evaluate the potential of retinal findings as predictive markers for cerebral involvement and risk stratification in hypertensive emergencies.
Methodology: This study was designed as a cross-sectional observational study conducted at Smt. B. K. Shah Medical Institute and Research Centre, Sumandeep Vidyapeeth Deemed to be University, Vadodara, Gujarat.
Result: The majority of patients had moderate to severe hypertensive retinopathy, with higher retinal grades significantly associated with severe intracerebral haemorrhage, lower GCS scores, midline shift, and raised intracranial pressure. Severe ICH and increased mortality were more frequently observed in patients with Grade III and Grade IV retinopathy.
Conclusion: Hypertensive retinopathy shows a positive correlation with the severity of intracerebral haemorrhage in hypertensive patients. Retinal findings are simple, non-invasive predictive markers for risk stratification in hypertensive emergencies.

Keywords: *retinopathy, Hypertension, cerebral.*

INTRODUCTION

Hypertension is one of the most significant modifiable risk factors for both cardiovascular and cerebrovascular diseases worldwide.[1] Chronic high blood pressure damages small blood vessels throughout the body, mainly affecting organs with rich vascular supplies such as the brain and retina. Intracerebral hemorrhage (ICH) is one of the most severe complications of uncontrolled hypertension, which often leads to high morbidity and mortality[2]. Microvascular changes resulting from systemic hypertension can directly be observed in the retina. Hypertensive retinopathy shows a range of retinal abnormalities—varies from arteriolar narrowing and arteriovenous nicking to hemorrhages, exudates, and papilledema—reflecting the severity and duration of elevated blood pressure[3]. Several studies have suggested that these retinal changes may parallel cerebral small vessel pathology, making the eye a "window to the brain."

Understanding the relation between the severity of hypertensive retinopathy and the severity of brain hemorrhage offer an important screening tool[4]. This correlation assist in early risk stratification, aggressive blood pressure control in at-risk patients. Moreover, identifying such a relationship help guide decisions in low-resource settings where access to neuroimaging is limited[5].This study aims to evaluate the association between grades of hypertensive retinopathy and the occurrence of intracerebral hemorrhage in hypertensive patients.[6] By correlating ocular findings with radiological evidence of brain injury, the study hopes to establish whether the severity of retinal changes can serve as a predictive marker of cerebral involvement. Such findings may reinforce the value of routine fundus examinations in hypertensive patients, especially those presenting with neurological symptoms[7,8].

AIM

To investigate the association between hypertensive retinopathy and intracerebral haemorrhage (ICH) in hypertensive patients, and to evaluate the potential of retinal findings as predictive markers for cerebral involvement and risk stratification in hypertensive emergencies.

METHODOLOGY

Study Design and Setting

This study was designed as a cross-sectional observational study conducted at Smt. B. K. Shah Medical Institute and Research Centre, Sumandeep Vidyapeeth Deemed to be University, Vadodara, Gujarat. The study was carried out over a defined period in the Departments of Emergency medicine and Critical care medicine. Ethical approval was obtained from the Institutional Ethics Committee prior to the commencement of the study, and written informed consent was obtained from all participants or their legally acceptable representatives in cases where the patient was unable to consent due to altered sensorium.

Study Population

The study included a total of 50 hypertensive patients with confirmed intracerebral hemorrhage (ICH) diagnosed on neuroimaging (CT or MRI brain).

Inclusion Criteria

The following patients were included in the study:

- Patients aged 18 years and above
- Known cases of hypertension or newly diagnosed hypertensive individuals presenting with ICH
- Patients with confirmed intracerebral hemorrhage on CT or MRI brain
- Patients who underwent fundoscopic examination within 48 hours of admission

Exclusion Criteria

The following patients were excluded from the study:

- Patients with retinal changes attributable to diabetes mellitus, ocular trauma, or other non-hypertensive causes
- Patients with known intracranial malignancies or cerebral aneurysms
- Patients with pre-existing ophthalmic pathologies that interfered with adequate visualization of the retina
- Patients who were hemodynamically unstable and unfit for fundoscopic examination
- Patients or their representatives who refused to provide informed consent

Sample size: The sample size for the present study was determined based on a review of previously published literature reporting the prevalence and association of hypertensive retinopathy with intracerebral hemorrhage. The expected prevalence of hypertensive retinopathy among hypertensive patients with intracerebral hemorrhage was estimated at 70%, based on findings from Chen Xet al. who reported a prevalence of 74.4% in hypertensive stroke patients [10]. Using the formula for cross-sectional studies:

n = Z2 x 2

Z=1.96 at 95% Confidence interval

p=prevalence of hypertension in critical care department taken as 70% =0.7

q =1-p =0.3

e =margin of error =10%

Sample size calculated is 47 and by adding 10% nonresponse rate total sample size is 50.

Data Collection

Data was collected using a structured and pre-tested proforma. The following parameters were systematically recorded for each participant:

1. Demographic Profile

Demographic details including age, sex, socioeconomic status, and residential background (rural or urban) were recorded for all enrolled patients at the time of admission.

2. Clinical Profile and Vital Signs

A detailed clinical history was obtained, including duration of known hypertension, history of antihypertensive medication use, and any prior episodes of hypertensive emergency. On admission, the following vital parameters were recorded:

- Blood pressure (systolic and diastolic) measured by using a standardized sphygmomanometer
- Heart rate, respiratory rate, and temperature

Oxygen saturation (SpO_2) on room air are noted

- The level of Consciousness amd neurological status is assessed by Glasgow Coma Scale (GCS)
- If there is any Presence neurological deficits such as focal weakness, speech disturbances, or cranial nerve involvement

3. Fundoscopic Findings

All patients underwent indirect ophthalmoscopy or direct fundoscopy performed by a qualified ophthalmologist within 48 hours of admission. Fundoscopic findings were graded according to the Keith-Wagener-Barker (KWB) Classification of hypertensive retinopathy as follows:

- Grade I — Mild generalized arteriolar narrowing
- Grade II — Definite focal arteriolar narrowing with arteriovenous nicking
- Grade III — Grade II changes with addition of flame-shaped hemorrhages, hard exudates, and cotton wool spots
- Grade IV — Grade III changes with papilledema

The specific retinal signs noted in each patient — including arteriolar narrowing, arteriovenous nicking, retinal hemorrhages, hard exudates, cotton wool spots, and papilledema — were individually documented to assess which signs carried the greatest predictive value for cerebral involvement.

4. Neuroimaging Reports — CT and MRI Brain

All patients underwent non-contrast computed tomography (NCCT) of the brain at the time of admission as the primary imaging modality. MRI brain was performed in selected cases where additional characterization of the hemorrhage was required. The following imaging parameters were assessed and recorded:

- Location of intracerebral hemorrhage (lobar, basal ganglia, thalamic, cerebellar, or brainstem)
- Volume of hemorrhage estimated using the ABC/2 method
- Presence or absence of intraventricular extension
- Degree of midline shift (measured in millimeters)
- Presence of perilesional edema
- Evidence of raised intracranial pressure (ICP)
- Severity of ICH graded using the ICH Score

Statistical Analysis

Data was entered and analyzed using the SPSS software version (mention version). Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as mean ± standard deviation. The association between the grade of hypertensive retinopathy and the severity of intracerebral hemorrhage was assessed using the Chi-square test for categorical variables and the Spearman's rank correlation coefficient for ordinal data. A p-value of less than 0.05 was considered statistically significant.

RESULT

Table 1: Demographic Characteristics of Study Participants (n = 50)

Age Group (years)	Number	Percentage
18–40	10	20%
41–60	28	56%
>60	12	24%
Gender	Number	Percentage
Male	32	64%
Female	18	36%

The majority of patients were 41–60 years age group, comprising 28 patients (56%) of the study population.Patients aged >60 years were 12 cases (24%), while 10 patients (20%) were in the 18–40 years age group.Out of the 50 patients included in the study, males were 32 cases (64%) while Females constituted 18 patients (36%) of the total study population.

Table 2: Blood Pressure at Admission

Systolic BP (mmHg)	Number	Percentage
140–159	8	16%
160–179	14	28%
≥180	28	56%
Diastolic BP (mmHg)		

90–99	12	24%
100–109	18	36%
≥110	20	40%

More than half of the patients (56%) had systolic blood pressure ≥180 mmHg at admission, while 28% had values between 160–179 mmHg and 16% between 140–159 mmHg.Regarding diastolic blood pressure, 40% had values ≥110 mmHg, 36% ranged between 100–109 mmHg, and 24% had readings between 90–99 mmHg.

Table 3:Glasgow Coma Scale (GCS) on Admission

GCS Category		Number	Percentage
Mild	13–15	14	28%
Moderate	9–12	20	40%
Severe	≤8	16	32%

On admission, 20 patients (40%) had moderate GCS scores (9–12), while 16 patients (32%) were with severe neurological impairment (GCS ≤8).Only 14 patients (28%) had mild GCS scores (13–15), showing relatively better neurological status at presentation.

Table 4: Distribution of Hypertensive Retinopathy (Keith–Wagener Classification)

Grade	Number	Percentage
No Retinopathy	8	16%
Grade I	12	24%
Grade II	15	30%
Grade III	10	20%
Grade IV	5	10%

Hypertensive retinopathy was most commonly Grade II, observed in 15 patients (30%), followed by Grade I in 12 patients (24%).Grade III and Grade IV retinopathy were seen in 10 (20%) and 5 patients (10%) respectively while 8 patients (16%) showed no retinal changes.

Table 5: Site of Intracerebral Hemorrhage

Site of Hemorrhage	Number	Percentage
Basal Ganglia	18	36%
Thalamus	9	18%
Lobar (Fronto-Parietal/Occipital)	14	28%
Brainstem (Pons)	4	8%
Cerebellum	5	10%

The most common site of intracerebral haemorrhage was the basal ganglia, observed in 18 patients (36%), followed by lobar regions in 14 patients (28%).Thalamic haemorrhage was seen in 9 patients (18%), while cerebellar and brainstem involvement accounted for 10% and 8% of cases, respectively.

Table 6: Midline Shift on Neuroimaging

Midline Shift	Number	Percentage
Absent	15	30%

<5 mm	10	20%
5–10 mm	14	28%
>10 mm	11	22%

Midline shift was absent in 15 patients (30%), while 10 patients (20%) had a shift of less than 5 mm.A shift of 5–10 mm was observed in 14 patients (28%), and 11 patients (22%) had a significant midline shift of more than 10 mm.

Table 7: Raised Intracranial Pressure (ICP) Signs

Raised ICP	Number	Percentage
Present	19	38%
Absent	31	62%

Raised intracranial pressure was observed in 19 patients (38%) at presentation.The remaining 31 patients (62%) did not exhibit clinical or radiological features of raised intracranial pressure.

Table 8: ICU Admission & Outcome

Variable	Number	Percentage
ICU Admission Required	34	68% of total
Conservative Management	25	73.5% of ICU
Surgical Intervention	9	26.5% of ICU
Mortality	12	35.3% of ICU
Survived	22	64.7% of ICU
Non ICU patients	16	32% of total
Conservative management	16	100% of non ICU
Mortality	0	0
Survived	16	100%
Overall cohort summary (n=50)		
Total surgical intervention	9	18%
Total medical / conservative management	41	82%
Total mortality	12	24%
Total survived	38	76%

A total of 34 patients (68%) required ICU admission, with the majority managed conservatively (82%), while 18% underwent surgical intervention.Overall mortality was observed in 12 patients (24%), whereas 38 patients (76%) survived during the hospital stay.

Table 9: Association Between Retinopathy Grade and Severe ICH (GCS ≤8)

Retinopathy Grade	Severe ICH (n=16)	Non-Severe (n=34)	Total
No retinopathy	1	7	8
Grade I	1	11	12

Grade II	4	11	15
Grade III	6	4	10
Grade IV	4	1	5
Total	16	34	50

p = 0.005 — Higher retinopathy grades (III & IV) were significantly associated with severe ICH. Grade III and IV accounted for 10 out of 16 severe ICH cases. Chi-square test applied.

Table 10:Association Between Retinopathy Grade and Systolic BP

Retinopathy Grade	SBP 140–159	SBP 160–179	SBP ≥180
No retinopathy	4	3	1
Grade I	3	5	4
Grade II	1	4	10
Grade III	0	2	8
Grade IV	0	0	5
Total	8	14	28

p = 0.007 — The majority of Grade III (8/10) and all Grade IV patients had SBP ≥180 mmHg, indicating a significant association between retinopathy severity and degree of blood pressure elevation.

Table 11:Association Between Retinopathy Grade and GCS

Retinopathy Grade	Mild (13–15)	Moderate (9–12)	Severe (≤8)
No Retinopathy	5	2	1
Grade I	5	5	2
Grade II	3	8	4
Grade III	1	4	5
Grade IV	0	1	4

Increasing severity of hypertensive retinopathy demonstrated a statistically significant trend toward worsening neurological status on admission. Patients with Grade III and Grade IV retinopathy were predominantly associated with severe GCS scores (≤8), accounting for 9 out of 16 severe cases (56.2%), while patients with no retinopathy or Grade I retinopathy were largely in the mild GCS category (10 out of 14 mild cases, 71.4%). This graded association between retinal severity and neurological impairment was statistically significant ($p < 0.05$), further supporting the role of hypertensive retinopathy.

Table 12: Association Between Retinopathy Grade and Midline Shift on Neuroimaging

Retinopathy Grade	Absent (n=15)	<5 mm (n=10)	5–10 mm (n=14)	>10 mm (n=11)	Total
No Retinopathy	6	2	0	0	8
Grade I	6	4	2	0	12
Grade II	3	4	6	2	15
Grade III	0	0	5	5	10

Grade IV	0	0	1	4	5
Total	15	10	14	11	50

$p < 0.05$ — Significant midline shift (>10 mm) was observed exclusively in Grade II, III, and IV patients. Grade III and IV accounted for 9 out of 11 cases (81.8%) of severe midline shift.

Table 13: Association Between Retinopathy Grade and Site of Intracerebral Hemorrhage

Retinopathy Grade	Basal Ganglia (n=18)	Thalamus (n=9)	Lobar (n=14)	Cerebellum (n=5)	Brainstem (n=4)	Total
No Retinopathy	3	2	2	1	0	8
Grade I	5	3	3	1	0	12
Grade II	6	3	4	1	1	15
Grade III	3	1	4	1	1	10
Grade IV	1	0	1	1	2	5
Total	18	9	14	5	4	50

Basal ganglia was the most common site across all grades. Brainstem hemorrhage was predominantly seen in Grade III and IV patients (3 out of 4 cases), suggesting an association between higher retinopathy grades and deeper, more critical hemorrhage locations(p value <0.05).

Table/ Figure 14: Association Between Retinopathy Grade and Mortality

Retinopathy Grade	Mortality (n=12)	Survived (n=38)	Total
No Retinopathy	0	8	8
Grade I	0	12	12
Grade II	3	12	15
Grade III	5	5	10
Grade IV	4	1	5
Total	12	38	50

$p < 0.05$ — Grade III and IV retinopathy accounted for 9 out of 12 deaths (75%). No mortality was observed in patients with no retinopathy or Grade I retinopathy.

DISCUSSION

Most of the patients were 41–60 years, accounting for 28 out of 50 cases (56%), showing a higher burden in the middle-aged group. Patients above 60 years were 12 cases (24%), while the 18–40 years age group included 10 patients (20%). Similar findings were reported by Singh et al.[9], who observed hypertensive intracerebral haemorrhage mainly in the fifth and sixth decades of life. In contrast to our study, which showed predominance in the 41–60 years age group, Chen et al.[10] reported a higher mean age of 63.3 years among hypertensive stroke patients. This difference here was mainly due to demographic variations and longer life expectancy in their study population.

A total of 32 patients were male, accounting for 64% of the cases in our study while female patients were representing 36% of the study population.our findings in study is in consistent with findings by Chen et al[10]. and Goel et al[11]., who also reported an association of hypertensive retinopathy and stroke among males.

In our study 28 cases (56%) having SBP ≥180 mmHg, followed by 14 patients (28%) in the 160–179 mmHg and 8 patients (16%) were between 140–159 mmHg. diastolic blood pressure, 20 patients (40%) recorded DBP ≥110 mmHg, while 18 patients (36%) had values between 100–109 mmHg. The remaining 12 patients (24%) had DBP between 90–99 mmHg,

indicating that most patients had severe hypertension at admission.Similar findings were reported by Li W et al.,[12] who demonstrated that individuals with stage 2 hypertension (175–179 mmHg) had an increased risk of intracerebral hemorrhage (adjusted HR 12.4; p<0.001). Even individuals within the prehypertensive range showed increased stroke risk. These findings support our observation that severe and sustained elevation of blood pressure plays a crucial role in the development and severity of intracerebral hemorrhage.

Glasgow Coma Scale (GCS) assessment in our study showed a variety of severity among patients, 14 cases (28%) have mild impairment (GCS 13–15). Moderate impairment (GCS 9–12) was observed in 20 patients (40%), while severe impairment (GCS ≤8) was seen in 16 patients (32%). This observation is consistent with the findings of Thiagarajah et al.,[13] who demonstrated that patients with low-severity retinopathy had significantly better GCS scores (9–15) on admission (p = 0.003), smaller clot volumes (<30 mL; p = 0.001), and improved 30-day mortality outcomes (p = 0.006). They also showed that the risk of developing hemorrhagic stroke was more in patients with high-severity retinopathy (RR 29.4) to low-severity changes (RR 0.42).

In our study Out of the 50 patients , 8 patients (16%) showed no evidence of hypertensive retinopathy on fundoscopy.Grade I retinopathy was observed in 12 patients (24%), while Grade II changes were seen in 15 patients (30%).Advanced retinal changes were present with Grade III retinopathy in 10 patients (20%).Grade IV retinopathy, representing the most severe form, was identified in 5 patients (10%). These findings are also comparable to those reported by Sonal Kochhar Suri et al.[14], who similarly observed Grade II retinopathy as the majority (44%), with relatively fewer cases of advanced Grade III (16%) and Grade IV (4%) changes. In contrast, Tripti Goel and Sunil Goel[10] reported a lower prevalence of hypertensive retinopathy (62.25%), with Grade IV changes seen in only 3.4% of participants. The comparatively greater proportion of advanced grades in our study is attributed to the hospital-based inclusion of acute intracerebral haemorrhage patients, suggesting that severe retinal microvascular damage is more common in patients presenting with cerebrovascular complications.

In present study The most common site of intracerebral haemorrhage was the basal ganglia, observed in 18 patients (36%).Lobar haemorrhages involving the fronto-parietal or occipital regions were seen in 14 patients (28%).Thalamic haemorrhage accounted for 9 cases (18%) of the study population.Cerebellar involvement was seen in 5 patients (10%).Brainstem haemorrhage, specifically involving the pons, was present in 4 patients (8%).This distribution is consistent with the well-established predilection of hypertensive hemorrhage for deep cerebral structures. Hypertensive vasculopathy leads to lipohyalinosis, fibrinoid necrosis, and formation of Charcot-Bouchard microaneurysms, with vessel rupture typically occurring in the basal ganglia (40–50%), lobar regions (20–50%), thalamus (10–15%), pons (5–12%), and cerebellum (5–10%)[15] . The basal ganglia, particularly the putamen, are the most vulnerable due to the high susceptibility of the lenticulostriate arteries to chronic pressure-induced degenerative changes[15,16].

Neuroimaging in our study showed no midline shift in 15 patients (30%), while 10 (20%) had a shift <5 mm, 14 (28%) had 5–10 mm, and 11 (22%) had >10 mm, indicating that 50% of cases demonstrated a shift greater than 5 mm and significant mass effect. Raised intracranial pressure (ICP) was observed in 19 patients (38%), whereas 31 patients (62%) had no clinical or radiological evidence of raised ICP at presentation. Midline shift is a recognised predictor of poor outcome in intracerebral hemorrhage. Yang et al. demonstrated that midline shift is independently associated with unfavourable functional outcome in supratentorial ICH patients[17] , and Bhattathiri et al. reported that a midline shift exceeding 5 mm is significantly associated with increased 30-day mortality and failure of conservative therapy[18] .

In our study Out of the 50 patients, 34 (68%) required admission to the intensive care unit due to the severity of their clinical condition.The majority of patients, 41 (82%), were managed conservatively with medical treatment and supportive care.Surgical intervention was required in 9 patients (18%) based on neurological deterioration or significant mass effect.These figures are consistent with published data showing that surgical evacuation is typically reserved for a minority of ICH patients with significant mass effect or neurological deterioration, with conservative management remaining the mainstay of treatment for the majority[19] .

Among patients with severe intracerebral haemorrhage (n=16), higher grades of hypertensive retinopathy were more common, with Grade III and IV seen in 6 and 4 patients respectively, while only 2 had no or Grade I changes. In contrast, most non-severe cases (n=34) had no or Grade I retinopathy (18 patients), indicating a positive association between increasing retinopathy grade and severity of intracerebral haemorrhage.Kwon HM et al[20].[15] demonstrated that increasing grades of hypertensive retinopathy were independently associated with a higher risk of subclinical stroke, with odds ratios rising from 2.17 in Grade I to 2.98 in Grade II retinopathy (OR, 2.17 [95% CI, 0.95–4.96] for grade 1; OR, 2.98 [95% CI, 1.20–7.42] for grade 2). Similarly, Ong YT et al.[21] [16] reported that even hypertensive patients with well-controlled blood pressure but persistent retinopathy had an increased hazard of cerebral infarction. While these studies focused on stroke risk prediction, our findings extend this evidence by demonstrating that higher grades of retinopathy are also associated with greater severity of intracerebral haemorrhage(HR, mild retinopathy: 1.96, 95%CI 1.09-3.55; moderate retinopathy: 2.98, 95%CI 1.01-8.83). Collectively, these observations support the hypothesis that retinal microvascular changes mirror underlying cerebral small vessel pathology.

In the present study, a clear association was observed between systolic blood pressure and the severity of hypertensive retinopathy. Lower grades, including no retinopathy and Grade I, were predominantly seen in patients with lower SBP ranges (140–179 mmHg), whereas higher grades showed a shift toward elevated SBP levels. , all patients with Grade III and Grade IV retinopathy belonged to the highest SBP category (≥180 mmHg), indicating severe hypertension. These findings are in comparable to the study by Guntupalli Sri Vishnu Sai Krishna et al.[22 17], which also demonstrated increasing mean systolic blood pressures with higher grades of hypertensive retinopathy, with statistical significance ($p = 0.05$). Their study further highlighted that patients with well-controlled blood pressure had milder retinopathy, while poorly controlled hypertension was associated with advanced grades.

In the present study, an increasing trend was seen between increasing grades of hypertensive retinopathy and decreasing Glasgow Coma Scale (GCS) scores. Lower grades (no retinopathy and Grade I) were majority associated with mild to moderate GCS, whereas higher grades showed a shift toward severe neurological impairment. Notably, Grade III and IV retinopathy had a higher proportion of patients with severe GCS (≤8), indicating significant systemic involvement.These findings are in comparable to the study by Thiagarajah et al[13]., which demonstrated a statistically significant association between retinopathy severity and GCS ($p = 0.003$). In their study, higher grades of retinopathy were associated with lower GCS scores and worse clinical outcomes.

In the present study, a statistically significant association was observed between the grade of hypertensive retinopathy and the degree of midline shift on neuroimaging ($p < 0.05$). Patients with no retinopathy or Grade I retinopathy showed absent or minimal midline shift, with all 20 such patients having either no shift or a shift of less than 5 mm. In contrast, patients with Grade III and Grade IV retinopathy demonstrated progressive and severe midline shift, collectively accounting for 9 out of 11 cases (81.8%) of significant midline shift exceeding 10 mm. No patient with Grade III or Grade IV retinopathy had an absent midline shift, indicating that advanced retinal microvascular damage corresponds to greater cerebral mass effect and more severe hemorrhagic injury. These findings are consistent with the observations of Thiagarajah et al., who reported that high-severity retinopathy was significantly associated with larger clot volumes ($p = 0.001$), which directly correlates with the degree of midline shift on neuroimaging[13]. Yang et al. further established that midline shift is independently predictive of poor functional outcome in supratentorial ICH patients[17].

In the present study, the basal ganglia was the most common site of intracerebral hemorrhage across all retinopathy grades, accounting for 18 cases (36%). This is consistent with the well-established predilection of hypertensive hemorrhage for the basal ganglia which is due to the vulnerability of the lenticulostriate arteries to chronic pressure-induced damage[18,19]. Lobar hemorrhages were the second most common, seen in 14 patients (28%), followed by thalamic hemorrhage in 9 patients (18%). A clinically significant observation was that brainstem hemorrhage, involving the pons, was predominantly seen in patients with Grade III and Grade IV retinopathy, accounting for 3 out of 4 brainstem cases (75%). This suggests that patients with advanced hypertensive retinopathy may be more likely to develop hemorrhage in deeper and more critical anatomical locations carrying a significantly worse prognosis, in keeping with the known pathophysiology of hypertensive small vessel disease, wherein chronic uncontrolled hypertension leads to lipohyalinosis and fibrinoid necrosis of deep perforating arteries[18].

The present study demonstrated a strong and statistically significant association between the grade of hypertensive retinopathy and in-hospital mortality ($p < 0.05$). In patients with no retinopathy or Grade I retinopathy no mortality was observed,while all 12 deaths occurred in patients with Grade II or above. Grade III and Grade IV retinopathy together accounted for 9 out of 12 deaths (75% of total mortality), despite constituting only 30% of the study population. Notably, Grade IV retinopathy, characterised by papilledema and representing the most severe form of hypertensive retinal damage, was associated with a mortality rate of 80% (4 out of 5 patients). These findings are strongly supported by Thiagarajah et al., who reported that patients with high-severity retinopathy had significantly worse 30-day mortality outcomes as assessed by the ICH score ($p = 0.006$) and poorer Glasgow Outcome Scale scores ($p = 0.001$)[13]. The relative risk of developing hemorrhagic stroke in high-grade retinopathy patients was reported to be as high as 29.4 compared to 0.42 in low-grade cases [13].

The findings of the present study extend this evidence by demonstrating that advanced retinopathy is not only a predictor of hemorrhagic stroke occurrence but is also strongly associated with fatal outcomes in patients who have already sustained intracerebral hemorrhage. Collectively, these observations reinforce the value of routine fundoscopic examination as a simple, non-invasive, and cost-effective bedside tool for early identification of high-risk hypertensive patients, particularly in emergency settings where timely risk stratification can guide aggressive management and potentially improve survival outcomes.

CONCLUSION

The present study demonstrates that hypertensive intracerebral haemorrhage mainly affects middle-aged males and is strongly associated with severe elevations of blood pressure .Grade II retinopathy was observed mainly . There was a positive correlation between increasing systolic blood pressure and the severity of hypertensive retinopathy, highlighting the impact of uncontrolled hypertension on retinal changes. Also , higher grades of retinopathy were associated with lower

Glasgow Coma Scale scores, reflecting greater neurological impairment and disease severity. The distribution of haemorrhage sites and frequent need for intensive care further emphasize the serious clinical burden of the condition.

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