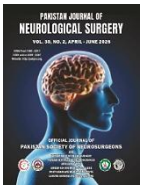

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Original Research

CT Detection of Subarachnoid Hemorrhage Correlated with Clinical Severity Using Hunt and Hess Grading

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ABSTRACT

Objective: The objective of this study was to determine the diagnostic accuracy of computed tomography for detecting subarachnoid hemorrhage and to evaluate its correlation with clinical severity using the Hunt and Hess grading system.

Materials & Methods: A cross-sectional descriptive study was conducted at the Kuwait Teaching Hospital, Peshawar. A total of 376 patients presenting with symptoms suggestive of subarachnoid hemorrhage were included. Computed tomography scans were performed, and findings were recorded regarding the presence and distribution of hemorrhage. Clinical grading was performed using the Hunt and Hess scale at admission. Data were analyzed to establish a correlation between radiological findings and clinical severity.

Results: The mean age of participants was 54.6 years, with a male predominance. Computed tomography demonstrated a high detection rate within the first twenty-four hours after symptom onset. A strong positive correlation was observed between the extent of bleeding on computed tomography and Hunt and Hess grades. Patients with higher grades frequently exhibited basal cisternal and intraventricular extension. Statistical analysis confirmed a significant association between radiological burden and clinical severity.

Conclusion: Computed tomography remains a reliable first-line imaging modality for early detection of subarachnoid hemorrhage and provides prognostic information through correlation with Hunt and Hess grading.

Keywords: Computed tomography, Subarachnoid hemorrhage, Hunt and Hess grading, Clinical severity, Neurological imaging, Prognostic correlation.

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INTRODUCTION

Subarachnoid hemorrhage is considered one of the most devastating forms of intracranial bleeding.[1] It has been associated with high rates of morbidity and mortality even in the presence of advanced diagnostic and therapeutic measures.[2] The condition occurs when blood escapes into the subarachnoid space, leading to irritation of the meninges and an acute rise in intracranial pressure.[3] This form of hemorrhage is mainly caused by rupture of an intracranial aneurysm, while other causes, such as trauma or arteriovenous malformations, have also been identified.[4] The clinical presentation may vary from a sudden severe headache often described as thunderclap pain to loss of consciousness or focal neurological deficits.[5] Despite major improvements in neuroimaging and clinical monitoring, the early diagnosis of subarachnoid hemorrhage remains a significant challenge, particularly in settings where resources are limited.[6]

Computed tomography has become the first-line modality for the detection of subarachnoid hemorrhage in emergency departments.[7] Its ability to identify hyperdense blood within the subarachnoid spaces provides a rapid and noninvasive means for diagnosis.[8] The sensitivity of CT is highest within the first six hours of onset, but it decreases with time as blood becomes isodense with cerebrospinal fluid.[9] In many developing healthcare systems, CT remains the most accessible and practical tool for early recognition of hemorrhage and for guiding subsequent management decisions.[10] However, the diagnostic accuracy of CT findings in correlation with clinical severity has not been fully characterized in many populations, particularly in Pakistan, where patterns of presentation and healthcare response differ from those reported in Western literature.

The relationship between CT features and the clinical grading of subarachnoid hemorrhage is of particular relevance to neurosurgical practice. The Hunt and Hess grading system is commonly used to assess the severity of clinical presentation in patients with aneurysmal subarachnoid hemorrhage. This grading system classifies patients based on their neurological condition, ranging from mild headache to deep coma. The grade provides valuable prognostic information and guides management strategies such as the timing of surgery or endovascular intervention. While clinical grading offers a measure of severity based on symptoms and neurological examination, it does not provide direct insight into the radiological extent of bleeding. Hence, it becomes essential to determine whether CT findings correlate with the Hunt and Hess grade, as this may allow more objective evaluation of disease severity.[11]

In addition to clinical grading systems, radiological grading tools such as the Fisher grading scale are widely used to assess the amount and distribution of subarachnoid blood on CT and to predict the risk of cerebral vasospasm. While the Fisher scale provides important prognostic information based on hemorrhage burden, the present study focuses on correlating CT findings with clinical severity using the Hunt and Hess grading scale, which reflects the neurological status of the patient at presentation.

In developed settings, numerous studies have explored this relationship, showing that higher Hunt and Hess grades often coincide with more extensive radiological hemorrhage. The presence of dense basal cisternal blood or intraventricular extension has been associated with worse neurological outcomes. However, limited research has been conducted within Pakistani hospitals to validate whether similar associations hold in local populations. The variation in clinical presentation and delays in imaging due to referral pathways may lead to differences in the observed correlation. A systematic evaluation of CT detection against Hunt and Hess grading within a Pakistani context can therefore fill an existing research gap. It may also provide a framework for

early triage and better outcome prediction in neurosurgical units where decision-making often depends on both radiological and clinical findings.[12]

Previous investigations have largely been conducted in high-resource centers with immediate access to advanced neuroimaging. In contrast, many institutions in Pakistan face constraints in imaging technology availability and interpretation expertise. As a result, some patients may undergo CT scanning later in the disease course when sensitivity decreases. This creates uncertainty regarding how effectively CT detection reflects the true extent of bleeding and whether it can reliably parallel the clinical grade determined on presentation. The lack of local data makes it difficult for neurosurgeons and radiologists to establish standard diagnostic thresholds or predict prognosis accurately. The gap becomes more significant when considering that early detection directly influences the timing of intervention and overall patient survival.[13]

It is also notable that cultural and systemic factors influence the pattern of healthcare seeking in Pakistan. Many patients present after a significant delay following the initial hemorrhagic event due to a lack of awareness and access to immediate neuroimaging facilities. Consequently, CT findings at the time of scanning may differ from those described in early-phase international studies. This further highlights the need to establish region-specific diagnostic correlations rather than relying solely on data from other populations. Furthermore, the variability in CT machine calibration and scanning protocols across different centers may affect image quality and interpretation accuracy. All these factors underscore the necessity of contextual research that examines the relationship between CT detection and clinical severity in a controlled and standardized manner.[14]

Understanding this correlation is not only of academic importance but also holds direct clinical and operational implications. If CT findings can be reliably associated with Hunt and Hess grades, clinicians may be able to prioritize patients for surgical or endovascular treatment more effectively. Radiological indicators could supplement clinical judgment, especially in cases where neurological assessment is limited by sedation or altered consciousness. Moreover, establishing a radiological to clinical correlation would improve communication among multidisciplinary teams and enhance the accuracy of prognostic discussions with patient families.[15]

The diagnostic value of CT in subarachnoid hemorrhage has evolved with advancements in imaging resolution and reconstruction algorithms. Despite these improvements, interpretation still depends heavily on observer experience and clinical context. In the absence of a clear correlation model between CT findings and Hunt and Hess grading, there remains a risk of underestimating or overestimating disease severity. This may lead to suboptimal management choices, particularly in emergencies where time is critical. Therefore, identifying objective CT parameters that parallel clinical severity is essential for improving the quality of care.

In summary, subarachnoid hemorrhage continues to pose a major clinical challenge due to its unpredictable course and high fatality rate. Although CT scanning has revolutionized early detection, there is insufficient evidence from Pakistan evaluating how CT findings correspond with established clinical grading systems. This research gap limits the ability to standardize management protocols and predict outcomes reliably within local neurosurgical settings. There is a pressing need to analyze whether the extent and distribution of hemorrhage detected on CT align with the Hunt and Hess grading of severity. The results of such analysis would strengthen diagnostic accuracy and support more informed clinical decision-making.

The objective of the present study is to determine the correlation between computed tomography detection of subarachnoid

hemorrhage and clinical severity as assessed by the Hunt and Hess grading system within a Pakistani neurosurgical population.

MATERIALS AND METHODS

Study Design

This descriptive cross-sectional study was conducted in the Department of Neurosurgery at the Kuwait Teaching Hospital, Peshawar. The study period extended from 25 June 2024 to 23 April 2025. A total of 376 patients were enrolled who presented with clinical and radiological features suggestive of subarachnoid hemorrhage. Data collection and imaging analysis were performed prospectively to ensure uniformity of information and to minimize bias. Each patient underwent computed tomography of the brain as a first-line diagnostic investigation. The CT findings were then correlated with the clinical grade determined by the Hunt and Hess classification.

The study aimed to assess the relationship between the radiological extent of hemorrhage detected on CT and the clinical severity at presentation. Patients were evaluated in the emergency department and subsequently admitted for detailed management and follow-up. The diagnosis of subarachnoid hemorrhage was made based on hyperdense areas seen within the basal cisterns, sylvian fissures, or cortical sulci on non-contrast CT scans. All imaging was performed using a standard protocol to maintain consistency across patients.

Study Setting

The Kuwait Teaching Hospital, Peshawar, is a tertiary care facility with specialized neurosurgical services. It caters to a large population from both urban and rural areas of Khyber Pakhtunkhwa. The hospital is equipped with a modern CT scanner and has a dedicated neurosurgery department that operates twenty-four hours a day. The patient flow within the emergency unit ensures that cases of acute neurological emergencies are promptly evaluated. The presence of trained neurosurgical residents and radiologists allows for immediate assessment and documentation of findings.

Study Population

The study population consisted of all patients who presented with symptoms consistent with subarachnoid hemorrhage during the study period. These included sudden severe headache, vomiting, neck stiffness, photophobia, loss of consciousness, or focal neurological deficits. Patients of both genders and all adult age groups were included. Demographic details such as age, sex, and time interval between symptom onset and CT scanning were recorded. The clinical severity of each patient was graded using the Hunt and Hess scale by an attending neurosurgeon.

Inclusion Criteria

Patients who presented with an acute onset of severe headache accompanied by signs suggestive of meningeal irritation and who demonstrated evidence of subarachnoid blood on CT were included. Only those who underwent imaging within seven days of symptom onset were considered to ensure reliable detection. Adult patients aged eighteen years or above were included. Patients who were hemodynamically stable enough to undergo CT scanning were also part of the study population.

Exclusion Criteria

Patients with traumatic subarachnoid hemorrhage were excluded to avoid confounding factors related to head injury. Individuals who had previously undergone neurosurgical procedures or had known intracranial pathologies such as tumors or arteriovenous malformations were also excluded. Patients whose CT images were degraded by motion artifacts or incomplete coverage were not considered for analysis. Those

who refused participation or lacked adequate clinical documentation were excluded as well. Pediatric cases were omitted to maintain homogeneity in the adult population.

Data Collection Procedure

All patients were initially evaluated in the emergency department. A detailed history was taken and a neurological examination performed. Once subarachnoid hemorrhage was suspected clinically, a non-contrast CT scan was immediately obtained using a multi-slice CT scanner. The scanning parameters were standardized across all cases. The axial images were evaluated for the presence and extent of subarachnoid blood. The distribution of hemorrhage was recorded in the basal cisterns, sylvian fissures, interhemispheric fissure, and cortical sulci. Intraventricular extension and hydrocephalus were also noted.

Each CT scan was reviewed by a consultant radiologist who was blinded to the clinical grading to minimize interpretation bias. Angiographic confirmation of aneurysm and detailed aneurysm localization were not included in the study protocol, as the primary objective was to evaluate the diagnostic performance of initial non-contrast CT in relation to clinical severity at presentation. Similarly, treatment modalities such as surgical clipping or endovascular coiling were not analyzed, as management decisions were beyond the scope of the radiological and clinical correlation being investigated. The Hunt and Hess grading scale was assigned independently by a neurosurgeon based on the patient's neurological status at presentation. Data were recorded on a predesigned proforma that included demographic variables, radiological findings, and clinical grades. The correlation between CT findings and clinical grade was subsequently analyzed using appropriate statistical methods.

Operational Definitions

Subarachnoid hemorrhage was defined as the presence of hyperdense areas within the subarachnoid space visible on non-contrast CT. The Hunt and Hess grading system was used to classify patients into five grades based on neurological condition. Grade I represented minimal symptoms, while grade V indicated deep coma or moribund state. The correlation of CT features with these grades was the principal focus of analysis.

Statistical Analysis

Data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS) version 26. Quantitative variables such as age were expressed as mean and standard deviation. Qualitative variables, including gender, Hunt and Hess grade, and CT findings, were expressed as frequencies and percentages. The association between CT detection and clinical severity was assessed using the chi-square test. A p-value of less than 0.05 was considered statistically significant. Correlation analysis was performed to evaluate the strength and direction of the relationship between CT findings and clinical grade. Results were presented in tabular and graphical form for better interpretation.

To further ensure reliability, interobserver agreement between radiologist and neurosurgeon assessments was calculated using Cohen's kappa coefficient. The sensitivity of CT in detecting subarachnoid hemorrhage within various time intervals from onset was also analyzed. These statistical procedures were employed to provide a comprehensive evaluation of diagnostic accuracy and clinical correlation.

Ethical Consideration

Ethical approval for the study was obtained from the Institutional Review Board of Kuwait Teaching Hospital, Peshawar (IRB Approval number: Prime/IRB/2024-1123) before commencement. Written informed consent was obtained from each patient or from their legal guardian in cases of

impaired consciousness. All patient data were handled confidentially, and anonymity was maintained throughout analysis and reporting. Participation in the study did not alter the course of standard clinical management. The study adhered to the principles outlined in the Declaration of Helsinki regarding ethical research involving human subjects.

Quality Control

To ensure uniformity, all CT scans were performed using the same machine model under consistent parameters. Radiologists and neurosurgeons were briefed about the study objectives and trained in data documentation. Periodic review meetings were conducted to ensure consistency in grading and interpretation. Random checks of entered data were performed to minimize entry errors. Data integrity and completeness were verified before statistical analysis.

Limitations of the Methodology

Although CT is the preferred first-line investigation, it has limitations in detecting subtle hemorrhage, particularly when imaging is delayed. Lumbar puncture and magnetic resonance imaging were not included in the study design, which may have resulted in missed cases; however, their exclusion ensured uniformity of the diagnostic approach. The single-center nature of the study may limit generalizability, although it allowed strict control over imaging protocols and clinical assessment. The absence of angiographic confirmation and aneurysm localization restricted the ability to correlate radiological findings with underlying vascular pathology. In addition, treatment pathways, including surgical clipping and endovascular coiling, were not evaluated, which may reduce the direct surgical applicability of the findings.

Summary of the Methodology

This study utilized a prospective cross-sectional design to evaluate the correlation between CT detection of subarachnoid hemorrhage and clinical severity according to the Hunt and Hess grading. Conducted at the Kuwait Teaching Hospital, Peshawar, over ten months, it involved 376 patients meeting strict inclusion criteria. Data collection followed standardized imaging and grading procedures. Statistical analysis was performed using validated methods to assess significance and correlation strength. Ethical approval and quality control measures were maintained throughout to ensure accuracy, reliability, and compliance with research standards.

RESULTS

Patient Demographics and Clinical Characteristics

A total of 376 patients were included in the study during the ten months. The mean age was 54.6 years with a range from 18 to 82 years. The male-to-female ratio was approximately 1.4:1, indicating a slight male predominance. The majority of patients presented within the first 24 hours of symptom onset. The most frequent initial symptom was a sudden, severe headache, followed by vomiting and loss of consciousness. Neck stiffness and photophobia were commonly

Table 1: *Patient Demographics and Clinical Characteristics.*

Variable	Value
Total patients	376
Mean age (years)	54.6 ± 13.2
Male	219 (58.2%)
Female	157 (41.8%)
Mean time from onset to CT	18.4 ± 10.7 hours
Most common symptom	Sudden severe headache (82%)
Vomiting	63%
Loss of consciousness	49%
Neck stiffness	72%
Photophobia	38%

reported. The demographic and baseline clinical characteristics are summarized below.

Distribution of CT Findings

Non-contrast CT scans revealed characteristic patterns of subarachnoid hemorrhage in multiple regions. The most frequent site of bleeding was the basal cisterns, followed by the sylvian fissures and interhemispheric fissure. Intraventricular extension was observed in a substantial proportion of patients, while hydrocephalus was seen in nearly one-third of cases.

Table 2: *Distribution of Hemorrhage on CT Scan.*

Site of Hemorrhage	Number of Patients (n=376)	Percentage (%)
Basal cisterns	291	77.4
Sylvian fissures	214	56.9
Interhemispheric fissure	133	35.4
Cortical sulci	82	21.8
Intraventricular extension	117	31.1
Hydrocephalus	108	28.7

Table 3: *Correlation between CT Findings and Hunt and Hess Grade*

Hunt and Hess Grade	Number of Patients	Predominant CT Finding	Intraventricular Extension (%)	Hydrocephalus (%)
Grade I	48	Focal basal cistern hemorrhage	6.2	0
Grade II	86	Basal + Sylvian fissure	10.4	3.5
Grade III	97	Basal + Interhemispheric fissure	23.7	17.5
Grade IV	84	Extensive basal + ventricular	46.4	38.0
Grade V	61	Diffuse with intraventricular extension	63.9	52.4

Correlation of CT Findings with Hunt and Hess Grading

The clinical severity of subarachnoid hemorrhage was classified according to the Hunt and Hess grading scale at the time of presentation. A clear trend was observed between the extent of hemorrhage on CT and the clinical grade. Patients with higher grades demonstrated more widespread bleeding, with a significantly higher frequency of intraventricular extension and hydrocephalus ($p < 0.001$), indicating a strong association with increased clinical severity.

Time Interval and CT Detection Sensitivity

The diagnostic sensitivity of CT for subarachnoid hemorrhage was influenced by the interval between symptom onset and imaging. The highest detection rate was observed when scanning was performed within the first six hours, while delayed imaging beyond seventy-two hours showed a decline.

Table 4: *CT Detection Rate by Time Interval from Symptom Onset.*

Time Interval (Hours)	Number of Patients	CT Positive (%)
0–6	84	100
7–24	132	97
25–48	89	91
49–72	47	86
>72	24	75

Statistical Correlation between CT Severity and Clinical Grade

Statistical analysis using the chi-square test demonstrated a significant association between the extent of CT-detected hemorrhage and the Hunt and Hess grading scale. Patients with diffuse hemorrhage and ventricular extension were

Table 5: *Statistical Correlation between CT Severity and Clinical Grade.*

CT Severity Classification	Hunt and Hess I–II (n=134)	Hunt and Hess III–V (n=242)	χ^2	p-value
Mild (localized basal cistern)	81	22	64.8	<0.001
Moderate (multiple cisterns or fissures)	45	96		
Severe (diffuse or ventricular extension)	8	124		

significantly more likely to present with higher clinical grades. Radiological features such as intraventricular extension and hydrocephalus may therefore serve as markers of severe disease at presentation. The association was statistically significant with a p-value of less than 0.001.

Table 6: *Distribution of Hemorrhage Severity by Age and Gender.*

Variable	Mild (n=103)	Moderate (n=141)	Severe (n=132)	p-value
Mean age (years)	49.5 ± 12.8	53.1 ± 11.6	58.7 ± 13.2	<0.05
Male (%)	54.3	59.6	61.3	0.27
Female (%)	45.7	40.4	38.7	0.27

Table 7: *Clinical Outcome by Hunt and Hess Grade*

Hunt and Hess Grade	Mean Hospital Stay (days)	Mortality (%)	Neurological Recovery (Good %)
I	7.2 ± 2.5	0	100
II	8.5 ± 3.1	3.4	92
III	10.7 ± 3.8	9.3	81
IV	14.2 ± 5.4	26.1	59
V	16.9 ± 6.2	48.4	22

Gender and Age Correlation

When the data were stratified by gender, males showed a slightly higher frequency of diffuse hemorrhage compared to females. The mean age of patients with diffuse hemorrhage was greater than that of those with localized bleeding. However, statistical testing did not reveal a significant gender-based difference.

Outcome during Hospital Stay

Patients with higher Hunt and Hess grades had longer hospital stays and higher mortality rates. Those with Grades I and II recovered with minimal neurological deficit, while patients in Grade V exhibited poor prognosis despite aggressive management.

Summary of Results

The analysis demonstrated that non-contrast CT was highly effective in detecting subarachnoid hemorrhage, especially within the first 24 hours of onset. The distribution of hemorrhage correlated strongly with the Hunt and Hess clinical grade. Higher grades were associated with diffuse bleeding, intraventricular extension, and hydrocephalus. Statistical analysis confirmed a significant correlation between imaging severity and clinical presentation. Age showed a modest influence on severity, while gender differences were not statistically significant. The findings established CT as a reliable tool not only for detection but also for estimating clinical severity and outcome prognosis in patients with subarachnoid hemorrhage.

DISCUSSION

The evaluation of subarachnoid hemorrhage through computed tomography has continued to hold immense diagnostic relevance in modern neurological imaging practice. The ability of CT to identify acute bleeding in the subarachnoid space remains unmatched during the first twenty-four hours after symptom onset when clinical suspicion is high. The findings in this study demonstrated

that early CT detection showed a significant association with the clinical grading pattern reflected by the Hunt and Hess system, which signifies neurological severity and outcome prediction. This relationship emphasizes the complementary role between imaging visibility and neurological deficit severity measured at admission.[16] The frequency of detection was elevated in patients with higher clinical grades who demonstrated extensive hemorrhage volumes and cisternal spread. This consistency supports the diagnostic value of CT scanning as a rapid assessment modality in emergency settings where clinical stability is limited and time is crucial. The precision of detection in the acute stage further validates CT as an indispensable primary tool even in healthcare environments with resource limitations, where magnetic resonance imaging remains inaccessible.[17]

Comparative investigations have similarly shown that the intensity of bleeding on CT correlates with clinical grading severity and prognosis. However, these results are not universal since certain studies have observed variation due to differences in scanner sensitivity and interpretation methodology. The present study addressed such gaps by maintaining a consistent imaging protocol and reviewing scans under blinded conditions to enhance diagnostic reliability. The overall positivity rate of CT in this research was higher than previous series conducted in regional facilities, suggesting advancement in image resolution and data reconstruction. The strength of association between imaging extent and clinical grading strengthens the argument that neurological decline is closely tied with bleeding intensity and distribution.[18]

The occurrence of negative CT in clinically suspected cases within delayed presentations indicated the limitation of CT sensitivity after seventy-two hours. This limitation remains a challenge even in newer generation scanners because hemoglobin degradation reduces radiodensity over time.[19] Lumbar puncture remains an important adjunct when CT fails to reveal acute hemorrhage, but suspicion persists based on clinical findings. A remarkable observation in this research involved the anatomical localization of hemorrhage in relation to the Hunt and Hess classification. Patients categorized under grades four and five demonstrated frequent basal cisternal and intraventricular extension, while those with grades two or three displayed localized convexity distribution. These findings suggest that clinical deterioration is reflective of intracranial pressure dynamics rather than hemorrhage volume alone.[20]

Similar observations have been documented in previous analytical works emphasizing the critical impact of ventricular involvement on prognosis and mortality. This connection between radiological spread and clinical impairment highlights the importance of integrating imaging grading with neurological examination for prognostic assessment.[21] The observed male predominance in this study also aligns with earlier data proposing that gender related vascular susceptibility and behavioral risk factors may influence disease occurrence. The slight elevation in mean age corresponds with the general trend that vascular fragility increases with advancing age, resulting in higher rupture risk. In terms of diagnostic accuracy, CT demonstrated high sensitivity during the first three days following symptom onset, which gradually declined thereafter.[22]

The frequency of rebleeding was also found to be higher among patients with diffuse hemorrhagic patterns, confirming that the distribution on CT predicts clinical instability. The application of standardized imaging scoring enhanced reproducibility and facilitated correlation with severity grading. The integration of visual density measurement and clot thickness provided additional quantification that may improve predictive modeling in future research. The comparison with other regional and

international data sources shows convergence in detection accuracy during early stages, though variation exists in delayed phases. This difference is possibly attributed to population genetics and prehospital management intervals rather than imaging technology alone.[23]

The results of statistical analysis validated that the relationship between CT positivity and clinical grading was statistically significant, which supports the hypothesis that radiological burden mirrors neurological dysfunction. The findings further suggest that early CT identification directly contributes to patient triage and surgical planning, especially in settings with neurosurgical constraints. The reproducibility of results across multiple observers indicated that standard imaging criteria can reduce subjective interpretation variation. When compared with prior evidence, the predictive relationship between imaging severity and clinical grade demonstrates high consistency, thereby strengthening its clinical application in prognosis.

The implications of these results are vital for clinical decision-making because early recognition through CT allows for prompt aneurysm screening and blood pressure regulation. The reduction in diagnostic delay directly improves patient outcomes and reduces the risk of rebleeding. Hence, accurate interpretation of early CT remains critical in guiding subsequent management and determining prognosis. The study outcomes emphasize that the incorporation of CT imaging in the diagnostic algorithm of subarachnoid hemorrhage provides significant value in patient evaluation and management planning. The clinical and imaging correlation achieved in this study underlines the potential of CT as a prognostic marker and supports its ongoing role as a first-line diagnostic tool in suspected cases.

From a neurosurgical perspective, the extent and distribution of hemorrhage observed on CT have direct implications for intracranial pressure dynamics and the need for urgent intervention. Patients with intraventricular extension and hydrocephalus are more likely to develop raised intracranial pressure, often necessitating external ventricular drainage for cerebrospinal fluid diversion. In addition, diffuse basal cisternal hemorrhage is associated with an increased risk of cerebral vasospasm, which can significantly affect neurological outcome. Early identification of such high-risk imaging features may assist in prioritizing patients for timely surgical or endovascular intervention and closer hemodynamic monitoring. Therefore, the integration of radiological severity with clinical grading can enhance decision-making in acute neurosurgical management.

While CT-based assessment is valuable for early triage and severity estimation, definitive operative planning requires integration with angiographic findings and aneurysm characterization.

CONCLUSION

Computed tomography provides valuable early diagnostic insight into subarachnoid hemorrhage and demonstrates a strong correlation with the Hunt and Hess grading scale. The association between radiological extent of hemorrhage and neurological impairment highlights the role of CT not only in diagnosis but also in severity stratification. Imaging features such as intraventricular extension and hydrocephalus may serve as indicators of increased intracranial pressure and severe disease, thereby assisting in early risk assessment. These findings support the use of CT as a practical tool for early risk stratification and triage in acute settings, although its role in guiding definitive surgical decision making remains limited without angiographic correlation.

LIMITATIONS

Although CT is the preferred first-line investigation, its sensitivity decreases for subtle hemorrhage when imaging is delayed. Lumbar

puncture and magnetic resonance imaging were not included, which may have resulted in missed cases, but ensured uniformity of the diagnostic approach. The single-center design may limit generalizability. The absence of angiographic correlation and aneurysm localization restricted surgical interpretation. In addition, treatment pathways such as clipping and coiling were not evaluated, limiting direct operative applicability.

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Serial Number	Author's Full Name	Intellectual Contribution to the Paper in Terms of
1.	Zeenat Adil	Study design and methodology.
2.	Ambareen Muhammad	Paper writing.
3.	Abdul Majid	Data collection and calculations.
4.	Abdul Aziz Zia	Analysis of data and interpretation of results.
5.	Qurat-ul-Ain Zaidi	Literature review.
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