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ORIGINAL ARTICLE

MRI IMAGE QUALITY AND DIAGNOSTIC CONFIDENCE IN BRAIN TUMOR EVALUATION

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Abstract

Background: MRI is the preferred imaging modality for brain tumor evaluation, and image quality significantly affects diagnostic accuracy. Quantitative measures such as Signal-to-Noise Ratio (SNR) and Contrast-to-Noise Ratio (CNR) may influence radiologists' diagnostic confidence and clinical decision-making.

Objective: To assess MRI image quality using quantitative measures including Signal-to-Noise Ratio (SNR) and Contrast-to-Noise Ratio (CNR) along with qualitative assessment, and to evaluate their association with diagnostic confidence in brain tumor diagnosis.

Material and Methods: Retrospective cross-sectional study was conducted at Department of Radiology, Liaquat University of Medical & Health Sciences (LUMHS) and Advanced Diagnostic Centre, Jamshoro and Hyderabad, from 1st July, 2025 to 30th November, 2025. A sample of 250 adult patients (≥18 years) was selected using non-probability consecutive sampling. Sample Size and Statistical Justification. All scans were performed on a 3.0 Tesla scanner. Image quality was analyzed quantitatively via Signal-to-Noise Ratio (SNR) and Contrast-to-Noise Ratio (CNR), and qualitatively via a 5-point Likert scale. Data were analyzed using Statistical Package for Social Sciences (SPSS) version 22.0.

Results: Out of 250 scans, 200 (80%) exhibited high quantitative quality. High qualitative diagnostic confidence was recorded in 210 (84%) cases, while 225 (90%) scans were clinically usable. Inter-rater agreement was 230 (92%). Although artifacts were present in 70 (28%) scans, they impacted clinical decision-making in only 45 (18%) cases. Tumor types included Gliomas (n=100, 40%), Meningioma's (n=75, 30%), and Metastases (n=50, 20%); contrast was administered in 200 (80%) patients.

Conclusion: Objective SNR and CNR metrics strongly correlate with radiologist confidence. Standardizing these parameters is vital for accurate tumor characterization and personalized neuro-oncology care.

Keywords: Brain Neoplasms,Magnetic Resonance Imaging; Signal-To-Noise Ratio, Contrast-To-Noise Ratio, Quality Control.
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Introduction:

MRI (Magnetic Resonance Imaging) is a non-invasive medical imaging technique that utilizes strong magnetic fields and radio waves to generate detailed anatomical images of the body. In the field of neuro-oncology, MRI is the gold standard for visualizing brain tissue and diagnosing tumors. Its unparalleled soft tissue contrast allows for the precise delineation of tumors, including their size, location, and relationship to critical structures. While the use of MRI for brain tumor diagnostics has evolved significantly since its clinical introduction, its foundational principles remain central to patient care. Early applications focused on basic anatomical visualization, but advancements in pulse sequences and contrast agents have transformed MRI into a powerful tool for characterizing tumor types, assessing treatment response, and guiding surgical interventions. This historical progression underscores its indispensable role, making it a cornerstone of modern neuro-oncological practice. Approximately 85,000 individuals in the United States are diagnosed with a primary brain tumor each year, of which approximately 29%

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aremalignant. Approximately 80– 85% of malignant brain tumors in adults are gliomas which diffusely infiltrate the brain parenchyma[1]. The quest to improve diagnostic accuracy through enhanced MRI image quality is a dynamic area of ongoing research. Recent studies have focused on developing advanced techniques to mitigate artifacts, such as patient motion and susceptibility artifacts, which can compromise image clarity and diagnostic confidence[2]. The application of deep learning and artificial intelligence (AI) has revolutionized this field, with new algorithms being developed to denoise images, improve resolution, and even synthesize high-quality images from low-quality scans[3]. These innovations directly support the clinical workflow, where precise visualization is paramount for treatment planning. While traditional therapeutic options for brain tumors include surgery, radiation therapy, and chemotherapy, the accuracy of their application and efficacy is directly dependent on the quality of diagnostic imaging [4]. However, a distinct research gap remains in current clinical imaging literature. While technical imaging studies extensively document the mechanical and software-based optimization of Signal-to-Noise Ratio (SNR) and Contrast-to-Noise Ratio (CNR), and separate clinical papers evaluate gross diagnostic accuracy rates, there is a profound scarcity of empirical data linking these objective mathematical performance metrics directly to the subjective diagnostic confidence of the interpreting radiologist during tumor characterization[5]. Consequently, this study establishes a standardized validation framework to quantitatively evaluate Signal-to-Noise Ratio (SNR) and Contrast-to-Noise Ratio (CNR) alongside qualitative parameters, directly assessing their clinical association with radiologist diagnostic confidence inbrain tumor evaluation[6]. The implications of achieving these objectives are profound. A standardized, quantitative assessment tool for MRI image quality would enable more consistent and reliable tumor diagnosis across different imaging centers and scanner types. Ultimately, enhanced image quality translates directly to improved patient outcomes by facilitating earlier and more accurate tumor detection, more precise surgical planning, and a more confident assessment of treatment efficacy[7]. The significance lies in its potential to elevate the standard of care, ensuring that clinical decisions are based on the most accurate and reliable imaging data possible[8].

Material and Method:

Study Design and study Settings: This retrospective observational study was conducted across two distinct clinical environments the Department of Radiology at Liaquat University of Medical & Health Sciences (LUMHS), Jamshoro a public tertiary-care teaching hospital and the Advanced Diagnostic Centre, an integrated multi-branch private diagnostic network operating. across Jamshoro and Hyderabad, Pakistan.

Ethical Considerations: The study was exempted from Research Ethics Committee approval vide letter No: LUMHS/REC/-673dated 24-03-25, as it utilized de-identified, retrospectively extracted medical records. No direct patient intervention or contact was involved, ensuring strict patient confidentiality.

DATA RETRIEVAL METHODS: Study participants were identified and their clinical data retrieved retrospectively by auditing the institutional Picture Archiving and Communication System (PACS) and Electronic Health Record (EHR) databases at the participating centers. Digital search filters were applied to extract all cranial MRI examinations performed within the designated study window (July 1, 2025, to November 30, 2025) that carried a billing or diagnostic code for suspected or confirmed intracranial neoplasm. Demographic data, clinical histories, and official radiologic reports were cross-referenced to verify eligibility.

Selection and Exclusion Framework:A total of 295 consecutive patient archives were initially retrieved and screened. To prevent selection bias and avoid overestimating overall image quality compared to routine clinical practice, all eligible consecutive scans meeting the clinical criteria were tracked. Of the screened sample, 45 cases were systematically excluded, resulting in a final analytical cohort of 250 unique adult patients (≥18 years).

Inclusion Criteria: 1. Adult patients aged ≥18 years at the time of the scan.

2. Referral for symptomatic neuro-imaging with a baseline clinical suspicion or a newly established diagnosis of a primary or metastatic intracranial tumor.

3. Complete documentation of a standardized 3.0T structural brain MRI protocol.

Exclusion Criteria and Reporting of Excluded Cases: To maintain structural and signal integrity while transparently accounting for everyday clinical variations, the following specific exclusions were made from the initial 295 screened cases:

Prior Therapeutic Interventions (n = 23**):**Patients with a documented history of prior cranial surgery, surgical resection, radiotherapy, or chemotherapy cycles were excluded to eliminate treatment-induced structural distortion, radiation necrosis signal changes, or post-operative artifact confounding.

Absolute MRI Contraindications (n = 12**):**Patients with incompatible implanted electronic devices, ferromagnetic foreign bodies, or documented severe claustrophobia preventing examination completion.

Severe Technical Non-Diagnostic Quality (n = 10**):**Scans displaying extreme patient motion or severe magnetic susceptibility artifacts that completely obscured anatomical landmarks and rendered quantitative calculations impossible.

By explicitly reporting these 10 excluded non-diagnostic datasets (comprising 3.4% of total audited scans), the study actively accounts for baseline technical failures encountered during routine, high-volume clinical practice.

Sample Size and Sampling Technique: The sample size of 250 was calculated based on a 95% confidence level and a 5% margin of error, assuming an estimated 20% baseline prevalence of intracranial neoplasms among symptomatic specialized neuro-imaging referrals, in accordance with established epidemiological tracking data derived from the Central Brain Tumor Registry of the United States (CBTRUS) multi-year oncology surveillance records[9].

Imaging Protocol and Acquisition Parameters: All imaging examinations were performed using a single high-field 3.0 Tesla Siemens magnetic resonance scanner utilizing a dedicated 20-channel phased-array diagnostic head coil. To maintain absolute data uniformity and eliminate technical variability across the cohort, all patients were evaluated using a highly standardized institutional neuro-oncology imaging protocol. The technical acquisition parameters were strictly fixed for all scans as follows:

Axial T1-Weighted (T1W) Spin-Echo: Repetition Time (TR) = 1800 ms; Echo Time (TE) = 2.5 ms; Slice Thickness = 4.0 mm; Inter-slice Gap = 1.0 mm; Field of View (FOV) = 230 mm; Matrix Size = 320 × 256.

Axial T2-Weighted (T2W) Fast Spin-Echo:TR = 4500 ms; TE = 95 ms; Slice Thickness = 4.0 mm; Inter-slice Gap = 1.0 mm; FOV = 230 mm; Matrix Size = 384 × 384.

Axial T2 Fluid-Attenuated Inversion Recovery (FLAIR):TR = 9000 ms; TE = 85 ms; Inversion Time (TI) = 2500 ms; Slice Thickness = 4.0 mm; Inter-slice Gap = 1.0 mm; FOV = 230 mm; Matrix Size = 256 × 256.

Diffusion-Weighted Imaging (DWI):TR = 3200 ms; TE = 70 ms; Slice Thickness = 4.0 mm; Inter-slice Gap = 1.0 mm; FOV = 240 mm; Matrix Size = 128 × 128; utilizing b-values of 0s/mm2 and 1000 s/mm2 for the automatic compilation of Apparent Diffusion Coefficient (ADC) maps.

Post-Contrast Axial T1W: Acquired using parameters identical to the baseline pre-contrast T1W sequence (TR = 1800 ms; TE = 2.5 ms; Slice Thickness = 4.0 mm) following the automated power-injector administration of macrocyclic gadolinium-based contrast agent (0.1 mmol/kg body weight) at a stable flow rate of 2.0 mL/s.

Image Quality Assessment: A detailed, dual-pronged methodology was executed to evaluate the dataset, ensuring both objective mathematical verification and subjective clinical validity.

Quantitative Radiometric Analysis (SNR and CNR): Quantitative evaluation was performed manually on a dedicated PACS workstation utilizing the post-contrast axial T1-weighted (T1W) sequence for contrast-enhancing lesions, and the axial T2-weighted (T2W) or T2-FLAIR sequences for non-enhancing tumors.

ROI Size and Placement Protocol: A trained radiologic technologist manually placed circular Regions of Interest (ROIs) strictly standardized to an area of 10 mm2. For each case, three separate measurements were obtained:

ROI_{tumor}: Positioned within the solid, maximally enhancing or hyper intense component of the tumor matrix, avoiding areas of macroscopic cystic necrosis, hemorrhage, or prominent calcification to prevent artificial signal skewing.

ROI_{brain}: Positioned within corresponding contralateral, normal-appearing white or gray matter.

$ROI_{background}$: Positioned in the external air background, entirely outside of the phase-encoding artifact direction and skull boundaries, to record raw image noise.

Noise Measurement Method: In accordance with standard clinical radiometry, the standard deviation (SD) of the background air (SD background) was utilized as the baseline parameter for image noise.

Mathematical Equations: Signal-to-Noise Ratio (SNR) and Contrast-to-Noise Ratio (CNR) were calculated using the following formulas:

$$SNR_{tumor} = \frac{\text{Mean Signal Intensity}_{tumor}}{\text{SD background}}$$

$$CNR = \frac{\text{Mean Signal Intensity}_{tumor} - \text{Mean Signal Intensity}_{brain}}{\text{SD}_{background}}$$

Cutoff Thresholds and Justification: Scans were categorized into a binary quality distribution using an established institutional and literature-supported baseline: High Quantitative Quality was defined as SNR > 25.0 and CNR > 15.0, while any scan falling below either threshold was graded as Low Quantitative Quality. These cutoffs are mathematically justified as they represent the minimum signal thresholds required to reliably distinguish tumor margins from adjacent vasogenic edema without visual degradation under standard 3.0T structural protocols

2. Qualitative Performance Analysis: Two expert neuroradiologists, completely blinded to the quantitative SNR/CNR values and patient clinical data, independently evaluated the structural sequences. Visual image parameters were graded using a rigid, standardized 5-point Likert scale defined as follows:

Score 1 (Unacceptable): Extreme artifact contamination or severe noise masking all anatomical and pathological features; non-diagnostic.

Score 2 (Poor): Substantial noise or artifacts obscuring tumor-to-brain interfaces; diagnostic utility significantly compromised.
Score 3 (Acceptable): Moderate artifacts or baseline noise present; major structural landmarks visible; sufficient for crude clinical localization but lacks precise edge delineation.
Score 4 (Good): Minor technical artifacts or minimal noise; sharp, clear definition of tumor margins and secondary internal diagnostic features.
Score 5 (Excellent): Pristine image quality with zero perceptible artifacts or background noise; ideal structural contrast and diagnostic confidence.
For analytical integration, a cumulative visual evaluation of Scores >4 was defined as High Qualitative Confidence, while Scores > 3 were classified as Low Qualitative Confidence.
Statistical Analysis: Data were analyzed using IBM SPSS version 22.0. Continuous SNR/CNR normality was evaluated via the Shapiro-Wilk test. To fulfill the study objective, non-parametric Spearman's rank correlation (rs) analyzed the relationship between continuous independent variables (SNR/CNR) and ordinal primary outcomes (5-point Likert diagnostic confidence). Inter-observer reliability was measured using Cohen's Kappa (k). Confounders (artifacts) were controlled through stratified sub-analysis. Pearson Chi-Square (X^2) tests evaluated nominal associations between baseline demographic strata and binary image quality classifications p≤0.05.

Results:

Table 1. Demographic characteristics of the study participants (n = 250)

Variables	Frequency (n)	Percentage (%)
Gender of Patients		
Male	150	60.0
Female	100	40.0
Age Groups		
Young Adults (18–59 years)	165	66.0
Older Adults (> 60 years)	85	34.0
Marital Status		
Married	200	80.0
Unmarried	50	20.0
Occupation		
Employed	75	30.0
Unemployed	175	70.0

Table 1 presents the baseline demographic characteristics of the study cohort. Males comprised 60.0% (n=150) of the sample, while females accounted for 40.0% (n=100). The age distribution showed a larger proportion of young adults (18–59 years) at 66.0% (n=165), with older adults (> 60 years) making up the remaining 34.0% (n=85). In terms of marital status, the vast majority of the participants were married (80.0%, n=200). Notably, a high rate of unemployment was observed, with 70.0% (n=175) of patients classified as unemployed, suggesting that the underlying neuro-oncological condition may significantly impact a patient's capacity to maintain active employment.

Table 2. Spearman's Rank Correlation Matrix Between Quantitative Imaging Metrics and Qualitative Diagnostic Confidence (n = 250)

Quantitative Imaging Parameter	Statistical Metric	Qualitative Diagnostic Confidence	Statistical Significance (p-value)	Clinical Interpretation
Signal-to-Noise Ratio (SNR)	Spearman's Rho (rs)	0.742	< 0.001	Strong Positive Correlation
Contrast-to-Noise Ratio (CNR)	Spearman's Rho (rs)	0.695	< 0.001	Strong Positive Correlation

Table 2 demonstrates a strong, statistically significant positive correlation between objective imaging metrics and a radiologist's diagnostic certainty ($p < 0.001$). Higher measured SNR (rs = 0.742) and CNR (rs = 0.695) values directly translate to superior qualitative confidence during brain tumor evaluations.

Table 3. Image quality metrics, diagnostic confidence and clinical impact in MRI brain tumor assessment (n = 250)

Variables	Frequency (n)	Percentage (%)
Quantitative Image Quality a		
High (SNR/CNR > Threshold)	200	80.0
Low (SNR/CNR < Threshold)	50	20.0
Qualitative Diagnostic Confidence		
High Confidence	210	84.0
Low Confidence	40	16.0
Image Usability for Diagnosis		
High Usability	225	90.0
Low Usability	25	10.0
Presence of Significant Artifacts		
Yes	70	28.0
No	180	72.0
Inter-Rater Agreement^b		
Excellent/Good Agreement	230	92.0
Poor Agreement	20	8.0
Impact on Clinical Decision-making		
Significant Impact	45	18.0
No Impact	205	82.0
Tumor Type		
Glioma	100	40.0
Meningioma	75	30.0
Metastasis	50	20.0
Other	25	10.0
Contrast Administration		
Yes	200	80.0
No	50	20.0

a Quantitative data categories established using predefined, optimized baseline Signal-to-Noise Ratio (SNR) and Contrast-to-Noise Ratio (CNR) reference thresholds for 1.5T/3.0T neuroimaging sequences.

b Categorical evaluation based on inter-observer consensus; overall statistical consistency was validated using Cohen's Kappa (K = 0.84), indicating excellent absolute agreement between the two independent readers.

The comprehensive imaging profiling detailed in Table III outlines the clinical and technical performance of the evaluated neuroimaging protocols. Optimizing technical scan sequences resulted in a substantial majority of the acquisitions meeting or exceeding predefined objective radiometric thresholds, which aligned strongly with high diagnostic confidence scores and excellent subjective image usability. The robust reproducibility of these subjective visual assessments was confirmed by an excellent inter-rater agreement rate.

While technical limitations and patient-related factors introduced significant artifacts in over a quarter of the cohort, these issues rarely compromised clinical management; less than one-fifth of the cases experienced an artifact-driven change or delay in the definitive diagnostic path. In terms of clinical pathology, the sample predominantly reflected standard epidemiological distributions for intracranial neoplasms, consisting mostly of primary gliomas and meningioma alongside secondary metastatic lesions. Finally, the heavy reliance on contrast-enhanced acquisitions across four-fifths of the sessions underscores its established role as an indispensable standard of care for clear tumor margin delineation.

Discussion:

This investigation provides a rigorous quantitative and qualitative evaluation of 3.0 T MRI image quality and its direct influence on clinical diagnostic confidence during brain tumor assessments. Our analysis of the 250-patient cohort confirmed that a vast majority of the scans achieved high quantitative targets based on predefined signal thresholds, directly matching excellent levels of visual diagnostic usability and inter-rater consistency (K = 0.84). Crucially, the study successfully bridges a long-standing technical-clinical gap by demonstrating a strong, statistically significant positive correlation between objective radiometric metrics (SNR and CNR) and the subjective diagnostic certainty of interpreting neuroradiologists (P< 0.001). Conversely, technical artifacts, while remaining mostly manageable within the clinical workflow, significantly lowered reading confidence when evaluating fine anatomical structures or subtle lesion boundaries. The robust positive correlation observed between objective image criteria and qualitative certainty where SNR (rs = 0.742) and CNR (rs = 0.695) strongly align with elevated diagnostic confidence stems from basic image physics. High spatial resolution and superior signal depth are physically mandatory to resolve fine structural details at the tissue interface. When the baseline SNR exceeds our designated threshold of 25.0, background thermal noise is sufficiently suppressed, allowing clear visual delineation of tumor margins from surrounding vasogenicperitumoral edema.

Furthermore, an optimized CNR is essential for defining tissue boundaries, enabling the clear characterization of internal tumor morphology, such as tracking non-enhancing tumor extensions or mapping cystic components. These objective signal metrics provide an empirical, reproducible foundation for diagnostic confidence, moving quality assurance beyond simple user perception.When these thresholds are not met, the risk of diagnostic ambiguity rises significantly. For instance, low-contrast areas can easily obscure early micro-infiltration or mask the presence of tiny, deep-seated satellite nodules. Our results expand upon previous neuro-imaging investigations while offering specific methodological points of comparison. Smith and Brown recorded a similar positive trend (r = 0.68, p < 0.01) when mapping generic image parameters to clinical utility on older 1.5T systems, but their analysis lacked the sequence-specific granularity and high-field 3.0T signal parameters established in this study 10. Our findings regarding artifact-driven confidence degradation align closely with Garcia and Nguyen, who demonstrated that persistent motion and susceptibility distortions reduced line-profile sharpness by up to 35%, frequently compromising structural evaluation[11].

Crucially, as highlighted by Jones and Lee, achieving high spatial resolution is a mandatory prerequisite for the sharp delineation of tumor boundaries from surrounding vasogenicperitumoral edema, which our study confirms is a vital step for accurate tumor grading and surgical mapping[12]. When technical quality drops, real pathology can be completely obscured or actively mimicked by technical noise; this supports the findings of Wilson and Chen, who noted that unmitigated vascular flow artifacts can easily mimic a cavernoma or hemorrhagic focus, leading to potential misdiagnoses or unnecessary, costly follow-up workups [13].

Regarding hardware performance, our data confirms the clear superiority of high-field 3.0 Tesla imaging for neuro-oncological mapping, mirroring the benchmarks reported by Thompson and Johnson, who observed an average 40% gain in baseline structural SNR when upgrading from 1.5T platforms[15]. However, a notable discrepancy emerged regarding sequence optimization in challenging anatomical zones. While standard multi-center literature suggests that generic gradient-echo profiles provide the highest raw CNR for tumor tissue, our site-specific evaluation demonstrated that tailored, long-TR fast spin-echo (FSE) axial T2-weighted and T2-FLAIR sequences yielded significantly higher visual clarity and fewer susceptibility artifacts within the posterior fossa. This variation highlights the profound impact of local hardware configurations, specialized

coil geometries, and patient-specific factors, confirming the clinical value of site-specific protocol optimization over rigid generic templates1[8].

These technical findings carry significant weight throughout the entire continuum of patient care. In primary treatment planning, achieving sharp spatial resolution directly influences the precision of stereotactic neurosurgical resections and conformal radiotherapy borders, minimizing the risk of leaving residual tumor cells behind or delivering accidental radiation doses to healthy eloquent brain parenchyma[14,16]. For long-term treatment monitoring, maintaining highly standardized image quality across longitudinal scans is absolutely critical; variations in baseline SNR/CNR can easily confound multi-temporal tracking, leading to misinterpretations of therapeutic success or errors when applying strict Response Assessment in Neuro-Oncology (RANO) criteria[15].

Achieving this required image quality, however, involves managing a demanding technical trade-off paradigm[19]. Maximizing structural resolution requires longer acquisition times, which directly increases the risk of voluntary or involuntary patient motion. This limitation is particularly challenging when imaging pediatric, claustrophobic, or critically ill patients. While modern acceleration features such as parallel imaging and compressed sensing effectively shorten scan times, they must be managed carefully at the console, as excessive acceleration can introduce unique geometry and reconstruction artifacts that degrade the very SNR and CNR baselines required for diagnostic certainty.

LIMITATIONS OF THE STUDY:

Despite its structural strengths, several limitations must be acknowledged to guide future investigations and clinical recommendations. First, although our cohort of 250 unique adult patients provided robust statistical power, it represents a single-center retrospective archive that may be influenced by institutional referral patterns, limiting its immediate generalizability to a broader global population. Second, while our qualitative assessment demonstrated excellent consistency (k = 0.84), it relied on a select panel of specialized neuroradiologists, meaning some subtle inter-observer variability may still persist in non-specialized general radiology practices. Furthermore, our evaluation was restricted to a specific set of primary intracranial neoplasms and a single manufacturer's 3.0T MRI platformhardware, which restricts the direct translation of our exact SNR/CNR cutoff values to alternative scanner ecosystems or rare neuropathologist. Finally, the retrospective design meant relying on existing clinical data acquired over a fixed window rather than a tightly controlled prospective pipeline. Moving forward, it is recommended that future multi-center trials adopt a prospective framework utilizing diverse scanner configurations and vendor-neutral optimization protocols. This approach will validate these quantitative radiometric baselines across broader clinical domains and fully standardize objective quality-assurance metrics for routine neuro-oncological management[20].

FUTURE DIRECTIONS AND RECOMMENDATIONS:

Based on our findings, we propose several future directions for research and clinical practice. There is a need for the development of a standardized, quantitative quality assurance protocol for brain tumor MRI that can be implemented across different institutions to ensure consistent and reliable image quality[21]. Future studies should focus on the use of deep learning-based reconstruction algorithms, which hold the potential to break traditional trade-offs between image quality and acquisition time[22]. Larger, multi-center studies are required to validate our findings across a more diverse patient population, different scanner models, and pathologies[23]. Lastly, we recommend clinical studies that directly correlate quantitative image quality metrics with patient outcomes, such as surgical success rates and long-term survival, to provide a definitive link between technical image parameters and clinical effectiveness[24,25]. These future research efforts would strengthen the foundation for precision oncology by ensuring that diagnostic imaging provides the highest possible accuracy for every patient[26].

Conclusion:

He meticulous assessment of MRI image quality is not merely a technical exercise but a fundamental component of diagnostic accuracy in neuro-oncology. Our findings underscore that optimizing parameters like Signal-to-Noise Ratio and Contrast-to-Noise Ratio is critical for confident tumor characterization, treatment planning, and monitoring. Embracing standardized quality assessment and emerging technologies will be pivotal in advancing personalized patient care.

CONFLICT OF INTERESTS: The authors declare that there are no competing interests to disclose.

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