Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/9km5kp33

NEUROIMAGING PITFALLS: WHEN TUBERCULOMAS MASQUERADE AS GLIOMAS ON MRI

Dr. Kunj Shah*

*Assistant Professor Radiology, Sirt Hosoital and Government medical College, Bhavnagar (Gujarat), drkunjsip@gmail.com

***Corresponding Author:** Dr. Kunj Shah
*Email: drkunjsip@gmail.com

Abstract
The clinical and radiological features of intracranial tuberculomas and gliomas share many similarities which creates a difficult diagnostic task for healthcare providers. This review examines the intricate neuroimaging errors which result in tuberculoma misdiagnosis as glioma on MRI examinations in endemic and non-endemic areas. MRI features of ring enhancement along with central necrosis and perilesional edema exist in both lesions which creates confusion during diagnosis. Additional diagnostic information comes from advanced imaging technologies DWI and MRS together with perfusion imaging and PET but these methods provide limited certainty. The application of artificial intelligence and radiomics technologies faces restrictions from current availability challenges and validation needs to boost their specificity potential. This review examines the research literature and retrospective studies with reported cases to establish the diagnostic imaging markers and determine clinical mistakes and diagnostic errors' implications which result in superfluous surgeries and delayed therapy with systemic adverse effects. The authors recommend using a structured diagnostic system which combines multiparametric imaging results with clinical evaluation and pathological verification. The article devotes particular attention to developing strategies for areas with limited resources and high tuberculosis burdens. The article provides support to clinicians and neuroradiologists for minimizing diagnostic errors while enhancing treatment decisions and patient outcomes during evaluations of CNS lesions with malignant-like characteristics.

Keywords: Artificial intelligence, Gliomas, Magnetic resonance imaging, Misdiagnosis, Tuberculomas, Neuroimaging pitfalls

1. Introduction

The global health burden of tuberculosis includes Central Nervous System Tuberculosis (CNS-TB) as a rare but dangerous presentation which can appear similar to gliomas (Perez-Malagon et al., 2021; Awada et al., 1998). Intracranial tuberculomas stand out as the most deceptive form of these manifestations. Space-occupying lesions develop from Mycobacterium tuberculosis blood vessel spread and appear as single or multiple masses (DeLance et al., 2013; Ramachandran et al., 2017). Gliomas represent the most common type of malignant brain neoplasm because they develop from glial cells (Makary et al., 2022). High-grade gliomas display mass effect and contrast enhancement and infiltrative growth patterns which share identical characteristics with tuberculomas on neuroimaging according to Coppola et al. (2024). The distinction between pediatric gliomas and granulomatous lesions becomes challenging for medical professionals (Haouas et al., 2024; Roy et al., 2025). The first step in assessing CNS lesions depends heavily on neuroimaging techniques.

Standard MRI features including ring enhancement together with perilesional edema and central necrosis exist in both gliomas and tuberculomas (Peer et al., 2021; Boruah et al., 2022; Sonmez et al., 2008). The diagnostic confusion between gliomas and tuberculomas becomes frequent when using conventional sequences alone (Kilani et al., 2003; Huang et al., 1999). The diagnostic confusion between gliomas and tuberculomas has been addressed through multiparametric imaging methods. The diagnostic information from diffusion-weighted imaging (DWI), MR spectroscopy (MRS) and perfusion imaging remains ambiguous according to research by Kulanthaivelu et al., 2021 and Alshoabi et al., 2022.

The spectroscopy results of elevated choline and reduced NAA levels appear in both infectious and neoplastic lesions (Ma et al., 2018; Bayındır et al., 2006). Advanced radiomics and machine learning models succeeded in developing better accuracy for differentiating these pathological entities in patient brain scans. The research by Indoria et al. (2024) demonstrated how radiomics features extracted through statistical modeling distinguished tuberculomas from gliomas. Research from Roy et al. (2025) produced the Fibonacci-Net lightweight CNN for automatized classification which shows potential value for clinical practice. The implementation of new technology has not eliminated the occurrence of clinical misinterpretation. Swamy et al. (2023) conducted a retrospective study which revealed that medical professionals diagnosed and treated significant symptomatic tuberculomas as gliomas. Zedde et al. (2024) demonstrated in their research that post-infectious vasculitides created additional challenges during radiological evaluation.

Medical professionals in TB-endemic areas including India and Sub-Saharan Africa and Southeast Asia start anti-tubercular therapy (ATT) treatment without confirmation through laboratory tests based solely on imaging results. Medical practitioners who follow this practice may experience delayed appropriate oncologic treatment because the lesion turns out to be neoplastic (Monteiro et al., 2013; Idris et al., 2007). The scarcity of tuberculomas in non-endemic areas prompts medical professionals to diagnose malignancies which sometimes requires them to perform unnecessary biopsies or surgeries (Casper et al., 2021; Nayfe et al., 2017). Medical reports have shown that tuberculomas were misdiagnosed as glioblastomas or metastases which led to improper treatment decisions (Loke et al., 2024; Mahmoud et al., 2023). The pathogenic agents Streptococcus intermedius along with other infectious pathogens generate ring-enhancing lesions which mimic both tuberculomas and gliomas (Hameed et al., 2017; Maliyil et al., 2011; Yamamoto et al., 1999). The risk of misdiagnosis remains high for children together with immunocompromised patients and those who lack known exposure to tuberculosis (Bathla et al., 2011; Anuradha et al., 2011). Radiologic findings by themselves do not provide enough information to diagnose atypical cases. Radiologists with extensive experience can also be confused by conglomerate lesions and midline shift and hemorrhagic components (Tarulli & Tarulli, 2021; Kioumehr et al., 1994; Sencer et al., 2003). The diagnosis standard remains histopathology yet this method becomes impractical because of patient health limitations and lesion accessibility and resource availability (Wasay et al., 2003; Awada et al., 1998). Medical professionals currently depend on imaging-based clinical assessments but these assessments become prone to mistakes when they lack structured clinical decision frameworks.

The study evaluates the imaging and clinical obstacles which exist when distinguishing intracranial tuberculomas from gliomas. The article utilizes a wide range of research materials such as case reports and retrospective studies and radiological analyses and machine learning applications to:

- The research will identify essential neuroimaging characteristics which lead to diagnostic confusion.
- A study investigates both case-based patterns alongside clinical outcomes that result from misdiagnosis.
- The evaluation of advanced imaging methods together with AI systems for solving diagnostic confusion in health care practices needs assessment;
- The authors provide useful guidance to radiologists and clinicians who handle these cases across TB-endemic and non-endemic settings.

The structured analysis of existing research and progressive technological advances in this review will benefit correct identification of medical conditions while decreasing unneeded treatment procedures to achieve superior healthcare results for CNS lesion patients.

2. Methods

2.1 Clinical Diagnostic Workflow in CNS Lesion Evaluation

Doctors start patient evaluation through diagnostic procedures by performing thorough clinical assessments and neurological examinations of people showing focal neurological deficits or seizures or elevated intracranial pressure signs. Medical professionals who practice in areas with high tuberculosis prevalence rate intracranial tuberculomas among their diagnostic possibilities after space-occupying lesions become visible on imaging tests. These lesions tend to receive glioma diagnoses instead of tuberculomas in non-endemic areas because their mass-like appearance mimics neoplastic growth (Perez-Malagon et al., 2021; Casper et al., 2021).

The initial clinical hypothesis develops based on risk factors including immunocompromised conditions (HIV or transplant patients) and exposure to tuberculosis or simultaneous pulmonary or lymphatic tuberculosis. The clinical indicators used to diagnose CNS tuberculosis are absent in many cases especially when treating children or when dealing with atypical presentations (Haouas et al., 2024; Nayfe et al., 2017). Radiological interpretation stands as the fundamental determinant for healthcare providers to make their treatment decisions.

2.2 Imaging Modalities and Interpretation Methodologies

Magnetic Resonance Imaging (MRI) stands as the primary diagnostic tool for evaluating intracranial lesions because it provides clear tissue resolution as well as clear soft tissue characterization. MRI scans show similar characteristics between tuberculomas and gliomas especially when ring-enhancing lesions appear with surrounding edema and central necrosis (Makary et al., 2022; Boruah et al., 2022).

Radiologists typically evaluate:

- The location of tuberculomas tends to develop in basal ganglia and infratentorial regions but gliomas typically occur supratentorially.
- The enhancement patterns of both conditions include ring-enhancing and solid lesions.
- The presence of midline shift together with hemorrhage or necrosis may indicate gliomas although these findings are not conclusive (Sonmez et al., 2008; Kilani et al., 2003).

The evaluation combines DWI and MRS procedures to achieve better imaging results. The imaging characteristics of tuberculomas include restricted diffusion with lipid-lactate peaks whereas gliomas exhibit elevated choline and reduced N-acetylaspartate (NAA) levels according to Kulanthaivelu et al (2021) and Ma et al (2018). Each diagnostic method shows overlapping results so they alone cannot provide definitive identification of tuberculomas or gliomas.

Table 1 demonstrates the diagnostic imaging modalities' complex ability to distinguish tuberculomas from gliomas. The widespread availability of conventional MRI produces results with ring enhancement and edema features that can result in incorrect diagnoses. DWI and MRS provide advanced structural and metabolic information to clinicians but produce ambiguous results in numerous cases. Availableness of radiomics and AI-based tools remains low because facilities lack required infrastructure and there exist difficulties with validation mechanisms. The table 1 shows that histopathology stands as the definitive method but remains invasive. This summary demonstrates that multiple parameters which take the context into account remain essential to improve correct medical diagnosis.

Table 1: Diagnostic Modalities and Their Pitfalls in Differentiating Tuberculomas from Gliomas

Modality	Key Features	Strengths	Common Pitfalls / Limitations	Relevant Studies
Conventional MRI	T1/T2-weighted imaging, ring enhancement, edema	Widely available, baseline imaging	Non-specific findings; both lesions can show ring enhancement	Makary et al., 2022; Sonmez et al., 2008
DWI (Diffusion Imaging)	Measures water diffusion in tissue	Helpful in abscess vs tumor; restricted diffusion in TB	Overlapping diffusion patterns in high-grade gliomas	Kulanthaivelu et al., 2021
MRS (Spectroscopy)	Choline, NAA, lipid-lactate peaks	Metabolic fingerprinting	Similar peaks in necrotic tumors and tuberculomas	Ma et al., 2018; Alshoabi et al., 2022
Perfusion MRI	Measures blood flow (rCBV)	Can suggest neovascularity in gliomas	TB lesions may show variable perfusion values	Peer et al., 2021
Radiomics & AI Models	Texture, shape, intensity features + ML classification	Quantitative, scalable, predictive	Requires large datasets, limited access in low-resource settings	Indoria et al., 2024; Roy et al., 2025
Histopathology (Biopsy)	Tissue sampling and microscopic analysis	Gold standard	Invasive, not always feasible or timely	Awada et al., 1998; Wasay et al., 2003

2.3 Common Diagnostic Pitfalls in MRI-Based Differentiation

Despite technological advances, diagnostic pitfalls are frequent and multifactorial:

- Ring enhancement occurs in multiple brain conditions which makes it an ambiguous sign for diagnosis. The ring enhancement characteristic exists in gliomas and metastases and abscesses and tuberculomas (Peer et al., 2021; Monteiro et al., 2013).
- Streptococcus intermedius abscesses have been diagnosed as gliomas multiple times through imaging examinations (Casper et al., 2021; Yamamoto et al., 1999).
- The practice of using only conventional MRI for interpretation leads to many misdiagnoses because radiologists fail to incorporate spectroscopy and perfusion imaging (Indoria et al., 2024; Alshoabi et al., 2022).
- Tuberculomas in children tend to present as large masses that resemble high-grade neoplasms particularly in the posterior fossa according to Coppola et al. (2024) and Swamy et al. (2023).
- Resource-limited settings sometimes initiate empirical anti-tubercular therapy (ATT) through imaging alone which delays proper treatment for gliomas (Ramachandran et al., 2017; Idris et al., 2007).

The appearance of imaging results becomes more challenging to interpret when patients receive previous treatments such as corticosteroids (Awada et al., 1998). Medical professionals sometimes mistake partial ATT response for tuberculoma when the actual condition remains neoplastic in nature (Sencer et al., 2003).

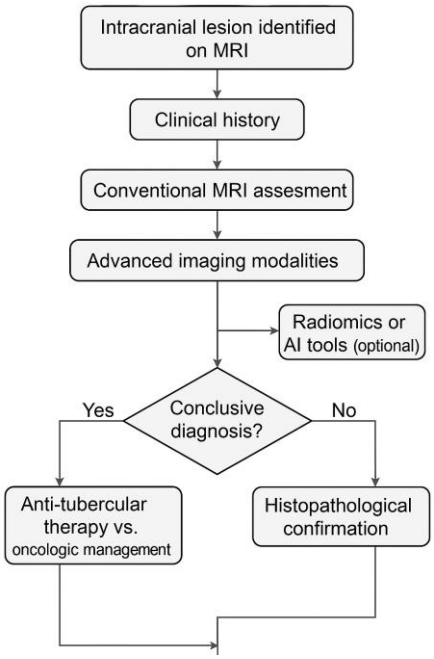

Figure 1: Diagnostic Workflow – Tuberculomas vs Gliomas

Figure 1 shows the diagnostic workflow which demonstrates the sequential clinical and radiological procedures for assessing intracranial lesions that might be tuberculomas or gliomas. The diagnostic pathway commences with MRI identification combined with clinical history after which it advances into standard imaging and sophisticated imaging evaluations. The diagnostic probability can be enhanced through optional use of radiomics or AI tools. Further diagnostic uncertainty requires histopathological examination to confirm the diagnosis. The figure provides clear instructions about starting anti-tubercular therapy versus starting oncologic treatment. A visual map presents in a structured way how planned multimodal approaches reduce diagnostic errors.

2.4 Role of Advanced Techniques and AI in Improving Accuracy

The combination of radiomics together with machine learning and artificial intelligence (AI) entered neuroimaging diagnostics during recent years. The tools extract quantitative features from imaging datasets which include texture shape and intensity features that cannot be seen by human eyes (Roy et al., 2025). The research by Indoria et al. (2024) proved that combining radiomics with multiple imaging modalities led to better discrimination between gliomas and tuberculomas. Artificial intelligence programs obtain training through large image databases where they build competency to detect understated changes for providing probabilistic diagnostic outputs. The analysis of voxels enables AI to predict treatment outcomes while categorizing different lesions (Zedde et al., 2024; Roy et al., 2025). Current developments in these technologies continue to advance but remain limited in their global reach mainly because of their restricted availability. The implementation of AI tools into clinical practice needs population-wide validation tests as well as standard imaging protocol definitions and joint efforts from radiologists and computer scientists with clinicians.

3. Clinical and Radiological Features

3.1 Pathophysiology of Tuberculomas

The central nervous system receives Mycobacterium tuberculosis through bloodstream dissemination which results in tuberculomas that form granulomatous focal lesions. A bacillus that enters cerebral tissue creates a Rich focus which develops into caseating necrosis. The pathologic development of this lesion includes three distinct stages that progress from non-caseating granuloma to caseating granuloma and finally ends with calcification (DeLance et al., 2013; Awada et al., 1998). The evolution of tuberculosis lesions depends heavily on immune system responses. The granuloma formation in immunocompetent patients remains confined but immunocompromised patients

experience either rapid disease progression or tissue changes resembling cancer (Ramachandran et al., 2017). The brain's response to the lesion through edema and gliosis and neovascularization creates radiological features that make it difficult to distinguish from tumors.

3.2 Imaging Features of Intracranial Tuberculomas

The appearance of tuberculomas on radiological images depends heavily on the pathological development stage of the lesion. The three distinct imaging patterns of tuberculomas identified on MRI include solid lesions and caseating lesions with central liquefaction and calcified tuberculomas. The radiological features of solid tuberculomas include hypointense signals on T2-weighted imaging and they enhance either homogeneously or with nodular patterns after contrast administration (Table 2). The T2-weighted images show a target sign which represents the hypointense or isointense central area surrounded by peripheral enhancement in caseating lesions with liquefaction (Sonmez et al., 2008; Ma et al., 2018). All MRI sequences show hypointense signals in calcified tuberculomas which rarely enhance.

Table 2. MRI Features of Tuberculomas by Pathological Stage

Type	T1-weighted MRI	T2-weighted MRI	Contrast Enhancement	Notable Features
Solid Granulomatous	Iso- to hypointense	Iso- to hypointense	Nodular or homogeneous	Common in early stage TB
Caseating (Non-liquefied)	Iso- to hypointense	Hypointense	Ring enhancement	Classic “target sign”
Caseating (Liquefied center)	Hypointense	Hyperintense center	Thick irregular rim	Often misdiagnosed as abscess or glioma
Calcified	Hypointense	Hypointense	Minimal or no enhancement	May resemble old granulomas or metastases

Adapted from Sonmez et al., 2008; Ma et al., 2018.

The inconsistent imaging characteristics of these brain abnormalities can confuse both experienced neuroradiologists and especially those working in high-grade glioma-endemic areas where ring enhancement is commonly linked to neoplastic growth (Makary et al., 2022).

3.3 Classification and Imaging Characteristics of Gliomas

The World Health Organization classifies gliomas which originate from glial cells into four different grades known as Grades I through IV. Low-grade gliomas (e.g., pilocytic astrocytomas, diffuse astrocytomas) exhibit minimal enhancement and little mass effect, while high-grade gliomas (e.g., glioblastomas) display aggressive imaging characteristics such as necrosis, hemorrhage, and significant perilesional edema (Makary et al., 2022; Coppola et al., 2024).

The imaging characteristics of gliomas include heterogeneous signal patterns and contrast-enhanced regions according to Table 3. High-grade brain lesions appear different in DWI data by showing irregular restrictability and PWI detects elevated rCBV levels which reveal new vessel formation. MRS shows two characteristic metabolic patterns in gliomas which include elevated choline levels and reduced NAA levels (Ma et al., 2018; Kulanthaivelu et al., 2021).

Table 3. MRI Characteristics of Glioma Types (WHO Grading System)

Glioma Grade	T1-weighted	T2-weighted / FLAIR	Contrast Enhancement	DWI	MRS
Grade I (e.g., Pilocytic Astrocytoma)	Hypointense	Hyperintense	Mild to moderate	Minimal restriction	Normal or slightly elevated choline
Grade II (e.g., Diffuse Astrocytoma)	Iso- to hypointense	Diffuse hyperintensity	Usually none	No restriction	Mildly elevated choline
Grade III (Anaplastic Astrocytoma)	Heterogeneous	Hyperintense	Irregular or nodular	Some restriction	Increased choline, decreased NAA
Grade IV (Glioblastoma)	Heterogeneous, necrotic	Hyperintense with edema	Thick, ring enhancement	Strong restriction	Very high choline, lipid/lactate peaks

Sources: Makary et al., 2022; Ma et al., 2018; Kulanthaivelu et al., 2021.

3.4 Overlapping Features and Potential Diagnostic Confusion

The imaging features of tuberculomas and gliomas tend to share similarities in both resource-constrained environments and atypical cases because of their different pathological origins.

The pathophysiological development of intracranial tuberculomas starts when Mycobacterium tuberculosis spreads through the bloodstream to reach cerebral tissue as shown in Figure 2. The formation of a tuberculous focus known as a Rich focus serves as the starting point for granuloma development. The host immune response forms a granulomatous inflammatory area around the focus which eventually results in central caseation necrosis. The imaging features of tuberculomas develop through this cascade to show ring enhancement and central hypodensity while their appearance depends on the lesion's development stage and the host's immune response.

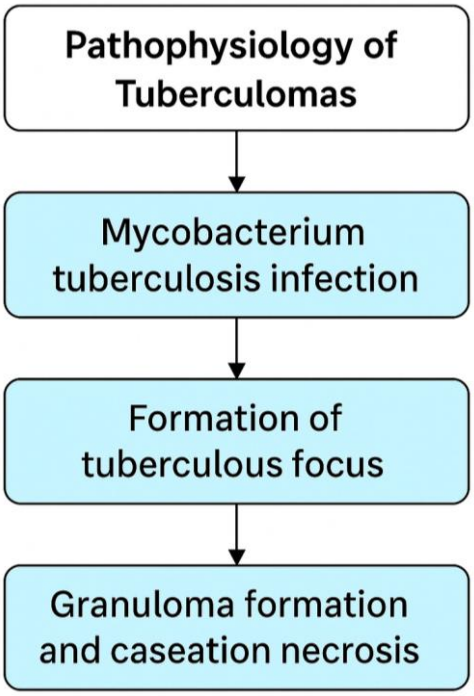

Figure 2. Overlapping MRI features of tuberculomas and gliomas contributing to diagnostic uncertainty.

Tuberculomas and gliomas share several radiological characteristics which include ring enhancement and mass effect together with central necrosis and perilesional edema. The diagram demonstrates the necessity of combining multiple assessment methods with clinical evaluation. The useful yet limited diagnostic capacity of MRS DWI and perfusion imaging exists in modern clinical practices. Both caseating tuberculomas and gliomas can display lipid peaks which resemble necrotic glioblastomas while gliomas sometimes exhibit restricted diffusion patterns that typically belong to abscesses or granulomas (Alshoabi et al., 2022; Roy et al., 2025). Experienced radiologists can also misdiagnose TB lesions when they occur in unexpected areas or when patients do not display typical TB risk factors (Mahmoud et al., 2023; Loke et al., 2024). A correct diagnosis of brain abscesses requires both a high level of clinical suspicion and multiple diagnostic methods that unite imaging results with clinical data and laboratory findings and histopathological analysis.

4. Advanced Neuroimaging Modalities

Cost-effective advanced neuroimaging helps distinguish the differences between tuberculomas and gliomas when MRI examinations fall short of clear identification. DWI when combined with MRS and PWI and PET and modern radiomics and artificial intelligence techniques give comprehensive info about tissue structures and metabolic activities and blood flow dynamics of brain tissues. A combination of diagnostic tests increases diagnostic accuracy by helping medical practitioners create more precise interpretations of data.

4.1 Diffusion-Weighted Imaging (DWI)

Rephrase the following sentence. DWI analyzes water molecule Brownian motion in tissues to generate a sensitive metric for cellular density. Tuberculomas containing caseating necrosis show restricted diffusion because their high cellular density and viscous nature. The DWI signal in these cases can mimic high-grade glioma diffusion patterns thus leading to misinterpretation when used alone (Kulanthaivelu et al., 2021; Peer et al., 2021). The restriction patterns differ between gliomas and tuberculomas because gliomas show heterogeneous restriction patterns in peripheral areas whereas tuberculomas demonstrate central restriction in necrotic regions. The interpretation of DWI with contrast enhancement and T2-weighted images helps identify lesions better but needs joint analysis with other modalities because it can lead to wrong diagnostic conclusions.

4.2 Magnetic Resonance Spectroscopy (MRS)

The tissue biochemistry of MRS functions through metabolite concentration measurement. Gliomas show increased levels of Cho metabolism and diminished NAA metabolism because both metabolites reflect specific cellular biochemical activity. Tuberculomas show lipid and lactate peaks through necrosis and anaerobic metabolic processes according to Ma et al. (2018) and Alshoabi et al. (2022). The metabolic profiles of necrotic glioblastomas overlap with tuberculomas because both conditions can produce lipid and lactate peaks yet tuberculomas with solid early stages may demonstrate minimal metabolic changes. The interpretation of MRS requires an analysis of metabolite ratios together with lesion topography as well as clinical suspicion and epidemiological data.

4.3 Perfusion-Weighted Imaging (PWI)

Tumor angiogenesis through brain blood volume (CBV) measurements and vessel permeability examination can be detected using perfusion imaging. Gliomas of high grade show increased blood vessel density which leads to elevated relative cerebral blood volume (rCBV). Tuberculomas present as either hypovascular or avascular tissue which demonstrates normal or decreased relative cerebral blood volume according to Makary et al. (2022) and Boruah et al. (2022). The difference in perfusion characteristics serves as an important diagnostic indicator to distinguish tuberculomas from glioblastomas or metastases. The presence of intense inflammation or peripheral granulation tissue in tuberculomas can occasionally produce increased perfusion which may result in incorrect interpretations. Perfusion results become most beneficial when combined with DWI and MRS findings.

4.4 Positron Emission Tomography (PET) and Hybrid Imaging

PET imaging with fluorodeoxyglucose (FDG) analyzes metabolic glucose activity to distinguish between infectious and neoplastic brain lesions. The FDG uptake pattern of gliomas typically increases but tuberculomas exhibit variable or low uptake levels which depend on the inflammatory stage (Mahmoud et al., 2023; Casper et al., 2021). FDG-PET imaging demonstrates restricted specificity because the brain naturally consumes high amounts of glucose particularly in cortical regions. The availability of C-11 methionine and F-18 fluorothymidine as emerging tracers provides better tumor-to-background contrast although these tracers remain scarce in the market. PET/MRI hybrid imaging systems unite metabolic and anatomical details to perform multiparametric assessments during one examination session yet these systems exist only in tertiary medical facilities.

4.5 Radiomics and Artificial Intelligence in Lesion Classification

The process of radiomics extracts numerous quantitative imaging features including texture features and shape features and intensity features using statistical algorithms as well as machine learning algorithms. The application of radiomics to brain imaging reveals patterns in images that are too subtle for human perception which helps identify lesions. The research by Indoria et al. (2024) demonstrated a radiomics model which distinguished tuberculomas from gliomas effectively through analysis of multimodal MRI features. Roy et al. (2025) created Fibonacci-Net which proved to be an effective lightweight CNN for brain tumor classification from standard imaging scans. Radiomics and AI-based diagnostics hold great potential but they need to overcome three major hurdles including restricted application across different scanner types and the requirement for large annotated database formation as well as workflow integration. These diagnostic tools show promise as the neurodiagnostic frontier because they have the potential to lower observer subjectivity while advancing early medical choices. The diagnostic ability of each imaging technology exists alongside interpretative challenges that healthcare professionals encounter (refer to Table 4). DWI detects necrosis which occurs in both lesions yet MRS reveals metabolic differences that necrotic gliomas can also produce lipid/lactate peaks. PWI provides important information about neovascularization although inflammation can potentially distort its results. The metabolic activity detected by FDG-PET overlaps with the metabolic activity of inflammatory lesions. The pattern-based assessment strategy provided by Radiomics and AI faces research limitations related to infrastructure accessibility. A comparative analysis through this table demonstrates the separate and collective impact of each diagnostic technique when used for creating a narrowed list of possible diagnoses.

Table 4. Comparative Overview of Advanced Imaging Modalities

Modality	Key Diagnostic Clue	Strengths	Common Pitfalls / Limitations
DWI	Restricted diffusion in caseating lesions	Excellent for detecting necrosis	Overlap with abscesses and gliomas
MRS	Lipid-lactate peak in TB; ↑Choline in glioma	Biochemical insights	Overlapping patterns; spatial resolution
PWI	↑rCBV in gliomas; ↓rCBV in TB	Reflects angiogenesis	Inflammation can elevate TB perfusion
PET	↑Glucose uptake in gliomas	Functional/molecular imaging	Low specificity in brain due to cortical uptake
AI / Radiomics	Pattern recognition from texture/features	High sensitivity and automation	Limited availability, data dependency

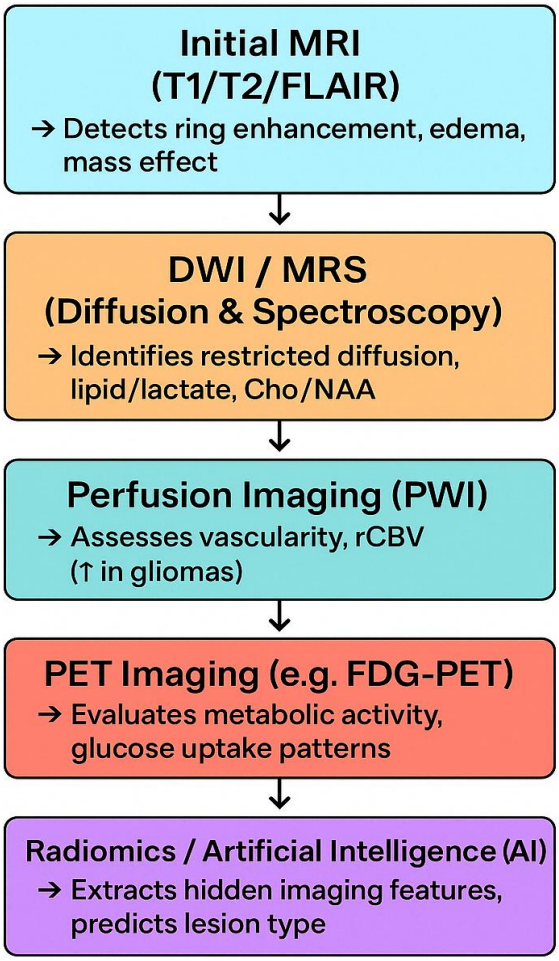

Figure 3. Multiparametric Imaging Approach to Differentiating Tuberculomas and Gliomas

The diagnostic evaluation of intracranial lesions requires a systematic combination of imaging techniques according to the illustration shown in Figure 3. MRI at the initial stage reveals structural information yet its features frequently overlap with other conditions. DWI together with MRS provides advanced assessment of tissue diffusion while perfusion imaging evaluates vascular behavior as a tool to identify neoplastic angiogenesis. PET enables the identification of lesions through metabolic activity assessment. Artificial intelligence tools together with radiomics extract numerous image features to enhance the detection accuracy. The diagnostic process requires histopathological biopsy when all other methods fail to produce a definitive conclusion. This multiple imaging method reduces misdiagnosis risk and supports medical professionals in making most effective clinical choices.

5. Differential Diagnosis Framework

The distinction between tuberculomas and gliomas demands an organized assessment method that unites radiological knowledge with medical experience. The interpretation of diagnostic imaging must take place in specific context especially when working within TB-endemic areas or diagnostic challenges exist in patients' presentations. Several diagnostic tools in combination will help refine the differential diagnosis by following this diagnostic approach.

5.1 Radiological Red Flags Distinguishing Tuberculomas from Gliomas

The diagnostic features on imaging tests share common elements yet specific radiological indicators help distinguish between these two conditions. The "target sign" appearance on T2-weighted MRI with restricted diffusion and lipid/lactate peaks on MRS serves as diagnostic indicators for tuberculomas. Tuberculomas demonstrate well-defined borders and tend to affect the posterior fossa and basal ganglia regions of the brain particularly in young patients (Sonmez et al., 2008; Alshoabi et

al., 2022). Gliomas show heterogeneous contrast enhancement patterns and infiltrative margins and elevated rCBV on perfusion imaging tests especially in their high-grade forms. The presence of hemorrhagic elements or necrosis or cortical involvement represents features which are uncommon in tuberculomas according to Makary et al. (2022) and Kulanthaivelu et al. (2021). The interpretation requires multiple comprehensive assessments because it involves features that appear in both conditions.

5.2 Role of Clinical History and Epidemiology in Imaging Interpretation

Medical imaging findings need interpretation in combination with patient medical background and local disease prevalence statistics. The pre-test probability for tuberculoma increases in TB-endemic areas when patients have pulmonary tuberculosis or HIV infection or have been exposed to tuberculosis. Symptoms including prolonged fever and weight loss together with systemic inflammatory markers help establish an infectious cause of disease (Ramachandran et al., 2017; Haouas et al., 2024). Gliomas tend to occur in older patients while tuberculomas develop without systemic signs but cause progressive neurological deficits and seizures and cognitive changes. Healthcare providers should decrease their suspicion of tuberculomas in immunocompetent patients from non-endemic regions who lack TB risk factors yet these patients should never be completely ruled out. The correct interpretation of imaging results depends heavily on knowing the epidemiological background.

5.3 Role of Biopsy and Histopathology in Ambiguous Cases

The definitive method to diagnose suspicious brain lesions is through histopathological testing following inconclusive results from advanced imaging and clinical features. Stereotactic biopsy serves as an effective tool for deep brain tissue examination and eloquent brain regions by obtaining tissue samples with minimal safety risks. The microscopic examination of tuberculomas shows granulomatous inflammation together with Langhans giant cells and caseation necrosis which can be diagnosed through Ziehl-Neelsen staining or PCR-based detection of Mycobacterium tuberculosis (DeLance et al., 2013; Wasay et al., 2003). The diagnosis of gliomas requires histopathology testing to determine both tumor grade and molecular markers which include IDH mutation and MGMT methylation status because these elements are essential for treatment decisions and prognostic predictions. Biopsy serves as an invasive procedure to prevent disastrous outcomes when treating gliomas with anti-TB medications or vice versa. The procedure should be strongly considered for non-responsive cases and situations where radiological changes do not match clinical expectations.

5.4 Diagnostic Algorithms and Flowcharts

Diagnostic algorithms helped healthcare professionals to arrange complicated data and to decrease their biases in clinical decisions. The diagnostic process starts with clinical assessment and MRI followed by DWI and MRS and PWI and PET as illustrated in Figure 4. The diagnostic process advances to radiomics analysis when MRI features remain unclear and biopsy provides the final confirmation. The algorithms need adjustments according to the available resources because some centers lack access to advanced diagnostic equipment. Healthcare providers in TB-endemic areas should start empirical anti-TB treatment for typical radiological findings when clinical evidence is strong yet must remain vigilant for proper treatment management. Resource-rich environments require early biopsy alongside multimodal imaging to stop the delay of oncological treatment.

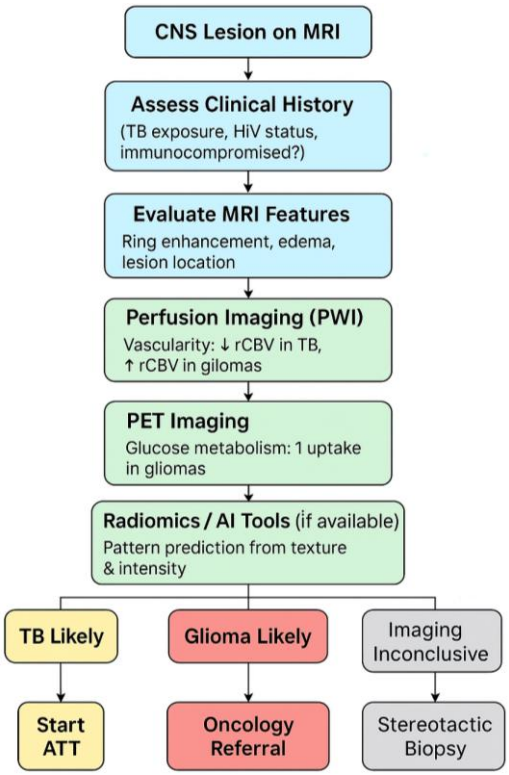

Figure 4. Diagnostic Algorithm for Differentiating Tuberculomas from Gliomas

Medical personnel can minimize misdiagnosis risks and enhance patient care by using an incremental approach which combines warning indicators and treatment environment and functional equipment assessment.

6. Consequences of Misdiagnosis

A wrong diagnosis between intracranial tuberculomas and gliomas results in severe clinical, psychological and socioeconomic impacts. The incorrect diagnosis of intracranial tuberculomas as gliomas or vice versa creates safety risks for patients while wasting healthcare resources and delaying proper medical care. Empirical decisions based on minimal radiological evidence become more dangerous in TB-endemic areas because they are made without histological confirmation.

6.1 Unnecessary Neurosurgical Interventions

The most rapid and aggressive consequence of incorrect diagnosis leads to unnecessary brain surgeries. Tuberculomas which appear similar to high-grade gliomas on imaging studies might lead doctors to perform aggressive surgical procedures or craniotomy especially when lesions are big or cause symptoms or display irregular enhancement patterns. Patients face surgical dangers including infection and hemorrhage alongside neurological damage and anesthesia complications because medical treatment would have sufficed for their condition (Swamy et al., 2023; Casper et al., 2021). The surgical team faces confusion because intraoperative findings tend to be non-discriminatory. The curable nature of tuberculomas with anti-tubercular therapy (ATT) becomes tragic because post-operative complications lead to extended hospital stays and disability or death.

6.2 Delay in Anti-Tubercular Treatment

The incorrect diagnosis of tuberculoma as a neoplastic lesion result in delayed initiation of essential anti-tubercular therapy. The lesion expands due to incorrect treatment which results in increased mass effect and seizures and potentially leads to herniation or hydrocephalus. The administration of corticosteroids under the wrong assumption of glioma-induced edema creates a temporary symptom relief that enables the infection to continue without detection (Haouas et al., 2024). The delayed treatment of tuberculosis in pediatric patients or those with compromised immunity results in systemic

tuberculosis spread and permanent neurological damage. The identification of tuberculosis early in combination with prompt treatment stands as a critical factor because delays in treatment result in worse outcomes.

6.3 Chemotherapy Toxicity in TB Patients Misdiagnosed with Glioma

The most severe outcome from misdiagnosis involves starting oncological treatments for patients who actually have infectious lesions. Patients who receive incorrect glioma diagnosis may face harmful side effects from temozolomide chemotherapy despite their actual tuberculoma condition. Chemotherapy applied to patients with latent tuberculosis or immunocompromised status can trigger tuberculosis reactivation and lead to miliary TB or TB meningitis (Mahmoud et al., 2023). The use of radiation therapy leads to leukoencephalopathy and necrosis while simultaneously deteriorating the patient's immune system. The treatments that work for gliomas should never be used for tuberculoma patients because they create unnecessary harm to patients through incorrect application.

6.4 Psychological and Socioeconomic Burden on Patients

The psychological impact of receiving an incorrect diagnosis of malignant brain tumor becomes extremely severe. A terminal diagnosis causes patients and their families to experience psychological distress as well as anxiety and trauma. The situation becomes especially difficult because tuberculoma is a condition that can be cured. The incorrect diagnosis of an infectious benign disease as cancer results in social rejection and social isolation and forces patients to plan for their death prematurely. The socio-economic impact of incorrect diagnosis includes diminished income and costly medical procedures and cancer treatments and extended travel to distant medical facilities and emotional distress from the diagnostic errors. Families in low-resource areas sell their properties or take loans to pay for treatments that provide no benefit for incorrect diagnoses which deepens both poverty and health disparities (Roy et al., 2025).

The incorrect diagnosis of tuberculomas as gliomas triggers multiple preventable medical problems which include harmful surgical operations and toxic cancer treatments and delayed proper tuberculosis treatment. Patients endure extreme mental and financial difficulties because their presumed terminal condition and expensive therapeutic interventions produce no clinical advantages. The lack of histopathology or advanced imaging facilities in TB-endemic and low-resource settings makes these consequences especially damaging. The presented table demonstrates the crystal-clear necessity for precise diagnostic methods working within understanding the context to stop medical injuries and structural inequalities in neuro-oncology treatment.

Table 5. Clinical and Systemic Consequences of Misdiagnosing Tuberculomas as Gliomas

Consequence	Description	Impact on Patient
Unnecessary Neurosurgery	Misidentified tuberculomas may be surgically resected as gliomas.	Risk of operative complications, neurological deficits, and delayed recovery.
Delayed Anti-TB Therapy	Incorrect classification postpones essential medical management.	Worsening infection, increased intracranial pressure, potential for neurological damage or death.
Chemotherapy / Radiotherapy Toxicity	TB patients receive cytotoxic therapy meant for malignancy.	Immunosuppression, TB reactivation or dissemination, and irreversible CNS damage.
Psychological Distress	A cancer diagnosis causes severe emotional and mental strain.	Anxiety, depression, trauma, and long-term fear of recurrence or fatal outcomes.
Socioeconomic Burden	Cost of cancer treatment without clinical benefit.	Financial ruin, unnecessary travel, lost income, and strain on families—especially in low-resource settings.

7. Diagnostic Challenges: Insights from Literature and Case Reports

Neuroimaging professionals face significant challenges when trying to differentiate tuberculomas from gliomas which results in diagnostic confusion and clinical errors. The diagnostic complexities faced by experienced neuroradiologists emerge from multiple studies and individual clinical cases and retrospective research. The section reviews valuable real-life observations and reports critical mistakes alongside unique cases and established clinical practices.

7.1 Review of Published Case Reports and Series

Neuroimaging professionals face significant challenges when trying to differentiate tuberculomas from gliomas which results in diagnostic confusion and clinical errors. The diagnostic complexities faced by experienced neuroradiologists emerge from multiple studies and individual clinical cases and retrospective research. The section reviews valuable real-life observations and reports critical mistakes alongside unique cases and established clinical practices.

7.2 Examples of Diagnostic Mimicry in Clinical Practice

The symptoms and imaging characteristics of a condition match those of neoplastic diseases instead of infectious diseases during clinical mimicry. The clinical presentation of both gliomas and tuberculomas includes seizures and headaches and focal deficits and space-occupying lesions with ring enhancement. The diagnostic challenge increases when brainstem or cerebellum areas are affected by the disease and when perilesional edema and necrotic centers and midline shift are present. Gliomas have been mistaken for tuberculomas by medical professionals because MRS detected lipid peaks and initial scans did not show aggressive characteristics. Granulomatous lesions show high perfusion values and heterogeneous enhancement patterns which can lead to misdiagnosis with high-grade tumors. The use of a solitary imaging technique leads to incorrect diagnostic interpretations in these cases.

7.3 Summary of Imaging Pitfalls Documented in Literature

Multiple imaging errors repeatedly lead to incorrect diagnoses according to the published literature:

- The imaging feature of ring enhancement occurs frequently in both pathologies when the enhancement shows incomplete or irregular patterns.
- The imaging technique of restricted diffusion shows up in both caseating tuberculomas and necrotic gliomas.
- Lipid and Lactate Peaks appear in tuberculomas while they also manifest in necrotic tumors.
- The imaging marker rCBV shows a typical pattern in gliomas yet it can also appear in inflamed granulomas.
- The pattern of tuberculomas typically shows multiple lesions yet gliomas and metastases can create diagnostic challenges.

The interpretation of DWI MRS and PWI data together proves essential according to Kulanthaivelu et al. (2021) and Indoria et al. (2024) instead of analyzing each sequence independently. Although promising AI tools exist there is still insufficient validation when analyzing various datasets.

7.4 Key Takeaways for Neuroradiologists and Clinicians

Multiple essential points from published studies guide clinicians and radiologists through uncertain diagnostic situations:

- Ring enhancement should not be the sole basis for diagnosis because additional features such as diffusion and spectroscopy and clinical history need evaluation.
- Medical professionals should always think about tuberculosis in areas where tuberculosis is common even when patients show unusual symptoms.
- A stepwise multiparametric evaluation should precede starting definitive treatment.

- Stereotactic biopsy should be selected as the diagnostic method because it minimizes both unnecessary treatment and inadequate treatment risks.
- The team should receive training about mimickers to prevent anchoring bias during urgent decisions.

The ability to detect tuberculomas through advanced technology depends on maintaining vigilance together with context-awareness and humility to differentiate between tuberculomas and gliomas. Literature-derived findings should function as warning indicators to enhance the precision of neuro-oncological diagnostic procedures.

8. Discussion

The review examines the diagnostic confusion between intracranial tuberculomas and gliomas when MRI-based interpretation is used. Ring-enhancing lesions together with perilesional edema and mass effect appear as overlapping radiological features between infectious tuberculomas and neoplastic gliomas despite their different origins. Misinterpretation leads to major consequences that force patients to receive either cancer treatment they do not need or to delay their tuberculosis treatment. Caudate bodies that include diffusion-weighted imaging along with spectroscopy and perfusion studies and radiomic methods have enhanced diagnostic capabilities even though misdiagnosis remains possible. Combining hospital data linked with medical images followed by surrounding information provides essential support for more accurate diagnoses.

The conclusions from this review generate substantial effects on both medical practice procedures and public health results. The diagnostic uncertainty impacts clinical decisions throughout the entire diagnostic process starting from biopsy selection to empirical therapy initiation and chemotherapy or ATT administration. Patients suffer major harm when healthcare providers implement incorrect treatment plans because these plans lead to adverse drug reactions and surgical complications and psychological distress. Healthcare systems operating in resource-constrained environments experience both resource wastage and increased healthcare demands because of misdiagnosis. The failure to detect tuberculomas in a timely manner creates an important weakness within TB control programs from a public health standpoint. The central nervous system forms of tuberculosis occur less frequently than pulmonary tuberculosis but lead to greater disease severity and death rates. A wrong diagnosis creates two major consequences: it harms the patient and it fails to provide valuable information for TB control programs and contact tracing efforts. Healthcare costs along with family mental suffering occur because of inaccurate glioma tests while these false positives also lead to inadequate utilization of oncological resources. A precise identification of conditions stands as both a vital medical care aspect and an important issue for the promotion of public health.

Multiparametric imaging has become an essential standard component in diagnostic protocols as one of the major advancements in the field. Multiparametric imaging which includes diffusion-weighted imaging and MR spectroscopy with perfusion-weighted imaging helps provide valuable knowledge about tissue structure and cellular distribution and metabolism. The analytical tools help doctors properly identify necrotic or caseating granulomas against malignant tumor appearances. Traditional imagining has received an advanced predictive capability through the development of radiomics technology as well as artificial intelligence models. Systematic image analysis through these technologies provides doctors with classification tools to help them in uncertain cases. AI continues validation procedures across various regions but could find application in clinical protocols during the upcoming years. The successful deployment of these technologies needs active teamwork between radiologists and both data scientists and medical staff to match new technology with actual medical requirements and patient-related needs.

The diagnostic strategies in TB-endemic regions need to adjust their methods according to the specific epidemiological characteristics of the area. Medical professionals should maintain heightened awareness about tuberculomas in younger patients and immunocompromised individuals and those with pulmonary tuberculosis. The use of empirical ATT becomes acceptable in these situations when imaging results strongly indicate the diagnosis and invasive procedures present significant risks or

lack availability. The diagnostic strategy needs to be supported by both regular clinical checks and radiologic assessments to determine treatment effectiveness as well as detect incorrect diagnoses.

High TB-burden areas should dedicate funds to training programs that help radiologists and neurologists recognize all forms of neurotuberculosis. The diagnostic quality will improve through established imaging protocols while providing access to MR spectroscopy and DWI and implementing AI-assisted analytical tools. Interdisciplinary review boards consisting of infectious disease specialists and neurosurgeons and radiologists collaborate to decrease wrong diagnoses through cross-group medical assessments.

Various hurdles persist after technological progress in imaging and analysis systems. The medical community lacks standard imaging criteria which can consistently distinguish tuberculomas from gliomas throughout all clinical applications. Rural areas together with underfunded health institutions lack equal access to modern imaging technology. The accuracy of AI together with radiomics diagnostics relies on the availability of sufficient training datasets that provide suitable TB pathology data representation for low- and middle-income countries. New studies should focus on creating integrated diagnosis rating systems that unify patient examination reports with computed imaging results and artificial intelligence assessment results. The validation of AI tools for clinical usage depends on performing large-scale multihospital research that tests AI diagnostics against microscopic pathology standards. Future research needs to establish imaging procedures which offer both accurate diagnosis and affordable operation for limited medical facilities. A diagnostic system that tailors results to individual patients and their context will become essential for resolving this ongoing diagnostic challenge as long as it receives strong research support and includes regional characteristics.

9. Conclusion

Intracranial tuberculomas and gliomas pose extensive difficulties for neuroradiologists to differentiate. The radiological distinction between intracranial tuberculomas and gliomas remains difficult for clinicians because of recent magnetic resonance imaging developments and multiparametric modalities. The diagnostic distinction between infectious granulomas and malignant tumors becomes difficult because they share ring enhancement characteristics with perilesional edema and restricted diffusion along with spectroscopy metabolic abnormalities. The incorrect medical diagnosis results in badly aligned surgical procedures with extended therapy times and generates unnecessary toxic treatment exposure and higher patient mental and financial concerns. The diagnostic challenges become more pronounced in tuberculosis-endemic areas because healthcare providers frequently misdiagnose tumors as well as fail to identify tuberculomas. Due to the medical complexity of these conditions health care professionals must work together for better case diagnosis and treatment. Neuroradiologists together with neurologists and neurosurgeons and infectious disease specialists and pathologists need to collaborate for proper interpretation of imaging by considering patient history and regional disease prevalence and clinical progression. Through team efforts the diagnostic process becomes more precise due to decreased cognitive distortions while taking advantage of sophisticated diagnostics systems and tissue research methods. Interdisciplinary boards and tumor rounds through case discussions help resolve unclear situations to select the best treatment approach which includes either starting anti-tubercular therapy empirically or performing surgical biopsy. The advancement of diagnostic accuracy between tuberculomas and gliomas demands both medical staff to remain alert and healthcare systems to integrate modern diagnostic tools. Radiologists need proper training to detect typical warning signs and abnormal manifestations yet healthcare facilities should ensure patients can obtain multiparametric imaging examinations and biopsies for appropriate medical treatment. Artificial intelligence together with radiomics technology continues to develop yet shows strong potential in identification of patterns and disease risk evaluation. Clinical history and epidemiological awareness function as essential tools that cannot be replaced when making interpretations. The main objective is to reduce damage to patients while maximizing their treatment benefits and achieving better results. Clinical practitioners who use evidence-based structured methods while considering the context can distinguish subtle yet essential distinctions

between these entities which leads to patients obtaining accurate proper life-saving treatment in timely manner.

References

1. Perez-Malagon, C. D., Barrera-Rodriguez, R., Lopez-Gonzalez, M. A., Alva-Lopez, L. F., & Alva-Lopez, L. (2021). Diagnostic and neurological overview of brain tuberculomas: a review of literature. *Cureus*, *13*(12).
2. Makary, M. S., Nine, E. B., Reddy, H., Bourekas, E. C., & Slone, H. W. (2022). Pitfalls in the neuro-imaging of brain tumours. In *Handbook of Neuro-Oncology Neuroimaging* (pp. 841-847). Academic Press.
3. Coppola, F., Löbel, U., Morana, G., Reddy, N., & Mankad, K. (2024). Tumour mimics in paediatric neuroimaging. *Neuroradiology*, 1-18.
4. Peer, S., Tiwari, S., Swaminathan, A. D., Jabeen, S., Saini, J., Prasad, C., ... & Srinivas, D. (2021). Multiparametric magnetic resonance imaging features of giant intracranial tuberculomas. *Clinical Neurology and Neurosurgery*, *210*, 107006.
5. Indoria, A., Kulanthaivelu, K., Prasad, C., Srinivas, D., Rao, S., Sinha, N., ... & Saini, J. (2024). Radiomics features for the discrimination of tuberculomas from high grade gliomas and metastasis: a multimodal study. *Neuroradiology*, 1-14.
6. Alshoabi, S. A., Almas, K. M., Aldofri, S. A., Hamid, A. M., Alhazmi, F. H., Alsharif, W. M., ... & Daqqaq, T. S. (2022). The diagnostic deceiver: radiological pictorial review of tuberculosis. *Diagnostics*, *12*(2), 306.
7. Kulanthaivelu, K., Jabeen, S., Saini, J., Raju, S., Nalini, A., Sadashiva, N., ... & Rao, S. (2021). Amide proton transfer imaging for differentiation of tuberculomas from high-grade gliomas: preliminary experience. *The Neuroradiology Journal*, *34*(5), 440-448.
8. Swamy, S. B. G., Jaikumar, V., Nagaraj, N. M., & Khandelwal, S. (2023). Intracranial giant tuberculoma: A 7-year institutional experience and literature review. *Clinical Neurology and Neurosurgery*, *225*, 107593.
9. Haouas, M. Y., Elkhamouye, A., Aadoud, K., Laaidi, A., Ibahioin, K., Hilmani, S., & Lakhdar, A. (2024). Giant intracranial tuberculomas in children: An unexpected diagnosis and difficult management–About two cases and review of the literature. *Surgical Neurology International*, *15*, 378.
10. Boruah, D., Sarma, K., Gogoi, P., Singh, B., Gogoi, B., Hazarika, K., ... & Phukan, P. (2022). Magnetic resonance imaging appearance of giant intracerebral tuberculoma: a retrospective analysis. *Acta medica Lituanica*, *29*(2), 249-261.
11. Tarulli, A., & Tarulli, A. (2021). Intracranial mass lesions. *Neurology: A Clinician's Approach*, 377-389.
12. Roy, S., Suresh, A., Gupta, A., Tiwari, S., Sahu, P., Adhikari, P., & Shekhawat, Y. S. (2025). Fibonacci-Net: A Lightweight CNN model for Automatic Brain Tumor Classification. *arXiv preprint arXiv:2503.13928*.
13. Zedde, M., Quatrale, R., Andreone, V., Pezzella, F. R., Micieli, G., Cortelli, P., ... & Pascarella, R. (2024). Post-infectious central nervous system vasculitides in adults: an underdiagnosed and treatable disease. *Neurological Sciences*, 1-18.
14. Loke, M., Namburi, D., & Gannon, S. (2024). Multiple Ring-Enhancing Brain Lesions and Mediastinal mass: a rare Presentation of Streptococcus Intermedius Infection in an Otherwise Healthy Individual. *CHEST*, *166*(4), A2466-A2467.
15. Casper, A. C., Stenehjem, E. A., Gill, D. M., & Evans, J. D. (2021). Streptococcus intermedius: A mimicker of brain metastases and a potential pitfall for radiation oncologists. *Advances in Radiation Oncology*, *6*(4), 100689.
16. Nayfe, R., Ascha, M. S., & Rehmus, E. H. (2017). Esophageal squamous cell carcinoma presenting with Streptococcus intermedius cerebral abscess. *Case Reports in Pathology*, *2017*(1), 5819676.

17. Mahmoud, A., Beliani, T., Alyassin, N., Zakharia, K., Basil, T., & Poulad, D. (2023). Streptococcus intermedius: From a Normal Oral Commensal to a Life-Threatening Organism. *Cureus*, *15*(12).
18. Hameed, S., Singh, J., Tricia, L. B., Machado, A., Ruggieri, P., & Mehta, A. C. (2017). Conglomerate mediastinal mass of a different etiology. *Oxford Medical Case Reports*, *2017*(12), omx072.
19. Maliyil, J., Caire, W., Nair, R., & Bridges, D. (2011, July). Splenic abscess and multiple brain abscesses caused by Streptococcus intermedius in a young healthy man. In *Baylor University Medical Center Proceedings* (Vol. 24, No. 3, pp. 195-199). Taylor & Francis.
20. Yamamoto, M., Fukushima, T., Ohshiro, S., Go, Y., Tsugu, H., Kono, K., & Tomonaga, M. (1999). Brain abscess caused by Streptococcus intermedius: two case reports. *Surgical neurology*, *51*(2), 219-222.
21. DeLance, A. R., Safaee, M., Oh, M. C., Clark, A. J., Kaur, G., Sun, M. Z., ... & Parsa, A. T. (2013). Tuberculoma of the central nervous system. *Journal of Clinical Neuroscience*, *20*(10), 1333-1341.
22. Ramachandran, R., Muniyandi, M., Iyer, V., Sripriya, T., Priya, B., & Govindarajan, T. G. (2017). Dilemmas in the diagnosis and treatment of intracranial tuberculomas. *Journal of the Neurological Sciences*, *381*, 256-264.
23. Bayındır, C., Mete, Ö., & Bilgic, B. (2006). Retrospective study of 23 pathologically proven cases of central nervous system tuberculomas. *Clinical neurology and neurosurgery*, *108*(4), 353-357.
24. Monteiro, R., Carneiro, J. C., Costa, C., & Duarte, R. (2013). Cerebral tuberculomas–A clinical challenge. *Respiratory Medicine Case Reports*, *9*, 34-37.
25. Idris, M. N. A., Sokrab, T. E., Arbab, M. A. R., Ahmed, A. E. M., El Rasoul, H., Ali, S., ... & Mirgani, S. M. (2007). Tuberculoma of the brain: a series of 16 cases treated with anti-tuberculosis drugs. *The international journal of tuberculosis and lung disease*, *11*(1), 91-95.
26. Awada, A., Daif, A. K., Pirani, M., Khan, M. Y., Memish, Z., & Al Rajeh, S. (1998). Evolution of brain tuberculomas under standard antituberculous treatment. *Journal of the neurological sciences*, *156*(1), 47-52.
27. Wasay, M., Kheleani, B. A., Moolani, M. K., Zaheer, J., Pui, M., Hasan, S., ... & Sarawari, A. R. (2003). Brain CT and MRI findings in 100 consecutive patients with intracranial tuberculoma. *Journal of Neuroimaging*, *13*(3), 240-247.
28. Sonmez, G., Ozturk, E., Sildiroglu, H. O., Mutlu, H., Cuce, F., Senol, M. G., ... & Kizilkaya, E. (2008). MRI findings of intracranial tuberculomas. *Clinical imaging*, *32*(2), 88-92.
29. Ma, H., Liu, Y., Zhuang, C., Shen, Y., & Wu, R. (2018). Clinical features and MRI findings of intracranial tuberculomas. *Radiology of Infectious Diseases*, *5*(4), 154-159.
30. Kilani, B., Ammari, L., Tiouiri, H., Goubontini, A., Kanoun, F., Zouiten, F., & Chaabene, T. B. (2003). Neuroradiologic manifestations of central nervous system tuberculosis in 122 adults. *La Revue de Médecine Interne*, *24*(2), 86-96.
31. Kioumehr, F., Dadsetan, M. R., Rooholamini, S. A., & Au, A. (1994). Central nervous system tuberculosis: MRI. *Neuroradiology*, *36*, 93-96.
32. Anuradha, H. K., Garg, R. K., Sinha, M. K., Agarwal, A., Verma, R., Singh, M. K., & Shukla, R. (2011). Intracranial tuberculomas in patients with tuberculous meningitis: predictors and prognostic significance. *The International journal of tuberculosis and lung disease*, *15*(2), 234-239.
33. Sencer, S., Sencer, A., Aydin, K., Hepgül, K., Poyanlı, A., & Minareci, O. (2003). Imaging in tuberculosis of the skull and skull-base: case report. *Neuroradiology*, *45*, 160-163.
34. Bathla, G., Khandelwal, G., Maller, V. G., & Gupta, A. (2011). Manifestations of cerebral tuberculosis. *Singapore Med J*, *52*(2), 124-131.
35. Huang, C. R., Lui, C. C., Chang, W. N., Wu, H. S., & Chen, H. J. (1999). Neuroimages of disseminated neurotuberculosis: report of one case. *Clinical imaging*, *23*(4), 218-222.