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REVIEW ARTICLE

Comparative Analysis of CT and MRI in Evaluating Brain Tumors: A Radiodiagnostic Perspective

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Abstract

Understanding brain tumors depends greatly on accurate imaging. Both magnetic resonance imaging (MRI) and computed tomography (CT) are commonly employed methods, and each has advantages and disadvantages of its own. This review focuses on open-access, PubMed-listed studies that compare brain tumor evaluation by CT and MRI. We review how the studies were done, how images were taken, how accurate the findings were and what the main pros and cons are for each type of imaging. Results demonstrate that CT is useful for rapid evaluations, especially in emergencies, but for diagnosing brain tumors, MRI with its clearer soft tissue images is more accurate. Sometimes, using both at the same time can make the diagnosis more certain. It was found that developing standard imaging procedures and exploring new imaging methods are needed. In the future, studies ought to concentrate on joining various imaging approaches to improve the way brain tumors are evaluated.

Keywords: Brain Tumors; Computed Tomography; Magnetic Resonance Imaging; Diagnostic Accuracy; Radiodiagnosis; Imaging Protocols

INTRODUCTION

Brain tumors are a group of different neoplasms that can seriously impact both brain function and the outlook for patients. Brain tumors are becoming more common globally, as both non-cancerous and

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cancerous growths play a major role in causing both ill health and death. To diagnose, classify, prepare for surgery, plan radiation therapy and monitor results, imaging is essential. Radiologists must carefully separate various tumor types and also tell apart tumor tissue, areas of swelling, dead tissue and normal brain tissue.

In this case, CT and MRI are the most common methods used for imaging. Due to being quickly performed, widely accessible and highly effective for detecting calcified and bloody areas, CT is commonly used first. Because MRI provides clear views of soft tissues and images from several angles, it is the main tool used to assess brain tumors. Even so, it is still unclear which imaging method is best for each situation, how accurate they are compared to one another and when two or more imaging techniques should be used together.

This article provides a comprehensive review of PubMed-indexed, open-access studies that compare CT and MRI in the evaluation of brain tumors. We examine imaging protocols, study methodologies, diagnostic performance metrics, and clinical utility. The goal is to identify best practices and current limitations to inform clinical decision-making and future research.

METHODOLOGY OF INCLUDED STUDIES

A search was carried out in PubMed with the terms "CT versus MRI in brain tumors," "comparative imaging brain tumors," and "diagnostic accuracy CT MRI brain neoplasms." Only those articles that were open-access and peer-reviewed and had been published between 2000 and 2024, were included in the study.

Studies were selected based on the following inclusion criteria:

- Head-to-head comparisons of CT and MRI in brain tumor imaging.
- Use of imaging protocols explicitly detailed within the article.
- Reporting of sensitivity, specificity, and/or diagnostic accuracy.
- Human studies.
- Full-text availability in open-access format.

Studies that focused exclusively on either CT or MRI, non-comparative analyses, or were not accessible as open-access articles were excluded. After screening titles, abstracts, and full-texts, 10 studies were included in the final analysis.

Data extraction focused on the following variables: study design, patient demographics, tumor types, imaging protocols, diagnostic performance, and key conclusions.

COMPARATIVE ANALYSIS

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Diagnostic Accuracy

A number of studies confirm that MRI is better at accurately depicting brain tumors since it can resolve details in soft tissue. The researchers Wang et al. (2016) found in primary brain lymphoma that MRI had the highest accuracy at 83.8%, higher than CT (82.8%), with both methods together giving even better accuracy (89.9%). Likewise, Stummer et al. (2000) pointed out that MRI identified additional metastases in the same patients as CT, where CT had suggested metastases in only one place.

Table 1 gives the sensitivity, specificity and total accuracy values found in some comparative studies. These data give a clear summary of how well CT and MRI perform in the diagnosis of brain tumors (Wang et al., 2016; Stummer et al., 2000).

Table no.1: Summary of Diagnostic Performance Metrics

Study	Tumor Type	Modality	Sensitivity (%)	Specificity (%)	Accuracy (%)
Wang et al. (2016)	Primary Brain Lymphoma	CT	75.5	67.4	82.8
		MRI	79.3	64.9	83.8
		CT + MRI	86.3	75.8	89.9
Stummer et al. (2000)	Brain Metastases	CT	-	-	-
		MRI	-	-	+31% lesion detection

Zhou et al. (2018) demonstrated that MRI is better than CT for assessing direct extension of malignant head and neck tumors, because it has better sensitivity and accuracy. Discrepancies in diagnostic accuracy are most obvious in posterior fossa tumors, brainstem lesions and situations requiring careful study of soft tissue interfaces (Zhou et al., 2018).

Imaging Protocols

When doing CT, doctors usually create axial images with contrast-enhanced scans that use iodinated contrast agents. It is very good at finding signs of calcification, skull changes and recent bleeding. Still, its disadvantages are that soft tissue contrast can be poor and radiation exposure is involved.

MRI makes use of T1-weighted, T2-weighted, FLAIR, DWI, GRE and contrast-enhanced imaging with gadolinium. Because of its clear images, MRI helps specialists tell apart tumor tissue from areas of necrosis and edema. PWI, DTI and MRS are advanced magnetic resonance imaging techniques that add to the characterization of tumors (Abrigo et al., 2018).

Table 2 points out that CT and MRI differ in how sensitive they are to contrast, how quickly they can perform, the amount of radiation they emit and what functions they offer.

Table no.2: Comparative Imaging Features

Feature	**CT**	**MRI**
Radiation	Yes	No
Calcification Detection	Excellent	Moderate
Soft Tissue Contrast	Poor	Excellent
Imaging Time	Fast	Longer
Availability	High	Moderate
Functional Imaging	No	Yes (PWI, MRS, DTI)

Clinical Use Scenarios

CT is the preferred imaging test in cases of acute trauma, suspected bleeding or when MRI cannot be used because of pacemakers or severe fear of confined spaces. MRI is the imaging modality of choice for finding tumors, determining their grade, planning surgery and monitoring how they respond to treatment. By using both CT and MRI, diagnosis may be improved when the results from one modality are not clear enough (Hojjati et al., 2018).

The table 3 shows different clinical situations and the recommended imaging techniques for each. It serves as a practical reference for clinicians deciding between CT and MRI in various situations.

Table no.3: Clinical Indications for CT and MRI Use

Clinical Scenario	**Preferred Modality**	**Rationale**
Acute Hemorrhage	CT	Rapid acquisition and sensitivity to blood

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Tumor Grading	MRI	Superior soft tissue characterization
Contraindicated MRI (e.g., pacemaker)	CT	Safe alternative
Treatment Response Monitoring	MRI	Functional sequences assess perfusion/metabolism

DISCUSSION

Evidence shows that MRI is superior to other imaging techniques in brain tumor detection. Although CT is still helpful in emergency situations and for bones, MRI gives much better images and outlines of different tissues. What's more, functional imaging helps it provide reliable results for tumor grading, planning treatments and following patients' progress.

Still, many low-resource areas cannot afford or access MRI machines, so CT is often the main option. In complex or uncertain cases, using both types of treatments together gives the best results. How procedures are carried out and how skilled the operator is can affect the results which proves the importance of standardization.

Gaps in Research and Future Scope

Although the findings are promising, many studies have low numbers of participants, are not done in real time and use different imaging methods. We must have many large studies that follow the same guidelines to compare results. In addition, the use of newer MRI methods such as functional MRI and molecular imaging to predict tumor behavior is not well studied.

Future research should also evaluate AI-assisted image interpretation in CT and MRI, as well as explore cost-effectiveness models in diverse healthcare settings. Combining imaging, histopathology and clinical information in a database may change how we diagnose and treat patients.

CONCLUSION

MRI offers superior diagnostic capabilities in evaluating brain tumors, especially for soft tissue characterization and treatment planning. CT retains importance in acute and contraindicated cases. A combined approach leveraging both modalities can optimize diagnostic accuracy and patient care. Standardization of imaging protocols and advanced multimodal studies are essential next steps.

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