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ROLE OF CONTRAST ENHANCED MRI IN DIAGNOSIS OF BRAIN TUMORS WITH PATIENTS HAVING BLURRED VISION AND HEADACHE IN LAHORE

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ABSTRACT

Background: *MRI using contrast boosts how well doctors spot brain tumors, since it shows irregularities more clearly. For patients with symptoms such as blurred vision and headache, advanced imaging is often warranted to investigate the presence of an underlying mass or lesion. This article endeavors to review the diagnostic value of enhanced MRI for diagnosing brain tumors in symptomatic patients.*

Objective: *The aim of this study will determine the diagnostic value of contrast-enhanced MRI for detecting brain tumors in patients who present to the hospital with blurred vision and headaches.*

Methodology: *This cross-sectional analytical study was conducted at Sheikh Zayed Hospital, Lahore, over four months and included 45 adult patients based on the prevalence 3%, selected through convenient sampling. Participants presented with headache and/or blurred vision and underwent contrast-enhanced MRI using standard sequences. Clinical imaging data were retrospectively reviewed and analyzed using SPSS version 25, with descriptive statistics and Chi-square tests applied to assess associations while maintaining ethical standards and patient confidentiality.*

Result: *Of the 45 people, ages and genders were fairly even though more were men (52.2%) and tended to be older. Right-side weakness showed up in 19.6%, blurry vision in 60%, headaches in 60.9%; yet 60.9% didn't have limb weakness at all. Most had physical brain issues mostly tumors (54.3%) or damaged areas (32.6%) spreading into nearby tissue half the time, though actual infiltration was uncommon (2.2%), along with strong pressure signs in 73.9%.*

Conclusion: *The study showed about equal numbers of men and women, mostly older people. Right-side weakness, fuzzy eyesight or head pain popped up a lot but major brain issues didn't show up much. A good chunk had physical changes in the brain, like growths or damaged areas, which frequently pressed on nearby tissue. Still, deep spreading damage or blocked fluid buildup hardly ever happened. Overall, the findings suggest that despite certain clinical and structural issues being highly prevalent, most participants exhibited conditions that were manageable or not particularly serious in nature.*

Keywords: *CE-MRI, Brain Tumours, Headache, Blurred Vision*

INTRODUCTION

Primary tumours of the central nervous system (CNS) comprise a diverse group of neoplastic conditions that arise from various cellular components within the brain and spinal cord. These tumors may present as benign or malignant forms. Despite advances in medical science, malignant brain tumors remain among the most difficult cancers to manage effectively and are considered some of the most aggressive tumors affecting humans [1]. Tumors of the brain and central nervous system (CNS) include neoplasms arising from the brain tissue, cranial nerves, spinal cord, spinal nerves and the meninges. These tumors are broadly divided into two major categories: malignant and non-malignant (benign) types. According to the World Health Organization (WHO) classification, CNS tumors are graded based on their biological behaviour, where lower-grade tumors indicate a more indolent course, while Grade III and Grade IV tumors represent high-grade or malignant forms, characterized by rapid growth and aggressive clinical outcomes [2]. Brain tumors represent a diverse group of neoplastic disorders that may originate within the brain (primary tumors) or spread from cancers elsewhere in the body (metastatic tumors). Among the malignant primary brain tumors, glioblastoma is the most prevalent type, typically arising from the glial cell lineage and known for its highly aggressive nature [3]. Metastatic brain tumors (MBTs) constitute the majority of intra-axial brain lesions in the adult population. It is estimated that up to one-third of individuals diagnosed with a primary cancer may eventually develop metastatic deposits in the central nervous system during the progression of their illness [4]. Timely detection and appropriate management of brain tumors are essential to prevent irreversible neurological injury and reduce the risk of mortality. In the domain of medical data analysis, feature selection and classification techniques are widely employed to evaluate patient information and differentiate between normal and abnormal findings with greater accuracy [5]. Patients with brain tumors frequently experience neurocognitive impairment, which significantly affects their quality of life. Early identification of such dysfunction is essential to initiate timely and effective neurocognitive rehabilitation strategies. In recent years, Raman spectroscopy has emerged as a promising technique for differentiating brain tumor tissues from normal structures. This technology enables accurate detection of tumor margins and supports the complete surgical excision of gliomas, which is a critical factor for improving postoperative outcomes during brain tumor surgery [6]. A detailed understanding of the complex, multistep progression of metastasis is based on three key concepts. First, tumors exhibit considerable heterogeneity, consisting of cancer cells that differ in morphology and phenotype, as well as in their proliferative, angiogenic, invasive and metastatic potential. Second, metastasis is a selective biological process in which only those cells that successfully complete the essential stages of the metastatic cascade are able to thrive and spread. Finally, the metastatic ability of a tumor relies on dynamic, bidirectional interactions between malignant cells, the surrounding tumor microenvironment and inherent homeostatic mechanisms that support tumor progression [7]. The most common brain tumor in adults is Meningioma according to data from Central Brain Tumor Registry of the United States (CBTRUS), meningiomas constitute approximately 36 % of all primary brain and central nervous system tumors. In 2015, CBTRUS projected that in the United States there would be about 24,000 new diagnoses of meningioma cases for that year [8]. The incidence of meningioma rises progressively with age and is observed to be approximately twice as common in females as in males. Additionally, its occurrence is about 20 % higher in Black populations compared to White populations. The majority of meningiomas are benign (Grade I), while 5–20 % are classified as atypical (Grade II) and only 1–3 % are malignant (Grade III) [9]. Glioma ranks as the second most common type of brain tumor in adults. According to 2015 estimates from the Central Brain Tumor Registry of the United States (CBTRUS), approximately 20,000 new glioma cases were diagnosed that year. Roughly half of these tumors are glioblastomas, which represent the most frequent malignant primary brain tumors in adults. Gliomas can arise

in nearly all lobes of the brain, with the frontal lobe being the most affected (23.6 %), followed by the temporal lobe (17.4 %), parietal lobe (10.6 %) and occipital lobe (2.8 %). A smaller proportion of gliomas are located in the brainstem, cerebellum and spinal cord [10]. Pituitary tumors rank as the third most common type of brain tumor in adults, accounting for approximately 15 % of cases. The majority of these tumors are benign, with pituitary adenomas representing the predominant subtype [11]. Symptoms can develop in individuals with pituitary tumors even when the tumors are non-functioning and do not secrete hormones, primarily due to the mass effect within the cranial cavity. Additionally, hormones that regulate normal pituitary activity, along with growth factors essential for the fetal development of the pituitary gland, appear to contribute to tumor proliferation [12].

Headache is a common symptom observed in nearly all patients with brain tumors. These headaches typically correspond to the temporal and spatial location of the tumor and often resolve within seven days following surgical removal or treatment with corticosteroids [13]. Studies indicate that the incidence of headaches in brain tumor patients is more closely associated with a family history of the condition than with the tumor's size [14]. Headache appears to be the most common presenting symptom, reported in approximately 41 % of patients in some studies. It is often accompanied by additional symptoms such as vomiting, gait instability, behavioral changes and cranial nerve deficits and tends to be most pronounced during the night or early morning hours [15]. The primary mechanism underlying headaches in brain tumor patients is thought to be pressure or traction exerted on pain-sensitive structures within and surrounding the skull. It is important to note that the brain parenchyma itself lacks pain receptors and therefore does not directly generate pain; rather, headache discomfort arises from the stimulation of adjacent structures [16]. Headaches were reported in 31 % of patients with supratentorial tumors and in 62 % of those with infratentorial tumors [17]. Abnormalities in cognitive and mental functions among brain tumor patients may be either specific or nonspecific. Specific deficits include aphasia, agnosia, abulia, alexia, and apraxia. Nonspecific manifestations, observed in approximately 16 -34 % of patients, can include irritability, personality changes, emotional lability, forgetfulness, reduced spontaneity or enthusiasm and delayed responses, which may progress to apathy and lethargy. Seizures represent the most frequent symptom in individuals with brain tumors, with their occurrence largely dependent on the tumor type and location; slow-growing tumors, in particular, are highly epileptogenic, affecting 30–100 % of such patients. Papilledema, indicative of raised intracranial pressure, is now an uncommon presenting sign. Similar to headaches, papilledema is more frequently seen in children and young adults, likely because in older adults, gradual tumor growth is often accompanied by cerebral atrophy, reducing the likelihood of this manifestation.[18] Patients with brain tumors who experience seizures often face increased morbidity and mortality, along with a significantly reduced quality of life [19]. Magnetic Resonance Imaging (MRI) is the most important modality for diagnosing brain tumors. It is widely used in biomedical imaging to visualize and detect fine structural details within the body. MRI enables differentiation between various tissue types and is generally considered superior to computed tomography (CT) in terms of soft tissue contrast and diagnostic accuracy [20]. Advanced MRI techniques, such as perfusion imaging, are increasingly utilized in the evaluation of brain tumors, based on the principle of increased tumor angiogenesis. Determining thresholds for relative cerebral blood volume (rCBV) on contrast-enhanced MRI (CE-MRI) has proven valuable in differentiating between high-grade and low-grade brain tumors [21]. Gadolinium-based contrast agents (GBCAs) have also been shown to enhance tumor visualization by clearly delineating tumor margins and distinguishing them from surrounding perifocal edema [22]. All gadolinium-based contrast agents (GBCAs) contain gadolinium, a rare-earth element, which possesses seven unpaired electrons the highest number among stable ions generating a strong magnetic moment that effectively enhances proton relaxation during MRI. [23,24]. Paramagnetic imaging enhancement Media reduce the T1

(longitudinal) and T2 (transversal) relaxation durations of nearby water protons to indirectly generate an effect of enhancing signals [25]. The ability of gadolinium-based contrast agents (GBCAs) to shorten relaxation times varies depending on their intrinsic relaxation characteristics and the properties of the surrounding tissue [26]. Research has highlighted the use of computer-aided feature extraction techniques on abnormal brain MRI scans to improve the accuracy of tumor classification. The MRI images are first pre-processed and divided into 3 × 3pixel blocks. For each block, 22 distinct texture features are extracted. These extracted features are then employed to classify brain tissue as either normal or abnormal, enhancing the precision of automated diagnostic outcomes [27]. The brain regulates all vital functions of the human body, and any disease affecting it can have serious consequences on overall health. Brain tumors, resulting from abnormal cellular growth, represent one of the most critical neurological disorders. Automated brain tumor classification plays a crucial role in the early detection of tumors, enabling timely diagnosis and improving patient survival. Additionally, such systems can support radiologists in clinical decision-making and treatment planning. In this study, we propose a novel approach for classifying three types of brain tumors Meningioma, Glioma and Pituitary tumors using MRI images. The process begins with pre-processing of the MRI scans to enhance image quality for subsequent analysis [28]. Recent advances in the study of primary brain tumors have demonstrated that specific molecular signatures can help predict tumor behavior. Traditional classification systems based on histology and morphology may, in the future, be complemented by molecular markers that provide insights into tumor progression and differentiation [29]. Magnetic resonance imaging of brain image analysis has significantly advanced the field of medicine by offering valuable insights. Various approaches to retrieve and display insights from healthcare data, gathered through multiple acquisition techniques. Tumor in the brain Segmentation is an important procedure for obtaining information from intricate MRI brain images. Magnetic resonance imaging (MRI) Methods provide an effective way to identify various types of diseases. The method for automated detection has profoundly enhanced understanding of typical and pathological examination for medical research [30]. Magnetic Resonance Imaging (MRI) is a particularly valuable tool in this context because of its high spatial resolution (approximately 10 μm in high-field scanners) and its capacity to noninvasively image entire organisms. Functional MRI (fMRI), which relies on contrast related to cerebral hemodynamics, provides an indirect assessment of neural activity [31].

Rationale of the study:

This research is designed to assess that brain tumors most often present with headache and blurred vision, so early diagnosis is crucial to avoid permanent neurological or visual loss. CE-MRI is globally accepted to enhance tumor visibility, but Pakistani evidence from Lahore is limited. Current Pakistani literature reports on general use of MRI or tumor epidemiology, not correlating findings with presenting symptoms. Important gaps consist of accurate diagnostic information, effects on clinical management, and CE-MRI access or safety issues. The present study will provide locally applicable evidence to inform timely referrals, streamline imaging protocols and inform healthcare policy in Lahore.

AIMS AND OBJECTIVES

To evaluate role of contrast enhanced MRI in diagnosis of brain tumors with patients having headache and blurred vision.

METHODOLOGY

This cross-sectional analytical study was conducted at Sheikh Zayed Hospital, Lahore, over a four-month period. A total of 45 patients were selected using convenient sampling, with the sample size calculated at a 95% confidence level and a 5% margin of error based on an expected prevalence of 3% [32], using the formula n=Z2P(1−P) d2n = \frac {Z^2 P(1-P)} {d^2} n=d2Z2P(1−P). The study included adults (≥18 years) presenting with headache and/or blurred vision, with no history of brain surgery or cranial radiation, normal or stable renal function, and

complete, good-quality MRI scans. Patients with MRI contraindications, contrast allergies, severe renal impairment (eGFR < 30 mL/min/1.73m²), pregnancy, or poor-quality or incomplete imaging were excluded. Imaging was performed using the Canon Medical Systems Vantage Orian 1.5T MRI system, employing standard MRI sequences including T1, T2, FLAIR, and DWI. Gadolinium-based contrast (0.1 mmol/kg) was administered intravenously, and post-contrast T1-weighted fat-suppressed images were acquired 3–5 minutes after injection in accordance with established safety protocols. Clinical data from patients aged 18-40 years with brain tumors identified on contrast-enhanced MRI at Sheikh Zayed Hospital were retrospectively reviewed in compliance with ethical guidelines. Prior ethics approval was obtained, and all patient identifiers were removed to ensure confidentiality. Demographic information, clinical history, tumor type, and available histopathology reports were collected from medical records and correlated with imaging findings. Data were analyzed using SPSS version 25. Descriptive statistics, including frequencies and percentages, were used to summarize categorical variables. Associations between categorical variables were assessed using the Chi-square (χ^2) test of independence. All data were securely stored and managed in Microsoft Office until analysis was completed.

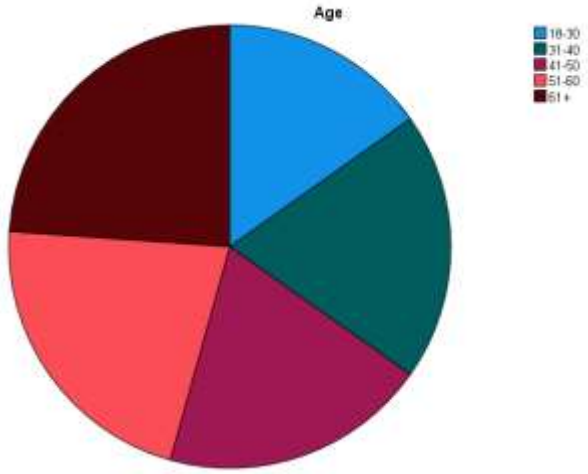
RESULTS

The research looked at information from 45 people; ages spread out pretty evenly, though patients aged 51-60 and older made up a bit more, showing slightly higher numbers of older adults. When it came to gender, men were 52.2%, women 47.8% - so nearly balanced, barely any gap between them. As for signs of illness, about 60.9% didn't feel weak physically, but 39.1% did experience some level of fatigue or muscle issues, mostly on the right side, which showed up in 19.6%. Sixty percent of the participants reported blurred vision as part of the visual disturbances within this group. Structural and diagnostic findings showed that most participants had abnormalities, with 54.3% being diagnosed with a mass, 32.6% with a lesion alone, and 10.9% showing a combined mass/lesion, while only 2.2% did not have an abnormality. It was also noted that extension of abnormalities occurred in 50% of cases, though true invasion was quite rare at 2.2%. A mass effect was quite significant in 73.9% of the participants, whereas obstructive hydrocephalus was relatively infrequent at 19.5%. Headaches were reported by 60.9% of the respondents, which further indicated that though certain symptoms were common, they did not affect all participants uniformly.

The age spread stays fairly balanced across categories, though numbers go up a bit for people 51–60 and those over 61 - so most participants here are middle-aged or older

Age

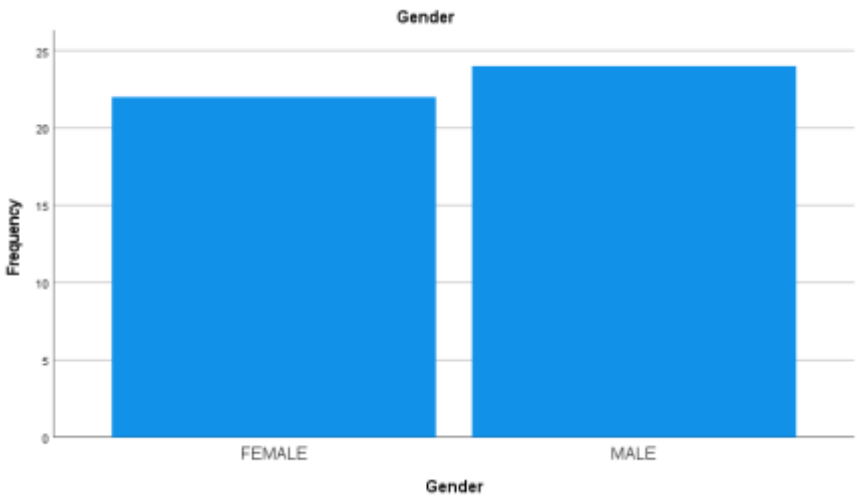
		Frequency	Percent
Valid	18-30	7	15.2
	31-40	9	19.6
	41-50	9	19.6
	51-60	10	21.7
	61+	10	23.9
	Total	45	100.0



The split between genders is almost even - males make up 52.2%, while females account for 47.8%. These small gaps show up clearly in the bar graph, where both groups appear close in size.

Gender

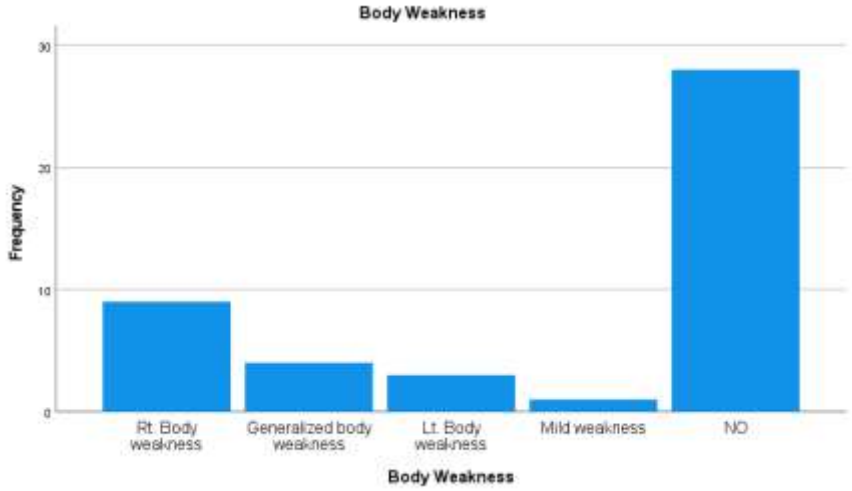
		Frequency	Percent
Valid	Female	22	47.8
	Male	23	52.2
	Total	45	100.0



Most respondents, 60.9%, had no body weakness, while 39.1% had different types; right-sided weakness was the most predominant, at 19.6%. Generalized, left-sided, and mild weaknesses were less frequent; thus, significant weaknesses among this group is not common.

Body Weakness

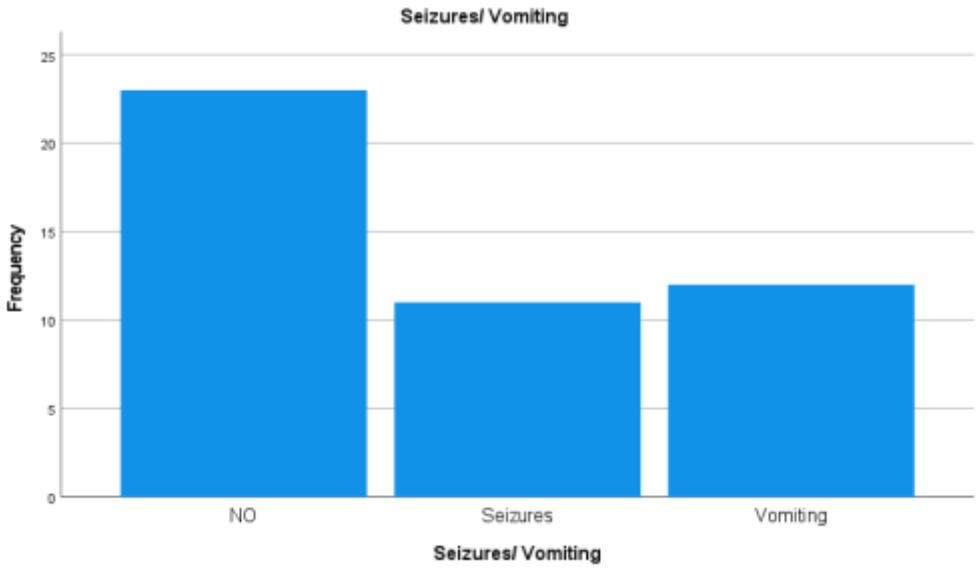
		Frequency	Percent
Valid	Rt. Body weakness	9	19.6
	Generalized body weakness	4	8.7
	Lt. Body weakness	4	6.5
	Mild weakness	1	2.2
	NO	27	60.9
	Total	45	100.0



Blurred vision was reported by 60.9% of the participants, showing it to be a frequent visual disturbance in the group. A further 39.1% did not have blurred vision, demonstrating that although this symptom occurred frequently, it did not occur in everyone.

Seizures/ Vomiting

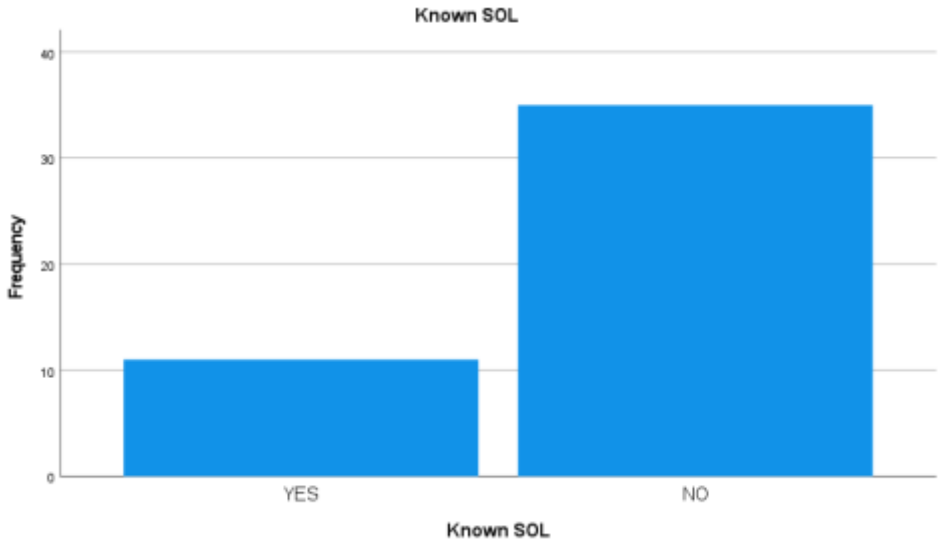
		Frequency	Percent
Valid	NO	22	50.0
	Seizures	11	23.9
	Vomiting	12	26.1
	Total	45	100.0



Most of the respondents, 76.1%, had no known SOL, while 23.9% were those who were identified to have confirmed SOL. This indicates that though most of them were clear, almost one-quarter had a serious underlying clinical condition.

Known SOL

		Frequency	Percent
Valid	YES	11	23.9
	NO	34	76.1
	Total	45	100.0



The diagnosis of a mass was made in more than half of the participants (54.3%), while additional cases showed either a lesion alone (32.6%) or a combined mass/lesion presentation (10.9%). Only 2.2% showed no abnormality, indicating that structural findings were present in most individuals.

Mass/ Lesion

		Frequency	Percent
Valid	Mass	24	54.3
	Mass or Lesion	5	10.9
	Lesion	15	32.6
	NO	1	2.2
	Total	45	100.0

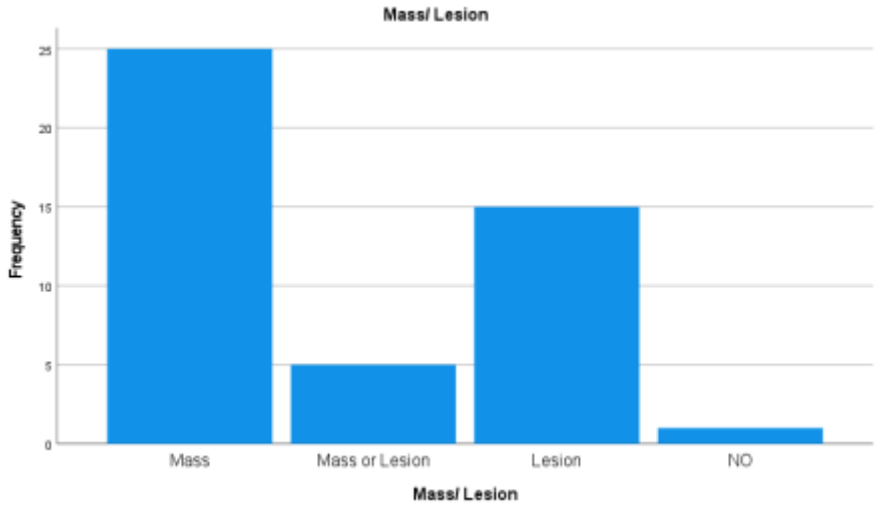
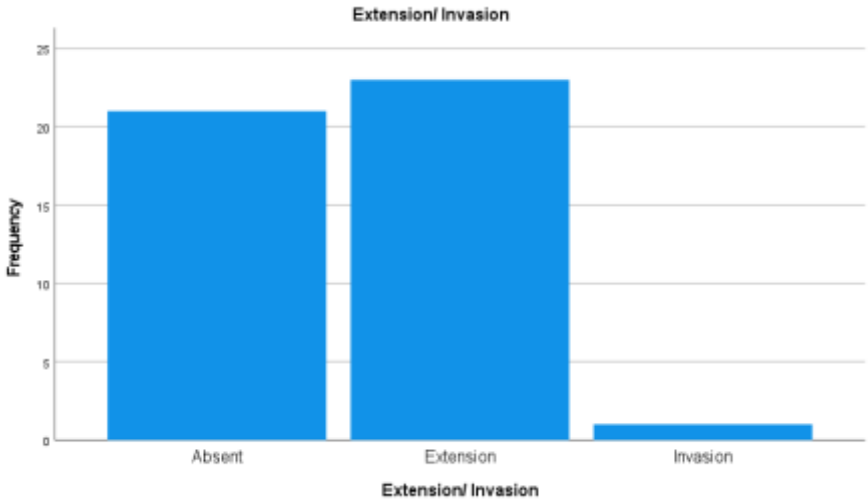


FIG 4.6

Of these, 50% demonstrated extension of the abnormality, 45.7% had no extension, and a small proportion showed invasion at 2.2%. This hints at how, even though lots of tumors moved past the original spot, actual deep invasion didn't happen often.

Extension/ Invasion

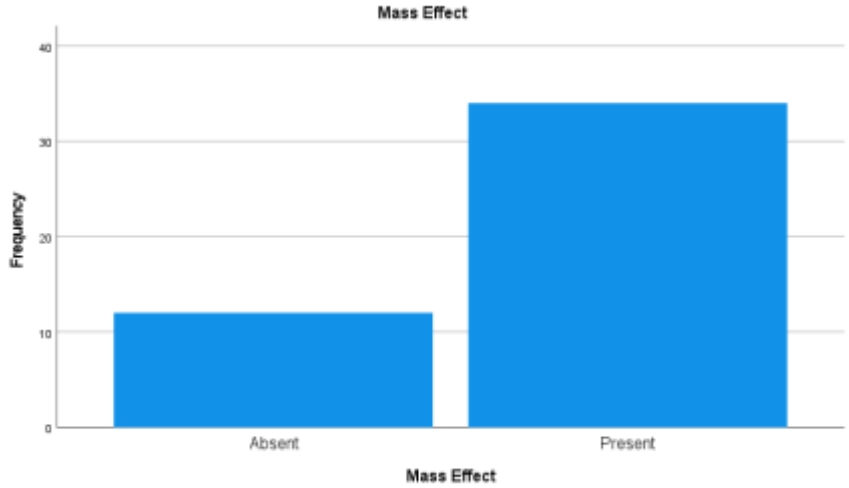
		Frequency	Percent
Valid	Absent	21	45.7
	Extension	23	50.0
	Invasion	1	2.2
	Total	45	100.0



Most people showed clear signs of swelling, since 73.9% had visible shifting or squeezing in nearby areas; meanwhile, just 26.1% didn't show such changes - hinting that bulkier issues were common.

Mass Effect

		Frequency	Percent
Valid	Absent	11	26.1
	Present	34	73.9
	Total	45	100.0

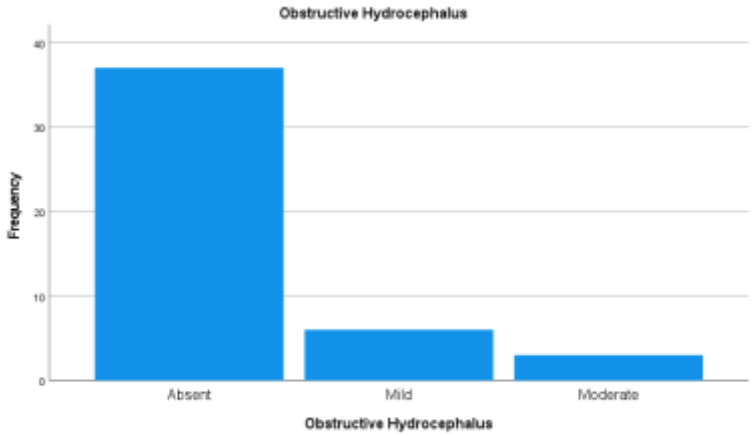


Most folks didn't have blocked fluid buildup - about 80%. Just under 19.5% had slight or mid-level signs. That shows the issue wasn't common, yet still popped up now and then. Still, there were clear differences in how much pressure built up in their brains.

Obstructive Hydrocephalus

		Frequency	Percent
Valid	Absent	36	80.4

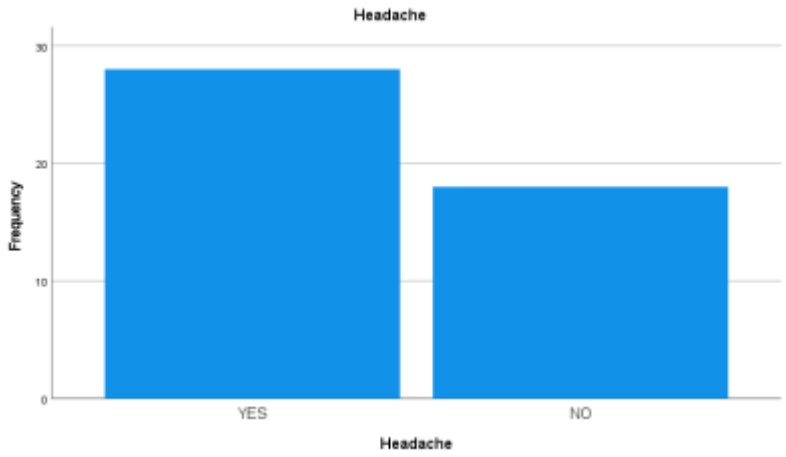
	Mild	6	13.0
	Moderate	3	6.5
	Total	45	100.0



Headaches showed up often - seen in 60.9% of people taking part. Yet nearly 39.1%, didn't feel any head pain at all, so even if it's widespread, not everyone gets them.

Headache

		Frequency	Percent
Valid	YES	28	60.9
	NO	17	39.1
	Total	45	100.0

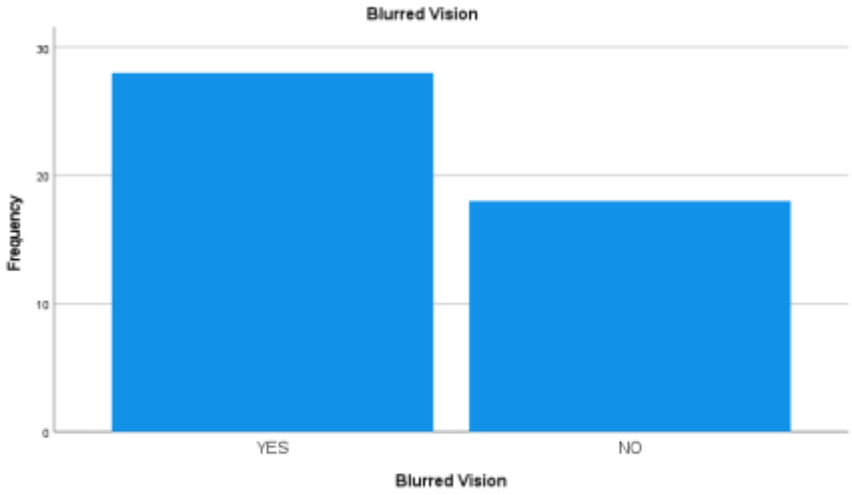


Some people said their sight got blurry about 60.9%. That means lots noticed this change when looking at things. But nearly 39.1% didn't see anything like that, so it wasn't something everyone went through.

Blurred Vision

Frequency	Percent	Frequency

Valid	YES	28	60.9
	NO	17	39.1
	Total	45	100.0



Crosstabs of Tumor Type * Headache

Count

		Headache		
		YES	NO	Total
Tumor Type	Intra-axial tumor	18	0	18
	Extra-axial tumor	1	17	18
	Metastasis	9	0	9
Total		28	17	45

The numbers show a strong link between kind of tumor and whether headaches happen. Not only do all people with intra-axial growths get head pain, but also everyone with spread-out cancer does too. On the flip side, those with outer brain tumors mostly don't feel such discomfort. In total, out of 45 patients, 28 ended up having headaches mostly tied to inner mass types or advanced disease.

Crosstab

Count

		Blurred Vision		
		YES	NO	Total
Tumor Type	Intra-axial tumor	0	17	17
	Extra-axial tumor	19	0	19
	Metastasis	9	0	9
Total		28	17	45

Fuzzy eyesight showed up a lot with outer-brain growths and spread-out cancer - every single person

had it. But when the tumors were inside the brain tissue, no one reported blurry sight, which made the difference between types crystal clear.

Mass Effect * Tumor Type Crosstabulation

Count

		Tumor Type			
		Intra-axial tumor	Extra-axial tumor	Metastasis	Total
Mass Effect	Absent	2	4	5	11
	Present	16	15	3	34
Total		18	19	8	45

The info shows mass effect popped up in nearly every tumor kind especially seen in intra-axial and outer ones. Only a few patients had no sign of it, with even fewer cases across each group.

DISCUSSION

In this study, clinical manifestations largely reflect patterns already established in neuro-oncology literature. Headache, which is presented in 60.9% of the respondents, is generally recognized as one of the most common presenting symptoms of intracranial tumors; Park et al. (2024) and Do et al. (2018) [33,34] reported headache frequencies ranging from 48% to 70% among brain tumor patients. The high prevalence of blurred vision (60%) agrees with studies by Agarwal et al. (2022) and Khan et al. (2020) [35,36], in which it was stated that visual disturbances, including blurred vision, decreased acuity, and papilledema, are frequent manifestations of raised intracranial pressure or tumor compression of the visual pathway. Motor weakness was observed in 39.1% of the patients, mostly unilateral weakness, which again corroborates the findings of Hossain et al. (2011) and Jain et al. (2016)[37,38], who highlighted that the strong associations of focal neurological deficits were with tumor location in motor cortex or corticospinal tracts. The predominance of the structural abnormalities on MRI, including masses in 54.3% and mass effect in 73.9%, corresponds to radiologic descriptions by Mallucci et al. (2012) and Osborn (2018)[39,40], who described mass effect and peritumoral edema as key imaging hallmarks associated with symptom severity. Obstructive hydrocephalus occurred in 19.5% of the patients, a prevalence consistent with the remarks of Young et al. (2019) [41] that hydrocephalus predominantly occurs with tumours that are situated close to the pathways of ventricular outflow. The incidence of true invasion relatively remains low at 2.2%, as explained by Louis et al. (2021)[42], since many brain tumours displace, rather than infiltrate adjacent structures, depending on tumour histology. Overall, these clinical and radiological trends within the research study reinforce the global evidence that brain tumors present with a combination of headache, visual disturbance, focal deficits, and mass-related imaging changes, pointing to the need for early detection and detailed imaging studies.

Limitations

There are several limitations that need to be addressed regarding this study. First, the sample size was limited to patients presenting within a specific time frame at selected hospitals in Lahore, which may restrict the generalizability of the findings to the larger population. Convenient sampling may further introduce selection bias, as the patients included may not fully represent all those presenting with headache or blurred vision due to brain tumors. The investigation was restricted to findings on contrast-enhanced MRI without the availability of advanced imaging techniques such as diffusion tensor imaging, perfusion studies, or MR spectroscopy. All these modalities could further enhance diagnostic accuracy. Inter-observer variability among

reporting radiologists was not calculated, which is a factor that can affect the consistency of MRI interpretation. Lastly, histopathological confirmation was not possible in some cases due to clinical or financial limitations, thus limiting the correlation of MRI findings with the final tumor type.

Recommendations

Based on the results of this study, several recommendations can be proposed to improve diagnostic accuracy and patient outcomes. Contrast-enhanced MRI should be used routinely in patients presenting with persistent headache and visual disturbances, as it significantly enhances the detection of intracranial lesions. Future studies should include larger and more diverse patient populations across multiple centers to enhance generalizability. Incorporating advanced MRI techniques, such as perfusion imaging, diffusion studies, and MR spectroscopy, is recommended to enable better lesion characterization and differentiation of tumor types. Standardized reporting protocols and inter-observer comparison are also advisable to reduce variability in radiological interpretation. Lastly, MRI findings should be correlated with histopathology whenever possible to enhance diagnostic reliability and provide more precise clinical decision-making.

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