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PITUITARY ADENOMAS EVALUATION USING MAGNETIC RESONANCE IMAGING: A SINGLE-CENTER OBSERVATIONAL STUDY

Dr Kailash Kumar Daseja[1*], Dr Din Muhammad Sohu[2], Dr Mohsin Hussain[3], Dr Daulat Ram[4], Dr Manoj Kumar[5], Dr Mohammad Ali Naper[6]

[1*]Assistant Professor, Department of Radiology, Chandka Medical College Hospital, Shaheed Muhtarma Benazeer Bhutto Medical University, Larkana, Pakistan
[2]Assistant Professor, Department of Radiology, Chandka Medical College Hospital, Shaheed Muhtarma Benazeer Bhutto Medical University, Larkana, Pakistan
[3]Assistant Professor, Department of Radiology, Pir Abdul Qadir Shah Jeelani Institute of Medical Science, Gambat, Khairpur Mirs, Pakistan
[4]Consultant Psychiatrist, Mental health Counseling unit, Chandka Medical College, Larkana, Sindh, Pakistan
[5]Senior Registrar, Department of Medicine, Jinnah Postgraduate Medical Center, Karachi, Pakistan
[6]Assistant Professor, Department of Surgery, Chandka Medical College Hospital, Shaheed Muhtarma Benazeer Bhutto Medical University, Larkana, Sindh, Pakistan

***Corresponding author:** Dr Kailash Kumar Daseja
[*]Assistant Professor, Department of Radiology, Chandka Medical College Hospital, Shaheed Muhtarma Benazeer Bhutto Medical University, Larkana, Pakistan

ABSTRACT

Objective: To assess magnetic resonance imaging's (MRI) precision and efficacy in the early identification of pituitary adenomas.

Methodology: In this cross-sectional study conducted at Chandka Medical College Hospital, Shaheed Muhtarma Benazeer Bhutto Medical University, Larkana, Sindh, Pakistan, 70 patients suspected of pituitary lesions were examined using MRI. All subjects gave their informed consent, and ethical approval was secured. Patients underwent thorough clinical evaluations and laboratory tests to assess pituitary function and rule out contraindications for MRI. MRI scans were performed using a 1.5 Tesla unit, with a standardized protocol including pre-contrast and post-contrast T1 and T2-weighted images. Dynamic imaging was conducted following gadolinium contrast administration. The study aimed to correlate clinical findings with MRI results to enhance diagnostic accuracy and guide patient management.

Results: In a cohort of 70 suspected patients of pituitary lesions, comprising 38 males and 32 females, our study identified 43 cases (61.4%) of pituitary macroadenoma and 27 cases (38.6%) of microadenoma. Clinical presentations included headaches (30%), visual disturbances (25%), or a combination of both (33%), with a minority exhibiting acromegaly (1%) or various hormonal irregularities. MRI revealed diverse characteristics of macroadenomas, extending in size from 1.2 to 4.9cm, with predominant homogeneous signal-intensity (60.5%) and encasement of the infundibulum (83.7%). Additionally, microadenomas typically exhibited isointense signals on T1WI (81.5%) and ranged in size from 3 to 9 mm, with lateral localization in the majority (85.2%). Elevated prolactin levels were common in both macroadenomas (90.7%) and microadenomas (81.5%).

Conclusion: This particular research highlights the critical importance of MRI in diagnosing and treating conditions related to the hypothalamus and pituitary gland. Through its ability to provide detailed imaging and differentiate between various disorders, MRI plays a crucial role in guiding treatment decisions, whether surgical or conservative. Our study emphasizes the essential role of MRI in optimizing patient care and tracking treatment progress, demonstrating its significance in improving overall patient outcomes.

Keywords: Pituitary adenoma, microadenoma, macroadenoma, MRI, Dynamic MR

Introduction

The field of pituitary gland imaging has witnessed significant advancements in recent years, transitioning from indirect evaluation methods to sophisticated direct visualization techniques.[1] Historically, pituitary gland dysfunction was assessed indirectly by evaluating the Sella turcica through skull films and tomography.[2] These methods, however, have been largely supplanted by computed tomography (CT) and magnetic resonance imaging (MRI), which allow for direct visualization of the gland. The introduction of these imaging techniques has improved our knowledge of the anatomical linkages throughout the brain and consequently raised the accuracy of detection of pituitary abnormalities.[3]

Among the advancements in imaging technology, dynamic contrast-enhanced MRI has emerged as a pivotal tool in the diagnosis and management of pituitary adenomas. This technique not only aids in the early detection of these tumors but also provides essential information regarding their nature, extent, and operability, thereby guiding surgical planning and treatment strategies.[4] As the most sensitive way to diagnose pituitary microadenomas, magnetic resonance imaging (MRI) has become the standard imaging modality for examining the pituitary gland. This is especially true for symptomatic patients who present with conditions like galactorrhea, irregular menstruation, amenorrhea, or compromised reproductive function, where pituitary adenomas and prolactin disorders are frequently associated. Sensitivities for MRI in detecting microadenomas are reported to be around 85-90% for contrast-enhanced studies.[5-6]

High-resolution MRI has now surpassed CT as the preferred choice for diagnosing pituitary microadenomas due to its superior sensitivity. The efficacy of detecting these lesions on MR images heavily depends on the image contrast between the microadenoma and the normal pituitary tissue.[7] Contrast-enhanced MR imaging, particularly with rapid dynamic techniques, enhances this contrast and thus improves detection rates. Optimal image contrast is typically achieved within less than a minute after the injection of the contrast agent, outperforming conventional contrast-enhanced imaging methods. This rapid enhancement is crucial as it maximizes the visibility of microadenomas against the normally enhancing pituitary gland, which lacks a blood-brain barrier and shows a distinctive enhancement pattern with contrast agents.[8]

Pituitary adenomas, which are the third most common primary intracranial neoplasm in adults, present with clinical features due to either excess or deficient hormone secretion or due to their mass effect.[9] An essential technique in the assessment of pituitary adenomas, MRI is still needed despite continuous discussions concerning its diagnostic sensitivity, specificity, and accuracy. Because it uses the differential augmentation patterns to distinguish between normal pituitary structures and adenomas, dynamic gadolinium-enhanced magnetic resonance imaging (MRI) of the pituitary gland is very useful.[10] Dynamic MRI, which is normally carried out in a coronal direction, can, however, overlook minute lesions that are situated at the front or posterior portions of the gland or in between slices, emphasizing the necessity for comprehensive imaging techniques.[11]

The development of higher magnetic field strengths, from 1.5T to 3T, in MRI has further improved the clarity of imaging, particularly for small pituitary microadenomas.[12] Despite these advancements, precise preoperative identification of microadenomas remains challenging. Pharmacotherapy plays a pivotal role in treating functional pituitary microadenomas, yet trans-sphenoidal surgery remains the gold standard for resection.[13] Accurate preoperative imaging is crucial for successful surgical outcomes, and while dynamic contrast-enhanced MRI is commonly used, alternative modalities such

as methionine positron-emission tomography (PET) are being explored for their potential in better visualizing these tumors.[14]

This study aims to evaluate the accuracy, sensitivity, and specificity of MRI in detecting pituitary adenomas. By doing so, we seek to solidify the role of MRI in the early detection and management of these tumors, ensuring better clinical outcomes for affected patients. Through comprehensive analysis, we aim to affirm MRI's status as the most effective imaging modality for pituitary adenomas, ultimately enhancing diagnostic and therapeutic approaches in clinical practice.

Objective

To assess magnetic resonance imaging's (MRI) precision and efficacy in the early identification of pituitary adenomas.

Methodology

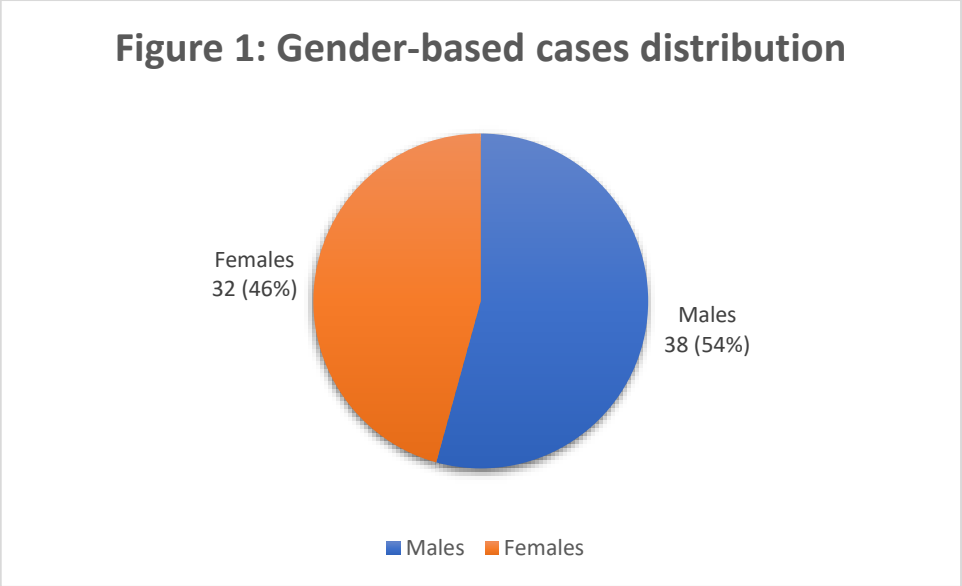
A cross-sectional study was carried out on 70 patients presenting with clinical suspicion of pituitary lesions. This study took place at Chandka Medical College Hospital, Shaheed Muhtarma Benazeer Bhutto Medical University, Larkana, Sindh, Pakistan, spanning across two years from January 2022 to December 2023. The patient population included individuals aged 18 to 75 years, comprising 38 males and 32 females. The institute's ethics committee approved the study, and each participant gave their informed consent before they were enrolled.

Patients with suspected pituitary abnormalities were the focus of the inclusion criteria; these patients were primarily referred from the departments such as Medicine, Neurology, and Endocrinology on the basis of their clinical presentations. These clinical characteristics, which may result in symptoms like headaches or impairments in vision, were linked to either the invasive effect of pituitary adenomas on nearby structures or the hypo- or hyperfunctioning of the pituitary gland. A thorough clinical history, comprehensive clinical examination, and laboratory workup were conducted for all patients. Depending on the clinical symptoms, the diagnostic assays comprised serum prolactin, growth hormone, serum IGF-1, serum ACTH, 24-hour urine free cortisol, serum TSH, T3, T4, FSH, and LH. Patients with ferromagnetic prosthetic valves, pacemakers, aneurysm clips, bare-metal coronary stents, and claustrophobia were among the exclusion criteria. The study proforma carefully documented the results of the laboratory tests and clinical diagnoses in order to correlate them with the imaging results. The MR scans were performed using a 1.5 Tesla [Machine Name/Model] unit from [Company Name], equipped with a head matrix coil. Adult patients had to fast for eight hours before the procedure in order to reduce the possibility of problems from the contrast, like nausea. Renal function tests were checked to ensure they were within normal limits before administering the contrast agent. For apprehensive or uncooperative patients, intravenous midazolam was used. Patients were thoroughly briefed about the procedure in their vernacular language and the importance of remaining still during the imaging process.

High-spatial-resolution pictures with a respectable signal-to-noise ratio have to be obtained as part of the MRI procedure. A narrow field of view (20x25 cm), thin slices (3 mm), and a high-resolution matrix (256x512) were used to first create pre-contrast T1 and T2 weighted spin echo scans in the axial, coronal, and sagittal planes. Following that, all three planes of T1 fat-saturated dynamic and post-contrast pictures were taken. A three-dimensional gradient echo sequence transformed by Fourier transform was used for the dynamic research. A dosage of 0.05–0.1 mmol/kg of gadolinium contrast agent was administered intravenously. Six sets of three pictures in the coronal plane were taken every ten seconds after the injection.

Results

Out the 70 cases, the sample consisted of 38 (54%) males and 32 (46%) females (Figure 1).

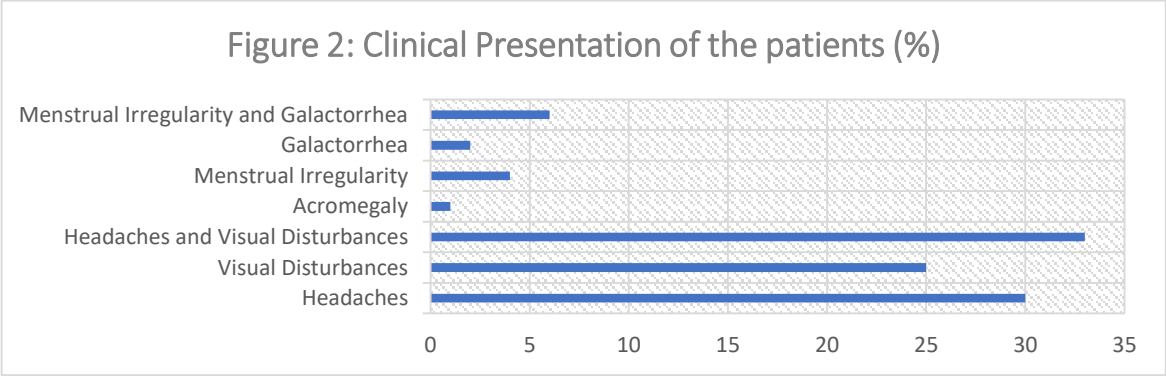


Out of the total 70 cases, 43 (61.4%) were diagnosed with pituitary macroadenoma, whereas 27 (38.6%) with microadenoma. The age-wise distribution of both macro and micro adenomas is shown in table-1.

Table 1: Age-related allocation of adenomas

Age (in Years)	Macroadenomas (N)	Macroadenomas (%)	Microadenomas (N)	Microadenomas (%)
0 – 20	2	4.7	1	3.7
21 – 30	14	32.6	10	37.0
31 – 40	10	23.3	7	25.9
41 – 50	8	18.6	5	18.5
51 – 60	6	14.0	3	11.1
61 – 70	3	7.0	1	3.7
Total	43	100	27	100

Of these individuals, figure 2 shows that 30% had headaches, 25% had visual disturbances, 33% had both headache and visual issues, 1% had acromegaly, 4% had irregular menstruation, 2% had galactorrhea, and 6% had both irregular menstruation and galactorrhea. 26 (60.5%) of the cases of acroadenoma were male, and 17 (39.5%) happened to be female.



The distribution of macroadenomas by type included 9 (20.9%) cases of purely sellar macroadenomas, 19 (44.2%) cases with suprasellar extension, 3 (7.0%) cases with sphenoid sinus invasion, and 12 (27.9%) cases with both suprasellar and sphenoid sinus invasion. Macroadenomas ranged in size, with

18 (41.9%) cases measuring between 1-3 cm and 25 (58.1%) cases measuring between 3-5 cm. The macroadenomas ranged in size from 1.2 cm for the smallest to 4.9 cm for the largest.
Of the macroadenomas on MRI, 26 (60.5%) had homogeneous signal intensity, and 17 (39.5%) had heterogeneous signal intensity. Furthermore, on both T1-weighted imaging (T1WI) and T2-weighted imaging (T2WI), 26 (60.5%) patients had isointense appearances. The macroadenoma showed up as hyperintense on T2WI and isointense on T1WI in 11 (25.6%) of the cases. The macroadenoma showed hypointense appearance on T1WI in 3 (7.0%) and hyperintense appearance on T2WI in 14 (32.6%) patients, indicating cystic alterations. On both T1WI and T2WI, three (7.0%) instances showed hyperintense appearances, suggesting internal bleeding.
In 36 (83.7%) of the cases, the infundibulum could not be visualized individually, indicating encasement or involvement. The infundibulum was seen individually in 7(16.3%) of the remaining cases; deviations were observed in 4(57.1%) patients to the left, 2(28.6%) cases to the right, and 1(14.3%) case in the midline. In 25 (58.1%) cases, the optic chiasma was compressed; in 5 (11.6%) cases, it was abutted; and in 13 (30.2%) cases, it was not involved.
In four cases (9.3%), hydrocephalus was the result of the suprasellar aspect of the macroadenoma compressing the third ventricle. Twenty (46.5%) patients had the third ventricle uninvolved, while 19 (44.2%) cases had the macroadenoma abutting it without resulting in hydrocephalus. Post-contrast imaging revealed homogenous enhancement in 26 (60.5%) cases, while 17 (39.5%) cases showed heterogeneous enhancement, indicative of necrosis, hemorrhage, or cystic change.
39 (90.7%) of the cases of macroadenomas that were identified as prolactinomas had increased prolactin levels, while 2 (4.7%) of the cases showed elevated growth hormone levels. Non-functioning macroadenomas accounted for 2 (4.7%) cases. Histopathologic findings confirmed the MRI results in 30 (69.8%) of the surgically managed cases, while the remaining 13 (30.2%) patients were treated conservatively. Whereas in microadenomas, the prolactin levels were elevated in 22 (81.5%) cases, diagnosed as prolactinomas. Somatotrophic adenoma was detected in one case (3.7%) with elevated growth hormone levels, while four other cases (14.8%) were unintentional findings. This is shown in table-2.

Table Characteristics of adenomas **-2:**

Category	**Number of Cases (N)**	**Percentage (%)**
Macroadenomas (N=43)		
Increased Prolactin Levels (Prolactinomas)	39	90.7
Raised Growth Hormone Levels (Somatotrophic Adenoma)	2	4.7
Non-functional Macroadenomas	2	4.7
Histopathologic Findings Confirmed	**30**	**69.8**
Treated Conservatively	**13**	**30.2**
Microadenomas (N=27)		
Increased Prolactin Levels (Prolactinomas)	22	81.5
Raised Growth Hormone Levels (Somatotrophic Adenoma)	1	3.7
Incidental Findings	4	14.8

Twelve patients (44.4%) had a superior convex surface on their pituitary MRI, nine (33.3%) had a concave surface, and six (22.2%) had a flat superior surface. In ten cases, there was a noticeable shift of the infundibulum from the midline.

According to plain MRI, 5 (18.5%) and 22 (81.5%) of the microadenomas had hyperintense signals on T2WI and T1WI, respectively, suggesting that they were cystic microadenomas. Variation in the microadenomas' enhancement was seen by dynamic contrast imaging; these lesions were comparatively non-enhancing within the highly enhancing pituitary gland. Microadenomas ranged from 3-9 mm in size, with 23 (85.2%) located laterally and 4 (14.8%) in the midline.

Discussion

The historical reliance on lateral skull x-rays for pituitary imaging has been supplanted by more advanced modalities, driven by their superior sensitivity and ability to delineate soft tissues. While computed tomography (CT) scans represented a significant advancement, they encountered limitations in detecting smaller nodules and accurately characterizing soft tissues. Because of its outstanding soft-tissue contrast, multiplanar visualization abilities, and lack of ionizing radiation, magnetic resonance imaging (MRI) has become the modality of choice as a result of this. These attributes make MRI invaluable for providing detailed anatomical information and aiding in precise surgical planning, a sentiment echoed in various studies such as those by Sakamoto et al. and Miki et al.[15-16]

In our study, MRI played a central role in confirming the diagnosis and delineating tumor characteristics. Consistent with previous research, we found that macroadenomas were readily detected on non-enhanced MRI, while microadenomas often required contrast for visualization.[17] This demonstrates how crucial cutting-edge imaging methods are for improving sensitivity in identifying pituitary tumors, especially microadenomas. One such method is dynamic contrast-enhanced MRI.

Dynamic contrast MRI, as demonstrated in studies such as those by Connor et al., offers valuable insights into tumor characteristics, such as enhancing patterns, facilitating more accurate diagnosis and treatment planning. Our findings revealed a high prevalence of increased prolactin levels in cases of macroadenomas, aligning with previous studies by Stadnik et al. and Connor et al.[18-19] Moreover, we observed that dynamic contrast-enhanced MRI was particularly useful in predicting complete removal of para-sellar components of macroadenomas, underscoring its utility in guiding surgical interventions.

For pituitary microadenomas, dynamic contrast-enhanced MRI emerges as a cornerstone in lesion detection, with peak enhancement typically occurring after the anterior pituitary gland. The technique of utilizing biplane dynamic MRI with separate contrast injections, as explored in our study, represents a promising approach for enhancing lesion detection and localization. This strategy aligns with findings from studies such as those by Bartynski et al., demonstrating the superiority of dynamic enhanced MRI over traditional imaging methods for detecting microadenomas.[20]

In our study, we noted a significant prevalence of increased prolactin levels in cases of both macroadenomas and microadenomas, consistent with findings from previous studies. Additionally, our observations regarding the utility of dynamic contrast-enhanced MRI in predicting surgical outcomes and guiding treatment decisions corroborate findings from studies by Connor et al. and Stadnik et al.[18-19] However, our study also identified limitations, such as the absence of delayed scans and diffusion-weighted imaging, which could provide valuable insights into tumor consistency and early detection of pituitary apoplexy. These limitations suggest areas for further research and technological refinement to optimize the diagnostic accuracy and treatment outcomes for patients with pituitary lesions.

This present study features the indispensable role of MRI in the comprehensive assessment and management of pituitary lesions. By leveraging advanced imaging methods, such as dynamic contrast-enhanced MRI, clinicians can achieve more accurate diagnoses, refine treatment strategies, and ultimately improve patient outcomes.

Conclusion

This particular research highlights the critical importance of MRI in diagnosing and treating conditions related to the hypothalamus and pituitary gland. Through its ability to provide detailed imaging and differentiate between various disorders, MRI plays a crucial role in guiding treatment decisions, whether surgical or conservative. Our study emphasizes the essential role of MRI in optimizing patient care and tracking treatment progress, demonstrating its significance in improving overall patient outcomes.

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