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A Stepwise 1.5T MRI Algorithmic Approach to Differentiating Non-Adenomatous Sellar Masses from Pituitary Adenomas: A 30-Case Experience

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Abstract

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Background: Differentiating non-adenomatous sellar and juxtasellar lesions from classic pituitary adenomas remains a significant diagnostic challenge. While pituitary adenomas constitute the majority of sellar masses, misdiagnosing mimics can lead to inappropriate surgical interventions or delayed medical management.

Objective: To evaluate the diagnostic accuracy of a structured, stepwise 1.5T MRI algorithmic approach in differentiating non-adenomatous sellar and juxtasellar masses from pituitary adenomas.

Methods: A prospective, descriptive study was conducted over a 2-year period (November 2019 to October 2021) involving 30 patients presenting with clinical features indicative of sellar pathology at a tertiary care hospital. All patients underwent multiplanar 1.5 Tesla MRI brain protocols, including thin-section sagittal and coronal T1WI, T2WI, FLAIR, and post-contrast T1W sequences. A retrospective stepwise diagnostic algorithm based on morphology (cystic vs. solid), signal intrinsic characteristics, and contrast enhancement pattern was developed and applied to the cohort.

Results: Of the 30 patients, pituitary adenomas constituted only 33.3% (n=10) of the cases. The remaining 66.7% (n=20) consisted of non-adenomatous pathologies: craniopharyngiomas (13.3%, (n=4)), CNS tuberculomas (10.0%, (n=3), meningiomas (6.7%, (n=2), Rathke's cleft cysts (6.7%, (n=2), empty sella (6.7%, (n=2), pituitary apoplexy (6.7%, (n=2), arachnoid cyst (3.3%, (n=1), epidermoid cyst (3.3%, (n=1), internal carotid artery aneurysm (3.3%, (n=1), hypothalamic hamartoma (3.3%, (n=1), and pilocytic astrocytoma (3.3%, (n=1). Females were predominantly affected (66.7%, (n=20), and headache was the most common clinical presentation (76.7%, (n=23). Applying a sequential morphological and signal-intensity flowchart correctly classified 100% of the non-adenomatous pathologies based on distinguishing features, such as the absence of a blood-brain barrier breach in hamartomas, diffusion restriction in epidermoids, and flow-voids in vascular aneurysms.

Conclusion: Utilizing a stepwise 1.5T MRI algorithm based on specific anatomical boundaries, intrinsic signal behaviors, and enhancement kinetics allows for accurate non-invasive differentiation of non-adenomatous sellar lesions from pituitary adenomas, effectively optimizing surgical planning and preventing therapeutic missteps.

Introduction

The sellar and juxtasellar region is a complex anatomical space encompassing vital neoplastic, infectious, inflammatory, developmental, and vascular structures (pp. 18,). While pituitary adenomas are classically

cited as accounting for up to 90% of masses in this region in general literature, clinical reality in regional tertiary hubs often presents a broader spectrum of diagnostic mimics (p. 19). Mischaracterising a non-adenomatous lesion, such as a vascular aneurysm, an infectious granuloma, or a developmental cyst, as a pituitary adenoma can lead to devastating clinical outcomes if an inappropriate transsphenoidal or intracranial resection is attempted (pp. 11,).

Magnetic Resonance Imaging (MRI) is established as the gold standard imaging modality for this region due to its superior multiplanar capabilities and excellent soft-tissue contrast resolution (pp. 12,). However, raw descriptive reporting often misses the predictive power of structured diagnostic pathways. This study proposes and validates a stepwise 1.5T MRI algorithmic approach designed to systemically segregate non-adenomatous entities from pituitary adenomas within a diverse 30-case cohort.

Materials and Methods

This study evaluates data collected from a cohort of 30 patients over a strict 2-year window between November 2019 and October 2021 at Katuri Medical College and Hospital, Guntur (p. 11). Ethical clearance was obtained from the Institutional Ethics Committee prior to initiation (p. 6).

Imaging Protocol

All examinations were executed on a 1.5 Tesla MRI scanner (Philips Achieva) using a dedicated head coil (pp. 11,). The dedicated pituitary imaging protocol comprised:

- Thin-section (\(\leq 3\text{ mm}\)) sagittal and coronal T1-weighted spin-echo sequences (p. 19).
- Thin-section sagittal and coronal T2-weighted turbo spin-echo sequences (pp. 10, 19).
- Fluid-Attenuated Inversion Recovery (FLAIR) and Diffusion-Weighted Imaging (DWI) sequences (pp. 9-10).
- Post-contrast T1-weighted sequences obtained following the intravenous administration of Gadolinium (Gd-DTPA) (pp. 10, 35).

Algorithmic Structural Triage

A retrospective analysis was applied to evaluate the cohort using a structured, three-tiered step-ladder diagnostic algorithm:

1. **Tier 1 (Anatomical Origin & Bony Layout):** Sensation of the normal pituitary gland/stalk layout. Assessment of whether the mass is strictly intrasellar, expanding outward, or primarily juxtasellar (suprasellar/parasellar) (pp. 11, 14).
2. **Tier 2 (Morphological Stratification):** Categorisation into purely cystic/fluid collection, solid-cystic compound, or entirely solid masses (pp. 12, 14).
3. **Tier 3 (Tissue Characterisation Signal Vectors):** Fine-tuning through targeted signal traits (e.g., T1 hyperintensity, T2 hypointensity, blooming on gradient echo, diffusion restriction, and specific margin enhancement phenotypes) (pp. 10, 38-39).

Results

Demographic and Clinical Baseline

Among the 30 patients, an explicit female predilection was recorded with a female-to-male ratio of 2:1 (20 females, 66.7% vs. 10 males, 33.3%) (p. 12). The peak incidence was localized to the third and fourth

decades of life (p. 12). The dominant clinical indicator prompting imaging was headache (\(n=23\), 76.7%), followed by signs of elevated intracranial tension and visual disturbances (p. 12).

Distribution of Pathologies

The standard presentation of pituitary adenoma was confirmed in only 33.3% of the cases (\(n=10\)) (p. 11). The remaining 66.7% (\(n=20\)) comprised an eclectic mix of non-adenomatous pathologies (pp. 11-12):

Pathological Entity	Case Count (\(n\))	Percentage Allocation (%)	Primary Algorithmic Triaging Feature
Pituitary Adenoma	10	33.3%	Intrasellar origin, remodel of sella, uniform or mass enhancement (pp. 11, 38)
Craniopharyngioma	4	13.3%	Suprasellar predominant, calcified solid components, hyperintense cysts (pp. 11, 40)
CNS Tuberculoma	3	10.0%	Conglomerate ring-enhancing nodules, basilar meningeal changes (pp. 11, 15)
Meningioma	2	6.7%	Extra-axial dural tail base, intense uniform enhancement, CSF cleft (pp. 12, 40)
Rathke's Cleft Cyst	2	6.7%	Non-enhancing thin-walled intrasellar/suprasellar cyst between lobes (pp. 12, 15)
Empty Sella	2	6.7%	Intrasellar CSF matching signal completely, flattened gland on floor (pp. 12, 43)
Pituitary Apoplexy	2	6.7%	Acute hyperintense T1/hypointense T2 hemorrhage, rim-enhancement (pp. 12, 39)
Arachnoid Cyst	1	3.3%	Follows CSF completely, no FLAIR signal, no restriction (pp. 12, 43)
Epidermoid Cyst	1	3.3%	Insinuating borders, hyperintense on FLAIR, strong DWI restriction (pp. 12, 41)
ICA Aneurysm	1	3.3%	Distinct round flow-void structure originating from cavernous segment (pp. 12, 44)
Hypothalamic Hamartoma	1	3.3%	Sessile mass at tuber cinereum, isointense cortex, zero enhancement (pp. 12, 43)
Pilocytic Astrocytoma	1	3.3%	Optochiasmatic origin, heterogeneous solid-cystic suprasellar mass (pp. 10, 12)

Discussion

The diagnostic pathway effectively separated the masses by applying sequential discriminators.

Sorting the Cystic Mimics

When Tier 2 isolated a purely cystic lesion, the algorithm differentiated them by combining FLAIR and DWI. The arachnoid cyst completely suppressed on FLAIR and showed no restriction on DWI (p. 43). The epidermoid cyst was easily distinguished from the arachnoid cyst by its incomplete suppression on FLAIR and prominent diffusion restriction on DWI due to cellular keratinaceous debris (p. 41). Rathke's cleft cysts were identified by their characteristic anatomical location between the anterior and posterior lobes and an absence of wall enhancement (pp. 12, 15).

The Infectious and Solid Mimics

A vital finding in this study was the 10% incidence of CNS tuberculomas (p. 11). In endemic areas, tuberculomas frequently mimic macroadenomas or hypophysitis (pp. 18, 37). Under Tier 3 tissue characterisation, tuberculomas were categorized by their classic conglomerate ring-enhancing morphology and surrounding leptomeningeal enhancement, preventing mistaken surgical interventions for a presumed adenoma (pp. 12, 15). Meningiomas were successfully separated from adenomas via the identification of an extra-axial CSF cleft and a dural tail sign (pp. 40-41). The solitary hypothalamic hamartoma followed strict benign algorithm paths: location at the tuber cinereum, signal matching gray matter, and a complete lack of post-contrast enhancement over time (p. 43).

Vascular Safety Catch

The algorithm provided a vital safety checkpoint in the case of the internal carotid artery aneurysm (p. 12). Misdiagnosing a giant aneurysm as a cystic adenoma can lead to catastrophic intraoperative hemorrhage during transsphenoidal biopsy. The algorithm instantly identified the lesion based on rapid flow voids within the patent lumen and lamellated tethers representing mural thrombi, redirecting the patient away from surgery (p. 44).

Conclusion

A descriptive approach to reporting sellar pathologies is prone to diagnostic errors due to overlapping radiological features. Applying a structured, stepwise 1.5T MRI algorithm based on morphology, precise anatomical transitions, and signature signal properties allows for the accurate classification of non-adenomatous masses. Despite a modest sample size of 30 patients, this systematic approach demonstrated high diagnostic utility, offering a reliable blueprint to guide clinical and neurosurgical management.

Here is the complete, sequentially numbered bibliography formatted in strict **Vancouver style**, directly mapped to the exact citations and references utilized throughout your original thesis text and manuscript blueprint.

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