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Magnetic Resonance Imaging of Suprasellar Tumors and Accuracy of Diagnosis

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Abstract

Background: One of the best ways to diagnose tumors involving intrasellar and suprasellar regions is MRI. Mostly, the differential diagnoses are Pituitary adenoma, Craniopharyngioma, and Rathke's cleft cysts. Differentiating them is essential because each has a distinct surgical approach. Therefore, we studied helpful MRI features to differentiate them.

Materials and Methods: We measured the clinical symptoms and functionality of the pituitary gland of 81 patients diagnosed with Pituitary adenoma (n=46), Craniopharyngioma (n=19), and Rathke's cleft cysts (n=16) from March 2010 to March 2019. We also used the MRI images performed by a 1.5 T MRI machine to determine the qualifications of the tumor, such as component characteristics, shape, volume, spatial extension, solid and cystic segment pattern.

Results: The most common component characteristic was solid type in pituitary adenoma (63.0%, n=29), mixed type in Craniopharyngioma (84.2%, n=16), and cystic in Rathke cleft cyst (100.0%, n=17). The most prevalent shape in pituitary adenoma, Craniopharyngioma, and Rathke cleft cyst was the snowman-like appearance (60.9%, n=28), superiorly lobulated (68.4%, n=13), and ovoid (70.6%, n=12), respectively. Small tumors were more frequent in the Rathke cleft cyst (88.2%, n=15), and large tumors were more common in Craniopharyngioma (89.5%, n=17). Compressing the optic chiasm in pituitary adenoma (95.6%, n=44) and compressing the third ventricle in Craniopharyngioma (68.4%, n=13) were significantly different. All Rathke's cleft cysts were surrounded by the lateral wall of the cavernous part of ICA (100.0%, n=17).

Conclusion: We statistically showed that several MRI features are specific for each tumor and suggest a precise diagnosis.

Keywords*:* MRI; Pituitary adenoma; Craniopharyngioma; Rathke's Cleft Neoplasm

Introduction

Pituitary adenomas are tumors of the pituitary gland and are responsible for 10% of the intracranial tumors. They are the most frequent neoplasm affecting both suprasellar and intrasellar regions. Based on their size, we can classify them into microadenomas and macroadenomas. Microadenomas are smaller than 10 mm in diameter, while macroadenomas are greater than 10

mm in diameter. Cystic degeneration and haemorrhage enhancement patterns are unfamiliar despite the typical signal intensity of unproblematic pituitary adenoma (1, 2).
In terms of functionality, pituitary adenomas are divided into functioning tumors and non-functioning tumors. Functioning tumors can lead to numerous irreversible problems, such as increased growth hormone, which eventuates in gigantism (3, 4).
Craniopharyngioma is a benign epithelial tumor of the central nervous system that arises from the remnant of the craniopharyngeal duct. It accounts for 5-13% of all intracranial tumors in children. Nevertheless, it has a bimodal age distribution. There are two pathological subtypes of Craniopharyngioma: adamantinomatous and squamous-papillary. The gold standard of diagnosis of Craniopharyngioma is magnetic resonance imaging (MRI). MRI of the adamantinomatous type usually shows cystic or predominantly cystic lesions. However, the squamous-papillary type is associated with a predominantly solid enhancement pattern (5, 6).
Rathke's cleft cysts are benign mucoid cysts that are thought to form during embryonic development from Rathke's pouch. Because of the tumor stability, enlargement and pituitary dysfunction are not common among them. Rathke's cleft cysts account for 1% of intracranial masses. 70% of them involve both suprasellar and intrasellar regions (7).
The presence of tumors in the intrasellar or suprasellar region requires an accurate diagnosis because each neoplasm has a distinct surgical approach: pituitary adenomas are removed by transsphenoidal surgery, craniotomy is needed for the radical surgery of Craniopharyngioma due to its high recurrence rate, and surgical drainage is used for Rathke's cleft cysts (8-10). The precise diagnosis followed by its best treatment is necessary for tumors of this region. Distinguishing between the neoplasms is based on the MR images. It shows the importance of the MRI features of these tumors. This study will demonstrate the specific MRI features of pituitary adenoma, Craniopharyngioma, and Rathke's cleft cyst in tumors shape, volume, and components intensifying the solid division of the cyst wall.

Methods and Materials

Study design

This study have the permission of the Ethics Committee at the Research Center of Shahid Beheshti University of Medical Sciences. Patients enrolled in the study were gathered from the pathology database based from March 2010 to March 2019. Three hundred eight patients had pathology results of pituitary adenoma, Craniopharyngioma, and Rathke cleft cyst, although 226 patients had exclusion criteria which were: (1) MRI was not found in the patient's file; (2) coincidence of other diseases; (3) previous surgery, biopsy or other procedures which lead to disarrangement of the anatomy of the region; (4) involvement of only suprasellar or intrasellar region. Of 82 patients with pituitary adenoma (n=46), craniopharyngioma (n=19), and Rathke cleft cyst (n=17) diagnosis, there were 47 men (57.3%) and 35 women (42.7%). Enrolled patients in this study had a mean age of 48.4 years. Among patients with pituitary adenoma, 6 (13.0%) patients had headaches, and visual disturbances were present in 35 (76.1%) patients. Half of the patients had a non-functional adenoma, while the other half had a functional one. Among patients with functional pituitary adenoma, 6 (13.0%) patients had GH producing pituitary adenoma, 10 (21.7%) patients had prolactin producing pituitary adenoma, 3 (6.5%) patients had ACTH producing pituitary adenoma, and 4 (8.7%) patients had FSH producing pituitary adenoma. 11 (57.9%) of all 19 patients with Craniopharyngioma were men, and 8 (42.1%) were women. Headache and visual disturbances were present in 14 (73.7%) and 17 (89.5%) patients, respectively. Pathology reports demonstrated that 6 (31.6%) patients had an adamantanoids type and 13 (68.4%) had a squamous-papillary type. Ultimately, among 17 patients with Rathke cleft cyst, 10 (58.8%) were men, and 7 (41.2%) were

women with a mean age of 45.6 years. About half of the patients (47.0%) had experienced visual disturbances, and 10 (58.8%) reported headaches.

MRI procedure and assessment of findings

A 1.5 T MRI machine performed MRI images with a section thickness of 5 mm with a 0.5 mm intersection interval in Axial T2-weighted, coronal, and sagittal T1-weighted views. Gadopentetate dimeglumine with 0.1 mmol/kg dosage was injected 1 minute before obtaining contrast-enhanced T1-weighted images.

Two blinded radiologists reviewed all MRI images and assessed the findings even though they were informed that all diagnoses were among pituitary adenoma, Craniopharyngioma, and Rathke cleft cyst. Tumor shape was categorized as superiorly lobulated, inferiorly lobulated, ovoid, or snowman-like appearance. Tumor size was considered by the most significant length in three-dimensional numbers: super inferior, anteroposterior, and transverse. Tumor compression was classified into three categories: without compression of the optic chiasm, compression of the optic chiasm, and advanced level compression of the third ventricle. Tumor extension was measured in super inferior and transverse dimensions. A super inferior extension was assumed as depression from the sellar region, and a lateral extension was considered an extension surrounded by or exceeded from the cavernous intracranial carotid artery (ICA). Tumor components were primarily solid and cystic. Signal intensities were measured in T1-weighted and T2-weighted images for the cystic and solid portions, respectively, and classified as hyperintense or non-hyperintense. Enhancement patterns were categorized into the cyst wall or solid portion. Furthermore, the solid enhancement pattern was subclassified into reticular or homogenous; the cyst wall was subclassified into no enhancement, thin, or thick enhancement.

Statistical analysis

Statistical analysis demonstrated remarkable differences in frequencies of MRI findings. Three tumor groups were compared via Fischer's exact test. Due to numerous MRI findings, Bonferroni correction was applied to all analyses to minimize "alfa" error. The significance level was set to 0.05. The gold standard to measure the accuracy of the diagnosis was based on the pathology report. SPSS statistical software package (version 26.0; SPSS, Chicago, IL, USA) was used to analyse all the study data.

Results

The vast majority of features were investigated during this study; A summary of those is shown in table 2. In this study, the significance level was set at P-value= 0.05, and items with a significant difference had a P-value<0.05, and those items with the shared feature had a P-value>0.05. Tumor shape was one of those different features among these three groups.

In the category of tumor characteristics, the most common feature was solid type in pituitary adenoma (63.0%, n=29), mixed type in Craniopharyngioma (84.2%, n=16), and cystic in Rathke cleft cyst (100.0%, n=17).

(**Table 2** pituitary adenoma, craniopharyngioma, and Rathke cleft cyst magnetic resonance imaging findings)

The most prevalent shape in pituitary adenoma, Craniopharyngioma, and Rathke cleft cyst was the snowman-like appearance (60.9%, n=28), superiorly lobulated (68.4%, n=13), and ovoid (70.6%, n=12), respectively.

The volume of the tumor was categorized into the small one and the large one. In pituitary adenoma, there was not a statistical difference between the occurrence of small or large tumors. Notwithstanding, the analysis demonstrated that the Rathke cleft cyst and Craniopharyngioma, the tumor size could be a suitable identifier in diagnosing these diseases. Small tumors were more

frequent in the Rathke cleft cyst (88.2%, n=15), and large tumors were more common in Craniopharyngioma (89.5%, n=17).

Compression of the optic chiasm in pituitary adenoma (95.6%, n=44) and compression of the third ventricle in Craniopharyngioma (68.4%, n=13) had a statistically significant difference among all three tumors.

Due to the lack of statistical difference in assessing Sellar floor depression, we cannot identify or suggest any specific kind of these tumors.

Tumors of all patients with Rathke cleft cyst were surrounded by the lateral wall of the cavernous part of ICA (100.0%, n=17), which had a significant difference compared to two other groups.

On T2-weighted images, the signal intensity of the solid portion of 37 (92.7%) pituitary adenoma patients and 13 (81.2%) craniopharyngioma patients was hyperintense, which did not have a significant difference.

Furthermore, on T1-weighted images, the signal intensity of the cystic portion of 10 (58.8%) Rathke cleft cyst patients did not have a statistical difference between all three tumors.

One of the different criteria between craniopharyngioma and pituitary adenoma diagnosis is the enhancement pattern of the solid segment. The homogenous pattern was seen in 39 (95.1%) patients with pituitary adenoma, and the reticular pattern was seen in 15 (93.7%) patients with Craniopharyngioma, which is a statistically significant difference between these two tumors. Additionally, the prevalence of thick enhancement in the Rathke cleft cyst was significantly lower versus pituitary adenoma and Craniopharyngioma.

Discussion

In the clinical setting, intrasellar and suprasellar tumors such as pituitary adenoma, Rathke cleft cyst, and Craniopharyngioma are barely distinguishable due to similarities in symptoms and signs. Albeit they have sharable clinical features such as headache, hypopituitarism, and visual disturbance, MRI characteristics of these tumors vary, and differential diagnosis is not complicated (11).

Pituitary adenomas account for less than 3% of supratentorial tumors in children (12); therefore, they are more prevalent in adulthood (13, 14). Additionally, our study also reveals a higher prevalence in adulthood than at younger ages. Among all three, the most prevalent shape of this tumor is the "snowman-like" appearance (15). We found 28 cases (60.9%) out of 46 that manifested this feature, and it was significantly distinguishable between pituitary adenoma and the other two neoplasms. Studies exhibit hormone-secreting masses are more constant than non-functioning tumors. However, in this research, the percentage of hormone-secreting masses is equal to the non-functioning ones (16). Based on the tumor size, pituitary adenomas are classified into two categories. Microadenomas are smaller than 10 mm in diameter and are surrounded by the pituitary gland; macroadenomas are greater than 10 mm (17, 18). Nevertheless, in this study, microadenomas were excluded, and macroadenomas were just analysed.

Craniopharyngioma is a benign epithelial tumor from the remnants of the craniopharyngeal duct (19). This tumor can affect any age group, albeit with a bimodal age distribution with peaks occurring at 5-14 years and in the 4th to the sixth decade of life (20, 21). However, in our research, patients under 18 years of age were excluded, but we had patients in their 20s and 30s, yet the mean age of craniopharyngioma patients was 41.8 years. Craniopharyngioma has two pathological subtypes. Squamous-papillary is believed to arise from squamous epithelial cells in pars tuberalis of the adenohypophysis, and it is prevalent in adult individuals (22). On MR images, the squamous-papillary type is a principally solid or mixed solid-cystic tumor. On the other hand, the adamantanoids type is frequent in childhood and is a cystic or predominantly cystic lobulated

tumor (23, 24). Because of the high protein concentration accompanied by methaemoglobin, cystic lesions are hyperintense in both T1-weighted and T2-weighted MR images (25, 26).

Rathke's cleft cyst is a benign cyst that originates from residues of Rathke's pouch. Consequently, they are embryologically linked to Craniopharyngioma. They account for less than 1% of all intracranial tumors (27). They commonly have a round or ovoid shape with variable signal intensity on T1-weighted MR images. 12 (70.6%) patients with Rathke's cleft cyst had an ovoid tumor in this study. Studies show that two-thirds of cysts are hyperintense to the brain, and one-third of them have a low signal intensity (28). However, in our investigation, hyperintense cysts accounted for 58.8% (n=10) of patients, and non-hyperintense cysts accounted for 41.2% (n=7) of patients. In addition to that, other usual findings in MR images of Rathke's cleft cyst are bland silhouette, lack of calcification, absence of internal enhancement, a sellar epicenter, and homogenous signal intensity inside the cyst.

Based on the MRI characteristics, Rathke's cleft cyst and Craniopharyngioma are distinguishable. Studies qualitatively demonstrate the diversity of location and component in these tumors (28, 29). Additionally, our study shows that craniopharyngiomas are not mostly intrasellar. However, Rathke's cleft cysts almost always lie entirely in the sellar region. This research statistically describes that wall enhancement and solid elements are reliable distinctions between these tumors.

Suprasellar germinoma is the differential diagnosis of pituitary adenoma, Rathke's cleft cyst, and Craniopharyngioma, a rare intracranial neoplasm that affects children. Due to our exclusion criteria, we did not have adequate patients with suprasellar germinomas to enroll in the research.

Diagnosis becomes unchallenging because of the meaningful differences in MRI findings of these three tumors, such as firm elements or cyst wall enhancement, extensions, and tumor aspects, albeit all tumors originate from the same region.

Our study strongly suggests, in terms of tumor characteristics, only the presence of the firm component was highly associated with pituitary adenoma diagnosis; nevertheless, mixed features were seen in both pituitary adenomas and craniopharyngiomas (30). In comparison, cystic tumors were profoundly associated with Rathke's cleft cyst. Due to the appearance of the combined trait tumor elements, the enhancement pattern plays a vital role in differentiating between Craniopharyngioma and pituitary adenoma; the homogenous pattern suggests pituitary adenoma. Nonetheless, the reticular pattern correlates with Craniopharyngioma.

This study has several limitations. First, this is a single-center study. Another limitation is the absence of a three-tesla MRI machine that can provide high-resolution images with more details. Another limitation was excluding diseases such as suprasellar germinomas, meningiomas, and gliomas due to inadequate cases to enroll in the study.

Conclusion

To conclude, in such diseases with high clinical similarities, MRI can be surprisingly helpful. Our study focused on three common diseases involving the sellar region: pituitary adenoma, Craniopharyngioma, and Rathke's cleft cyst, based on their shape, components, enhancement, and volume. We statistically demonstrate that specific features can suggest a diagnosis.

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Conflict of interest

The authors declared no conflict of interest.

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Table 1: demographic of participants												
Disease	Gender		Mean age	Headache	Visual disturbances	Functionality					Type	
	Male	Female				Non-functional	Functional				Adamantinous	Squamous-papilary
							GH	Prolactin	ACTH	FSH		
Pituitary adenoma	26 (56.5)	20 (43.5)	52.2	6 (13.0)	35 (76.1)	23 (50.0)	6 (13.0)	10 (21.7)	3 (6.5)	4 (8.7)	0	0
Craniopharyngioma	11 (57.9)	8 (42.1)	41.8	14 (73.7)	17 (89.5)	19 (100.0)	0				6 (31.6)	13 (68.4)
Rathke cleft cyst	10 (58.8)	7 (41.2)	45.6	10 (58.8)	8 (47.0)	17 (100.0)	0				0	0

Table 2 pituitary adenoma, craniopharyngioma, and Rathke cleft cyst magnetic resonance imaging findings					
MRI findings			Pituitary adenoma (n=46)	Craniopharyngioma (n=19)	Rathke cleft cyst (n=17)
Component characteristic		Cystic	5 (10.9)	3 (15.8)	17 (100.0)
		Mostly cystic	3 (6.5)	9 (47.4)	0 (0.0)
		Mostly solid	9 (19.5)	7 (36.8)	0 (0.0)
		Solid	29 (63.0)	0 (0.0)	0 (0.0)
Shape		Snowman-like appearance	28 (60.9)	1 (5.3)	2 (11.8)
		Ovoid	2 (4.3)	3 (15.8)	12 (70.6)
		Superiorly lobulated	8 (17.4)	13 (68.4)	2 (11.8)
		Inferiorly lobulated	8 (17.4)	2 (10.5)	1 (5.9)
Volume		Small*	13 (28.3)	5 (26.3)	15 (88.2)
		Large*	33 (71.7)	17 (89.5)	2 (11.8)
Vertically extension	Superior	Inferior to optic chiasm	1 (2.2)	1 (5.3)	9 (52.9)
		Compressing optic chiasm	44 (95.6)	5 (26.3)	7 (41.2)
		Compressing the third ventricle	1 (2.2)	13 (68.4)	1 (5.9)
	Inferior	With Sellar floor depression	28 (60.9)	3 (15.8)	2 (11.8)
		Without Sellar floor depression	18 (39.1)	16 (84.2)	15 (88.2)
Lateral extension	Right	Surrounded by lateral wall of cavernous part of ICA	32 (69.6)	11 (57.8)	17 (100.0)
		Exceeding lateral wall of cavernous part of ICA	14 (30.4)	8 (42.1)	0 (0)
	Left	Surrounded by lateral wall of cavernous part of ICA	28 (60.9)	12 (63.1)	17 (100.0)
		Exceeding lateral wall of cavernous part of ICA	18 (39.1)	7 (36.8)	0 (0.0)
Solid segment	Enhancement pattern	Reticular	2 (4.9)	15 (93.7)	0 (0.0)
		Homogenous	39 (95.1)	1 (6.3)	0 (0.0)
	Signal intensity on T2 weighted images	Hyperintense	37 (92.7)	13 (81.2)	0 (0.0)
		Non-hyperintense	4 (9.7)	3 (18.7)	0 (0.0)
Cystic segment	Enhancement pattern of cyst wall	Without enhancement	0 (0)	2 (10.5)	8 (47.0)
		Thin**	9 (40.9)	8 (42.1)	8 (47.0)
		Thick**	13 (59.1)	9 (47.4)	1 (5.9)
	Signal intensity on T1 weighted images	Hyperintense	2 (9.1)	8 (42.1)	10 (58.8)
		Non-hyperintense	20 (90.9)	11 (57.9)	7 (41.2)
*Small tumor volume was considered as <2.5ml and large tumor volume was considered as ≥2.5ml					
**Thin wall enhancement was considered as <3mm and thick wall enhancement was considered as ≥3mm					