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Original Article

Intracranial Meningiomas in Udonthani Hospital and Review of the Literature

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Abstract

Objective: To report CT scan and MR image findings of symptomatic fifty patients with intracranial meningiomas and review of the literature.

Methods: Retrospective review CT scan and MR image findings of fifty symptomatic patients with intracranial meningiomas operated in Udonthani hospital from October 2005 to June 2008.

Results: Fifty patients (4:1 female to male ratio. Mean age was 44.7 years; range 15-82 years.) were studied. 73.6% of CT scans demonstrated typical features and 18.9% showed hyperostosis. Most common locations were cerebral convexity and sphenoid ridge. three patients showed multiple meningiomas. 80% of patients showed typical MR image features and 60% dural tail sign. Peritumoral edema was found in 67.3% of patients.

Conclusion: Meningiomas are usually benign tumors with characteristic CT and MR imaging features. However on a review of the literature, there are several important histologic variants of meningiomas that can have unusual or misleading radiologic features.

Introduction

Hospital-based brain tumor series indicate that the incidence of meningiomas is approximately 20% of all intracranial tumors (the most common nonglial primary intracranial tumor), whereas autopsy-based studies indicate an overall incidence of 30%.[1] Symptomatic meningiomas occur two to three times more commonly in female patients, especially those in the middle age (40-60 years) group[2] and generally are benign tumor that are derived from meningoendothelial cells.[3] Because complete surgical resection is the definite treatment for meningiomas, the single most important feature regarding therapy is tumor location, as it substantly affects surgical accessibility. Unusual imaging features are also important to avoid misdiagnosis.

Patients and Methods

The author retrospectively analyzed CT scan and MR image findings of fifty symptomatic patients with intracranial meningiomas who underwent an operation at Udonthani hospital from October 2005 to June 2008. Forty-five patients were examined with non contrast and contrast-enhanced CT scan (Elscint EXEL 2400 ELECT CT scanner). Two patients, with non contrast T1- and T2-weighted pulse sequences and Gadolinium-enhanced a 1.5 Tesla MR (Siemens Magnetom Symphony) alone, and three patients, with CT scan and MRI. All CT scans and MRI studies were reviewed. Edema in adjacent areas of the brain, when present, was graded as mild (extending less than 1 cm. from the tumor), moderate (extending 1-4 cm. from the tumor), or severe (extending more than 4 cm. from the tumor).[3]

Result

Age of 50 patients at the time of diagnosis were 15 to 82 years (mean 44.7 years) (Table 1) and 55 meningiomas (Table 2). The most common locations of intracranial meningiomas in this study were cerebral convexity and sphenoid ridge. Three patients showed multiple meningiomas (Table 3), all the patients were female and showed no manifestations of von Recklinghausen disease. In 73.6% of meningiomas, CT scan demonstrated typical diagnostic features, including a sharply circumscribed homogeneous hyperdensity on CT scan without contrast material enhancement, and homogeneously enhanced after the administration of contrast material. In Table 4, 13 (24.5%) meningiomas showed rim, sandlike, globular and focal calcifications. Intraaxial vasogenic edema was seen around meningiomas (which are extraaxial masses) 67.3% of patients (Table 5) and there was little associated between grade of edema and location of the tumor.

14 (25.5%) meningiomas showed midline shift which there was association with tumor location. (8 in 12 patients of sphenoid ridge meningiomas showed midline shift.)

Discussion

Brain imaging with contrast-enhanced CT or MR imaging is the most common method of diagnostic of intracranial meningioma.[1] Contrast material enhancement of meningioma is usually rapid and striking owing to their highly vascular nature. (Fig.1)

Inhomogeneous enhancement (13.2%) was found which area of non-enhancing hypodensity should be necrotic portion of meningiomas. (Fig.2)

Table 1 Sex and age of patients with intracranial meningiomas

Sex	Numbers of patient (%)	Age (years)	Mean age (years)
Female	41 (82)	15-81	46.2
Male	9 (18)	23-82	43.0
Female & Male	50	15-82	44.7

Table 2 Location of intracranial meningiomas demonstrated by CT scans and MR images

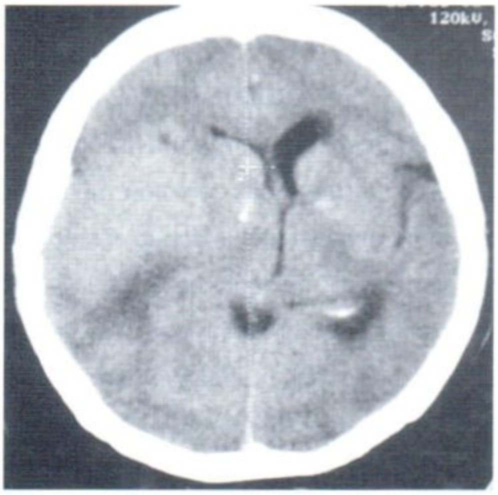
Tumor location	Number of meningiomas (%)
Cerebral convexity	12 (21.8)
Sphenoid ridge	12 (21.8)
Parasagittal	11 (20)
Sellar, suprasellar, parasellar	8 (14.6)
Olfactory groove	5 (9.1)
Cerebellopontine angle	3 (5.5)
Tentorial cerebelli	2 (3.6)
Intraventricular	1 (1.8)
Middle cranial fossa	1 (1.8)
Total	55

Table 3 Age and locations of patients with intracranial multiple meningiomas

Age at the time of diagnosis (years)	Locations
31	Convexity, intraventricular, CPA
40	Olfactory groove, sphenoid ridge, convexity
54	Sphenoid ridge, CPA

Table 4 Computed tomographic findings in meningiomas

CT findings	Number of meningiomas (%)
Hyperdensity	39 (73.6)
Hypodensity	2 (3.8)
Isodensity	5 (9.4)
Inhomogeneous hyperdensity	7 (13.2)
Homogeneous enhancement	46 (86.8)
Inhomogeneous enhancement	7 (13.2)
Calcification	13 (24.5)
Hyperostosis	10 (18.9)
Total	53



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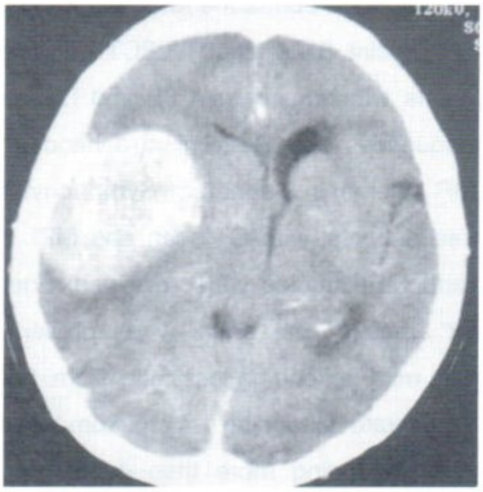

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Fig.1 (A) Non contrast and (B) contrast-enhanced CT scan obtained in a 54-year-old woman showing right temporal extraaxial hyperdense mass with homogeneous enhancement, typical CT features of intracranial meningioma.

Table 5 Intracranial meningiomas with peritumoral edema

Peritumoral edema	Number of meningiomas (%)
No	18 (32.7)
Mild	14 (25.5)
Moderate	16 (29.1)
Severe	7 (12.7)
Total	55

Table 6 Magnetic resonance image findings in meningiomas

MR findings	Number of meningiomas (%)
Hypointense on T1 - weighted images	-
Isointense on T1 - weighted images	5 (100%)
Isointense on T2 - weighted images	4 (80%)
Hyperintense on T2 - weighted images	1 (20%)
Homogeneous enhancement	4 (80%)
Inhomogeneous enhancement	1 (20%)
Dural tail	3 (60%)

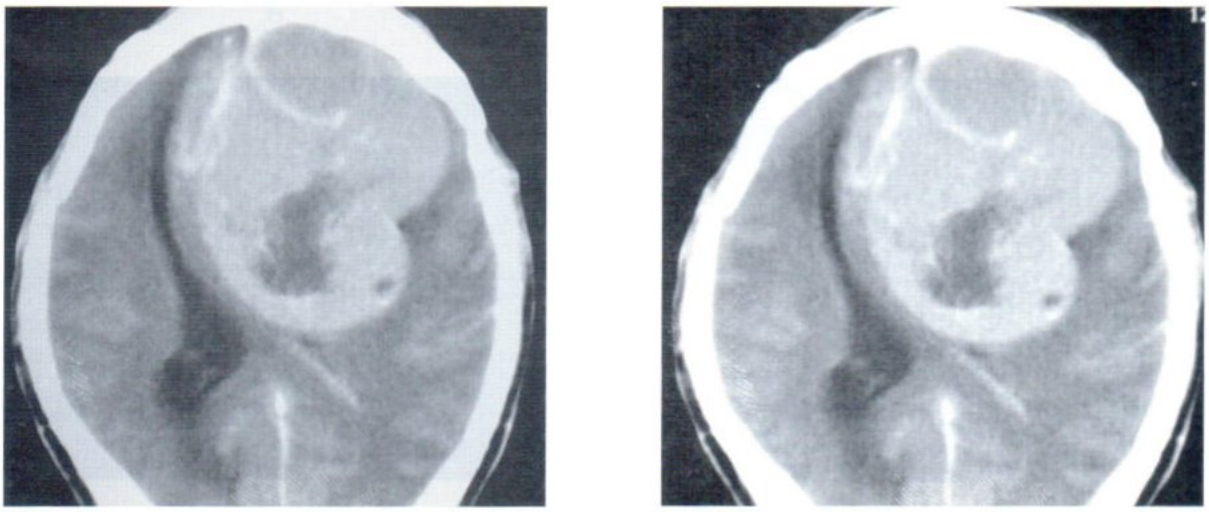

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Fig.2 (A) Non contrast and (B) contrast-enhanced CT scans obtained in a 32-years-old man showing falx meningioma with inhomogeneous hyperdensity and inhomogeneous enhancement.

The CT scan best reveals the chronic effects of slowly growing mass lesions on bone remodelling. (Fig.3)

Calcification in the tumor (24.5%) (Fig.4) and hyperostosis (18.9%) (Fig.5) were features of intracranial meningioma that can easily identified on noncontrast CT scan.

The typical diagnostic features of meningiomas on magnetic resonance (MR) images, include a unilocular mass with sharply circumscribed margin and inward displacement of the cortical gray matter which on MR images obtained without contrast material enhancement, characteristically hypointense or isointense to gray matter with T1-weighted pulse sequence and isointense or hyperintense to gray matter with T2-weighted pulse sequence, and on MR images obtained with Gadolinium, there were homogeneously enhanced.[4,5] However in this report (Table 6), MR images demonstrated dural-based isointense to gray matter on T1-weighted images (100%) and isointense to gray matter on T2-weighted images (80%) with homogeneous enhancement

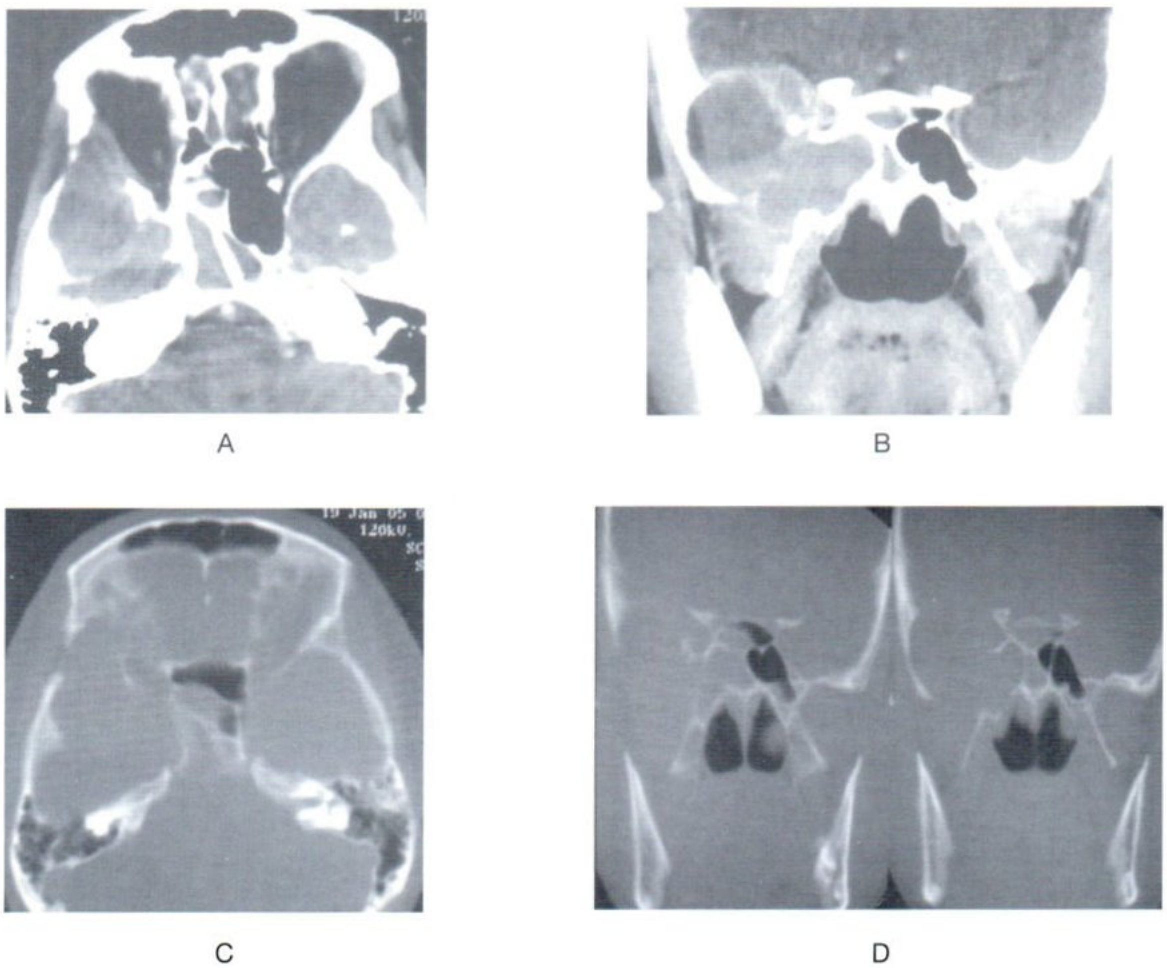

Fig.3 (A) Axial, (B) coronal contrast-enhanced CT scans with soft tissue window and (C) axial, (D) coronal CT scans with bone window obtained in a 31-years-old man of underlying hemophilia A with sphenoid ridge meningioma and associated bone remodelling.

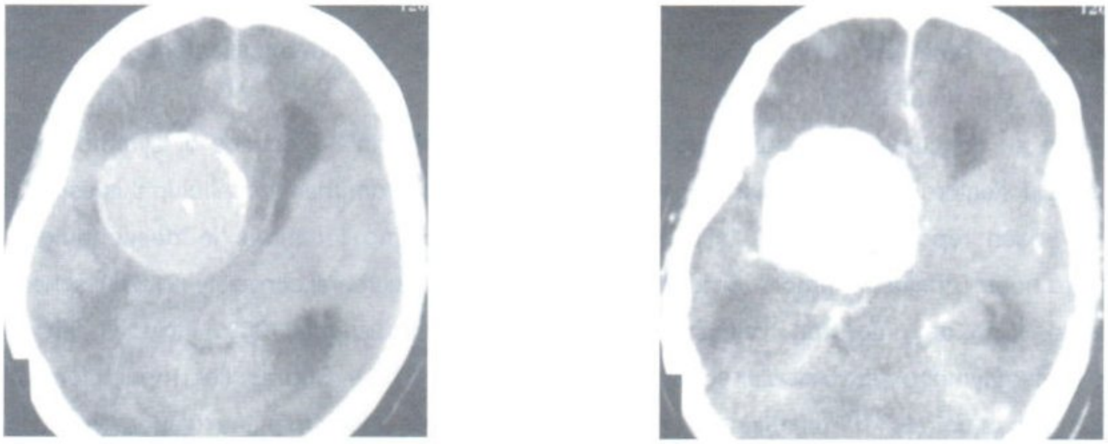

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Fig.4 (A) Non contrast CT scan with soft tissue window demonstrated mass with rim and sandlike calcifications. (B) after contrast enhancement revealed rather homogeneous enhancement of meningioma in a 64-years-old woman.

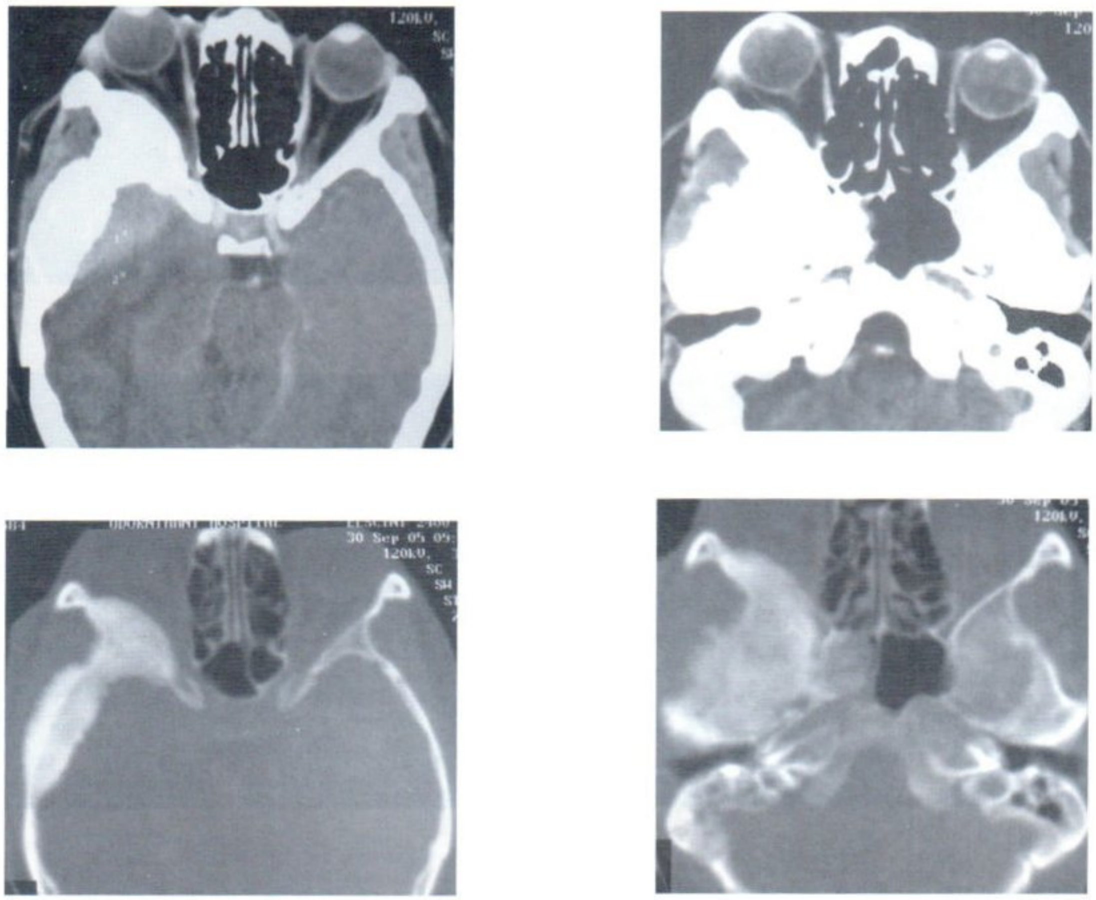

Fig.5 CT scan with soft tissue and bone windows revealed extensive thickening of the right sphenoid and temporal bones in 42-years-old woman with sphenoid wing meningioma.

(80%)(Fig.6, 7), frequent cerebrospinal fluid cleft, and often enhancing dural tail (60%). (Fig.7e, 8) The pathology of the dural tail is unclear.[6,7] Although Goldsher et al[8] concluded that dural tails were a "highly specific feature of meningiomas" many cases have now been reported of dural tails that are attached to nonmeningioma tumors (or tumefactive processes) such as chloroma, primary central nervous system lymphoma, vestibular schwannoma and metastatic tumor etc.[6] MR imaging was superior to CT in defining extracerebral location, tumor vascularity, arterial encasement, and venous sinus invasion.[5]

Intracranial locations of symptomatic meningiomas in Udonthani hospital in this series arised in the following locations in descending order of frequency: cerebral convexity (21.8%), sphenoid ridge (21.8%), parasagittal (20%) including falcine meningioma (9.1%). Suprasellar meningioma (14.6%) commonly arise from the diaphragmatic sellae or

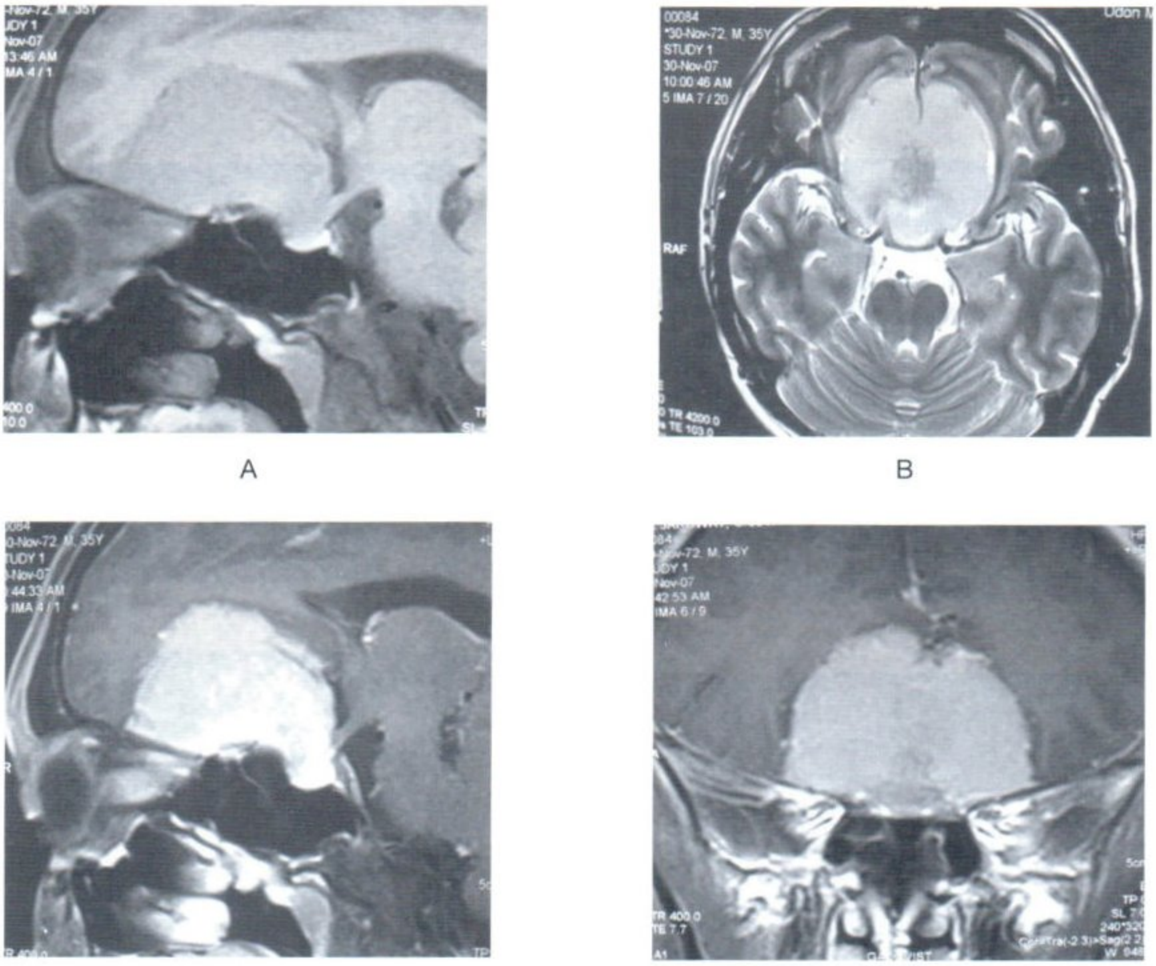

Fig.6 (A) Sagittal T1-weighted and (B) axial T2-weighted MR images of an olfactory meningioma obtained in a 35-year-old man showing isointense to gray matter with homogeneous enhancement on (C) sagittal and (D) coronal Gadolinium-enhanced MR images.

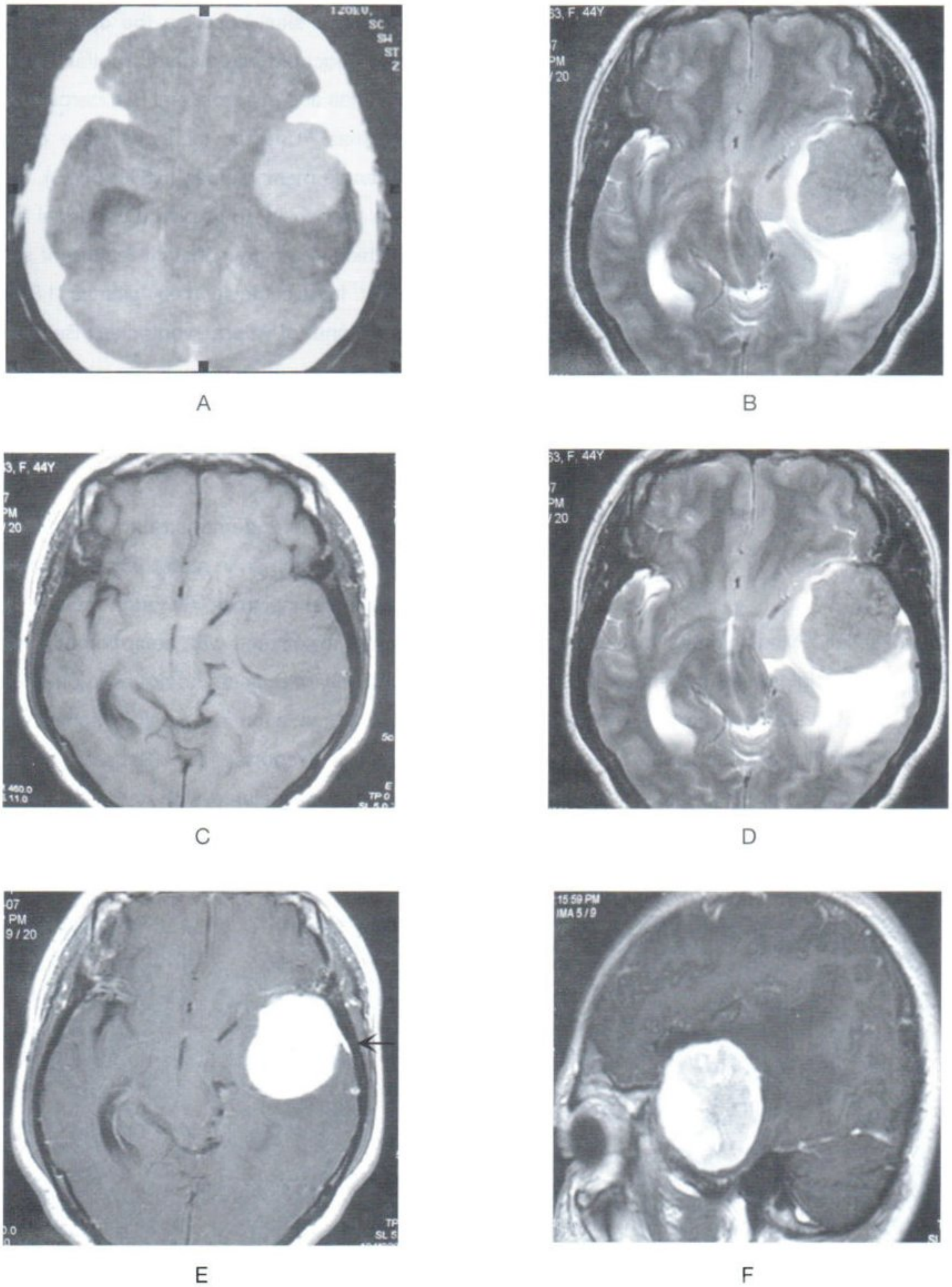

Fig.7 (A) Non contrast and (B) contrast-enhanced CT scans in a 44-years-old woman with left temporal convexity meningioma revealed homogeneous hyperdensity and homogeneous enhancement. (C) Axial T1-weighted, (D) axial T2-wieghted, and (E) axial, (F) sagittal MR images after Gadolinium administration revealed enhancing hypointense mass. Dural tail sign is shown. (arrow in e.)

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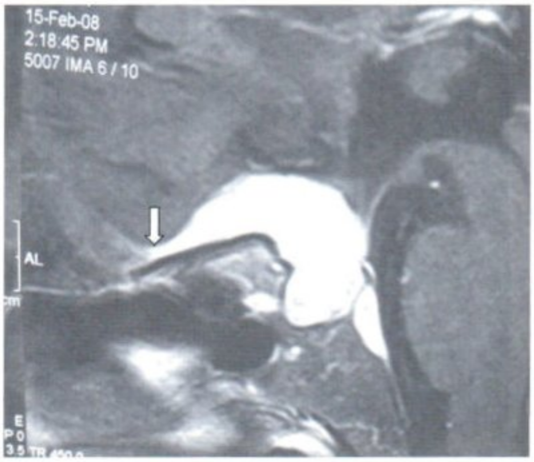

Fig.8 Sagittal T1-weighted MR image with Gadolinium enhancement in 54-years-old woman revealed an enhancing dural tail sign along planum sphenoidale (arrow).

tuberculum sellae.[7] Meningiomas may be entirely parasellar if they originate from the dural wall of the cavernous sinus. Olfactory groove meningiomas (9.1%) arise over the cribiform plate, they can be differentiated from tuberculum sellae meningiomas because olfactory groove meningiomas arise more anterior in the skull base, so the optic nerve and chiasm are located inferolateral to olfactory groove meningiomas and superolateral to tuberculum sellae meningiomas.[9] Unusual locations were cerebello-pontine angle meningiomas (5.5%) (Fig.9), they did not have propensity to involve the internal auditory canal (which is a fairly constant feature of schwannomas).[10,11] Intraventricular meningiomas (1.8%) were in the trigone of lateral ventricles. Because the choroid plexus is more bulky in the lateral ventricles, incidence of lateral ventricle meningiomas is higher compared with those in the third and fourth ventricles.[12,13]

Lusin et al[14] demonstrated CT findings of multiple meningiomas in about 9% of patients with intracranial meningiomas. Although multiple meningiomas are associated with neurofibromatosis type 2, the majority of patients do not have other characteristic features such as multiple schwannomas.[2] Geuna et al[15] reported 2 of 9 cases of multiple meningiomas associated with neurofibromatosis.

Meningiomas are known to be hypervascular,

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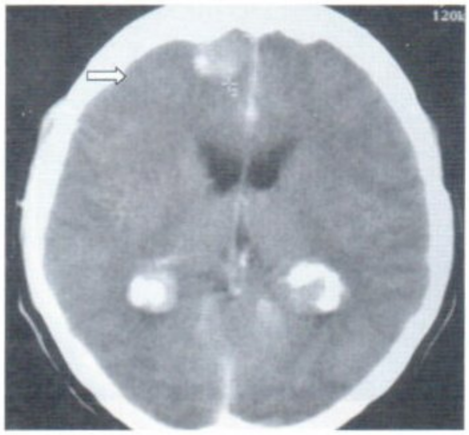

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Fig.9 Contrast-enhanced CT scans of a 31 years-old woman showed multiple meningiomas (A) bilateral CPA and (B) intraventricular meningiomas with globular calcifications. The right parasagittal meningioma with peripheral focal calcification was noted. (arrow in b.)

which results in additional adjacent reactive changes such as hyperostosis and sinus blistering.[16] In this study 10 (18.9%) meningiomas showed hyperostosis.

The dural tail sign is seen on contrast-enhanced MR images as a thickening of the enhanced dura mater that resembles a tail extending from a mass. Many investigators[8,17] were able to show little or no direct tumor involvement. It was therefore proposed that dural tails represented reactive changes to the dura mater, with perhaps minimal to meningothelial nodules that were adjacent to but not in contiguity with the tumor.

The cause of intraaxial peritumoral edema associated with meningiomas is controversial. However, Bradac et al[18] have found poor correlation between peritumoral edema and either the vascular supply of a meningioma or the presence of dural sinus invasion. The degree of peritumoral edema has little correlation with tumor size[18] and no correlation with location of tumor.[19]

On a review of the literature, any meningoendothelial cell whether intracranial, spinal or ectopic, can potentially result in the formation of a meningioma. These ectopic meningiomas may arise within diploic space, from the outer table of the skull, in the overlying skin, inside the paranasal sinuses,[20-22] in the parotid gland, and from the parapharyngeal space. Theories to explain these sites of origin include derivation from the arachnoid around the cranial nerve sheaths or from arachnoid cells disseminated during the formation of the skull.[2] A variety of pathological subtypes of meningioma have been defined and are outlines in table 7. Eric et al[3] reviewed 21 in 131 cases of CT and pathological findings showed atypical features of intracranial meningiomas such as necrosis, hemorrhage, scarring and cystic change. The term *cystic meningioma* has been used to described two different morphologies: intratumoral cavities and extratumoral or arachnoid cysts[2] which should be considered in the differential diagnosis of brain tumors with a cystic component. Cysts may result from direct secretion of fluid by tumor cells, from absorption of internal hemorrhage, or from loculated cerebrospinal fluid in scar tissue within or adjacent to the meningioma.[23] Lipoblastic meningioma and meningeal hemangiopericytoma are also atypical features of meningiomas.[2]

Table 7 World Health Organization classification of tumors of meningothelial cell origin

Grade	Tumor Types
I	Meningioma
	Meningothelial (syncytial)
	Transitional
	Fibrous
	Psammomatous
	Angiomatous
	Microcystic
	Secretory
	Clear cell
	Lyphoplasmocyte-rich
	Metaplastic variants (xanthomatous, myxoid, osseous, cartilaginous)
II	Atypical meningioma
III	Anaplastic (malignant) meningioma

Conclusion

Meningiomas are usually benign tumors with characteristic CT and MR imaging features, although too small group of MR image findings in this study. However on a review of the literature, there are several unusual or misleading features of meningiomas such as cysts, hemorrhage and fat. Meningiomas may originate in unexpected locations such as the ventricles, orbit, paranasal sinuses and meningioma en plaque. Because meningiomas are so common, the radiologists must be aware of their less frequent and uncharacteristic imaging features in order to suggest the correct diagnosis in cases that are atypical.

References

1. Rockhill J, Mrugala M, Chamberlain MC. Intracranial meningiomas: an overview of diagnosis and treatment. Neurosurg Focus 2007;23(4):1-7.
2. Buetow MP, Buetow PC, Smimiotopoulos JG. Typical, atypical, and misleading features in meningioma. Radiographic 1991;11:1087-106.
3. Russell EJ, George AE, Kricheff II, Budzilovich G. Atypical computed tomographic features of intracranial meningioma: radiological-pathological correlation in a series of 131 consecutive cases. Radiology 1980;135:673-82.
4. Elster AD, Challa VR, Gilbert TH, Richardson DN, Contento JC. Meningiomas: MR and histopathologic features. Radiology 1989;170:857-62.
5. Spagnoli MV, Goldberg HI, Grossman RI, Bilaniuk LT, Gomori JM, Hackney DB, Zimmerman RA. Intracranial meningioma: high-field MR imaging. Radiology 1986; 161(2):369-75.
6. Wallace EW. The dural tail sign. Radiology 2004;233:56-7.
7. Johnson DE, Woodruff WW, Allen IS, Cera PJ, Funkhouser GR, Colemo LL. MR imaging of the sellar and juxtasellar regions. Radiographics 1991;11:727-58.
8. Goldsher D, Litt AW, Pinto RS, Bannon KR, Kricheff II. Dural "tail" associated with meningiomas on Gd-DTPA-enhnaced MR images: characteristics, differential diagnostic value, and possible implications for treatment. Radiology 1990;176:447-50.
9. Hentschel SJ, DeMonte F. Olfactory groove meningiomas. Neurosurg Focus 2003;14(6):1-5.
10. Derome PJ, Guiot G. Bone problems in meningiomas invading the base of the skull. Clin Neurosurg 1978;25: 435-51.
11. Wu E, Tang Y, Bai R. CT in diagnosis of acoustic neuromas. AJNR 1986;7:645-50.
12. Laird FJ, Harner SG, Laws ER Jr, Reese DF. Meningiomas of the cerebellopontine angle. Otolaryngol Head Neck Surg 1985;93(2):163-7.
13. Bhatoe HS, Singh P, Dutta V. Intraventricular meningiomas: a clinicopathological study and review of the literature. Neurosurg Focus 2006;20(3):1-6.
14. Jelinek J, Smirniotopoulos JG, Parisi JE, Kanzer M. Lateral ventricular neoplasms of the brain: differential diagnosis based on clinical CT and MR findings. AJNR 1990;11:567-74.
15. Lusin JO, Nakagawa H. Multiple meningiomas evaluated by computed tomography. Nuerosurgery 1981;9:137-41.
16. Rowbotham GF. The hyperostosis in relation with the meningioma. Br J Surg 1939;26:593-622.
17. Tokumaru A, Ouchi T, Eguchi T, et al. Prominent meningeal enhancement adjacent to meningioma on Gd-DTPA-enhanced MR images: histopathologic correlation. Radiology 1990;175:431-3.
18. Bradac GB, Ferszt R, Bender A, Schorner W. Peritumoral edema in meningioma: a radiological and histological study. Neuroradiology 1986;28:304-12.
19. Go KG, Wilmink JT, Molenaar WM. Peritumoral brain edema associated with meningiomas. Neurosurgery 1988;23(2):175-9.
20. Lee KF, Suh JH, Lee YE, Berry RG. Meningioma of the paranasal sinuses. Neuroradiology 1979;17(3):165-71.
21. Thompson LD, Gyure KA. Extracranial sinonasal tract meningiomas: a clinicopathologic study of 30 cases with a review of the literature. Am J Surg Pathol 2000;24(5): 640-50.
22. Swain RE Jr, Kingdom TT, DelGaudio JM, Muller S, Grist WJ. Meningiomas of the paranasal sinuses. Am J Rhinol 2001;15(1):27-30.
23. Worthington C, Caron J, Melanson D, Leblanc R. Meningioma cysts. Neurology 1985;35:1720-4.