

Imaging sellar and suprasellar lesions

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Abstract:

Background: Various types of neoplastic and non-neoplastic lesions arise in the anatomically complex sellar and suprasellar region. Pre-operative imaging evaluation of these various lesions is very important in deciding mode of management. CT and MRI are usually the most commonly used cross sectional imaging modalities in evaluating sellar and suprasellar pathologies and both are complimentary to each other. Pituitary macro adenoma, meningioma and craniopharyngioma are few of the common conditions affecting this region. In this article we aim to review their imaging features and characterise them for better understanding and evaluation.

Conclusion: The sellar and suprasellar regions hold complex anatomical region with multiple neurovascular structures and the site of multiple pathologies of varying clinical significance. Imaging is very important in guiding the treatment.

Keywords: MRI, sellar and suprasellar pathology.

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I. Introduction

Sella and supra sellar region is an anatomically complex region in the skull base. It houses important structures of central nervous system, endocrine system and vessels and nerves related to them and bones surrounding them. Structures in this region give rise to varying types of neoplastic and non-neoplastic lesions. Pre-operative differentiation and delineation of their margins is very important in deciding nature of management and choosing the route of surgery and degree of surgical resection^[1]. In this study we aim to review imaging features of different sellar and suprasellar lesions and their characterisation.

Computed tomography (CT) and Magnetic resonance imaging (MRI) are most commonly used cross-sectional imaging modalities used in evaluation of sellar and supra sellar region and both are complimentary to each other. Computed tomography (CT) is useful for evaluation of the pathologies which produce changes in the bones of sella and in whom MRI is contraindicated and MRI is the main stay of pre-operative evaluation of soft tissue pathologies of sellar and supra sellar region.

Common conditions affecting the sellar and supra sellar region which require imaging are pituitary macro adenoma^[2], meningioma^[3], craniopharyngioma, Rathke's cleft cyst and aneurysms.

II. Technical factors

CT SCAN:

Computed tomography (CT) is very useful in the distinct visualization and evaluation of the bony borders of the sella. It is particularly valuable in evaluating the pathologies which produce changes in the bones of sella. CT is the sole option in evaluations of patients in whom MRI examination is contra indicated (e.g. pacemakers, incompatible orthopedic and dental implants) and in patients with severe claustrophobia. Thin axial section images can be reformatted into sagittal and coronal images. The examination can be done with contrast for evaluation of soft tissue and vascular pathologies and without contrast for exclusive evaluation of osseous pathology.

MRI:

MRI examination is useful in comprehensive evaluation of soft tissues contents of sellar and suprasellar regions. It is the fundamental preoperative and postoperative imaging modality. Sagittal and coronal images with a small field of view in thin sections (≤ 3 mm) are obtained through the sella turcica to include the parasellar structures, including the suprasellar cistern, cavernous sinuses, Meckel's cave and hypothalamus. Post-gadolinium enhanced sequences are obtained with fat saturation to improve contrast between pathology and the basicranium.

There are various types of MRI machines with variable magnetic field strengths such as 1.0, 1.5, 3 T. 1.0 T MRI machines have poor resolution, therefore average must be kept high to obtain good quality images,

however it will increase overall examination time and risk of movement of patient. 3.0 T MRI machines are faster for scanning and acquire high quality images but its sensitivity and specificity is equivalent to 1.5 T MRI, however, 3.0 T MRI have high metallic artefact.

III. Anatomy

Sellar and supra sellar region is a complex anatomical region and holds multiple neurovascular structures.

The primary component of the sella turcica is the sphenoid bone. Anteriorly, it is bounded by a bony ridge, the tuberculum sellae, and posteriorly by the dorsum sellae and the posterior clinoid processes. The anterior clinoid processes of the lesser wing of the sphenoid are lateral to the tuberculum sellae and project posteriorly. The roof of the sphenoid sinuses forms the floor of the sella, and their architecture affects the floor of the sella and its reaction to pathology. A dural extension defines the superior margin, the diaphragm sellae. This lines the sella turcica, envelopes the pituitary gland and forms the incomplete superior border. Laterally, there are the venous sinusoids of the cavernous sinuses and middle clinoid processes are variably present. The pituitary fossa holds the pituitary gland, which is composed of the adenohypophysis and neurohypophysis. The pars distalis, pars intermedia and pars tuberalis form the adenohypophysis. The neurohypophysis is made up of the pars nervosa, infundibular stalk and the infundibula proper. The size of the pituitary gland varies with age and gender: 6mm in children, 8 mm in males and post-menopausal females, 10 mm in pre-menopausal females, and up to 12 mm in pregnant lactating females.

The hypothalamus and pituitary gland are connected by important neurovascular connections. Axons of supra-optic and paraventricular nuclei of the hypothalamus traverse the infundibular stalk and extend into the neurohypophysis.

The secretory granules carrying vasopressin and oxytocin appear as the "bright spot" of the posterior lobe of the pituitary gland on T1-weighted unenhanced magnetic resonance imaging (MRI). Releasing and inhibiting factors produced in the neurons in the hypothalamus are transported to the adenohypophysis via the tuberohypophyseal neural tract and the hypophyseal portal system. Bilateral cavernous sinuses extend from the petrous segment of the temporal bone to the orbit and contain cranial nerves III (oculomotor), IV (trochlear), V1 (ophthalmic division of the trigeminal nerve), V2 (maxillary division of the trigeminal nerve) and VI (abducens). The cavernous segment of the internal carotid arteries and their meningeohypophyseal trunks travel through these paired duraperiosteal spaces. The most medial structures within the cavernous sinuses are the internal carotid artery and cranial nerve VI. The other fore mentioned cranial nerves travel along the lateral aspects. The mandibular division of the trigeminal nerve (V3) lies external to the cavernous sinus and exits through foramen ovale vertically oriented beneath Meckel's cave. Bilateral Meckel's caves are inferolaterally to each of the cavernous sinuses. Above the sellar region lies the suprasellar cistern. Several critical structures traverse this area, including the circle of Willis, optic nerves and optic chiasm, hypothalamus, pituitary infundibulum, and the infundibular and superchiasmatic recesses of the third ventricle

IV. Imaging Features of Sellar And Supra Sellar Mass Lesions

1) PITUITARY MICROADENOMA:

Micro adenoma are less than 10 mm in size, usually detected when investigating hormonal imbalances and does not produce symptoms due to mass effect,

MRI is the imaging modality of choice and requires a dedicated pituitary study (thin slice, small field of view, dynamic contrast acquisition). Post-contrast thin-section dynamic contrast-enhanced imaging is very sensitive in detecting pituitary micro adenomas.

On T1 –weighted images they are usually isointense to normal pituitary and on T2 weighted images they appear hyperintense, on post contrast T1 images they usually show delayed enhancement (i.e. immediately after contrast administration they appear as areas of non-enhancement within in enhanced pituitary) or rarely they may remain isointense to rest of the pituitary.

Nonspecific morphological changes involving sella are often noticed and they include bulkiness of the pituitary gland on the side of the micro adenoma, remodeling of the floor of the sella and deviation of the pituitary infundibulum away from the adenoma.

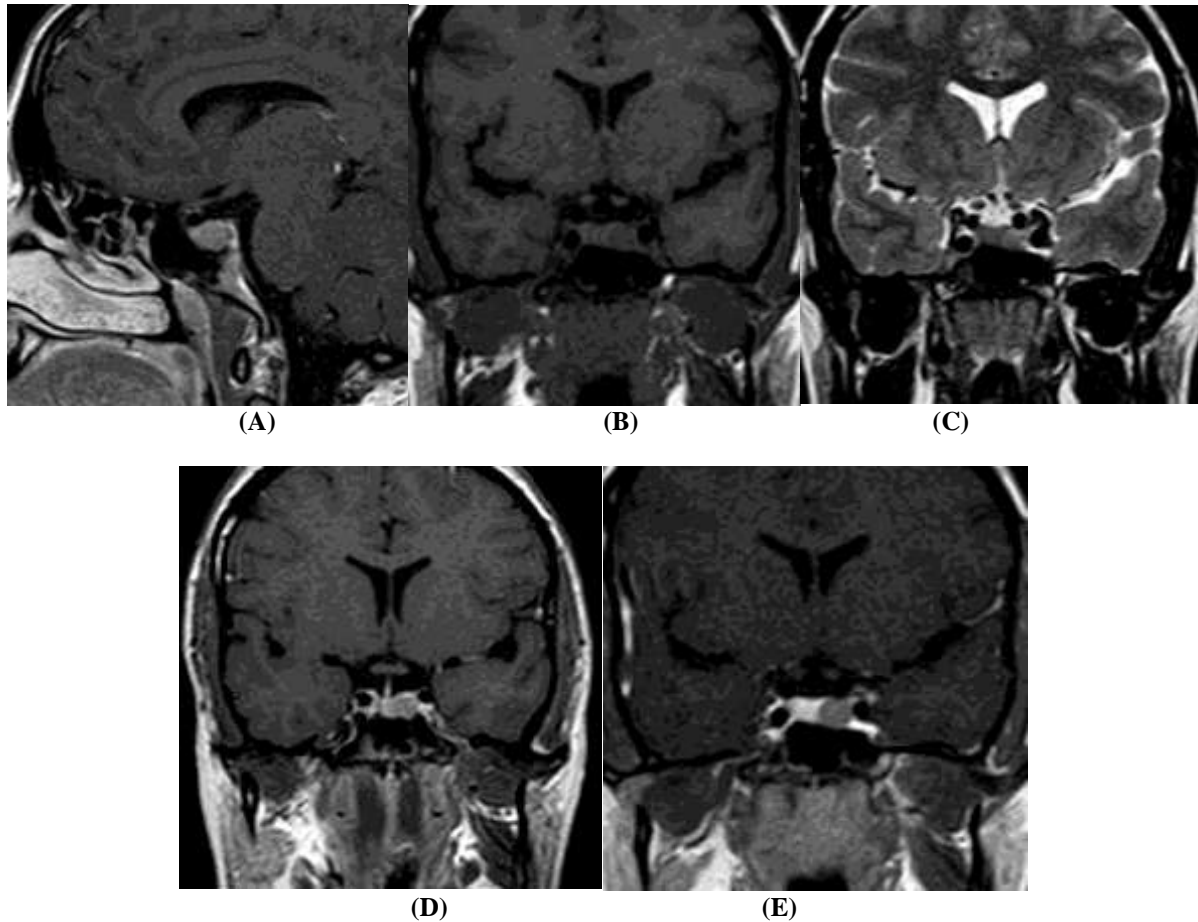


FIGURE1: Pituitary micro adenoma, (A) unenhanced sagittal T1 image, (B) unenhanced coronal T1 image and (C) coronal T2 image, show a well-defined smooth margined altered signal intensity lesion (isointense on T1 and hyperintense on T2) in sella (D) post contrast T1 fat sat image show delayed enhancement of the lesion. and (E) post contrast dynamic study on immediate scan show area of non-enhancement within enhanced pituitary.

2) PITUITARY MACRO ADENOMA:

Macro adenomas are >10 mm in diameter. These lesions are isodense to brain on CT (30-40 HU) and isointense to Gray matter on T1- and T2- weighted imaging and demonstrate homogenous enhancement on contrast administration.

Approximately, 10% of adenomas are complicated by haemorrhage, infarction or necrosis/cystic changes, which alters the MRI signal intensities.

Adenomas as they grow first expand the sella and then later extend in cephalad direction to involve suprasellar cistern and compress the optic chiasm and optic nerves. Because they are soft tumours, they usually indent at the diaphragm sella, giving them a 'snowman' Configuration, caudally to erode the sella turcica, and laterally to compress or invade the cavernous sinuses. A reliable imaging finding of cavernous sinus involvement is abnormal tissue between the lateral wall of the cavernous sinus and the cavernous internal carotid artery^[4].

Sellar enlargement and erosion, cavernous sinus invasion, and lobulated margins are reliable indicators of an adenoma. Sellar enlargement is seen in 94-100% of pituitary macro adenomas^[5], however sellar enlargement is also common in meningioma's (64%), absence of sellar enlargement in a supra sellar mass is significant as it rules out pituitary macroadenoma. Osseous sellar wall erosion is seen in 76% of macro adenomas but is less common in meningiomas.

A multilobulated upper tumour margin has been reported to be more common in macro adenomas than any other sellar and supra sellar mass lesions.

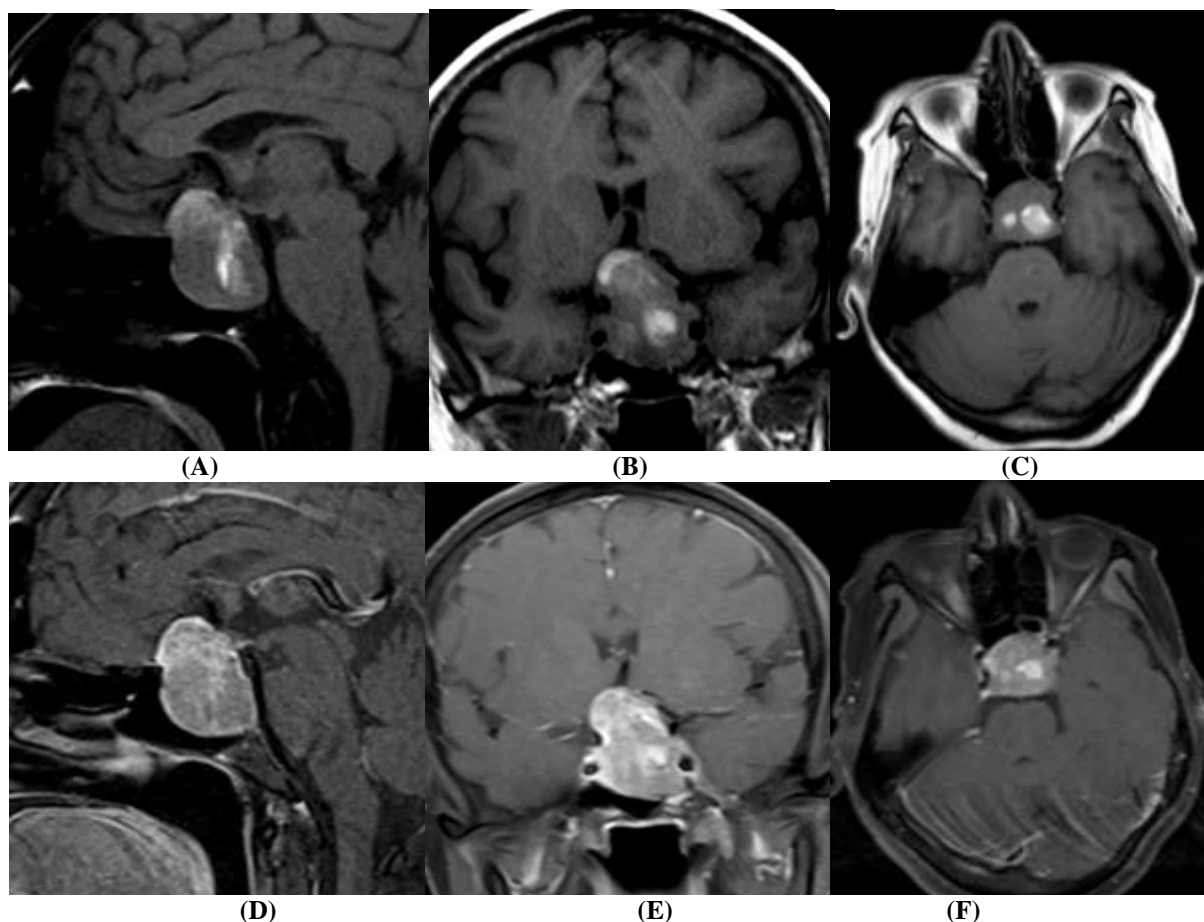


FIGURE 2: Pituitary macroadenoma, (A), (B), (C) are sagittal, coronal and axial unenhanced T1-weighted images showing a well-defined smooth margined altered signal intensity lesion in sella and suprasellar region giving snowman appearance, with internal cystic area and hemorrhage. Expansion and thinning of sella turcica can also be noted, (D),(E),(F) post contrast T1 fat sat sagittal, coronal and axial images show heterogeneous enhancement, with normal bilateral internal carotid arteries and basilar artery

3) MENINGIOMA:

Meningiomas are most common intracranial tumour in adults with 20% occurring at the skull base, the epicentre of the lesion is above the sella. Meningiomas are usually solid lesions, sometimes with cystic changes at the margins.

They elevate the arachnoid to a small extent and show uniform enhancement. Supra- and intrasellar meningiomas arise from the diaphragm, tuberculum, or dorsum sellae and are not usually centered on the sella turcica. The signal intensity and enhancement features and vascular nature of meningiomas are more characteristic than those of adenomas.

Meningiomas are isointense to cortex on T1 and T2 weighted images similar to adenomas. Three characteristic features of meningiomas are dense homogeneous enhancement, obtuse dural margins and dural tail enhancement.

Dense homogeneous enhancement is characteristic of meningioma. Homogeneous enhancement is reported in 94% of sellar meningiomas⁽⁶⁾. Macroadenomas enhance homogeneously only in 37% cases and dense homogenous enhancement is very rare among them. Homogeneous enhancement in craniopharyngiomas and Rathke's cleft cyst have not been described so far.

Obtuse dural margins is common in meningiomas involving the tuberculum or dorsum sellae, but very less common in macro adenomas and other supra sellar masses.

Dural tail enhancement is more common in meningiomas arising from sella and less common in pituitary macro adenomas.

Hyperostosis is also associated with meningiomas of sellar and supra sellar region. As with meningiomas of any other location, calcifications within craniopharyngioma may sometimes mimic hyperostosis associated with meningiomas.

If MR angiography shows flow voids or abnormal vessels with characteristic broom like or sunburst morphology, then meningioma is a more likely cause.

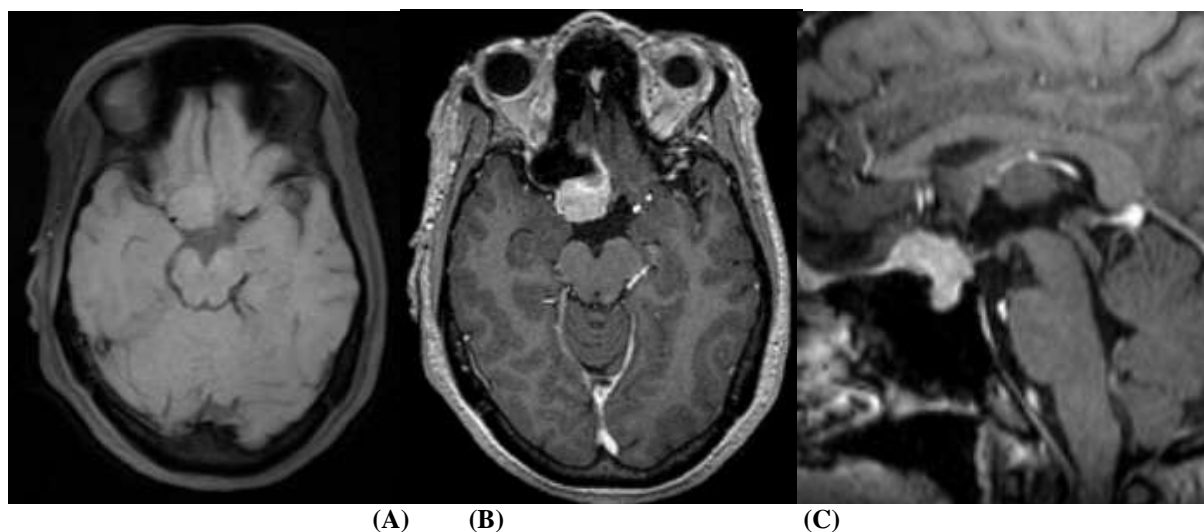


FIGURE 3: Meningioma, (A) fat suppressed T-1 weighted axial image shows a well-defined rounded extra axial altered signal intensity (isointense on T1WI) lesion in suprasellar and right para-sellar region, **(B)and (C)**post contrast T1 fat sat axial and sagittal images show dense homogeneous enhancement, with dural enhancement, dural tail sign and obtuse dural margins, it lies in close relation with optic chiasm and right internal carotid artery.

4) **CRANIOPHARYNGIOMA:**

Craniopharyngioma is a locally invasive but benign tumour arising from Rathke's pouch remnants and can originate from anywhere between the nasopharynx to floor of the third ventricle.

Macroscopically, it is a complex mass with multiple nodules at the base of the brain, sinuating along the fissures.

Two histological subtypes have been described adamantinomatous and papillary, former is 3 to 9 times more common than the latter. Adamantinomatous is more common in children and papillary is seen almost exclusively in adults. Adamantinomatous type usually presents as single or multiple cysts filled with thick oily fluid. Calcification is present ~90% of the cases of this type⁽⁷⁾.

Papillary type is usually presenting as solid mass. Cyst formation is unusual and calcifications are very rare.

Not surprisingly, radiological features depend on histological type.

Over 50% of cases craniopharyngiomas have a pathognomonic appearance, solid cystic lesion with lobulated contour in intrasellar and suprasellar region with clear visualisation of calcifications on unenhanced CT and incomplete enhancement of solid and cystic components on contrast administration. These findings in a child are virtually pathognomonic for craniopharyngioma (only other the differential diagnosis a dermoid)

On unenhanced and enhanced T1-weighted images, cysts within the lesion appear iso to hyperintense and partly hyperintense on T2-weighted images, solid component shows vivid enhancement on post contrast T1-weighted images. A compressed pituitary gland can be identified within the sella. Calcifications are much evident on MRI, MRI angiography might show displaced ACA and on MR spectroscopy cyst contents may show a broad lipid spectrum.

Papillary subtype mainly presents as spherical solid mass with no internal cystic changes or calcification.

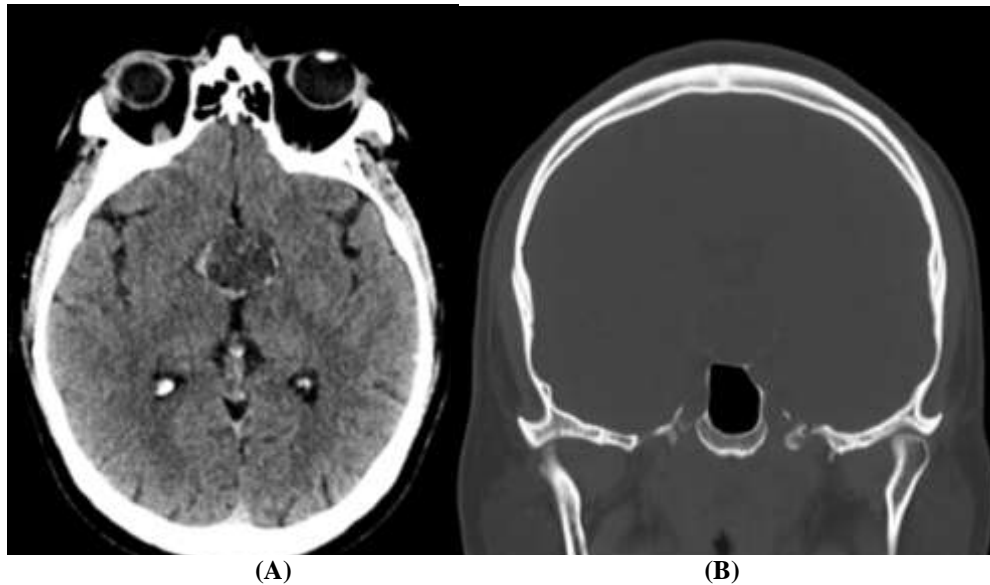


FIGURE 4: Craniopharyngioma. (A) shows a well-defined extra-axial hypo dense lesion in sellar and supra sellar region with multiple foci of peripheral calcification, suggestive of adamantinomatous type of craniopharyngioma, (B) shows CT bone window coronal section with faint peripheral calcification around the lesion with normal bony structures in the region.

5) RATHKE'S CLEFT CYST:

Rathke's cleft cysts are non-neoplastic, sellar or suprasellar epithelium-lined cysts arising from the embryologic remnants of Rathke's pouch in the pituitary gland. The cyst is fluid-filled and has very thin walls with a thickness of only one or two cell layers. These walls can contain cells which secrete fluid, allowing the cyst to grow and compress adjacent structures. Rathke's cleft cysts can occur either in or above the sella turcica. On non-contrast CT they typically appear as non-calcified and of homogenous low attenuation. Rarely it may be of mixed iso- and low-attenuation, or contain small curvilinear calcifications in the wall (seen in 10-15% of cases). In contrast enhanced CT they are non-enhancing, although the cyst wall may enhance in some cases.

On MRI they have a high signal intensity on the unenhanced T1-images. Only two things that are that bright on unenhanced T1-weighted images are either fluid (blood or proteinaceous fluid) or fat.

A cystic craniopharyngioma is also in the differential diagnosis. On T2 weighted images 75 % of them appear as hyperintense, and does not show enhancement on post contrast T1 images. In ~75% of Rathke's cysts, a small non-enhancing intracystic nodule hyperintense to surrounding fluid on T1 and hypointense on T2 can be identified which is pathognomonic of a Rathke's cleft cyst⁽⁸⁾. In case of an intra cystic hemorrhage a fluid-fluid level may be appreciated.

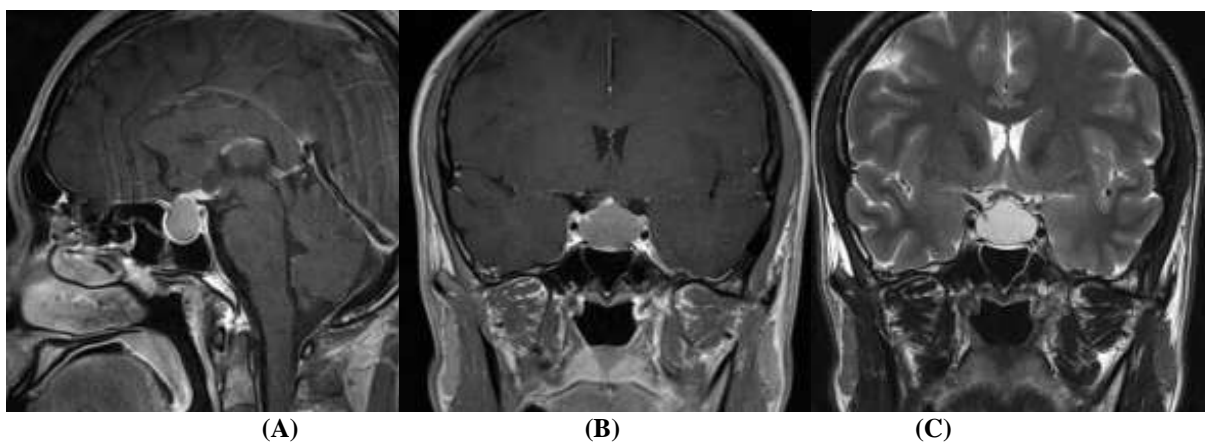


FIGURE 5: Rathke's cleft cyst,(A), (B)and (C)are unenhanced sagittal and coronal T1-weighted images and coronal t2 weighted image respectively, which show a well-defined smooth margined altered signal intensity lesion (iso to hyperintense on T1 and hyperintense on T2) predominantly in sella with slight extension into suprasellar region.

6) ANEURYSM:

Aneurysms involving the sella typically arise from the cavernous or supraclinoid internal carotid artery. They develop from a combination of hemodynamic stress and acquired or inherited factors such as connective tissue disorders that result in progressive weakening of the vessel. Aneurysms greater than 25 mm in diameter are rare and regarded as Giant aneurysms

Recognition of aneurysm is critical, particularly to avoid a biopsy. Giant aneurysms can cause osseous erosion of the skull base and may occasionally extend to the parapharyngeal space, paranasal sinuses, or infra temporal fossa.

Radio graphical features of aneurysms are sometimes misleading, their imaging characteristics may be misleading and prominent features are significant signal heterogeneity, pulsation artifact in the phase-encoding direction and curvilinear calcification on CT.

Significant signal heterogeneity is typically seen with areas of hyperintense T1 signal intensity caused by sub-acute thrombus or flow-related enhancement or with areas of hypointense T2 signal intensity caused by intracellular deoxy- or methemoglobin, calcification, or flow void.

Areas of profound T2 hypo intensity within a skull base mass may represent a vascular flow void and the lesion should be carefully scrutinized to rule out an aneurysm.

Craniopharyngiomas may have significant heterogeneity. They usually have a more geographic variability from a combination of cysts, cholesterol laden lakes and tumor tissue.

Flow-related artifacts play a large role in aneurysmal signal heterogeneity and often have linear configurations. Signal misregistration artifact in the phase-encoding axis due to disordered or pulsatile flow within the aneurysm is also a characteristic finding. It is not seen in other masses involving the sella. The adjacent cavernous carotid arteries in other masses may create the same artifact, but it can be localized to the normal artery rather than the mass. Curvilinear calcification with intense enhancement of the residual lumen contrast enhanced CT is relatively specific, but differentiation from other masses involving the sella is still difficult.

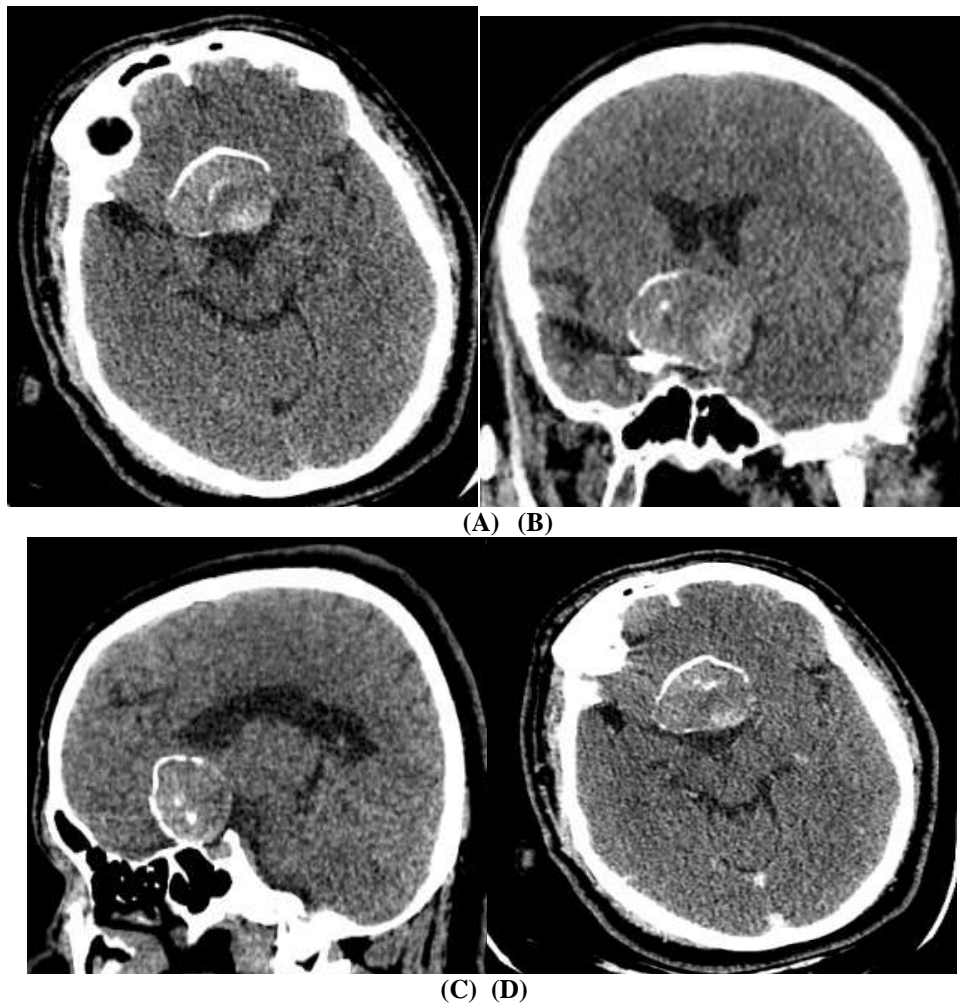


FIGURE 6: Aneurysm, (A), (B), (C) unenhanced CT axial, coronal and sagittal images show hypo dense lesion in supra sellar region with curvilinear calcification along the its margins, (D) shows axial image of contrast enhanced CT, which shows minimal enhancement.

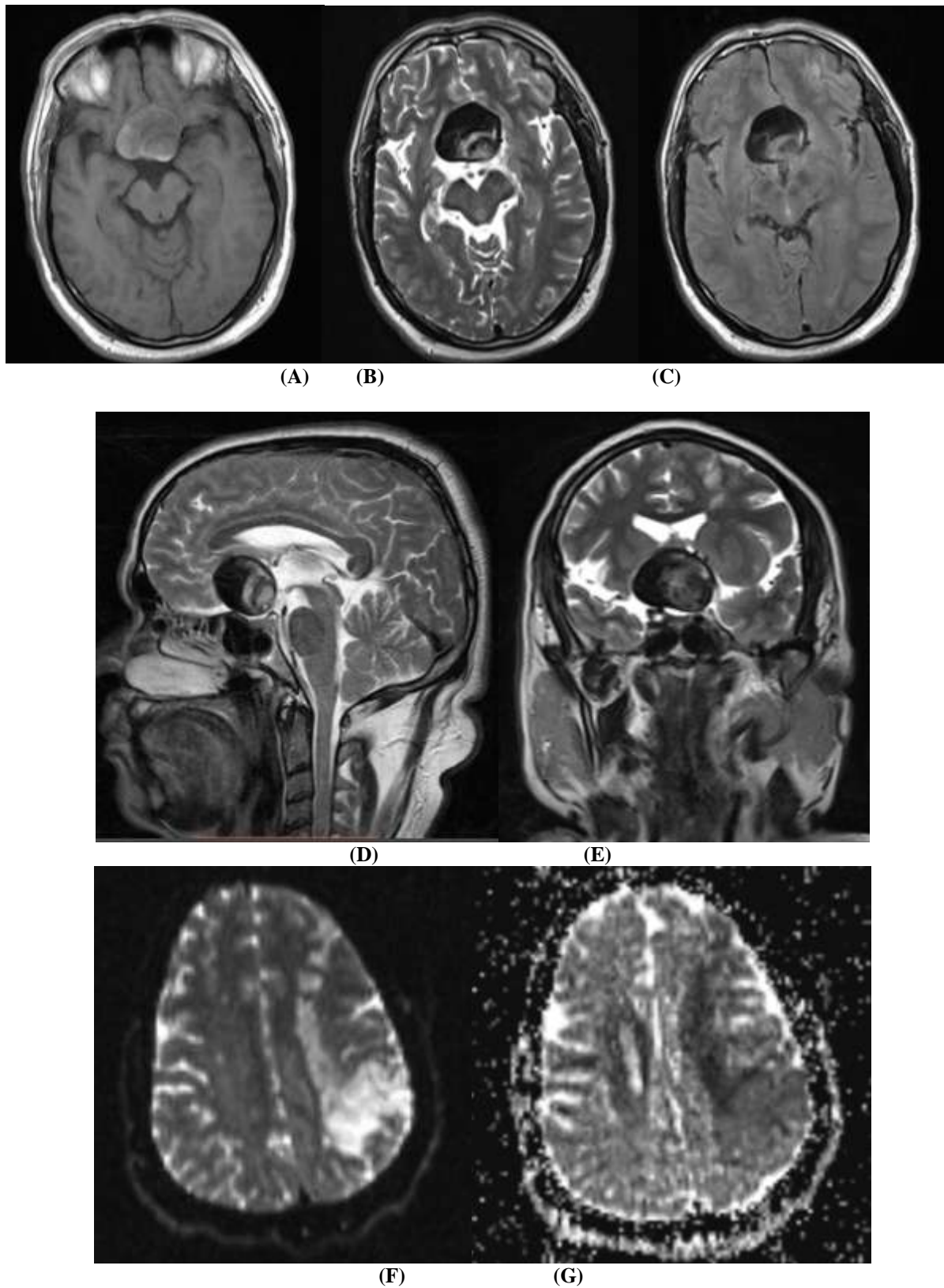


FIGURE: 7 Aneurysm, (A) to (E) are axial T1, T2 AND FLAIR image and T2 sagittal and coronal images show a large well circumscribed saccular out-pouching (predominantly hypointense with internal

hyperintense areas on T2WI and FLAIR and iso- to hyperintense on T1WI) possibly arising from clinoid segment of left internal carotid artery in supra sellar location at supra-clinoid region, (F) and (G) show altered signal intensity (hyperintense on T2WI, FLAIR image and hypointense on T1WI and restriction diffusion on DWI) area involving cortex, sub cortex and periventricular white matter of left fronto-parietal lobes suggestive of acute infarct.

7) TUBERCULOMA:

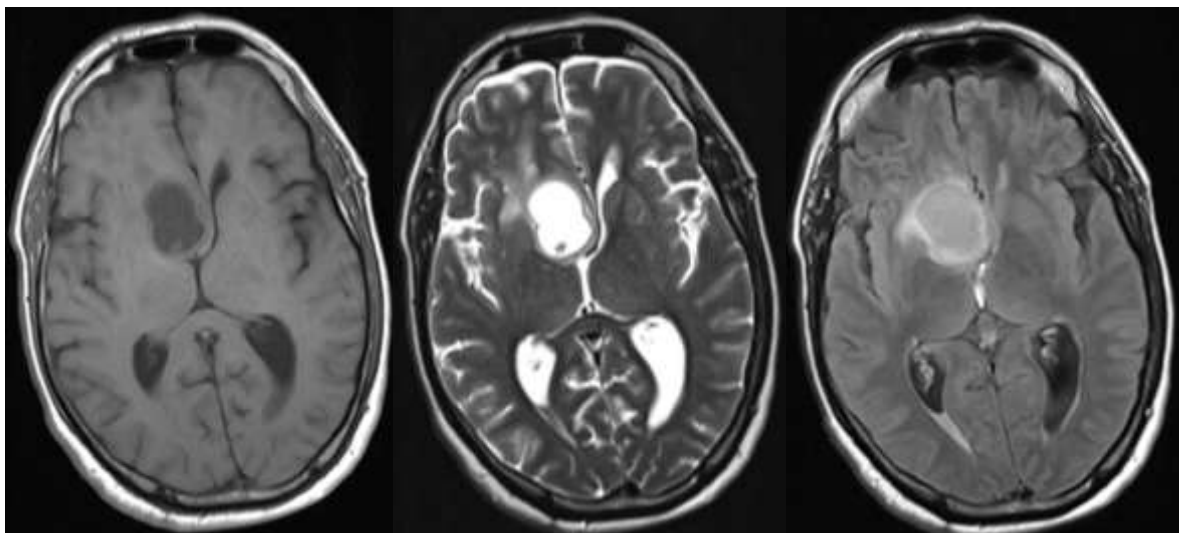
Tuberculosis is responsible for 20% of the intracranial space-occupying lesions in India and tuberculomas of the sellar and suprasellar region comprise only 1% of all intracranial tuberculomas⁽⁹⁾

Pituitary tuberculosis is difficult to differentiate inflammatory lesions from a pituitary adenoma. MRI is the preferred imaging modality to establish the differential diagnosis.

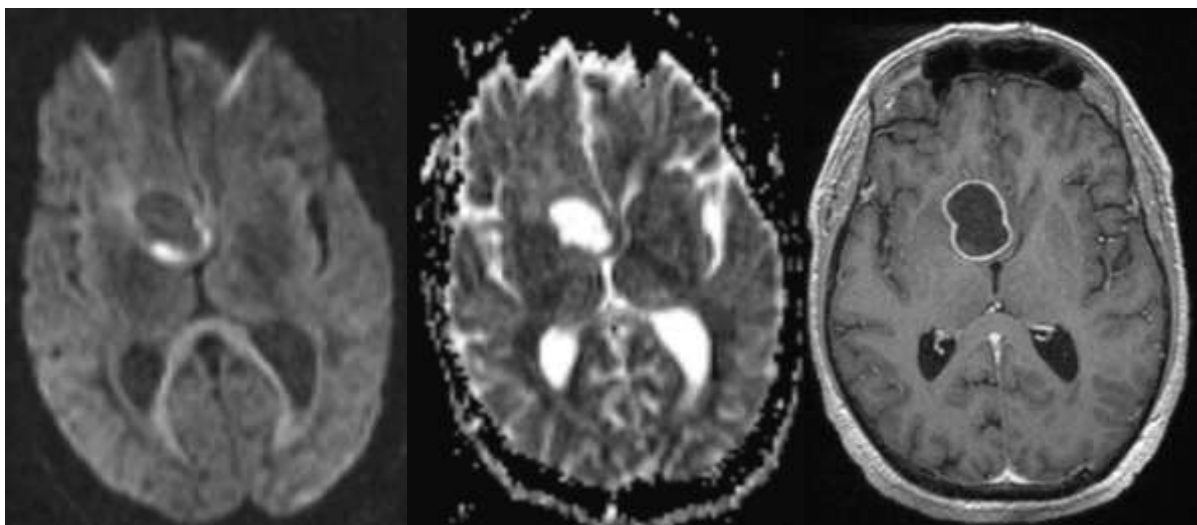
Thickening and nodularity of the pituitary stalk are considered to be a sign of pituitary tuberculoma; however, this finding is nonspecific as it is also seen in other inflammatory conditions like sarcoidosis, syphilis, and idiopathic hypophysitis⁽¹⁰⁾

T1-weighted image usually are hypointense; nevertheless, they can also be hyperintense too due a high protein content. Rarely they may be isointense on T1-weighted image. Lesions may appear hyperintense on T2-weighted image or may have a hyperintense center surrounded by a hypointense rim with peripheral ring enhancement of the lesion and enhancement of the adjacent dura and basal cistern.

On T2-FLAIR images most lesions were hyperintense, this feature helpful in differentiating them from other inflammatory conditions.



(A) (B) (C)



(D) (E) (F)

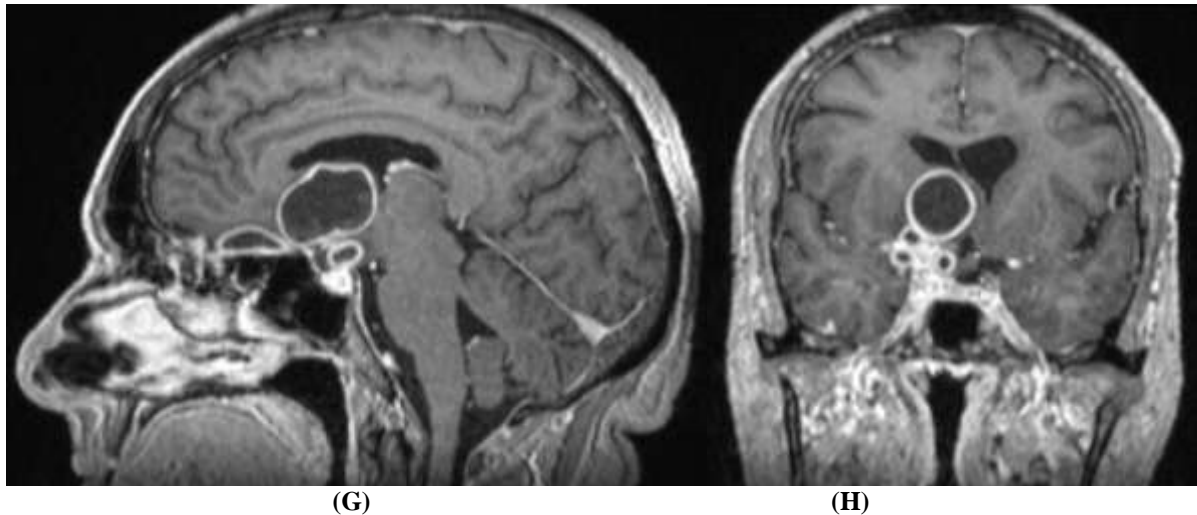


FIGURE 8: Tuberculoma,(A), (B) and(C) are axial T1, T2 and FLAIR images respectively showing altered signal intensity lesion hypointense on T1 and hyperintense on T2 and FLAIR images. (D) and (E) are axial diffusion and ADC images showing no evidence of any diffusion restriction. (F), (G) and (H) are post contrast T1 Fat sataxial, sagittal and coronal images respectively shows ring enhancing hypointense lesions (4 to 5 in number) in suprasellar location involving right hypothalamus, head of right caudate nucleus and right gyrus rectus.

8) METASTASES:

Metastatic lesions comprise approximately 1% of the tumors in the sellar or suprasellar region. Possible metastatic pathways to the pituitary and parasellar region include direct blood-borne metastasis to the posterior pituitary lobe, pituitary stalk, clivus, dorsum sellae, or cavernous sinus or leptomeningeal spread with involvement of the pituitary capsule.

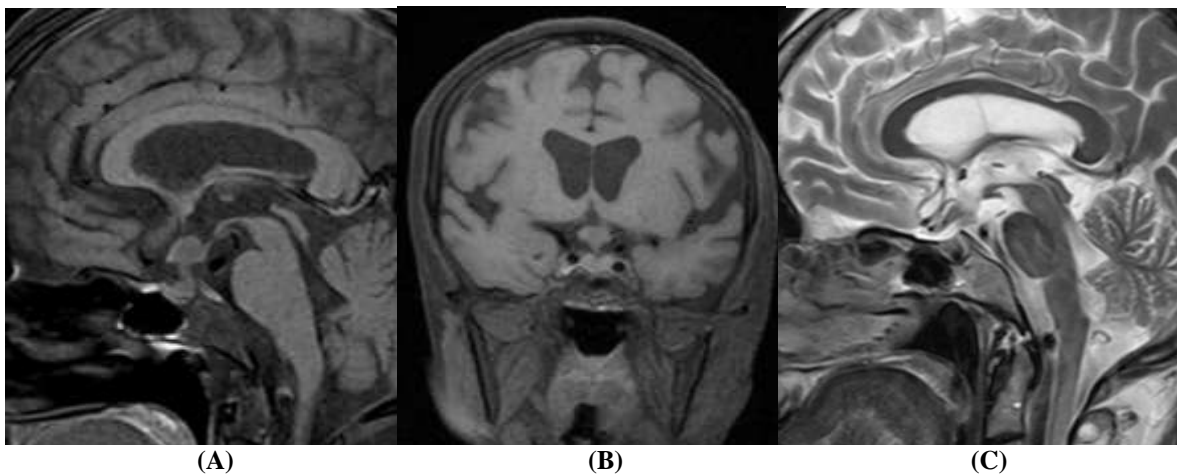
Radiological features of metastatic lesions involving sellar or supra sellar region are non-specific and similar to pituitary adenoma in many ways, hence difficult to differentiate.

Although nonspecific, the characteristics of these lesions on MR imaging are an iso- or hypointense mass on T1-weighted imaging with a usually hyperintense signal on T2-weighted imaging, and homogeneously enhancing mass in images obtained after the administration of contrast agent.

Invasion of the cavernous sinus, sclerotic changes around the sella turcica and clivus, isointense signal on both T1- and T2-weighted imaging and loss of high-intensity signal in the posterior pituitary have been reported to be helpful in differentiating metastatic lesions from benign ones ⁽¹¹⁾

Thickening or enhancement of the infundibulum has also been described as most characteristic CT or MR imaging feature in some studies. ⁽¹²⁾

Invasion of the infundibular recess in a suprasellar mass has also been suggested as a sign of metastasis ⁽¹³⁾ Involvement of multiple compartments in the anterior, middle, posterior cranial fossae, extension to the infra-temporal and pterygopalatine fossae, sphenoid sinus, and nasal cavity with bony destruction in the cranial base and asymmetric or bilateral invasion into the cavernous sinus is definitely indicator of metastatic lesions.



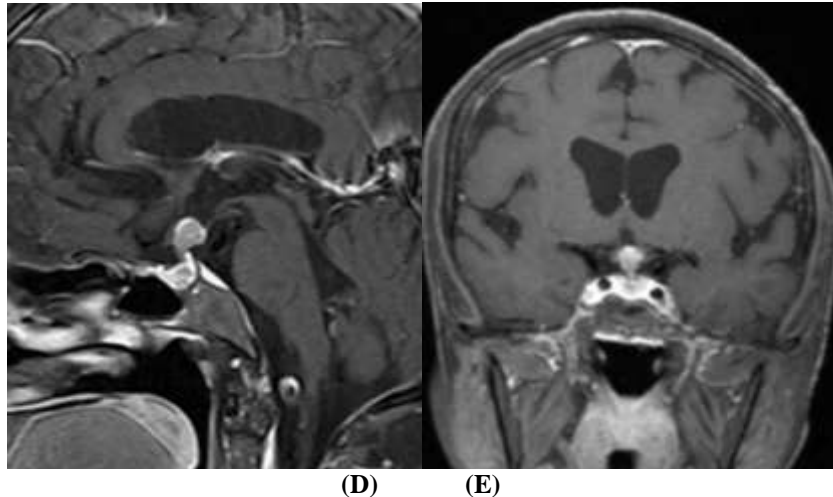


FIGURE9:Supra sellar metastatic lesion, (A)and (B) are fat suppressed unenhanced T1 weighted images and (C) t2 weighted image,which show a well-defined altered signal intensity (hypointense on T2WI, T1WI and FLAIR) lesion involving suprasellar regioninvolving hypothalamus. (D) and (E) show post contrast t1 images which intense enhancement of the lesion.

APPROACH TO CHARACTERISATION OF SELLAR OR SUPRA SELLAR MASS:

Identification of pituitary gland.

- 1) Identification of the pituitary gland and sella turcica.

Localisation of the lesion.

- 2) Determination of the epicentre of the lesion (i.e. sella or above, below or lateral to the sella).
- 3) If sellar lesion, presence or absence of sellar enlargement.

Signal intensity pattern of the lesion.

- 4) Solid or cystic lesion, enhancement

Specific imaging features.

- 5) Does it contain any abnormal vessels?
- 6) Are there any calcifications? And so on.

Differential diagnosis.

- 7) Finally establish a Differential Diagnosis.

V. Conclusion

The sellar and suprasellar regions hold complex anatomical region with multiple neurovascular structures, and the site of multiple pathologies of varying clinical significance. Imaging is very important in guiding the treatment.

Through knowledge of the anatomy and patho-physiological process behind the pathologies of the region with systematic evaluation of the region with clinical correlation of findings help indeveloping a differential diagnosis.

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