Imaging of intracranial pathologies with fluid levels: A radiological approach to the diagnosis

Poster No.: C-0609
Congress: ECR 2017
Type: Educational Exhibit
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Keywords: Infection, Blood, Neoplasia, Imaging sequences, MR, CNS
DOI: 10.1594/ecr2017/C-0609

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Learning objectives

1. To familiarize readers the key imaging features of spectrum of intracranial pathologies causing fluid levels.

2. To discuss the pertinent features related to the pathology with emphasis on the pathophysiological cause of appearance.

3. To understand the role of advanced sequences in the diagnosis of intracranial lesions causing fluid levels.

Background

Intracranial pathologies which include extra-axial and intra-axial lesions showing fluid levels are not uncommon and have broad imaging spectra. The authors have classified them as blood-fluid, air-fluid, protein-fluid and fat-fluid levels and discussed the common and rare pathologies in each category in a case based approach under the categories of location, incidence of fluid levels, imaging characteristics and postulation for fluid level. Image acquisition near perpendicular to the plane of the fluid level is required to optimally demonstrate it.

Findings and procedure details

Classification of Fluid Levels

Although MR signal characteristics are helpful in identifying the contents of the fluid levels, their formation is actually related to density differences secondary to their composition within the layers. Fluid levels occur when two or more immiscible substances of unequal density coexist. The fluid levels that we confronted are classified into four groups (Fig. 1 on page 17).

Blood-fluid levels:

Common: Pituitary adenoma, venolymphatic malformation, aneurysmal bone cyst, post-operative changes, anti-coagulation therapy.
Rare: Fifth, seventh and greater superficial petrosal nerve cranial nerve schwannomas, pilocytic astrocytoma, glioblastoma multiforme, ependymoma, atypical neurocytoma, metastasis, Ewing's sarcoma, cortical venous thrombosis, cavernoma.

**Air-fluid levels:**

Common: Immediate postoperative changes, sinusitis

Rare: CSF leak

**Protein-fluid levels:**

Common: Mucocele

Rare: Caseating tuberculoma, abscess, craniopharyngioma

**Fat-fluid level:** Dermoid cyst

**BLOOD-FLUID LEVEL:**

**Sequence of choice:** Susceptibility weighted imaging (SWI)/T2 * is useful to differentiate fluid and protein. The maximum blooming occurs in late deoxyhemoglobin and methemoglobin stage. Fluid level due to hemorrhage mostly occurs in late subacute stage or chronic stage and it is important because it suggests that the lesion is not acute. The cause of blood fluid level is mostly due to repeated hemorrhage within the existing lesion (Fig. 2 on page 18).

**Postulation of fluid level:** When there is hemorrhage into a lesion, the serum and plasma being lighter have a nondependent position and have a high signal intensity of T1- and T2-weighted images. RBCs have a dependent position and have low signal intensity on T2-weighted images (Fig. 2 on page 18). Therefore, while various stages of methemoglobin and deoxyhemoglobin are responsible for the signal characteristics, the physical formation of the fluid level is due to settling of the relatively denser cellular components.
1. Pituitary adenoma:

**Location**: sellar and suprasellar region.

**Incidence for fluid levels**: 2-4 percent of pituitary adenomas have haemorrhage, but not all these have fluid level. Fluid level is rare; however, it is the most common intracranial lesion to have fluid level.

**Imaging characteristics** (Fig. 3 on page 19)

- Most common suprasellar mass
- Signal characteristics depend on components such as haemorrhage, cystic formation and necrosis
- Typically isointense on T1 and T2 weighted images.
- T2* gradient echo/ SWI is the most sensitive sequence for detecting any haemorrhagic components, which appear as areas of signal loss.

**Postulation for fluid level**: It is seen during chronic stage of a clot or hemorrhage, when sedimentation of the blood cells produces a distinctive fluid-debris level within the lesion. Only acute bleed generally does not cause fluid level.

**Key points**

- The presence of a fluid-fluid level favours pituitary adenoma over rathke's cleft cyst.
- The presence of fluid level usually indicates hemorrhagic pituitary adenoma.
- The fluid-fluid level is more likely to be observed in hemorrhagic adenomas than in craniopharyngiomas, in which only a pseudo-fluid-fluid level may be seen that corresponds to tenacious secretions or to a fortuitous position of the interface between the fluid and solid components of the tumor.
- It is the most common tumour in our study with blood-fluid level and also it is the most common tumour which frequently occurs with intratumoural hemorrhage in literature.
- Fluid level within a fluid cavity suggests that surgery in these cases can be relatively straightforward despite the size. However, recurrence rates are relatively higher in such cases as compared to non hemorrhagic pituitary adenomas.

2. Pilocytic astrocytoma:

**Location**: Cerebellum in children and supratentorial location in adults.
Incidence for fluid levels: rare

Imaging findings: (Fig. 4 on page 20)

- Most commonly appear as large cystic component with a brightly enhancing mural nodule.
- In our patient, the lesion was only cystic with no mural nodule. There was fluid level with enhancement of cyst wall.
- Haemorrhage is a rare complication.

Postulation for fluid level:

- The abnormal vasculature due to endothelial proliferation and dysplastic capillary beds within the tumor can cause spontaneous haemorrhage within the cyst, resulting in fluid level at a late subacute/chronic stage.

3. Ependymoma:

Location:

- Intracranial ependymomas are usually infratentorial and are commonly intraventricular.
- Supratentorial ependymomas are commonly extraventricular, located in cerebral parenchyma.

Incidence for fluid levels: Although haemorrhage is encountered in 10 percent of lesions, fluid levels are rarely noted.

Imaging findings: (Fig. 5 on page 21)

- Heterogeneous lesion on T1, T2 weighted images with mild to moderate enhancement with contrast.
- A highly typical feature of ependymoma is extension into foramina of Luschka into the cerebellopontine angle and/or inferiorly through the foramen of Magendie into the posterior aspect of the upper cervical cord.
- In our case, the lesion was neither extending into the foramen lushka/near the fourth ventricle due to which a differential of schwannoma was also included.
- Supratentorial ependymomas are usually large and variable in appearance, ranging from completely solid, enhancing masses to cysts with a mural nodule, or more heterogeneous masses.
Postulation for fluid level: Ependymoma have protein rich cystic areas. Hemorrhage is seen in 10 percent and thus when hemorrhage occurs it can cause a fluid level.

4. Greater superficial petrosal nerve (GSPN) schwannoma: (Postulation for fluid level for all schwannomas is described after acoustic schwannoma)

Location: along petrous bone of temporal region.

Incidence for fluid levels: None reported in literature.

Imaging findings: (Fig. 6 on page 22)

- Extra-axial lesion projecting up into the middle cranial fossa.
- Most commonly they are hypointense on T1, heterogeneously hyperintense on T2 weighted images with vivid post contrast enhancement.
- Location with fluid level can aid in the diagnosis.

Key point:

- A schwannoma originating from the GSPN is very rare comprising only 0.8% of all petrous bone lesions.
- Only 14 patients with schwannomas originating from the GSPN have been reported in the literature.

5. Trigeminal schwannoma:

Location: Meckel's cave and parasellar region.

Incidence of fluid level: rare

Imaging characteristics: (Fig. 7 on page 23)

- Smoothly marginated tumors and are usually isointense relative to gray matter on T1 and hyperintense on T2 weighted images.
- Grow primarily in the parasellar region or extend posteriorly through the porus trigeminus into the posterior fossa. Tumor extension into the pterygoid fossa or paranasal sinuses occurs in 10% of cases.
- Typically follow the course of the fifth cranial nerve and have a dumbbell-shaped configuration.
6. **Acoustic schwannoma**:

**Location**: Cerebellopontine angle.

**Imaging characteristics**: (Fig. 8 on page 24)

- Most vestibular schwannomas have an intracanalicular component, and often result in widening of the porus acusticus.
- Most commonly they are hypointense on T1, heterogeneously hyperintense on T2 weighted images with vivid post contrast enhancement.

**Incidence of fluid levels**: Rare

**Postulation for fluid level for all schwannomas**: Schwannomas are predominantly solid tumours but cystic degeneration is also encountered. The cystic contents may be serous, colloid or may be hemorrhagic. Fluid level formation is probably due to the differing densities of the cyst constituents.

7. **Glioblastoma multiformae(GBM) with oligodendroglioma component/ anaplastic oligodendroglioma**:

Anaplastic oligodendrogliomas make up 20-50% of all oligodendrogliomas. When necrosis is present in anaplastic tumours then they are considered WHO Grade IV lesions and referred to a GBM with oligodendroglioma component.

**Location**: Supratentorial location

**Incidence of fluid level**: Rare

**Imaging characteristics**: (Fig. 9 on page 25)

- A large heterogeneous intra-axial mass in the cerebral hemisphere causing mass effect exhibiting necrosis, hemorrhage.
- At spectroscopy, elevation of choline peak at 3.2 ppm and depression of N-acetylaspartate(NAA) at 2.0 ppm.
- At perfusion MR imaging, relative cerebral blood volume is increased.

**Postulation for fluid level**: Neovascular proliferation with possible rupture of fragile blood vessels can lead to fluid levels.
8. **Atypical neurocytoma:**

It has been proposed that those central neurocytoma exhibiting a MIB-1 labelling index (LI) greater than 2% and/or vascular proliferation is defined as atypical central neurocytoma.

**Location:**
- Septum pellucidum or the ventricular wall.
- About 13% of central neurocytoma are bilateral like in our case, and only 3% occur in the third ventricle as an isolated location.

**Incidence of fluid level:** Rare.

**Imaging characteristics:** (Fig. 10 on page 26)
- Typical neurocytoma is a bubbly lesion attached to the septum pellucidum.
- Atypical neurocytoma do not have characteristic MRI imaging findings.

**Postulation for fluid level:** Neurocytomas being bubbly lesions have multiple cysts and when vascular proliferation occurs (common in atypical neurocytoma), it gives way to intratumoural hemorrhage which appears as fluid level.

9. **Cystic Metastasis:**

Most common cause for brain metastasis includes lung carcinoma, renal cell carcinoma, breast carcinoma, melanoma, gastrointestinal tract adenocarcinomas (the majority colorectal carcinoma).

Primaries for hemorrhagic metastasis are melanoma, thyroid Carcinoma, renal cell Carcinoma and Choriocarcinoma.

**Location:** most common in posterior fossa.

**Incidence of fluid level:** None reported in literature

**Imaging characteristics:** (Fig. 11 on page 27)
• Solid enhancing mass with well-defined margins and extensive edema.
• Can be cystic due to necrosis, which can be of cystic signal. May show low ADC values.
• The can also appear with solid and cystic areas (like in our case).
• Hemorrhagic metastases can be visualised well on SWI with areas of blooming within them.

Postulation of fluid level:

In adenocarcinoma, tumour cells are embedded in mucinous pool. There is also focal micro vascular proliferation within it leading to bleed and this difference in densities can result in blood fluid level.

10. Cavernoma or cavernous haemangiomas:

Cavernous haemangiomas are defined as vascular malformations consisting of abnormal, dilated vessels within intervening neural tissue.

Location: supratentorial location

Incidence of fluid level: Rare.

Imaging characteristics: (Fig. 12 on page 28)

• Characteristic "popcorn" or "berry" appearance with a rim of signal loss due to hemosiderin, which demonstrates prominent blooming on susceptibility weighted sequence.
• They often bleed and have varying ages of bleed evident on imaging. However blood-fluid levels are very atypical but may be present (like in our case).
• Gradient echo or T2* sequences are able to delineate these lesions better than T1 or T2 weighted images.

Postulation for fluid level: Cavernomas have venous channels lined by thin and weak epithelium and hence they are prone to bleed. Fluid levels occur in varying stages of bleed.

11. Anti-coagulation therapy:

Location: Intra-axial.
Incidence of fluid level: Rare.

Imaging characteristics: (Fig. 13 on page 29)

Well defined lesion with variable intensity on T1 and T2 (depending on stage of bleed) and blooming in SWI images.

Postulation for fluid level:

- Possibility is that intracerebral hematomas with a fluid-blood interface secondary to a coagulation defect prevent clot formation or lyse the coagulum once it is formed.
- Consumption of all clotting factors results in two components, creating a fluid-level.
- In vitro studies also support the hypothesis that an intracerebral hemorrhage fluid-blood level reflects the inability to either form or maintain a clot matrix.

12. Chondromyxoid fibroma with secondary aneurysmal bone cyst(ABC):

Chondromyxoid fibroma with secondary aneurysmal bone cyst has been seen in cervical spine and rib but has not been reported in calvaria. Our case involved the occipital bone and the clivus. Many cases of calvarial and facial ABCs occur secondarily in fibrous dysplasia unlike our case, which was secondary to chondromyxoid fibroma.

Location: Calvarial and facial bones.

Incidence of fluid level: rare in association and non-specific finding.

Imaging characteristics: (Fig. 14 on page 30)

- Expansile lesion with solid cystic component.
- Solid component hyperintense on T2wt images.
- Intense enhancement of solid component. Matrix mineralisation of chondroid pattern -hallmark.

Postulation for fluid level:

- Blood -fluid levels in this case is due to the association of ABC which is blood filled spaces of variable size separated by connective tissue septa with osteoclast giant cells and variable reactive bone.
• When blood is allowed to settle, the RBCs take a non-dependent part and the serum may rise up giving rise to fluid level.

13. Hemangioma

Location: Skull within diploic space, most often seen in the frontal and parietal regions. They occur less frequently within the occipital, temporal, sphenoid, and petrous bones.

Incidence of fluid level: Rare.

Imaging characteristics: (Fig. 15 on page 31)

• Intensely hyperintense solid component on T2 wt images
• Thickened trabeculae (as in polka dot appearance in vertebra)
• Prominent vessels within the lesion.
• Intense enhancement of solid components.
• Sometimes aggressive bone destruction.

Postulation for fluid level: Hemangiomas are thin-walled blood vessels and sinuses lined by endothelium interspersed among longitudinally oriented trabeculae of bones and rupture of these are thin-walled blood vessels can result in blood fluid level within the vascular stroma.

14. Ewing's sarcoma:

Location: Ewing's sarcoma of skull vault is very rare. Frontal, parietal and occipital bones are common sites in the skull. Skull base and facial bones are less commonly involved.

Incidence of fluid level: None reported in literature

Imaging characteristics: (Fig. 16 on page 32)

• Younger age group.
• Do not have characteristic imaging appearance.
• Soft tissue component which is hypo intense on T2 wt images with restricted diffusion (indicates high cellularity).

Postulation for fluid level: Neovascular proliferation resulting in haemorrhage within areas of necrosis gives rise to blood-fluid levels.
15. **Venous lymphatic malformation**:

**Location**: orbit- intra and extraconal compartment.

**Incidence of fluid level**: common.

**Imaging characteristics**: (Fig. 17 on page 33)

- Cystic lesion with loculations
- Pyramidal shape with base towards globe
- High signal intensity on T1WI due to high protein or hemorrhage.
- High signal on T2
- Hemorrhage resulting in fluid-fluid levels
- Do not enhance unless there is a venous component that may show enhancement.

**Postulation of fluid level**: venous component causes hemorrhage with the cystic lymphatic component leading to a fluid level.

**Key point**: Fluid-fluid levels produced by hemorrhages of various ages within multiple cysts are almost pathognomonic especially in orbital location.

16. **Subdural hemorrhage due to venous infarct**:

**Incidence**: Not reported in literature

**Imaging characteristics**: (Fig. 18 on page 34), (Fig. 19 on page 35)

- Subdural hemorrhage with variable T1, T2 intensities depending on stage of bleed with associated blooming in SWI, with increased blooming in late subacute stage.
- Filling defect with loss of flow void in T2 in the venous sinuses suggestive of dural venous sinus thrombosis.

**Postulation of fluid level**:

Chronic venous thrombosis causes hemodynamic stress and collateral venous pathways causing rupture of bridging veins, leading to SDH. Varying ages of bleed give rise to blood fluid level in acute on chronic stage.
**AIR-FLUID LEVEL:**

Nondependent air layer should always have a signal void, while the dependent fluid layer could vary in signal intensity according to the amount of fat, protein, or blood within the fluid.

**Sequences of choice:** T1, T2 (Fig. 2 on page 18)

1. **Immediate post-operative period- AIR CSF LEVEL :**

We had 8 cases of air fluid level in the ventricles in the immediate post-operative period.

**Location:** post-operative site with meddling of the ventricles

**Incidence of fluid level:** rare

**Imaging characteristics:** (Fig. 20 on page 36)

Air appears low signal in all sequences. CSF fluid follows CSF signal intensity in all sequences.

**Postulation of fluid level:** Air being low density with respect to the CSF causes non-dependent air and dependent CSF to produce fluid level. This indicates immediate post-operative period.

**Key point :**

Small amounts of air in ventricle is asymptomatic, resolves spontaneous within 2 months in most cases and do not require any active intervention. However, the presence of tension pneumoventricle (symptomatic intraventricular air) may lead to significant clinical deterioration.
2. Spontaneous CSF leaks:

Spontaneous, or primary, CSF fistula is considered a separate entity, describing patients with no other discernible etiology for their CSF leak. Demographically, these leaks most frequently occur in obese middle-aged women and frequently coexist with a small encephalocele.

Location: anywhere in the skull base, but is most common at the ethmoid roof, cribiform plate, or at two locations in the sphenoid sinus, parasellar or at the inferolateral or pterygoid recesses

Cause:

- One theory proposed to explain spontaneous CSF leaks is that chronically increased intracranial pressure results in arachnoid granulations that fill small pits in the inner table of the calvarium or sinus wall. The dura thins and small diverticula of arachnoid extend through the bony defect and rupture.
- Another theory (likely in our case) that has been proposed begins with impaired CSF absorption, leading to transiently elevated pulsatile CSF pressure that ultimately causes dural herniation and a CSF leak through anatomically weakened sites.

Incidence of fluid level: very rare

Imaging characteristics: (Fig. 21 on page 37)

- Defect in the skull base
- Active CSF leak
- Herniation of CSF filled sac.

Postulation of fluid level: Air being low density with respect to the CSF causes non-dependent air and dependent CSF to cause fluid level

PROTEIN-FLUID LEVELS:

Sequences of choice: T1, T2, Diffusion with ADC- to differentiate protein and blood (Fig. 2 on page 18).
1. **Paranasal sinus mucoceles:**

Paranasal sinus mucoceles represent complete opacification of one or more paranasal sinuses by mucus, often associated with bony expansion due to obstruction of the nasal sinus drainage.

**Location:** most commonly involves frontal sinus, the ethmoidal sinuses are the next most common, whereas maxillary and sphenoidal sinuses like in our case (figure) are infrequently involved

**Incidence of fluid level:** rare

**Imaging characteristics:** (Fig. 22 on page 38)

- Enlarged sinus.
- Water rich content: is low signal on T1, high signal on T2 weighted images.
- Protein rich content: like in our case (Fig. 23 on page 39), it is low or high signal on T2, high signal on T1.
- Rim enhancement of the lesion.

**Postulation for fluid level:** Different protein densities in the Mucocele cause fluid level.

2. **Necrotising granulomatous tubercular lesion:**

Tuberculous granulomas are well defined focal masses that result from Mycobacterium tuberculosis infection, and are one of more severe morphological forms of tuberculous disease. Histologically it consists of a central core of caseating necrosis with a surrounding wall of a granulomatous reaction containing Langhans giant cells, epithelioid histiocytes and lymphocytes.

**Location:** Intra-axial

**Incidence of fluid level:** extremely rare, not reported in literature

**Imaging characteristics:** (Fig. 24 on page 40)

- Caseating tuberculomas with a solid center are isointense to hypointense on both T1- and T2-weighted MR images.
• They usually have a variable amount of surrounding edema, which is hyperintense on T2-weighted images.
• Caseating tuberculomas with a liquid center like in our case are hypointense on T1-weighted images and centrally hyperintense on T2-weighted images, with a peripheral hypointense rim on T2-weighted images that represents the capsule.
• On MR spectroscopy, elevated lipid peak at 1.3 ppm.

Postulation for fluid level: Caseation (High density) within a cyst gives rise to fluid level.

3. Craniopharyngioma:

Location: sellar/suprasellar region.

Incidence for fluid levels: rare

Imaging findings: (Fig. 25 on page 41)

• Solid cystic lesion (like in our case) in adamantinomatous craniopharyngioma
• Solid in papillary type
• Cysts are variable in intensity depending on protein content, most are T1 iso- to hyperintense to brain, hyperintense on T2, solid components show vivid enhancement
• Susceptible sequences may better demonstrate calcification
• MRS with lipid peak at 1.3 ppm (like in our case) is noted in adamantinomatous craniopharyngioma

Postulation for fluid level: single or multiple cysts filled with thick oily fluid which is high in protein, blood products, and/or cholesterol will result in fluid levels.

Key point:

Solid cystic lesion with fluid level and lipid peak on MRS favours adamantinomatous craniopharyngioma over papillary craniopharyngioma

FAT FLUID LEVEL:

Sequence of choice: Fat sat images: To differentiate fat and protein (Fig. 2)
**Dermoid cyst:**

Dermoid cysts are congenital inclusion cysts that appear as well-circumscribed heterogeneous extraxial masses. Their contents may vary and may include, for example, fat and calcifications or teeth.

**Location:** The sellar or parasellar region is the most frequent site of their occurrence.

**Incidence of fluid level:** Fat fluid level is rarely seen in dermoid

**Imaging characteristics:** (Fig. 26 on page 42)

- Dermoid cysts consists of dermal and epidermal elements with a characteristic stratified squamous epithelium cyst wall surrounding a mixed collection of fat, keratin, hair, bone, cartilage, sebaceous and sweat glands. All these variable contents of the cyst determine its radiological features.
- Most common appearance being hyperintense and heterogeneously hyperintense on T1, T2 with suppression on fat sat sequences.

**Postulation for fluid level:** The mixed composition of the tumor with the lipid and cholesterol which collect within the cyst may result in fat-fluid level.

**Images for this section:**
**Fig. 1:** Intracranial fluid levels and its causes.

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**Fig. 2:** MR appearances of fluid levels.

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Fig. 3: Pituitary adenoma in 43 year old gentleman with history of headache and blurring of vision for 1 year. A cystic lesion in the sella and suprasellar region(A,B). Blood-fluid level in T2 wt image(A) secondary to haemorrhage with dependent part blooming on SWI(C).

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Fig. 4: Pilocytic astrocytoma in 35 year old gentleman with history of giddiness, vomiting, occipital headache and slurring of speech since 1 month. Cystic lesion in the right cerebellar hemisphere causing midline shift and mass effect. Blood-fluid level in both T1 and T2 wt images(A,B) secondary to haemorrhage with dependent part blooming on SWI (C)

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Fig. 5: Ependymoma in 43 year old gentleman. Cystic lesion in the left cerebellar hemisphere with blood-fluid level in both T1 (B) and T2 wt images (A) secondary to haemorrhage seen as low ADC values (C) blooming on SWI (D).

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Fig. 6: Skull base schwannoma (right greater petrosal nerve) in a 27 year old lady. An extra-axial cystic lesion in the right middle cranial fossa with blood-fluid levels in T2 wt image (A) secondary to haemorrhage blooming on SWI (B). Wall and septa show enhancement (C). CT scan shows destruction of the petrous bone involving predominantly anterior aspect, widening of the foramen lacerum (arrow) (D). Bone fragments are seen secondary to bone erosion while some areas show remodelling (block arrow) (D).

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Fig. 7: Trigeminal schwannoma in a 30 year old lady who presented with history of headache since 2 years. Axial T2 weighted image(A) demonstrates extra-axial cystic lesion in the prepontine space at right cerebello-pontine angle with blood-fluid level(arrows)(A,D) blooming on SWI(B). The lesion is extending through the Meckel's cave into the cavernous sinus and infratemporal fossa with peripheral enhancement in post contrast images (E,F).

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**Fig. 8:** Vestibular schwannoma in a 30 year old gentleman who presented with right sided hearing loss. Extra-axial solid cystic lesion in the right cerebello-pontine angle extending into the right internal auditory canal with multiple blood-fluid levels (B) secondary to haemorrhage blooming on SWI (B) and heterogeneous enhancement of the solid components (C).

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**Fig. 9:** Glioblastoma multiformae (GBM) with oligodendroglioma component/ anaplastic oligodendroglioma in a 6 year old child. A heterogeneous solid cystic lesion in the right frontoparietal lobe which is hyperintense on T2 weighted image with fluid level (arrow) (A), isointense in T1 weighted image (b), peripheral restricted diffusion (C) with heterogeneous thick peripheral enhancement (D).

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**Fig. 10:** Atypical neurocytoma in a 29 year old lady. An intraventricular lesion in the atria of left lateral ventricle extending into the right lateral ventricle with fluid level (arrows) on T1 (B) and T2(A) weighted images secondary to haemorrhage blooming on SWI(C) with heterogeneous enhancement (D).

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**Fig. 11:** Hemorrhagic metastasis from lung primary in a 36 year old lady. A well defined intra axial cystic lesion in the left parietal lobe. The cystic component showing fluid level on T1(B) and T2 weighted images(A)(asterix) in the dependent part. Solid component is hypointense on T2(arrow) and shows heterogeneous enhancement with peripheral rim enhancement of cystic component(C,D).

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**Fig. 12:** Cavernoma in a 25 year old male patient who presented with seizures. A well defined lobulated T1 hyperintense(B), T2 hyperintense lesion(A) with surrounding hypo intense rim on T2(block arrow) seen in the right temporal lobe with fluid level well seen on T1 and T2.arrow). The lesions shows significant blooming on SWI.

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**Fig. 13:** Anticoagulation therapy. An intra-axial cystic lesion in the right frontal lobe with fluid level and perilesional edema (A), peripheral T1 hyperintensity (B), with blood-fluid level blooming of dependent part in SWI (C).

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**Fig. 14:** Chondromyxoid fibroma with ABC/chondroblastoma in a 11 year old boy. Clivus is replaced by expansile, well defined lesion with multiple fluid levels in T1 (B) and T2 (A) and septations which show enhancement (C). CT scan image show matrix mineralisation with chondroid pattern.

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Fig. 15: Hemangioma in a 7 year old child. Expansile lesion involving the right high parietal bone, which is hyper intense on T2 wt images(A), shows fluid-fluid levels(asterix) in both T1(A) and T2 wt images(B) secondary to haemorrhage seen as blooming in SWI images(C). There are multiple thick trabaculae within the lesion(A). Note intracranial extension causing compression on the superior sagittal sinus(D). There are prominent vessels within the lesion(arrow)(E). Note intracranial extension causing compression on the superior sagittal sinus. Intense enhancement of solid component(F) in T1 post contrastolinium images.

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Fig. 16: Ewing's sarcoma. A well defined extra-axial lesion in the left fronto-parietal region with calvarial extension. It is isointense on T2 with hyperintense areas showing fluid level (asterix) (A), isointense on T1 (B), with heterogeneous enhancement of the solid components (C). CT shows permeative pattern of destruction of the adjacent calvaria with calcification of the rim. On histopathology, hemorrhage was noted in the lesion.

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Fig. 17: Venolymphatic malformation in a 21 year old lady who presented with proptosis. A well defined T2 heterogeneously hyperintense (A,B), T1 isointense lesion with hyperintense areas (C), seen in the intraconal and extraconal compartment of the left orbit. The fluid level shows blooming in SWI (arrow head)(D).

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Fig. 18: Stages of subdural hemorrhage due to sequelae of venous thrombosis. Scan done on 27-09-2016(A-C) shows bilateral subdural hemorrhages which are hyperintense on T2(A), isointense on T1 weighted images (B) with few areas of blooming(C). Scan done on 3-12-2016(D-F) shows bilateral subdural hemorrhages which are heterogeneously hyperintense on T2(D), hyperintense on T1 weighted images(E) with significant blooming in SWI with fluid level(arrow)(F).

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Fig. 19: Thrombosis of the left transverse sinus (short arrow) (A) and sigmoid sinus (long arrow) (B) with loss of flow void on T2 and loss of signal on MRV TOF.

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Fig. 20: Immediate post operative period. Air- CSF level in both lateral ventricles, non dependent air anteriorly with air being hypointense on T2(A), T1(B) and blooming in SWI (C).

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**Fig. 21:** Spontaneous CSF leak in a 50 year old lady with spontaneous CSF rhinorrhoea. There is defect in the clivus / posterior wall of sphenoid sinus - at the level of sphenoorbital synchondrosis with herniation of CSF filled sac (arrows) with air-CSF level in the sphenoid sinus (blue asterix). On CT, there is defect in the sphenoid (small arrow head) with leakage of contrast into the sphenoid sinus causing air-contrast level (white asterix) in the sinus.

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Fig. 22: Mucocele in a 47-year-old man presenting with proptosis. Enlarged sphenoid sinus with hyper intense content both on T1 (A) and T2 weighted images (B) with fluid level due to varying proteinaceous contents (asterix) (A). No post contrast enhancement (C).

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**Fig. 23:** MRI of sinus secretions. Signal intensity of sinus secretions depends on the protein concentration.

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Fig. 24: Necrotising granulomatous tubercular lesion in 30 year old male patient. Few well defined cystic lesions of varying sizes in the left temporal lobe which are hyperintense on T2 weighted image with peripheral hypointense rim and fluid level (asterix) and perilesional edema causing mass effect with fluid level (A), hypointense on T1 weighted image with smooth peripheral ring enhancement(C). Similar lesions are noted in the basal, suprasellar cisterns and along the sylvian fissure with leptomeningeal enhancement(C). Restricted diffusion with low apparent diffusion coefficient(ADC) values noted. On MR spectroscopy, elevated lipid peak at 1.3 ppm is observed(F).

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**Fig. 25:** Adamantinomatous craniopharyngioma. Solid cystic lesion (pink block arrows) in the suprasellar region extending into the left temporal region. The cystic component is hyperintense on T1 and T2 weighted images with fluid level (asterix)(C). MR spectroscopy showing lipid peak at 1.3 ppm(arrow)(E).

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Fig. 26: Suprasellar dermoid in a 45 year old gentlem who presented with reduction in vision in both eyes for 2 months. A cystic suprasellar lesion with fat fluid level(arrows) on T1(A) and T2(B)weighted images, with suppression of non dependent fat on the fat suppressed T1 image(C).

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Conclusion

- This pictorial review provides an useful algorithm for accurate pre operative diagnosis. This review also provides additional information about the common location of lesions and postulations for resultant fluid levels.
- Also increases the awareness of rare intracranial pathologies causing fluid levels and emphasizes the sequence of choice for a particular type of fluid level.
- It is important to remember that the MR appearance of a specific lesion may vary according to its composition and analysis of MR signal characteristics with clinical, histopathological correlation is helpful in accurate diagnosis.

Personal information

References


