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PICTORIAL REVIEW OF INCIDENTAL FINDINGS ON BRAIN IMAGING- LEAVE THEM ALONE, REFER OR FOLLOW

Radiodiagnosis

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ABSTRACT

The increasing availability of cross-sectional imaging, incredibly magnetic resonance imaging, detects findings in the patient's scan unrelated to the reason the scan is initially acquired. These findings refer to the so-called incidental findings mentioned in the radiology report as "Note made of" without any good impression about their clinical significance or further management. This type of report leads to anxiety among patients. The radiologist is the first person to encounter these incidental findings. Therefore, it is an essential duty of the radiologist to communicate to the clinician about the significance and urgency/non-urgency of these findings so that clinicians can decide timely appropriate management. Therefore, this review discusses the prevalence and spectrum of these incidental findings and the available guidelines for their management.

KEYWORDS

Cavum septum pellucidum, arachnoid cyst, meningioma, hippocampus.

INTRODUCTION

Incidental findings refer to detecting findings in the patient's scan unrelated to the initially acquired scan. This increased detection is possible because of the increasing availability of cross-sectional imaging, especially magnetic resonance imaging (MRI), and higher field strengths.

So-called incidental findings are often mentioned in the radiology report as "Note made of" without any good impression about their clinical significance or further management, causing anxiety among patients. Fortunately, the radiologist is the first person to encounter these incidental findings. Therefore, the radiologist's essential duty is to communicate to the clinician about the significance and urgency/non-urgency of these findings and give an impactful radiology report that will help clinical colleagues timely decisions about the management.

DEFINITION AND CLINICAL RELEVANCE

Incidental findings refer to those encountered on the patient's scan, which is unexpected and unrelated to the patient's symptoms and was previously unknown to the patient and the physician [1]. These findings can be either clinically insignificant and left alone or clinically significant, needing follow-up or urgent referral for appropriate management. Furthermore, there are no concrete guidelines for incidental CNS findings, unlike other organ systems of the body like solitary pulmonary nodules, renal cysts, and ovarian cysts.

CLASSIFICATION

Few authors have tried to classify them as per their clinical relevance. One of such categorizations given by Teuber et al. [2] They classified them into three categories as follows

Category I: Normal anatomical variations without clinical significance, e.g., Cavum septum pellucidum, or pathological findings without clinical relevance, e.g., developmental venous anomaly, diffuse cerebral atrophy in the elderly. These findings can be left alone with no referral needed.

Category II: Findings that require further radiological or medical evaluation.

IIa: Findings where radiological assessment is equivocal and further imaging usually MRI is needed. e.g., Small meningiomas, suspected inflammatory or neoplastic lesion.

Iib: Findings where radiological assessment is relatively straightforward on imaging and that require further medical evaluation. e.g., old brain infarcts, space-occupying cysts, normal pressure hydrocephalous, white matter lesions of suspected vascular origin.

Category III: Findings requiring immediate medical referral, e.g., Space occupying neoplasms, ischemic or hemorrhagic stroke, and subdural hematoma.

CATEGORY I INCIDENTAL FINDINGS (NORMAL VARIANTS)

Cystic variants

Cavum septum pellucidum

Septum pellucidum is a thin membrane-like structure separating the brain's lateral ventricles and consists of 2 fused laminae. In the fetal life and at birth, these two laminae are separated and filled with CSF called cavum septum pellucidum. In the literature, it is also often referred to as the "fifth ventricle," but that has been inappropriate because of lack of ependymal lining, choroid plexus, and communication with the ventricular system. Within 3-6 months after birth, the potential Space between the two lamina fuses with the growth of surrounding brain structures. However, in some cases, non-fusion of the two lamina leads to persistent cavum septum pellucidum (CSP), a box-shaped cavity surrounded by corpus callosum superiorly, fornix posteriorly, and leaflets of septum pellucidum laterally **(Figure 1)**. If the fusion failure of the leaflets extends further posteriorly beyond the fornix between lying anterior to the splenium of the corpus callosum, it is known as cavum verge [3]. There are inconsistent studies in the literature that related persistent cavum septum pellucidum and vergae with psychiatric disorders like schizophrenia and in boxers and professional football players [4]. Nevertheless, they are primarily normal variants and can be best left alone without any further diagnostic assessment.

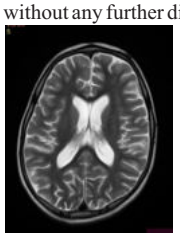


Figure. 1: Cavum septum pellucidum: Axial T2W MRI image showing a CSF filled space between the leaflets of septum pellucidum consistent with cavum septum pellucidum.

Partially Empty Sella

It refers to the situation where CSF spaces replace the pituitary fossa with an associated compressed or flattened pituitary gland. In most cases, no cause is found, and it is possibly related to the herniation of subarachnoid Space through a deficient diaphragma sellae referred to as primary empty Sella and is an incidental finding with no clinical significance. Secondary empty Sella occurs due to some incident cause leading to defect in the diaphragma Sella for e.g., prior surgery, tumor, and radiotherapy. **(Figure 2)**

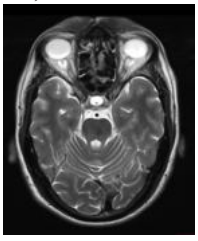


Figure. 2: Partially Empty Sella: Axial T2W image shows enlarged Sella filled with CSF space through which pituitary stalk is seen to pass through (Infundibulum sign)

Though it is an incidental finding and does not need further investigation, the close differentials in this region may present as a cystic lesion in pituitary fossa like cystic macroadenomas, and Rathke's cleft cyst has to be ruled out. A simple sign known as the infundibulum sign is beneficial for distinguishing empty Sella and cystic lesions in the pituitary fossa as the infundibulum crosses the CSF space in empty Sella and is laterally displaced in cystic lesions [5].

Arachnoid cysts

Arachnoid cysts are extra-axial benign lesions resulting from congenital splitting in the arachnoid membrane creating a potential space in the layer which gets filled with CSF to form a cyst. They are usually small in size and remain asymptomatic, and do not need any further management. However, sometimes they can be large and cause mass effect and remodeling of the adjacent bone. The typical cysts are the middle cranial fossa in 50-60 % cases, posterior fossa, and cerebellopontine angle.[6] On imaging, they appear as a well-defined lesion with CSF signal intensity on all sequences without any enhancement or mass effect.

Although the diagnosis is usually straightforward, the occurrence of these cysts in specific locations like cerebellopontine angle needs careful differentiation from epidermoid cysts, which are ectodermal inclusion cysts and are more extensive, cause mass effect and appear hyperintense on T1 and T2WI with incomplete suppression on FLAIR images and a thin rim of peripheral enhancement and also shows diffusion restriction**. (Figure 3)** They need to be surgically removed compared to arachnoid cysts which are left alone.

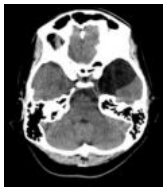


Figure.3 Arachnoid Cyst: Axial NCCT image reveals well defined extra lesion with CSF density in the left temporal region with no significant mass effect likely suggestive of arachnoid cyst.

Mega cisterna Magna

Cisterna magna is the CSF cistern posterior and inferior to the cerebellum and typically measures between 3 and 8 mm; when the size exceeds 10 mm, it is called mega cisterna magna. Vermis and fourth ventricle are normal, which differentiates if from inferior vermin hypoplasia and blake pouch cyst. **(Figure 4)**

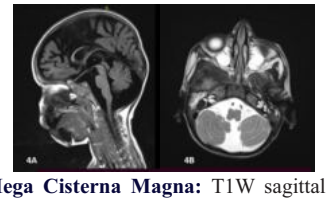


Figure. 4: Mega Cisterna Magna: T1W sagittal (A) and T2W axial(B) image shows enlargement of retro cerebellar CSF space with normal appearing 4th ventricle and and cerebellar vermis likely suggestive of mega cisterna magna.

Hippocampal cysts

The cerebral cortex is phylogenetically advanced and called the neocortex, consisting of six cell layers. However, the mesial temporal structures have a primitive allocortex consisting of three, four, or five cell layers. They develop as a flat cortical plate along the medial wall and floor of the temporal horn of the lateral ventricle. Due to unequal growth of the neocortex and allocortex, this plate gradually folds to form hippocampus proper and dentate gyrus with intervening sulcus known as the hippocampal sulcus, which on further growth eventually closes. However, at times a residual cavity persists, known as sulcus remnant cysts [7]. They appear as small (1-2 mm) multiple cysts with CSF intensity on all sequences on imaging. **(Figure 5)** Another cystic variant in this region is the hippocampal choroidal fissure cysts, which are usually larger in size (1-2 cm) along the long axis of the hippocampus and can be either arachnoid neurenteric cysts or neuroepithelial cysts.

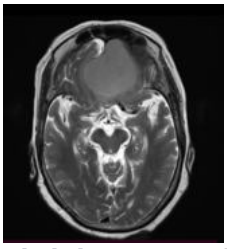


Figure. 5: Hippocampal sulcal remnant cysts: Multiple small sized cysts are seen in bilateral hippocampal regions likely hippocampal remnant cysts. Note made of olfactory groove meningioma.

Perivascular spaces (Virchow robin spaces)

These are pia-lined interstitial spaces in the brain along the perforating vessels in the inferior basal ganglia, centrum semiovale, substantia nigra, and sub-insular region. On imaging, they typically appear as smaller (typically < 5mm) fluid-filled cysts with similar intensity to CSF on all sequences [8]. Important differential diagnoses are lacunar infarcts, which are category II lesions and need medical evaluation and can be easily differentiated from perivascular spaces as lacunar infarcts are more common in the upper part of basal ganglia and have T2/FLAIR surrounding rim of gliosis. **(Fig.6)**

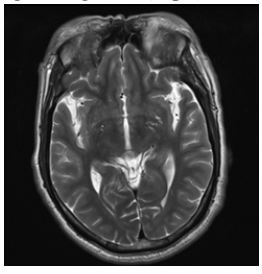


Figure. 6: Dilated Virchow Robin Spaces: Axial T2w MRI image shows dilated perivascular spaces in bilateral basal ganglia region without any associated gliotic rim or mass effect.

Vascular variants

Asymmetric venous sinuses

Venous sinus often shows asymmetric anatomy with the most common variations seen in the transverse sinus, which can be aplastic or hypoplastic. Knowledge of this variant anatomy is vital as this can be mistaken for venous sinus thrombosis. A helpful imaging clue is to look at the sinus's bony groove, which will be proportionally small in hypoplastic sinus and regular-sized in venous sinus thrombosis with filling defect in the involved sinus. **(Fig 7)**

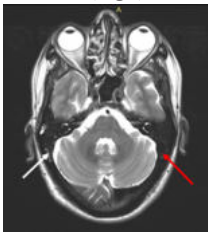


Figure. 7: Hypoplastic Right Transverse sinus: Axial T2W MRI

image reveals hypoplastic right sinus (white arrow) as compared to normal left transverse sinus (Red arrow).

Developmental venous anomalies (DVA)

These are the most common vascular malformation characterized by the collection of dilated medullary veins draining normal brain parenchyma, giving a caput medusa appearance. These dilated veins drain into a more prominent transcortical or subependymal collector vein, eventually draining into the superficial or deep venous sinus. The most common location is the frontoparietal region, followed by cerebellar hemispheres [9]. DVAs are not clinically relevant but are associated with increased incidence of cavernoma that should be actively sought for, as they have a bleeding risk and can be fatal. **(Fig 8)**

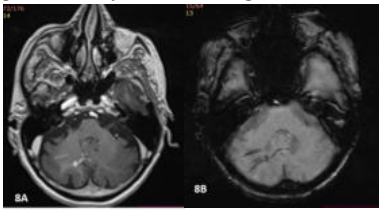


Figure.8: Developmental Venous anomaly: T1 post contrast (A) and SWI images (B) show abnormal linear venous structures coalescing into single collector veins and draining into superficial and deep venous system. No cavernoma was found in this case.

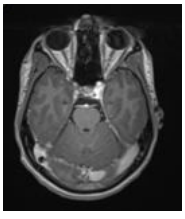
Capillary telangiectasias

These are the second most common vascular malformation of the brain after DVA and consist of dilated capillaries within the normal brain parenchyma. The most common site of affliction is the brainstem, specifically pons in around 80% of cases followed by basal ganglia. On imaging, they appear as subtle T2 hyperintensity with the corresponding hypointensity on T1W without any mass effect and enhancement. Hemorrhage is rare in these lesions, but blooming is often seen on SWI because of deoxyhemoglobin as these are slow-flow malformations leading to sluggish flow and increased deoxygenation. [10]

Meningeal variants

Arachnoid granulations

Arachnoid granulations, also known as Pacchionian granulations, are outpouchings from the arachnoid membrane into the dural venous sinuses to allow drainage of CSF from subarachnoid Space into the venous system. On imaging, they appear as sharply demarcated filling defects in the superior sagittal or transverse sinuses on contrast studies and can be confused with venous sinus thrombosis. Nevertheless, their sharp margins and specific location allow the correct diagnosis. **(Fig 9)**



Fatty falx cerebri

Falx cerebri consists of dural infolding with two layers of dura separating the two cerebral hemispheres. The Space between the two layers frequently contains fat derived from the extradural compartment.[11] On imaging, it follows fat signal on all sequences with suppression on fat suppression images and no contrast enhancement. It is a frequent incidental finding and should not be confused with the intracranial lipoma or ruptured dermoid cyst. Ruptured dermoid cyst presents as multiple droplets of fat scattered in the CSF spaces, and intracranial lipoma is associated with agenesis of the corpus callosum.

Falx cerebri calcification

These are frequently seen findings on brain scans and are of no clinical significance if small and limited. However, extensive calcifications are associated with rare diseases such as nevoid basal cell carcinoma, chondrocalcinosis, and endocrine system disorders.

Variants of skull bone

Hyperostosis frontalis interna

As the name suggests, it is a benign overgrowth of the skull's inner table, which is bilaterally symmetrical and can be sessile or nodular. If growth is enormous, it can cause compression of the underlying brain parenchyma leading to cerebral atrophy, but it is usually an asymptomatic incidental finding.Possible diseases which can be confused with this condition are Paget's disease, fibrous dysplasia, and calcified meningioma.[12]

Arrested pneumatization of skull base

Basisphenoid contains red bone marrow up to the age of 4 months, after which it gets converted to yellow marrow as a precursor event before pneumatization. Arrested pneumatization is a departure from regular aeration of sphenoid sinus where the aeration does not fully replace the fatty marrow conversion sites, and it persists as fatty marrow often asymmetrically. These areas of arrested pneumatization can be confused with various disease entities such fibrous dysplasia, ossifying fibroma, and clivus tumors such as chordoma and chondrosarcoma on imaging.

However, the distinction of arrested pneumatisation can be made based on it being non-expansile lesion with curvilinear calcification in specific sites of pneumatisation.[13]

Category II or III findings

The findings in these categories usually present with symptoms, but sometimes they can be seen incidentally on the scan done for unrelated reasons, especially when the lesion is small in size or subacute, or chronic in nature. In addition, the findings in these categories include findings that require further radiological or medical evaluation (Category II) or findings that require an immediate medical referral (Category III).

The commonly encountered lesions are listed as follows

1. Neoplastic lesions-

- Small meningiomas (Fig 10)
- Vestibular schwannoma (Fig 11)
- Pituitary macroadenoma (Fig 12)
- Intracranial lipoma

2. Vascular lesions

- Unruptured aneurysm
- Cavernoma
- AV malformation (Fig 13)
- Subacute hematoma

3. Other lesions

- Chiari malformation Type 1
- Corpus callosum agenesis
- Dandy-Walker variant
- Subdural collection (Fig 14)

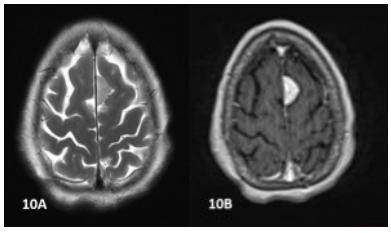


Figure 10: Meningioma: Axial T2W(A) and T1W post contrast (B) MRI image show well defined homogenously hyperintese extraaxial lesion along the fax cereberi with intense homogneous enhancement on post contrast images suggestive of meningioma.

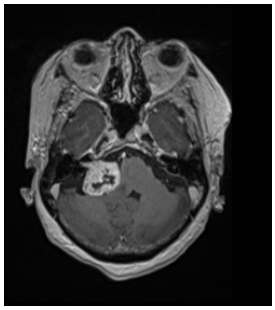


Figure. 11: Vestibular Schwannoma: Axial post contrast T1w image show well defined heterogeneously enhancing extra axial mass lesion

in right cerebello pontine cistern with visible intracanalicular component giving "ice cream cone" appearance suggestive of vestibular schwannoma.

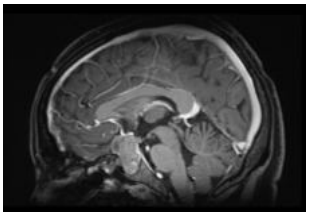


Figure 12: Pituitary macroadenoma: Axial Post contrast T1W image show a well-defined hypo enhancing lesion in the pituitary fossa causing its expansion and extension into suprasellar region suggestive of pituitary macroadenoma.

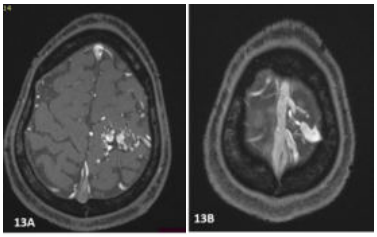


Figure. 13: AV malformation: Axial post contrast (A &B) images show a nidus in left frontal region with prominent arterial feeder and venous drainage suggestive of arterio-venous malformation.

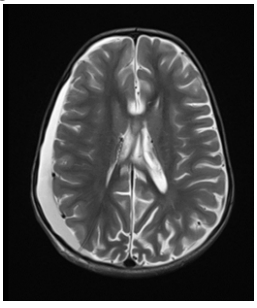


Figure 14: Subdural collection: Axial T2w MRI image show extra axial fluid collection along right fronto-temporo-parietal region.

Reporting incidental findings

Concerning the incidental findings, the "Good practice for radiological reporting" guidelines from the European Society of Radiology (2011) states that an accurate description of the presence of incidental findings should be made in the radiological report as well as their interpretation as "either relevant or non-significant" in conclusion. [14]

European Society of Radiology (ESR), in their published guidelines for the "communication of urgent and unexpected findings," emphasized the role of radiology reports and benefits from timely communication.

They acknowledged the fact that radiologists take great care to ensure the diagnostic accuracy of their reports. However, their main concern was that patients might not benefit from this expertise if there is a failure of timely communication of the imaging findings".

These guidelines further state that "usual methods of communication may not be reliable enough to ensure that those responsible for clinical care of the patient act promptly." Furthermore, it also suggested methods for improving communication in these circumstances, using clear protocols and procedures between imaging units and referrers. [15]

The same guidelines further state that if the examination reveals an abnormality requiring further evaluation or treatment, the radiologist must communicate this to the referring medical doctor, usually by telephone. Information regarding the exact date, time, a person notified, means of notification should be clearly stated in the report (ideally at the beginning or end of the report, rather than within the body of the report). About some situations which are not an emergency, but where there may be adverse consequences for the patient if a significant unexpected finding revealed on imaging is not subsequently acted upon. Here the duty is less clear, but 'alert' methods for referrers should be in place so that such patients are further investigated or treated in an appropriate time frame. [14]

CONCLUSION

Incidental findings have become familiar with the use of high field strength MRI and often cause patient anxiety. Knowledge about the commonly encountered incidental findings and their potential pitfalls, their classification according to clinical relevance, and the existing guidelines on their reporting and communication to the concerned physician will help direct patients toward appropriate management or follow-up depending on the case.

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