

LET US LOOK AT ASTRONOMY THROUGH THE EYES OF A RADIOLOGIST

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ABSTRACT

OBJECTIVE: The objective of this article is to present astronomical inspired signs seen in radiology, which will eventually help in imaging based diagnosis. **STUDY DESIGN:** Retrospective study. **PLACE AND DURATION OF STUDY:** Radiology Department, Shifa International Hospital, from 2020 to 2023. **METHODOLOGY:** We compiled all the cases with interesting astronomical signs manifested on various radiological modalities including radiograph, ultrasound and CT.

- Comet tail artifact seen on grey scale ultrasound is noted in gallbladder adenomyomatosis & thyroid colloid cyst.
- Comet tail artifact seen on colour doppler ultrasound is noted in renal/ureteric calculus.
- Comet tail sign seen on CT chest is noted in round atelectasis.
- Galaxy sign seen on CT chest is noted in sarcoidosis or pulmonary TB.
- Loss of half-moon sign seen on shoulder radiograph is noted in posterior shoulder dislocation.
- Starry sky appearance seen on grey scale ultrasound is noted in acute hepatitis.
- Starry sky appearance seen on MR is noted in multiple biliray hamartomas.
- Suburst appearance seen on radiograph is noted in osteosarcoma.
- Sunburst sign seen on MR brain is noted in meningioma.
- Sunburst sign seen on DSA is noted in renal angiomyolipoma.
- Sunset eye sign seen on CT brain in obstructive hydrocephalus.
- Twinkling artifact seen on colour Doppler ultrasound is noted in calculi.
- Earth heart sign seen on radiograph chest is noted in tension pneumomediastinum.
- Milky sign seen on MR brain is noted in multifocal leukoencephalopathy.
- Starfield pattern seen on MR brain is noted in fat embolism.

RESULT: Imaging features in various modalities of aforementioned diseases are explained narrowing down the differentials. **CONCLUSION:** Understanding of these clearly discernible astronomy-based signs is crucial since it aids in cutting down the lengthy range of differentials and also aids in imaging-based diagnosis.

Keywords: Astronomy, CT, MRI, Radiology.

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Introduction

A sign is a term for radiological appearance that suggest the presence of condition.¹ Classic signs in radiology, when invoked, immediately bring an image to mind and add confidence to the diagnosis of certain conditions.² Familiarity with these signs helps to narrow down the differential diagnosis. There are many signs in radiology that have been inspired by astronomical phenomenon.³

Methodology

A pictorial review performed after Institutional Review Board s approval. Patients with aforementioned astronomy related signs on various modalities of radiology including ultrasound, CT and MRI were included. Involvement of different organs by these signs is studied by radiological modalities. We compiled different cases over the year 2020-2023. CT scan was performed on three machines namely Toshiba 640 slices, Siemens 128 slices and Siemens 16 slices. MRI was performed on Siemens 3 tesla, Toshiba-titan 1.5 tesla and Hitachi 0.4 tesla. Ultrasound was performed on different ultrasound machines including aplio 100 and 200. Corresponding radiology images were collected and digital illustration was created to demonstrate the relationship between the astronomical terms and radiology appearance.

Discussion

A literature review was performed to determine the cause of appearance of these signs, the reliability of the signs and differential diagnosis to be considered when encountered.

1. Comet tail artifact:

Comet tail artifact is a grey scale ultrasound finding when small highly reflective objects are interrogated. It is seen in benign gall bladder diseases like adenomyomatosis of gallbladder, cholesterosis and xantho-granulomatous cholecystitis, pancreatic calcifications of chronic pancreatitis, testicular microlithiasis, thyroid colloid nodules, small renal or ureteric calculi and small common bile duct stones.⁴ It is also encountered in identification of foreign bodies like surgical clips, catheter tips and debris or glass. In a study published

in 2019 all gallbladder lesions exhibiting the comet tail artifact on ultrasound examination were confirmed as benign gallbladder diseases after cholecystectomy, including 71 cases of adenomyomatosis (47.3%), 74 cases of chronic cholecystitis (49.3%), two cases of xantho-granulomatous cholecystitis (1.3%), and three cases of cholesterolosis (2.0%); suggesting comet tail artifact as reliable sign of benign gallbladder disease.⁵ Important differential diagnosis to be considered is ring down artifact which is a special type of resonance artifact produced by completely different mechanism.

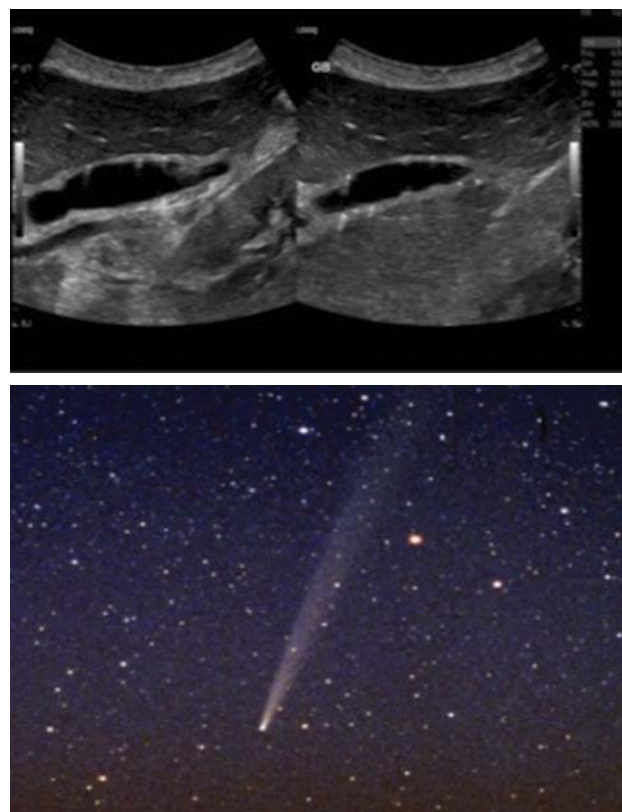


Figure 1: Grey scale ultrasound of gall bladder showing comet tail artifact arising in gall bladder wall consistent with adenomyomatosis.

Color comet tail artifact:

It is seen in situation when highly reflective object is interrogated with color Doppler. It resembles the grey scale comet tail artifact and is seen in same situations. It is helpful for improving diagnostic confidence about calcification at site in body in body when presence is not expected. The area of imaging that would most benefit from the use of the color comet-tail artifact is renal sonography for the evaluation of small kidney stones.⁶

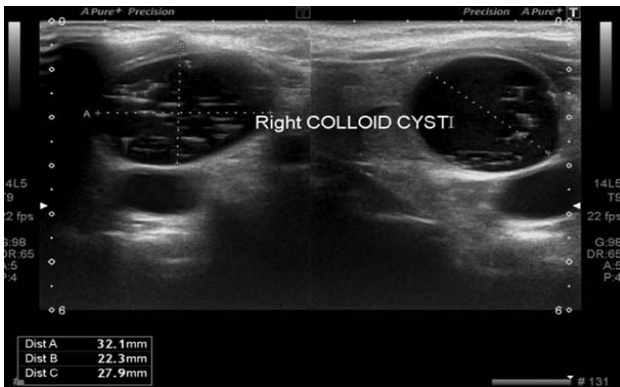


Figure 2: Grey scale ultrasound of thyroid gland showing a cyst in right lobe of thyroid gland with multiple comet tail artifact within the cyst representing thyroid colloid cyst.

2. Comet tail sign:

Comet tail sign is seen in CT of chest. It consists of a curvilinear opacity that extends from a subpleural "mass" toward the ipsilateral pulmonary hilum. The distortion of bronchovascular bundles resemble a comet tail and leads to an adjacent area of round atelectasis, which is the mass.⁷

3. Loss of half moon overlap sign:

It is a sign of posterior shoulder dislocation on AP radiographs. On true AP shoulder radiograph there

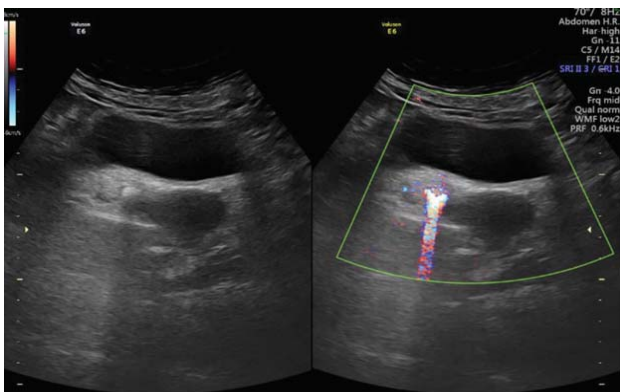


Figure 3: Grey and color Doppler ultrasound of ultrasound showing small echogenic focus with posterior acoustic shadowing at right vesico-ureteric junction consistent with small calculus demonstrating color comet tail artifact on Doppler ultrasound.



Figure 4: Axial non-contrast CT chest lung window left sided subpleural atelectasis pulling adjacent bronchovascular bundles producing comet tail appearance.

is half moon overlap between humeral head and glenoid. In posterior shoulder dislocation there is lateral displacement of humeral head with respect to glenoid resulting in losing of half moon overlap. This is however less reliable sign as compared to other signs including internal rotation, rim sign and trough line.⁸



Figure 5: AP right shoulder radiograph (a) showing posterior dislocation of humeral head with respect to glenoid cavity resulting in loss of normal half moon overlap shown on normal AP radiograph of left shoulder (b).

4. Galaxy sign:

Galaxy sign is seen on CT chest and represents central nodule with innumerable smaller nodules emanating from the margins of central nodule. The concentration of smaller nodules becomes less dense towards periphery resulting in multiple small satellite nodules resembling the appearance of galaxy. It was initially described as sarcoid galaxy seen in patients with pulmonary sarcoidosis.⁹ The galaxy sign may also be present in active tuberculosis and may also be seen in progressive massive fibrosis and neoplasms. A true galaxy sign favors benign etiology and in context of appropriate demographics and associated findings such as lymphadenopathy can be quite helpful in establishing diagnosis.¹⁰

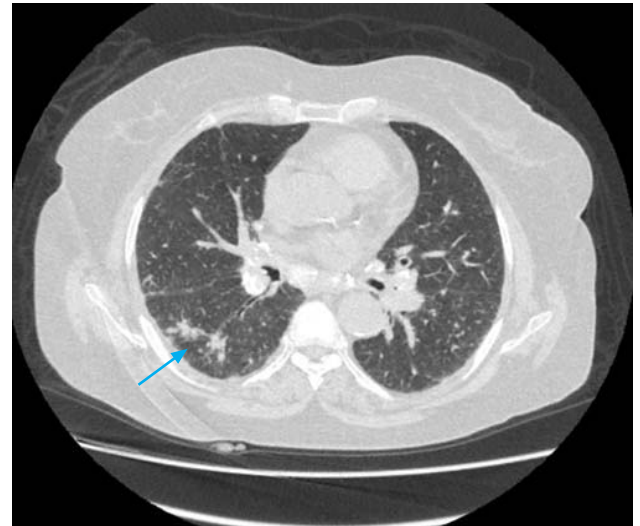


Figure 6: CT chest axial view lung window demonstrating tiny coalescent nodules in superior segment of right lower lobe resembling appearance of galaxy. These findings with perifissural nodularity and calcified bilateral hilar and mediastinal lymph nodes are in favour of sarcoidosis.

5. Starry sky appearance

In ultrasound imaging, the "starry sky appearance" describes the visual observation of numerous bright spots dispersed against a darker background, resembling stars in the night sky. It is observed in number of medical conditions such as liver in twin to twin transfusion syndrome secondary to right sided heart failure,¹¹ tuberculous lymph nodes¹² and testicular microlithiasis.¹³ It is an important parameter in acute viral hepatitis where it is characterised by the observation of intense periportal triads in ultrasonographic imaging. The characteristic manifestation of periportal triads arises from hepatocellular edema, leading to diminished liver echogenicity. This edematous condition induces alterations in acoustic properties, thereby accentuating the boundaries of portal venous channels.¹⁴

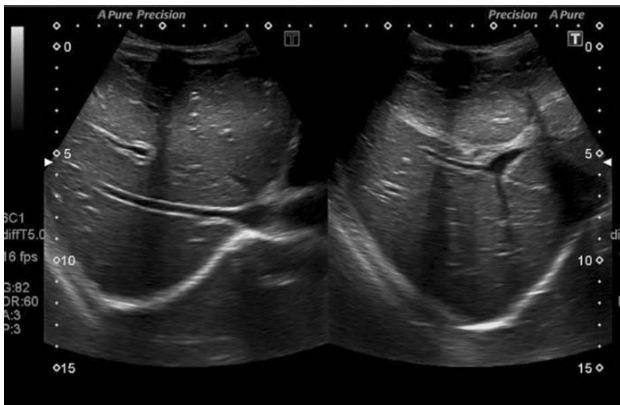


Figure 7: Grey scale image of hepatic ultrasound showing multiple scattered echogenic foci in hepatic parenchyma resembling starry sky in patient with acute hepatitis.

In magnetic resonance imaging (MRI), biliary hamartomas exhibit hypointensity on T1-weighted images and hyperintensity on T2-weighted images relative to the adjacent liver parenchyma, resulting in the distinctive "starry sky appearance".¹⁵ Biliary hamartomas represent infrequent benign anomalies of the bile ducts, characterized by the presence of numerous localized duct-like structures lined with biliary epithelium and encased within a fibrous stromal matrix. Starry sky appearance is also seen in a number of other conditions on MRI particularly in brain like neurocysticercosis and tuberculomas.¹⁶

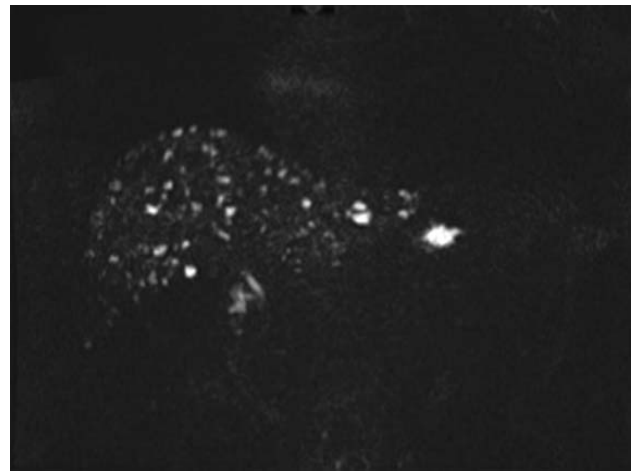


Figure 8: MRI of liver T2 sequence demonstrating numerous small T2 hyperintense cystic lesions consistent with biliary hamartomas.

6. Sunburst appearance:

Sunburst appearance in bone shows aggressive periostitis and is noted in most aggressive osseous lesions particularly osteosarcoma. Osteosarcoma is characterized as a primary malignant mesenchymal

bone neoplasm, wherein the neoplastic cells directly generate osteoid, bone, or a combination of both. The distinctive radiographic attributes manifest as a sunburst appearance.¹⁷ The occurrence of ossification within the soft tissue component of the bone, delineated by a "sunburst" pattern, is a classical manifestation of osteosarcoma; however, it lacks sensitivity and specificity as a diagnostic feature.¹⁸

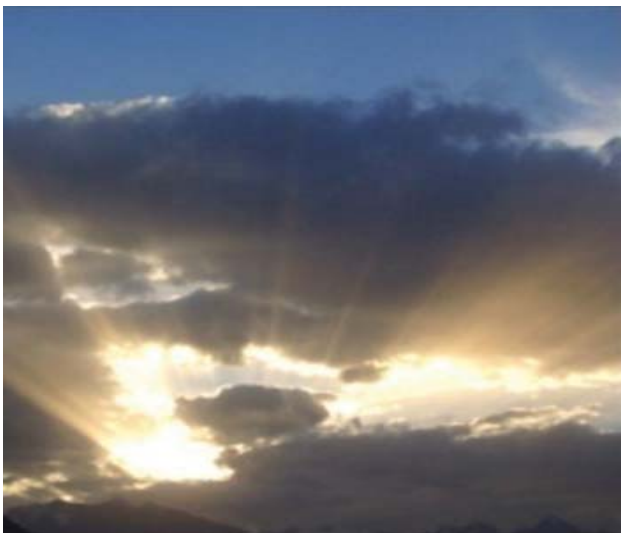


Figure 9: Frontal radiograph of left femur demonstrating extensive diffuse sun-burst type of periosteal reaction (shown by arrow) involving a long segment of left mid to distal femoral shaft up to the metaphysis and diffuse heterogeneous increased marrow density with indistinct outline of the adjacent cortex and endosteal margins and associated large soft tissue component. Biopsy later shows this lesion to be ewing sarcoma.

Sunburst sign:

The sunburst sign or spoke wheel appearance denotes the distinctive vascular supply observed in certain meningiomas when visualized tangentially to their dural attachment. Dural branches stemming from the external carotid artery, internal carotid artery, and vertebral artery may contribute to the tumor's vascularization. Additionally, the tumor may parasitize pial arteries. The feeder arterial branches emanate radially into the lesion, adopting a distribution reminiscent of sunrays. This imparts a sunburst appearance evident on T2-weighted or postcontrast images, as well as during angiography.¹⁹

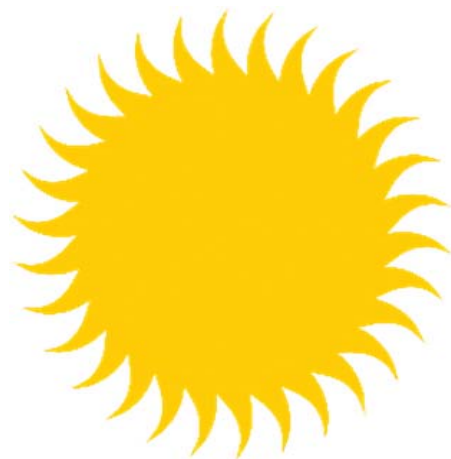
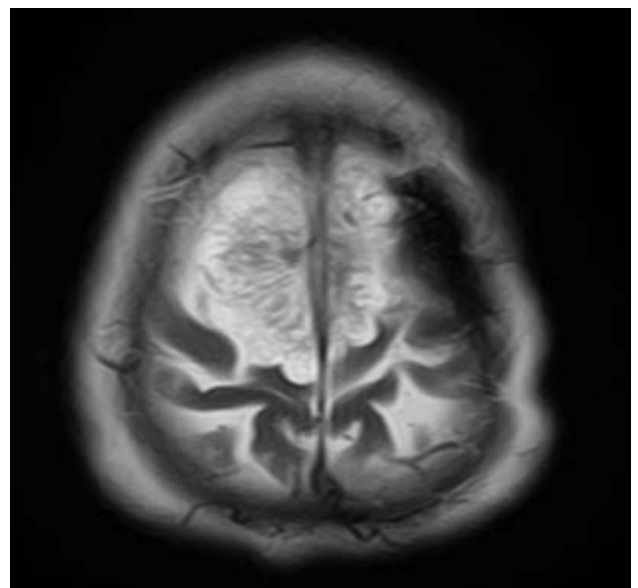


Figure 10: T2 weighted MR image of brain in patient with meningioma demonstrating broad base extra-axial T2 hyperintense mass arising from midline falx at vertex with feeding arterial branches diverging radially into lesion giving sunburst/spokewheel appearance.

Sunburst arterial blush:

Sunburst arterial blush is seen in renal angiomyolipoma on digital subtraction angiography. Renal Angiomyolipoma (AML) constitutes a solid, benign renal lesion characterized by inadequately organized blood vessels, smooth muscle, and varying degrees of mature adipose tissue. Digital Subtraction Angiography (DSA) may be employed for the diagnosis of AML, featuring specific characteristics such as the 'sunburst appearance' manifested by tortuous vessels and a whorled arrangement of peripheral vessels.²⁰

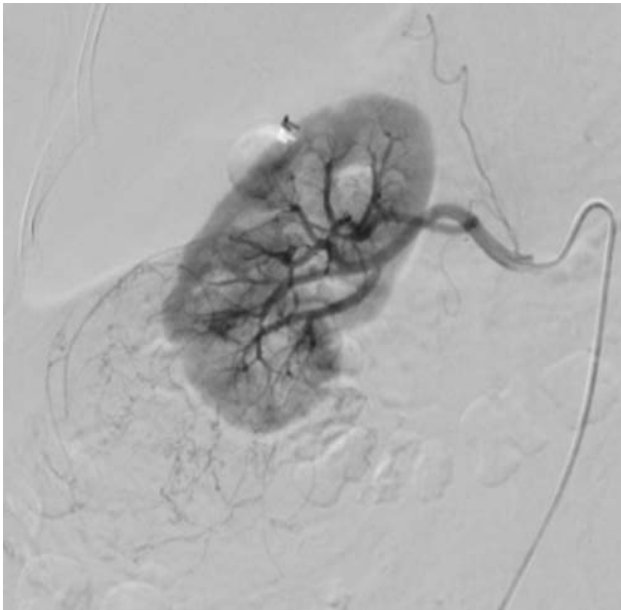


Figure 11: DSA spot image of patient having known large right lower pole AML depicting hypervascular mass with dense early arterial vascular network of tortuous irregular vessels.

7. Sunset eye sign:

The sunset eye sign also known as setting sun phenomenon is a clinical sign in children with raised intracranial pressure. It consists of upward gaze paresis with eyes appearing driven downward bilaterally. The inferior border of the pupil is often covered by the lower eyelid, creating the sunset appearance. It is seen in 40% of children with obstructive hydrocephalus and 13% of patients with ventriculoperitoneal shunt dysfunction.²¹ It presumably results from compression of peri-aqueductal structures and related to perinaud syndrome. Clinically it is a valuable warning sign to warrant neuroimaging.

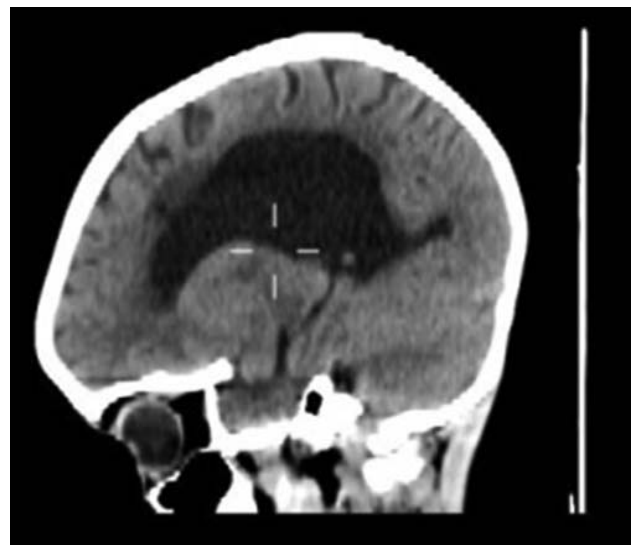


Figure 12: Ct brain sagittal reformatted image of 2 months old male having large head with downward turned eyes and hydrocephalus.

8. Twinkling artifact:

Twinkle artifact is an intrinsic machine noise which presents as a focus of alternating colors on the Doppler mode signals, related to a strongly reflecting interface of an object (such as a calculus or air), and giving the appearance of turbulent blood flow. The twinkle artifact exhibits higher sensitivity in detecting small stones, such as those in urolithiasis and cholelithiasis, compared to acoustic shadowing. Several studies have validated the utility of the twinkle artifact in identifying renal stones, demonstrating varying degrees of sensitivity. One recent study conducted in paediatric age group showed the twinkle artifact is a sensitive US tool for detecting pediatric kidney and ureter stones, but with a small risk of false positive findings.²²



Figure 13: Grey and color Doppler ultrasound of ultrasound showing small echogenic focus with posterior acoustic shadowing at lower pole of left kidney consistent with small calculus demonstrating twinkling artifact on color Doppler ultrasound.

9. Milky Way sign:

The Milky Way sign or the punctate pattern is an MRI characteristic observed in progressive multifocal leukoencephalopathy (PML). Its significance becomes apparent in differentiating PML from new lesions associated with multiple sclerosis.²³ This sign signifies numerous punctate areas of high T2 surrounding the primary element of the new lesion. It resembles the diffuse band of brightness in the night sky, reminiscent of the Milky Way, formed by the amalgamation of countless stars that aren't individually discernible. Although usually seen in PML, it can be seen in other disorders like central nervous system vasculitis, neurosarcoidosis and Chronic Lymphocytic Inflammation with Pontine Perivascular Enhancement Responsive to Steroids (CLIPPERS).²⁴

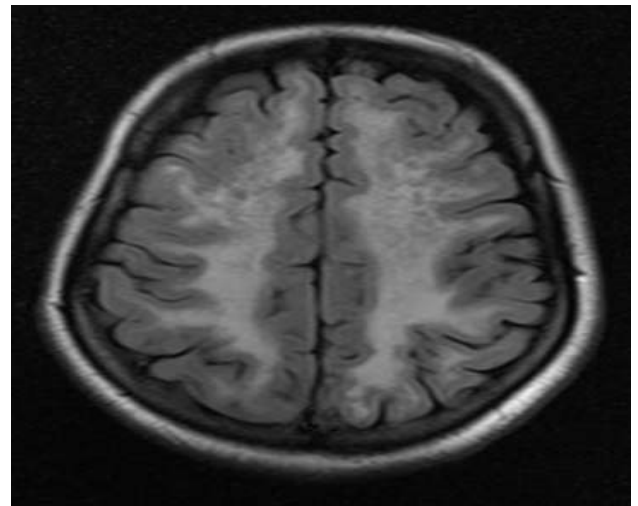



Figure 14: FLAIR sequence of MR Brain in patient with suspecting PML depicting confluent hyperintense signal in subcortical white matter.

Conclusion

These aforementioned signs should be kept in mind while reporting. Understanding of these readily discernible astronomy-based signs is crucial because it helps to cut down the complex list of differentials and improves imaging-based diagnosis.

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