Signs in neuroradiology – Part 1*

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Abstract The use of signs or analogies for interpretation and description of medical images is an old and common practice among radiologists. Comparison of findings with animals, food or objects is not unprecedented and routinely performed. Many signs are quite specific and, in some cases, pathognomonic. Indeed, notwithstanding their degree of specificity, signs may help in the characterization of certain diseases. Several neuroradiological signs have been already described. The authors will present 15 neuroradiology signs in the present essay, approaching their main characteristics, the significance of their role in the clinical practice, as well as their respective imaging findings.

Keywords: Radiological signs; Neuroradiology; Computed tomography; Magnetic resonance imaging.

INTRODUCTION

Descriptive terms in radiology are usually based on standards and consensus. There are cases, however, in which the radiologist utilizes metaphors in the form of signs in allusion to foods, animals or objects, to support his hypothesis for a given problem and describe the findings of a particular disease. Signs, when present, are important as they allude to a more specific diagnosis, and contribute with a certain degree of confidence in the diagnosis. In general, “we recognize what we already know”, and tools that aid in the interpretation of images are valuable. In this first part, the authors discuss 15 neurological signs, with illustrative images for each one of them.

“Ice-cream cone sign” of the temporal bone

The temporal bone ice-cream cone sign represents the normal appearance of the malleoincudal joint on computed tomography (CT). The malleus (hammerhead) represents the ice-cream ball, and the body of the incus (anvil) represents cone (Figure 1).

Figure 1. High resolution, axial CT image demonstrating the ice-cream sign of the temporal bone. The sign represents the normal appearance of the malleoincudal joint. The malleus represents the ice-cream ball (arrow head) and the body of the incus, the cone (arrow). The lateral epitympanic space (Prussak’s space) is located laterally to the malleus and incus (asterisk).

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Resumo O uso de sinais ou analogias na interpretação de imagens na radiologia médica é prática comum e antiga entre os radiologistas. Comparação entre achados de imagem com animais, alimentos ou objetos se faz de modo natural. Muitos sinais são bastante específicos e em alguns casos patognomônicos. Independentemente do grau de especificidade, sinais auxiliam a prática radiológica. Vários sinais já foram descritos em neurorradiologia. Neste artigo os autores demonstrarão 15 sinais neurorradiológicos. Serão abordados as principais características de cada um, a sua importância na prática clínica e os seus achados de imagem.

Unitermos: Sinais radiológicos; Neurorradiologia; Tomografia computadorizada; Imagem por ressonância magnética.
years of age, with the superior sagittal sinus (SSS) being most frequently affected (62% of cases). Such increased incidence can be explained by pregnancy, puberty and use of oral contraceptives. The diagnosis can be achieved by means of CT (the most readily available), magnetic resonance imaging (MRI) (the method of choice) or by conventional angiography (CA) (the most invasive method). In 20% of cases, CT scans are normal. CVT findings can be classified in direct and indirect. The cord sign and the empty delta sign are direct signs of CVT. Indirect signs include: edema, infarction and hemorrhage. The cord sign is characterized as increased density of the sinuses or of the cortical or deep veins (Figure 2), originated from the thrombosed material inside the affected vessel. The cord sign is most frequently identified within two weeks after the first symptoms onset. With time, the thrombus becomes isodense and subsequently, hypodense.

“Empty delta sign” in venous sinuses thrombosis

The empty delta sign may occur in cases of CVT, characteristically involving the SSS. On contrast-enhanced CT/MRI, the sign is characterized by a non-enhancing central triangular shaped area (the thrombus itself), limited by enhancing dura mater (Figure 3). Numerous factors may lead to CVT, as follows: inflammatory processes, infection, fibrosis of the venous sinuses walls, direct tumoral compression or/and extension, and hypercoagulable states. The empty delta sign is usually not identified at the first week (the material is isodense) as well as in chronic cases (more than two months), due to thrombus recanalization.

“Arrow sign” in ruptured middle cerebral artery aneurysm

In ruptured aneurysms the pattern of distribution of subarachnoid hemorrhage can indicate its most likely location. In cases of bifurcation middle cerebral artery (MCA) aneurismal rupture the bleed may present the shape of an arrow, with the shaft and the tip representing blood in the horizontal segment of the Sylvian fissure and in the frontotemporal opercular area, respectively (Figure 4).

“Dense artery sign” in acute middle cerebral artery infarction

The dense MCA sign is one of the early signs of infarct. This is due an increase in density of its proximal segments, secondary to thrombosis (Figure 5). False-positive results may occur, particularly in cases of parietal calcification. It is important to observe that the distal branches of the MCAs rarely present parietal calcifications. Focal subarachnoid hemorrhage may simulate an abnormally dense MCA especially when located at the Sylvian fissure and constitute an additional cause for false-positive results.

“Dot sign” in acute middle cerebral artery infarction

The dot sign is one of the early signs of acute infarction and corresponds to a punctate hyperdensity in the Sylvian fissure. The signal represents thrombosis in the M2 and M3 segments of the MCA on plain CT scans. The presence of a thrombus/clot within the vessel alters and increases its density (Figure 6). The dot sign has a high specificity and high positive predictive value, but has low sensitivity.

“Hot nose sign” at brain death

The hot nose sign can be seen in cases
of brain death and it is defined by the presence of early and increased radiotracer activity in the nasopharyngeal region. It may also be seen as an intense blush (hyperemia) at CA examinations (Figure 7). The phenomenon is a result of a reduced blood flow in the internal carotid artery and increased flow in the external carotid branches. Such signal is not exclusive of brain death and may be found in different situations that lead to intracranial flow reduction in one or both internal carotid arteries(9).

“Tau (t) sign” in persistent trigeminal artery

The sign of the Greek letter t occurs in cases of persistent trigeminal artery (PTA) and can be identified at CA, CT angiography and MR angiography. PTA is the most prevalent type of carotid-basilar anastomosis and it is formed by the horizontal and vertical segments of the internal carotid artery (Figure 8). Despite being an incidental finding in the majority of the cases, PTA is usually associated with basilar artery hypoplasia and can be accompanied by oculomotor nerve palsy, trigeminal neuralgia or, eventually, with the presence of aneurysms(10).
“Caput medusae sign” in developmental venous anomaly

The caput medusae sign is indicative of developmental venous anomaly (DVA), and is identifiable at CA, CT and MRI. DVAs correspond to a network of dilated, abnormal medullary veins with radial distribution, converging into a dominant, calibrous transparenchymal vein, which may drain into a cortical vein, dural sinuses or into the deep venous system (Figure 9). DVAs are the most frequent intracranial vascular abnormalities, which are associated with cavernomas in around 30% of cases. Despite being considered incidental findings, in some cases these may lead to intracranial hemorrhage, thrombosis and venous infarction\textsuperscript{13}. Hemorrhages secondary to DVA are rarely found, with an annual risk of 0.7\%\textsuperscript{12}.

“Spoke wheel sign” in meningioma

The spoke wheel sign refers to the typical angiographic appearance found in meningiomas. This sign corresponds to multiple small arteries radially distributed from a dominant feeding artery (Figure 10). Meningiomas are the most common primary intracranial tumors in adults. They are extra-axial, slow-growing, well-vascularized lesions with a benign behavior (grade I, according to the World Health Organization). Another remarkable and very common characteristic of meningiomas is the presence of a dural tail and, in 25\% of cases, hyperostosis of the adjacent bone\textsuperscript{13}.

“Onion skin sign” in Baló’s concentric sclerosis

The onion skin sign is considered pathognomonic for Baló’s concentric sclerosis\textsuperscript{14}. According to the first reports on such disorder, most patients had an unfavorable history with progression either to death or disability. Recent cases however, have presented a less dramatic course. Baló’s concentric sclerosis may occur as an isolated phenomenon or precede the development of multiple sclerosis. The lesions present a peculiar pattern of concentric lamellae of demyelination alternated with lamellae of myelinating or remyelinating white matter. Such lesions are most frequently found in the frontal lobes, but may be seen in the whole neuroaxis\textsuperscript{14}. Magnetic resonance imaging (MRI) is the best method for the disease diagnosis and follow-up. In spite of the high sensitivity of T2-weighted images to demonstrate demyelinating lesions, the concentric rings are better identified on T1-weighted images (Figure 11). The enhancement following contrast administration is variable and probably represents active areas of demyelination\textsuperscript{15}.

“Eccentric target sign” in toxoplasmosis

The eccentric or asymmetrical target sign is highly suggestive of central nervous system toxoplasmosis. The sign represents a ring enhancing abscess associated with an enhancing mural nodule (Figure 12). This finding is highly specific, but has low sensitivity, being found in approximately 30\%
Figure 10. Two female patients with meningioma. Note the characteristic spoke wheel sign in both patients, formed by multiple small arteries radially distributed from a dominant feeding artery. On A, axial T2-weighted image of a 60-year-old patient with a greater sphenoid wing meningioma, and on B, digital subtraction angiography of a 55-year-old female patient with a meningioma in the right temporal region.

Figure 11. Sagittal T1 (A) and axial T2-weighted images (B) of a female 50-year-old patient with history of progressive weakness particularly on the right side, with sensory aphasia and dysphagia. Concentric rings are observed in the frontal lobes, particularly on the left side. Such lamellar appearance (onion skin sign) is virtually pathognomonic of Baló’s concentric sclerosis. This case is a courtesy by Doctor Silvana Alves (Brasília, DF, Brazil).

Figure 12. Axial enhanced T1 image of a 35-year-old female patient with acquired immune deficiency syndrome, encephalopathy and decreased level of consciousness. An eccentric enhancing mural nodule is seen in a ring-enhancing lesion characterizes the eccentric or asymmetric target sign.

Figure 13. Unenhanced axial CT image of an 18-month-old patient with a history of near drowning. Inversion of attenuation is observed between the supra and infratentorial structures with a relative increase in the density of the cerebellum and decreased density of the cerebral cortex and white matter. Such finding is known as reversal sign, characteristic of diffuse cerebral anoxia.

of cases. The pathological correlation of such sign is not completely understood, but it is believed to represent internal folds and invaginations of the abscess walls.

“Reversal sign” in diffuse cerebral anoxia

Such sign is characterized by the relative inversion of attenuation between the supra and infratentorial structures on unenhanced CT and may indicate diffuse brain ischemia. The sign can explained by relative increase in the density of the cerebellum, basal ganglia and thalami, and decreased density of the cerebral cortex and white matter (Figure 13). Reversal sign can occur secondary to head trauma, hypoxia, birth anoxia, near drowning, status epilepticus, hypothermia, bacterial meningitis and strangulation. The pathogenesis is not completely clarified.

“Dawson’s fingers” in multiple sclerosis

The Dawson’s finger’s in multiple sclerosis are related to white matter inflammatory changes that occur around the perimedullary veins. These are ovoid lesions, with the longest axis perpendicular to the corpus callosum (Figure 14). James Walker Dawson was Scottish pathologist who developed relevant studies on multiple...
sclerosis. The demyelinating plaques are commonly located in the juxtacortical and periventricular white matter, in the corpus callosum and callosal-septal interface, with high signal intensity on sequences with long repetition time and hypo to iso-signal intensity on T1-weighted images\(^\text{18}\).

**“Mount Fuji sign” in hypertensive pneumocephalus**

This sign is seen in bilateral subdural hypertensive pneumocephalus. These air collections cause compression of the frontal lobes, which take up a shape similar to the Mount Fuji silhouette (Figure 15). Hypertensive pneumocephalus is a neurosurgical emergency, in which the increased air pressure is thought to be secondary to a check-valve mechanism. Air would enter freely into the subdural space by a defect in the bone but would not escape with obstruction of the egress of air being blocked by an obstruction. This sign is useful in the differentiation between hypertensive and non-hypertensive pneumocephalus. Hypertensive pneumocephalus may also follow drainage of subdural hematomas, causing compression over the frontal lobes. Such imaging finding is known as Mount Fuji sign, as an allusion to the Japanese mountain.

**CONCLUSION**

The aforementioned signs are important tools as they lead to a more specific diagnosis and add a certain degree of confidence in the diagnosis. With such information, the assisting physician can better establish the correlation between imaging and clinical findings.

**REFERENCES**