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Bright stuff on T1 – Applications in Clinical Neuroradiology

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Purpose: Only a few, but very different things appear hyperintense on T1w images. The purpose of this presentation is to recapitulate the different substances and mechanisms of hyperintensities on T1w images. The differential diagnoses and consequences for the strategy and interpretation of neuroradiological imaging are considered.

Outline of Content: Fat, proteins, gadolinium (contrast agent), melanin, blood, and miscellaneous things (calcium, manganese, flow) appear hyperintense on T1w images. Different mechanisms lead to this appearance. Proteins and fat have a natural short spin-lattice relaxation time (Figure 1). Gadolinium, iron (e.g. in hematomas) and melanin are capable of modifying the magnet field by shortening the T1 relaxation time. Imaging of blood is demanding as its signal properties change according to the age of the hematoma (Table 1). Thus hemorrhaged or melanin containing metastasis can appear hyperintense in T1w images even before the application of contrast agent. A consequence for the neuroradiologist is to stage postoperative MRI imaging after intracranial tumor surgery within the first three days to avoid misinterpretation of hematoma as residual tumor. In patients with hepatic impairment manganese can accumulate and be deposited in the basal ganglia. Metal artefacts and flowing blood can also appear hyperintense on T1w images (Figure 2). The signal of flowing bood is more hyperintense with short TE and TR and if gradient echo sequences are used ("time of flight effect").

Summary: Classically, fat, proteins, gadolinium, melanin and blood are considered to appear hyperintense in T1w images. Additionally, e.g. flow, calcium, manganese can appear hyperintense as well. The mechanisms leading to this appearance are different: short spin-lattice relaxation time (proteins, fat), modification of the magnet field (melanin, gadolinium), and "time of flight effect" (flow).

Stage	Time	T1	T2
Oxyhemoglobin	< 6 hours	hypointense	hyperintense
Deoxyhemoglobin	> 6 hours to 3 days	isointense	hypointense
Methemoglobin (intracellular)	3 days	hyperintense	hypointense
Methemoglobin (extracellular)	7 days to weeks	hyperintense	hyperintense
Hemosiderin	weeks to months	hypointense	hypointense

Table 1: Appearance of intracranial hematomas on T1w and T2w images according to their age and stage.

Figure 1: Hyperintense intra- and suprasellar cyst (X) in a patient with craniopharyngeoma. The cyst's content was protein rich and thus appears hyperintense.

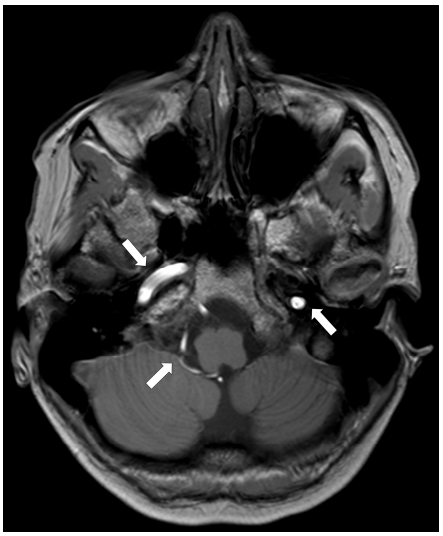

Figure 2: Flow in the basal brain supplying arteries (arrows).