Direct validation of MRI findings in postmortem brain

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Target audience

The following content might bring valuable information to radiologists, clinicians, as well as pathologists.

Purpose

Research in forensic imaging increasingly develops from case reports into statistically meaningful designed studies[1]. Its application to traumatic brain injury assessment can add important information to forensic expert reports. However, although there is evidence that posttraumatic changes can be detected using quantitative MR parameters[2] forensic imaging is still in an initiate stage, and there is a need for direct and case-based validation of MR findings, not only in forensic medicine but also as a feedback for clinical radiology. The aim of this work was to compare MRI findings with corresponding brain slices in a postmortem imaging study.

Methods

After excluding subjects with decomposition or massive cerebral hemorrhage, 6 corpses (1 ♀, 5 ♂, median age 68 years, 37–92) with a history of recent, accidental blunt head trauma (group A) and 11 deceased subjects without head trauma (group B: 3 ♀, 8 ♂, median age 64y, 48-81) underwent MRI at 3T (Magnetom Trio, Siemens AG, Germany) within 64 hours postmortem. Median body temperature at the beginning of the scan was 16.4°C (6.3-26.9) in group A and respectively 15.2°C (4.6-23.7) in group B. The scan protocol consisted of: a) high-resolution T1w MPRAGE (TI=700 ms; TR/TE=1.9s/2.19ms; 1x1x1mm³), b) T2w TSE (TR/TE=5.26s/73ms; 1x1x3mm³), c) T2*w spoiled 3D GRE (TR/TE=30ms/20ms; 0.5x0.5x2mm³), d) PDw TSE (TR/TE=5.26s/10ms; 1x1x3mm³), e) FLAIR (TI 1.25s; TR/TE=10s/70ms; 1x1x3mm³) and f) DWI EPI (TR/TE=6.7s/95ms; 2x2x3mm³) with b_{max}=2000 s/mm² to account for reduced diffusivity in cooled tissue. Temperature adaption of the acquisition parameters was essential for sequences a), e) and f). Total acquisition time for whole brain coverage was 53 min. Brains were extracted, formalin fixed and axially cut[2]. MR images were evaluated independently by two blinded board certified radiologists using a standardized reading protocol. Referee decision of incongruent findings was done by a third radiologist. Radiologic results were compared to the macroscopic findings of corresponding brain slices.

Results

In total, 30 findings were found in the MRI data, whereas 16 findings were detected in the brain slices (Tbl. 1). In group A findings associated with trauma such as contusion, hemorrhage and microbleeds (MCBs) were seen mostly in both, macroscopy and MRI. Whereas 8 MCBs remained undetected in MRI compared to macroscopic evaluation, MRI was superior for all other investigated kinds of findings, particularly those which are not primarily associated with trauma. Fig. 1 illustrates a trauma case in which subarachnoid and intra-cerebral hemorrhage as well as MCBs were seen in both, MRI and brain slices.

Discussion

The comparison between macroscopic and radiologic evaluation revealed some incongruity in both groups. Though it is known that besides MRI histology is the method of choice for the diagnosis of subtle findings such as microangiopathy, discrete calcifications or multiple sclerosis related tissue changes, it was not expected that trauma related findings such as hemorrhage or contusion remained undetected in macroscopy. In contrast, the lower sensitivity for the detection of MCBs with MRI might result from the difficult differentiation of MCBs from vessels. This observation is in agreement with related work that found considerable inter-rater disagreement for punctate lesions in survivors of TBI in T2w and FLAIR images[3].

		Contusion		Hemorrhage		Micro bleed		Micro angiopathy		DVA		Leuco araiosis		MS Lesion		Calcification		Megacisterna magna		Lacuna		Lipoma	
Macroscopy	Number	-	-	6	-	8	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cases	-	-	1	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MRI	Number	1	-	7	1	2	-	2	4	1	-	-	2	-	2	-	1	-	1	1	3	-	2
	Cases	1	-	2	1	1	-	2	4	1	-	-	2	-	2	-	1	-	1	1	2	-	2

Tbl. 1: Findings in cases of group A (shaded in grey) and B, respectively (DVA, developmental venous anomaly).

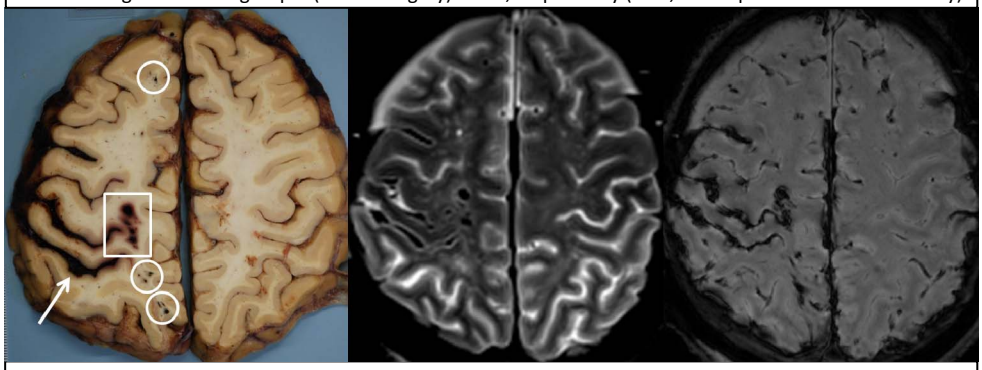

Fig. 1: Brain slice, T2 weighed turbo spin-echo - and T2* weighed MR-images of an 89-years-old male showing a subarachnoid (arrow) and intra-cerebral (rectangle) hemorrhage as well as microbleeds (circles).

Conclusion

Direct validation studies in clinical as well as in forensic imaging are important as there are discrepancies in detection of findings. Particularly trauma related findings such as MCBs seem to be difficult to detect in MRI. However, as MRI provides non invasive qualitative and quantitative information, it will complement traditional methods in forensic cases in the future.

References

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