Contrast uptake enhancement patterns in neuroendocrine liver metastases

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Introduction: Neuroendocrine liver metastases have been described as being hypervascular in nature, showing arterial enhancement and washout. However, other enhancement patterns have been observed in clinical practice (plateau and progressive enhancement). We aim to study the various enhancement patterns of neuroendocrine liver metastases and relate their behavior to microcirculatory properties derived from tracer kinetic modeling with DCE-MRI.

Methods

Patient: 7 out of 15 patients with DCE MRI were included from a yttrium Y 90-DOTA-tyr3-octreotide trial. Seven patients were excluded because portal vein was not included in the imaging field, and one case was excluded due to extensive necrosis. The baseline DCE-MRI of these patients were evaluated to characterize the microcirculatory characteristics of these tumours.

DCE-MRI: DCE MRI was performed on a 1.5T MR unit (Avanto, Siemens, Erlangen, Germany) with a TIM coil system using a 3D VIBE sequence. Scan parameters were: TE = 0.89 ms, TR = 3.28 ms, flip angle = 2° and 18°, 12 slices per slab for native T1 map. Contrast agent (Magnevist, Bayer Healthcare, Leverkusen, Germany) was injected at a dose of 0.1 mmol/kg using an automatic injector and at a rate of 5 ml/s. 40 post-contrast acquisitions were performed with flip angle 18° repeatedly with 2 consecutive acquisitions (3 seconds each) followed by a 6 sec breathing gap.[1]

Data Analyses: Post-processing was performed off-line on a Pentium IV personal computer with Matlab™ (MathWorks, Natick, MA). One Region-of-interest (ROI) consisting of a representative lesion was manually drawn in each patient. Concentration was estimated using a dual flip angle technique. Deconvolution and curve-fitting was performed using a two-compartment dual-input – aorta (AIF) and portal vein (PV) (see inset in Figure 2) – distributed parameter model.[2]

Results: Figure 2 shows the three types of enhancement curves in neuroendocrine tumor: (1) Rapid increasing followed by decrease (highlighted in red in the table below), (2) Rapid increasing followed by plateau (yellow), and (3) Progressively increasing (blue). The Type I pattern show higher % intravascular volume (v_1) compared to % interstitial volume (v_2). Type II and III pattern show higher v_2 compared to v_1. The Type I pattern shows higher blood flow (F) compared to Type II/III.

Case	Type	F	v_1	v_2
NE11	I	1.415	0.243	0.095
NE19		1.159	0.293	0.219
NE9	II	0.767	0.203	0.212
NE12		0.4	0.16	0.84
NE13		0.521	0.231	0.348
NE8	III	0.635	0.111	0.259
NE15		0.298	0.025	0.975

Conclusion: Neuroendocrine liver metastases are a hetereogenous condition which appear to demonstrate three different enhancement kinetics. In our study, only about 28.6% (2/7) show high intravascular volume and high flow., which corresponds to early arterial enhancement followed by contrast washout observed on at conventional dynamic contrast enhanced morphological imaging.

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References

1. Orton M, et al. Phys Med Biol 2009:54;2197-2215.
2. Koh TS, et al. Radiology 2008;249:307-320.

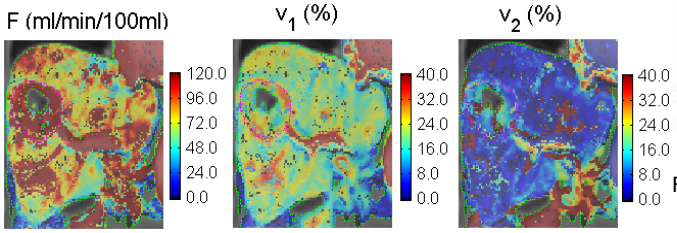
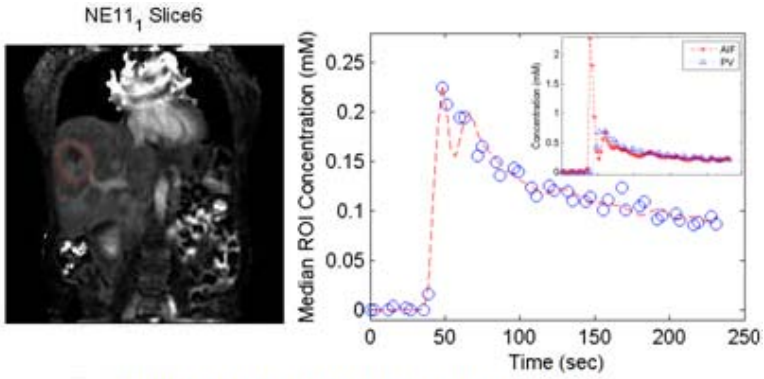
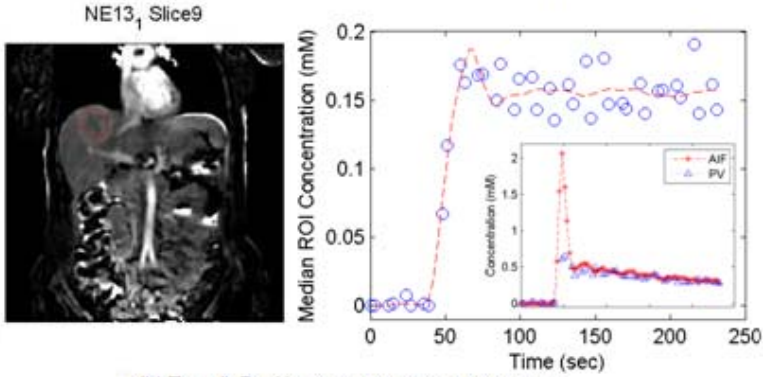


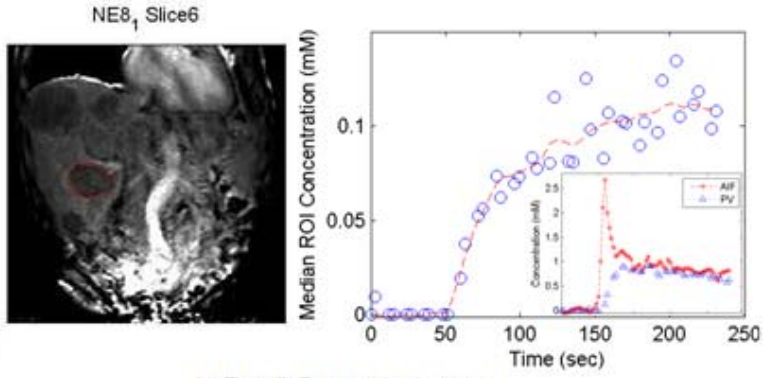
Fig 1. Microcirculatory parameters map for NE11 Slice 6.



(a) Type I: Rapid increase followed by decrease



(b) Type II: Rapid increase followed by plateau



(c) Type III: Progressive increase

Fig 2. Three types of enhancement curves in neuroendocrine tumor