Dynamic contrast-enhanced magnetic resonance imaging to assess desmoid tumours in familial adenomatous polyposis

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Background: Familial adenomatous polyposis (FAP) is an autosomal dominant hereditary condition characterised by multiple colonic polyps at an early age, which if left untreated become cancerous. Modern management has altered patient outcome such that extracolonic manifestations are now the leading cause of death following prophylactic colectomy. Up to a quarter of patients will develop desmoid tumours, rare tumours arising from the musculo-aponeurotic tissues. Approximately 10% will grow relentlessly, resulting in death. Outcome cannot be reliably predicted from histologic findings. Different patterns of MRI enhancement may be seen which may reflect tumour behaviour. This exploratory study was performed to evaluate the feasibility of dynamic contrast enhanced magnetic resonance imaging (DCE-MRI) to assess the vascularisation of desmoid tumours in FAP.

Materials and Methods: Following ethical approval and informed consent, nine FAP patients (four male, five female, mean age 39 years) with desmoid tumours underwent diagnostic 1.5T MRI (T_1-weighted, T_2-weighted, STIR of the abdomen and pelvis). 0.1ml/kg gadolinium-based intravenous contrast (Magnevist™) was administered during acquisition of a dynamic contrast-enhanced (DCE) MRI series. (Table 1.)

Table 1: MRI Diagnostic and DCE Acquisition parameters

Sequence	TR ms	TE ms	TI ms	FA °	NEX	Slicewidth mm	FOV mm	Matrix
T1 axial bh	138	4.76	-	70	1	8	300*263	256*179
T2 axial bh	97	2180	-	150	1	5	300*300	512*512
STIR axial	3800	93	150	160	1	5	300*300	256*256
Proton Density	7.38	4.76	-	2	6	5	300*300	512*512
T1W DCE	7.38	4.76	-	18	1*40 repeats	5	300*300	512*512

Quantitative parameters K^{trans} (Transfer Constant), v_e (Extravascular Extracellular Space, EES), k_{ep} (rate constant) and $IAUGC_{60}$ (integrated area under the gadolinium-time curve at 60s) were calculated from the gadolinium concentration-time curve using the Tofts model[1] and a modified Fritz-Hansen assumed AIF[2]. The percentage of non-enhancing pixels was noted. Tumour location, size, and T_2 signal characteristics were also recorded. Surviving patients were followed up a year later with a diagnostic MRI examination.

Results: DCE-MRI was abandoned in 1 female patient who could not be cannulated. 13 desmoid tumours (four intra-abdominal, two extra-abdominal, seven abdominal wall; mean area 68cm^2) were analysed in the remaining eight patients. 6/13 were low signal on morphological T_2-weighted images; the remainder were of mixed signal intensity, consistent with previous observations[3].

Results are given in Table 2. Two lesions (Patient 3, extra-abdominal and Patient 8, intra-abdominal, marked * in Table) showed significant growth in 1yr. Two patients died between the exams (one pulmonary embolism, one desmoid-related). There was a high percentage of non-enhancing and non-modelling pixels (%). Low AUC_{60}, K^{trans} and k_{ep} indicate these tumours are hypoperfused with slow bi-directional transfer of contrast between blood plasma and EES. The large v_e is also compatible with the fibrous nature of the tumours. There were no significant correlations between kinetic parameters and size.
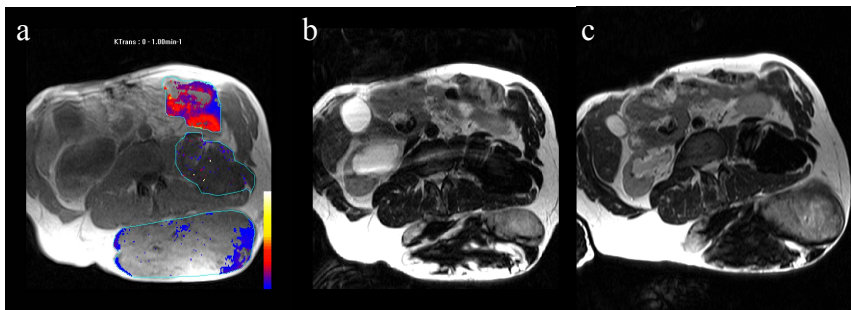

Figure 1a): Patient 3 K^{trans}, b) baseline T2W and c) 1 yr follow-up T2W, showing three desmoids. Very low enhancement in extra-abdominal tumours (back and erector muscle); more enhancing and higher v_e abdominal wall tumour at front left. The back desmoid is rapidly growing, with mixed signal on T2W.

Table 2. Desmoid results. IA: Intra-abdominal, AW: Abdominal Wall, EA: Extra-abdominal

patient	site	T_2w signal	K^{trans} (min^{-1})	v_e (%)	k_{ep} (min^{-1})	$IAUGC_{60}$ (mmol.s)	%NE fail	Initial MR size (cm^2)	Follow-up size (cm^2)
1	IA	low	0.231	55.3	0.448	13.40	24.4	27.6	16.3
2	AW	mixed	0.080	59.4	0.137	9.85	1.5	191.2	-
3*	EA	mixed	0.038	29.3	0.171	0.95	75.6	145.7	181.5
3	AW	mixed	0.143	64.3	0.234	16.88	6.0	32.2	24.2
3	EA	low	0.053	15.0	0.362	2.97	92.6	30.4	26.8
4	AW	mixed	0.195	67.9	0.295	17.17	1.3	47.3	24.5
4	AW	low	0.055	17.7	0.298	3.38	13.3	3.17	2.5
5	IA	low	0.174	60.0	0.312	9.82	19.5	70.7	-
6	AW	mixed	0.095	47.4	0.214	6.44	2.3	89.5	25.3
6	AW	mixed	0.378	55.8	0.671	21.34	4.2	2.5	5.5
7	IA	low	0.238	38.2	0.649	12.61	32.7	18.1	18.3
8*	IA	low	0.234	39.6	0.612	11.97	45.2	25.3	34.8
8	AW	mixed	0.280	60.2	0.488	18.34	9.9	2.1	1.5
means			0.169	0.469	0.376	11.16	25.3	52.7	32.8

Conclusion: DCE-MRI is feasible but presents significant challenges for quantification. The tumours are generally hypovascular, with a large volume of distribution.

References:
[1]Tofts PS. *J Magn Reson Imaging*. 1997 Jan-Feb;7(1):91-101. [2] Walker-Samuel S, Leach MO, Collins DJ. *Phys Med Biol*. 2006 Jul 21;51(14):3593-602. [3] Lee JC, Thomas JM, Phillips S, Fisher C, Moskovic E. *Am J Roentgenol*. 2006 Jan;186(1):247-54.