

Report of MR Safety Testing on Thermal Blanket

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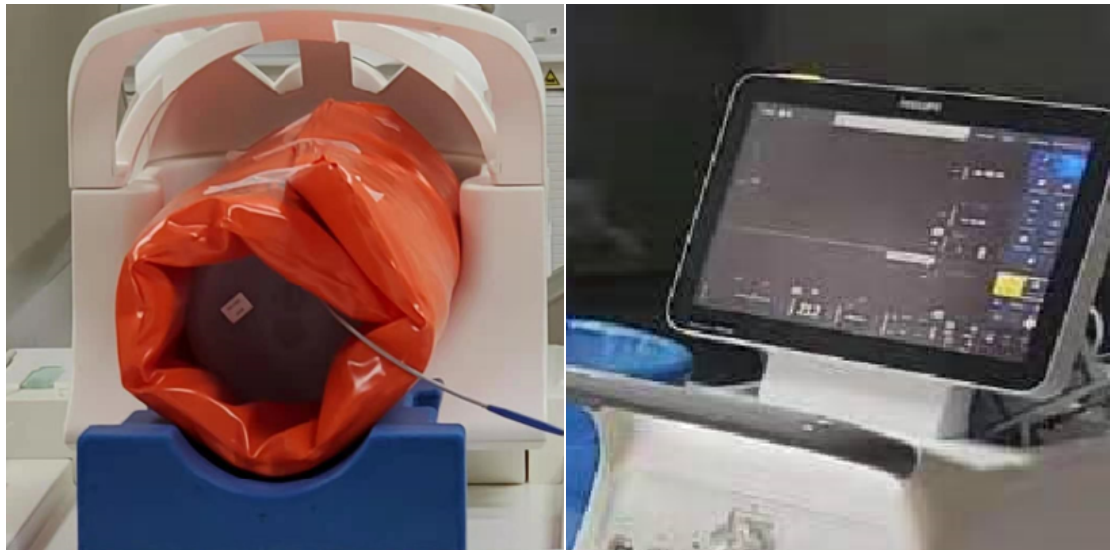
6. Limitations

1. Background

The patients under HIFU procedure loss their temperature very quick due to convection and conduction and radiation. We have purchased a special thermal blanket to keep patients warm. The thermal blanket, bought from Veterinary Warming Solutions LLC, is labeled as ConRad (MRI-Safe) Technical Information. There are two component layers inside: 1) a heat insulative layer made of Rayon 2) a heat trapping layer made of polyurethane. Therefore, there are no ferromagnetic and conductive material to cause hazards in the MR environment. However, since the company haven't test it on a scanner for human, we are going to perform a test focusing on artifacts and possible heating related safety on our clinic 3T Siemens Skyra scanner.

2. Testing Setup

Phantom: A 5 liters phantom was wrapped inside the ConRad thermal blanket and put in the center of a 20-channel head coil. The temperature probe was firmly attached to the surface of the phantom using tapes. The temperature changes is displayed on the monitor. The setup is shown in the following figure:



Volunteer: Second part was the tests on a volunteer with 178 cm height and 82 kilogram weight. The blanket was set on top of the volunteer's chest since its size is not large enough to wrap around the participant body. This would be a significant difference between our test and what is expected in the reality of HIFU procedure on pediatric patients. The temperature probe was put under armpit for recording the temperature change.

3. Protocols

Phantom: Two sequences was used in the testing: 1. DWI epi sequence for testing of artifacts. 2. T2 space for testing heat deposition.

Institution Name	Texas Childrens Main	Texas Childrens Main	Texas Childrens Main
Manufacturer's Model Name	Skyra	Skyra	Skyra
Software Versions(s)	syngo MR E11	syngo MR E11	syngo MR E11
Series Description	localizer_quiet	DWI ep2d_diff_orth_p2	AX T2 SPACE
Series Number	1	2	5
Number of Averages	2	4	12
Repetition Time	10	5900	1400
Echo Time	3.69	102	155
Flip Angle	20	90	135
Slice Thickness	7	4	0.600000024
Rows	512	192	384
Columns	512	192	384
Number of Phase Encoding Steps	233	143	304
Echo Train Length	1	71	69
Percent Sampling	91	100	100
Percent Phase Field of View	100	100	100
Pixel Spacing	0.48828*0.48828	1.1458*1.1458	0.57292*0.57292
MR Acquisition Type	2D	2D	3D
Imaging Frequency	123.262462	123.262514	123.262507
Pixel Bandwidth	355	1040	290
SAR	0.016362395	0.135543143	0.507811481
duration (minutes)	2	1.2	44.4

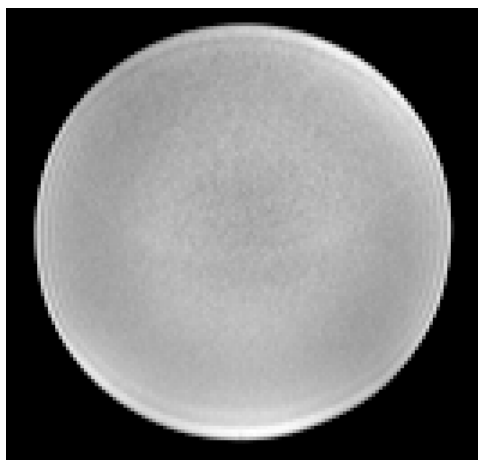
Volunteer: The testing sequences includes high SAR T2 TSE, EPI DWI, EPI fMRI and fieldmap, aiming to find out any discomfort and image artifacts caused by the blanket. Totally it takes around 10 minutes.

Institution Name	Texas Childrens Main	Texas Childrens Main	Texas Childrens Main	Texas Childrens Main	Texas Childrens Main
Manufacturer's Model Name	MAGNETOM Vida	MAGNETOM Vida	MAGNETOM Vida	MAGNETOM Vida	MAGNETOM Vida
Software Versions(s)	syngo MR XA20	syngo MR XA20	syngo MR XA20	syngo MR XA20	syngo MR XA20
Series Description	head_scout_64ch-head-coil_MPF	AX DWI_TRACEW	AX T2	gre_field_mapping	measurement functions
Series Number	3	5	7	8	10
Number of Averages	1	2	2	1	1
Repetition Time	3.15	7000	6430	400	3000
Echo Time	1.37	114	95	4.92	30
Flip Angle	8	90	150	60	90
Slice Thickness	1.6	4	4	3	3
Rows	162	296	512	94	94
Columns	162	292	512	94	94
Number of Phase Encoding S	160	148	358	94	94
Echo Train Length	1	73	13	0	47
Percent Sampling	100	100	70	100	100
Percent Phase Field of View	100	101.37	100	100	100
Pixel Spacing	1.6*1.6	0.85616*0.85616	0.48828*0.48828	2.6596*2.6596	2.6596*2.6596
MR Acquisition Type	3D	2D	2D	2D	2D
Imaging Frequency	123.243655	123.243679	123.243655	123.243674	123.243681
Pixel Bandwidth	539	1631	195	598	1773
gain	391.561	391.561	391.561	391.561	391.561
SAR	0.028502319	0.173783505	0.541391252	0.157953401	0.138823148
duration (min:sec)	1:30	2:30	5:15	1:42	0:45

4. Results

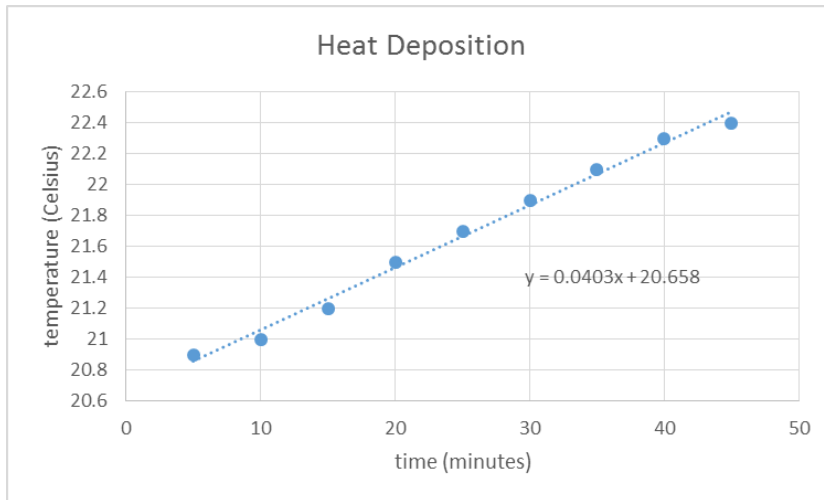
Phantom: There was no extra artifact found on images of the DWI EPI sequence (see figure left)

The temperature gradually increased along with time during the 45 minutes continue scan.

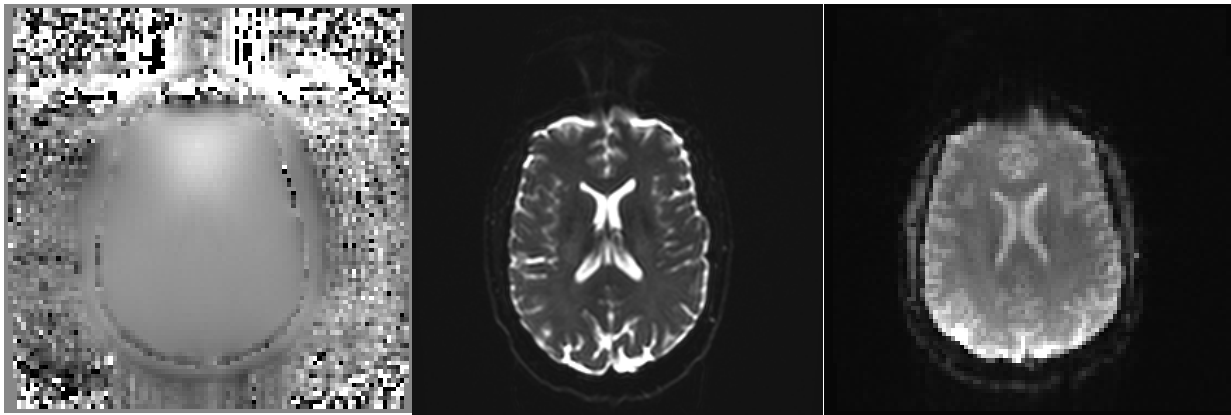


time (minutes)	temperatue (°C)
0	21
5	20.9
10	21
15	21.2
20	21.5
25	21.7
30	21.9
35	22.1
40	22.3
45	22.4

The temperature increased at a rate of 0.04 (°C) per minute. The maximum increase of temperature was 1.7 (°C) within 45 minutes continue scan. This was normal energy deposition by a high SAR sequence. The blanket didn't raise any concern of MR safety.



Volunteer: The temperature increased within one degree Celsius from 34.9 °C to 35.5 °C. No notable extra artifacts were found on fieldmap, DWI and fMRI images:



According to the Volunteer, there was no discomfort during the MR session.

5. Limitations

Our volunteer test was performed on adult which is very different from an infant in our HIFU study in terms of SAR and artifacts.

6. Conclusions

Since no ferromagnetic and no metal components was contented in the blanket according to the description from the manufacture in combination of our tests, it is safe to conclude that the ConRad thermal blanket should be safe in our HIFU 3T MR system.