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The Verification of Effects of Electromagnetic Wave Protective Clothing for Capsule Endoscopy in MRI Head Area Scans.

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Disclosure of Conflict of Interest

- ✓ Research collaborators Matsui Hideki is employee of MEDICAL-AID Co.,LTD ,in Osaka.
- ✓ Device (MG Vest CES) used in this study was provided by MEDICAL-AID Co.,LTD , Osaka, Japan.

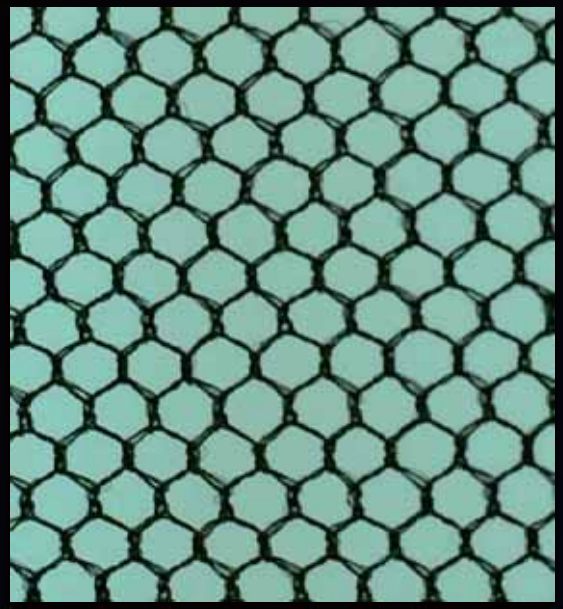
Background

- Cardiac pacemaker, ICD and body metal device, such as heart stents, metal implants and so on, may lead to lose the opportunity of useful diagnostic benefit of MRI examination.
- Suppress the heat of metal device in the body generated by the RF wave.

➢ ***Focus on reflection and electromagnetic wave shielding effect by electromagnetic wave shielding material.***

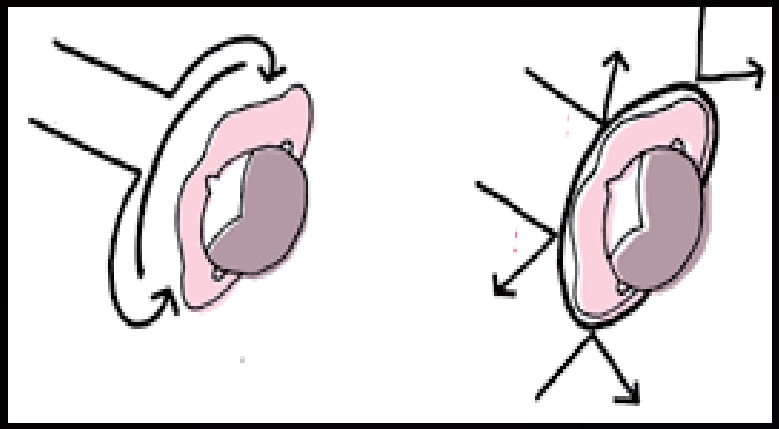
☞ ***Application of commercially available Electromagnetic Wave Protective Clothing for Capsule Endoscopy to MRI.***

Application of commercially available Electromagnetic Wave Protective Clothing for Capsule Endoscopy to MRI.



Sumitomo Hospital

Heat generation of metal devices and of lead wires and malfunction of electromagnetic field products never happen!



- ➡ Reflect RF waves / Shield RF waves
- ➡ Prevent penetration of RF waves
- ➡The MR signal cannot outputReflect and Shield RF waves
- ➢ ***About 34dB (10㎒ ~1㎓) reduction of RF waves.***

Protective Clothing (-)

Protective Clothing (+)

Purpose

- ***The Verification of Effects of Electromagnetic Wave Protective Clothing for Capsule Endoscopy in MRI Head Area Scans.***

Methods

1. *Measurement of changes in SIR of each tissue in the head region.*
2. *Comparison of images of collar and neck surface.*
3. *Comparison of SAR with before and after imaging in B1+rms.*

Materials

MRI

- GE Co. SignaHDxt 1.5T
- SIEMENS Co. Magnetom Skyra 3.0T

Coil

- GE Co. HD Head Neck Spine29
- SIEMENS Co. HeadNeck20

Electromagnetic Wave Shielding mMterial

- MEDICAL-AID,Inc. MG Vest CES

(Endoscope capsule electromagnetic wave protective clothing)

Image Analysis Software

- ImageJ

T2 Weighted Sequence Parameter

Sequence parameter	T2 Weighted Image					
MRI Unit	Siemens Skyra3.0T			GE signaHDx1.5T		
Pulse Sequence	2D-Quiet TSE			2D-FSE XL		
Scanning orientation	Axial	Sagittal	Coronal	Axial	Sagittal	Coronal
Field of view(mm)	240	240	240	240	240	240
Matrix	512*302	512*302	512*333	416*224	256*256	256*256
Slice thickness(mm)	5.0	5.0	5.0	5.0	5.0	5.0
Repetition time(ms)	4500	4500	4500	4300	4300	4300
Echo time(ms)	91	91	91	102	102	120
PAT mode	GRAPPA2	GRAPPA2	GRAPPA2	ASSET2.0	ASSET2.0	ASSET2.0
Band width	238Hz/Px	238Hz/Px	250Hz/Px	31.25MHz	31.25MHz	31.25MHz
TSE factor	11	11	10	14	14	14
Flip angle(deg)	150	150	180	180	180	180
Phase enc.dir	R>>L	R>>L	A>>P	R>>L	R>>L	A>>P
FOV phase(%)	90.6	90.6	100	100	100	100
Averages	1	1	1	1	1	1
Coil elements	HEAD NECK20			HD HEAD NECK SPINE29		
Filter	Prescannormalize nomal			PURE		

Methods

1. Measurement of changes in SIR of each tissue in the head region.

① SignaHD xt 1.5 T and Magnetom Skyra 3.0 T were used.

② Protective clothing made by Medical Aid (MG Vest CES) was used.

③ In case of wearing protective clothing (15 persons) and without wearing (15 persons), were imaged with both models.

④ Height and weight entered declared values.

⑤ Imaging cross sections were Axial, Coronal and Sagittal.

⑥ The *AutoAlign* was used to set the imaging section (3.0 T).

⑦ T2W TSE method was used.

Methods

1. *Measurement of changes in SIR of each tissue in the head region.*

⑧ The tissue of measurement (Target_Tissue (mean)) is ***Spinal cord, Sternocleidomastoid muscle, 2th cervical vertebra, Back of the head fat, Mandibular head, Pons, Thalamus, Cerebral white matter and Cerebral gray matter.***

⑨ Cerebrospinal fluid (CSF (mean)) was used as the control tissue.

⑩ Image analysis software ”Image J” was used.

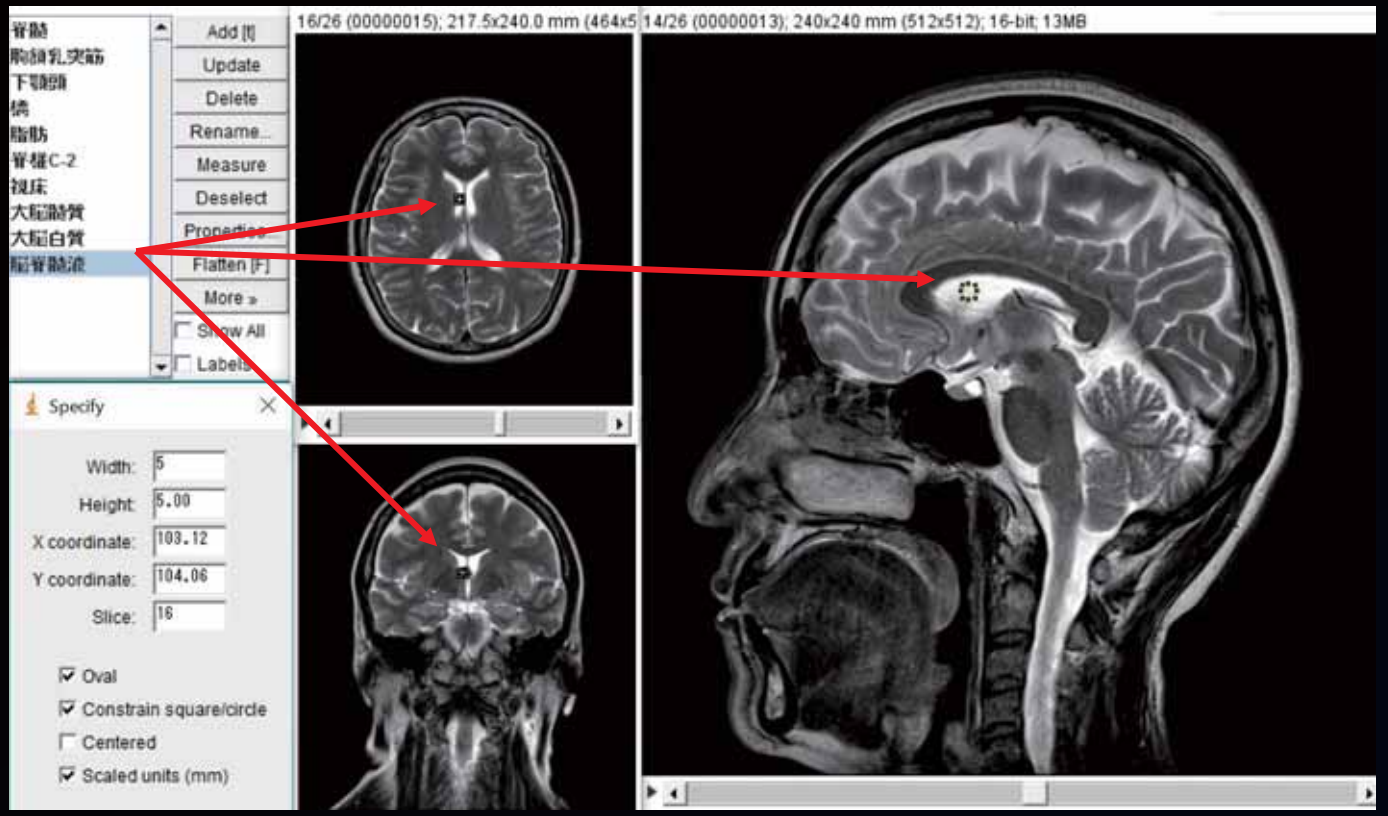
⑪ The MEAN value of each tissue was extracted using ROI Manager function of ImageJ.

⑫ The SIR (avg.) Of each organization was obtained from the following equation.

SIR (avg.) = Target_Tissue (mean) / CSF (mean)

⑬ Visual assessment was carried out.

ROI



- ROI Manager function of ImageJ was used.
- Setup not to include lesion or uneven signal area in ROI measurement area.
- Oval, Constrain circle, 5mm × 5 mm
- Pixels size 21.3

Methods

2. ***Comparison of images of collar and neck surface.***

- Measurement of the extent of signal loss by the interference of the collar portion of the protective clothing.

① Magnetom Skyra 3.0T was used only.

② Protective clothing made by Medical Aid (MG Vest CES) was used.

③ In case of wearing protective clothing (5 persons) and without wearing (5 persons), were imaged with both models.

④ Imaging cross sections were Coronal and Sagittal.

⑤ The *AutoAlign* was used to set the imaging section (3.0 T).

⑥ T2W TSE method was used.

Methods

2. *Comparison of images of collar and neck surface.*

⑦ Height and weight entered declared values.

⑧ ROI measurement area was set up the width of "30 mm in height × Phase FOV" from the lower end of the image.

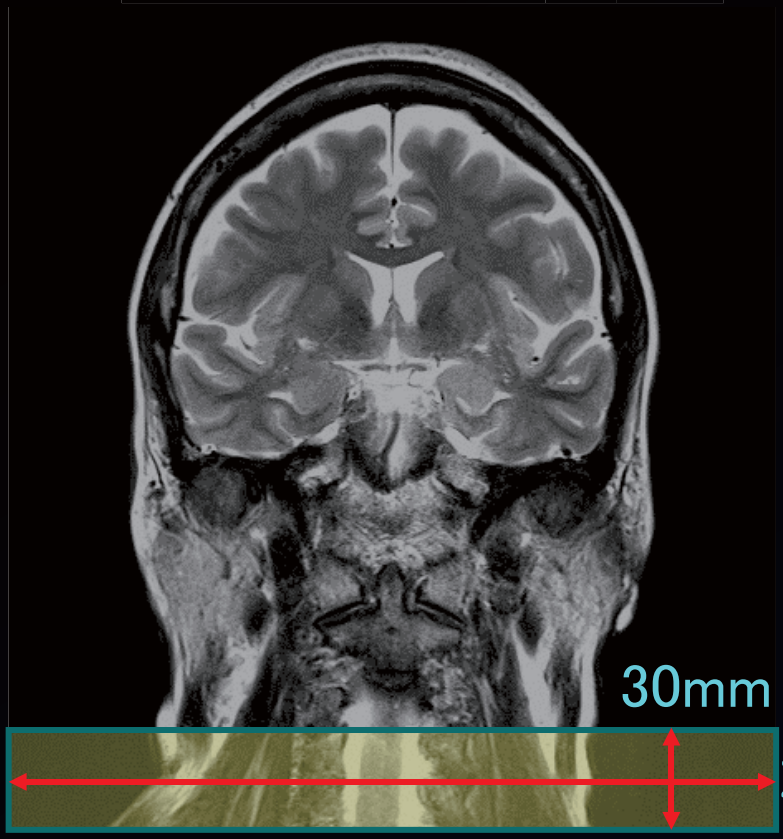
⑨ Image analysis software ImageJ was used.

⑩ Using the ROI Manager function of ImageJ, the MEAN value in all cross sections was extracted .

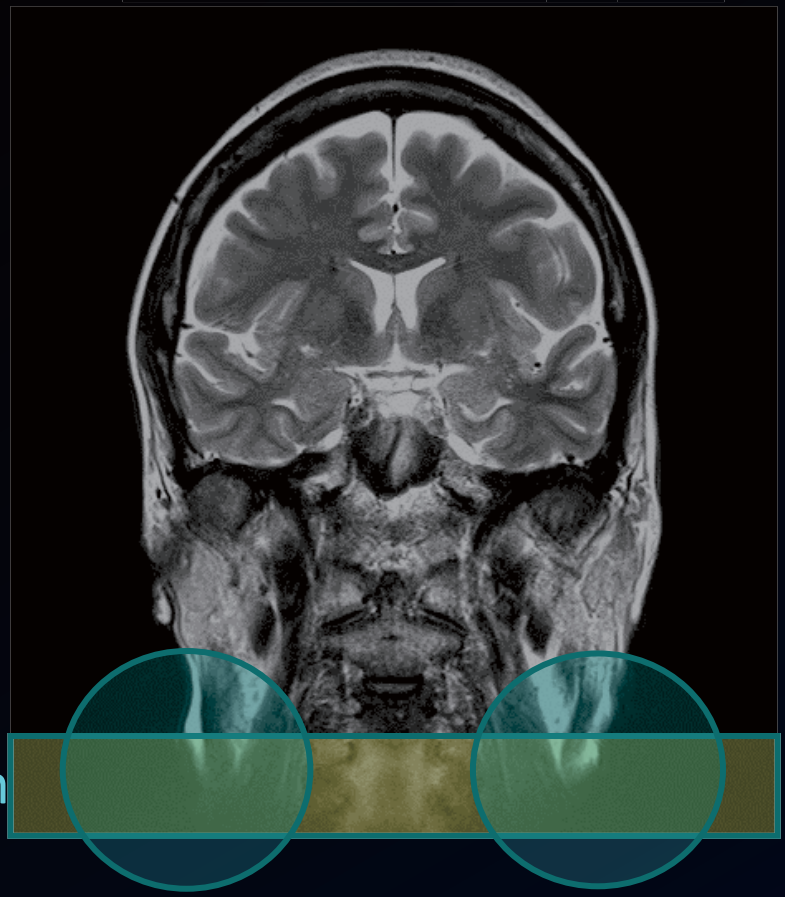
⑪ The decrease rate of the average signal value in each cross section image was determined.

Coronal View

Protective clothing（－）



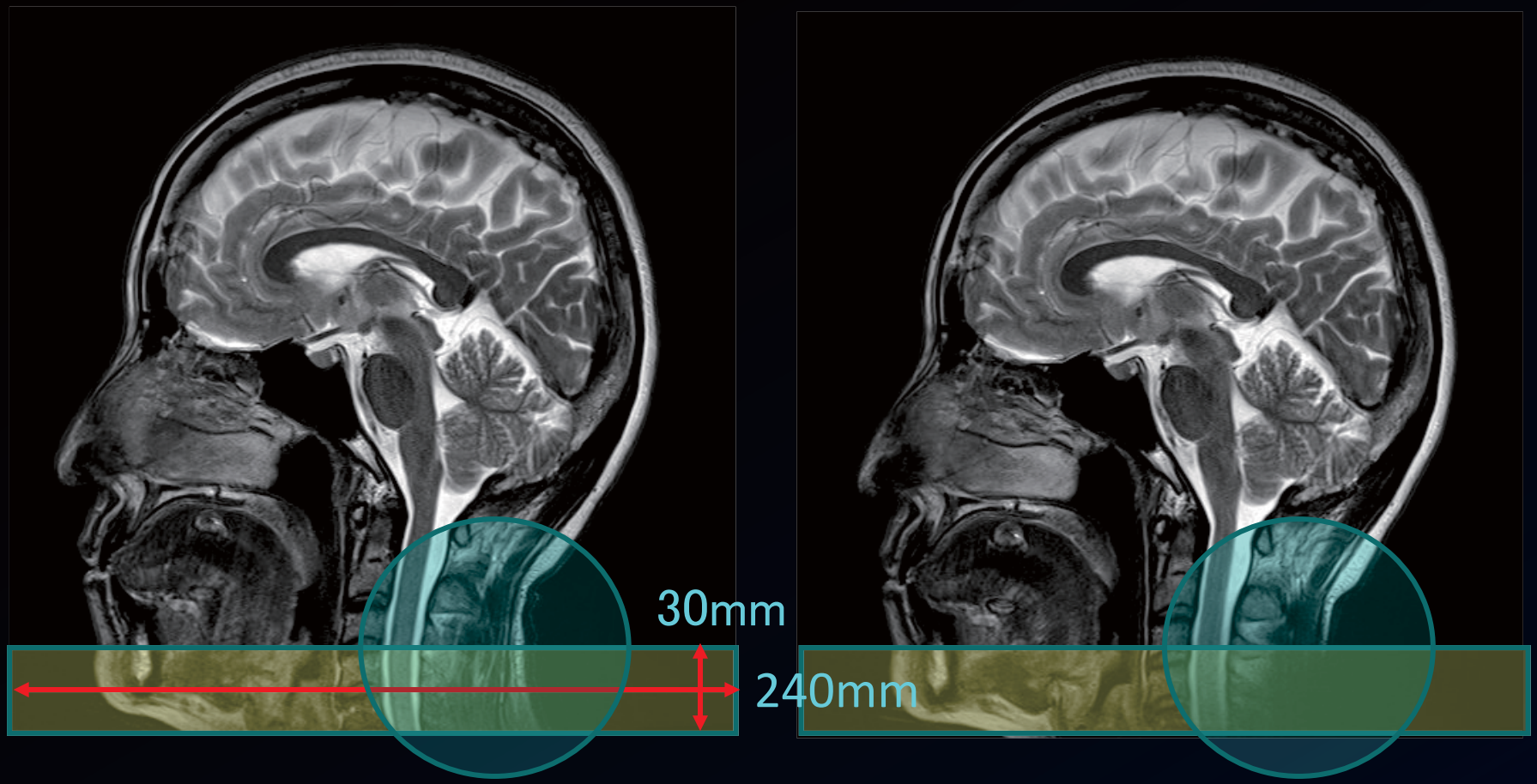
Protective clothing（＋）



Sagittal View

Protective clothing（－）

Protective clothing（＋）



Methods

3. Comparison of SAR with before and after imaging in B1+rms.

① Magnetom Skyra 3.0 T was used only.

② Protective clothing made by Medical Aid (MG Vest CES) was used.

③ In case of wearing protective clothing (5 persons) and without wearing (5 persons), were imaged with both models.

④ Height and weight entered declared values.

⑤ Imaging cross sections were Localizer, Axial, Coronal and Sagittal.

Methods

3. Comparison of SAR with before and after imaging in B1+rms.

⑥ The *AutoAlign* was used to set the imaging section (3.0 T).

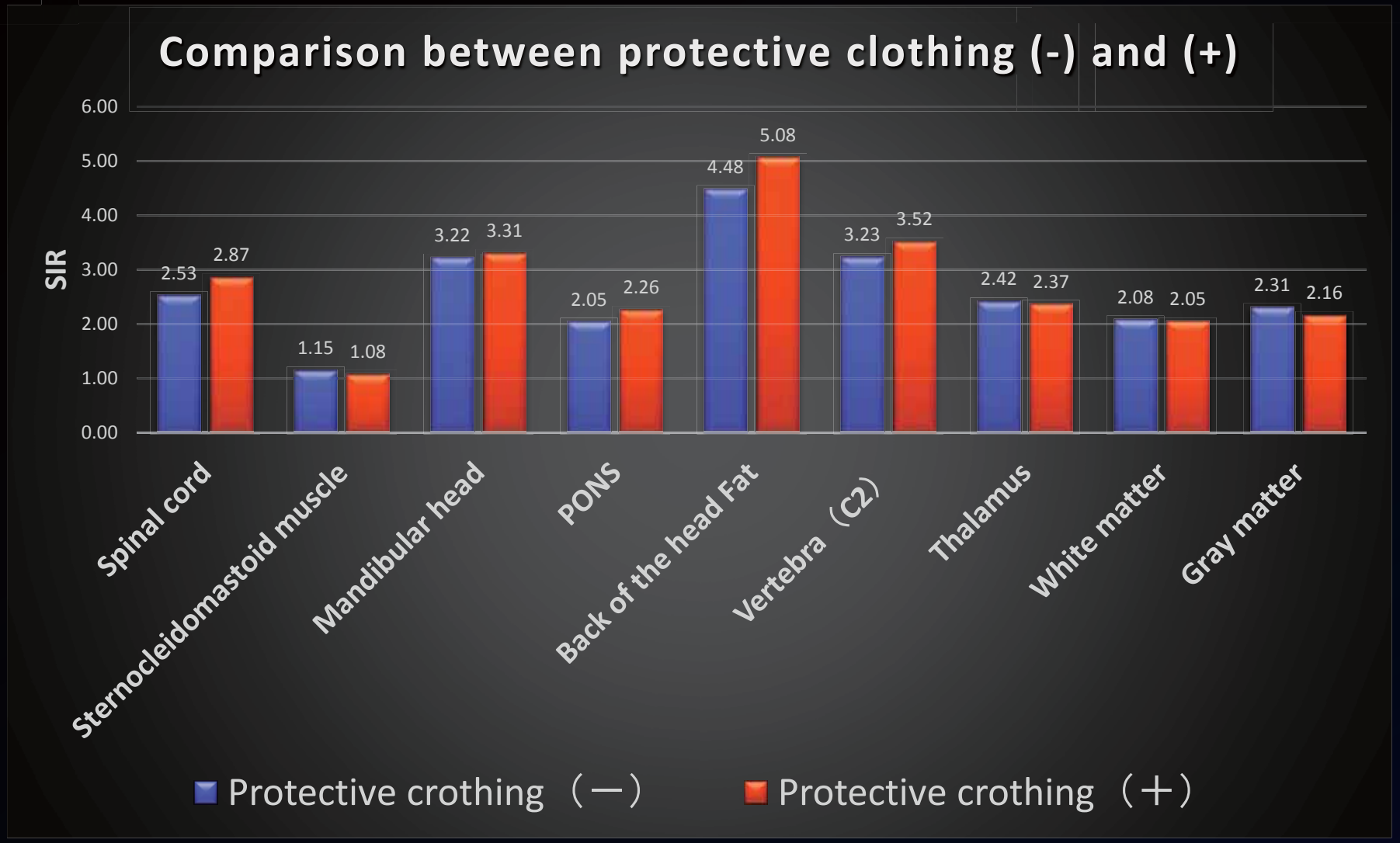
⑦ T2W TSE method was used.

⑧ SAR and B1+rms (Prediction value) displayed before and after imaging were measured.

⑨ The average rate of change in the presence or absence of protective clothing was determined in each of cross section.

Results

1. Measurement of changes in SIR of each tissue in the head region.



Discussion

1. Measurement of changes in SIR of each tissue in the head region.

Comparison between protective clothing (+) and (−)

No statistically significant difference (P＞0.05).

① The average SIR increased by 0.09% to 0.6%.
spinal cord, mandible head, pons, occipital fat, and second cervical vertebra

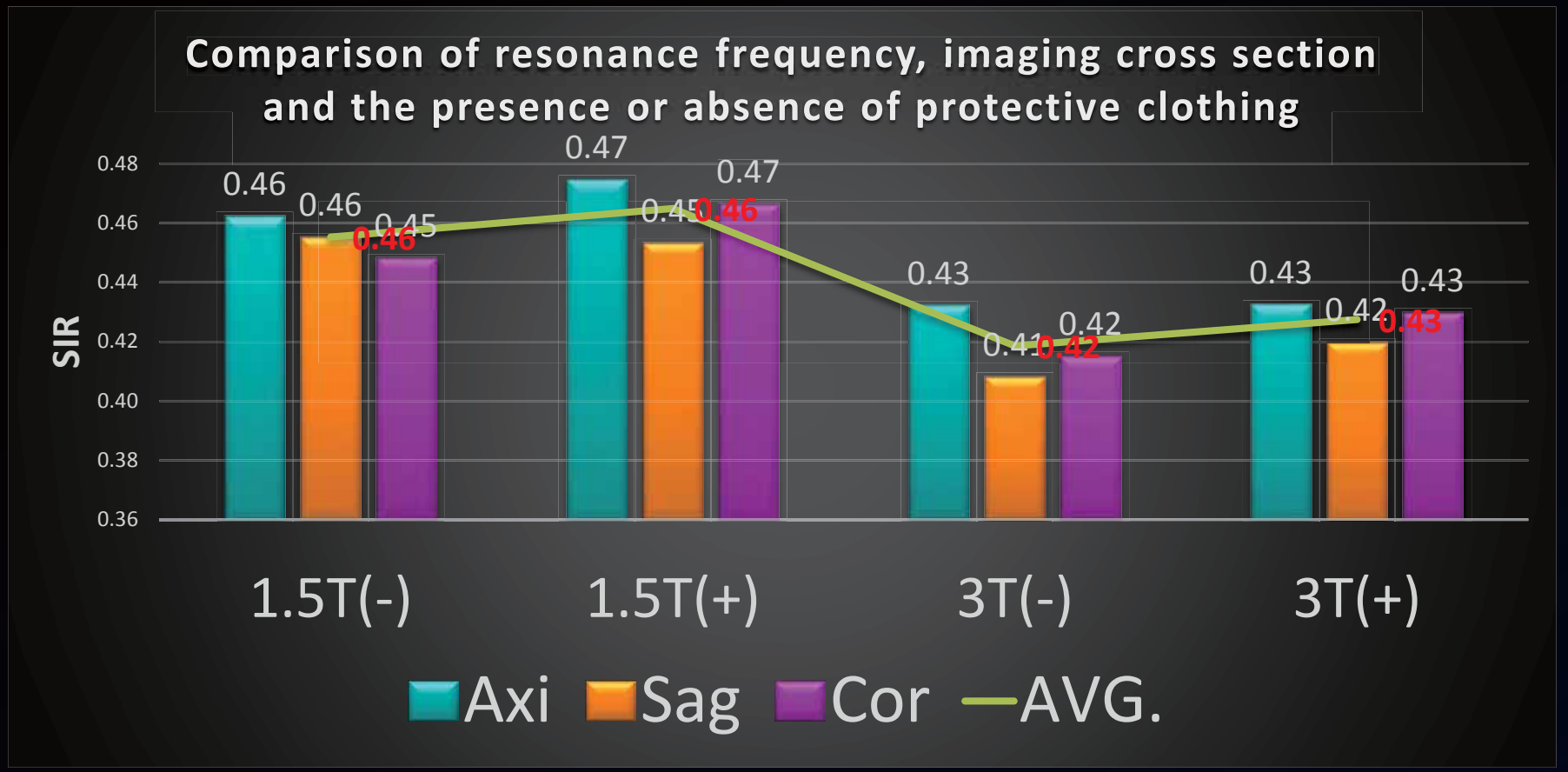
② The average SIR decreased by 0.03% to 0.15%.
sternocleidomastoid muscle, mandibular head, thalamus, deep cerebral deep white matter, cerebral gray matter

③ The SIR in occipital fat close to the collar of the protective clothing showed the most change.

④ The signals of the upper tissue from the inside of the head and the thalamus remained largely unchanged.

Results

1. Measurement of changes in SIR of each tissue in the head region.



Discussion

1. Measurement of changes in SIR of each tissue in the head region.

Comparison of resonance frequency, imaging cross section and the presence or absence of protective clothing

No statistically significant difference (P＞0.05).

① The visual evaluation in the presence or absence of protective clothing did not change.

② The visual evaluation did not change despite the difference in the resonance frequency.

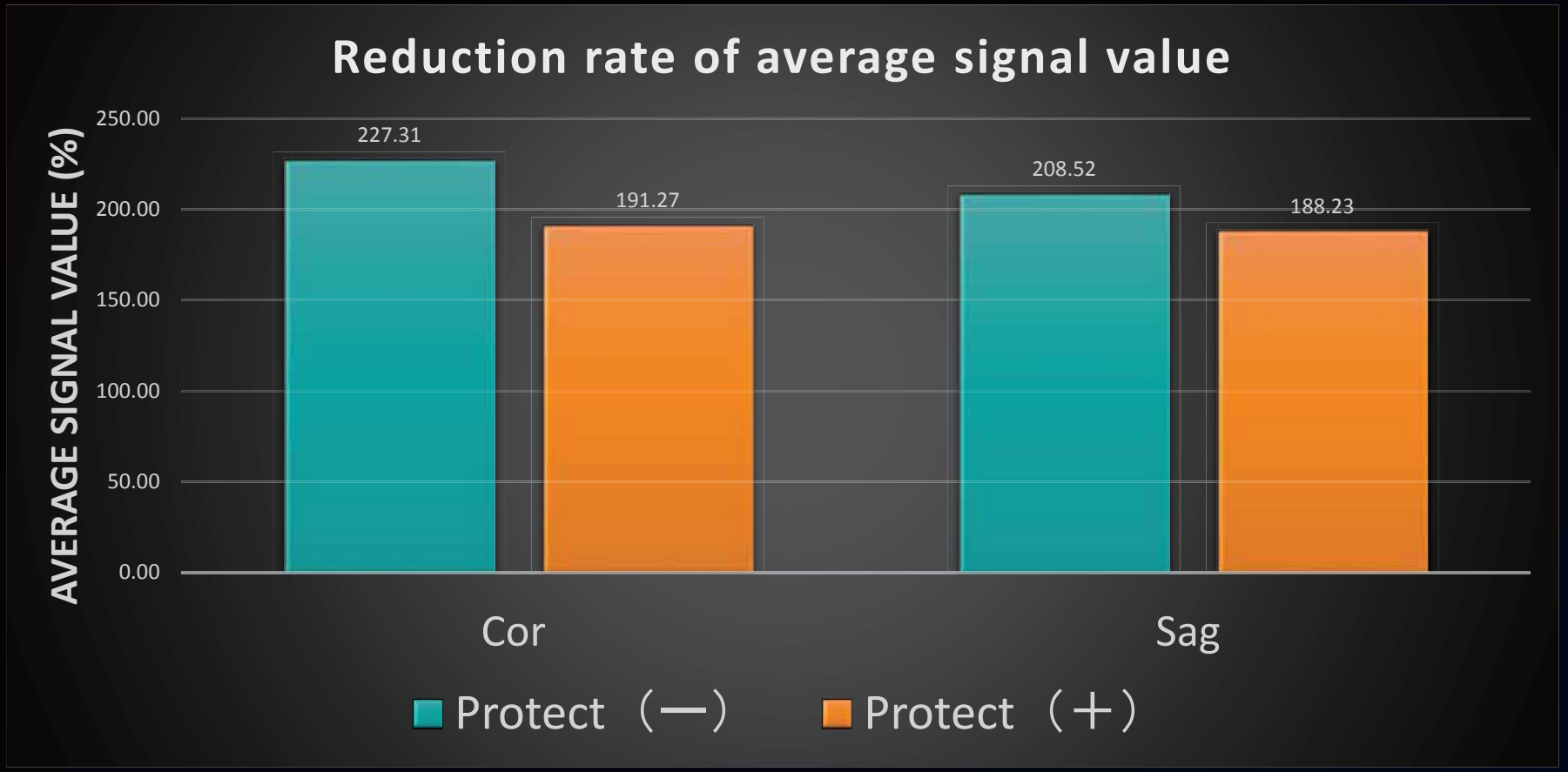
③ Axial cross section images were little affected by protective clothing.

④ The overall average SIR increased slightly.

⑤ Visual change of the images could not be recognized under various different conditions.

Results

2. *Comparison of images of collar and neck surface.*



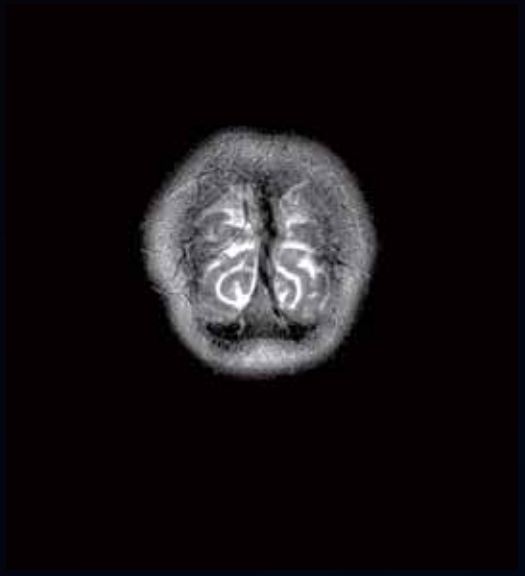
Results

2. *Comparison of images of collar and neck surface.*

Image Number	Mean Value of Protect(-)	Mean Value of Protect(+)	(Protect(+)/Protect(-)*100)-100(%)
1	40.62	24.88	-38.75
2	44.14	27.28	-38.20
3	48.05	30.05	-37.46
4	52.43	34.10	-34.96
5	56.48	38.68	-31.51
6	60.71	42.61	-29.82
7	64.17	46.06	-28.21
8	67.63	48.37	-28.48
9	75.68	50.88	-32.77
10	170.02	58.07	-65.84
11	265.80	63.86	-75.97
12	257.49	73.11	-71.61
13	261.41	88.97	-65.96
14	286.09	113.36	-60.38
15	300.80	139.65	-53.57
16	311.61	148.67	-52.29
17	295.81	158.89	-46.29
18	287.23	188.05	-34.53
19	257.53	201.78	-21.65
20	270.25	241.07	-10.80
21	260.40	237.48	-8.80
22	240.64	209.71	-12.86
23	216.33	201.66	-6.78
24	209.92	210.90	0.47
Avg.	183.39	111.59	-39.15

Protective clothing(－)

Protective clothing(+)



56years Female 38kg 148cm
Protective crothing : L Size

Discussion

2. ***Comparison of images of collar and neck surface.***

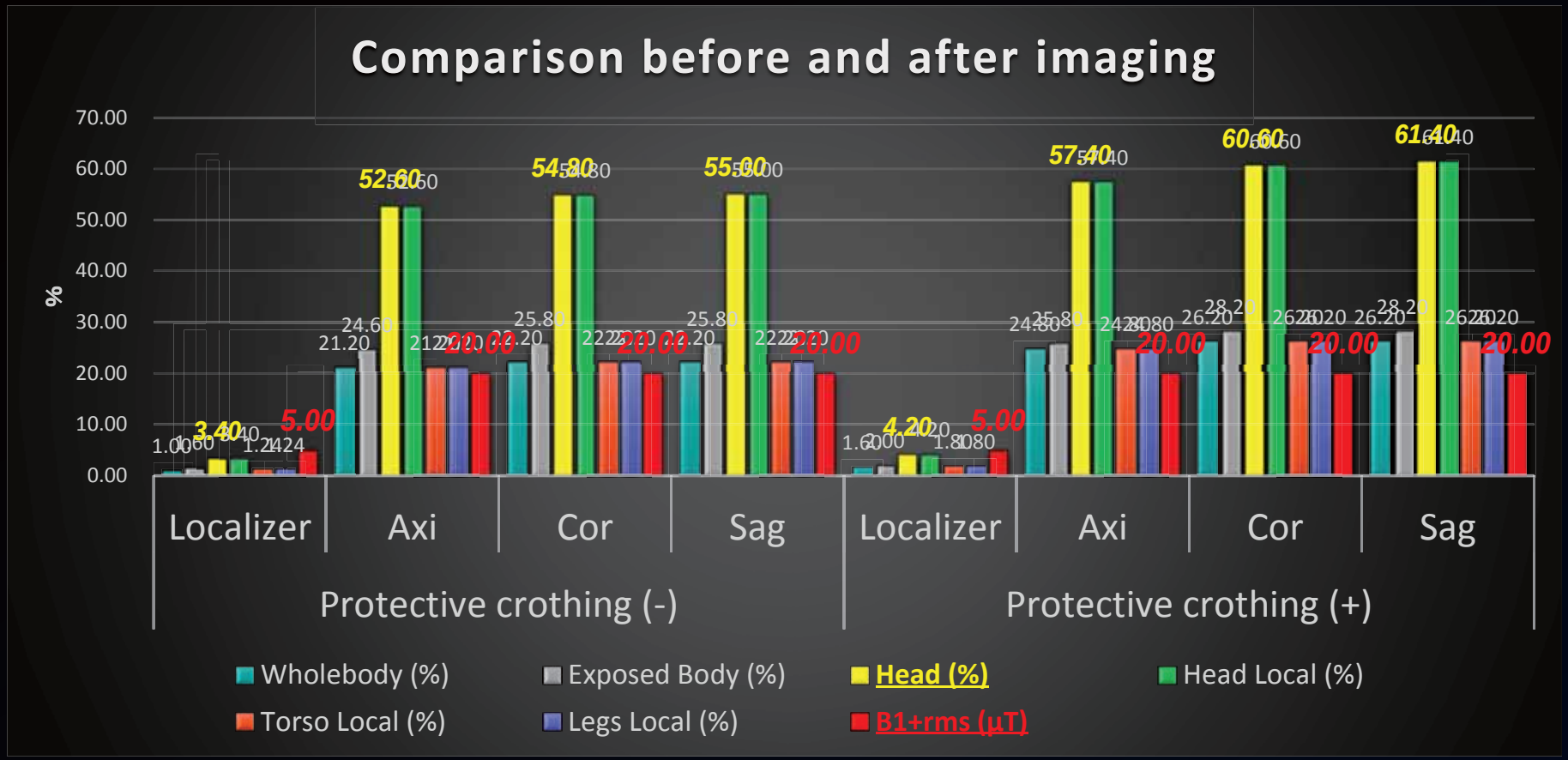
Reduction rate of average signal value

No statistically significant difference (P＞0.05).

① Cor cross section 36.04% attenuation ↓
② Sag cross section 20.29% attenuation ↓
③ Attenuated by an average of 28%. ↓
Cor is more susceptible than Sag.
Considered to be due to influence of the collar of the protective clothing from right and left in the Coronal cross section.
④ It is necessary to select suitable protective clothing for patients, especially for a small person and a person with a short neck.
⑤ The collar type closed with string in protective clothing prevents penetration of RF waves.

Results

3. Comparison of SAR with before and after imaging in B1+rms.



Discussion

3. Comparison of SAR with before and after imaging in B1+rms.

No statistically significant difference (P＞ 0.05).

By wearing protective clothing

- There was a discrepancy between the transmission power amount in the RF amplifier calculated from the input weight value and the actual reflected power amount, due to reflection and shielding effect of RF wave by protective clothing. Therefore, it is estimated that SAR increased as a result of an increase of the transmission power amount in the device.

- Consideration of reduction of SAR

  Extension of Repetition Time, reduction of Turbo factor, reduction of number of images etc.

Conclusion

- Electromagnetic wave protective clothing for capsule endoscope can provide a safe MRI examination to remove the risk of heat generation of the body metal.
- Electromagnetic wave protective clothing for capsule endoscope has there is no influence on image diagnosis in head MRI examination, and its usefulness is high.

“Thank you for your attention.”