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Investigation of buffer thickness for reducing artefacts from the table in CT examinations with extremities 3D imaging

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Disclosure of
Conflict of Interest (COI)

We have nothing to declare
for this study.

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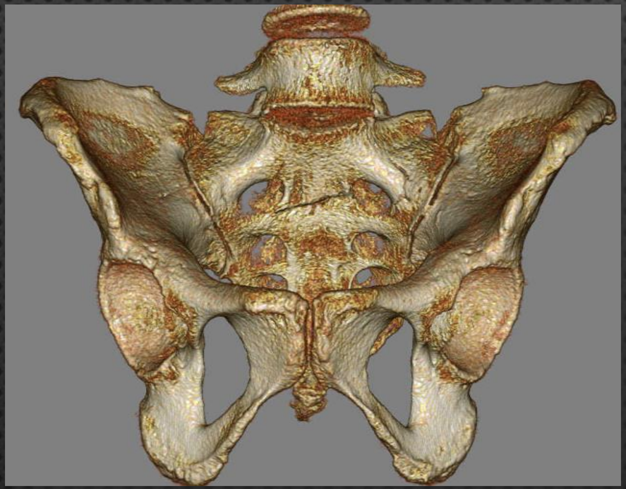
Background

CT volume data can be utilized to effortlessly generate MPR and VR images, which serve as beneficial resources for treatment selection and surgical support.




Background

It is well-established that during the creation of 3D hand bones through direct placement of fingers on a mat, bed mat artifacts are generated, thereby increasing the overall creation time.

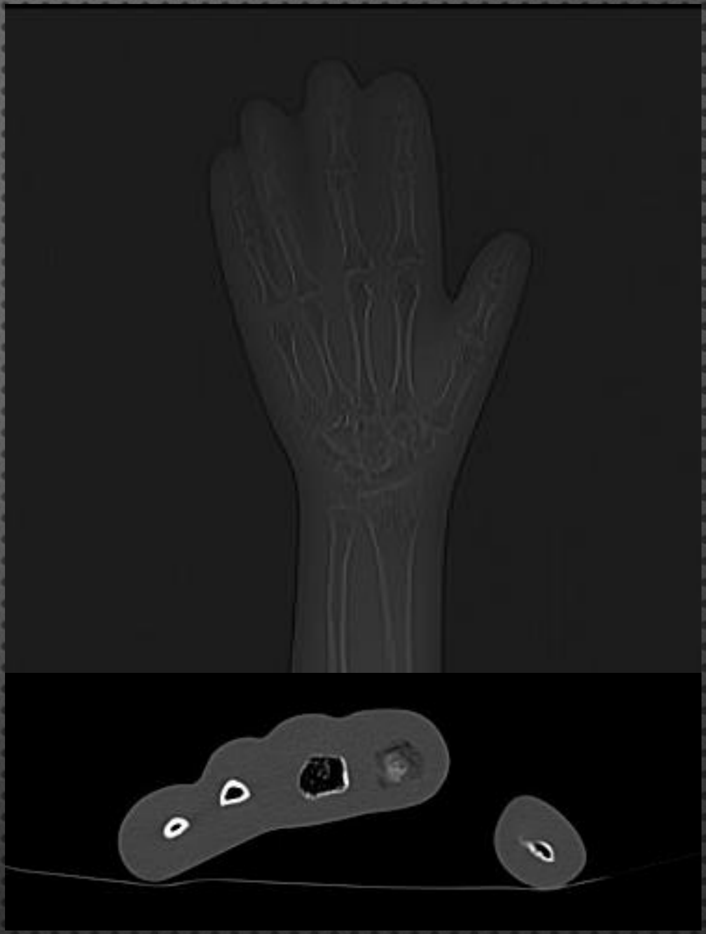
Purpose

The purpose of this study is to investigate the optimal thickness of the buffer material using at the 3D creation, in order to mitigate any artifact generation resulting from the separation of the hand from the CT table mat.

Materials

- CT System : Aquilion Prime SP/iEdition (Canon Medical Systems Co.)
- Subject : Forearm Human Body Phantom (Kyoto Kagaku Co.,Ltd.)
- Buffer : Styrofoam 1, 2, 3, 4, 5mm,and non-woven gauze for medical used
- 3D Workstation Ziostation2 Plus ver. 2.9.8.4

Method 1



Scan parameter

- Tube voltage 135 kVp
- Tube current 100 mA
- Rotation time 1.0 s
- Helical pitch 0.637
- Slice thickness 1.0 mm

3D reconstruction

- Reconstruction interval 0.5 mm
- FC30 AIDR3D mild
- Aice Bone mild , Post-processing Filter(+)
- Aice Bone standard , Post-processing Filter(+)

Method 2

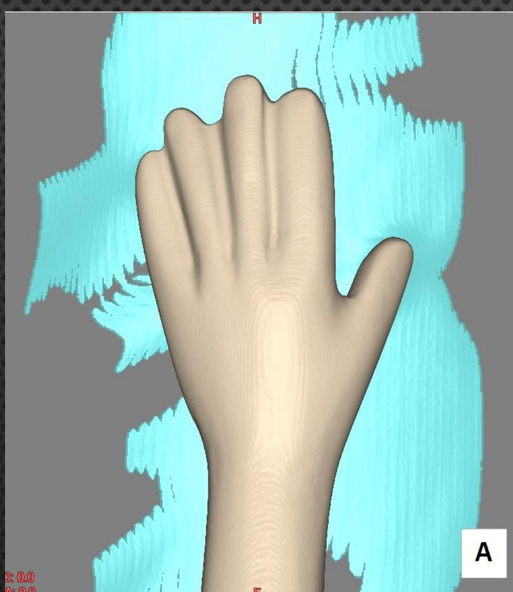
Positioning

- Placement of the phantom in the center of the CT
- The phantom's thumb and little finger were positioned on the CT table mat
- No buffer（None）, 1 piece of gauze（Gauze）, Styrofoam 1, 2, 3, 4, and 5 mm（1,2,3,4,5）were obtained for each 10 times scan

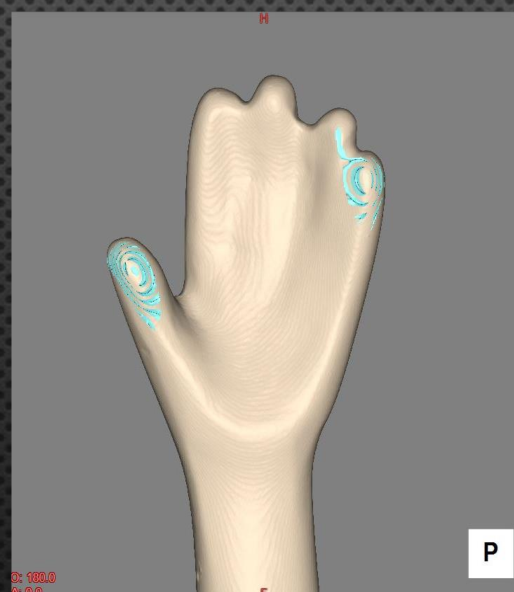
Method 3

Visualization score

- A radiology technologist with 7 and 9 years of experience qualitatively evaluated in this study.
- Artifacts were evaluated using a 3-point scale at the 0 or 100 threshold.



0 : Poor

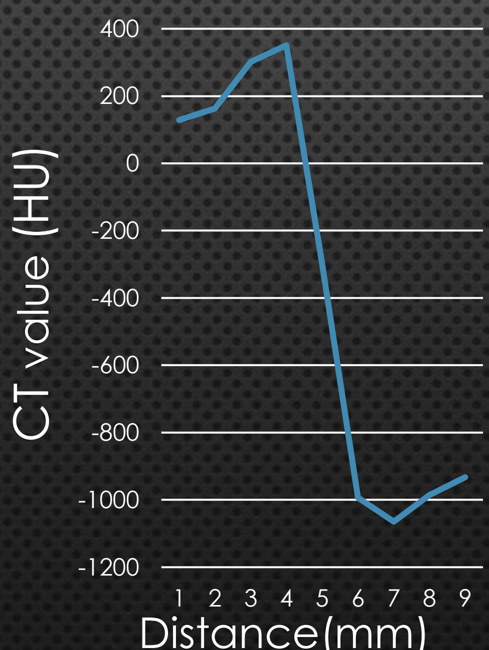


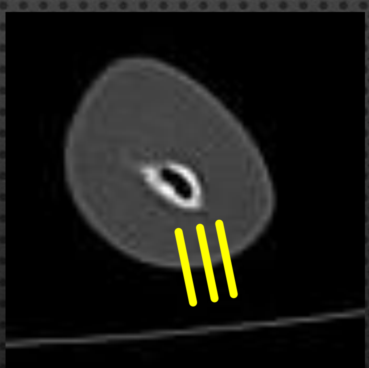
1 : Good

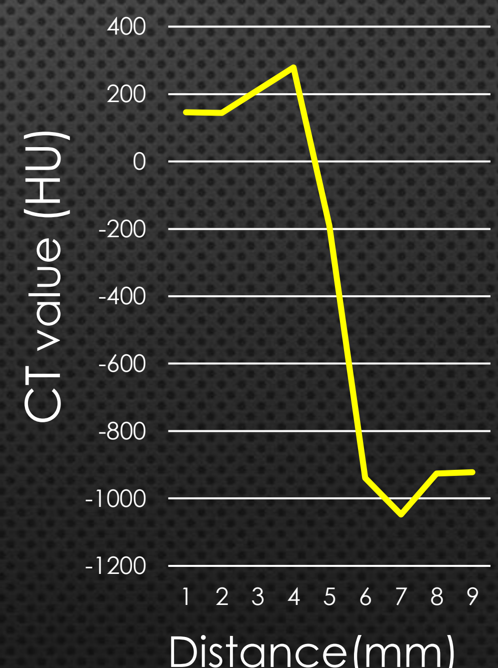
2 : Excellent

Method 4

- Place three ROIs on the same slice of both the unbuffered and 5mm buffered images
- Created profile curves
- Compared for the maximum CT values of phantom edge

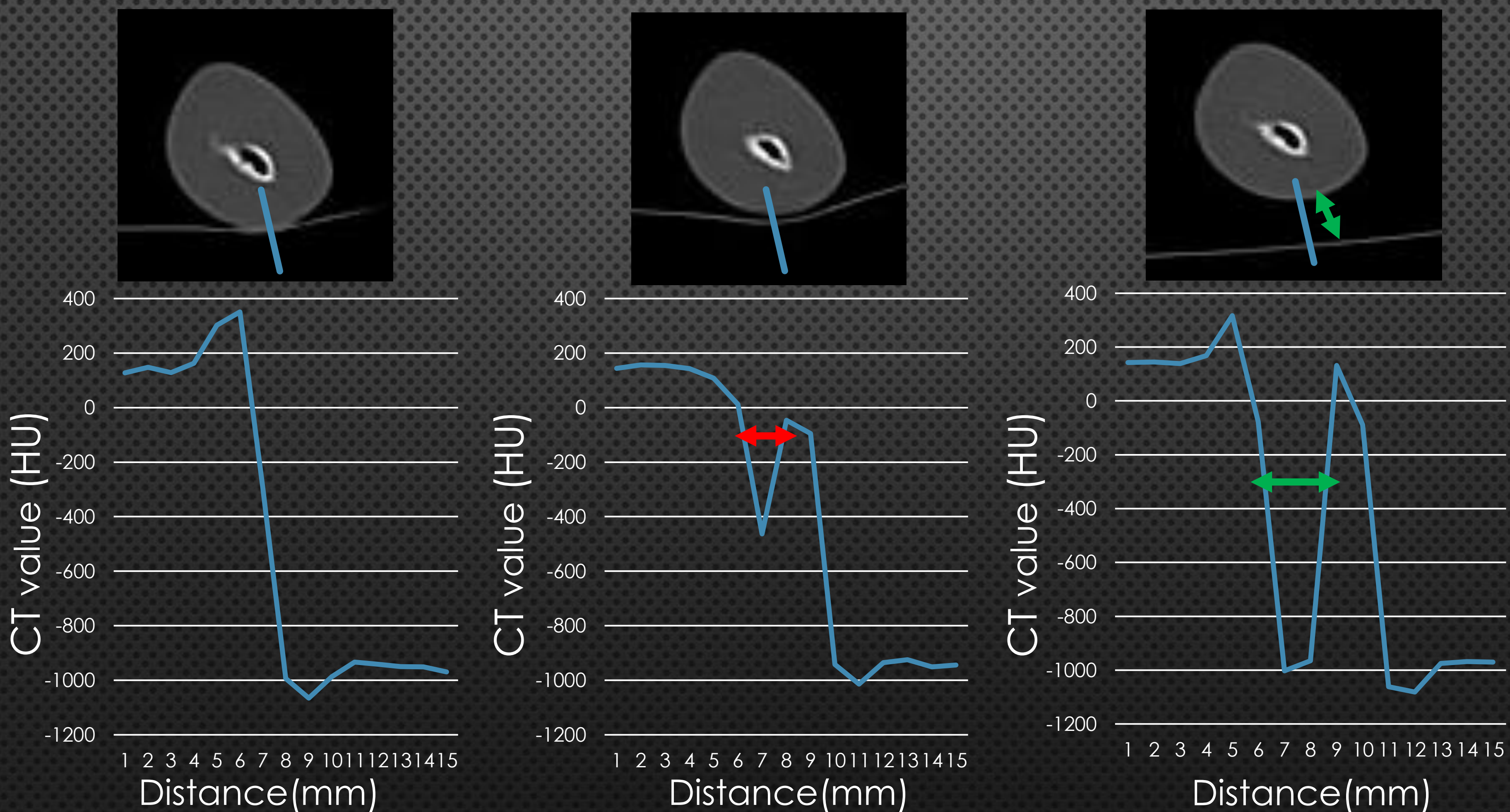






Method 5

Compared for the FWHM among no buffer, gauze, buffer 1mm



Method 6

Statistical analysis

- EZR Ver.1.55

  Kruskal-Wallis test or Mann–Whitney U test

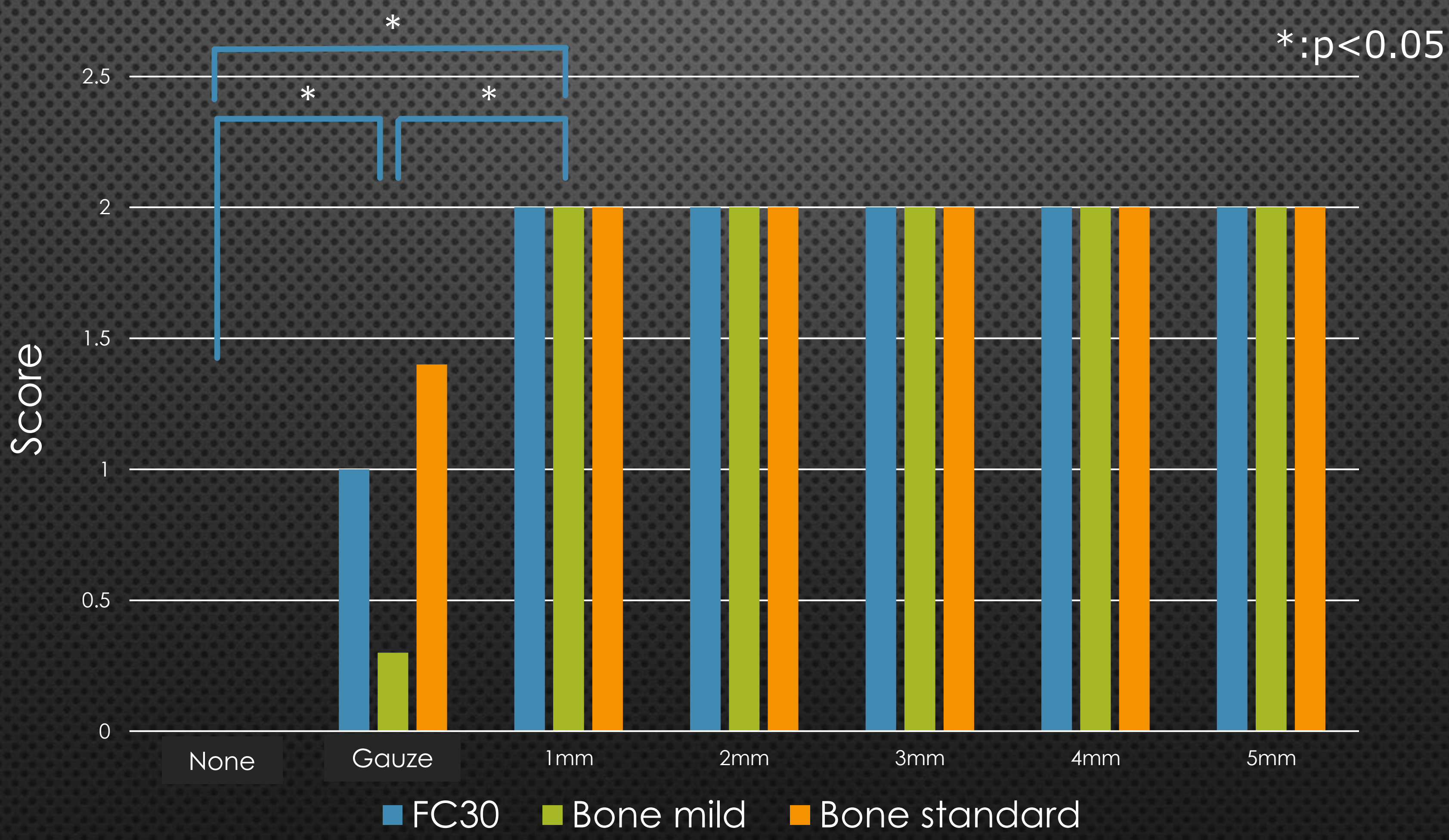
- Differences were considered statistically significant at $p < 0.05$

- Cohen's kappa coefficient

Results 1a

Visualization score　　k＝0.78

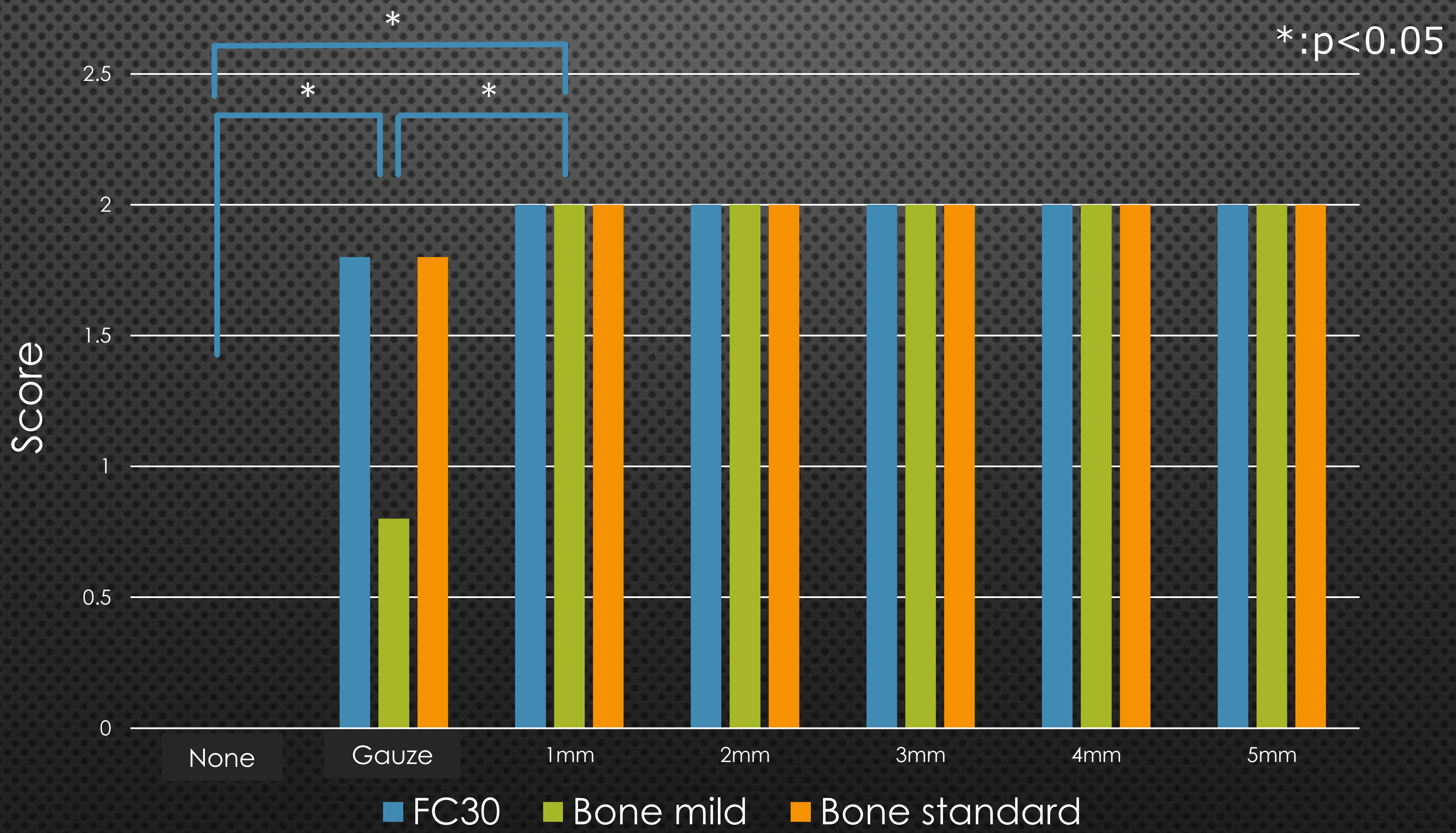
Threshold ： 0



Results 1b

Visualization score　k＝0.81

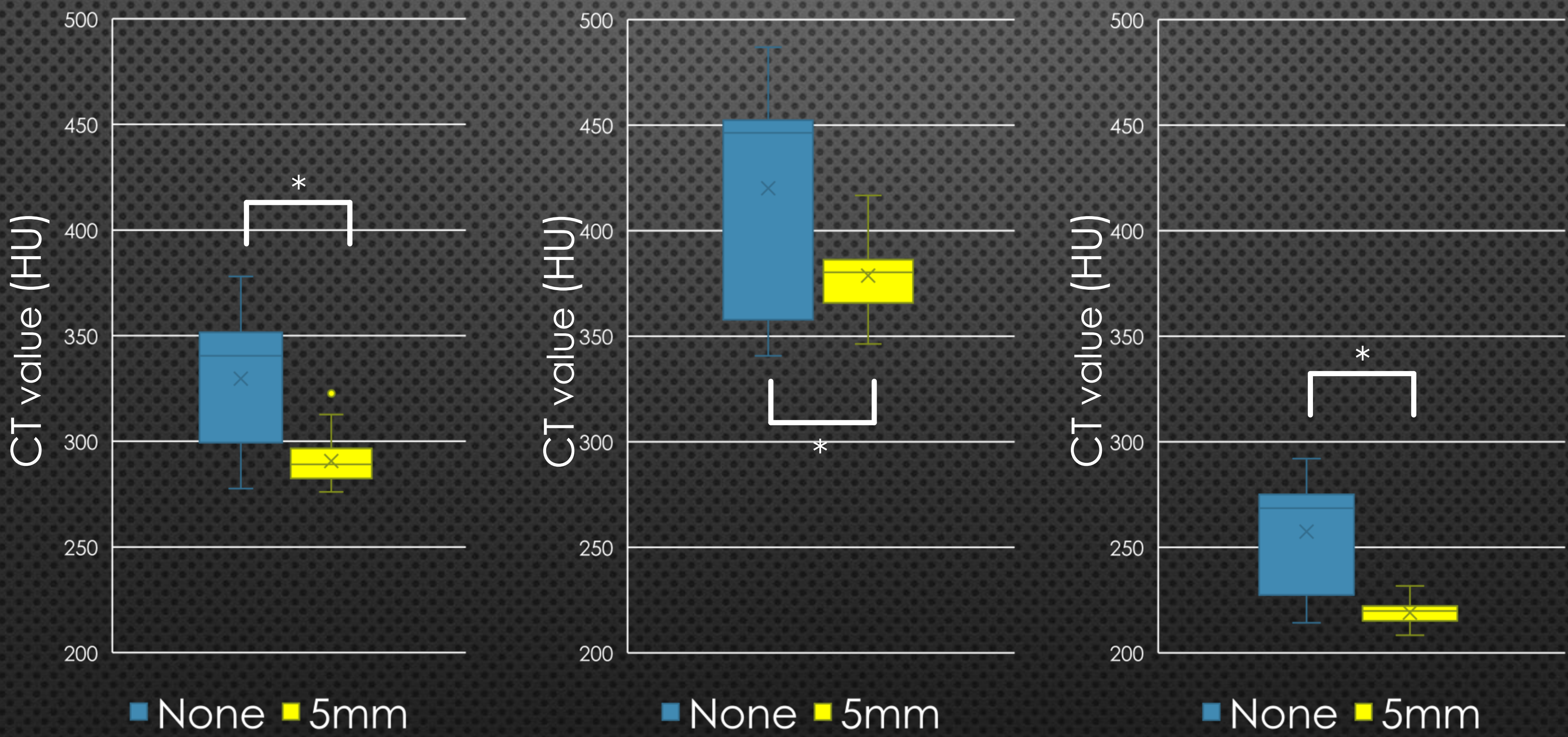
Threshold：100



Results 2

Compared for the maximum CT values of phantom edges

*:p<0.05



FC30 **Bone mild** **Bone standard**

Results 3

Compared for the FWHM

	Gauze	1mm	p value
FC30	0.77(0.71-0.85)	1.08(1.07-1.18)	< 0.05
Bone mild	0.72(0.63-0.81)	1.00(0.99-1.08)	< 0.05
Bone standard	0.70(0.41-0.82)	1.10(1.04-1.16)	< 0.05

Discussion 1

- Maximum CT values were significantly higher without buffer compared to 5 mm buffer, therefore we have a first study to investigate the this artifact.

- The CT table mat is causing in this artifacts unsuitable for 3D creation, although the reason for this artifact is unclear.

Discussion 2

- The comparison of FWHM at gauze and 1 mm styrofoam indicates that gauze is significantly narrower, therefore visualization score may be decreased in gauze.

- We think that gauze is an inadequate buffer material, therefore a buffer that is 1 mm or larger is likely to be more effective at separating the object of interest from the surrounding material, which would make it easier to create a 3D model.

Limitation

- Firstly, our investigation was a phantom study and only wrist protocol.
- Secondly, we performed our study using a single CT scanner model obtained from a single vendor.
- Lastly, the thickness of the gauze is unknown.

Conclusion

By inserting a buffer material with a thickness of at least 1mm between the hand and the CT table mat at creating 3D imaging, the separation of the hand and the CT table mat can be achieved easier for regardless of the conditions.