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Influence of couch position on the behavior of the automatic tube current modulation equipped with the automatic couch height positioning compensation mechanism during pediatric thoracoabdominal CT scan

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Disclosure of Conflict of Interest (COI)

We have nothing to declare for this study.

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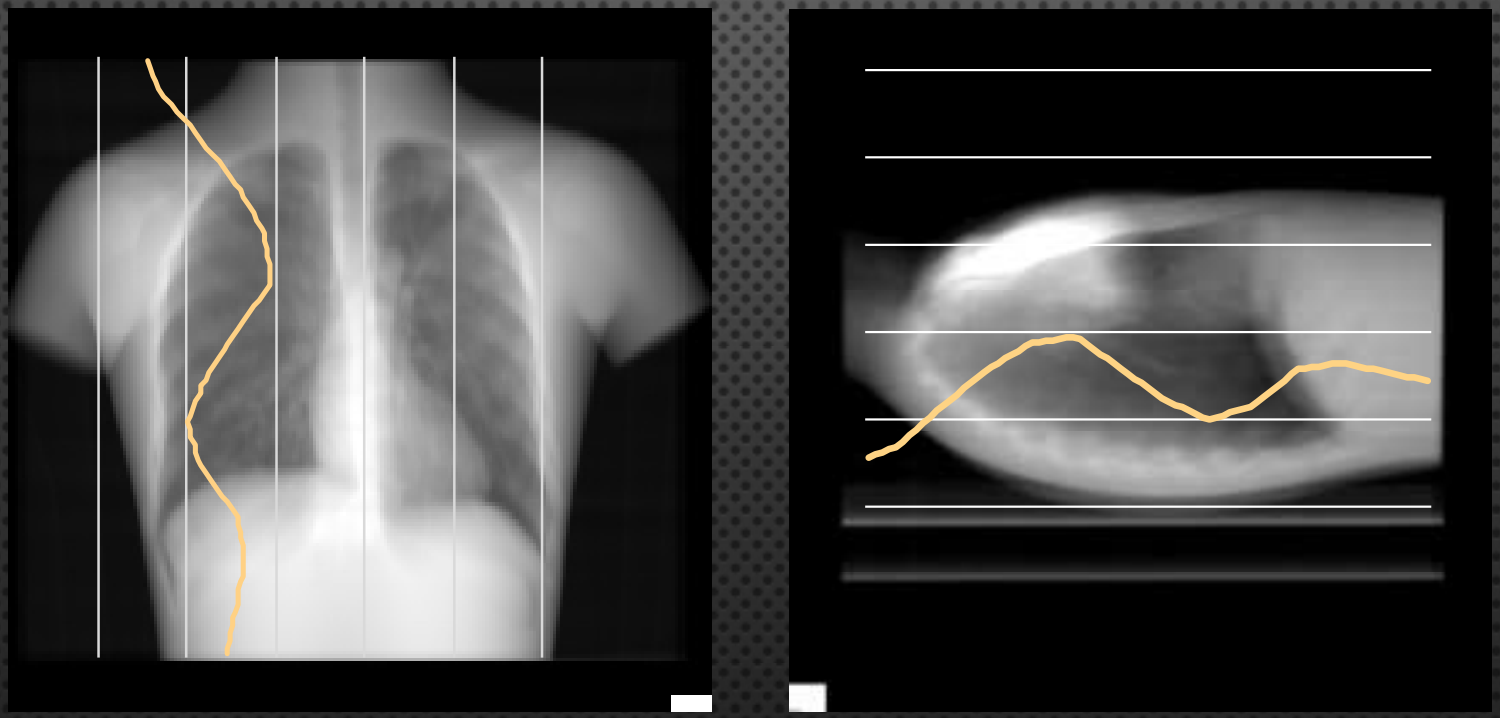
Background

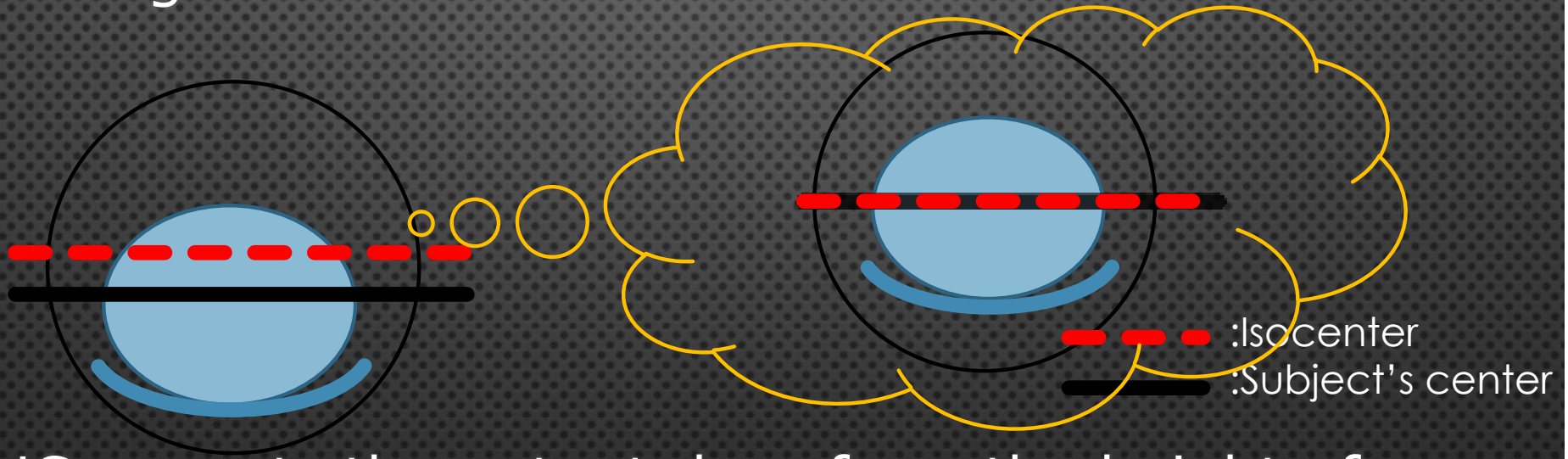
Computed tomography automatic exposure control (CT-AEC) is the exposure dose reduction technique that modulates the tube current according to the size of the patient.



CT-AEC is affected for the table height, because the tube current is determined for the scout image.

Background

Recent CT scanner is equipped with an " auto couch height positioning compensation (AHC) " that optimizes the exposure dose regardless of the height of the bed.



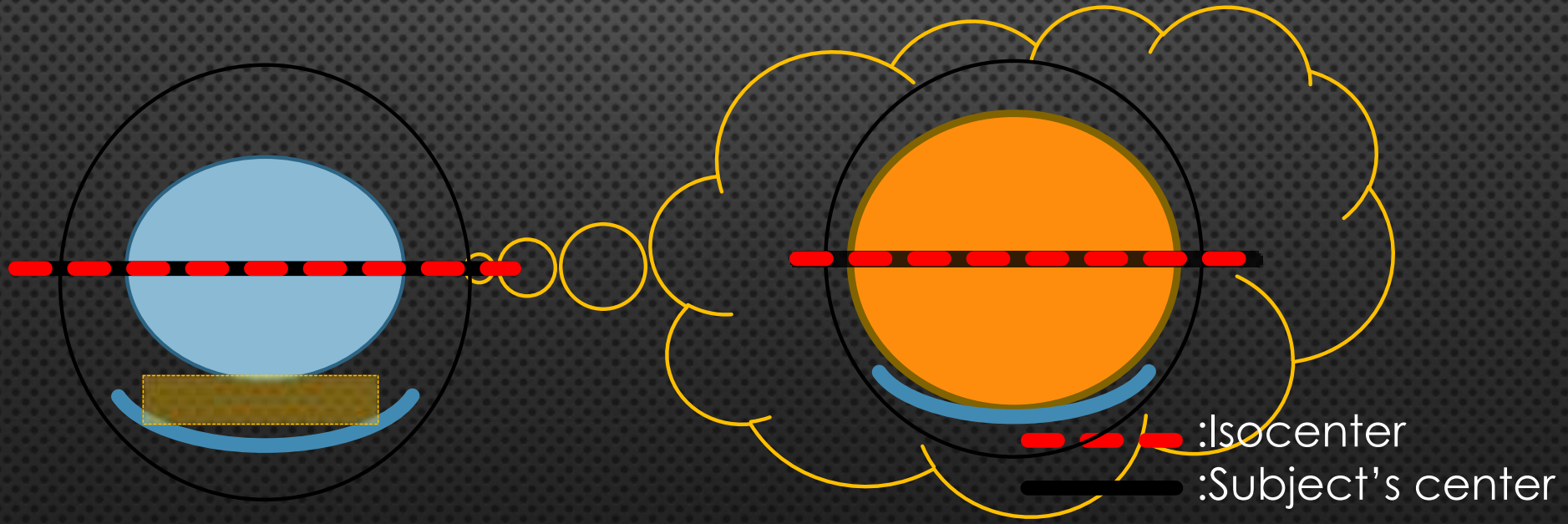
AHC corrects the output dose from the height of the CT gantry center, the table height set by the operator, and the estimated radius of the water equivalent thickness from the scout image.

Zhang D, Ayala R. Auto couch height positioning compensation–making SURE exposure a smarter dose reduction tool. Toshiba America Medical Systems. 2014;CTWP12271US:1–8.

Background

When using the spacers and keeping the phantom height constant, the exposure dose was found to increase with increasing thickness of the spacer.

We think that CT-AEC with AHC may have overestimated the thickness of the subject.



Fujiwara Y, et al. Evaluation of overexposure risk when there is a space between the subject and the couch in computed tomography: a phantom study. Radiol Phys Technol. 2024;17(2):561-568. doi:10.1007/s12194-024-00804-y

Background

In pediatric examinations, fixtures are utilized to prevent body movement.

The use of fixtures creates a gap between the bed and the subject, potentially leading to excessive radiation exposure due to AHC.

Purpose

The purpose of this study is to evaluate the when employing CT-AEC with AHC during the insertion of the patient fixation device in pediatric CT examinations.

Materials

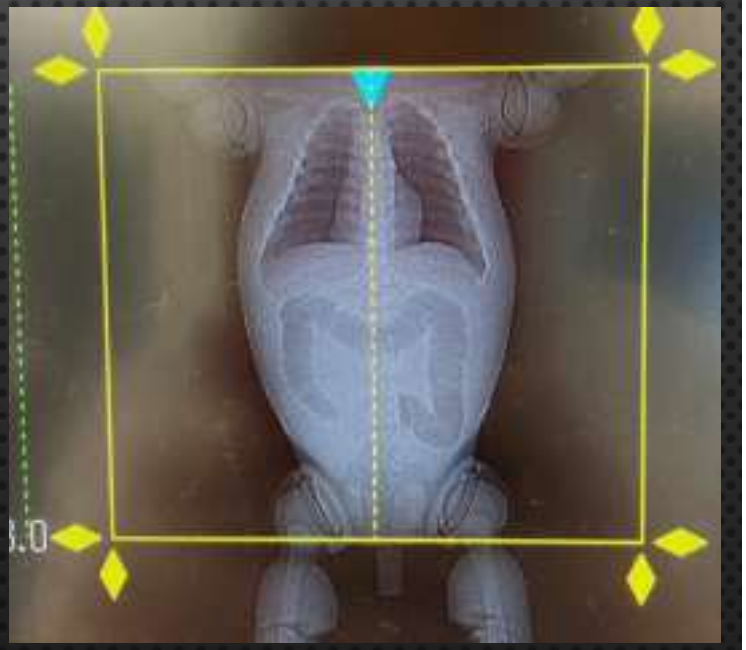
- Aquilion Prime SP/iEdition (Canon Medical Systems Co.)
- PH-50B Newbone Whole Body Phantom PBU-80 (Kyoto Kagaku Co., Ltd.)
- Rollbord（SAMARIT）：CTValue -890 HU, Thickness 24mm

Method （Scan parameter ）

Number of Scan	8
Scout direction	Anterior-to-Posterior
Tube voltage[kV]	80
FOV[mm]	320
Set SD value	18(FC03, 5.0mm)
Maximum current[mA]	350
Minimum current[mA]	10
Pitch factor	1.388
Rotation time[s/rot]	0.35
Detector row[mm]	0.5 × 80
Slice thickness[mm]	5.0
Scan Length[mm]	213

Method (Positioning)

- Placement of the phantom in the center of CT gantry.
- The phantom was secured on a custom-made fixture, both hands were elevated, and imaging was performed from the clavicle to the ischial tuberosity.

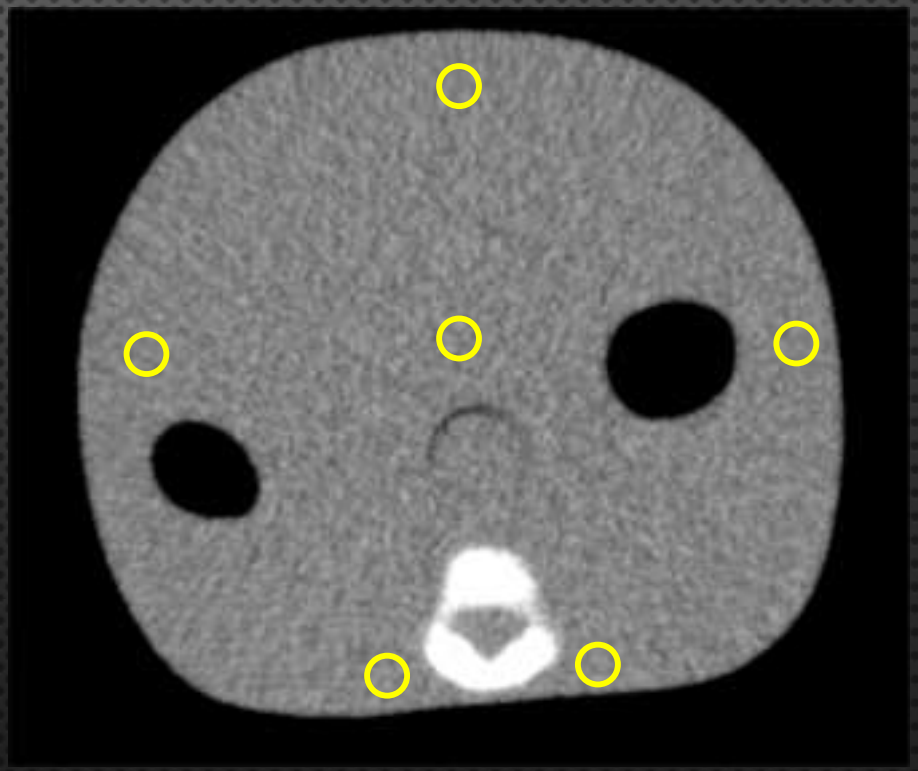


Method （Exposure dose)

Computed tomography dose index volume （CTDIvol ） and Dose length product （DLP) values were obtained from the CT console.

Method (Image analysis)

Standard deviations (SD) were calculated from six regions of interest (ROIs) at the same level in the chest and abdomen axial images.



Method （Statistical analysis)

- EZR Ver.1.55

  Mann–Whitney U test

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

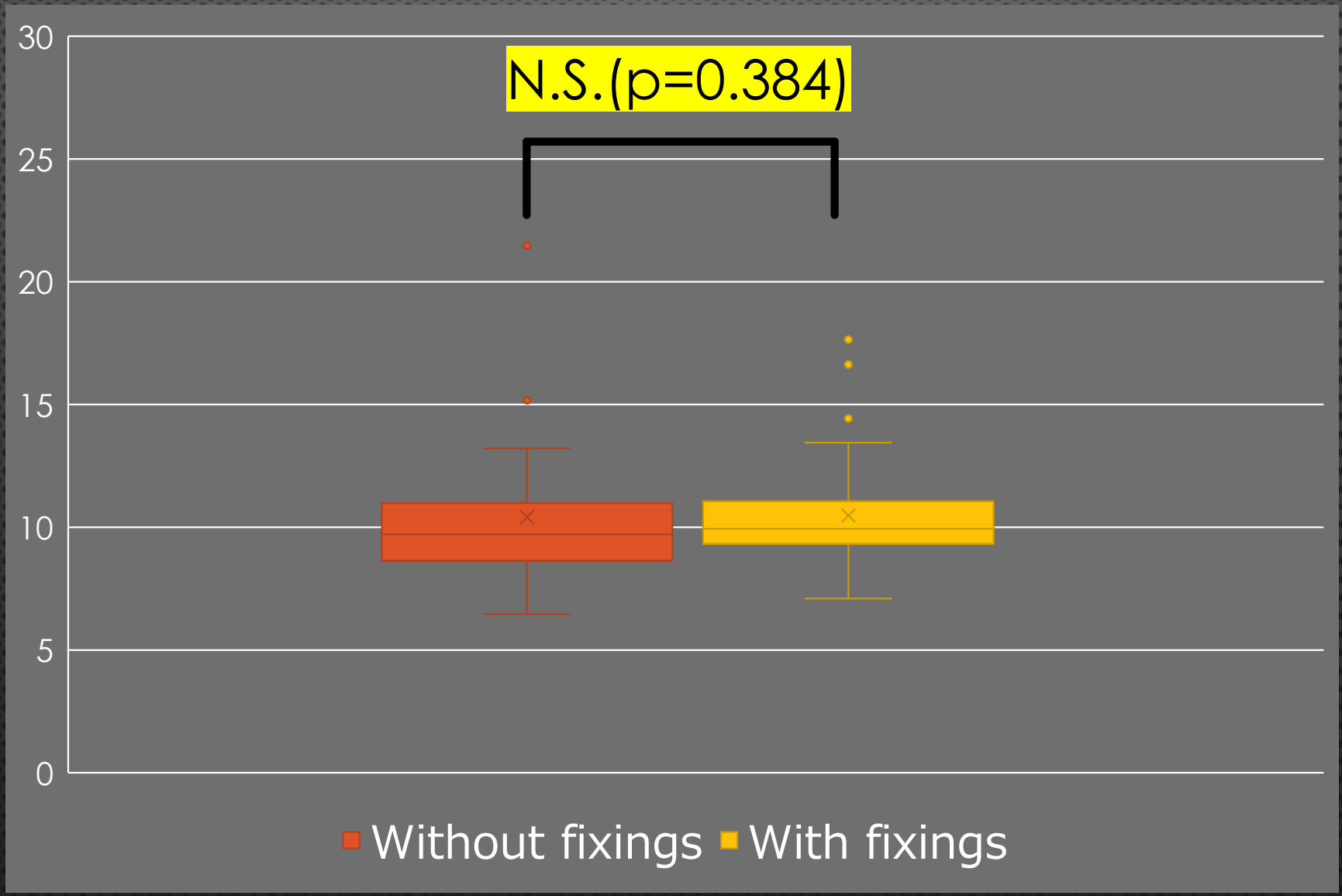
Bone Marrow Transplantation 2013: 48, 452–458

Results1 (Mean CTDIvol,DLP)

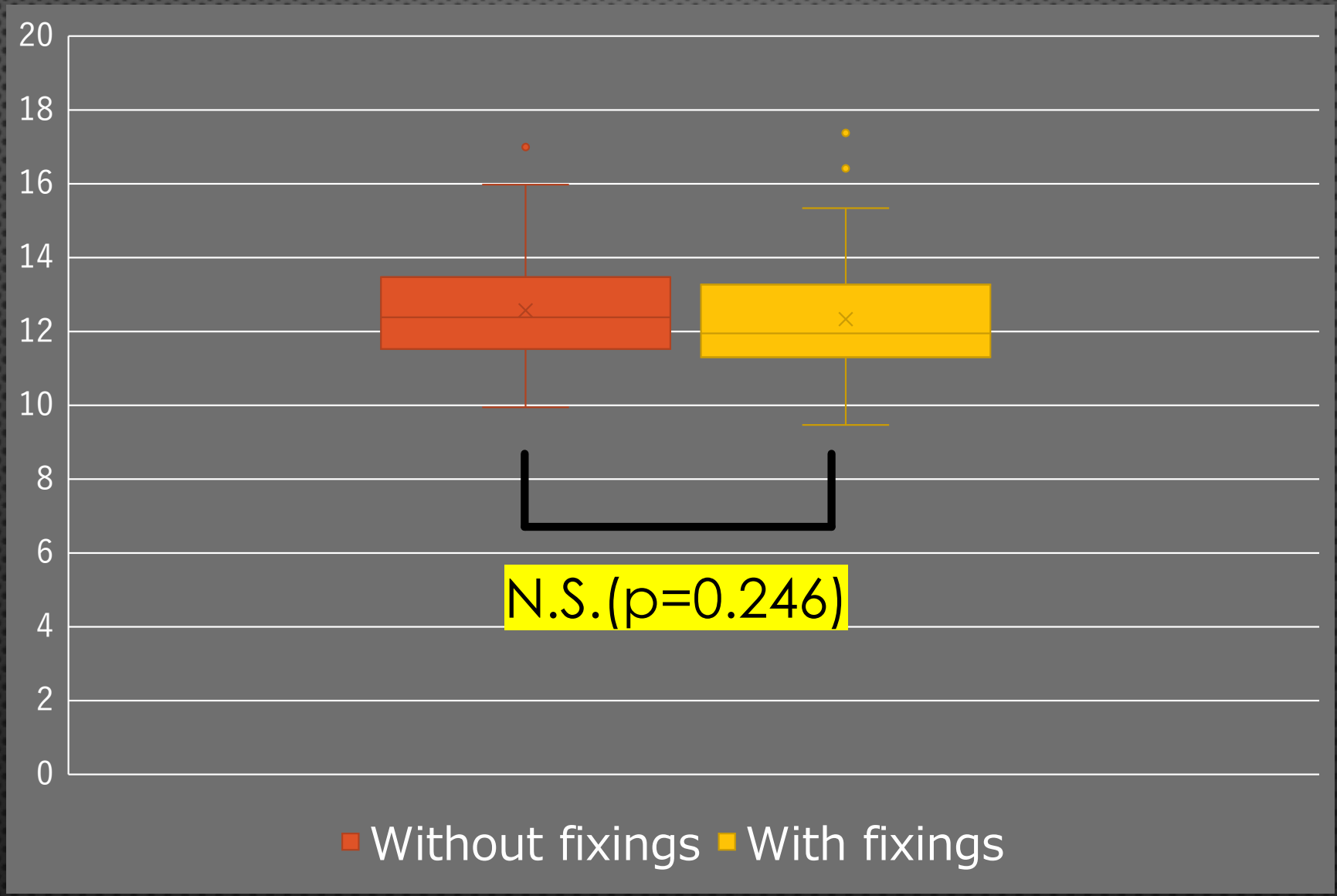
	Without fixings	With fixings	*P* value
CTDIvol	0.975(0.9-1.025)	1.275(1.275-1.3)	<0.05
DLP	27.2(25.9-28.0)	35.15(34.6-35.65)	<0.05

Data are presented as median and interquartile range (25the75th percentile).

Results2a (SD of the chest image)



Results2b (SD of the abdomen image)



Discussion

- Both CTDI and DLP showed an approximately 30% increase.
- The results were consistent with previous study, suggesting a potential influence of the AHC.

Discussion

- As air-containing chest and abdomen may yield different results, SD was measured separately for the pediatric chest and abdomen images.
- In the present study, no significant difference in SD was observed with or without fixtures.
- The small sample size and low output dose may have hindered the detection of SD variations with the current measurement method.

Limitation

- This correction mechanism is exclusive to Canon Medical Systems.
- This study was conducted at a single facility.
- This study is based on phantom measurements.
- The absorbed doses in tissues were not experimentally measured.

Conclusion

- In this study, no overexposure dose was identified when employing CT-AEC with AHC during the insertion of the patient fixation device.
- In pediatric CT examinations, caution should be exercised regarding overexposure when using CT-AEC with AHC, when placing the patient fixation device or other objects between the patient and the CT couch, as this may result in overexposure dose.