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UTILIZING A RADIOLOGY-BASED INFORMATICS SYSTEM TO IMPACT CLINICAL PRACTICE: A STUDY TO IMPROVE AND TRACK PATIENT ALIGNMENT IN COMPUTED TOMOGRAPHY

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INTRODUCTION

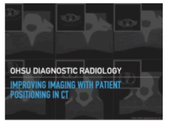
Ideal use of Computed Tomography (CT) imaging systems relies on accurate patient positioning. Suboptimal alignment degrades the efficacy of tube current modulation (TCM) algorithms and bowtie filters. Large patient offsets have been shown to over-filter the beam and produce current increases due to spurious TCM readings. These lead to losses in image quality and potential increases in radiation dose[1,2]. A Quality Improvement (QI) approach is presented aimed at mitigating the inaccuracies of patient alignment at our facility through an educational initiative. This study employs a radiology-based informatics system to more efficiently and accurately evaluate the progress of the educational initiative.

AIMS

1. Assess the efficacy of a broad educational initiative in improving the accuracy of CT alignment.
2. Determine if the radiology-based informatics system employed in the study is effective in QI projects at our facility.

METHODS

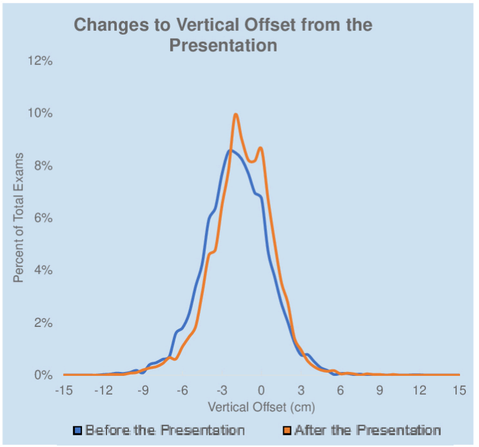
- Baseline data of overall percent accuracy and peer ranking was acquired from the calendar year before as a reference.
- A qualified medical physicist instructed CT technologists at our facility via a presentation on the deleterious effects of misalignment and methods to improve patient positioning.



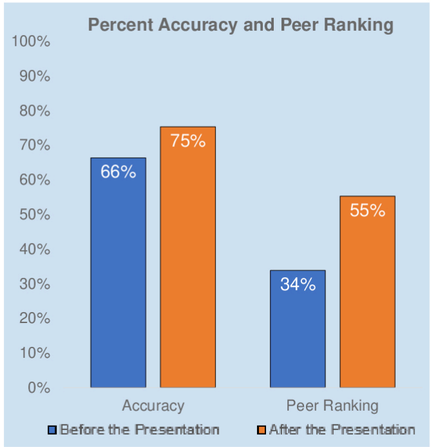
- Scout images were analyzed by the software program to measure directional displacements from isocenter.
- Efficacy of the presentation was evaluated according to shifts in percent accuracy (fraction of exams within 3 cm of isocenter vertically), peer ranking comparisons, and average vertical offset from isocenter.
- $CTDI_{Vol}$ and SSDE were utilized to evaluate radiation dose changes in the context of patient alignment shifts.
- Statistical analysis of average offsets and dose changes was performed using a two-tailed t-test with a bi-modal distribution.

RESULTS

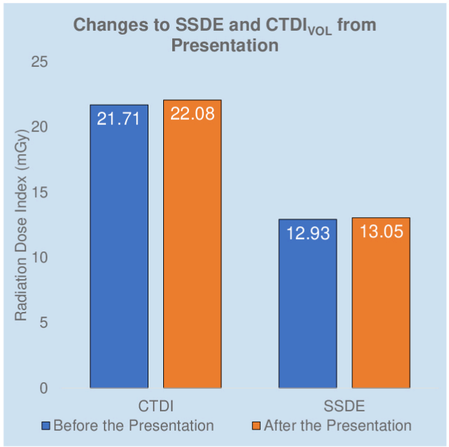
- Vertical alignment increased toward isocenter by 0.49 cm on average following the presentation ($p < 0.0001$).
- Lateral alignment mean improved 0.02 cm towards isocenter, and was not a significant increase.
- Accuracy within 3 cm of isocenter improved from 68.8% to 77.7%.
- Vertical accuracy increases corresponded to a 30-percentile improvement in a peer ranking among other hospitals.
- Modest increases of 1.37 mGy ($p = 0.14$) and 0.12 mGy ($p = 0.43$) were noted in $CTDI_{VOL}$ and SSDE, respectively, but were considered to be insignificant.
- Alignment shifts were not large enough to significantly impact dosimetry. There was no reduction in radiation dose in this study.



Histograms of the vertical displacement from isocenter before and after the presentation.



Percent accuracy and associated peer ranking among other facilities that use the same metrics recording software.



Changes to recorded dose indices as a result of the presentation

CONCLUSIONS

- Improvements in vertical alignment showed that the educational initiative was successful.
  - On average, more scans were performed closer to isocenter following the presentation. There was a greater percentage of scans performed with zero vertical displacement as a result of the presentation.
  - Lateral alignment was unchanged, but was highly accurate before the presentation.
- Radiation dose changes were inappreciable.
  - Vertical offset was not large enough to invoke a significant change in dosimetric quantities. Marsh et al. reported that significant failure of TCM systems that produced large shifts in dose were noted for vertical displacements of several centimeters[2].
  - Decreases in dose were anticipated, but this study only noted increases. Since the patients were moved upwards on average, they were closer to the tube during the scout image. This resulted in magnification of the patient and increased tube output from the TCM system.
- Further work is needed to continue improvements in patient alignment at our facility.
  - All vertical offset averages in this study were still below isocenter. Future studies will need to further improve accuracy.
  - More targeted educational approaches are needed to identify problem areas and specifically address them.
- The informatics system and data acquisition methods employed by this study were essential to the success of the QI program. Thousands of scout images were analyzed by this software, which would not have been feasible by hand.
- Analytical and educational methods utilized by this study provide our facility and others with new methods for future QI initiatives.

REFERENCES

[1] Marsh RM, Silosky MS. The effects of patient positioning when interpreting CT dose metrics: A phantom study. Medical Physics. 2017;44(4):1514-1524. doi:10.1002/mp.12137

[2] Szczykutowicz TP, DuPlissis A, Pickhardt PJ. Variation in CT Number and Image Noise Uniformity According to Patient Positioning in MDCT. American Journal of Roentgenology. 2017;208(5):1064-1072. doi:10.2214/AJR.16.17215

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CONTACT INFORMATION

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