Minimizing CT Double-Coverage to Reduce Radiation Dose

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Conflicts & Acknowledgements

- No conflicts of interest to declare
- We’d like to thank the University of Saskatchewan Departments of Medical Imaging & Surgery for conference funding
Background

- Ionizing radiation from CT exams has been linked to malignancy
- When multiple body regions are scanned, there may be double-coverage of an area depending on CT protocols
- By minimizing the area of double-coverage, patients' exposure to radiation can be reduced
Dose Measurement

- **CT Dose Index (CTDI)**
  - Scanner radiation output over single length of scan

- **Dose Length Product (DLP)**
  - Total radiation output, calculated as CTDI x scan length

- **Effective Dose (ED)**
  - Estimate of effective radiation dose received by the patient. Varies depending on region scanned. Calculated as DLP x conversion factors

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Aim of Study

- To determine whether CT protocol redesign can reduce double-coverage in studies of the neck, chest, abdomen, and pelvis, with resultant lower radiation doses.
Methods

- **Pre-intervention (2010):**
  - Using Phillips iSite Radiology PACs software, data was collected on CT chest, abdomen, pelvis (CHAP) studies; and CT neck, chest, abdomen, pelvis (NCHAP) studies from the Saskatoon Health Region across three sites.
  - Existing CT protocols were used.
  - Data collected on: number of scan segments, total cranio-caudal (CC) length of the chest segment, the CC length of anatomical overlap between segments, and the dose length product (DLP) for each segment.
  - DLP values converted to effective doses based on conversion factors:
    - 0.0054 mSv/mGy-cm for neck,
    - 0.017 mSv/mGy-cm for chest,
    - 0.017 mSv/mGy-cm for abdomen-pelvis.
  - “Doubled-doses” and “% doubled-doses” were calculated:
    - Single-pass dose calculated as total ED minus areas of double-coverage (the ideal).
    - “Doubled-dose” defined as total ED owing to image overlap.
    - “Percent doubled-dose” defined as % of ED from doubled-dose vs. the ideal single-pass dose.
Ideal protocol minimizes or eliminates areas of double coverage

Single pass coverage
Methods

Intervention

- CT protocols for CHAP and NCHAP studies were modified at each of the three Saskatoon Health Region sites
  - Goal was minimizing overlapping coverage
- For non-trauma patients, CHAP studies were changed to a single portal venous phase requiring only one scan with no overlap
- For NCHAP studies two scans were utilized
  - A separate scan of the neck was required in addition to CHAP since neck is imaged with arms down, and chest with shoulders extended.
  - Technologists were asked to keep the neck-chest overlap to a minimum.
- Additional factors:
  - Site 2 had a scanner upgrade during the study period with multiple lower dose protocols also instituted
  - Sites 1 and 3 also performed other dose optimization strategies in the interval
Methods

- Post-intervention (2014)
  - Pre-intervention methods were repeated
  - Data was compared with pre-intervention results
Results

- **Pre-intervention:**
  - **45 NCHAP studies reviewed**
    - All NCHAP studies scanned the neck, chest and abdomen-pelvis in three separate segments
    - Average doubled-dose 4.32 mSv
    - Average % doubled-dose 24%
  - **145 CHAP studies reviewed**
    - All CHAP studies obtained as two separate segments
    - Average doubled-dose 1.07 mSv
    - Average % doubled-dose 12%
Results

- **Post-intervention**
  - **44 NCHAP studies reviewed**
    - All NCHAP studies scanned in two segments (single scan for chest and abdomen-pelvis)
    - Average doubled-dose 0.70 mSv
    - Average % doubled-dose 8%
  - **58 CHAP studies reviewed**
    - All CHAP studies obtained as single scan
    - Doubled-dose 0 mSv
    - % doubled-dose 0%
Results

- **Pre- vs. Post-intervention**

![Bar chart showing percent doubled-dose before and after intervention at different sites and in total.](chart.png)
Discussion

- Two ways to minimize image overlap in CHAP and NCHAP studies:
  - Combine regions into single scan
  - Reduce area of overlap when multiple scans required

- This strategy successfully reduced CT radiation at our centre
  - Results correspond to study by Ptak et. al\(^2\) that found a 17% reduction in radiation when single-pass CT imaging was utilized in trauma

- Further benefits of these modified CT protocols include:
  - Smoother image reformatting
  - Simplified process for technologists
  - Fewer duplicate images for radiologists to review

- Drawbacks include:
  - Loss of ‘bonus’ liver arterial phase
  - Limitations when different passes desired for chest and abdomen (i.e., trauma)

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\(^2\)Ptak T, Rhea JT, Novelline RA. "Radiation dose is reduced with a single-pass whole-body multi-detector row CT trauma protocol compared with a conventional segmented method: initial experience." Radiology. 2003;229(3):902-5.
Conclusion

- Our experience demonstrates how CT CHAP and NCHAP protocols can be modified to minimize anatomical overlap and eliminate unnecessary radiation.
- This technique is neither highly technical nor expensive, and is therefore available to any centre.