Imaging Technique, Radiation Dose, and Image Noise: CT Acquisition for Noninvasive 3D Cardiac Mapping Using the CardioInsight™ System

T Patel, MD; P Norton, MD; E Rrapo Kaso, MD; A Lam, MD; KD Hagspiel, MD; KC Bilchick, MD; A Darby, MD; N Mehta, MD; PK. Mason, MD; R Malhotra, MD; JD Ferguson, MD; JM Mangrum, MD
University of Virginia Health System, Charlottesville, Virginia, U.S.A

Background

- Noninvasive 3D cardiac mapping, CardioInsight™ Cardiac Mapping System (Fig 1), (Medtronic, Inc. Minneapolis, MN) requires the patient to wear a multi-electrode vest and then undergo a CT from the neck through the abdomen in order to spatially locate each vest electrode and relate it to the cardiac surface. Vest size (S, M, L, XL) is matched to patient's weight and height.
- Objective: To compare two different CT techniques and their associated radiation doses and image noise for patients undergoing 3D cardiac mapping.

Methods

- 53 patients (age range 19-84, male 57%) underwent CT prior to non-invasive 3D mapping using either a dual-source CT with an automatic kVp selection (120 or 100) protocol or a single-source CT with a fixed 120 kVp protocol.
- Effective dose measurements were calculated using Radimetrics (Bayer Healthcare, LLC. Whippany, NJ). Imaging noise was measured as standard deviation of CT density of the air anterior to the chest. T-test was used to compare means for significant differences.
- CT scanners used: GE (Fixed) and Siemens (Automatic)
- Metrics: Patient requires a 20g IV in AC or power injectable central line capable of 4ml/sec injection rate. Pt position is head first and supine
- Contrast: Omnipaque 350 Volume-100mL Rate- 4mL/sec
  Saline Volume-50mL Rate- 4mL/sec
  Bolus tracking for triggering the scan

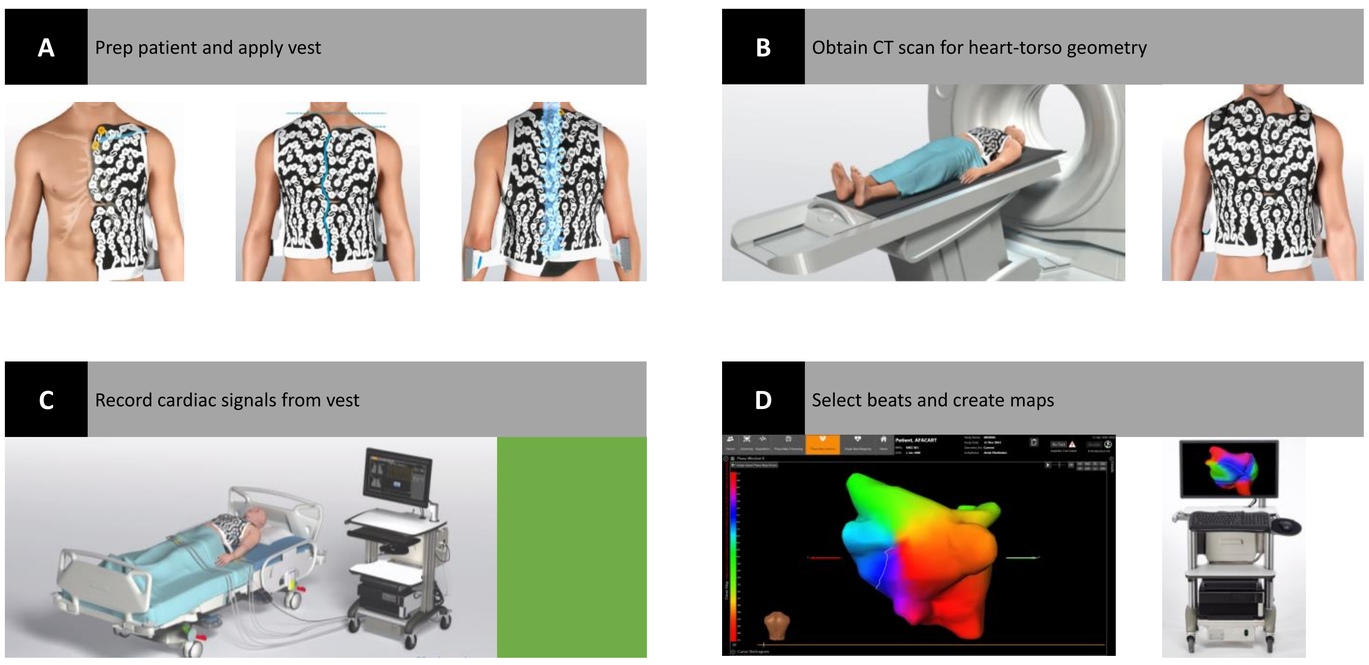

Figure 1. Patient Workflow A) The CardioInsight™ vest with 252 body surface electrodes is placed on the patient B) Patient then undergoes CT scan while wearing the vest C) Non-Invasive mapping of the arrhythmia is performed D) Combining the anatomical and electrical data in order to reconstruct maps on a 3D segmented image.

Disclosures: J.M. Mangrum: Advisory Board, Medtronic; Speaker's Bureau, Medtronic.

Protocol

CT Acquisition

GE

Scan range: skull base through paperclip

SEIMENS

Scan Mode Helical
Tube Rotation 0.4 sec
Thickness 1.25mm
Interval 0.625mm
kV 120.0
Pitch 0.984:1
Speed 39.37mm/s
Sure mA ON
Noise index 303
Number of Detectors 64
Total Collimation 40mm
Auto mA 100-600

Scan Mode Helical
Tube Rotation 0.285 sec
Thickness 1.5mm
Interval 1.0mm
Ref kV 120.0
Quality Ref mAs 150
Pitch 0.6
Dose Modulation ON
Single Slice Collimation 0.6mm
Number of detectors 128

Results

- 53 CT exams were performed with a mean effective dose of 9.3 mSv (±2.2) and mean image noise 8.7 (±2.9).
- 20 of 53 exams were performed using an automatic kV selection CT protocol with a mean effective dose and image noise of 8.3 (±2.0) mSv and 6.7 (±1.6).
- 14 of the 20 exams selected 100 kVp. Mean values for 100kVp vs 120 kVp selection groups: body mass index 28.1 (±4.8) vs 36.8 (±9.2) kg/m2, body surface area 2.0 (±0.2) vs 2.3 (±0.3) m2, effective dose 7.5 (±1.2) vs 10.2 (±2.4) mSv [$p<0.04$], and image noise 6.1 (±0.9) vs 8.5 (±1.8) [$p<0.02$].
- 33 of 53 exams were performed with a fixed 120 kVp CT protocol. Mean effective dose and image noise was 9.8 (±2.2) mSv and 9.3 (±3.2).
- Comparing automatic kVp selection protocol vs fixed 120 kVp protocol, there is significantly less effective dose ($p<0.01$) and less image noise ($p<0.001$) despite similar BSA (2.07 and 2.11 ±0.36) and BMI (30.76 ±7.41 and 30.85 ±6.25)
- There was no significant difference between effective doses based on vest size.

Conclusions

Employing an automatic kVp selection protocol when performing CT imaging prior to 3D cardiac mapping results in significant reduction in effective radiation dose and image noise as compared to a fixed kVp protocol.

Contact: trp7uu@Virginia.edu