Reduction in Radiation Exposure in Cardiovascular CT Imaging

PROspective Multicenter Registry on Radia**T**ion Dose **E**stimates of Cardiac **CT** Ang**IO**graphy I**N** Daily Practice in 2017 (PROTECTION VI)

Jörg Hausleiter

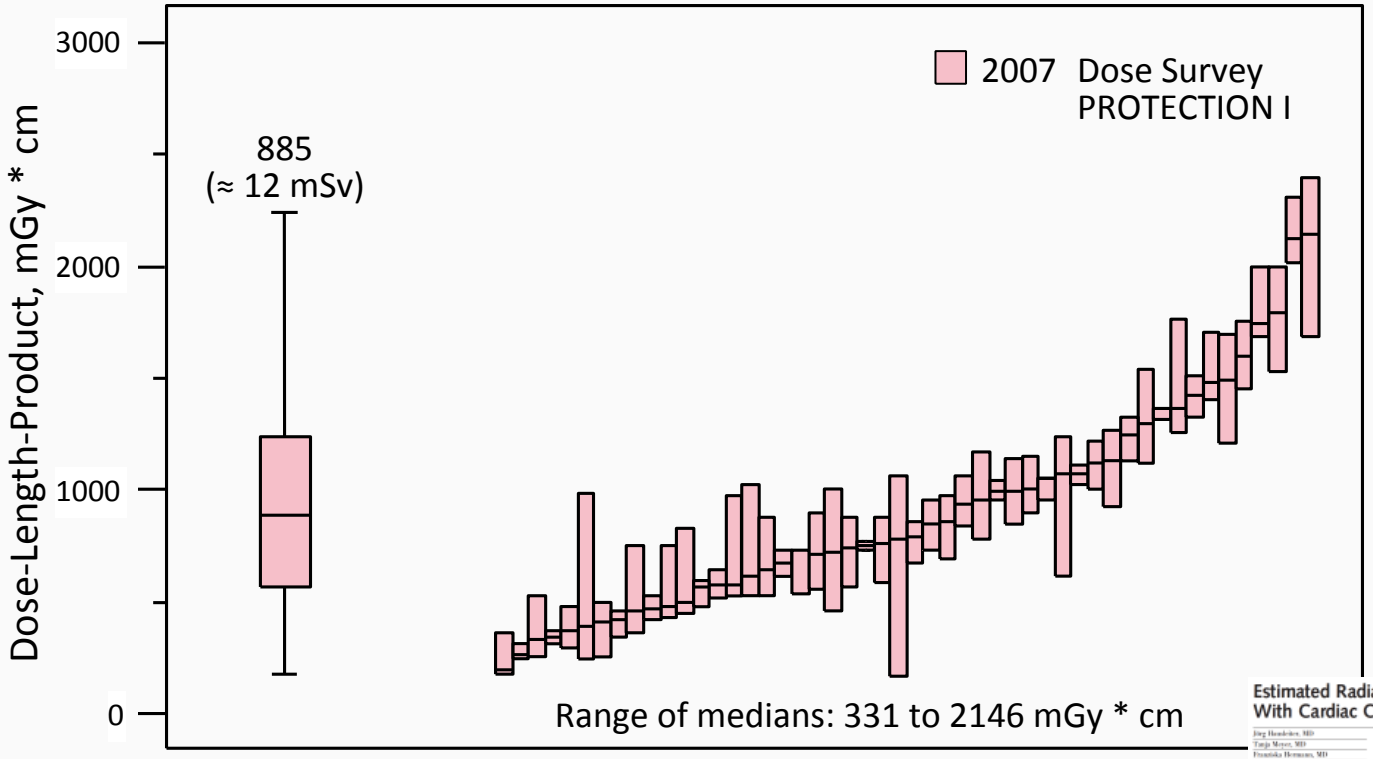
T. Stocker, S. Deseive, J. Leipsic, M. Hadamitzky, M.Y. Chen, R. Rubinshtein, M. Heckner, J.J. Bax, X.-M. Fang, E. Grove, J. Lesser, P. Maurovich-Horvat, J. Otton, S. Shin, D. Andreini, H. Marques, B. Chow, C.H. Nomura, R. Tabbalat, A. Schmermund, J.-W. Kang, C. Naoum, M. Atkins, E. Martuscelli, S. Massberg
for the PROTECTION VI investigators

ESC Congress
Munich 2018

Declaration of interest

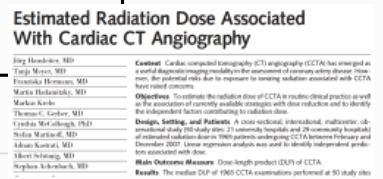
- Research contracts (Abbott Vascular)

Radiation Dose in 2007



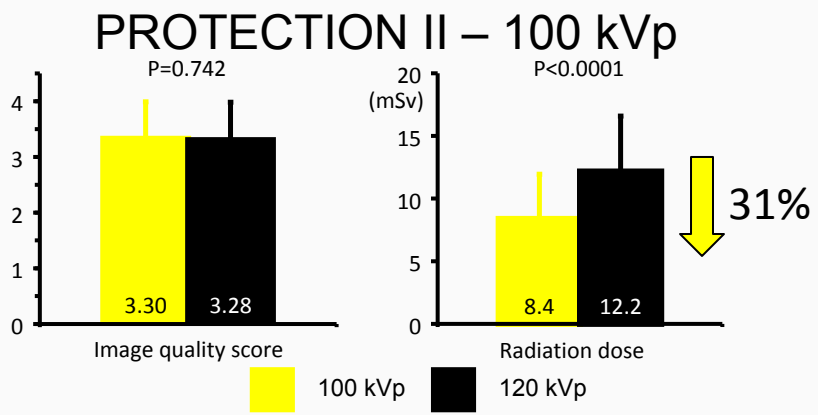
All sites

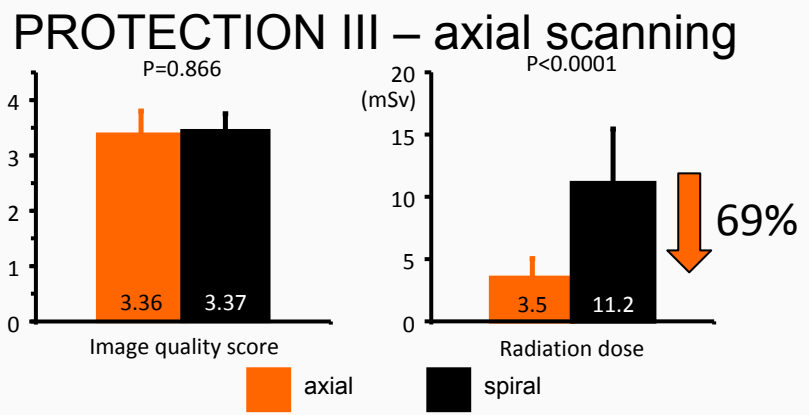
Intersite variability (median ±IQR)

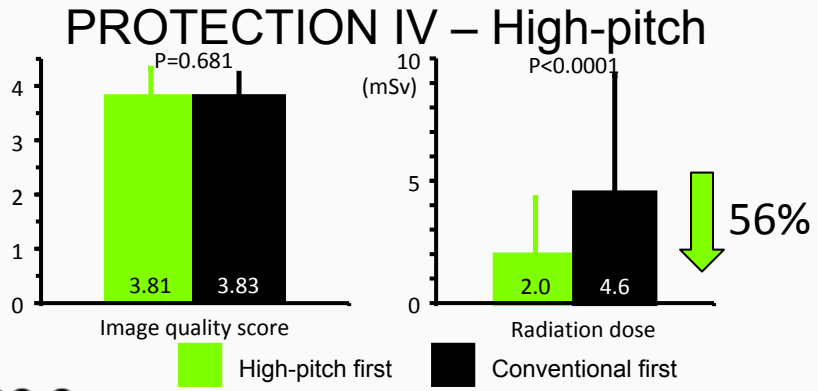

Estimated Radiation Dose Associated With Cardiac CT Angiography

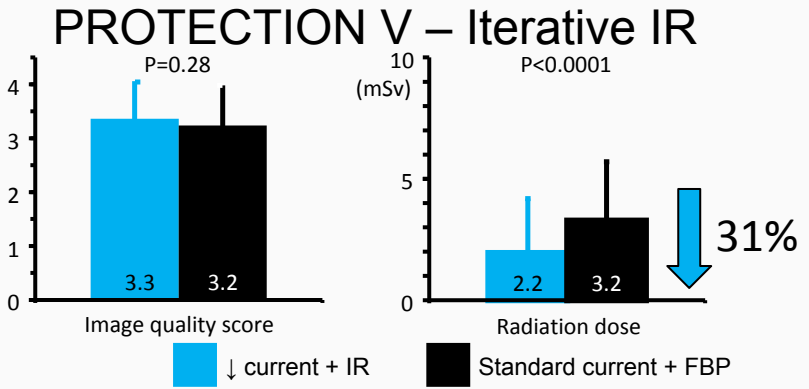
Hausleiter et al; JAMA 2009

PROTECTION II – V series









ESC Congress
Munich 2018

Hausleiter et al, JACC Imag 2011; Hausleiter et al, JACC Imag 2012
Deseive et al, JCCT 2015; Deseive et al, JACC Imag 2015

Rationale

to investigate in a real-world setting in 2017:

- the radiation dose of cardiac CTA (primary endpoint),
- the utilization and efficacy of established dose saving strategies, and
- the independent predictors for radiation dose

Methods

- PROTECTION VI is an international, industry-independent, multi-vendor, prospective, observational study.
- 435 clinicians from 62 different countries were invited to participate
- Study investigators prospectively identified one calendar month in 2017 for participation and enrolled all consecutive patients
- Cardiac CTAs were carried out according to local standard of clinical care
- Cardiac CTA study details and CT images were collected and analyzed in a central core laboratory
- Registered at clinicaltrials.gov (NCT02996903)

Results

- 61 international sites (42 university hospitals, 19 community hospitals) from 32 different countries
- 51 patients (IQR 27 – 91 patients) per site during the month of enrollment;
- 4502 patients undergoing diagnostic cardiac CTA

Study Site Characteristics

	2007 Dose Survey (1965 patients)	2017 Dose Survey (4502 patients)
Site experience, years	3 (1.5 – 5.5)	10.5 (7.0 – 13.0)
Number of CTAs/month	26 (10 – 46)	51 (27 – 93)
CT system		
16-slice CT, % (n)	4% (72)	0%
64-slice CT, % (n)	96% (1893)	9% (387)
≥128-slice CT, % (n)	NA	91% (4115)
CT manufacturer		
GE, % (n)	24 (466)	26 (1168)
Philips, % (n)	8 (159)	13 (574)
Siemens, % (n)	59 (1155)	48 (2160)
Toshiba, % (n)	9 (185)	13 (600)

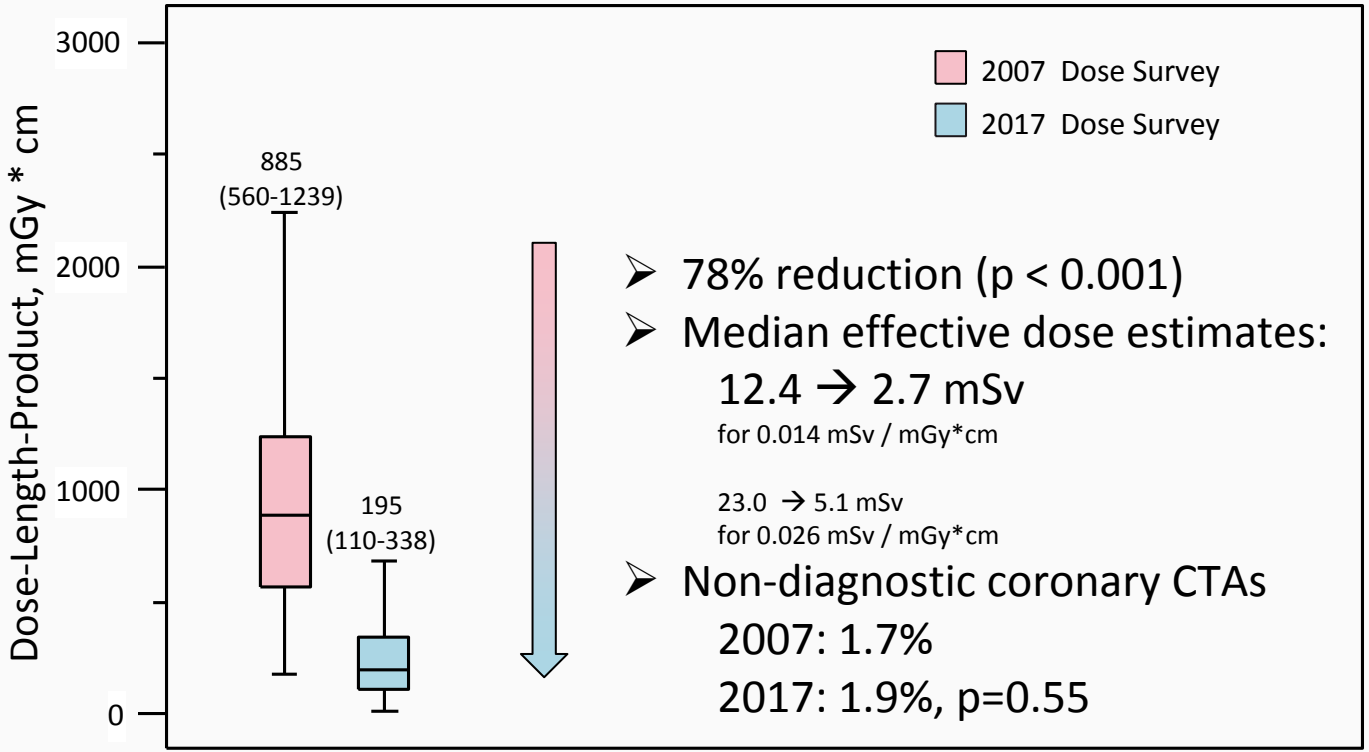
Patient Characteristics

	2007 Dose Survey (1965 patients)	2017 Dose Survey (4502 patients)
Age, years	NA	60 (51 – 69)
Male gender, % (n)	NA	58 (2623)
BMI, kg/sqm	26.2 (23.8 – 28.8)	26.8 (24.1 – 30.1)
Indication: Coronary, % (n)	82 (1611)	89 (4006)
ß-Blocker medication Taking daily, % (n) Admin. for CTA, % (n)	 12 (233) 46 (904)	 13 (603) 53 (2370)
Stable sinus rhythm, % (n)	95 (1874)	90 (4055)
Heart rate, beats/min	61 (55 – 75)	60 (55 – 67)

Coronary CTA Scan Protocols

	2007 Dose Survey (1611 patients)	2017 Dose Survey (4006 patients)	P-value
Scan length, mm	131 (118 – 144)	137 (125 – 157)	< .001
Tube potential ≤100kV, % (n)	5 (82)	56 (2226)	< .001
Low-pitch helical scan protocol, % (n)	94 (1512)	11 (447)	< .001
with ECG-correlated tube current modulation, % (n)	95 (1440)	73 (325)	< .001
Axial scan protocol, % (n)	6 (99)	78 (3094)	< .001
High-pitch helical scan protocol, % (n)	0 (0)	11 (449)	NA
Iterative image reconstruction, % (n)	0 (0)	83 (3306)	NA

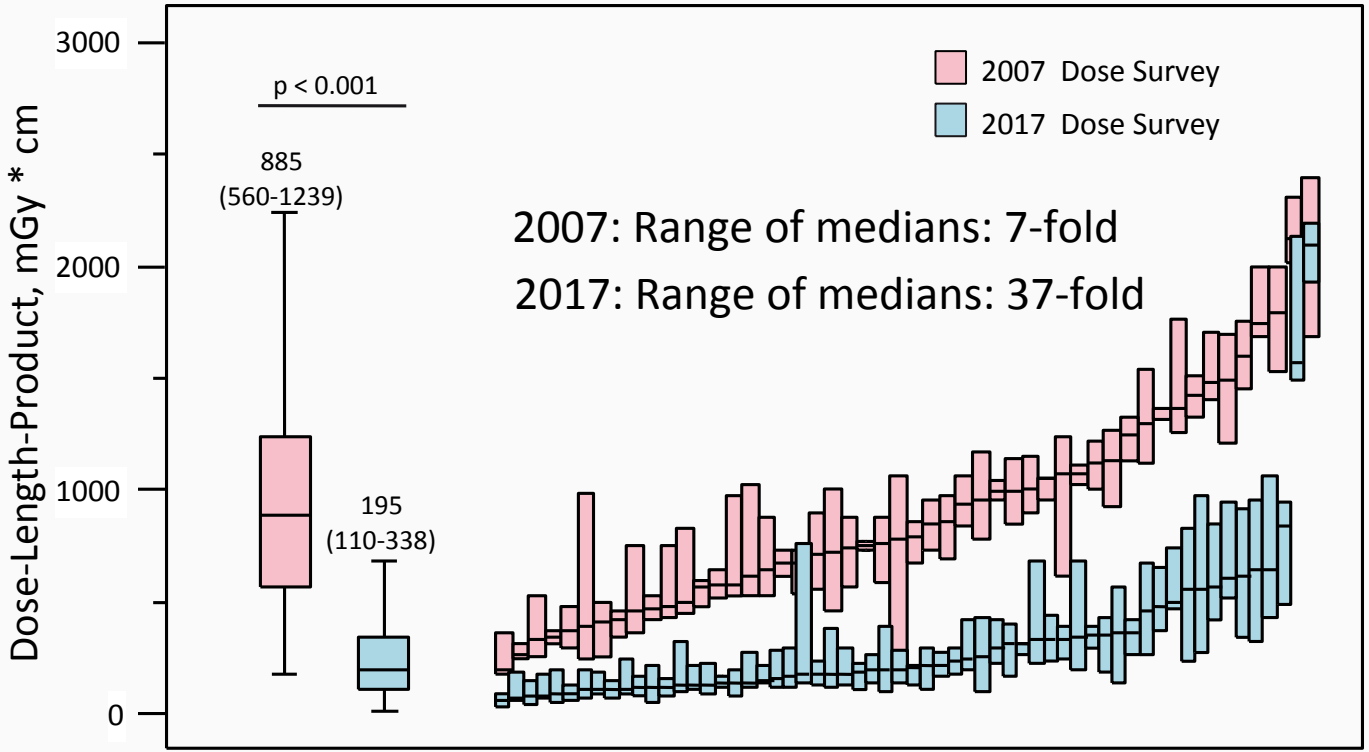
Coronary CTA: Dose



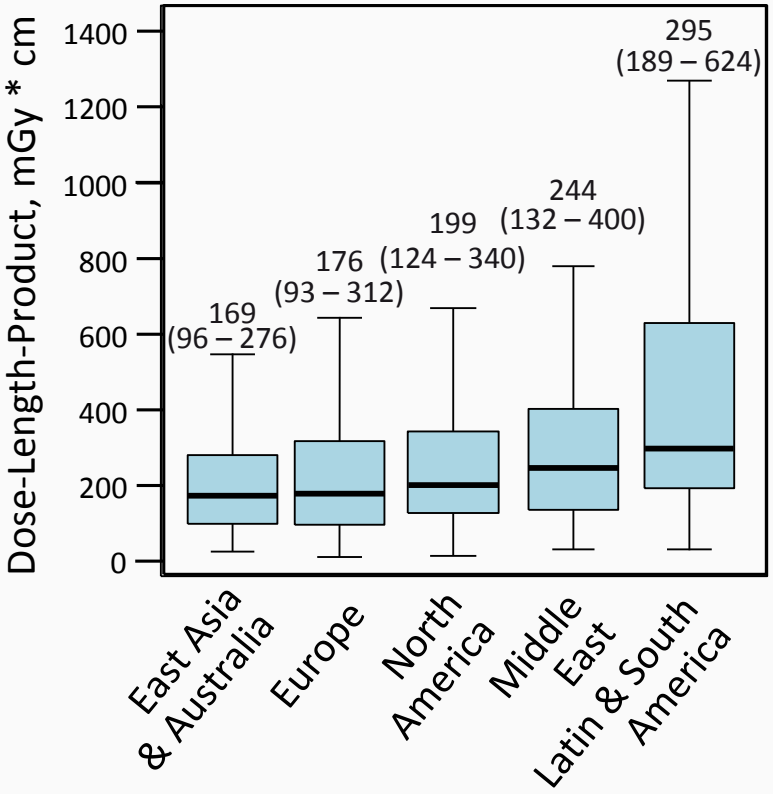
- 78% reduction ($p < 0.001$)
- Median effective dose estimates:
  - 12.4 → 2.7 mSv
    for 0.014 mSv / mGy*cm
  - 23.0 → 5.1 mSv
    for 0.026 mSv / mGy*cm
- Non-diagnostic coronary CTAs
  - 2007: 1.7%
  - 2017: 1.9%, p=0.55

All sites

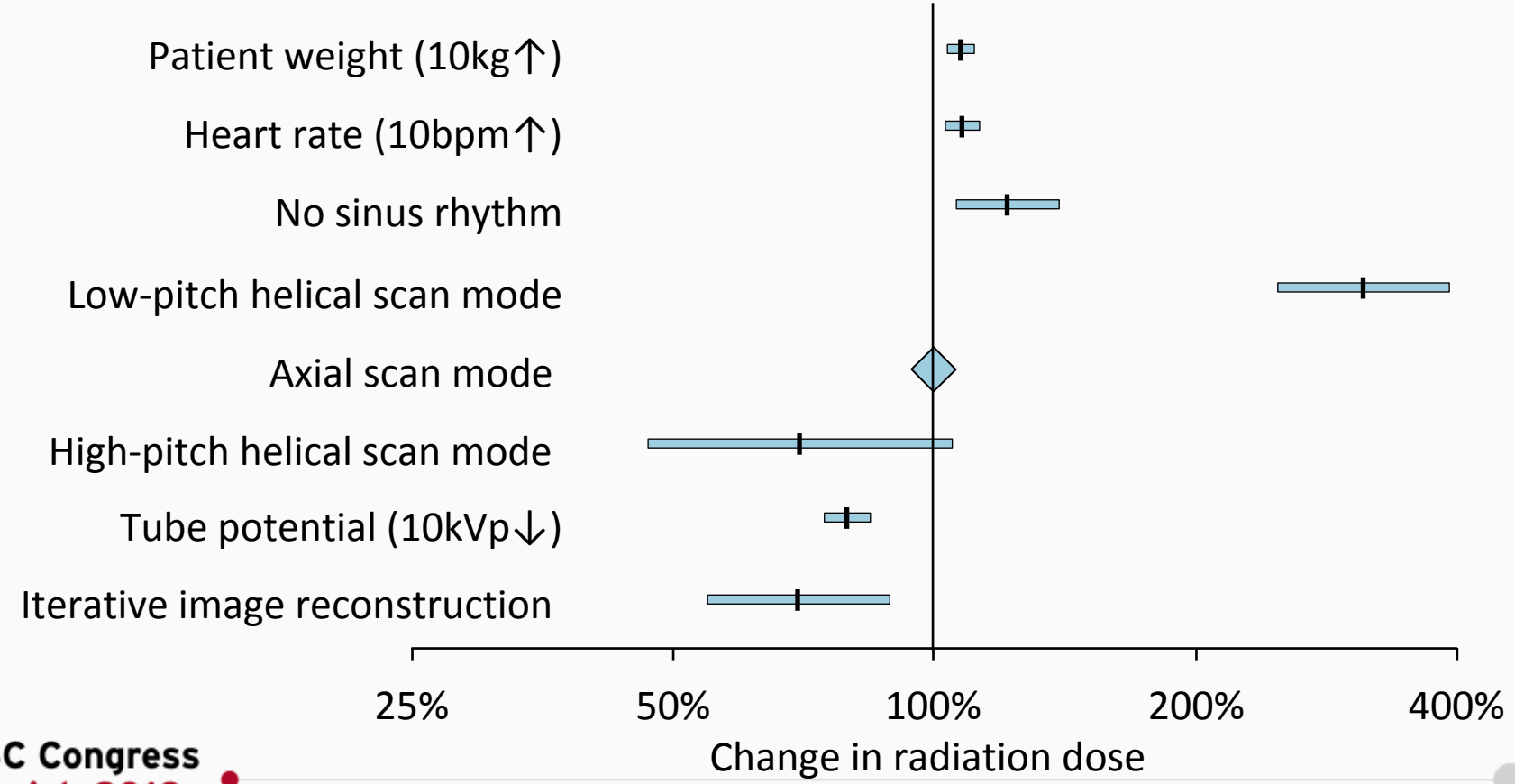
Coronary CTA: Dose Variability



Regional Dose Results



Coronary CTA: Independent Predictors



Conclusions

The current PROTECTION VI survey demonstrates that :

- the radiation exposure from cardiac CTA has been considerably reduced by 78% over the last 10 years.
- This was mainly accomplished by an increased use of (a) low tube potential scan protocols, (b) prospectively ECG-triggered axial and high-pitch scan protocols, and (c) iterative image reconstruction.
- Given the high diagnostic accuracy and the low radiation dose, coronary CTA should be considered as a first-line diagnostic test.
- The large 37-fold inter-site variability in median radiation dose underlines the need for further site-specific training and adaptation of contemporary cardiac scan protocols.

PROTECTION VI Investigators

1. P. Carrascosa and A. Deviggiano, Diagnóstico Maipú, Buenos Aires, Argentina
2. C. Naoum and J. Magnussen, Macquarie University Hospital, Sydney, Australia
3. J. Otton and A. Kaplan, Spectrum Radiology Liverpool, Sydney, Australia
4. G. Feuchtner and F. Plank, Medizinische Universität, Innsbruck, Austria
5. K. De Smet and N. Buls, Universitair Ziekenhuis, Brussel, Belgium
6. R.C. Cury and M.S. Bittencourt, Delbo
7. C.H. Nomura and R.N. Dantas Junior,
8. J. Leipsic and P. Blanke, University of
9. C. Chartrand-Lefebvre and A. Chin, U
10. G. Small and B. Chow, University of C
11. C. Silva F, Clinica Alemana de Santiag
12. M. Godoy Z. and C. Silva F., Clinica Al
13. X.-M. Fang and W. Jie, Wuxi People's
14. A. Cadena, Clínica de la Costa, Barran
15. T. Adla and V. Suchanek, Motol Unive
16. E.L. Grove and K.B. Pedersen, Aarhus
17. J. Lambrechtse and M. Husic, OUH-Sv
18. J. Knuuti and T. Maaniitty, Turku Univ
19. B. Bischoff and E. Arnoldi, Klinikum d
20. A. Schmermund and J. Eckert, CCB, F
21. M. Hadamitzky and T. Finck, Deutsch
22. M. Hell and M. Marwan, Universitäts
23. F. Bamberg and S. Mangold, Universi
24. T. Schlosser and J. Ludwig, Universitä
25. M. Mylona and S. Skiadopoulos, Olyn
26. P. Maurovich-Horvat and B. Szilveszt
27. U. Jadav and B.V. Pinto, MGM New B
28. R. Rubinshtein and E. Hussein, Lady D
29. D. Andreini and G. Pontone, Centro C
30. E. Martuscelli and M. Sperandio, Poli
31. K. Kitagawa and N. Nagasawa, Mie U
32. R. Tabbalat and R.A. Farhan, Khalidi H
33. L.M. Sierra Galán and L.A. Delgado, American British Cowdray Medical Center Observatory Campus, Mexico City, Mexico
34. L.M. Sierra Galán and M.A. Reza Orozco, American British Cowdray Medical Center Santa Fe Campus, Mexico City, Mexico
35. F.C. Castellón and M.D. Zamudio, Instituto Ignacio Chavez, Mexico City, Mexico

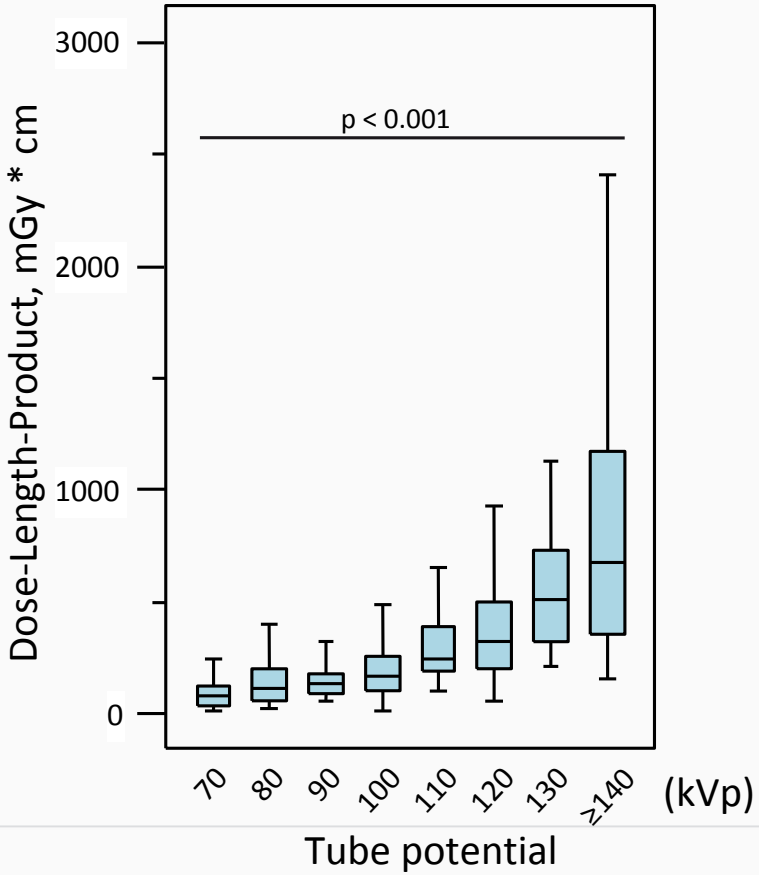
ESC European Society of Cardiology
European Heart Journal (2018) **00**, 1–9
doi:10.1093/eurheartj/ehy546
FASTTRACK CLINICAL RESEARCH
Imaging

Reduction in radiation exposure in cardiovascular computed tomography imaging: results from the Prospective Multicenter Registry on RadiaTion Dose Estimates of Cardiac CT AngIOgraphy IN Daily Practice in 2017 (PROTECTION VI)

Thomas J. Stocker[1,2], Simon Deseive[1,2], Jonathon Leipsic[3], Martin Hadamitzky[4], Marcus Y. Chen[5], Ronen Rubinshtein[6], Mathias Heckner[1], Jeroen J. Bax[7], Xiang-Ming Fang[8], Erik Grove[9], John Lesser[10], Pál Maurovich-Horvat[11], James Otton[12], Sanghoon Shin[13], Gianluca Pontone[14], Hugo Marques[15], Benjamin Chow[16], Cesar H. Nomura[17], Ramzi Tabbalat[18], Axel Schmermund[19], Joon-Won Kang[20], Christopher Naoum[21], Melany Atkins[22], Eugenio Martuscelli[23], Steffen Massberg[1,2], and Jörg Hausleiter[1,2]*; for the PROTECTION VI investigators[†]

Sorted by country

Tube Potential and Dose



CT Manufacturer and Dose