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ORIGINAL ARTICLE

Outcomes of Obese and Morbidly Obese Patients Undergoing Percutaneous Coronary Intervention

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Background The risks of percutaneous coronary intervention (PCI) in obese and particularly morbidly obese patients remain uncertain.

Methods 1082 consecutive patients were categorised as non-obese (NO, body mass index (BMI) <30 kg/m^2, n = 688), obese (O, BMI 30–40 kg/m^2, n = 354) or morbidly obese (MO, BMI ≥40 kg/m^2, n = 40). Demographic and procedural information was collated. Monte Carlo simulations modelled radiation dosimetric data.

Results Obese and morbidly obese patients were younger (p = 0.016), more frequently female (p = 0.036), more frequently diabetic (p < 0.0001), with better renal function (p < 0.0001), and prior PCI (p = 0.01). There was no difference in major adverse cardiovascular or cerebrovascular events (MACCE) (NO = 1.2%, O = 0.8%, MO = 2.5%, p = NS), acute kidney injury, bleeding, length of stay, 30-day readmission or 30-day mortality. Obese and morbidly obese patients received increased contrast (NO = 180 [150–230]mL, O = 190 [160–250] mL, MO = 200 [165–225]mL, p = 0.016), dose area product (NO = 75.56 [50.61–113.69]Gycm^2, O = 116.4 [76.11–157.82]Gycm^2, MO = 125.62 [92.22–158.81]Gycm^2, p < 0.0001), entrance air kerma (NO = 1439.42 [977.0–2075.5]mGy, O = 2111.63 [1492.0–3011.0]mGy, MO = 2376.0 [1700.0–3234.42]mGy, p < 0.0001), and peak skin dose (NO = 1439.42 [977.0–2075.5], O = 2111.63 [1492.0–3011.0], MO = 2376.0 [1700.0–3234.42], p < 0.0001). Effective radiation dose increased in obese patients (NO = 20.9 ± 14.9mSv, O = 27.4 ± 17.1mSv, MO = 24.1 ± 12.6mSv, p < 0.0001 for NO *vs* O, p = 0.449 for NO *vs* MO).

Conclusions Percutaneous coronary intervention can be performed in obese and morbidly obese patients without elevated risk for most clinical outcomes. However, radiation increases above levels that could cause both transient and late effects. Strategies should be pursued to minimise radiation dose.

Keywords Morbid obesity • Percutaneous coronary intervention • Radiation • Monte Carlo

Introduction

Q4 Australia, like all other developed countries, is experiencing an 'obesity epidemic'. In the Global Burden of Disease Report, obesity was identified as the strongest contributor to burden of disease for modern Australasia [1]. Obesity is increasing both in prevalence and also in severity, with the heaviest sector of growth being in 'morbid obesity', equating to body mass index (BMI) >40 kg/m^2 [2]. Q5

Consequent to a global epidemic of obesity, the typical weight of patients undergoing percutaneous coronary intervention (PCI) is also rising. Traditional risk:benefit ratios and

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complication rates quoted when consenting patients for PCI may not be accurate in the setting of obesity and morbid obesity.

Most available data relating to procedural outcomes in obese and morbidly obese patients undergoing PCI derives from the United States, and one Australian registry [3–7]. However, clinical practice in PCI has altered significantly since the publication of these audits, with increasing use of radial access, newer generations of stents, and the introduction of novel antiplatelet and anticoagulant medication use. Clinically relevant outcomes such as length of stay, contrast use and radiation dose were also not assessed in any of these trials.

In order to quantify the contemporaneous risks of PCI in obesity, we analysed data in a consecutive series of patients undergoing PCI at our institution.

Methods

The medical records of all patients who underwent PCI in the cardiology unit of St Vincent's Hospital, Fitzroy, Melbourne, Australia between the dates of 08 January 2013 and 31 May 2015 were reviewed. A total of 1082 consecutive patients were identified as suitable for this audit, and all (100%) were included in this study. The study was approved by the hospital research ethics committee (QA code 101/15).

Patients were categorised as either non-obese (NO, BMI <30 kg/m^2), obese (O, BMI 30–40 kg/m^2) or morbidly obese (MO, BMI ≥40 kg/m^2). For each group we recorded age, gender distribution, diabetic status, baseline creatinine (umol/mL), baseline renal function (using corrected Cockcroft-Gault formula), presence of an acute coronary syndrome (ACS) at time of PCI, history of prior PCI or coronary artery bypass graft surgery (CABG), and percutaneous access site used for procedure (radial or femoral access). Procedures were performed using a 6 French catheter and either a radial or femoral access site at the operator's discretion, with manual injections of contrast. All procedures were performed on either a Siemens Artis Zee machine (65.7% patients) or a Phillips FD-10 machine (34.3% patients).

Patient outcomes assessed were in-hospital major adverse cardiovascular or cerebrovascular events (MACCE, a composite endpoint of death, stroke, infarction post PCI or need for urgent bypass surgery post PCI), acute kidney injury (defined as increase in creatinine ≥44.2umol/L or ≥25% up to five days post PCI) [8], any bleeding (defined by Bleeding Academic Research Consortium score 1-5), major bleeding (BARC score 3-5) [9], contrast usage (mL), fluoroscopy time (min), median combined fluoroscopy dose area product (DAP) (Gycm^2) from examination fluoroscopy and cineangiography runs, median combined entrance air kerma (EAK) of radiation (mGy) [cumulative radiation dose at a reference point in space] from examination fluoroscopy and cineangiography runs, length of stay in-hospital (days), 30-day readmission to hospital, and 30-day mortality.

These Monte Carlo simulations were performed using the PCXMC (PCXMC 2.0, STUK Corporation, Helsinki, Finland) software package that allows the modelling of x-ray fields at set angles of incidence onto an anthromorphic phantom of specified height and weight (Figure 1). The output from this software allows the specific calculation of resultant organ-absorbed radiation dose and total body effective radiation dose. The simulations were performed for nine specific

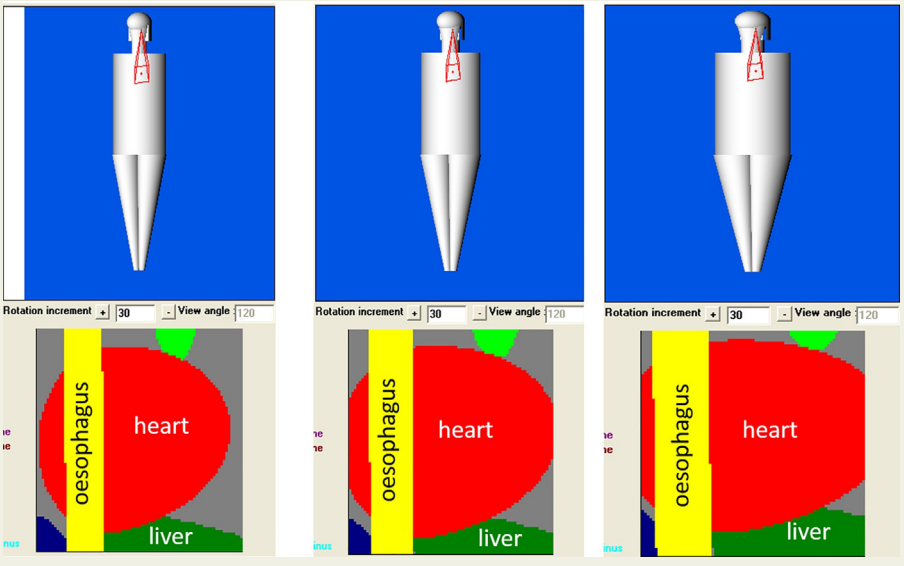

Figure 1 'Phantoms' used to conduct Monte Carlo simulations.
A triptych of 'phantoms' representing three different patients with varying dimensions. For all 1,082 patients, body dimensions were entered into PCXMC modelling software to create 'phantoms' for whom radiation modelling could be applied in a variety of standard views. Radiation dosage to both skin and organs was separately modelled, incorporating the variable radiosensitivity of each organ penetrated.

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