Heart, Lung and Circulation (2015) **24,** 264–269
1443-9506/04/$36.00
http://dx.doi.org/10.1016/j.hlc.2014.09.022

ORIGINAL ARTICLE

Radiation Exposure During Cardiac Catheterisation is Similar for Both Femoral and Radial Approaches

Belinda Gray, FRACP [a,b,d], Harry Klimis, MBBS [a,b], Shafqat Inam, MBBS [a], Nilshan Ariyathna, MBBS [a], Shweta Kumar, MBBS [a], Brian Bailey, FRACP [a], Sanjay Patel, FRACP PhD [a,b,c*]

[a]Department of Cardiology, Royal Prince Alfred Hospital, NSW
[b]Sydney Medical School, University of Sydney, NSW
[c]The Heart Research Institute, Sydney, NSW
[d]Agnes Ginges Centre for Molecular Cardiology, Centenary Institute, NSW

Received 11 August 2014; received in revised form 22 September 2014; accepted 22 September 2014; online published-ahead-of-print 22 October 2014

Objectives Radial approach invasive coronary angiography has been shown to be superior to the femoral approach in terms of reducing vascular access complications and improving patient comfort. However, one major limitation has been the perception of higher patient radiation exposure, with guidelines recommending 7mSv as an appropriate average effective dose (E) for routine coronary angiography. Therefore, we sought here to assess differences in radiation exposure between the femoral and radial access routes in patients undergoing diagnostic coronary angiography with or without angioplasty (CA +/- PCI), as performed by two operators, experienced in both techniques.

Methods Consecutive patients (n = 870) from July 2011-December 2012, undergoing routine CA +/- PCI at Royal Prince Alfred Hospital, Sydney by two experienced interventional cardiologists were identified. Radiation doses were automatically recorded as dose area products (DAPs) at procedure time and converted into *E* using a conversion factor of 0.18 mSv/(Gycm2), as validated by the National Radiological Protection Board (NRPB).

Results Of the 870 patients, 598 underwent diagnostic CA (347 femoral, 251 radial); and 272 underwent CA+ PCI (179 femoral, 93 radial). The mean age of the patients was 65 ± 12 years and the majority (n = 617, 71%) were male. Both groups were well matched with respect to baseline demographics, clinical presentation and angiographic characteristics, though there was an excess of patients with a history of coronary grafts in the femoral group, due to operator preference. In the patients who underwent diagnostic CA, there was no significant difference in the average effective radiation dose for femoral versus radial arterial access ($E = 7.9 \pm 8.2$ vs. 8.3 ± 10.6mSv; p = 0.66). Similarly, there was also no difference in average effective radiation dose for femoral versus radial arterial access in patients undergoing CA + PCI ($E = 13.2 \pm 8.1$ vs $E = 14.4 \pm 8.3$ mSv; p = 0.26).

Conclusion In our high volume cardiac catheterisation laboratory, radiation doses for routine angiography were near UNSC targets. Patient radiation exposure was comparable between femoral and radial approaches, for both CA and CA +/- PCI. Thus, our results allay concerns that radial cardiac catheterisation might be associated with greater radiation exposure.

Keywords Radiation • Radial • Femoral • Cardiac catheterisation • Angioplasty

*Corresponding author at: Department of Cardiology, Royal Prince Alfred Hospital, Missenden Road, Camperdown NSW 2050. Tel.: +612 95157615; fax: +612 95506262., Email: sanjay.patel@sswahs.nsw.gov.au

Introduction

It is well established that investigations to diagnose and manage coronary artery disease expose patients to significant doses of ionising radiation. This includes coronary angiography, computed tomography coronary angiography (CTCA), percutaneous coronary interventions and nuclear medicine investigations. The dose delivered to the patient is typically measured as '*E*' (Effective dose) with the unit Sievert (Sv) [1]. The United Nations Scientific Committee (UNSC) on the Effects of Atomic Radiation cites that the range of effective doses per procedure for diagnostic catheterisations is 3.1-15.8 mSv, and for percutaneous coronary interventions 5.4-14.1mSv [1] and recommends an average effective dose for diagnostic cardiac catheterisation of 7 mSv [2–4].

The radial approach for coronary angiography with or without percutaneous coronary intervention has previously been criticised for increasing the radiation dose to the patient, when compared with the femoral approach [5–9]. This is most apparent in low volume centres and has been attributed to operator inexperience with radial artery coronary angiography [10]. Therefore, this study sought to assess the effective dose of radiation to the patient via the radial approach, when compared with a femoral approach at our institution with operators experienced in both techniques.

Methods

Patient Selection

From July 2011 to December 2012 consecutive patients presenting to the cardiac catheterisation laboratory at Royal Prince Alfred Hospital, Sydney Australia for coronary angiography (CA) and or coronary angiography + percutaneous coronary intervention (CA + PCI) were identified retrospectively. Procedures were performed by one of two interventional cardiologists, each with over 10 years experience, who regularly use both femoral and radial access. Other operators in the institution were not included in this study as they did not use radial access routinely.

Angiography access site was at the discretion of the operating interventionist. For those undergoing radial catheterisation, the right radial artery was used almost exclusively, as dictated by our standard catheterisation table set-up, and hence patients with a history of coronary artery bypass grafting were almost exclusively studied via the femoral approach, to avoid the potential issues of accessing the LIMA from the right radial. Patients with severe aortic stenosis and end-stage renal impairment undergoing haemodialysis were also accessed from the femoral artery. Standard Judkins coronary catheters were used for femoral angiography, whereas the radial TIG (Terumo, NJ, USA) catheter was used, at least initially for radial angiography.

Baseline demographics, indication for angiography, and complications related to the procedure were recorded. If the patient proceeded to percutaneous intervention, lesion characteristics and number of stents deployed was also recorded. Patients undergoing CA and/or CA + PCI via the femoral approach were compared with patients undergoing CA and/or CA + PCI via the radial approach.

Calculation of Radiation Exposure

Our angiography suites employ Siemens Axiom Artis dFC (flat panel) and FC (image intensifier) equipment. Radiation doses were automatically recorded as dose area products (DAPs) at procedure time and converted into an effective dose (*E)* using a conversion factor of 0.18 mSv/(Gy cm^2), as validated by the National Radiological Protection Board (NRPB) [1]. The method of measuring DAP is well established and is thought to be more accurate than entrance dose measurements, especially when the x-ray beam is continuously changing, as with coronary angiography [2,3].

Statistical Analysis

Statistical analysis was carried out using GraphPad Prism (version 5.0). Contingency analysis and unpaired t-tests were used to analyse categorical and continuous variables, respectively. The patients were analysed in two groups, i.e. those who underwent coronary angiography only (CA) and those who underwent coronary angiography plus percutaneous coronary intervention (CA + PCI). For continuous variables, means (SDs) are reported, p values were considered significant if <0.05.

Results

We identified n = 870, consecutive patients undergoing CA or CA + PCI by two interventional cardiologists over the study period. Of these 598 underwent diagnostic CA (347 femoral, 251 radial) and 272 underwent CA + PCI (179 femoral, 93 radial). The mean age of the patients was 65 ± 12 years and the majority (617, 71%) were male.

In the patients undergoing routine CA alone, there were no differences in baseline demographics, cardiovascular risk factors, indication for angiography, performance of ventriculography or access site complications between patients undergoing radial *v* femoral access. However, as expected, patients who underwent radial access were less likely to have a history of previous coronary artery bypass grafting (5% vs 18%, p < 0.01), due to operator preference of not accessing the left radial artery. Patients undergoing radial angiography also had a lower serum creatinine, again driven by operator preference to not study patients with endstage renal failure and forearm fistula via the radial artery (89umol/L vs 106umol/L, p < 0.01) (Table 1). In both groups, the average effective radiation dose was similar (femoral: *E* = 7.9 ± 8.2, radial: 8.3 ± 10.6mSv; p = 0.66; Figure 1a). Notably, there was no difference in average effective dose when patients with a history of coronary artery bypass grafting were excluded (femoral: *E* = 7.2 ± 7.5,radial: 8.3 ± 10.8mSv, p = 0.2).

Similarly, in the patients who underwent CA + PCI both groups were well matched with respect to baseline