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Original articles

Do Indo-Asians have smaller coronary arteries?

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Summary
There is a widespread belief that coronary arteries are smaller in Indo-Asians. The aim of the present study was to compare the size of atheroma-free proximal and distal epicardial coronary arteries of Indo-Asians and Caucasians. We analysed normal coronary angiograms from 77 Caucasians and 39 Indo-Asians. The two groups were comparable for dominance of the coronary arteries. Indo-Asian patients had generally smaller coronary arteries, with a statistically significant difference in the mean diameters of the left main coronary artery, proximal, mid and left anterior descending, and proximal and distal right coronary artery segments. There was a non-significant trend towards smaller coronary artery segment diameters for the distal left anterior descending, proximal and distal circumflex, and obtuse marginal artery segments. However, after correction for body surface area, none of these differences in size were statistically significant. Thus, the smaller coronary arteries in Indo-Asian patients were explained by body size alone and were not due to ethnic origin *per se*. This finding nevertheless has important therapeutic implications, since smaller coronary arteries may give rise to technical difficulties during bypass graft and intervention procedures such as percutaneous transluminal coronary angioplasty, stents and atherectomy. On smaller arteries, atheroma may also give an impression of more severe disease than on larger diameter arteries.

Keywords: Indo-Asians; coronary artery; body surface area

Epidemiological data show wide differences in the prevalence and incidence of cardiovascular disease in different countries. For example, coronary heart disease (CHD) is rare in the predominantly black population of Africa and West Indies, but is relatively common in the Indo-Asian population from the Indian subcontinent. Similar disease patterns have been noted in the UK, where there are significant Afro-Caribbean and Indo-Asian communities as a result of immigration in the 1960s and early 1970s.[1 2] For example, there is a high incidence of CHD deaths amongst Indo-Asians in Britain, which contrasts with a low incidence of CHD and high incidence of hypertensive- and stroke-related deaths amongst Afro-Caribbeans.[1 3] Mortality from coronary artery disease (CAD) is 40% higher amongst Indo-Asians, when compared to the indigenous Caucasian population. Indo-Asians also have four times the risk of developing myocardial infarction (MI), with more extensive CAD seen angiographically.[4] Indeed, the mortality from CAD amongst Indo-Asians has been generally increasing, whilst the overall mortality has generally been decreasing in European countries.

There are more than 1.5 million people from the Indian subcontinent who have settled in the UK. The high incidence of CHD amongst Indo-Asians cannot be explained by a high prevalence of hypertension, cigarette smoking, total cholesterol levels or vasculotoxic (diene conjugated) lipids.[5–8] However, Indo-Asians have been shown to have a high prevalence of insulin resistance and diabetes mellitus and a high proportion of fat in foods purchased,[9 10] factors which may partly explain their increased CHD risk.

There is a widespread belief that coronary arteries are smaller in Indo-Asians. However, we are not aware of any studies which have systematically compared the size of the main coronary artery segments (both proximal and distal) in Indo-Asians and other ethnic groups. If Indo-Asians as an ethnic group had generally smaller coronary arteries, this may give the impression of more severe disease, and have clinical implications, especially for revascularisation procedures, such as coronary artery bypass grafting (CABG), percutaneous transluminal coronary angioplasty (PTCA), stent implantation and atherectomy. The aim of the present study was to compare the size of atheroma-free proximal and distal epicardial coronary arteries of Indo-Asians and Caucasians.

Methods

We analysed 116 consecutive normal coronary angiograms, free of localised atheroma, between January 1992 and January 1998. These patients had presented with chest pain, valvular heart disease, or cardiomyopathy. Coronary angiograms were performed by a standard Judkins technique, using a catheter of known luminal dimensions. The coronary arteries were selectively cannulated and injected with radio-opaque contrast media (Niopam). Standard projections were taken for visualisation of the main epicardial coronary arteries. Excluded were coronary angiograms with evidence of localised atheroma, coronary

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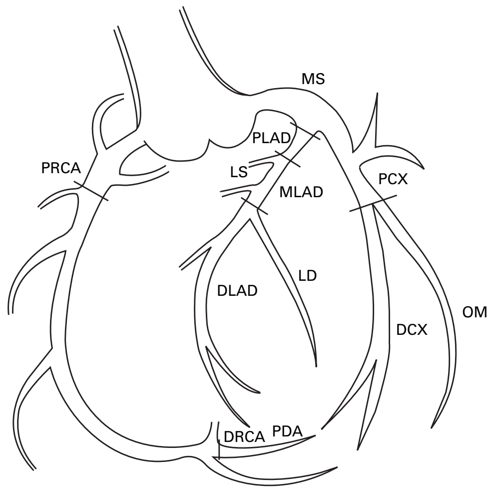

Figure Segments of the epicardial coronary arteries. MS = main stem; PLAD, MLAD, and DLAD = proximal, mid, and left anterior descending artery; PCX and DCX = proximal and distal circumflex artery; OM = obtuse marginal artery; PRCA and DRCA = proximal and distal right coronary artery

Table 1 Demographic data of patients studied

	Caucasians	*Asians*
n	77	39
Sex (male/female)	39/38	20/19
Mean age (years) (SD)	53.3 (10.3)	50.9 (11.7)
Mean body surface area (m^2) (SD)	1.88 (0.19)	1.77 (0.15)*
Associated conditions (*n*) (%):		
chest pain	68 (88)	36 (92)
valvular disease	6 (8)	3 (8)
smokers	14 (18)	4 (10)
diabetes mellitus	4 (5)	8 (39)
hypertension	17 (22)	12 (31)
hyperlipidaemia	14 (18)	7 (18)
Dominance of coronary arteries (*n*)		
right	69	33
left	8	6
balanced	0	0

unpaired t-test, *p=0.0005

spasm, or if there was a previous history of myocardial infarction with recanalisation of the artery.

Films were initially assessed visually by two independent observers (VSR, RK) and caliper measurements further validated using standard quality control analysis software on the digital acquisition system of the cardiac catheter suite (Siemens, Germany). Measurements were made by observers who were blinded with respect to the ethnicity of the patient. The (known) catheter tip diameter was used as the calibration object to assess the size of artery, with the settings of the image intensifier constant. Measurements were uniformly taken in diastole. Each artery was measured in defined segments (figure), and measurements were taken of the widest dimension in each segment. The left main (LM), left anterior descending (LAD) and left circumflex (LCX) coronary arteries were measured in the 30° right anterior oblique projection. The right coronary artery (RCA) was measured in the 60° left anterior oblique projection.

Segments of each epicardial coronary artery were measured as follows:

- LM (left main stem)
- the LAD artery was divided into three segments, the proximal LAD (PLAD) segment (before the first septal), the mid-LAD (MLAD) segment (between first septal and first diagonal), and the distal LAD (DLAD) segment after the diagonal branch of the LAD
- the LCX was also divided into three segments, the proximal LCX (PCX) segment before the obtuse marginal, the distal LCX (DCX) segment after the origin of the obtuse marginal branch, and the first obtuse marginal
- the RCA was divided into two segments, the proximal RCA (PRCA), and the distal RCA (DRCA), where the maximum diameter of posterior descending branch was measured.

Measurements were entered into a spreadsheet and analysed using the Minitab verson 8 statistical software (Minitab, PA, USA). As coronary artery size can be influenced by dominance of the coronary system and the body stature, we matched each coronary angiogram from an Indo-Asian patient with approximately two coronary angiograms of similar dominance from age- (±5 years) and sex-matched Caucasian patients, and also reported mean coronary artery diameter corrected for body surface area. Patient characteristics were compared using the χ^2 test. Continuous variables were expressed as mean (standard deviation, (SD)), and comparisons of means performed using the unpaired *t*-test. A probability of $p<0.05$ was considered statistically significant.

Results

We analysed normal coronary angiograms from 77 Caucasians (39 men, 38 women; mean age 53.3 (SD 10.3) years) and 39 Indo-Asians (20 men, 19 women; mean age 50.9 (SD 11.7) years). There were no significant differences in age or sex ratio between Indo-Asian and Caucasian patients. Associated medical conditions and dominance of coronary arteries are summarised in table 1. The proportion of diabetics was higher in the Indo-Asian group, whilst the proportion of smokers was higher in the Caucasians. The two groups were comparable for dominance of the coronary arteries.

Indo-Asian patients had generally smaller coronary arteries, with a statistically significant difference in the mean diameters of the LM, PLAD, MLAD, PRCA and DRCA segments (table 2). There was also a non-significant trend towards smaller coronary artery segment diameters for the DLAD, PCX, DCX and OM segments. However, after correction for body surface area, none of differences in size of the coronary artery segments between the two groups were statistically significant (table 2). Thus, the smaller coronary arteries in Indo-Asian patients were explained by body size alone and were not due to ethnic origin *per se*.

Table 2 Coronary artery segment sizes in Indo-Asians and Caucasians

	LMS	*PLAD*	*MLAD*	*DLAD*	*PCX*	*DCX*	*OM*	*PRC*	*DRC*
(a) Unadjusted mean diameter (mm) of coronary artery segments									
Indo-Asians	3.98	3.22	2.77	2.26	3.01	2.37	1.96	2.98	1.69
SD	0.67	0.56	0.56	0.60	0.66	0.67	0.53	0.63	0.48
Caucasians	4.44	5.53	3.13	2.44	3.17	2.47	2.08	3.35	2.01
SD	0.91	0.69	0.68	0.62	0.63	0.58	0.62	0.69	0.50
p	0.003	0.012	0.005	0.13	0.22	0.46	0.31	0.006	0.003
(b) Coronary artery segment size adjusted for individual body surface area (mean coronary artery diameter/body surface area)									
Indo-Asians	2.26	1.83	1.57	1.28	1.71	1.34	1.12	1.70	0.97
SD	0.41	0.34	0.29	0.31	0.39	0.37	0.29	0.39	0.27
Caucasians	2.38	1.89	1.68	1.31	1.71	1.32	1.10	1.79	1.06
SD	0.47	0.37	0.37	0.32	0.32	0.29	0.31	0.39	0.26
p	0.15	0.44	0.10	0.63	1.0	0.78	0.86	0.25	0.09

Abbreviations: LMS - left main stem; PLAD/MLAD/DLAD - proximal/mid/distal left anterior descending; PCX/DCX - proximal/distal circumflex; OM - obtuse marginal; PRC/DRC - proximal/distal right coronary artery.

Discussion

This study is limited by its cross-sectional nature of patients attending a city centre teaching hospital and its results may not be generalisable to the population as a whole. In addition, we have studied normal coronary angiograms in patients who had reasons to undergo the investigation, such as chest pain or valvular heart disease, and such patients may not represent a 'normal' population. Nevertheless, undertaking coronary angiography on apparently healthy asymptomatic controls would be unethical, unfeasible and may actually reveal disease. Our technique also measures lumen size rather than artery size, and the higher incidence of diabetes in Indo-Asians may have contributed to a smaller vessel lumen. We have nevertheless demonstrated in the present study that Indo-Asians in general have smaller coronary arteries than Caucasians. When the Indo-Asians were compared to two matched Caucasian subjects to minimise errors, and the data were adjusted for body surface area, however, there were no significant differences in coronary artery size between the two groups, suggesting that differences in size of the coronary arteries were not due to an ethnic difference, but rather to the generally smaller stature of Indo-Asian subjects.

This finding indicates that the cardiologist or cardiothoracic surgeon contemplating revascularisation should be prepared to encounter generally smaller coronary artery segments in Indo-Asian subjects. This would have considerable clinical implications, in view of the widespread increase in coronary interventions such as PTCA, coronary stenting and atherectomy. CABG surgery would also be more difficult in view of the difficulties in anastomoses between saphenous vein grafts or internal mammary conduits to small calibre native coronary arteries. For any intervention, it is the real or absolute size of the coronary arteries that matters. For example, there is some evidence that acute or subacute stent occlusion or thrombosis is more common in vessels less than 2.5 mm in diameter.[11] On smaller calibre arteries, atheromatous disease may give a visual impression of more severe disease when compared to larger diameter arteries. Haemodynamically, this is nevertheless important, as a moderate (say, 60%) stenosis in a 2.5-mm vessel would have more effects on flow than the same degree of stenosis in a 3.5-mm vessel, as the cross-sectional area in the former would be reduced to 1.76 mm^2, compared with 3.46 mm^2 in the larger vessel. Thus, a moderate plaque would cause significant obstruction in a small vessel.

The influence of age, sex, left ventricular mass and vasomotor tone on size of coronary arteries has been previously recognised.[12 13] Indeed, the poorer outcome of women undergoing PTCA or CABG may be related to their smaller coronary arteries. However, we did not quantify left ventricular mass or vasomotor tone as part of this study. The present study is broadly consistent with previous reports of smaller coronary arteries in Indo-Asians,[14 15] although we are not aware of any previous systematic comparison of different disease-free coronary artery segments between Indo-Asians and Caucasians, as in the present study. For example, Saldana *et al*[14] found that the calibre of grafted vessels were smaller in Indo-Asians with a mean diameter of 1.5 mm in 55% of their cohort; Indo-Asians were also reported to have smaller and thinner coronary arteries compared to Caucasians, thus making bypass grafting more difficult. The study by Dhawan and Bray[15] only measured the proximal segments of disease-free coronary arteries in a consecutive series of 72 male Caucasian and 70 male Indo-Asian patients undergoing cardiac catherisation; they derived a total coronary artery diameter by adding the diameters of proximal right, left anterior descending and circumflex arteries, and found that Indo-Asians had significantly smaller total coronary artery diameters and body surface areas, compared with Caucasians. Whilst in the present study we measured disease-free coronary arteries, we quantified not only the proximal segments of individual coronary arteries but also included other coronary artery segments, including the distal disease-free portion, and made adjustments to the mean coronary artery segment diameters for body surface area. This is particularly important since the distal segments of the coronary arteries are frequently used for bypass grafts and performing invasive procedures.

In conclusion, Indo-Asians as a whole have generally smaller coronary arteries than Caucasians, although this may be a reflection of their smaller stature rather than a true size difference. This finding has important therapeutic implications since smaller coronary arteries may result in technical difficulties during bypass graft and intervention procedures such as PTCA, stents and atherectomy. In smaller arteries, atheroma may also result in more severe disease on haemodynamic grounds, compared with larger diameter arteries.

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