

Automatic retinal image analysis (ARIA) to predict coronary artery disease in HIV-infected individuals

Background

People living with HIV (PLWH) had twice the risk of developing cardiovascular diseases than the HIV-uninfected population. Coronary atherosclerosis was common in PLWH. The currently available risk prediction tools for cardiovascular disease are derived from the general population or predominantly Caucasian PLWH. These tools have poorer performance in PLWH of Asian ethnicity. Therefore, more accurate non-invasive tools for prediction of cardiovascular disease, particularly in Asian PLWH, are urgently needed.

It has long been recognized that retinal characteristics are associated with the development of coronary artery disease. Recently, more detailed evaluation of the complex retinal vasculature has been made feasible with advances in digitalized retinal imaging techniques.

This study aims to determine the prevalence of coronary artery disease and the performance of retinal image analysis of the retinal vasculature in predicting coronary atherosclerosis and coronary artery disease in a cohort of PLWH with risk factors for cardiovascular disease in Hong Kong.

Methodology

We performed a prospective cross-sectional study. PLWH followed up at Infectious Diseases Clinic at Prince of Wales Hospital with one or more cardiovascular risk factors were enrolled to the study. We performed coronary CT angiogram for detection of coronary atherosclerosis and obstructive coronary artery stenosis, and automatic retina image analysis to evaluate a wide spectrum of characteristics of retinal vasculature. We determined the association between retinal information and other traditional cardiovascular risk factors and coronary artery disease, using multivariable stepwise logistic regression analyses.

Results

One hundred and twenty participants were enrolled. Two did not perform retinal imaging due to death and loss to follow-up. Three other patients were excluded from analyses due to inadequate images taken from one or both eyes. One hundred and fifteen participants were included in the final analyses.

Seventy-one (62%) had coronary atherosclerosis, while 23 (20%) had obstructive coronary artery disease. Coronary atherosclerosis was associated with age and male gender, and a trend with higher triglycerides and lower HDL cholesterol. The retinal characteristics that were associated with coronary atherosclerosis included left and right adjusted central retinal arteriolar and venular equivalent and bifurcation coefficient of artery, and right venous asymmetry index. Table 1 showed the logistic regression analysis of the variables associated with coronary atherosclerosis using both traditional cardiovascular risk factors and retinal characteristics. Figure 1 and Table 2 showed the comparisons

between area under curves (AUC) for the three different models. Inclusion of both traditional cardiovascular risk factors and retinal characteristics had the best performance in predicting coronary atherosclerosis. Likewise, inclusion of both traditional cardiovascular risk factors and retinal characteristics had the best performance in predicting obstructive coronary artery disease.

Table 1. Stepwise logistic regression analysis showing factors associated with coronary atherosclerosis in different models.

	OR	95% CI for OR		P Value
		Lower	Upper	
Model 1: Inclusion of traditional cardiovascular risk factors only				
Sex	5.27	1.29	21.58	0.021
Age group	1.63	0.96	2.75	0.070
Triglycerides	1.48	0.98	2.25	0.063
AUC: 0.6962 (95%CI: 0.596-0.7965)				
Model 2: Inclusion of retinal characteristics only				
IMBCA	0.69	0.46	1.04	0.079
rCRVE	2.16	1.10	4.24	0.025
radjustedCRAE	0.32	0.15	0.65	0.002
rMVasymmetry	0.58	0.36	0.92	0.020
AUC: 0.7298 (95%CI: 0.6356-0.8241)				
Model 3: Inclusion of traditional cardiovascular risk factors and retinal characteristics				
Sex	16.92	3.05	93.91	0.0012
Triglycerides	1.93	1.26	2.96	0.0026
ICRVE	1.09	1.01	1.18	0.0209
ladjustedCRAE	0.39	0.18	0.84	0.0168
IMBCA	0.53	0.31	0.90	0.0183
IMAangle	0.50	0.29	0.84	0.0094
lExudates	0.60	0.36	1.00	0.0515
IAVR	1.09	1.03	1.16	0.0046
radjustedCRAE	0.46	0.24	0.91	0.0255
rMBCA	0.64	0.35	1.17	0.1495
rTortuosity	0.60	0.36	1.01	0.0533
AUC: 0.8377 (95%CI: 0.7637-0.9117)				

Figure 1. AUC comparison between different models. (Model 1: Inclusion of traditional cardiovascular risk factors only; Model 2: Inclusion of retinal information only; Model 3: Inclusion of traditional cardiovascular risk factors and retinal information).

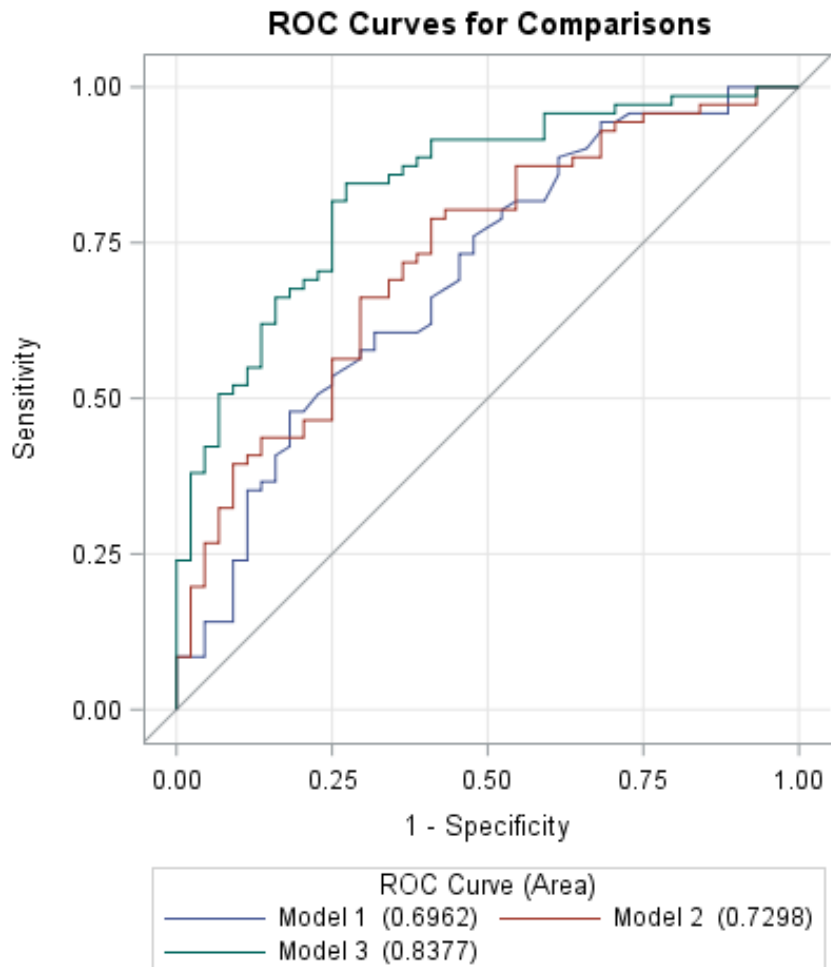


Table 2. Comparison of area under receiver operating characteristic curves (AUC) between different models using DeLong method.

Model comparison	P Value
Model 1 vs Model 2	0.617
Model 1 vs Model 3	0.001
Model 2 vs Model 3	0.037

Conclusion

Our study showed that inclusion of retinal characteristics was feasible and performed better in the prediction of coronary atherosclerosis and obstructive coronary artery disease in PLWH with cardiovascular risk factors than traditional cardiovascular risk factors.