Blood lead level in Chinese adults with and without coronary artery disease

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ABSTRACT

BACKGROUND   The Trial to Assess Chelation Therapy study found that edetate disodium (disodium ethylenediaminetetraacetic acid) chelation therapy significantly reduced the incidence of cardiac events in stable post-myocardial infarction patients, and a body of epidemiological data has shown that accumulation of biologically active metals, such as lead and cadmium, is an important risk factor for cardiovascular disease. However, limited studies have focused on the relationship between angiographically diagnosed coronary artery disease (CAD) and lead exposure. This study compared blood lead level (BLL) in Chinese patients with and without CAD.

METHODS   In this prospective, observational study, 450 consecutive patients admitted to Beijing Anzhen Hospital with suspected CAD from November 1, 2018, to January 30, 2019, were enrolled. All patients underwent coronary angiography, and an experienced heart team calculated the SYNTAX scores (SXscore) for all available coronary angiograms. BLLs were determined with atomic absorption spectrophotometry and compared between patients with angiographically diagnosed CAD and those without CAD.

RESULTS   In total, 343 (76%) patients had CAD, of whom 42% had low (0−22), 22% had intermediate (23−32), and 36% had high (≥ 33) SXscore. BLLs were 36.8 ± 16.95 µg/L in patients with CAD and 31.2 ± 15.75 µg/L in those without CAD ($P = 0.003$). When BLLs were categorized into three groups (low, middle, high), CAD prevalence increased with increasing BLLs ($P < 0.05$). In the multivariate regression model, BLLs were associated with CAD (odds ratio (OR): 1.023, 95% confidence interval (CI): 1.008−1.039; $P = 0.0017$). OR in the high versus low BLL group was 2.36 (95% CI: 1.29−4.42, $P = 0.003$). Furthermore, BLLs were independently associated with intermediate and high SXscore (adjusted OR: 1.050, 95% CI: 1.036−1.066; $P < 0.0001$).

CONCLUSION   BLLs were significantly associated with angiographically diagnosed CAD. Furthermore, BLLs showed excellent predictive value for SXscore, especially for complex coronary artery lesions.

Coronary artery disease (CAD) has become a public health problem in developed and developing countries worldwide, with increasing incidence year by year.[1,2] A large number of studies suggest that heavy metals such as lead, cadmium, and arsenic toxic substances may be important risk factors of CAD, in addition to the known traditional risk factors.[3,4] Recently, in

Chinese population, the relationship of blood lead levels (BLLs) were found independently associated with coronary vascular disease defined as a composite measure including coronary heart disease, myocardial infarction, and stroke.[2] However, the contribution of BLLs to the prevalence of CAD in China is still poorly defined.

The SYNTAX score has been developed and is an

important angiographic grading tool that has recently been used clinically to calculate the complexity of CAD. Few studies have shown a significant relationship between blood lead levels (BLLs) and CAD severity in patients with acute coronary syndromes (ACS).[5] In this study, we evaluated the relationship between SYNTAX score[6] and BLLs and aimed to investigate the ability of BLLs in predicting the complexity of CAD in ACS patients.

METHODS

Study Population

In this cross-sectional study, we enrolled 450 consecutive patients with chest pain suspected of acute coronary syndrome (ACS). All enrolled patients underwent coronary angiography from November 1, 2018, to January 30, 2019, at Beijing Anzhen Hospital affiliated to Capital Medical University. The inclusion criteria were (1) age 18–80 years; (2) presence of angina pectoris or equivalent symptoms; (3) presence of significant stenosis (≥ 50%) in at least one large vessel of the three coronary arteries; and (4) diagnosis as per the diagnostic criteria for ACS in the 2007 Heart Disease Guideline.[7] Patients with a history of congestive heart failure, ectasia, valvular heart disease, hyperthyroidism, and chronic obstructive pulmonary disease were excluded from the study.

Our study complied with the principles of the Declaration of Helsinki, and the research protocol was approved by the Ethics Committee of Beijing Anzhen Hospital (approval no. 2018060X). Informed consent was obtained from the participants or their legal representatives. The trial was registered at the Chinese Clinical Trial Registry, ChiCTR (http://www.chictr.org.cn/; identifier ChiCTR2000 031696).

Clinical and Laboratory Data Collection

Medical records were reviewed for clinical characteristics, medications, and laboratory results. Collected data included age, sex, diabetes, hypertension, and current medications (including antiplatelet agents, anticoagulants, angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, beta blockers, calcium channel blockers, diuretics, nitrates, and statins). Demographic data, including educational background, alcohol use, and smoking history, were obtained. Current smoking was defined as having smoked at least 100 cigarettes in a lifetime and currently smoking cigarettes. Current alcohol use was defined as alcohol intake more than once per month (200 mL unit at a time) during the past 12 months.[8] Educational background was divided into three categories: lower than high school, high school graduate, and beyond high school.[2] Fasting blood samples of hemoglobin A1c, uric acid, total cholesterol, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, triglycerides, C-reactive protein (CRP), serum creatinine (Cr), and homocysteine levels were obtained and analyzed using automated enzymatic assays. Quantification of lead in whole blood samples, which entails extensive quality control, was performed using graphite furnace atomic absorption spectrophotometry.[5,9]

Angiographic and SXscore Analysis

Coronary angiography was performed using the radial artery approach. At least four orthogonal plane images were obtained for the right and left coronary arteries. Philips Allura Xper FD10 cardiovascular X-ray system (Philips Healthcare/Philips Medical Systems BV, Eindhoven, the Netherlands) was used for angiography. CAD was diagnosed when there was at least 50% diameter stenosis of a major coronary artery including the right coronary artery, left main artery, left anterior descending artery, and left circumflex artery. The SXscore system was used as a grading tool to determine CAD complexity and to further guide revascularization[10] and was calculated by two experienced interventional cardiologists who were blinded to patient data. Using the SXscore calculator 2.28 (available online at www.SYNTAXscore.com), the SXscore was calculated as the sum of points assigned for all coronary lesions with > 50% diameter stenosis in vessels with a diameter of > 1.5 mm.

The following terms were defined based on the tutorial available online at www.SYNTAXscore. com: dominance, total occlusion, trifurcation, bifurcation, aorto-ostial lesion, severe tortuosity, heavy calcification, thrombus, and diffuse disease. An SXscore of ≥ 23 was defined as intermediate to high SXscore.[9]

Statistical Analysis

Continuous variables were expressed as means ± SD, and categorical variables were expressed as percentages. Continuous variables were

compared using the unpaired t-test or Wilcoxon rank sum test, and categorical variables were compared using Fisher's exact test or χ^2 tests as appropriate. Pearson's correlation coefficient was calculated to assess the linear correlation between BLLs and SXscore.

Univariate binary logistic regression analysis was performed to investigate the association between intermediate/high SXscore and different variables. Then, multiple regression analysis was performed to detect independent variables. Variables with a significance level of $P < 0.10$ in the univariate model were entered into the multivariable model. We used the receiver operating characteristic (ROC) curve to evaluate the ability of BLLs to predict CAD and intermediate/high SXscore. While comparing the area under the ROC curve (AUC) of the presence of CAD with the AUC of intermediate/high SXscore, a two-sided P value of < 0.05 was considered significant. We also estimated AUC improvement using the methods of DeLong, et al. [4] All statistical analyses were performed with the SPSS version 22 for Windows (IBM Corp., Armonk, NY, USA).

RESULTS

Patient Characteristics

During the study period, 450 patients (mean age: 59 ± 9.8 years; 31% women) met the inclusion criteria. Baseline characteristics are summarized in Table 1. CAD was present in 343 (76%) patients, of whom 310 (90%) presented with unstable angina, 28 (8%) with non-ST segment elevation myocardial infarction, and 5 (2%) with ST segment elevation myocardial infarction.

Angiographic findings and medications are also summarized in Table 1. The mean BLL of our cohort was 35 ± 17 µg/L, and 87 (19%) patients had BLLs of ≥ 50 µg/L. The distribution of SXscore was as follows: 107 (2623.7%) with 0, 80 (18%) with low (0−22), 101 (22%) with intermediate, and 163 (36%) with high (≥ 33) scores. From the baseline character-

istics of the enrolled patients, we compared the zero/low ($n = 187$) and intermediate/high ($n = 263$) SXscore groups. Results showed that smoking and BLLs were significantly correlated with CAD sever-

Table 1 Baseline characteristics of the enrolled patients.

Variables ($n = 450$)	
Age, yrs	59 ± 9.8
Gender (M/F)	311/139
Smoker (current/no)	166/284
Drinker (current/no)	124/326
HTN	267 (59.3%)
DM	148 (32.9%)
Dyslipidemia	413 (91.7%)
Coronary artery disease	343
UAP	310
NSTEMI	28
STEMI	5
Education levels	
< high school	125 (27.7%)
high school	255 (56.6%)
> high school	70 (15.7%)
BMI, kg/m²	25.90 ± 3.12
Ca^{2+}, mmol/L	1.75 ± 0.23
Phosphorus, mmol/L	1.20 (1.07, 1.31)
Mg^{2+}, mmol/L	1.26 (1.17, 1.42)
Lead, µg/L	35.60 ± 16.82
≥ 50 µg/L, n =87	60.10 ± 10.32
< 50 µg/L, n =363	29.50 ± 11.28
CHO, mmol/L	4.16 (3.54, 4.86)
TG, mmol/L	1.40 (1.01, 2.11)
LDL, mmol/L	2.49 ± 0.79
HDL, mmol/L	1.16 ± 0.29
CRP, mg/L	1.16 (0.48, 3.16)
Hcy, µmol/L	12.40 (9.40, 16.20)
Cr, µmol/L	70 ± 18
HbA1c	5.90% (5.50%, 6.82%)
Aspirin	427 (95.5%)
Antihypertensive drug	275 (61.1%)
Antidiabetic agents	138 (31.1%)
Statin use	308 (68.4%)
Lesion involved	
LAD	189 (42%)
LCX	150 (33%)
RCA	176 (39%)

Continued

Variables ($n = 450$)	
SXscore	24.6 ± 18.3
Zero	107 (23.7%)
Low (0–22)	80 (17.7%)
Intermediate (23–33)	101 (22%)
High (> 33)	162 (36%)

Data are presented as n (%) or median (Q1, Q3). BMI: body mass index; CAD: Coronary artery disease; Cr: serum creatinine; CRP: C-reactive protein; DM diabetes mellitus; HbA1c: glycated hemoglobin; HCY: homocysteine; HDL: high density lipoprotein; HTN: hypertension; LAD: left anterior descending; LCX: left circumflex; LDL: Low-density lipoprotein; NSTEMI: non-ST elevation myocardial infarction; STEMI: ST elevation myocardial infarction; TC: cholesterol; TG: triglyceride; UAP: unstable angina pectoris; RCA: right coronary artery.

ity ($P < 0.05$), but there was no significant correlation between SXscore and alcohol consumption, education level, and body mass index ($P > 0.05$). We also observed a positive correlation between diabetes mellitus, dyslipidemia, renal function, and severity of CAD ($P < 0.001$; Table 2).

Correlation between SXscore and BLLs

Figure 1 shows the correlation between SXscore and BLLs. The strongest correlation was found between BLLs and high SXscore ($n = 162$, $r = 0.52$, $P < 0.001$). A strong correlation was also observed between BLLs and all patients ($n = 450$, $r = 0.24$, $P = 0.034$). In addition, a weak but statistically significant correlation was noted between BLLs and intermediate SXscore ($n = 101$, $r = 0.24$, $P = 0.034$). In contrast, the correlation between BLLs and low SXscore was not significant ($n = 80$, $r = 0.03$, $P = 0.42$).

Association of BLLs with CAD and SXscore

In the univariate logistic regression analysis, age, sex, hyperlipidemia, diabetes mellitus, BLLs, and LDL, CRP, and Cr levels were significantly associated with CAD. The odds ratio (OR) of BLLs in this model was 1.022 (95% confidence interval [CI]: 1.009–1.037; $P = 0.0014$). As shown in Table 3, in the multivariate logistic model, after adjusting for confounding factors, BLLs remained independently associated with the presence of CAD (OR = 1.023; 95% CI: 1.008–1.039; $P = 0.0017$).

In addition, in the univariate logistic regression model, age, sex, diabetes mellitus, BLLs, CRP level, and Cr level were significantly associated with an intermediate/high SXscore. The OR of BLLs in this model was 1.049 (95% CI: 1.035–1.064; $P < 0.0001$). As shown in Table 4, in the multivariate logistic model, after adjusting for confounding factors, BLLs remained independently associated with intermediate/high SXscore (OR = 1.050; 95% CI: 1.036–1.066; $P < 0.0001$). Then, we analyzed the association between low BLLs and CAD and between low BLLs and intermediate/high SXscore. Interestingly, low BLLs remained independently associated with the presence of CAD (OR = 1.026; 95%: CI 1.006–1.050; $P = 0.014$) (Figure 2A) and intermediate/high SXscore (OR = 1.060; 95% CI: 1.044–1.090; $P < 0.0001$) in the fully adjusted model (Figure 2B).

In the ROC analysis, the AUC statistics for the presence of CAD was 0.62 (95% CI: 0.54–0.67; $P = 0.001$) (Figure 3A). The AUC of BLLs to predict intermediate/high SXscore was 0.71 (95% CI: 0.66–0.78; $P = 0.001$) (Figure 3B). The difference between the two ROC curves was statistically significant (AUC difference = 0.09, $P = 0.02$) (Figure 3C). When we set the cut-off value of BLLs at 30.8 μg/L, the sensitivity and specificity for intermediate/high SXscore were 78% and 68%, respectively. Similarly, a cut-off value of 29.2 μg/L presented a sensitivity and specificity for CAD of 71% and 68%, respectively. Figure 4 presents a few cases of patients with their corresponding BLLs and angiographic findings.

DISCUSSION

In this study, we measured BLLs in Chinese adults with suspected ACS undergoing coronary angiography. The major findings of our study were as follows: BLLs (including low levels) were associated with both the presence of angiographically proven CAD and intermediate/high SXscore. These associations were independent of clinical confounders, including age, sex, diabetes mellitus, and CRP level.

Many studies showed an association between lead exposure and increased cardiovascular risk and all-cause mortality.[6,11-14] The contribution of BLLs to the prevalence of CAD in China is still poorly defined. A survey on the prevalence of metabolic diseases and risk factors in East China (SPECT-China) identified that BLLs were independently as-

Table 2   Baseline characteristics of the enrolled patients (zero/low *vs.* intermediate/high SXscore groups).

	Zero/low (n = 187)	Intermediate/high (n = 263)	P-value
Age, yrs	58 ± 10	60 ± 9	0.002**
Gender (M/F)	108/79	203/60	0.0001**
Smoker (current/no)	108/155	58/129	0.028**
Drinker (current/no)	44/143	80/183	0.105
HTN	104 (55.6%)	163 (61.9%)	0.176
DM	51 (27.3%)	97 (36.8%)	0.031*
Dyslipidemia	166 (88.77%	247 (93.92%)	0.054*
Coronary artery disease	80 (42%)	263 (100%)	< 0.001**
UAP			
NSTEMI			
STEMI			
Education levels			
< High school	56 (29.95%)	69 (26.24%)	0.67
High school	102 (54.55%)	153 (58.17%)	
> High school	29 (15.51%)	41 (15.59%)	
BMI, kg/m^2	26.1 ± 3.1	26.2 ± 3.0	0.62
Ca^{2+}, mmol/L	1.69 (1.56, 1.96)	1.68 (1.57, 1.93)	0.72
Phosphorus, mmol/L	1.19 (1.08, 1.33)	1.21 (1.08, 1.30)	0.84
Mg^{2+}, mmol/L	1.28 (1.18, 1.41)	1.25 (1.17, 1.42)	0.26
Lead, μg/L	28 ± 14	40 ± 16	< 0.001**
CHO, mmol/L	4.26 (3.63, 4.92)	4.06 (3.54, 4.86)	0.43
TG, mmol/L	1.34 (0.99, 2.05)	1.46 (1.02, 2.17)	0.66
LDL, mmol/L	2.54 ± 0.83	2.46 ± 0.75	0.31
HDL, mmol/L	1.22 ± 0.27	1.11 ± 0.30	0.0001**
CRP, mg/L	0.98 (0.42, 2.56)	1.39 (0.51, 4.04)	0.0021**
Hcy, μmol/L	12.5 (9.1, 17.20)	12.3 (9.50, 15.80)	0.58
Cr, μmol/L	66 ± 16	72 ± 18	0.002**
HbA1c, %	5.8% (5.5%, 6.4%)	6.1% (5.60%, 7.10%)	0.47
Aspirin	164 (89%)	263 (100%)	0.0001**
Antidiabetic agents	44 (23%)	94 (35%)	0.0052**
Statin use	103 (55%)	172 (65%)	0.027**

Data are presented as n (%) or median (Q1, Q3). BMI: body mass index; Cr: serum creatinine; CRP: C-reactive protein; DM: diabetes mellitus; HbAC1: glycated hemoglobin; HCY: homocysteine; HDL: High density lipoprotein; HTN: hypertension; LDL: Low-density lipoprotein; MI: body mass index; NSTEMI: non-ST elevation myocardial infarction; STEMI: ST elevation myocardial infarction; TC: cholesterol; TG: triglyceride; UAP: unstable angina pectoris. *P < 0.05, **P < 0.01

sociated with the prevalence of cardiovascular disease.[2] Our findings are consistent with previously reported data. However, there were several differences between the present study and SPECT-China: (1) the present study recruited inpatients instead of community population; (2) all enrolled patients underwent coronary angiography; and (3) BLLs were also established to be independently associated with the severity/complexity of coronary artery lesions.

In our study, we established that BLL was a stronger predictor of angiographically diagnosed CAD in ACS patients. In addition, our study showed that BLLs are an independent predictor of intermediate/high SXscore. Interestingly, this correlation was present only with intermediate/high SXscore group, which

Table 3 Association of variables with the presence of coronary artery disease (multivariate logistic regression model).

Variable	Unadjusted OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Age, per 10 yrs	1.030 (1.004−1.049)	0.019	1.029 (1.003−1.056)	0.027*
Gender (male)	3.092 (1.972−4.874)	< 0.0001	3.250 (1.830−5.830)	<0.0001**
BMI, kg/m^2	0.990 (0.920−1.067)	0.860		
Hyperlipidemia	3.452 (1.720−6.870)	0.0004	4.06 (1.805−9.240)	0.0008**
Hypertension	1.250 (0.810−1.940)	0.3130		
DM	1.962 (1.192−3.323)	0.0069	1.970 (1.152−3.470)	0.0130*
Lead, µg/L	1.022 (1.009−1.037)	0.0014	1.023 (1.008−1.039)	0.0017**
Ca^{2+}, mmol/L	1.190 (0.460−3.120)	0.7120		
TC, mmol/L	1.004 (0.990−1.077)	0.6900		
TG, mmol/L	1.130 (0.980−1.390)	0.1512		
LDL, mmol/L	0.690 (0.540−0.912)	0.0093		
CRP, mg/L	1.072 (1.020−1.150)	0.0043	1.087 (1.028−1.166)	0.002**
Hcy, µmol/L	1.002 (0.978−1.020)	0.8290		
Cr, µmol/L	1.023 (1.010-1.042)	0.0005	1.018 (1.001−1.035)	0.001**
Current smoker	1.590 (1.002−2.570)	0.0490		
Current drinker	1.420 (0.860−2.410)	0.1720		

BMI: body mass index; Cr: serum creatinine; DM: diabetes mellitus; Hcy: homocysteine; LDL: low-density lipoprotein; TC: cholesterol; TG: triglyceride; *P < 0.05, **P < 0.01.

Table 4 Association of variables with intermediate/high SXscore (multivariate logistic regression model).

Variables	Unadjusted OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Age, per 10 years	1.026 (1.006−1.046)	0.0086	1.026 (1.003−1.051)	0.027*
Gender, male	2.470 (1.642−3.730)	< 0.0001	2.78 (1.670−4.690)	< 0.0001**
BMI, kg/m^2	0.980 (0.920−1.046)	0.626		
Hyperlipidemia	1.950 (0.990−3.910)	0.052		
Hypertension	1.320 (0.890−1.920)	0.176		
DM	1.552 (1.039−2.353)	0.0032	1.630 (1.036−2.610)	0.0345*
Lead, µg/L	1.049 (1.035−1.064)	< 0.0001	1.050 (1.036−1.066)	< 0.0001**
Ca^{2+}, mmol/L	1.158 (0.520−2.630)	0.720		
TC, mmol/L	1.006 (0.990−1.113)	0.590		
TG, mmol/L	1.018 (0.940−1.124)	0.668		
LDL, mmol/L	0.878 (0.690−1.130)	0.316		
CRP, mg/L	1.065 (1.023−1.114)	0.0034	1.070 (1.020−1.120)	0.001**
Hcy, µmol/L	1.004 (0.980−1.022)	0.590		
Cr, µmol/L	1.018 (1.006−1.032)	0.0014	1.016 (1.010−1.030)	0.0018**
Current smoker	1.550 (1.046−2.320)	0.0280		
Current drinker	1.440 (0.920−2.190)	0.1020		

BMI: body mass index; Cr: serum creatinine; DM: diabetes mellitus; Hcy: homocysteine; LDL: Low-density lipoprotein; TC: cholesterol; TG: triglyceride. *P < 0.05, **P < 0.01.

implies that BLLs may offer an additional consideration for the choice of revascularization: coronary artery bypasses grafting *vs.* percutaneous coronary intervention.[15]

Theoretically, The cardiovascular toxicity of lead stems from various mechanisms including oxidative stress, inflammation, endothelial dysfunction, and progression of atherosclerosis.[6,9,11,16] These mechanisms suggest, but are not sufficient to infer, a causal relationship between lead levels and cardi-
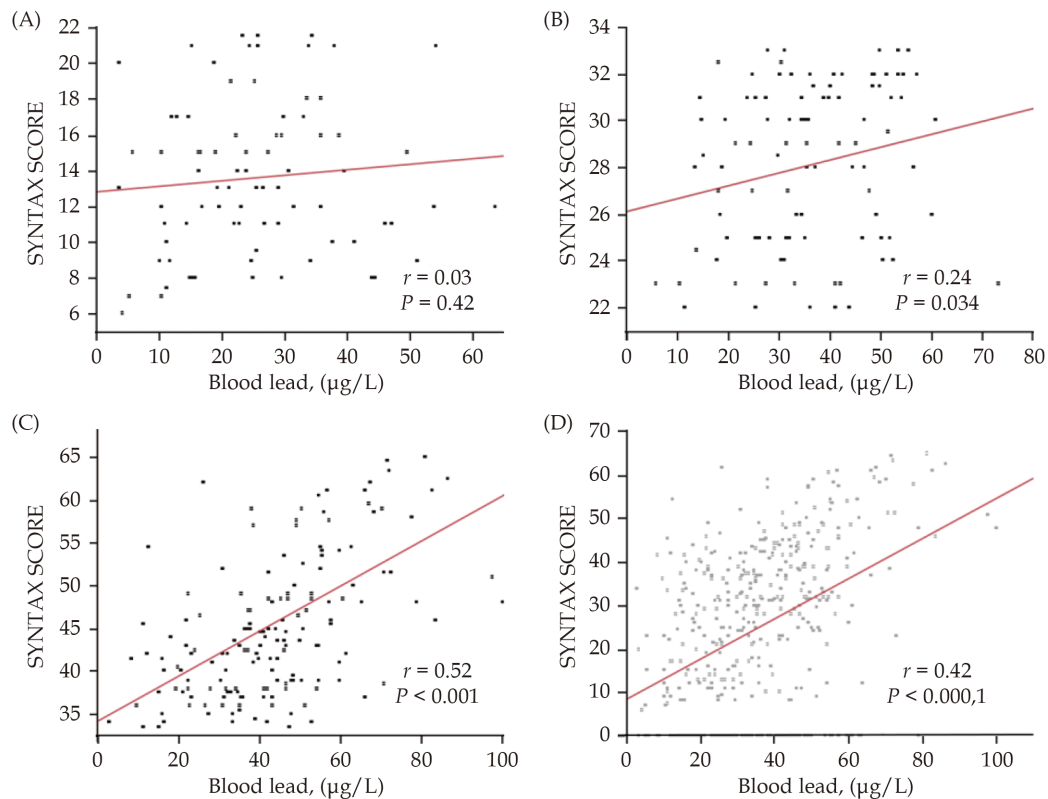
Figure 1   Correlation between blood lead levels and SXscore. (A): Low SXscore group (n = 80); (B): intermediate SXscore group (n = 101); (C): high SXscore group (n = 162); and (D) including all the enrolled patients (n = 450).
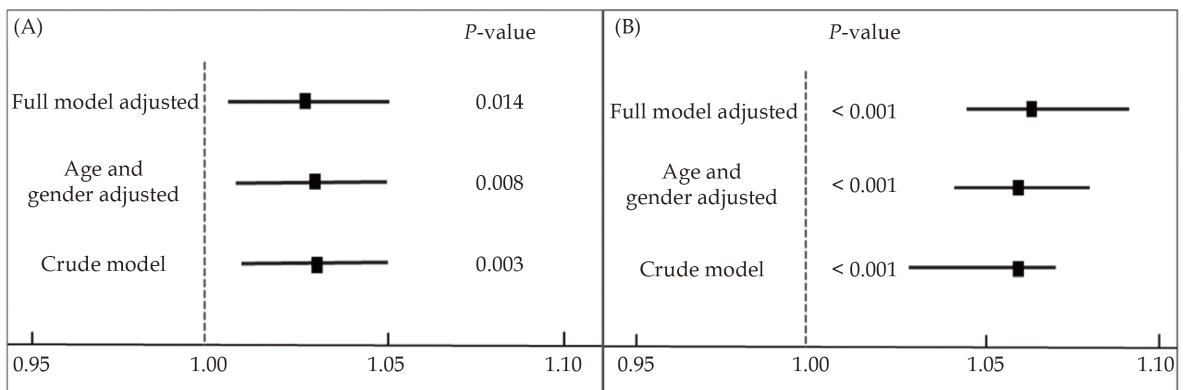

Figure 2   Association of low blood lead levels (< 50 μg/L) with the presence of CAD and intermediate/high SXscore: logistic regression analysis. (A): Prevalence of CAD; (B): intermediate/high SXscore. Fully adjusted model included age, gender, hyperlipidemia, DM, CRP, Cr and current smoking. CAD: coronary artery disease; DM: diabetes mellitus; CRP: C-reactive protein; Cr: serum creatinine.

ovascular disease.[17] Additionally, the SXscore takes into account complex lesions including bifurcations, chronic total occlusions, and calcification, as well as thrombus, which play an important role in triggering the process of ACS. Therefore, we first clarified that heavy metals can lead to a series of physiopathological changes in ACS.

So far, a safe BLL has not been established, since even low level exposure can increase the risk of cardiovascular injury in high-risk populations, including peripheral artery disease, hypertension, and diabetes. In our study, BLLs of < 50 μg/L remained an independent predictor of cardiovascular disease. This is in line with prior study that showed that BLL of any level is unsafe.[18] Therefore, low-level lead exposure is an important, largely overlooked risk factor for coronary and vascular disease.
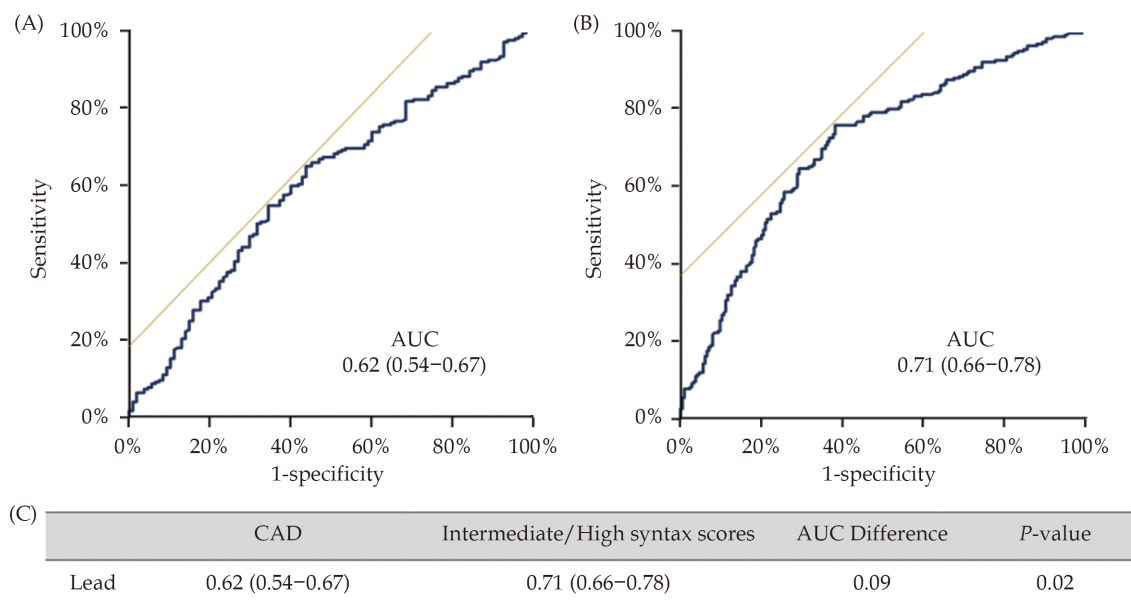
Figure 3   ROC analysis: predicting the presence of CAD and intermediate/high SXscore. The receiver-operating characteristic curve for the blood lead to identify patients with CAD (A) and with intermediate or high SXscore (B). (C): A significant AUC improvement of intermediate or high SXscore when compared with CAD was observed. AUC: area under the curve; CAD: coronary artery disease; ROC: receiver operating characteristic curve.
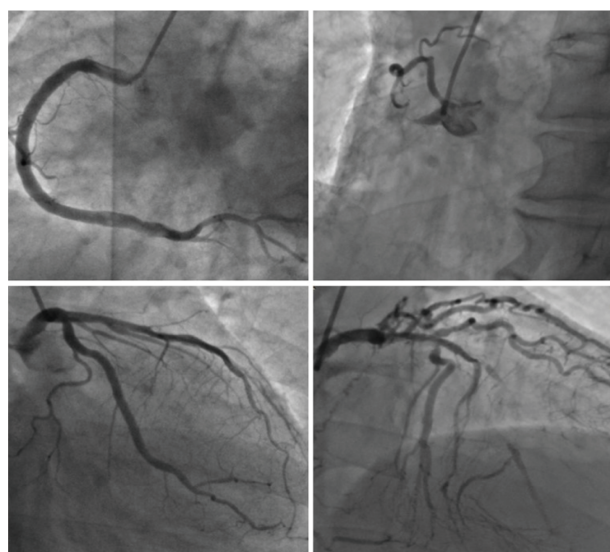

Figure 4   Representative case of blood lead levels with corresponding angiographic findings. left side: normal coronary artery, SXscore = 0, blood lead level = 32 µg/L; right side: three-vessel coronary artery disease, SXscore score = 25, blood lead level = 62 µg/L.

Clinical Implications

The Trial to Assess Chelation Therapy study found that edetate disodium (disodium ethylenediamine-tetraacetic acid, EDTA) chelation therapy significantly reduced cardiac events in stable post-myocar-dial infarction[19] and diabetic patients.[20] Evidence on the efficacy and safety of chelation therapy with disodium EDTA (edetate) in preventing CAD remains limited. Our study adds new evidence to previous studies and helps strengthen implications in the clinical setting. For clinicians, BLLs can provide substantial therapeutic information. They can serve as an auxiliary factor in the assessment of CAD.

Strengths and Limitations

Our study has several strengths. First, previous studies recruited community population in industrial areas through a self-reported questionnaire.[21–23] In the present study, CAD was defined by coronary angiography. So far, this is the largest study to date that explored the association of lead exposure and cardiovascular risk in patients undergoing coronary angiography. Second, we observed a significant association between BLLs and intermediate/high SXscore CAD even in those with low BLLs. In addition, the association between BLLs and intermediate/high SXscore was also observed in ACS patients.

However, our study has intrinsic limitations related to the relatively small sample size compared with community-based studies. In addition, lead level was assessed using blood samples and not bone samples, which can better assess the cumulat-

ive lead exposure associated with cardiovascular disease. Finally, we did not consider heavy metal exposure, such as cadmium, which might have confounded the lead-associated prevalence of CAD.

CONCLUSION

In this study, both the presence of angiographically diagnosed CAD and complexity of coronary artery lesions were significantly associated with BLLs. BLLs can assist clinicians in the evaluation of cardiovascular risk and initiation of preventive measures to lower the risk of CAD. Whether BLLs are helpful in stratifying CAD patients and in determining the best choice of revascularization warrants further investigation.

ACKNOWLEDGEMENTS

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