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BRIEF COMMUNICATION

Evaluation Of Cobalt and Chromium Levels Following Implantation of Cobalt Chromium Coronary Stents: A Pilot Study

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Background Large increases in myocardial trace elements may adversely affect metabolism and become detrimental to cardiac function. Percutaneous coronary intervention (PCI) allows for the revascularisation of obstructive coronary artery disease using drug-eluting stents. These stents are comprised of a metallic stent backbone covered in an engineered polymer which delivers a drug over a prescribed period to the vessel wall. Given the potential implications of trace metal accumulation within the myocardium, our goal is to determine if metallic coronary stents are able to cause detectable elevations in serum cobalt and/or chromium levels.

Methods This study was a single centre, observational, pilot study with 20 patients who underwent planned PCI with implantation of a cobalt chromium drug eluting stent. Serum blood samples were drawn at baseline prior to PCI, 4 hours post-stent deployment and at the time of routine follow-up after PCI. All blood samples were analysed for cobalt and chromium concentrations. The primary outcome of this study was the difference in serum cobalt and chromium levels at routine clinical follow-up.

Results The mean follow up was 64.1 ± 17.3 days. There was no difference in serum cobalt levels when comparing baseline and routine clinical follow up (3.32 ± 2.14 nmol/L vs. 3.14 ± 1.00 nmol/L, $p = 0.99$) nor in chromium levels (4.24 ± 2.31 nmol/L vs. 2.82 ± 1.22 nmol/L, $p = 0.11$). There was also no difference between baseline and 4 hours post-PCI serum concentrations.

Conclusions Percutaneous coronary intervention with cobalt chromium coronary stents does not appear to cause an elevation in these trace element serum concentrations.

Keywords Cobalt • Chromium • Cardiomyopathy • Trace metals • Percutaneous coronary intervention • Drug eluting stents

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Introduction

Trace elements play crucial roles in myocardial metabolism and disruptions in the levels of these elements may lead to cardiac dysfunction. In particular, myocardial cobalt accumulation is known to be associated with dilated cardiomyopathy [1]. First described in 1967 [2], cobalt cardiomyopathy has been increasingly studied [3], including elevated cobalt levels stemming from metal-on-metal hip arthroplasties leading to cardiologic, neurologic, and endocrinologic dysfunction [4]. Thresholds of what constitutes organ specific toxic concentrations of cobalt have not yet been well defined [5] although levels above seven parts per billion, which is equivalent to 119 nmol/L cobalt or 134.5 nmol/L chromium, are considered to be unsafe [6].

Percutaneous coronary intervention (PCI) remains a standard of care for the revascularisation of obstructive coronary artery disease. The current state of the art in coronary stenting involves modern drug-eluting stents—comprised of a metallic stent backbone covered in an engineered polymer which delivers drugs over a prescribed period to the vessel wall [7]. Advancements in the metallic struts as the backbone for treating obstructive coronary artery disease include the use of stainless steel, platinum chromium, and cobalt chromium metals. In particular, cobalt chromium stents are commonly used within many centres worldwide.

Given the potential implications of trace metal accumulation within the myocardium, our goal is to determine if coronary stents, which are only micrometres in thickness and millimetres in length, are able to cause detectable elevations in cobalt and/or chromium serum levels.

Methods

Design

This study was a single centre, observational, pilot study with 20 patients who were undergoing planned PCI with implantation of a cobalt-chromium drug eluting stent, either with Xience V (Abbott Vascular, Santa Clara, California, USA) or Resolute Integrity (Medtronic, Santa Rosa, California, USA) stents. Informed consent was obtained from each patient. The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in *a priori* approval by the institution's human research committee.

Blood Samples

Blood samples were drawn at baseline prior to PCI, 4 hours post-stent deployment and at the time of routine follow-up after PCI. The blood samples were spun at 3000 rpm for 10 minutes and then stored in a −20° C freezer until sampling was performed. All samples were analysed for quantification of serum cobalt and chromium levels in a single third party laboratory.

Inclusion/Exclusion Criteria

The inclusion criteria for this study were broad and included all patients greater than 18 years of age awaiting PCI with cobalt-chromium stents. Patients were excluded if they had previous PCI, non-cobalt chromium stents deployed at time of their procedure, previous cobalt-based arthroplasties,

Table 1 Patient and procedural characteristics.

	Participants
Men	14 (70%)
Age, y	62.9 (8.8)
Height, m	1.7 (0.1)
Weight, kg	88.7 (16.0)
Body mass index, kg/m^2	29.4 (4.4)
Medical co-morbidities/history	
Hypertension	13 (65%)
Diabetes	2 (10%)
Smoking	8 (40%)
Family history of premature CAD*	3 (15%)
Dyslipidaemia	11 (55%)
Previous myocardial infarction	4 (20%)
Previous CABG	1 (5%)
Previous stroke	1 (5%)
Chronic kidney disease	0 (0%)
Dialysis	0 (0%)
Congestive heart failure	1 (5%)
Medications	
ACEI/ARB	8 (40%)
Beta blocker	10 (50%)
Statin	15 (75%)
ASA	18 (90%)
Clopidogrel/Ticagrelor	17 (85%)
Therapeutic anticoagulation	3 (15%)
Nitrate	3 (15%)
Indication for PCI	
Stable angina	10 (50%)
Acute coronary syndrome	7 (35%)
Chronic total occlusion	3 (15%)
Location	
Right coronary artery	8 (40%)
Left anterior descending	7 (35%)
Left circumflex	5 (25%)
Total no. stents inserted	1.95 (0.8)
Total length of stents, mm	56.7 (23.6)
Deployment pressure, atm	15.0 (2.8)
Maximum post-dilatation pressure, atm	18.9 (3.9)

Abbreviations: ACEI/ARB: angiotensin converting enzyme inhibitor/angiotensin receptor blocker; CABG: coronary artery bypass surgery; CAD: coronary artery disease; PCI: percutaneous coronary intervention.
*Defined as having a first-degree relative with clinically overt CAD (myocardial infarction, angina pectoris, need for coronary artery revascularisation) before age 55 (men) or 65 (women).

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