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Improved Coronary Sinus Blood Sampling for Cardiac Research

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Abstract

Background: Coronary sinus (CS) blood sampling is important for measuring metabolites and biomarkers in cardiovascular research, but can be technically challenging. Here we demonstrate the use of the antecubital fossa for CS blood sampling as an alternative to femoral access, and a simple technique of paired venous and CS blood gas analysis for confirmation of valid CS sampling. We also demonstrate improvement in sampling accuracy by using a coronary guide wire to stabilize the sampling catheter in the CS.

Methods: Paired blood samples from CS and peripheral vein were collected from patients at the time of primary PCI for acute myocardial infarction. Venous access for CS sampling was *via* the antecubital vein. Blood gas analysis was used to confirm a true CS sample (pO_2[CS]<pO_2[v]). CS sampling was carried out with a catheter in the CS (standard technique) or with the addition of a coronary guide wire for stability (modified technique).

Results: 108 patients underwent CS and peripheral venous blood sampling. The standard technique for CS sampling was used in 62 patients and the modified technique in 46 patients. Blood gas analysis confirmed a true CS sample in 77% of patients using the standard technique and 100% using the modified technique.

Conclusions: CS blood sampling *via* the antecubital fossa is feasible and safe. Blood gas analysis of paired venous and CS samples can be used to confirm a valid CS sample. A coronary guide wire can be used to stabilise the sampling catheter in the CS, and this increases CS sampling accuracy.

Keywords: Cardiac biomarkers; Coronary sinus; Myocardial infarction

Introduction

Sampling blood from the coronary sinus allows direct analysis of venous blood draining from the heart, enabling quantification of cardiac release of biomarkers and metabolites, and detection of analytes which may be undetectable in the systemic circulation [1-4]. The coronary sinus is typically accessed using a catheter from the femoral vein [5]. However, maintaining catheter position in the coronary sinus can be challenging, and a technique using a coronary guide wire to stabilize catheter position has been described previously [6]. However, it is frequently unclear whether a blood sample from a CS catheter is truly drawn from CS blood, and this uncertainty may adversely affect the biological and statistical power of studies that aim to discover new cardiac-specific biomarkers, or quantify cardiac biomarker release.

Coronary sinus sampling for clinical research is typically undertaken as part of cardiac catheterization or percutaneous coronary intervention (PCI), which are now carried out *via* the radial rather than the femoral artery, due to reduced mortality and bleeding risk [7]. With this change, it is becoming more difficult to justify additional femoral venous access for clinical research.

Here, we describe a modified technique for CS sampling from an antecubital vein thus avoiding the use of femoral venous access in an anti-coagulated patient, with the attendant risk of bleeding. We demonstrate sample collection using the standard technique (using a catheter in the coronary sinus) and the modified technique (using a catheter in the coronary sinus with a guidewire for stability). We hypothesize that sampling accuracy, determined using blood gas analysis to confirm the coronary sinus sample is a true coronary sinus sample, will be increased by using the modified technique.

Methods

Paired coronary sinus and peripheral venous blood samples were collected from patients undergoing primary PCI participating in the Oxford Acute Myocardial Infarction (OxAMI) study.

All patients underwent PCI *via* radial artery access. Blood gas analysis of pO_2 was carried out on all samples. The protocol was approved by the National Research Ethics Service Committee South Central – Oxford (REC reference: 11/SC/0397).

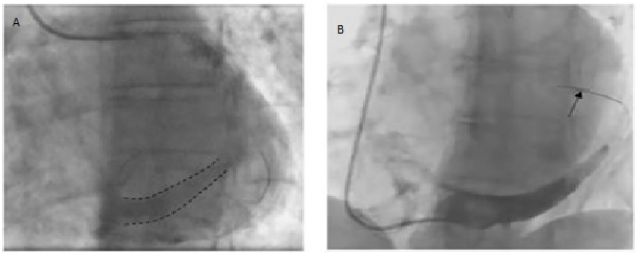

Figure 1: A) Visualization of the CS ostium through contrast injection and image acquisition in the left anterior oblique (LAO) position; **B)** Confirmation of the Catheter position with a 2 mL contrast injection under fluoroscopic guidance.

The CS sampling method was as follows:

1. Once the culprit vessel was successfully treated with primary PCI, a final contrast injection and image acquisition were carried out with the image intensifier in the left anterior oblique (LAO) position, so that the location of the CS ostium could be visualised. This acquisition was used to provide landmarks for successful CS intubation (Figure 1A).
2. Under aseptic conditions, a standard 20G cannula was placed into a superficial vein in the right antecubital fossa.
3. A 6F radial sheath was prepared and the sheath guide wire was passed into the 20G cannula. The cannula was then exchanged for the sheath.
4. A hydrophilic coated guide wire (e.g. Terumo J (Terumo Corporation, Tokyo, Japan)) was passed into the sheath and advanced through the right atrium and into the inferior vena cava under fluoroscopic guidance.
5. A 6F CAS II catheter (Cordis Corporation, Fremont, California, USA) was advanced along the wire to the IVC and the guide wire removed.
6. With the image intensifier in the LAO position, the catheter was withdrawn and steered into the CS, using the landmarks identified in step 1.
7. Catheter position was confirmed with a 2 mL contrast injection under fluoroscopic guidance (Figure 1B). For the standard technique, a blood sample was then gently aspirated. For the modified technique, a coronary guidewire (e.g. Balanced Middleweight Universal (Abbott, Chicago, USA)) was advanced in the CASII catheter into the CS before sample aspiration. If the catheter was not fully engaged it was advanced over the wire to ensure optimal placement in the CS.
8. A paired sample was then collected from a peripheral vein.
9. Blood gas analysis was carried out on both samples to assess sample quality: a sample was assumed to be a true CS sample where pO_2[CS] was less than pO_2[V].

Results

108 patients underwent coronary sinus and peripheral venous blood sampling using a 5F sheath inserted into a vein in the antecubital fossa. Samples were collected without the use of a coronary guide wire (the 'standard technique') or using a coronary guide wire to stabilise the catheter (the 'modified technique').

62 patients underwent paired CS and peripheral venous sampling using the standard technique. No complications related to CS sampling occurred. A true coronary sinus sample (pO_2[CS]<pO_2[V]) was confirmed in 48 patients (77%) (Figure 2). Using the modified technique, 46 patients underwent blood sampling. One sample was excluded from analysis as coronary sinus engagement was not confirmed on fluoroscopy. A true coronary sinus sample was confirmed in 45 (100%) patients. Comparison using the Fisher's Exact Test confirmed a statistically significant difference between the groups (p=0.0005).

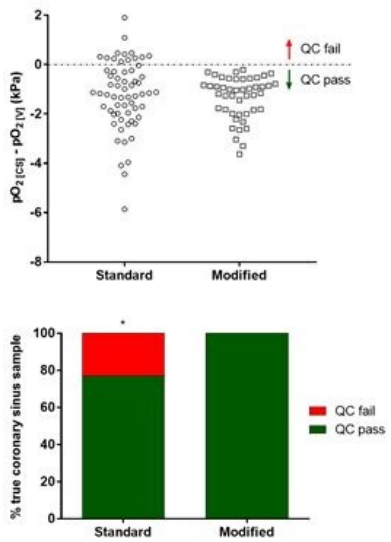

Figure 2: A true coronary sinus sample (pO_2[CS]<pO_2[V]) was confirmed in 48 patients.

Discussion

We demonstrate that routine analysis of a small blood gas sample in the cath lab is a useful technique to ensure the validity or CS sampling in cardiac research studies. We describe and validate techniques for CS sampling from the antecubital vein rather than femoral vein, combined with guide wire stabilisation of the catheter that consistently yields high-fidelity CS sampling in the setting of radial artery PCI.

Aspirating blood from the coronary sinus can be difficult because CS blood pressure is low and the tip of the catheter may be obstructed by adherence to the vessel wall. When aspiration is particularly difficult, gently withdrawing or repositioning the catheter often makes aspiration possible. However, this may lead to inadvertent right atrium sampling, suggesting that some samples collected using the standard technique are less likely to be true CS samples, thus diminishing the biological and statistical power of the study to quantify cardiac biomarker release, or to discover new cardiac-specific biomarkers. With the modified technique, the coronary guide wire increases catheter stability, allows full and co-axial engagement of the catheter tip within the CS, and biases the catheter away from the vessel wall, which makes aspiration easier without the need to adjust the catheter

and risk losing position. In the excluded sample, the coronary guide wire failed to pass into the proximal coronary sinus and attempting to advance it backed the catheter out of the ostium. This issue could likely be solved using fluoroscopic repositioning and blood gas resampling, which is typically readily available in the catheter laboratory environment.

The measurement and discovery of biomarkers from the coronary sinus is likely to continue to be an important part of clinical research in cardiac disease, in areas such as metabolism, ischemia-reperfusion, arrhythmia, inflammation and cardiac remodelling. The acceptability, safety and sample quality are of paramount importance. Collection of paired venous and CS blood samples allows the rapid confirmation of valid CS sampling, thus improving scientific rigour by avoiding the confounding effects of false CS samples on subsequent analyses.

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