Original article

Sampler filling time during arterial and venous puncture: An observational study

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Abstract

Introduction: An arterial blood gas (ABG) is a blood test that is performed using blood from an artery. When obtaining an arterial blood sample via percutaneous puncture, there is a risk of accidentally obtaining venous blood. Conventional methods of confirming arterial blood at the bedside such as blood colour and pulsatile return can be misleading in patients with low blood pressure or hypoxaemia. The blood of patients with hypoxaemia can show a dark colour similar to venous blood and patients with low blood pressure may have very low pulsatile action. **Aim:** The purpose of this study was to determine if the arterial sampler filling time can be an accurate predictor of obtaining arterial blood sample in adults. **Methodology:** Forty patients were enrolled prospectively who required arterial blood sample or venous sample in medical and surgical intensive care unit. During the arterial and venous puncture procedures the amount of time it took to fill the sample tube was measured with the help of stop watch in s/ml was measured. **Results:** Twenty patients were in the arterial group and 20 patients in venous group. The mean ± SD filling time was 12 ± 3 s/ml for the arterial group and 112±21 s/ml for the venous group. **Conclusion:** There is a statistically significant difference between arterial and venous filling times using an arterial blood sampler in human subjects. There is no relationship between mean arterial pressure (MAP) and arterial sampler filling times.

Keywords: Arterial and venous puncture, sampler filling time.

Introduction

An arterial blood gas (ABG) involves drawing a blood sample from an artery percutaneously when an arterial line is not *in situ*. To reduce pain, a thin needle and syringe are used. The most common puncture site is radial artery at the wrist. Other sites are femoral artery in the groin area, dorsalis pedis in lower limb at the ankle joint or brachial artery joint, brachial artery in the upper arm. Decisions on patient care often depend on these reports.[1] The results of arterial blood gas analysis enable the clinicians to evaluate the adequacy of oxygenation, ventilation and acid-base status, response to therapeutic intervention and to monitor the severity and progression of the disease process.[2]

Percutaneous puncture for arterial blood sampling may draw venous blood accidentally. This is usually identified clinically by observation of blood colour and its pulsatility through the needle, both of which can be misleading in patients with low blood pressure or hypoxaemia. Arterial blood of patients with hypoxaemia can be dark and similar to venous blood. Similarly, patients with low blood

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pressure may not be very pulsatile.[2] A study using an extracorporeal circuit has shown a significant difference between arterial and venous filling times and a negative correlation between mean arterial blood pressure (MAP) and arterial sampler filling time in a laboratory setting.[3] In order to determine clinical validity, sampler filling times and variable blood pressures should be measured using real patients.[4] The purpose of this study was to determine if the arterial sampler filling time can be an accurate predictor of obtaining arterial blood sample in adults. Our hypothesis was there is a statistically significant negative correlation between sampler filling time during arterial puncture and MAP, and a statistically significant difference between venous and arterial sample filling times in human adults.

Methodology

Forty patients were enrolled prospectively who required arterial blood sample or venous sample in medical and surgical Intensive care Unit of the University and Medical College Hospital between February 2014 and May 2014. The study protocol was approved by the institutional board of ethics committee. Twenty patients were in arterial group and twenty were in venous group. The demographic data and diagnosis of the study subject was noted for both arterial and venous group. 1 cc syringe was used with a 23 gauge needle to take blood sample. In the venous group, blood was drawn by an experienced nurse *via* the brachial vein using an arterial blood sampler. In the arterial group, systemic arterial blood pressure was measured noninvasively, and arterial blood sample was drawn by a trained Respiratory Therapist *via* femoral artery using an arterial blood sampler. During the arterial and venous puncture procedures, blood was allowed to fill the syringe passively without any negative force applied to it. The speed of filling the sampler was measured in s/ml by noting the time taken to fill the sampler using a stopwatch and the volume of blood obtained. A training session was conducted prior to the actual study.

The amount of time to fill the sampler, from the initial blood flash in the needle hub until the blood flow stopped was recorded. The position of the subject was the same during the measurement of blood pressure and during the arterial blood gas procedure. For the venous group, either no tourniquet was used or it was removed simultaneously with the blood flash in the needle hub. For the arterial group, the needle angle of entry was 90°, and 30° was used for the venous group. The arterial blood samples obtained were verified as arterial or venous by measuring PaO_2. The mean arterial pressure (MAP) was estimated in the arterial group using the equation: MAP = (Systolic pressure + 2 x Diastolic pressure)/3.

We used SPSS 17.0 software (SPSS, Chicago, Illinois) for statistical analysis. Pearson correlation coefficient was calculated to determine the relationship between MAP and seconds of filling time per millilitre in the arterial group. One tailed t test for independent samples was calculated to determine if arterial sampler filling times were significantly different between the arterial and venous groups.

Results

Our study included 40 adult subjects: 20 patients in the arterial group, and 20 patients in venous group. There was a statistically significant difference between the arterial and venous group ($P < .001$). The mean (± SD) filling time was 12 (± 3) s/mL for the arterial group and 112 ± 21 s/mL for the venous group represented in *Table 1*. The range of MAP was 70-130 mm Hg. The mean (± SD) MAP was 93 (± 12) mmHg. The Pearson correlation coefficient for MAP and sampler filling times was -0.224 (P=.34). Thus there was no correlation between MAP and sampler filling time. *Figure 1* shows the relationship between MAP and sampler filling time for the arterial group.

Table 1: Sampler filling times in arterial and venous subjects

Group	Filling time in s (mean ± SD)	P
Arterial (n=20)	12.13 ± 3.2	<0.001
Venous (n=20)	112.95 ± 21.6	

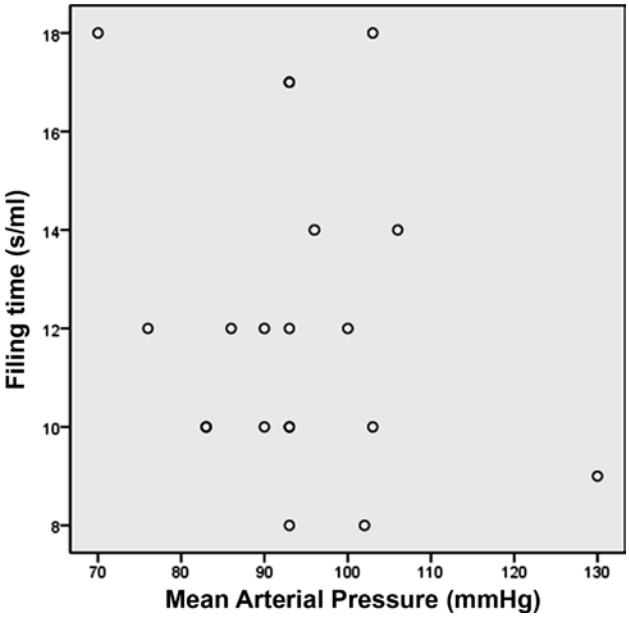

Figure 1: The relationship between mean arterial pressure and sampler filling time with arterial punctures

Discussion

We found a statistically significant difference between arterial and venous sampler filling times and a statistically no relationship between MAP and arterial sample filling times. We believe the difference between arterial and venous sampler filling times to be clinically important. Our results are consistent with a previous study. Our arterial group had a mean filling time of 12 s/ml, whereas Jeffrey *et al*[5] measured a filling time of 15 s/ml.[5]

The mean filling time for our venous group was also similar to the study conducted by Jeffrey *et al.* Our mean venous sampler filling time was 112 s/ml, whereas Jeffrey *et al* reported 115 s/ml. The same investigators[5] also found that there was a negative correlation between MAP and sampler filling time.[5] We could not find any relationship between MAP and arterial sampling filling time in arterial group. The speed of sampler filling time during arterial puncture may be a useful seful parameter to assure that the blood sample is truly arterial. A prolonged time may indicate the blood sample is venous. Having confidence that the sample is arterial may help reduce unnecessary repeated punctures and delays in patient care decisions. Limitations in our study included that we did not confirm venous sample by measuring PaO_2 with a blood gas analyser and we were dependent on Nurses' skills. We used femoral artery for arterial sample and the angle of entry of the needle was 90° as compared to venous sample where it was 30°. The haematocrit or haemoglobin concentration were not taken into account, which may affect blood viscosity and consequently blood flow through the needle and sampler filling time.

Conclusion

Sampler filling time for arterial blood is significantly faster than for venous blood. There is no relationship between MAP and arterial sampler filling times in human subjects. Arterial sampler filling time as a useful indicator of successful arterial puncture at the bedside.

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