Arterialised earlobe blood gas analysis: an underused technique

A D Pitkin, C M Roberts, J A Wedzicha

Abstract

**Background** – Techniques for sampling arterialized capillary blood from the finger pulp and the earlobe were first described over two decades ago but, although close agreement between arterial values and earlobe samples has been demonstrated in normal subjects, this technique is not in common usage.

**Methods** – Forty patients with chronic lung disease and a wide range of arterial blood gas values were studied. Simultaneous earlobe and arterial samples were drawn with the patient at rest and analysed in the same blood gas analyser. The respiratory function and laboratory staff in 50 UK hospitals with a respiratory department were telephoned and asked whether the technique was used in their hospital and the reasons, if known, for not adopting it.

**Results** – Earlobe and arterial blood gas tensions agreed closely over a wide range of values of arterial pH, PaO₂ (mean difference 0.21, 95% confidence intervals −0.24 to +0.67 kPa) and PaCO₂ (mean difference −0.17, 95% confidence intervals −1.09 to +0.75 kPa), especially at arterial PaO₂ values lower than 8 kPa. Of 50 UK centres surveyed 18% used the arterialized earlobe technique and 4% had plans to introduce it. Reasons for not using it were lack of knowledge in 64%, no blood gas analyser in 6%, the technique was considered inaccurate in 4%, and insufficient staff in 4%.

**Conclusions** – Although earlobe blood gas analysis is sufficiently accurate to be reliably substituted for arterial sampling in routine clinical practice, most centres in the UK do not use the technique. The main reasons for this appear to be lack of knowledge of its existence and uncertainty over its accuracy.

(Thorax 1994;49:364–366)

Measurement of arterial blood gas tensions is a routine part of the assessment of patients with acute and chronic respiratory disorders producing abnormalities of gas exchange. Blood sampling by direct arterial puncture is the accepted technique established in clinical practice. This method, however, requires qualified medical staff to perform it and may result in significant discomfort and morbidity for the patient. Alternative methods such as cutaneous pulse oximetry have also been used to estimate arterial oxygen tension but corre-
Comparative data for pH, Po2, and Pco2 values of simultaneous arterial and capillary blood samples in 40 patients

<table>
<thead>
<tr>
<th></th>
<th>Range</th>
<th>Maximum difference</th>
<th>Mean difference</th>
<th>95% limits of agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.32-7.50</td>
<td>0.034</td>
<td>+0.007</td>
<td>-0.008 to +0.022</td>
</tr>
<tr>
<td>Pco2 (kPa)</td>
<td>3.87-10.03</td>
<td>0.78</td>
<td>+0.21</td>
<td>-0.24 to +0.67</td>
</tr>
<tr>
<td>Po2 (kPa)</td>
<td>4.42-12.97</td>
<td>-1.6</td>
<td>-0.17</td>
<td>-1.09 to +0.75</td>
</tr>
</tbody>
</table>

important) but may require a small amount of manual massage. The arterialised blood collects in a drop on the inferior aspect of the earlobe. It is drawn into a thin glass capillary tube by surface tension under the control of a gloved finger over the open end of the tube and then aspirated into the analyser.

Arterial samples were collected directly into a preheparinised 3 mL plastic syringe by direct puncture of the radial artery.

Respiratory function laboratories in 50 hospitals around the UK were contacted by telephone. They consisted primarily of teaching hospitals and centres with an interest in respiratory medicine. The senior laboratory technician was asked how routine blood gas measurements were performed in that hospital. If the earlobe blood gas technique was known they were asked the reasons, if any, for not using it.

Simple descriptive statistics for the pH, Po2, and Pco2 values obtained with each technique were calculated, consisting of mean differences and 95% confidence intervals for arterial and earlobe blood gas tensions. The data are shown graphically using simple scatter plots of earlobe Po2 vs arterial Po2, and earlobe Pco2 vs arterial Pco2. They were also plotted as the difference between arterial and earlobe values vs the mean value as recommended by Bland and Altman.8

Results

The range, mean, standard deviation, and 95% limits of agreement for pH and blood gas values obtained by simultaneous sampling of earlobe capillary and arterial blood in 40 patients are shown in the table. The concordance between earlobe and arterial blood gas tensions was good throughout a wide range of values of arterial Po2 (fig 1) and Pco2 (fig 2). A particularly good correlation between samples was observed at arterial Po2 values lower than 8 kPa. Above this level earlobe Po2 values tended to be slightly lower than arterial Po2 values. Nearly all values, however, lie within 0.5 kPa or less and underestimation of true arterial Po2 at higher levels of oxygenation is unlikely to be of clinical significance. The correlation between Pco2 measurements derived from the two methods is even better with the earlobe technique, tending towards slightly higher values. The mean difference between samples was, however, only 0.21 kPa.

Fifty hospitals were surveyed by telephone. Of these, nine (18%) used the arterialised earlobe technique and two (4%) had plans to introduce it. In 32 (64%) of the 39 remaining hospitals the main reason for not using earlobe blood gases was that the laboratory staff were unaware of the technique. In three hospitals (6%) a blood gas analyser was not available in the laboratory. In two centres (4%) the technique was thought to be inaccurate, and in a further two (4%) there were insufficient technical staff to carry out the procedure.

Discussion

The close agreement between arterial and earlobe blood gas values found in our study confirms the findings of earlier work in normal subjects where earlobe blood gas values have been found to be sufficiently accurate for use in exercise testing to calculate cardiac output, venous admixture, and dead space.6-7 Our findings indicate that this accuracy extends throughout the much wider ranges of arterial Po2 and Pco2 found in patients with respiratory disease, and suggest that earlobe blood gas analysis can reliably be extended from a research technique into routine clinical practice.

Earlobe blood gas measurement could have a valuable role in the assessment of patients for long term oxygen therapy in accordance with published guidelines.8-10 Although pulse oximetry is useful for screening,11-12 it is not sufficiently precise to be substituted for direct arterial Po2 measurement.13 Earlobe blood gas analysis, however, is particularly accurate at arterial Po2 values less than 8 kPa, can determine arterial Pco2, and is painless enough to allow several samples to be taken on a single occasion with the patient breathing oxygen at varying flow rates to ensure adequate correc-
Arterial difference between earlobe and arterial $\text{Pco}_2$.

Figure (B)

- **A** Earlobe capillary $\text{Pco}_2$ v arterial $\text{Pco}_2$; (B) difference between earlobe and arterial $\text{Pco}_2$.

**Figure 2**

- **A** Earlobe capillary $\text{Pco}_2$ v arterial $\text{Pco}_2$; (B) difference between earlobe and arterial $\text{Pco}_2$.

- **B** Mean earlobe $\text{Pco}_2$ - arterial $\text{Pco}_2$ [kPa] (95% CI).

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