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A COMPARISON OF pO_2, pCO_2, pH AND BICARBONATE IN BLOOD FROM THE CAROTID AND COCCYGEAL ARTERIES OF CALVES

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ABSTRACT

Gustin, P., de Groote, A., Dhem, A. R., Bakima, M., Lomba, F. & Lekeux, P. 1988. A comparison of pO_2, pCO_2, pH and bicarbonate in blood from the carotid and coccygeal arteries of calves. *Veterinary Research Communications,* **12(4–5),** 343–346

A technique is described for the subcutaneous deviation of the carotid artery into the jugular groove of calves weighing between 90 and 200 kg. This makes sampling arterial blood or chronic cannulation for further experimentation very easy. Values of oxygen tension, carbon dioxide tension, pH and bicarbonate concentration in blood sampled from the ventral coccygeal artery were compared with the values obtained in blood from carotid artery puncture. The high correlations observed indicate that blood samples from the ventral coccygeal artery can be used for measurement of blood gases and pH in calves.

INTRODUCTION

Measurement of blood gases and pH in arterial samples is essential for assessment of pulmonary function (Gustin *et al.*, 1986).

Many arterial blood sampling techniques have been described in cattle. Blood has been obtained from arterialised capillaries in the ear (Verhoeff & Wierda, 1983), the saphenous artery (Donawick & Baue, 1968), the brachial artery (Fisher, 1956) and the caudal auricular artery (Fisher *et al.*, 1980). For the carotid artery, methods for establishing an external carotid loop in cattle (McClymont, 1950) and for subcutaneous deviation (Butler, 1962) have been described for experimental purposes.

Collection of blood from the ventral coccygeal artery has also been described (Vestweber *et al.*, 1977). However, the values of oxygen tension (pO_2) obtained by these authors were abnormally low. The values of pO_2 measured by Naito and Murakami (1982) in blood from the coccygeal artery of adult Friesian cows were very similar to those obtained by Lekeux *et al.* (1984) in blood samples from the brachial artery of adult cattle.

These contradictory data led us to devise a method of sampling at the coccygeal artery and to compare the values for blood gases and pH measured in arterial blood sampled from the coccygeal and the carotid artery respectively. A technique for subcutaneous deviation and for chronic cannulation of the carotid artery is also described.

MATERIALS AND METHOD

Eleven healthy Belgian White and Blue (n=6) and Friesian calves (n=5), weighing between 90 and 200 kg were used.

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A subcutaneous deviation of the carotid artery was performed when the weight of the animals reached 80 kg. This involved bringing a loop of the carotid artery out from beneath the muscular layers to a point just under the skin in the jugular groove.

The animals were anaesthetized with Xylazine (Rompun^R, Bayer) (20 mg/100 kg IM) followed, in some cases, by Thiopenthal (Penthotal; Abbot) (maximal dose: 10 mg/kg intravenously). After shaving and disinfection, the skin was cut over approximately 7 cm at the lateral aspect of the middle third of the neck just above the jugular vein. The incision was located midway between the angle of the mandible and the first rib. The subcutaneous tissues were dissected until the jugular vein and the cleidomastoideus muscle were exposed. An incision was performed between these. The carotid artery was exposed by dissection with blunt scissors at the upper side of the sternocephalicus muscle.

The carotid artery was then separated over 5 cm from other structures such as the vagus and sympathetic nerves and the internal jugular vein. The artery was brought to the surface and the fibrous sheath enclosing the jugular vein was sutured (catgut 0) to the inferior side of the cleidomastoideus muscle so as to leave a loop of artery in the jugular groove. The skin was sutured with Mersilène (0).

Cannulation of the carotid artery was performed on animals weighing between 115 and 200 kg. The calves were sedated with Xylazine (Rompun^R; Bayer) (10 mg/100 kg IM). After shaving and disinfection of the skin at the site of the loop, a 17-gauge intravascular catheter (leader-cath; Vygon; Brussels, Belgium) was introduced into the carotid artery using the method of Seldinger and fixed to the skin. The catheter was left in place for one or two weeks, during which time any problems connected with its insertion would have been observed. The catheter was regularly flushed with heparin.

Blood from the carotid and from the coccygeal arteries was sampled to compare values of pO_2, carbon dioxide tension (pCO_2), pH and bicarbonate concentration. One animal was sedated with Xylazine (10 mg/100 kg) during blood sampling.

For the collection of blood from the ventral coccygeal artery, the tail of the animal was raised to approximately an angle of 45° with the horizontal. The ventro-proximal surface of the tail was disinfected. This region being relatively insensitive, sedation or local anaesthetic were not required. The site of puncture was situated between the two parallel cutaneous folds observed in this region, a few centimeters above the anus. In most cases, the pulse discernable between the two ventral processes gave a good guide as to the point of entry. A needle was inserted: its external diameter being chosen as a function of the size of the animal (18 or 21 gauge). The colour and flow rate of the blood indicated that arterial and not venous blood was being sampled. If venous blood was obtained, it was necessary to reinsert the needle a few centimeters above the first point of puncture.

Carotid blood samples were collected from the catheter after allowing the blood to flow for at least 10 seconds.

Blood samples were taken in heparinized glass syringes which were placed on ice immediately after collection. They were analyzed within 10 minutes of collection at 37°C using a blood gas analyser (AVL; VEL, Louvain, Belgium). Values of pO_2, pCO_2 and pH were corrected for body temperature (Kelman & Nunn, 1966; Gustin *et al.*, 1988). Values of HCO_3^- concentration were computed from these parameters.

Linear correlations were calculated between the pO_2, pCO_2, pH and HCO_3^- values measured in blood from the coccygeal and the carotid artery.

Student's t test was used for calculating the statistical significance.

RESULTS

Comparisons of pO_2, pCO_2, pH and HCO_3^- concentrations ($[HCO_3^-]$) of blood obtained from the carotid and ventral coccygeal arteries are illustrated in Figure 1.

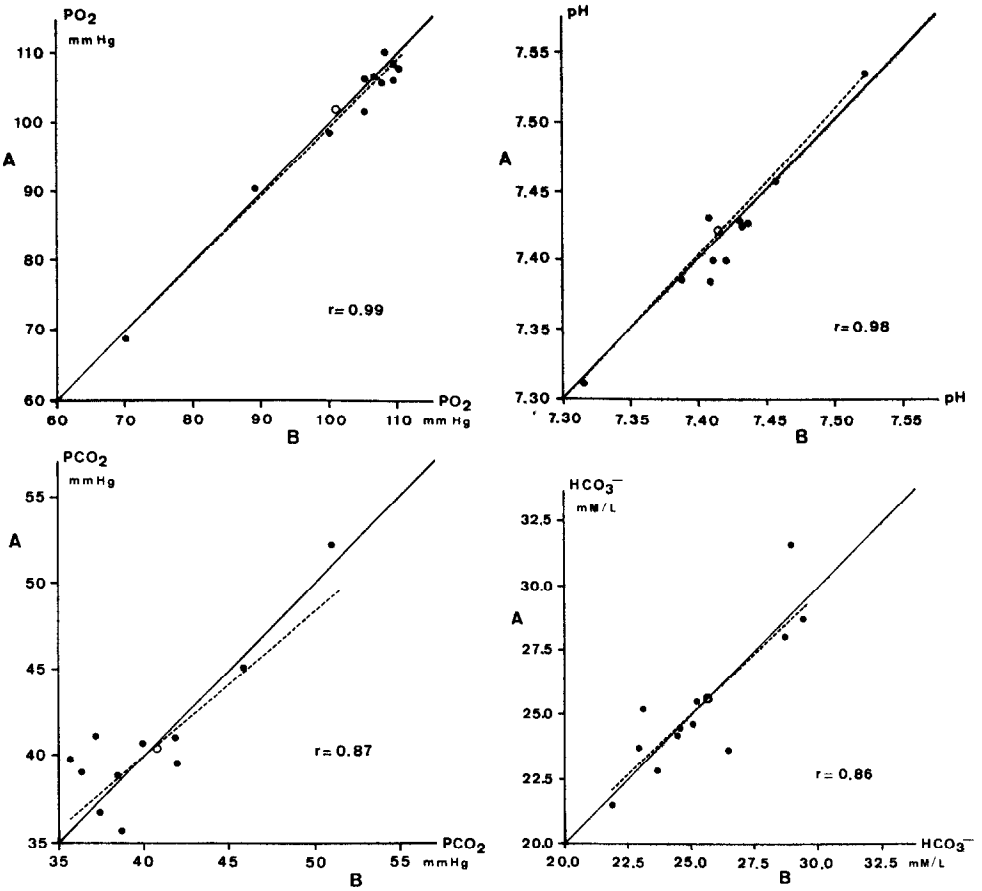

Figure 1. Correlation between the values of oxygen tension (pO_2), carbon dioxide tension (pCO_2), pH and HCO_3^- concentration ($[HCO_3^-]$) measured in blood sampled from the coccygeal artery (A) and the carotid artery (B).
The solid line is the line of identity. The dotted line is the linear regression line. r: correlation coefficient. The correlations are all statistically significant ($p<0.001$). ○: mean value. ●: individual values.

The mean values of pO_2, pCO_2, pH and $[HCO_3^-]$ measured in blood from the carotid and coccygeal arteries were practically identical and highly significant correlations between the individual values were obtained ($p<0.001$).

DISCUSSION

Our results demonstrate that the carotid artery can be deviated into the jugular groove for at least 16 weeks and that this artery can then be catheterized without any difficulty. Blood from the coccygeal artery can also be used for the measurement of pO_2, pCO_2, pH and $[HCO_3^-]$.

Subcutaneous deviation of the carotid artery in calves has been described by Butler (1962). The loop of the artery was situated at the level of the sternocephalicus muscle and a piece of polyethylene tubing was placed around the artery to prevent it rolling about

under the skin. When the carotid artery is deviated into the jugular groove, as in our study, rolling is very limited and there is no need to use the polyethylene tubing. Moreover, a catheter placed at this level is more accessible than when it is situated more medially.

In a previous study, Vestweber *et al.* (1977) reported values for pO_2, pCO_2 and pH for blood from the ventral coccygeal artery. Their pO_2 values from healthy calves were very low (77 mm Hg) as compared to values obtained for blood sampled from the carotid artery (99.7 mm Hg) (Kuhlman *et al.*, 1985). Vestweber *et al.* (1977) gave no explanation for this difference. Later, Fisher *et al.* (1980) found similar results with blood collected from the auricular artery and postulated that arteries located far away from the heart tend to have lower pO_2 values. They suggested that some oxygen could be lost between the heart and peripheral arteries (Fisher *et al.*, 1980). Our data are not in agreement with these findings and suggest that arterial blood can be collected at the coccygeal artery for further analysis for blood gases and pH if great care is taken to avoid obtaining a sample of mixed venous and arterial blood.

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