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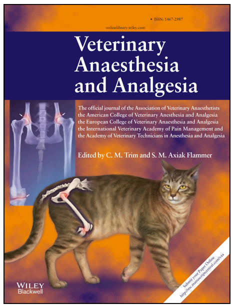

Haemodynamic changes occurring in a loggerhead sea turtle (*Caretta caretta*) during mechanical ventilation under general anaesthesia

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PII: S1467-2987(17)30138-1

DOI: 10.1016/j.vaa.2016.08.010

Reference: VAA 126

To appear in: *Veterinary Anaesthesia and Analgesia*

Received Date: 16 February 2016

Revised Date: 4 July 2016

Accepted Date: 2 August 2016

Please cite this article as: Monticelli P, Hedley J, Pinelas R, Haemodynamic changes occurring in a loggerhead sea turtle (*Caretta caretta*) during mechanical ventilation under general anaesthesia, *Veterinary Anaesthesia and Analgesia* (2017), doi: 10.1016/j.vaa.2016.08.010.

LETTER TO THE EDITOR

Haemodynamic changes occurring in a loggerhead sea turtle (*Caretta caretta*) during mechanical ventilation under general anaesthesia

We wish to report the occurrence of significant haemodynamic changes during mechanical ventilation in a sea turtle under general anaesthesia.

A 67-year-old loggerhead sea turtle (*Caretta caretta*), weighing 94 kg, was referred for a 16-week period of inappetence. Physical appearance was unremarkable. A computed tomography scan revealed the presence of an enterolith causing intestinal obstruction, requiring surgical intervention. The patient was anaesthetised with 6 mg kg^{-1} of ketamine (Anaestamine; Animalcare, UK) and 0.025 mg kg^{-1} of dexmedetomidine (Dexdomitor; Vetoquinol, UK), injected into the left cervical sinus. An additional 2 mg kg^{-1} of propofol (PropoFlo Plus, Abbott, UK) was administered via this route to allow for orotracheal intubation with a size 9 endotracheal tube. The latter was connected to a circle breathing system (Model 2800C; Mallard Medical, USA) and mechanical ventilation was initiated with a tidal volume of 5 mL kg^{-1} and a respiratory rate ranging between 8 and 12 breaths $minute^{-1}$. Anaesthesia was maintained with desflurane (Suprane; Baxter, UK) vaporized in oxygen (end-tidal percentage: 7.4% -8.4%). Morphine [0.3 mg kg^{-1} (Morphine Sulphate; Martindale Pharmaceuticals, UK)] was administered intramuscularly before performing the celiotomy. Intravenous access was obtained in the left cervical sinus and 2 mL kg^{-1} $hour^{-1}$ of Hartmann's solution was administered throughout the anaesthesia. A Datex-Ohmeda S/5 multiparametric monitor was used to monitor physiological parameters. Throughout the anaesthetic end-tidal carbon dioxide partial pressure ranged from 15 to 27 mmHg (2.00–3.60 kPa) and the heart rate (HR) varied between 12 and 20 beats $minute^{-1}$. Pulsed Wave Doppler ultrasonography was performed intermittently through the left cervicobrachial acoustic window (Valente et al. 2008) using an ultrasound machine (S9v Sonoscape, China) with a 8-4 MHz micro-curved probe set to cardiology mode (Fig. 1). The animal was initially positioned in ventral recumbency to perform a colonoscopy, and then turned into the dorsal position to allow for pre-femoral celiotomy. After changing the recumbency, the peak airway pressure increased from 8 to 15 cm H_2O and a concurrent increase in the peak aortic systolic velocity from 0.35 to 0.49 m s^{-1} was observed. The presence of diffuse yolk coelomitis, together with the severely compromised appearance of the intestines, prompted euthanasia.

The HR recorded during anaesthesia were lower than the physiological reference intervals reported for this species [29 (23-36) beats $minute^{-1}$], whose values seem to correlate negatively with the body mass (Valente et al. 2008). The administration of dexmedetomidine and morphine could have caused bradycardia. Unfortunately, since baseline physiological parameters were not obtained before premedication, this hypothesis cannot be confirmed.

During the anaesthetic we recorded peaks in aortic systolic velocity higher than the values reported in the literature for the species (0.22 ± 0.08 m s^{-1}; Valente et al., 2008), and these values further increased when the turtle was repositioned. This finding was unexpected and it is challenging to propose a reasonable explanation.

The cardiovascular effects of α_2-agonists in chelonians are comparable to the ones in mammals (Dennis & Heard 2002), and the administration of dexmedetomidine and opioids was found to consistently decrease the aortic peak flow velocity in dogs (Kellihan et al. 2015). Therefore, the administration of these agents to this sea turtle was expected to decrease, rather than increase, the aortic flow velocity, and, consequently, the origin of our findings should be sought elsewhere.

One potential reason could be cardiovascular changes associated with mechanical ventilation, possibly exacerbated by dorsal recumbency. Chelonians are known to have broad systolic peaks, as well as high velocity peaks in diastole, which generate a continuous flow throughout the cardiac cycle (Valente et al. 2008). However, blood flow distribution between the lungs and systemic circulation is mainly controlled by changes in vascular resistances (Skovgaard & Wang

2006). Furthermore, lungs actively expand and contract due the action of the trunk muscles on the ventral postpulmonary septum. Previous investigators (Shelton & Burggren 1976) observed considerable changes in vascular resistances, cardiac output and flow throughout spontaneous ventilation, with both pulmonary and systemic flow increasing during inspiration when the intrapulmonary pressure is lower. It is therefore plausible to hypothesize that mechanical ventilation might have altered the entire vascular resistance increasing the intrapulmonary pressure. This would have resulted in a cardiac right-to-left shunt and therefore an increased aortic flow. As corroborated by the dramatic increase in peak airway pressures observed after the turtle was repositioned, it is also likely that dorsal recumbency enhanced these haemodynamic changes, by applying a direct pressure on the airways as well as on the aorta. To the best of the authors' knowledge, there are no published guidelines with respect to mechanical ventilation in reptiles, although it is common belief that low respiratory rates and pressures should be applied. We decided to administer conservative tidal volumes to this turtle, because chelonians are known to have highly compliant lungs (Herman et al. 1997). As a result, in order to maintain minute ventilation, relatively high respiratory rates were required. Further clinical evaluations are necessary to improve the understanding of the interaction between haemodynamics and mechanical ventilation in reptiles.

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Acknowledgements

The authors would like to thank Dr. Sue Thornton for her kind advice

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Figure Legend

Figure 1 Aortic peak flow in the left aortic artery of a 67-year-old loggerhead sea turtle (*Caretta caretta*). The Pulse Wave Doppler ultrasonography was performed with the machine (S9v Sonoscape, China) set on cardiology mode using a 8-4 MHz micro-curved probe through the left cervicobrachial acoustic window. Identification of the left aortic artery was based on the position, shape, large diameter and caudal blood flow direction; parameters reported by Valente and others in 2008.


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PWR 70
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PG: 0.76 mmHg
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WF 100
GN 105
FRQ 4.5
PWR 70
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SV 1.4
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