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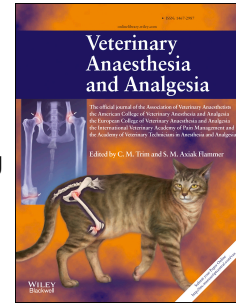
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Haemodynamic changes occurring in a loggerhead sea turtle (*Caretta caretta*) during mechanical ventilation under general anaesthesia

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

27 animal was initially positioned in ventral recumbency to perform a colonoscopy, and then turned
28 into the dorsal position to allow for pre-femoral celiotomy. After changing the recumbency, the
29 peak airway pressure increased from 8 to 15 cm H₂O and a concurrent increase in the peak
30 aortic systolic velocity from 0.35 to 0.49 m s⁻¹ was observed. The presence of diffuse yolk
31 coelomitis, together with the severely compromised appearance of the intestines, prompted
32 euthanasia.

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

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

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

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

53 2006). Furthermore, lungs actively expand and contract due the action of the trunk muscles on
54 the ventral postpulmonary septum. Previous investigators (Shelton & Burggren 1976) observed
55 considerable changes in vascular resistances, cardiac output and flow throughout spontaneous
56 ventilation, with both pulmonary and systemic flow increasing during inspiration when the
57 intrapulmonary pressure is lower. It is therefore plausible to hypothesize that mechanical
58 ventilation might have altered the entire vascular resistance increasing the intrapulmonary
59 pressure. This would have resulted in a cardiac right-to-left shunt and therefore an increased
60 aortic flow. As corroborated by the dramatic increase in peak airway pressures observed after
61 the turtle was repositioned, it is also likely that dorsal recumbency enhanced these
62 haemodynamic changes, by applying a direct pressure on the airways as well as on the aorta.
63 To the best of the authors' knowledge, there are no published guidelines with respect to
64 mechanical ventilation in reptiles, although it is common belief that low respiratory rates and
65 pressures should be applied. We decided to administer conservative tidal volumes to this turtle,
66 because chelonians are known to have highly compliant lungs (Herman et al. 1997). As a result,
67 in order to maintain minute ventilation, relatively high respiratory rates were required.
68 Further clinical evaluations are necessary to improve the understanding of the interaction
69 between haemodynamics and mechanical ventilation in reptiles.

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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.

