Arteriovenous Patterns in Beaked Whales

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LONG-TERM GOALS

To describe the venous morphology in the head of beaked whales, with a special focus on the venous structures associated with the accessory sinus system and the acoustic fat bodies. To describe the vascular morphology of the terminal airways of beaked whales, as it relates to presence and actuation of intrapulmonary shunts.

OBJECTIVES

The objectives of the first year are to gain an understanding of the vasculature in the head. The primary focus of this objective is to describe the complex venous morphology associated with the acoustic fat bodies and the air-filled sinuses on the ventral part of the skull (Costidis & Rommel, 2012). These regions of interest were determined as potential sites of nitrogen absorption, storage and elimination and well as locations of possible fat and gas embolus formation observed in the literature reporting DCS-like lesions in beaked whales (Bernaldo de Quiros *et al*., 2012; Ferrnandez *et al.*, 2005; Jepson *et al.*, 2005). The objectives of the second year are to better describe the pulmonary vasculature of bottlenose dolphins and beaked whales in an attempt to demonstrate the presence or absence of intrapulmonary shunts, as such shunts will play in important role in understanding nitrogen gas absorption and elimination in the lungs (Fahlman *et al.*, 2006; Hooker *et al.*, 2009; 2012; Houser *et al.*, 2001).

APPROACH

The technical approach will involve the use of traditional anatomical methodology such as vascular latex casting and gross dissection, with modern imaging modalities such as computed tomographic (CT) contrast angiography. The PI (Alex Costidis, Ph.D.) and his colleague (Sentiel Rommel, Ph.D.) will conduct a portion of the research at the veterinary college of Massey University in Palmerston North, New Zealand. For the first year of research, beaked whale specimens have been secured and saved by the National Museum of New Zealand Te Papa and the New Zealand marine mammal stranding network. These specimens cannot be shipped outside of NZ and must therefore be worked up there. Costidis and Rommel will travel to Palmerston North in mid-November to conduct injections, imaging, and dissections on the acquired specimens. Following this research, Costidis and

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Rommel will return to their parent institution (UNC Wilmington) to collate the findings and produce a manuscript.

For the second year of research, Costidis will be applying CT contrast angiography and corrosion casting techniques to describe the anatomy of the vasculature in the distal airways of the pulmonary system of dolphins and beaked whales. The majority of this research will be conducted at UNC Wilmington, however CT and microCT imaging of specimens will be conducted at neighbouring institutions (e.g. North Carolina State University-College of Veterinary Medicine, Duke University, etc.). Following completion of the research, Costidis will collate findings and produce a manuscript. In the second year, Costidis and Rommel will also present findings at an international conference on marine mammal biology (SMM Biennial Marine Mammal Conference)

WORK COMPLETED

Due to the required relocation of the PI, no formal work has been completed to date. The start date was changed to September 1, 2012. Necessary purchasing has begun in order to initiate the first year of the research. Computers and airfare have been purchased. Accomodations in New Zealand are currently under negotiations.

In preparation for the beginning of the research, Costidis and Rommel have conducted numerous gross dissections of opportunistically available beaked whale specimens (*Mesoplodon mirus, M. europaeus, Hyperoodon ampulatus*) at the University of North Carolina Wilmington and the Smithsonian National Museum of Natural History.

RESULTS

Preliminary dissections suggest that the pterygoid venous plexus associated with the accessory sinus system is similar in its connections to that observed by the investigators in the deep diving kogiids and physeteriids. If successive research validates these findings, it may provide supporting evidence for the theory that DCS-like pathology in beaked whales is associated with their diving profiles and possible behavioral alterations in response to ensonification, rather than a unique vascular anatomy that predisposes them to embolization. Upcoming research should provide necessary microscopic/histologic information on the tissue interfaces between veins and air spaces. This should inform modeling of gas kinetics across the walls of the air spaces and potential nitrogen supersaturation. It is not clear yet whether the similarities in gross structure of the pterygoid venous plexus are continued on to its connections. This is important as the connections will likely dictate the flow of blood through the plexus.

Preliminary dissections also resulted in identification of a large intramandibular fat body venous plexus similar to that observed in other odontocete cetaceans (Costidis & Rommel, 2012). Findings suggest that a larger contribution to the drainage of this plexus may be made through the pterygoid and fibrovenous plexus, with more minor contributions made from the facial vein. It is unclear what this preliminary finding means, however it couple play a significant role in the direction and velocity of flow of blood within the venous system of the acoustic jaw fat and the air-filled sinus system. This may in turn affect distribution of gases (e.g. nitrogen) in the jaw fat as well as pathologic distribution of emboli following a DCS-like event.

RELATED PROJECTS

No related projects

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