Computed Tomography (CT): A Non-Invasive Technique for Assessing Trauma and Disease in Stranded Marine Mammals

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INTRODUCTION: Computed tomography (CT) is an exceptional tool for understanding internal anatomical structure. Two and three-dimensional visualizations of internal structures are valuable data for researchers and clinicians interested in functional anatomy, pathology, or forensics. This poster presents an overview of CT scan techniques developed over the last decade for imaging stranded marine mammals. It also provides special protocols for maximizing detection and diagnosis of a range of pathologies, including blunt trauma, hemorrhage, fractures, parasites, temporal bone pathology, emboli and lung pathology. Images with cases presented are for educational purposes.

RESULTS:

BLUNT TRAUMA

Figure 1. Transaxial CT (a) (bone window; 3 mm slice) through the head of a harp seal (Phoca groenlandica) with multiple fractures of the right mandible and orbit, and right eye rupture. Volume Rendering Technique (VRT) reconstruction (b) (1 mm slice; 3 mm spiral CT) of the head showing the fractures (arrows) of the zygoma, mandible, and malar bone. Seal (c) prior to CT. Note the edema and ecchymosis along the right mandible and eye and vitreous humor oozing of the right eye. (Specimen courtesy of NMFS/NOAA).

DISCUSSION: BLUNT TRAUMA - This harp seal (P. groenlandica) presented post mortem with evidence of blunt trauma to the side of the head: a ruptured eye, swelling, and contusion. CT scans confirmed underlying fractures.

HEMORRHAGE

Figure 2. Transaxial CT (a) (soft tissue window; 3 mm slice) through the head of a Blainville’s beaked whale (Mesoplodon densirostris) with a left temporal fossa intracranial hemorrhage (arrow) (Ketten, 2005a). Tissue reconstruction (b) of the head using 3D Slicer software shows the hemorrhage (red), the brain (orange), the ear bullae (beige), and the jaw fats (brown) (Ketten, 2005a). Removal of the brain (c) confirmed the hemorrhage. (Specimen courtesy Bahamas Stranding Network and NMFS/NOAA).

DISCUSSION: HEMORRHAGE – This animal died in a stranding associated with a Naval sonar exercise. The mechanism behind this hemorrhage is unknown at this time but has been reported in beaked whale strandings under similar circumstances.

FRACUTRES / PARASITES

Figure 3. Coronal CT (a) (bone window; 1 mm slice) of a Blainville’s beaked whale (M. densirostris) with bilateral compound mandibular fractures (arrows) (Ketten, 2005b). VRT reconstruction (b) (1 mm slice; 3 mm spiral CT) of the head highlighting the fractures (Ketten, 2005a). Jaw fractures were confirmed during necropsy (arrows). (Specimen courtesy Caribbean Stranding Network).

DISCUSSION: FRACTURES / PARASITES – Necropsy of the beaked whale confirmed multiple bilateral, parallel mandibular fractures (Ketten, 2005a). Adjacent contusions on the ventral surface suggested blunt trauma from post mortem handling.

TEMPORAL BONE PATHOLOGY

Figure 4. Transaxial CT (a) (bone window; 0.5 mm slice) through the head of a post mortem Risso’s dolphin (Grampus griseus) with a parasitic infestation (arrows) of the peribullar sinuses. Extraction of the right ear (b) revealed nematodes and cysts (arrow) in the retro bullar cavities. Transaxial CT (b) (bone window; 0.5 mm slice) through the sinus region of the same animal. Dissection revealed calcified cysts (d) in the peribullar sinuses. VRT reconstruction (c) (1 mm slice; 3 mm spiral CT) of the middle ear parapet (Phocoena phocoena) with a > 0.5 m calcified parasitic track invading the bulla, muscle, periosteum and skin (e) (Norman et al., 2011; Photo C. Cod Strandin). This research was supported by Woods Hole Oceanographic Institution (WHOI) and the Office of Naval Research (ONR).

DISCUSSION: TEMPORAL BONE PATHOLOGY – The absence of a right peribullar CT of the Risso’s dolphin (G. griseus) were identified as two species of Metastrongyles spp (Crassicauda grampicola and NWMSF). In the harbor porpoise (P. phocoena) these parasites identification is pending.

PARASITES

Figure 5. Transaxial CT (a) (bone window; 1 mm slice) through the head of a post mortem beluga whale (Delphinapterus leucas) with a right ear anomaly (Ketten, 2005b), Including absence of a right peribullar bone. Shaded Surface Display (SSD) reconstruction (b) (0.5 mm slice; 3 mm spiral CT) of the right ear in situ. Right tympanic bone (c) during necropsy. (Specimens courtesy Woods Hole Oceanographic Institution (WHOI) and NMFS/NOAA).

DISCUSSION: PARASITES - The parasites observed in the Risso’s dolphin (G. griseus) were identified as two species of Metastrongyles spp and NWMSF. In the harbor porpoise (P. phocoena) these parasites identification is pending.

DISCUSSION: AUDITORY PATHOLOGY - The absence of a right peribullar CT of the Risso’s dolphin (G. griseus) may be due to non-development or a lytic process. The normal left ear organizes against but does not rule out a congenital defect. The absence of the peribullar bone, the pitted and compressed right tympanic, the extensive calcified adhesions, and dense granular material in the peribullar sinuses suggest postmortem infection (Ketten, 2005b).

EMBOLI

DISCUSSION: EMBOLI – This harp seal (Phoca phocoena) with a > 0.5 m calcified parasitic track invading the middle ear parapet of a Risso’s dolphin (G. grampicola) with evidence of hemorrhages. Gas bubbles were observed on CT (a) and in necropsy (b, c) in blood vessels, muscles, lungs, heart, brain and kidney (Bogomolni, 2007). (Specimen courtesy NMFS/NOAA).

UNITED PATHOLOGY

DISCUSSION: LUNG PATHOLOGY – A significant proportion of cetaceans diagnosed with bacterial or viral respiratory tract problems exhibit pulmonary abscesses subsequent to heavy parasite infestation (Danni, 2001). Pneumonia and or pneumoconiosis may also be secondary pathologies to inhalation of chemicals, trauma to the chest wall, and a small minority to ricketsiase, fungi, and yeasts.

REFERENCES: References listed on poster handout

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