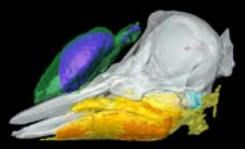
3D Visualization Of The Odontocete Melon Using Computerized Tomography



Arruda, Julie; Ketten, Darlene; Yamato, Maya; Cramer, Scott
Woods Hole Oceanographic Institution, USA

Introduction

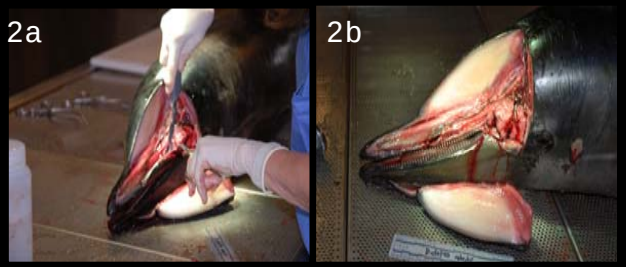
Computerized Tomography (CT scanning) is a valuable tool for visualizing undisturbed bony and soft tissue relationships that can be disrupted or distorted by dissection. It is also possible with CT to discern features by segmenting based on attenuation values. Such differences in tissues can be functionally important. The odontocete melon is a primary example of a complex tissue that can be explored non-invasively with CT as a complement to classic dissection. This study demonstrated differences in melon architecture amongst cetacean taxa.

Methods

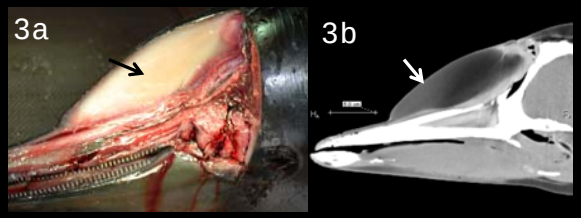
Initial heads from 5 species were examined with a Siemens Volume Zoom CT Scanner using the following protocol:
- 1-3mm slice /250-500 mAs/120kV
- Transaxial plane with soft tissue and bone algorithms at 1-3mm increments
- Parasagittal and coronal multi-planar(MPR) reformatted images
- 512 matrix image /1024 raw attenuation data.

CT scanning of an Atlantic white sided dolphin, *Lagenorhyncus acutus* (fig 1a) and a pygmy sperm whale, *Kogia breviceps* (fig 1b)

Dissection and gross measurement:
- Heads were hemi-sected sagittally (fig2)
- The melon and surrounding tissue layers of were excised



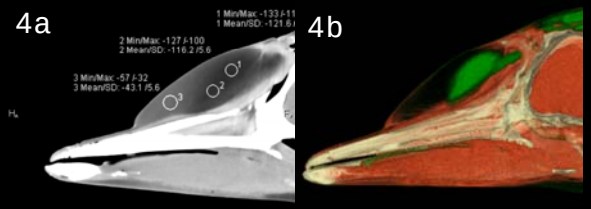
A common dolphin, *Delphinus delphis* is hemi-sected sagittally (fig 2a,2b)



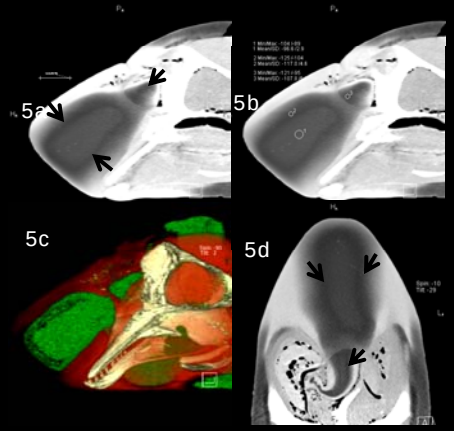
- During dissection, the sublayers of melon tissues were measured and photographed (fig 3a) to compare actual dimensions and conformation for the melon with the measures and shapes obtained via CT scanning (fig 3b)

Results

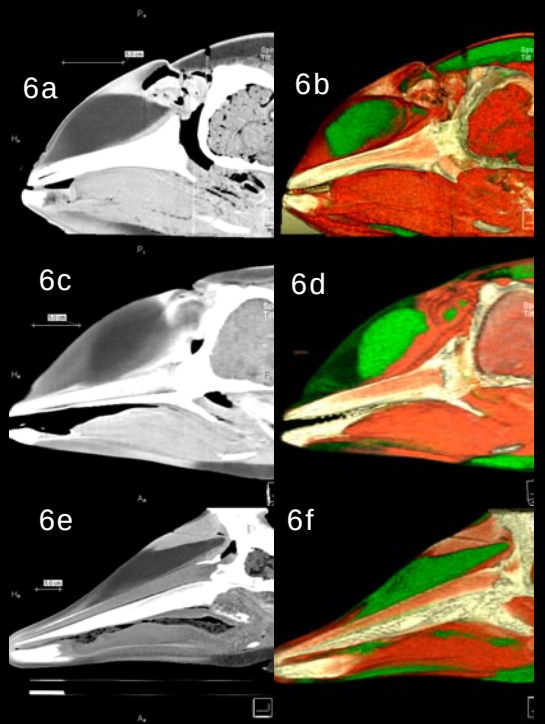
- Direct visualization of the actual tissues assisted in determining melon specific attenuations (Hounsfield units) that were used in developing 3D reconstruction parameters



- Hounsfield units were measured with a circular probe tool (fig 4a) to determine threshold parameters for 3D Volume Ray Tracing (VRT) imaging (fig 4b) for a common dolphin *Delphinus delphis*. Note the multi-lobed structure of the posterior melon shown here.
- The images show species-specific variations in the melon anatomy, particularly asymmetric posterior lobes most evident in the pygmy sperm whale, *Kogia breviceps*



Sagittal MPR (fig 5a), ROI probe tool used to determine Hounsfield units (fig 5b), sagittal 3D VRT of melon (fig 5c), coronal MPR which demonstates separated lobes (fig 5d) and three distinctly different tissue regions



Using the CT scan attenuation threshold values for segmenting the melon, the remaining specimens were similarly imaged:
- Harbor porpoise, *Phoceona phocoena* (fig 6a,6b)
- Atlantic white sided dolphin, *Lagenorhyncus acutus* (fig 6c,6d)
- Blainville's Beaked whale, *Mesoplodon densirostris* (fig 6e,6f)

Conclusions

CT scanning is an extremely useful modality for marine mammal research. Although CT has been used in medical research for many years, it is a fairly new tool for marine mammal anatomy research. All species examined were found to have complex melon shapes not previously described. All had at least two layers to the melon, a less dense inner core and dense outer core, with the exception of *Kogia breviceps.* In that species, the inner core is denser significantly. The delphinids had the most regular form, ovoid and bilobal, but with species-specific shapes, particularly for the posterior sublobes. *Phoceona phoceona* had the highest percentage of head tissue devoted to core melon structure. The lowest percentage was observed in the delphinids. Models and measures of beam formation clearly need to consider species-specific differences in both shape and density of all layers. We are currently developing a CT scan database of detailed head structures in major taxa for such applications.
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