ABSTRACT

Over the last decade, there has been a rapid increase in the use of biomedical imaging procedures on both live and post mortem marine mammals. Post mortem imaging of large bore machines, rapid data acquisition, and increased weight capacity, computerized tomography (CT) and magnetic resonance imaging (MRI) become more accessible and more useful diagnostic and research tools. Scanners are now capable of acquiring data in high resolution as fast as 18 minutes, providing a table time of less than 4 minutes for a full body scan of a 1.2 meter otariid. In addition, digitized images effectively produce micro-images or 3D scanning postmortem with most modern clinical skills. Because of the rapidity of modern imaging techniques, it is feasible to perform concurrent studies of marine mammal species at origin and those species including large samples such as juvenile mysticete specimens. This poster will present an overview of CT and MRI scan protocols that have been developed over the last decade for imaging marine mammals as well as modifications of these protocols to maximize detection and diagnosis of the following categories of pathologies in both cetaceans and pinnipeds; blunt force trauma, traumatic fractures, gunshot wounds, parasites, pneumonia, hematicoma, brain lesions, hearing pathology, parasites, otitis media, and dental adhesions. Digital case histories will be shared to demonstrate these techniques.

INTRODUCTION

Spiral computed tomography (CT) is an x-ray tomographic technique in which an x-ray beam, in the shape of a thin fan, rotates around an object. CT scanning is highly advantageous in several respects – it is rapid, non-invasive, can be repeated, provides diagnostic quality images of tissues from different directions and is capable of providing images that measure the intensity of the attenuated radiation as it emerges from the body (Prokop, 2008). These attenuation coefficients are converted into “CT numbers” also known as Hounsfield units (HU) which is then converted into a scale of gray that is displayed on an image (Prokop, 2008). Scanned are is used in CT for the estimation and anatomical localization of marine mammals has been reported in the literature since the early 1960s (Norky and Bills, 1985; Ketten and Warfe, 1993). This technique is most used in post mortem studies (Ketten, 2005a; Technologies, 1993; Panagiotakis et al., 1998; Etoh et al., 1998; Ketten and Moore, 2004; Moore, 2006, Ketten, 2007, Arzouan et al., 2007). Recent years, it’s seems more appropriate to use CT in marine mammal studies were dedicated primarily to research applications (Van Bonn et al., 2001). Clinical methods had not been established for the extent they have been used in diagnostic testing of human and domestic species (Ketten, 2005b). Additionally, most if not all clinical CT scanners have integrated software limitations designed to control radiation doses and exposure times. These limitations are generally set as a factor when scanning smaller samples. But in case of larger marine mammals, limitations on parameters can greatly effect image resolution to a point where diagnostic are not possible (Prokop, 2008). Larger and more massive tissues such as juvenile mysticete heads or larger whole aquatic mammals allow x-ray images expose longer to either the present patient and image acquisition systems. The accuracy and consistency of the CT image is a serious problem of clinical imaging in marine mammals.

MATERIALS AND METHODS

Marine mammal samples used in this research were obtained in accordance with state and federal regulations and approved under the University of Florida Institutional Animal Care and Use Committee (IACUC) protocol #2001–058. All procedures were performed at the Shedd Aquarium, Shedd Aquarium Marine Mammal Health Assessment, Rehabilitation, and Research Center, Chicago, Illinois, USA, a Marine Animal Rehabilitation Center. Live animals were scanned under the observation and guidance of licensed veterinarians and technicians. Nearly 100 studies were performed in 2001, 2002, and 2003 at Shedd Aquarium. Photographs and slides were taken from the last decade. Some cases included samples from other sources including the Woods Hole Oceanographic Institution’s (WHOI), Woods Hole, MA and Massachusetts Eye and Ear Infirmary (MEEI), Boston, MA, using samples from their High Resolutions CT (HRCT) system for volume rendering. Animals were examined without anesthesia, using portable, MRI compatible anesthesia, and in vivo when possible or were obtained by means of observation and scanned within 24 hours post mortem using ultra-high resolution spiral computed tomography (SCT) software. Effective doses, and all X were at the range of 0.05 mSv for smaller animals and 0.1–0.3 mSv for larger species. Transmission slice increments were typically set at 2 mm slice thicknesses through whole animals; 1 mm through local anaesthetics, and 0.5 mm through local intravenous infusions. All images were acquired and processed using dedicated software applications.

RESULTS

Marine mammal trauma includes blunt force trauma and gunshot wound trauma. The presence of numerous ovoid cysts (arrows) observed in CT scans (pa4) were confirmed in this porpoise with normal bone. Figure (pa4) shows the right tympanic bone after extraction. Figures (pa3) and (pa4) demonstrate the presence of the hemorrhage observed in CT scans shown in figure (pa1). Figure (pa3) is a 3D Volume Rendering Technique (VRT) reconstruction, 1 mm slice thickness from spiral CT scans through sections of the head of a harbor porpoise (Phocoena phocoena). (Specimens courtesy of New England Aquarium (NEAq) and Cape Cod Stranding Network (CCSN).) The fracture spans from the superior medial region of the right mandible to the inferior lateral region of the right parasymphyseal region (Figures (pa3) and (pa4)). Dissection confirmed the presence of the hemorrhage observed in CT scans shown in figure (pa1). The fracture was consistent with a fracture resulting in immediate death (Norman, 2004). Determination of the cause of death was not feasible. The fracture was consistent with blunt or blast trauma resulting in immediate death (Norman, 2004).

DISCUSSION

The use of CT and MRI technology as a non-invasive, fast, and accurate means of collecting high resolution images is rapidly gaining popularity. Large in size and weight, the equipment and the clinical and research applications, the technology allows the access to the undefined animal at a very high resolution and allows clinical and research diagnoses. In addition, the techniques and applications of diagnostic techniques will continue to develop. Therefore, this technology allows the access to the undefined animal at a very high resolution and allows clinical and research diagnoses.

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