Dental Care for a Captive Killer Whale, *Orcinus orca*

Mark S. Graham and Pierre R. Dow

Vancouver Public Aquarium (M.S.G.) and Faculty of Dentistry, University of British Columbia (P.R.D.), Vancouver, British Columbia, Canada

The crowns of several teeth of a captive killer whale, particularly on the mandible, were worn to the level of the pulp cavities by biting a cement structure in the pool. Food plugging partially vacant pulp cavities created intense vascularization, inflammation, and eventually a systemic focus for infection. This trauma correlated with an elevated white blood cell count. Haematology was restored to normal following regular care for the worn teeth. Patent drainage of the pulp cavity was maintained through routine brushing with a large-scale toothbrush. Administration of antibiotics was not necessary in controlling the white blood cell count.

Key words: tooth wear, killer whales, brushing, infection

INTRODUCTION

The dentition of marine mammals, particularly cetaceans, show some interesting departures from land-based mammals. Perhaps the greatest difference is the presence of baleen in place of teeth in mysticete whales. In the odontocete whales, the lack of heterodont dentition is a significant variation from land mammals. Within each odontocete species there is basically one type of tooth. For example, in the killer whale, *Orcinus orca*, the teeth are all conical in shape, up to 13 cm in length, and when the jaw is closed the upper and lower teeth do not oppose but, rather, interlock. The crown is about one-third of the entire tooth and is covered with enamel, normally. These teeth curve back into the mouth and suit the carnivorous lifestyle of this predator.

As in land mammals, the odontocetes demonstrate a wide interspecies variation in tooth shape, from the incredible length of the single narwhal tusk (*Monodon monoceros*), to the numerous small narrow teeth in the porpoise. Odontocete teeth are monophyodont [Ishiyama, 1987], so the same teeth function throughout life. This fact in concert with the enamel structure of the odontocete teeth can provide problems for both wild and captive odontocetes.
There is published information about the tooth condition of wild killer whales. Perrin and Myrick [1980] have commented that tooth wear is often seen in older whales. It is not unusual to see teeth worn down to the level of the dentin, often exposing the pulp cavity. Caldwell et al. [1956] and Caldwell and Brown [1964] have reasoned that the extensive wear seen in wild animals is related to the curved shape of the teeth, the manner in which they interlock during jaw opposition, and any shearing action that occurs during the normal feeding process. This sort of wear was documented in male, female, and juvenile whales from the Atlantic and Pacific Oceans. There are several accounts of abscesses in killer whales as a result of tooth wear: [references in Mitchell and Baker [1980], Ulmer [1941], and Tomes [1873] have attributed cases of tooth wear in killer whales to mandibular misalignment. Mandible alignment was thought to be altered during high velocity feeding behaviour involving large prey [Ulmer, 1941].

These scenarios of tooth wear in wild animals make interesting comparisons with that seen for captive killer whales. Captive killer whales are kept in two types of enclosures, net pens and enclosed pools (the majority of oceanariums). In net pens there are no hard surfaces for the animals to chew on, so tooth wear is not evident after several years in captivity. However, in enclosed pools killer whales can produce considerable wear on their teeth by chewing on corners or other hard surfaces. The most extensive wear is always on the mandible (moveable surface). In these cases the teeth are worn to the level of the pulp cavity and are flat. This wear is attributed entirely to biting of hard surfaces and is not due to feeding behaviour. A normal diet for captive killer whales does not require biting or shearing as it may in wild whales. The food items are small fish (for example, salmon, sole, herring, mackerel, capelin) and are presented into the whale’s mouth so that limited processing other than swallowing is required by the animal.

Tooth wear that exposes the pulp cavity also creates a convenient location for the collection of food and debris. The deterioration of the pulp allows space for this material to collect and impact, and it is this space that will require the most attention in tooth care. Because the vacant pulp cavity extends into the gum region it is warm, and thus is an area for incubation that may lead to infection.

The role of this manuscript is to discuss the dental care of captive killer whales. The following documentation was the result of observation and sampling from a killer whale at the Vancouver Public Aquarium and provides information on the simple, non-intrusive, care of the teeth.

MATERIALS AND METHODS

The Study Animal

This study was conducted on one captive killer whale from the Vancouver Public Aquarium, British Columbia, Canada. The female whale was 11 years old and had been in captivity for 7 years. All examinations and samples were done at the pool side while the animal rested its chin on the edge. The whale was naturally passive and cooperative throughout the study. There were no signs of discomfort during handling and manipulation around the teeth and gums.

Sampling and Observations

An extensive visual examination of the abraded dentition was done and is summarized as clinical observations below.
As part of the routine health inspection of the killer whale, blood samples were taken for haematological analysis. The whale came to the side of the pool and presented its tail fluke while floating on its back. The samples were taken from the caudal fluke into a vacutainer containing EDTA (ethylenediaminetetraacetic acid), with the use of an 18 G needle. Samples were immediately taken to a local laboratory for analysis. Blood samples were taken during a period when no tooth wear was evident and during a period of gingival infection following the tooth wear described.

Scrapings of the plaque were taken from the teeth during the dental inspection. The debris was plated onto two types of media. Blood agar was used to obtain a range of possible microbes, and mitis salivarius agar (Difco 0298-01-0) was used to culture sulfur-reducing bacteria, thought to be involved with the blackening of the teeth. Scrapings were also observed under phase-contrast microscopy in an attempt to identify any organic forms.

RESULTS AND DISCUSSION

Clinical Observations

A gross discoloration was present on the buccal surface of the lower arch. The green-black discoloration lining the plaque formation (Fig. 1) was not the result of chromogenic microorganisms such as sulfur-reducing bacteria. After extensive phase-contrast microscopy of scrapings of this substance, no cellular objects could be recognized. This led to the suggestion that the dark coloration was inorganic, and possibly an iron- or copper-based compound. All organisms grown from scrapings of the teeth were typical enteric streptococci.
Fig. 2. Teeth in the mid-region of the mandible show the most wear.

Plaque formation occurs in captive whales owing to the absence of chewing or any other coarse actions around the teeth. The sharp point of the conical teeth in the mid-anterior region of the mandible was worn down to the pulp (Fig. 2). The exposed dental pulpal tissue either became infected and died or became hyperplastic, similar to what was seen in young children with extensive caries [Ingle, 1965]. When an exposed area was touched the whale showed no sign of distress or pain, similar to the reaction in humans under these circumstances.

Frank abscess was first recognized in this study as a marked swelling of the gingiva. Correlated with the oral problems was an elevated white blood cell count. At a time before advanced tooth wear a white cell count of 7,200 cells/mm³ was normal. However, a blood sample taken during gingival infection had a white cell count of 12,900 cells/mm³. At that time there were no other outward signs of infection that would lead to such an alteration in haematology. The white cell values that indicated a healthy condition for this particular animal are well within the ranges given in other reports for healthy killer whales in captivity [Cornell, 1983; MacNeill, 1975].

When the vacant pulp cavity is impacted the inflammatory reaction is driven into the underlying tissue, and the gingival cellulitis, osteomyelitis, and systemic impact result. These conditions are expected to be much more painful to the whale and more difficult to treat.

Aside from the physical manifestations of this condition, there was also a definite change from the animal’s normal behavior as part of the group. She was somewhat withdrawn from the others, and not as active.
Tooth Care for Captive Whales

During normal tooth wear in captive and in some reported cases of wild killer whales [Tomes, 1873], the exposed and remaining pulp can become highly inflamed and extensively vascularized. This disturbance would not create complications outside of the range of the immune system if the pulp cavity remained unplugged. In the wild condition the feeding action would resolve this. However, captive whales do not feed like wild whales, and any food plugging the pulp cavity must be removed or the area will act as a systemic focus.

Remedying this condition was straightforward. With the whale at the edge of the pool with its mouth open the blockage was easily removed. Rapid remission of the physical health problems were apparent by establishing drainage via the gingival sulcus, and by cleaning the orifice in the worn crown of the tooth with a large-scale toothbrush, creating free passage for the exudate. The process took only a few minutes to do a thorough job, required little or no staff training, and was completely effective. No further medical attention was pursued. Antibiotics were not administered.

If dental problems occur in captive odontocetes and the animals are trained to allow access by trained handlers, treatment can be quite simple. With the knowledge of what killer whales can do to their teeth when in captivity, the challenge becomes one of effective habitat design as a preventive measure. The challenge becomes even greater if the habitat is to resemble a natural, or wild condition, with irregular shapes and textures on the bottom.

Killer whales that have been kept in net pens for several years, in the absence of hard abrasive objects to bite, will have an entire complement of pointed teeth: an ideal situation for dental health. However, such facilities have no underwater viewing of the animals. Net pens are not acceptable to existing or newly planned aquariums because of the difficulty in underwater viewing. Another disadvantage of net enclosures is the danger of entanglement. Although this possibility is remote, it is something that would have to be considered carefully.

Until the ideal substrate for killer whale habitats is formulated, there is some consolation for animal handlers in that dental care can be straightforward but nonetheless important.

ACKNOWLEDGMENTS

The marine mammal keepers at the Vancouver Aquarium are thankfully acknowledged. Heather Merrileas, Faculty of Dentistry, University of British Columbia, was helpful in processing scrapings from the teeth. St. Paul’s Hospital, Vancouver, generously provided analysis of the blood samples. Helpful comments on this manuscript were provided by Drs. M. Newman, A. MacNeill, J. Marliave, and Mr. G. Hewlett. Photographs were produced by Finn Larsen.

REFERENCES
Caldwell, D.K.; Layne, J.N.; Siebenaler, J.B. Notes on a killer whale (Orcinus orca) from the
Cornell, L.H. Hematology and clinical chemistry values in the killer whale (Orcinus orca) L.
Ulmer, F.A., Jr. Notes on a killer whale (Grampus orca) from the coast of New Jersey. NOTULAE NATURAE 83:5, 1941.