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Serial endoscopic characterization of foreign body-associated esophageal and forestomach ulcer resolution in *Tursiops truncatus*

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Foreign body ingestion is a recognized cause of digestive disease in cetaceans, with reported consequences including mucosal ulceration, erosive gastritis, gastric obstruction or impaction, perforation, septic peritonitis, and death (Jaber et al., 2006; Baulch & Perry, 2014; Díaz-Delgado et al., 2018; Puig-Lozano et al., 2018). Odontocetes are particularly susceptible to prolonged retention of indigestible material because their stomach is divided into a non-glandular forestomach, a main glandular chamber, and a pyloric chamber (Mead, 2007; Puig-Lozano et al., 2018). Once retained, foreign material may abrade the mucosa, producing erosions, ulceration, hemorrhage, and secondary inflammation.

Flexible endoscopy provides direct visualization of the upper digestive tract and allows minimally invasive removal of retained foreign objects in dolphins (Wirtschafter, 1977; Kinuta et al., 1982; Eo et al., 2013; Civelek et al., 2015), and it is the most accurate method for assessing gastric mucosal lesions in living dolphins (Buhrmann et al., 2023). However, repeated endoscopic evaluations can be limited by the need for sedation or manual restraint (Gulland et al., 2018). Positive-reinforcement medical training has expanded the possibility of performing diagnostic and therapeutic procedures voluntarily in marine mammals, reducing handling-related stress and allowing procedures that require repeated access over time (Brando, 2010; Clegg et al., 2017; Lacave, 2018). Detailed descriptions of serial endoscopic follow-up of esophageal and forestomach lesions in cetaceans remain scarce. This note describes endoscopic removal of retained foreign material from a bottlenose dolphin (*Tursiops truncatus*) following acute exposure to plastic biofilter carrier media associated with the life-support filtration system, and serial endoscopic follow-up of esophageal and forestomach ulcer resolution under a voluntary medical behavior program.

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An adult male bottlenose dolphin under human care, body mass 255 kg, was evaluated the morning after an accidental overnight release of plastic K1 biofilter media (moving bed biofilm reactor [MBBR] carrier elements) from a life-support filtration system into the habitat pool. The exposed animals were moved to a separate pool, and all visible carrier elements were removed from the affected pool. Because ingestion could not be excluded, endoscopic screening of all exposed animals was performed that morning, hereafter designated day 0. Retained carrier elements were found only in the dolphin described here; in this animal, hemorrhagic gastric fluid was observed during the initial endoscopic examination. No visible clinical or behavioral signs suggestive of esophagogastric ulcerative disease in cetaceans (Walsh et al., 2008), including lethargy, inappetence, reduced cooperation, abdominal discomfort, regurgitation, or vomiting, had been observed before diagnosis. Previous weekly gastric-content samples and routine endoscopic examinations had been normal, and available health records showed no hematologic or biochemical evidence compatible with inflammation or blood loss. No blood sample was collected specifically between the overnight release and the day-0 endoscopy. Together, these observations were consistent with a single acute exposure rather than repeated or chronic ingestion and suggested that the visible lesions developed rapidly, likely within hours after ingestion.

The initial endoscopic examination and foreign-body retrieval were performed on day 0 with a flexible high-definition videoendoscope (EickView HD 300, Eickemeyer, Tuttlingen, Germany; 300 cm working length, 13.0 mm outer diameter, 3.2 mm instrument channel) equipped with LED illumination and digital image capture. A semi-rigid cylindrical mouth gag was placed to prevent jaw closure and protect the endoscope from bite damage (Fig. 1).

Endoscopic examination revealed multiple retained K1/MBBR carrier elements in the distal esophagus and forestomach, associated with severe mucosal injury (Fig. 2A, B). The visible elements were cylindrical plastic carriers, grossly intact rather than fragmented, with a finned outer wall and internal cross-

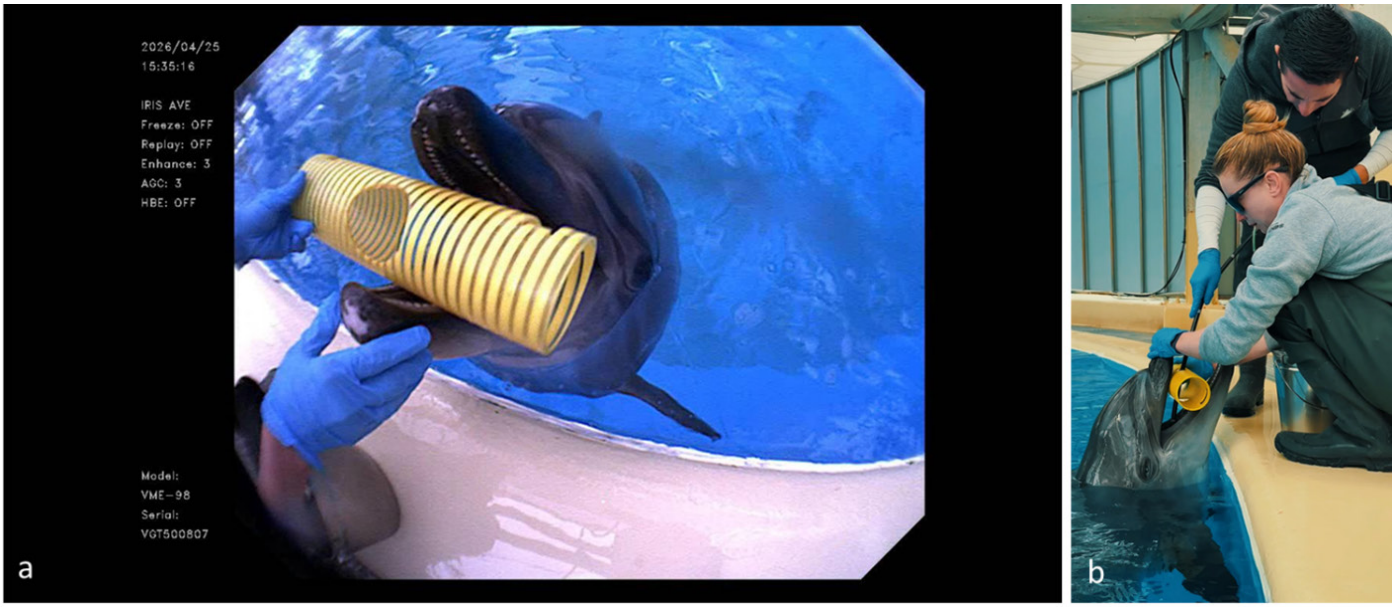


Figure 1. Voluntary endoscopic procedure performed on a bottlenose dolphin (*Tursiops truncatus*) under a medical behavior program. (a) Cylindrical mouth gag used to prevent dental occlusion and protect the flexible endoscope during examination. (b) Dolphin maintaining a trained stationing behavior during the procedure, allowing endoscopic evaluation without sedation or physical restraint.

shaped structure; nominal dimensions for K1-type carriers are approximately 10 mm in diameter and 7 mm in height. Multifocal erosive-to-ulcerative lesions with active hemorrhage were observed in the distal esophagus and forestomach, most prominently within the forestomach folds. The surrounding mucosa showed diffuse hyperemia, edema, and multifocal erosions progressing to deep ulceration, and several lesions had elevated, erythematous margins and areas of active bleeding with adherent clots. The distribution and morphology of the lesions were consistent with mechanical trauma associated with retained foreign material.

The retained elements were retrieved using flexible tripod grasping forceps (Eickemeyer ref. 306344) introduced through the working channel of the endoscope. The exact total number of recovered carrier elements was not recorded contemporaneously in the clinical record. Removal required five separate endoscope insertions. No additional visible retained elements were identified at the end of the procedure. Fish reward was withheld during the procedure to avoid interfering with visualization and retrieval. Between insertions, the dolphin remained under stimulus control through conditioned tactile reinforcement and social interaction from the training team, and voluntarily resumed the stationing position after each interruption. All elements were removed without sedation, physical restraint, or procedure-related complications such as iatrogenic perforation or aspiration. No sedative or analgesic medication was administered before retrieval, and no overt behavioral responses interpreted as pain or discomfort were observed during the procedure, including breaking station, refusal to re-engage, abrupt avoidance, or prolonged interruption of participation.

Following removal of the foreign bodies, treatment was directed at hemorrhage control, acid suppression, mucosal protection, and reduction of mechanical irritation during recovery. Tranexamic acid (1000 mg orally twice daily for 3 days), a synthetic lysine analogue that inhibits plasminogen activation and thereby stabilizes formed clots, was administered to support control of mucosal hemorrhage. Yunnan Baiyao® (3 capsules [0.25 g each] orally twice daily for 7 days), a proprietary Chinese herbal preparation used clinically as an adjunctive hemostatic agent, was also administered. Omeprazole (40 mg orally once daily for 15 days), a proton pump inhibitor, was used to reduce gastric acidity and acid exposure of the injured mucosa (Sachs et al., 2006). Sucralfate suspension (4 g BID PO for 7 days, then 3 g BID PO for a further 7-day period), a sucrose octasulfate-aluminum complex that forms an adherent protective layer over ulcerated tissue, was administered for mucosal protection. Because sucralfate may interfere with absorption of concurrently administered oral drugs, it was given approximately one hour apart from the other oral treatments, during the second and fourth feeding sessions of the day.

The dolphin's regular diet consisted of capelin (*Mallotus villosus*) (11.5 kg d-1), herring (*Clupea* spp.) (2 kg d-1), and Indian squid (*Uroteuthis duvaucelii*) (0.5 kg d-1). After foreign-body removal, the diet was temporarily simplified to chopped capelin alone (12 kg d-1), divided into seven feeding sessions, and maintained until complete endoscopic resolution of the visible lesions was documented on day 19. The dolphin was also withdrawn from performance programs and non-essential training sessions for the duration of treatment, while voluntary medical behaviors needed for care and monitoring were maintained.

Serial follow-up endoscopy was performed on days 4, 11, and 19 after foreign-body removal. On day 4, endoscopy showed residual superficial erosions and focal ulcerative lesions with irregular margins, together with areas of residual hemorrhage. Whitish plaques and loosely adherent material interpreted endoscopically as fibrin were present along the ulcer borders, consistent with an active inflammatory phase and early endoscopic signs of repair (Fig. 2C, D). On day 11, repeat endoscopy showed marked improvement: the main ulcerative lesion had decreased in apparent size and depth, with a cleaner base and marginal tissue

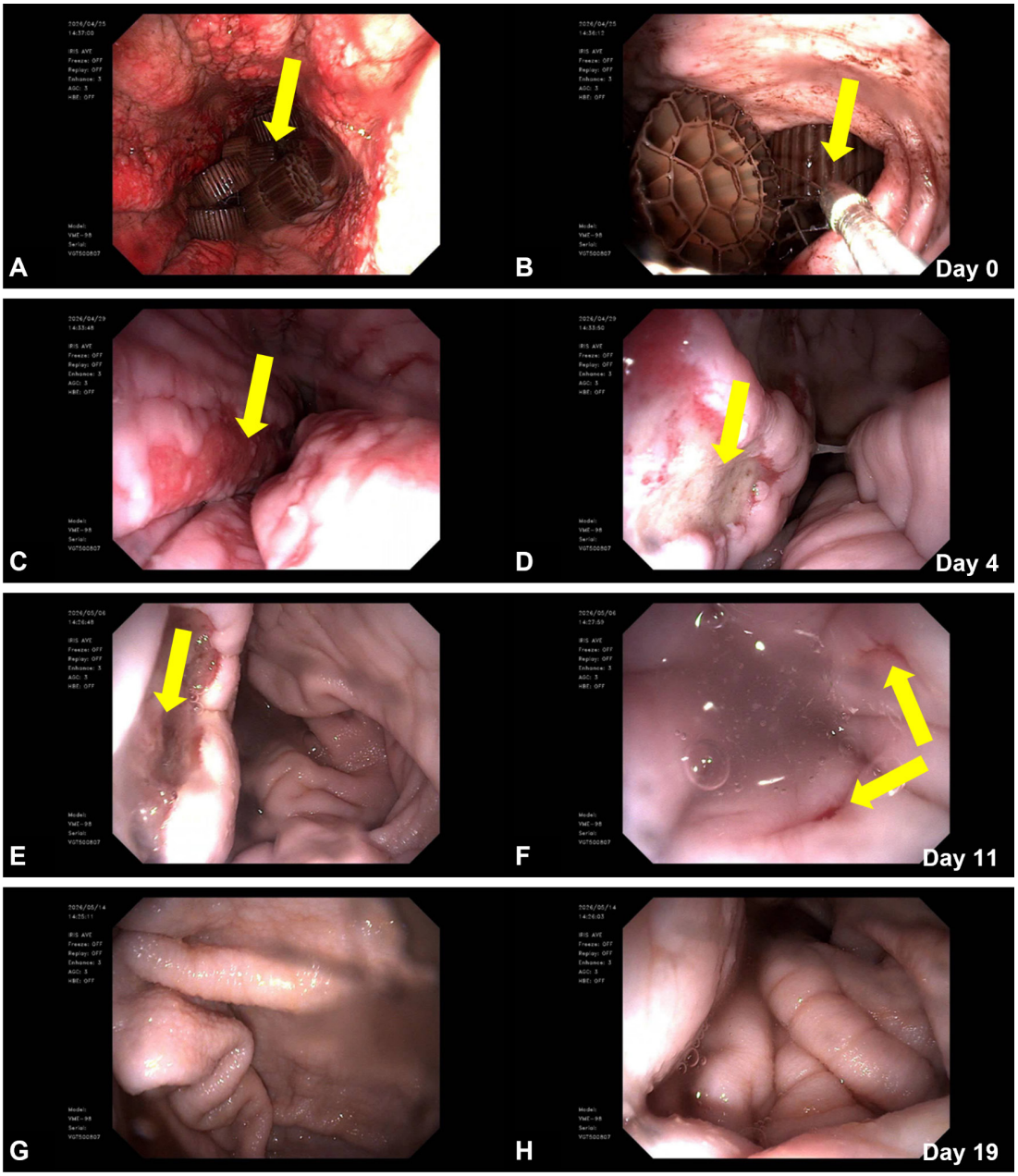


Figure 2. Serial endoscopic documentation of lesion progression and resolution after foreign-body removal from a bottlenose dolphin (*Tursiops truncatus*). On day 0, multiple retained K1/MBBR elements were visible within the forestomach (A), and retained material was removed using tripod grasping forceps (B). On day 4, residual mucosal injury was characterized by focal erythema (C) and ulceration with adherent fibrinous material (D). By day 11, the lesions had markedly improved, with only a residual linear mucosal defect (E) and near-complete endoscopic resolution with mild residual mucosal change (F). By day 19, no visible lesions remained and the mucosal surface had returned to a normal endoscopic appearance (G, H). Arrows in panels A–F indicate the principal lesions or findings highlighted in the text. Calibrated scale bars could not be provided because measurement was not available from the endoscopic image-capture system.

with the endoscopic appearance of granulation tissue, and the surrounding inflammation had subsided (Fig. 2E). Most minor erosions were no longer visible, the affected mucosa appeared uniformly pink with restored folding, no active bleeding was observed, and forestomach contents were clear (Fig. 2F). A final examination on day 19 showed complete endoscopic resolution of the visible lesions: no ulceration, fibrin, or exposed granulation-like tissue remained, and the mucosa was smooth, normally folded, and uniformly pink (Fig. 2G, H). Calibrated measurement was not available from the image-capture system, and no biopsies were obtained. Lesion progression was therefore assessed semi-quantitatively from sequential endoscopic images, using apparent reduction in ulcer size and depth, decreasing peripheral inflammation, restoration of mucosal folding, and disappearance of visible ulcer craters; histological confirmation of complete mucosal repair was not possible.

The rapid onset and severity of the lesions were clinically relevant. This dolphin had shown no visible abnormalities before

diagnosis, and previous gastric-content samples and routine endoscopic monitoring had been normal. These observations suggest that severe esophageal and forestomach ulceration with active hemorrhage may develop rapidly after ingestion of small, rigid plastic carrier elements. They also support proactive endoscopic screening after detection of potentially ingestible foreign material in a habitat pool, even when exposed animals appear clinically normal.

The lesion pattern was most consistent with mechanical trauma associated with retained foreign material rather than spontaneous ulcerative disease. The cylindrical K1/MBBR carrier elements were small enough to be ingested but rigid enough to become trapped among forestomach folds, where repeated contact likely contributed to mucosal abrasion, bleeding, and ulceration. This interpretation remains inferential because intraluminal movement of the retained elements was not directly measured, but it is supported by the documented presence of biofilter carrier media in the habitat pool, the recovery of retained material, the spatial association between foreign bodies and mucosal injury, and the absence of previous endoscopic abnormalities.

The treatment protocol combined removal of the mechanical cause, hemostatic support, acid suppression, mucosal protection, diet modification, and temporary reduction of routine activity. Because several treatments were administered concurrently, the outcome cannot be attributed to any single medication. Nevertheless, acid suppression and mucosal protectants are consistent with general clinical principles for ulcer management in cetaceans (Walsh et al., 2008) and with broader mechanisms of gastrointestinal ulcer repair, including inflammation, granulation tissue formation, and epithelial restitution (Tarnawski, 2005; Tarnawski & Ahluwalia, 2012).

The voluntary medical behavior program was central to the clinical management of this case. Repeated endoscopic examinations could be completed without sedation or manual restraint, providing a level of follow-up detail that is rarely available in cetacean medicine. Although restraint-based approaches remain necessary in unconditioned or stranded animals (Civelek et al., 2015; Shirakata et al., 2024), such approaches may limit the feasibility of frequent serial examinations. In the present case, cooperative behavior made it possible to evaluate lesion progression directly and to adjust clinical expectations during recovery.

Because the material in this case originated from the life-support system rather than from environmental marine debris, the case also has management implications. Removable components of filtration and life-support systems should be physically secured against access by animals, and any unplanned release of ingestible material should prompt immediate removal of the material, relocation of exposed animals where feasible, and clinical screening of all exposed individuals even in the absence of clinical signs.

Standardized descriptions of mucosal recovery following foreign-body removal in cetaceans are still limited. Endoscopic re-evaluation of esophageal and gastric ulceration before and after treatment has been reported in an Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) with inappetence, lethargy, and social isolation, in which mucosal improvement was documented at a single re-examination 14 days after treatment was started (Elmanaviean & Seta, 2023). That report differs from the present case because no retained foreign body was involved, the animal was clinically affected at presentation, and the follow-up consisted of a single post-treatment examination. We are not aware of previous reports providing serial endoscopic documentation of complete endoscopic resolution of foreign body-associated esophageal and forestomach ulceration in a bottlenose dolphin managed through voluntary medical behaviors following acute exposure to plastic biofilter carrier media associated with the life-support filtration system. These observations may serve as a practical reference for the evaluation and follow-up of similar cases and illustrate how voluntary medical behaviors can expand the diagnostic and monitoring options available for managing digestive disease in cetaceans under human care.

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All procedures described were part of routine clinical management performed for diagnostic and therapeutic purposes under professional veterinary care. No experimental procedures were carried out, and all data were collected during standard clinical care. Animal management and veterinary practice complied with applicable animal welfare regulations and institutional guidelines at the facility. The authors thank M. Rodríguez Gómez and the animal training team for their support in developing and implementing the voluntary medical behaviors that made the endoscopic procedures possible.

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