Guidelines for tusk fracture treatment in elephants

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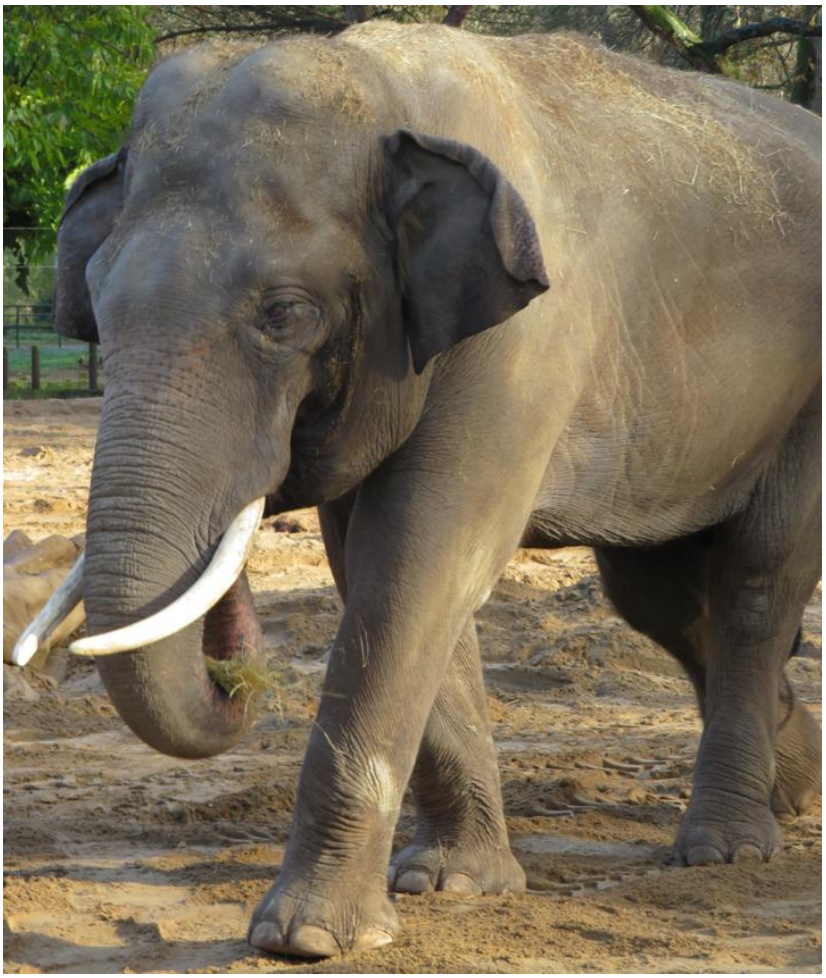
The nomenclature applied here is based on the official tooth injury nomenclature of the American Veterinary Dental College (AVDC Nomenclature – AVDC.org), but we indicate the elephant-specific nomenclature by Rose et al. (2022) as well.

Disclaimer: The methods described in these guidelines are intended to make the zoo vet more familiar with the options for treatment. They are not considered a step-by-step treatment manual. We recommend to contact experts in the field before embarking in a tusk fracture procedure.



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A) Tusk fracture – Treatment protocol

Introduction

Although tusk disorders occur comparatively frequently in elephants under human care, evidence-based knowledge on best treatment options is scarce (Rose et al. 2022; Rose et al. 2022a). According to good veterinary practice, treatment should be based on a thorough examination resulting in a clear diagnosis prior to considering treatment, which needs to be initiated in a timely manner. These guidelines were compiled in order to facilitate the decision making process for zoo and wildlife veterinarians working with elephants. A thorough diagnosis and appropriate tusk treatment will ensure dental health and elephant welfare. Above all, prevention of tusk disorders plays a main role in elephant dental care.

Both routine and focused dental examinations may uncover tusk disorders. The flow chart below (Figure 1) will facilitate recognition of the different classes of tusk trauma, essential for deciding on the subsequent course of action.

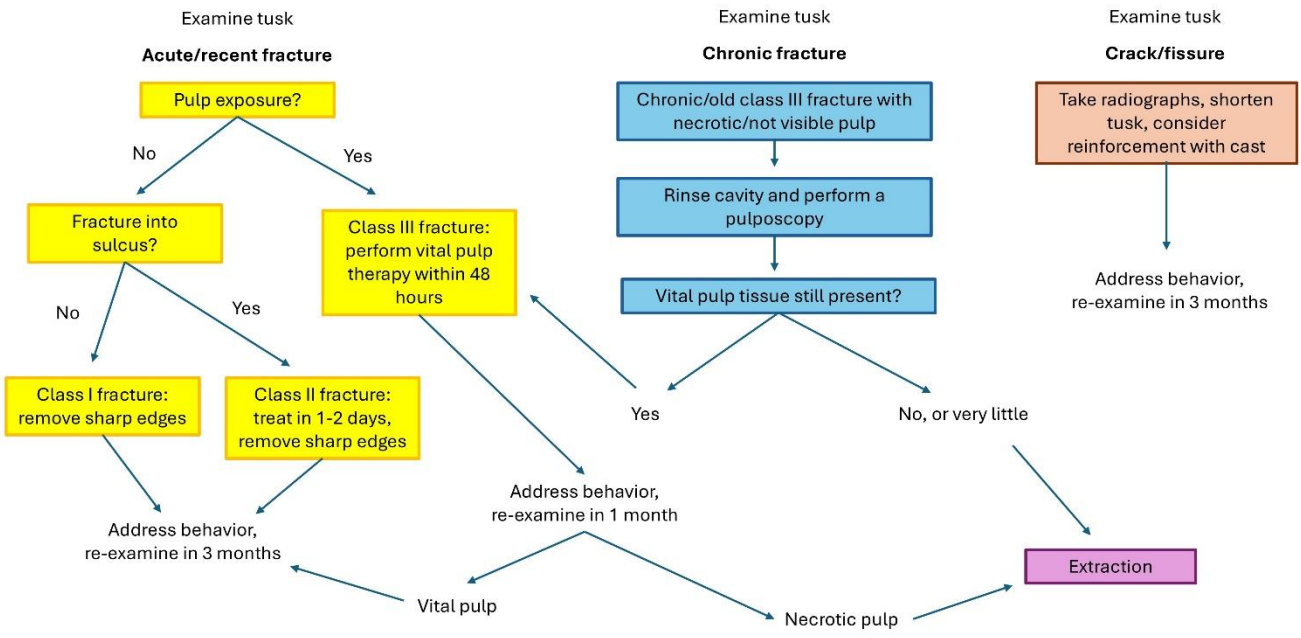


Figure 1. Flow chart of recommended treatment in case of tusk fracture in elephants (modified and extended from Steenkamp (2019)).

Crown cracks/fissures

The trauma is limited to the crown (Figures 2 and 3). Treatment within 7 days (ideally as soon as possible) is recommended to prevent further splitting of the crown.

Actions to be taken:

- Whenever possible, obtain a radiograph to determine the depth of the cracks/fissures and evaluate possible complicating factors. Note that due to the limitations of this diagnostic imaging technique (2D rather than 3D), this examination may not always allow to determine whether the crack involves the pulp cavity.
- Using a reciprocating saw, shorten the tusk to remove the affected crown or explore the fissure. This thorough exploration by visualization and probing should confirm whether the fissure/crack communicates with the pulp cavity. For tusk trimming and cutting, various equipment can be used depending on the specific fracture, the individual elephant and the preference of the surgeon. A list of proven equipment is provided in the Appendix I.
- Deep cracks need curetting, extensive flushing with sterile saline and drying. Subsequently, they can be filled with glass ionomer cement (to avoid the accumulation of dirt) and a carbon-reinforced cast can be placed to prevent further trauma (Figure 3).
- If shortening accidentally results in exposure of the pulp cavity, proceed to partial pulpectomy, preferably under standing sedation (Appendix II). If circumstances do not allow for a standing sedation, general anesthesia may be required. Plan this procedure in the first 48 hours after pulp exposure.
- Measure the distance between the proximal end of the fissure and the gingival margin and mark these points. This will enable the monitoring of both wear and growth, and of potential elongation of the fissure. If a mark at the gingival margin is set on the contralateral (healthy) tusk as well, growth rates can be compared.
- Investigate potential causes of the crack/fissure and identify preventive measures.

Figure 2. A longitudinal crack in the right tusk of a male Asian elephant. © PS

Figure 3 Left: Exploration of the depth of the crack (afterwards filled with glass ionomer cement). Middle: application of carbon-reinforced cast. Right: finishing touch of the final layer of the cast. © Willem Schaftenaar.

Uncomplicated crown fracture (Class I fracture according to Rose et al. 2022)

The crown is fractured above the gingival margin and the pulp is not exposed (Figure 4). Treatment within 7 days (ideally as soon as possible) is recommended only if needed to prevent further splitting and fissures of the crown.

Actions to be taken:

- Remove any sharp edges with a rasp, sandpaper, a polishing disc on an angle grinder (preferably combined with a flexible extension) or a milling cutter/“Dremel“, and shape to remove stresses from the edges of the crack.
- Mark the affected and contralateral tusk next to the gingival margin and monitor wear and growth.
- Investigate potential causes of the fracture and identify preventive measures.

Figure 4. Class I fracture in the left tusk of a female African elephant.

Uncomplicated crown-root fracture (Class II fracture according to Rose et al. 2022)

The crown fracture extends into the gingival sulcus, but the pulp is not exposed (Figure 5). Periodontal bleeding may occur. To prevent infection of the periodontium, treatment within 1-2 days (as soon as possible) is recommended.

Actions to be taken:

- Smooth any sharp edges (with a rasp, sandpaper, polishing disc on an angle grinder or a milling cutter/"Dremel"). This may require standing sedation, as sulcus trauma will be painful (Appendix II).
- If pain management is required, non-steroidal anti-inflammatory drugs (NSAIDs) should be given (see Appendix III). Pain management cannot replace the need for removal of the sharp edges.
- Flush the gingival sulcus initially with 0.12% chlorhexidine solution and subsequently on a daily basis with sterile saline or Ringer's lactate solutions.
- Check vaccination status against tetanus. In case of negative status, administer a primer or booster of a vaccination in accordance with the recommendation by the Elephant TAG (https://www.elephantmedicine.info/copy-of-documents-procedures-index).
- Mark the affected and contralateral tusk next to the gingival margin to monitor wear and growth.
- Investigate potential causes of the fracture and identify preventive measures.

Figure 5. Class II fracture in the left tusk of two female Asian elephants. The pulp is not exposed, but there is inflammation of the sub-gingival sulcus. Picture on the right © Zoo Planckendael.

Complicated crown fracture/complicated crown-root fracture/root fracture (Class III fracture according to Rose et al. 2022)

The tusk fracture involves the pulp cavity (also defined as a complicated crown fracture) (Figure 6). This is considered extremely painful and the pulp wound will be infected. It represents a dental emergency and prompt treatment is necessary.

Actions to be taken:

- Hemostasis is seldom required.
- These fractures are painful and analgesia needs to be administered (Appendix III).
- Remove any exposed pulp tissue immediately under sedation and adequate analgesia. Gravity and movement of loosely hanging pulp tissue protruding through the fracture site will detach the pulp tissue from the inner wall of the tusk higher up.
- Even though clear evidence on antibiotic treatment in these cases is currently lacking, the authors of these guidelines agree that systemic antibiotics may not be necessary. Instead, a timely treatment within 48 hours of tusk fracture should be aimed for.
- Carefully flush the pulp cavity 3-5 times daily with saline or Ringer's lactate solution. We advise against the use of chlorhexidine solution on pulp tissue due to its negative effect on fibroblast activity and tissue survival.
- Check vaccination status against tetanus. In case of negative status, administer a primer or booster of a vaccination in accordance with the recommendation by the Elephant TAG (https://www.elephantmedicine.info/copy-of-documents-procedures-index).
- Perform curative treatment in the form of partial pulpectomy (vital pulp therapy) under standing sedation or general anaesthesia (depending on circumstances and fracture), preferably within 48 hours.
- Mark the affected and contralateral tusk next to the gingival margin and monitor wear and growth.
- Investigate potential causes of the fracture and identify preventive measures.

Figure 6. Class III fracture in the left tusk of a sub-adult male Asian elephant. © PS

Note on the ‘conservative treatment‘ approach

In the past, several Class III tusk fractures have been managed in zoo elephants with a so-called ‘conservative approach’, consisting of daily flushing with non-irritant solutions. Anecdotally, the tusk seems to have an ability to repair an open pulp by the creation of a dental bridge. In cases where this occurred, physiological growth rates and no pathological signs in mid to long term have been observed. However, evidence-based knowledge on the prognostic factors for such a healing is lacking. In a comparative study by Rose et al. (2022) a 12-fold higher healing percentage of endodontic treatment was found compared to the conservative approach. The latter often resulted in the extraction of the affected tusk. However, no details about the nature of the fracture and the conservative treatment were provided in this study. Based on these findings, we consider endodontic treatment (with partial pulpectomy and subsequent filling) the treatment of choice for tusk trauma with pulp exposure. In situations with accessible fractures (i.e. located distal to the gingival margin), endodontic treatment can be done under standing sedation. In our view, the risks accepted with a conservative approach do not seem justifiable. We expect such cases to often end up in tusk extractions, although sometimes several years later. Further epidemiological research is required to confirm or reject this hypothesis.

B) Vital pulp therapy of elephant tusks

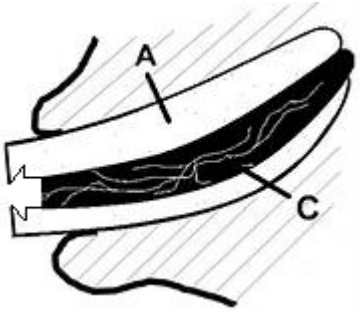
Below are best practice guidelines for vital pulp therapy (VPT) in elephants based on our current knowledge. These may need adapting, depending on logistics and available equipment. Each fracture is unique and improvisation is essential. Scientific studies comparing the different methods and their outcome are lacking so far.

It is strongly recommended to take radiographs before and after the intervention to monitor the healing process.

1. Clean: after scrubbing the tusk and the surrounding skin with an antiseptic scrub, avoiding the exposed pulp, the pulp tissue should be rinsed preferably with sterile saline or Ringer's lactate solution.
    a. Do **not** force tap water **into** the pulp cavity
    b. To remove visible dirt at the level of the fracture line, use sterile swabs soaked in sterile saline or Ringer's lactate solution to clean the pulp wound. We advise against the use of chlorhexidine solution on pulp tissue due to its potential negative effect on fibroblast activity and tissue survival.
2. Shorten the tusk remnant using gigli wire or other appropriate instrument (Appendix I), making the cut perpendicular to the longitudinal axis of the tusk, if this part is within reach.
3. Perform partial pulpectomy:
    a. Although regional anaesthesia may seem preferable, the method and efficacy of nerve blocks have not yet been established in elephants. The effect of intra-pulpal administration of lidocaine may be limited due to the low pH in inflamed tissues. If lidocaine is injected into the pulp, we recommend to add a vasoconstrictor (e.g. epinephrine) and to only inject in the part of the pulp that will be removed. The potential risk of bleeding and serious cardiovascular effects should be considered. There is no scientific evidence on appropriate dosages for local anaesthesia of the pulp in elephants.
    b. This is needed for two reasons: (a) removing the coronal contaminated/inflamed part of the pulp and (b) creating space for the restorative materials. The older the fracture is, the more pulp tissue will need to be removed, as inflammation, infection and loss of vitality will involve a larger portion of tissue. Resect it until reaching healthy, viable pulp. This may be difficult to recognise. Indicators of viable pulp are the absence of inflammatory signs and necrosis, as well as substantial

bleeding upon resection. To ensure that all unhealthy pulp has been removed, and the tusk capping has a good chance of success, it is recommended to remove slightly more pulp tissue than strictly necessary. To obtain enough depth for the filling materials, removal of several centimeters (at least 3 cm) of pulp tissue may be needed. Depending on the size of the opening, a scalpel blade or pointed scissors can be used to cut the pulp tissue, but by nature the cut will be oblique and not perpendicular. Cutting is preferred over the use of 'biting' biopsy forceps, as traction on the pulp tissue is undesirable.

4. Hemostasis:
    a. Pressure is the most important technique to ensure hemostasis. Use sterile cotton swabs or cotton rolls, slightly damp with sterile saline/Ringer's solution. Have several sizes of rolls prepared so that the most suitable diameter can be applied. Never use cotton wool, because it sticks to the tissue and may be difficult to remove. Push the pulp tissue about 1-2cm in apical direction by compression and retain pressure for 2-5 minutes. Remove carefully.
    b. If this is insufficient to stop the bleeding, a cotton swab can be soaked in adrenaline; repeat the compression. Be patient and remove it carefully.
    c. If still insufficient, mineral trioxade aggregate (MTA) powder or calcium hydroxide [Ca(OH)2] can be added to a new swab/roll; repeat the compression. Remove carefully.
5. Prepare the coronal portion of the pulp canal for final restoration. If the diameter of the pulp canal is more than 5 mm, the use of a threaded rod (sterilized polyether ether ketone (PEEK) or polyvinyl chloride (PVC)) is recommended (Woody et al. 2022): drill the tusk cavity round and make a thread using a thread maker. If the diameter of the pulp cavity is less than 5 mm, a threaded rod is not strictly necessary, but still recommended. No chemical bonding between the threaded rod and the dentine is expected. If such a rod is not used, an undercut should be made into the dentine, about 3-5 mm from the pulp surface (to allow room for the capping material). This is to prevent the restorative material from falling out if the chemical bonding to the dentinal walls is not optimal (see picture on the right, with A = dentine and C= pulp cavity, © Willem Schaftenaar). This can be done by using a small milling cutter (Dremel).



6. Pulp capping (Table 1): Ideally MTA has superior properties over Ca(OH)2 and is therefore the material of choice. However, MTA is expensive in large volumes compared to Ca(OH)2. Ca(OH)2 can be bought as powder in vials of 10 grams (e.g. Calcipro, Lege artis Pharma, Dettenhausen, Germany), or in larger versions.

MTA comes in many versions. Portland cement (sieved and sterilized) might present an alternative to MTA, although there are concerns about trace amounts of heavy metals like arsenic, chromium and lead. Hence, we consider MTA or Ca(OH)2 the first choice materials.

   a. The powder is mixed with sterile saline on a sterile glass plate (or similar) to form a viscous paste, in a portion large enough to cover the pulp wound in a thickness of minimum 3-5 mm. The paste must be thick and firm, so as not to slip out . The paste can be scooped up into a sterile syringe from which the tip has been cut off, to enable extrusion of the material. Use a syringe with a slightly smaller diameter than the pulp cavity size. Place the syringe in the pulp cavity at a short distance from the pulp and insert the cement. Then CAREFULLY compress the material with a dry cotton roll to ensure that the cement is resting on the surface of the pulp.

7. The threaded rod, if chosen as part of the restoration, is placed at this point (Figure 7).
8. Conditioning the inner side of the pulp canal is important for the adhesion of the final restoration. Apply the conditioning agent (generally a polyacrylic acid solution, EDTA or phosphoric acid) on the dentinal walls of the pulp canal with a cotton-tip and gently flush it out with sterile saline for 15-30 seconds. An etching gel (37.5% phosphoric acid) can be an alternative.
9. Restoration (all depends on the specific case; this might only present a very general recommendation) with the aim of a proper occlusal seal:
   a. Place multiple layers of glass ionomer cement (in total about 10-20mm) over the threaded rod or directly over the capping material. If an undercut was made, make sure to fill it completely. The glass ionomer cement should be allowed to harden between layers.
   b. Place an extra layer (at least 5-10mm) of composite resin on top of the glass ionomer cement layer. Dual-cure composite may be preferred over light-cure composite, as a larger volume can be placed in one go. But again, this will heavily depend on the specific fracture and also the dentists preference.
10. Mark the affected and contralateral tusk next to the gingival margin for monitoring of continuous growth.

Pulp capping material	MTA (or Portland cement), calcium hydroxide
Physical barrier	Silicon threaded rod
Etching gel	Phosphoric acid (37.5%)

Base	Glass ionomer cement
Final restoration	Composite resin

Table 1: Suggested materials for vital pulp therapy.

Figure 7. Nylon threaded rods, thread makers and drills in various sizes. © Willem Schaftenaar.

Follow up: Regular thorough clinical and radiographic examinations of the crown are strongly recommended. Signs of failure of the procedure include:

- Soft tissue swelling and heat, indicative of infection.
- Discharge at the sulcus or around the restoration.
- Behavioural signs of discomfort, such as consistently touching with trunk or head pressing on cables and uprights.
- Reduced/absent growth of the tusk (physiological growth is expected to be about 15-17cm per year). However, normal growth of the tusk is no guarantee that the procedure was successful. Pulp infections acquired during treatment can initially go unnoticed and show up after several years.

Note: You may find illustrations of the various treatment steps on the elephant medicine website under Tusk fracture | Elephant Medicine

C) Tusk fracture – long-term monitoring protocol

After the occurrence and subsequent treatment of a tusk fracture, we strongly recommend a thorough monitoring protocol consisting of the following aspects:

- **Daily:** Inspection of the tusk, sulcus, gingiva and alveolar area (Figure 8) with a focus on swelling (Figure 9), pain, discharge and heat (note: thermal imaging is very helpful in detecting the latter).
- **Monthly:** Measurement of the affected and contralateral tusk growth by documenting the distance between the marking notches and the margin of the sulci (Figure 10).
- **Three-monthly:** Haematological examination, to assess inflammatory parameters.
- **Six-monthly:** Radiographic examination (Figure 11) of both the affected and the contralateral tusk for comparison.

Actions to be taken

In case of alterations in any of these aspects, more specific examinations will be required to provide the basis for decisions regarding the most appropriate treatment options.

Figure 8 (left). Examination of the gingiva and sulcus of the left tusk of a sub-adult male African elephant. © ET

Figure 9 (right). Swollen alveolar area of the left tusk in a sub-adult male African elephant.

Figure 10. A marking notch in the right tusk (arrow) of this sub-adult male African elephant will facilitate an objective evaluation of the growth rate (note: this individual suffered from chronic pulpitis of his left tusk, showing purulent discharge).

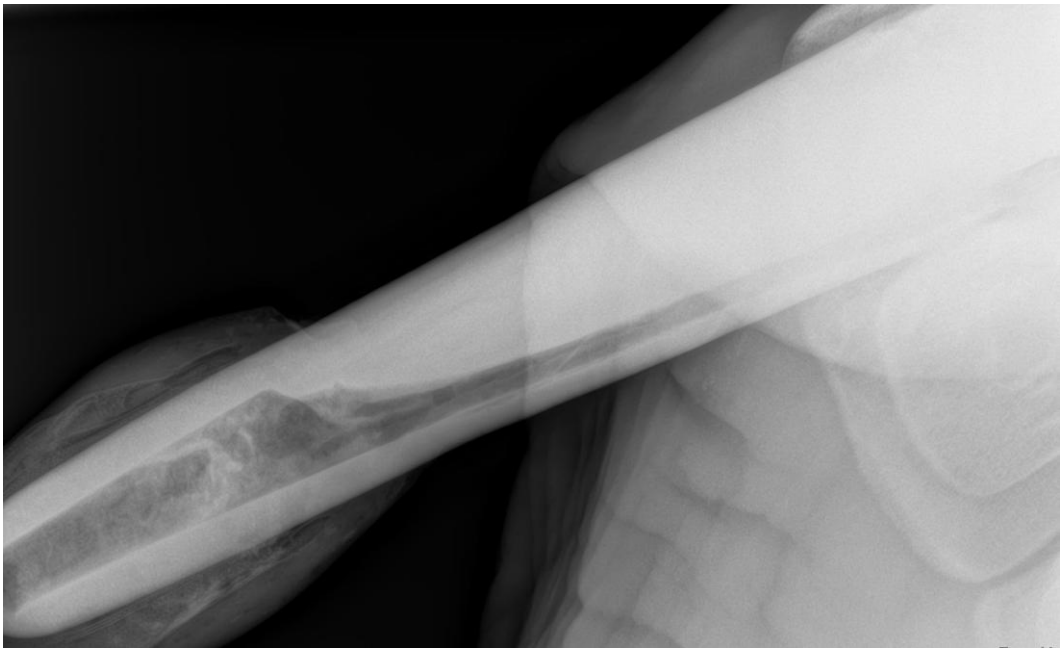


Figure 11. Radiographs of the tusk enable assessing the extent and shape of the pulp cavity in a sub-adult male African elephant (note: the tusk tip of this individual was covered with Technovit several months before this radiograph was obtained). © RP

D) Tusk fracture – prevention

Background

Tusk fracture treatment is a delicate task and prevention represents the most relevant approach. A recent comparative study revealed an association of several risk factors for tusk fractures in elephants under human care (Rose et al. 2022). These mainly include conspecific interactions due to unstable hierarchy, and tusk contact with enclosure or enrichment items, in particular steel and concrete.

Based on this evidence, it is crucial to thoroughly consider these aspects of elephant husbandry when aiming to prevent tusk fracture incidents.

Physical environment

Elephants make use of their tusks to interact with their environment. In their natural habitat, they will rarely find unyielding substances such as concrete and steel. These are however commonly used to build elephant facilities in zoological collections. Interaction with these unyielding materials can cause severe damage to tusks. This damage can happen in a slow, progressive manner, or acutely. While slowly progressing alterations (e.g. due to uneven wear or over-wear) may be recognized through continuous monitoring and management over time, acute presentation of tusk trauma is more common. Therefore it is crucial to adapt the physical environment and replace steel and concrete wherever possible. There are also options to cover such structures with more malleable and soft materials (e.g. wood or rubber). The risk of tusk fractures should also be considered when choosing enrichment items, as well as during transport and during the induction of general anesthesia. Of outmost importance is the substrate (Figure 12). Resting in lateral recumbency on a heavily abrasive surface may lead to increased wear of the lateral section of the tusk, predisposing it to cracks, splits or weakening of the tooth (Figure 13). This is even more relevant if an individual elephant prefers to rest on a specific side. If this is the case, a more holistic approach is encouraged, aiming at a more balanced and satisfying resting behavior. Deep sand and the creation of mounts of earth are helpful to provide resting and leaning places, especially for elephants that have difficulty laying down or that can only get up from one side, because of previous injuries or degenerative disorders such as osteoarthritis.

Figure 12. Two indoor areas for elephants. In one case the animals can barely interact with anything apart from steel and concrete (a), while in the other environment wood and malleable sand substrate are predominant (b).

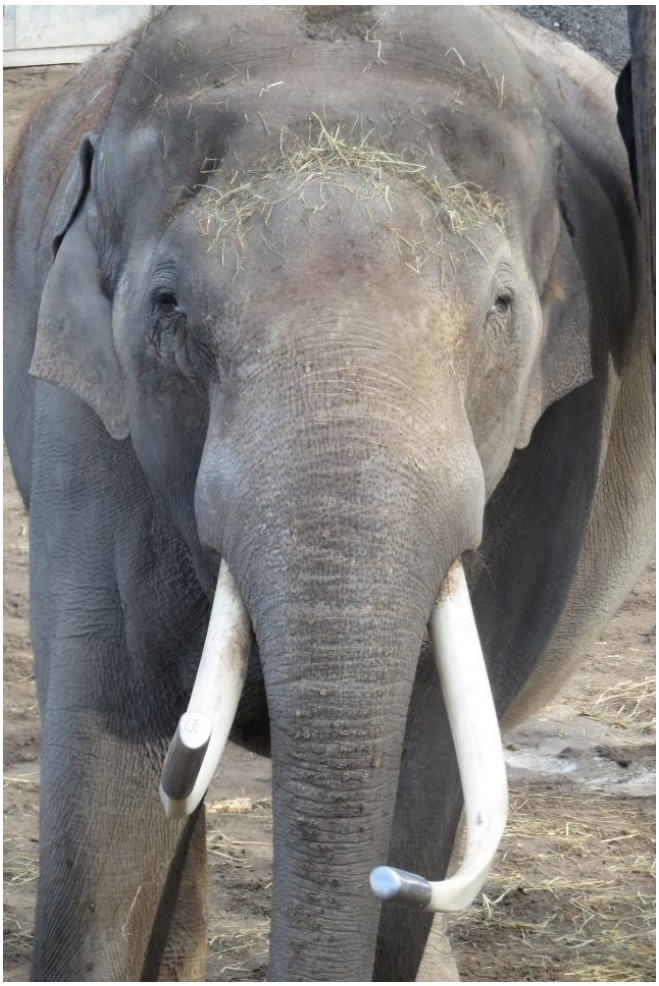


Figure 13. An adult male Asian elephant with an unequal resting behavior, mainly lying on his left side during rest. Subsequently, his left tusk has worn very thin in the corresponding region of ground contact, increasing the risk of tusk fracture. © PKK

Social environment

The social situation of an elephant may be a significant risk factor for tusk trauma. If socially incompatible elephants are separated by an unyielding barrier (see section above), antagonistic behaviors may lead to tusk trauma. However, even if elephants are considered socially compatible and sharing the same space, continuous social physical interactions may increase the risk of tusk fractures (Figure 14). Sparring represents a natural behavior, but the extent and intensity can vary depending on the group composition and age of the elephants. In well-structured all-male groups, these interactions may be less intense compared to groups with several individuals on a similar hierarchy level, resulting in constant battles. Therefore, to reduce the risk of tusk trauma, the social composition of an elephant group should also be given thought.

Figure 14. Natural social interactions can increase the risk for tusk trauma.

Tusk wear

Tusk use in various ways is part of an elephant's natural behavior. Hence it is our responsibility to provide an elephant under human care with the appropriate structures and substrates. Wood, mud, sand and other natural substrates ensure normal wear of the tusks, while concrete and steel may increase the risk for uneven and excessive wear (Figure 15). This can be aggravated by repetitive behaviors such as swaying. Again, a holistic approach is necessary, looking at all elements of elephant husbandry, including behavior monitoring.

Figure 15. Unnatural tusk wear on steel structures may lead to alterations in tusk shape as seen bilaterally in this female African elephant.

Capping

Protective tusk capping (Figure 16) is currently not recommended as a long-term preventive approach for tusk fractures. In case of thin brittle tusk tips, tusk shortening is preferential to capping with unnatural materials (e.g. steel caps). The latter may lead to damage of conspecifics in physical social interactions (e.g. play-fighting, fighting, pushing).

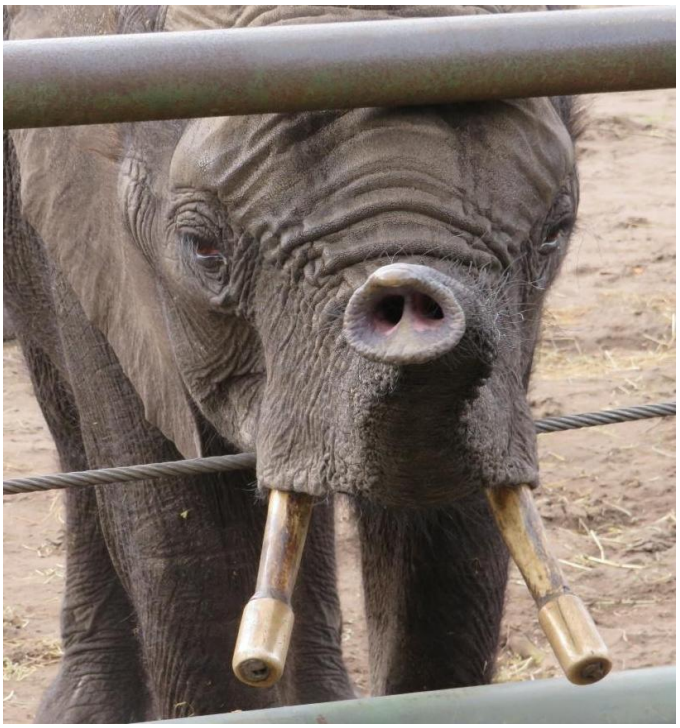


Figure 16. As it can cause trauma to conspecifics, protective tusk capping as a preventive measure is not recommended.

Monitoring

The aforementioned aspects should be monitored on a daily basis. With this holistic approach, long-term tusk health can be ensured, and the risk of tusk trauma reduced. Such a continuous monitoring protocol can be conducted internally by the zoo staff, and/or with the help of an external expert in elephant dentistry.

Pre- and post-operative care

According to the EAZA Elephant Best Practice Guidelines 2020 (accessible online Elephant_TAG_BPG_2020_6956205c9a.pdf) positive reinforcement training presents a central part of elephant management in European zoos. This is relevant not only in the daily monitoring and care, but also when it comes to diagnostic examinations and treatments. A reliable training standard is critical for preoperative examinations, and most important to ensure access during the postoperative period, when painful treatments (e.g. flushing) and oral or parenteral drug administration are to be expected. Hence, training for medical interventions should focus on these aspects well before access is actually required. A preventive approach based on a thorough medical training protocol is therefore strongly recommended, independent of age and sex of the elephant under human care.

Disclosure statement

With respect to the current scarcity of scientific knowledge in this area, some parts of this protocol and our recommendations are not evidence-based. They present a best practice approach on the basis of the experiences of our group, *Elephant Dental Vets (EDV)*. We are an independent working group of veterinarians with a particular interest in elephant and/or dental medicine. The group acts as a not-for-profit, charitable organization with members from various countries across Europe. The main objective of *Elephant Dental Vets (EDV)* presents the long-term provisioning of high standards of dental care and treatment for elephants in Europe. Although every tusk fracture is different and treatment needs to be adapted specifically, this document is supposed to offer a basic guidance for veterinarians caring for elephants.

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Appendices

Appendix I: Equipment for tusk trimming and cutting

Please note that the choice for an appropriate tool is always case-dependent

Tool		Advantages (+) / disadvantages (-)	Notes
Reciprocating saw		+: cuts even large tusks easily; cuts in straight lines -: soft tissues need to be protected; water-cooling required; noisy	choose saw blade size according to tusk size; saw blade can be sterilized
Gigli wire and handles		+: high flexibility; no electricity required -: bleeding may function as lubricant, reducing its efficacy; soft tissues need to be protected	ensure to have a plyer at hand to cut off the wire
Dremel and extension cable		+: powerful and handy -: intense vibration and sound	keep rpm as low as possible to reduce heat production; extension cable is very useful when working in the sulcus
Angle grinder		+: powerful; angle easily adaptable; sharp edges can be softened quickly -: intense noise and heat production	many elephants are familiar with the tool due to foot care experiences
Metal saw		+: no electricity required; cuts in straight lines; minimal noise production -: relatively slow cutting action	heat production can be controlled through the speed of sawing

Appendix II: Standing sedation in elephants – drug combinations

STANDING SEDATION IN ELEPHANTS – SUGGESTED PROTOCOLS				
Acronyms	**Drugs**	**Intramuscular dose (mg/kg)**	**Dose range (+/- mg/kg)**	**Referenced species**
BAM	Butorphanol	0.016	0.002	African elephant (Laubscher et al., 2021)
	Azaperone	0.006	0.0008	
	Medetomidine	0.006	0.0008	
DB	Detomidine	0.018	0.001	Asian elephant (Bouts et al., 2017)
	Butorphanol	0.018	0.001	
MB	Medetomidine	0.009	0.002	African elephant (Luders et al., 2016)
	Butorphanol	0.030	0.007	
X	Xylazine	0.120	0.030	Asian, juveniles only (Jansson et al., 2021)

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Appendix III: Non-steroidal anti-inflammatories (NSAIDs) used for dental pain management in elephants

NON-STEROIDAL ANTI-INFLAMMATORIES (NSAIDs) USED FOR DENTAL PAIN MANAGEMENT IN ELEPHANTS			
Drug	**Dose**	**Frequency**	**Reference**
Flunixin meglumine	1 mg/kg	q24h	Mikota and Plumb, 2023
	1.1 mg/kg	q24h	EDV guidelines authors
Ibuprofen	6 mg/kg (Asian elephants) 7 mg/kg (African elephants)	q12h	Bechert and Christensen, 2007
Meloxicam	0.2 mg/kg loading dose, followed by 0.05-0.1 mg/kg	q24h (q30h)	EDV guidelines authors (pers. observ. Prof. Steenkamp)
Phenylbutazone	1-2 mg/kg	q24h	Mikota and Plumb, 2023
	4 mg/kg	q24h	EDV guidelines authors

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