How hard is too hard?

Lisa Milella BVSc DipEVDC

ABSTRACT: Tooth fracture is commonly seen in practice although a lot of owners may not be aware that their pet has a fractured tooth. It is often only after treatment that owners appreciate how much pain and discomfort their pet was suffering. While chew products can be a good way to help maintain a dog's oral hygiene, not all chews would be considered safe. Any chew or toy that does not break under the maximum load reported may have the potential to cause tooth fracture, resulting in potential pain and infection for the pet. Client education is also important as many dog owners are unaware of the incidence of tooth fractures as well as the potential harm of some chewing behaviour or products. Nurse clinics provide the ideal opportunity to discuss all aspects of oral care including the risk of certain products to cause tooth fracture.

KEYWORDS: Bite forces; chewing behaviours; tooth fracture

Lisa Milella BVSc DipEVDC

Lisa Milella is a European specialist in veterinary dentistry and a trustee of International Animal Rescue. Since first becoming involved with the charity in 2005, when she operated on a dozen rescued dancing bears in India, Lisa has performed dental surgery on numerous exotic animals in its care, including orangutan.

Introduction

Tooth fracture in dogs is commonly seen in practice, with a reported prevalence of 20–27%. Many pet owners may not even be aware that their pet has a fractured tooth so thorough dental examinations during nursing consults will help identify fractured teeth and highlight the problem (Capik, Ledecky, & Sevcik, 2000). In maxillofacial trauma patients the reported prevalence of tooth fracture is even higher (67–85%) and whilst this may not be a priority at the time of presentation, fractured teeth should not be overlooked during the course of treatment (Soukup, Mulherin & Snyder, 2013). Tooth fractures often occur as a result of traumatic impacts, such as road traffic accidents or direct trauma to the mouth, but there is an increasing concern about the potential role of chewing on treats and toys in the fracture of large cheek teeth. Tooth fractures have been reported to occur most commonly in functionally important teeth that play a role in prehension and chewing, namely the canine and carnassial teeth (Gracis & Orsini, 1998).

Tooth fractures

Tooth fractures may be uncomplicated, involving just the enamel and/or dentine, or complicated which involves the pulp cavity too. This is clinically important as the pulp cavity contains blood and lymph vessels, nerves, odontoblasts and connective tissue, which when exposed, become inflamed resulting in pulpitis and may ultimately lead to pulp necrosis. Pulpitis in the acute stages results in sharp pain and in the chronic stages results in dull throbbing pain (Nanci, 2013). It is often only after treatment that we can appreciate the pain that the pet was suffering by the notable changes in their behaviour. Clients will often comment during post op checks how much more playful their pet has been or how they are much more social following dental treatment. Clinically a tooth with a recent complicated crown fracture will have a pink or red spot indicating pulp exposure, and if the pulp has started to become necrotic, the pulp will be a black colour (Figures 1–3). All these teeth require treatment, either extraction or endodontic treatment (root canal therapy) if suitable (Niemiec, 2005).

Chewing behaviours

As well as clinical treatment it is also advisable to ask the owner about potentially damaging chewing behaviours. While chew products can be a good way to help maintain a dog's oral hygiene, not all chews would be considered safe. A letter from veterinary dentists to the editor of the Veterinary Times a few years ago highlighted concerns about the increase in the number of fractured teeth seen following dogs chewing on antlers or nylon bones (Milella, 2013). The general guidelines have always been that a dog should not chew on anything hard that cannot bend or break when in contact with teeth or anything that cannot be indented with your thumbnail. Whilst expert opinion is valuable, it is the lowest form of evidence, and for a number of years independent veterinary dentists have expressed their concerns to the industry regarding unsafe products, requesting more evidence based research exploring the relationship of chew structural properties and tooth fracture be performed.

Most reported studies relating to chews have investigated the role of chews in the maintenance of oral hygiene, looking at their effect on factors affecting periodontal disease such as plaque and calculus, rather than specifically potential trauma to teeth (Quest, 2013). Until now the role of chewing activity in the development of tooth fractures in dogs had been controversial, in part due to the lack of information available about the resilience of

DOI: 10.1080/17415349.2020.1717100

Figure 1. Complicated crown root fracture. The pulp is exposed and the fracture extends subgingivally.

Figure 2. Complicated crown root fracture as a result of chewing on an antler.

Figure 3. Fractured carnassial tooth with a necrotic pulp.

teeth to masticatory forces and the impact of the treat or toy's textural properties in transmitting a potentially harmful stress concentration through the teeth. In addition to this, stress distribution on functionally important teeth during chewing activity had not been evaluated (Miura, Maeda, Nakai, & Zako, 2009). This meant that there were no limits for the textural properties or hardness of chews, food and toys for dogs available to the industry as guidelines for safety. Even the Veterinary Oral Health Council had no formal recommendations regarding the textural properties or hardness of chews, food or toys (VOHC, 2019).

Forces

Early studies showed that dogs can generate voluntary bite forces ranging from 13 to 1,394 Newtons when working, and the forces were shown to be directly proportional to their size (Lindner, Marretta, Pijanowski, Johnson, & Smith, 1995). When all four canine teeth are involved, the maximum pulling force can range from 480 to 1,200 Newtons. It is also known from modelling and stimulated chewing under anaesthesia that the maximum potential bite forces for dogs can be significantly higher, peaking at over 3,400 Newtons at molar teeth (Ellis, Thomason, Kebreab, & France, 2008). We do not know however what forces dogs would actually use when chewing voluntarily (Currey et al., 2009).

Since then one study has looked at the fracture resistance of canine teeth. It showed that when a force was applied to the canine tooth at a 45° angle in a direction from the occlusal surface, the maximum force the tooth could sustain before fracturing was between 494Newtons and 630Newtons depending on the crown height to diameter ratio (Soukup, Collins, & Ploeg, 2015).

A more recent study conducted at the University of Pennsylvania confirmed that dog's teeth will indeed fracture if they chew on a product that is too hard. The research investigated exactly what external forces were required to cause tooth fracture to the maxillary carnassial teeth. Sample teeth with surrounding gingiva and alveolar bone were harvested from cadavers and set in polymethylmethacrylate. A force was applied to the cusp of the tooth at an angle set at 60°. This angle was chosen as it gave a fracture pattern most consistent with fractures seen in clinical practice and those described by the American Veterinary Dental College (Figure 4). The point of contact of the force on the tooth used tried to mimic that of contact during normal chew behaviour. Results showed that the mean maximum load sustained by

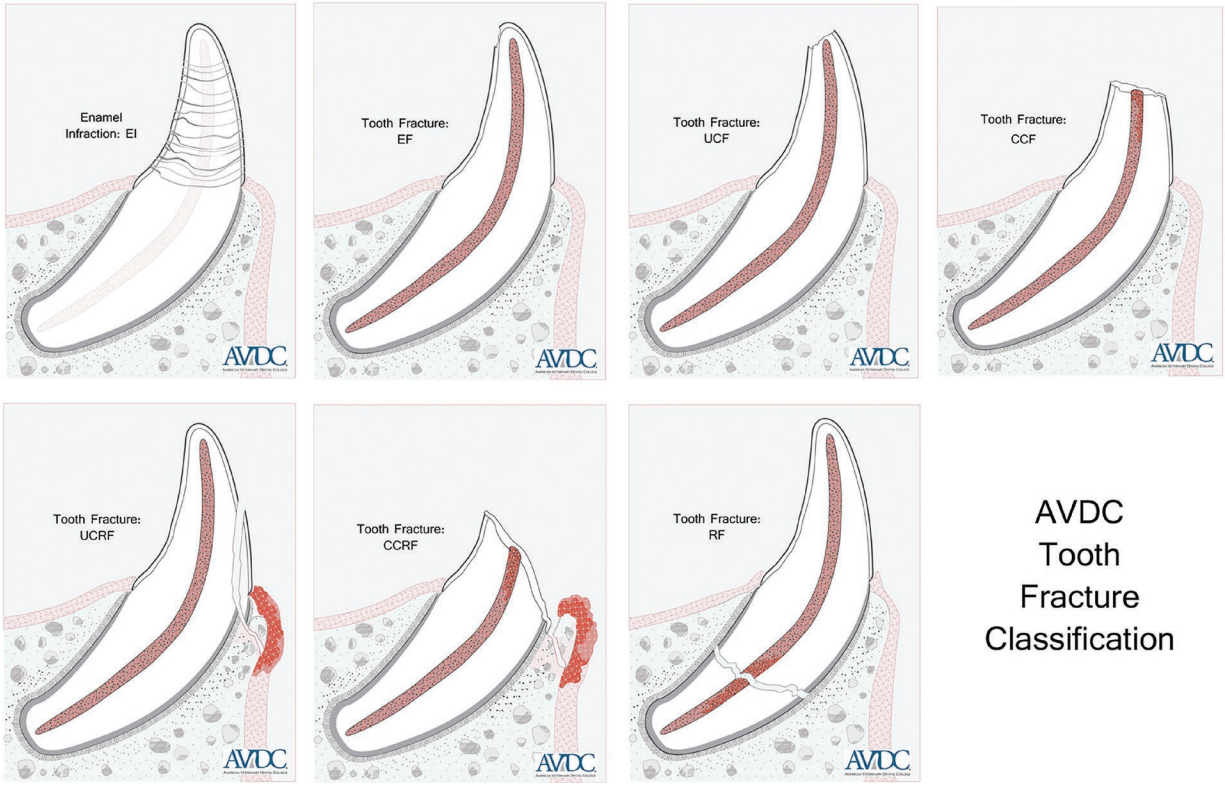

Figure 4. AVDC classification of tooth fractures.

the maxillary carnassial teeth tested at the point of fracture was 1,281 Newtons at a mean impact angle of 59.7°. The most common fracture type that occurred among all samples was a complicated crown fracture, followed by an uncomplicated crown fracture (Soltero-Rivera, Elliot, & Hast, 2019).

These studies though were conducted on sample teeth and only mimic what occurs when chewing. Other factors for example, pulp vitality and the periodontal ligament, play a role in fracture resistance in vivo. The periodontal ligament not only supports the tooth, but also through its' proprioceptive properties adapts whilst chewing, protecting the tooth and acting as a shock absorber to some of the forces (Fristad & Berggreen, 2016; Mcculloch, Lekic, & Mckee, 2000). The mean maximum force sustained by the teeth in the above studies prior to fracture, however, was within the maximum chewing capability of the average dog, raising the concern that dogs who chew on treats and toys that do not yield significantly below the failure rates described above might be at increased risk of tooth fracture. This is of particular concern to the maxillary fourth premolar teeth as a result of overexertion during chewing.

Conclusion

Any chew or toy that does not break under the maximum load reported may have the potential to cause tooth fracture, resulting in potential pain and infection for the pet. This research will hopefully be adopted by the industry as it proves what the maximum load is that a tooth can sustain and should be used in future to assess all chew products to determine whether or not they are likely to cause a tooth fracture. Client education is also important as many dog owners are unaware of the incidence of tooth fractures as well as the potential harm of some chewing behaviour or products, and the impact and discomfort it may cause their pet. Nurse clinics provide the ideal opportunity to discuss all aspects of oral care including the risk of certain products to cause tooth fracture. The veterinary profession too should not be complacent in treating fractured teeth. Just because the dog is coping and not showing overt signs of pain does not mean that these teeth can be monitored or ignored -any tooth with pulp exposure needs treatment.

References

Capik, I., Ledecky, V., & Sevcik, A. (2000). Tooth fracture evaluation and endodontic treatment in dogs. *Acta Scientiae Veterinariae*, *69*, 115–122. doi:10.2754/avb200069020115

Currey, J. D., Landete-Castillejos, T., Estevez, J., Ceacero, F., Olguin, A., Garcia, A., & Gallego, L. (2009). The mechanical properties of red deer antler bone when used in fighting. *Journal of Experimental Biology*, *212(24)*, 3985–3993. doi:10.1242/jeb.032292

Ellis, J. L., Thomason, J. J., Kebreab, E., & France, J. (2008). Calibration of estimated biting forces in domestic canids: Comparison of post-mortem and in vivo measurements. *Journal of Anatomy*, *212(6)*, 769–780. doi:10.1111/j.1469-7580.2008.00911.x

Fristad, I., & Berggreen, E. (2016). Structure and functions of the dentin-pulp complex. In: K. M. Hargreaves & L. H. Berman (Eds.), *Cohen's pathways of the pulp* (11th ed., pp. 532–572). St Louis: Elsevier.

Gracis, M., & Orsini, P. (1998). Treatment of traumatic dental displacement in dogs: Six cases of lateral luxation. *Journal of Veterinary Dentistry*, *15(2)*, 65–72. doi:10.1177/089875649801500201

Lindner, D. L., Marretta, S. M., Pijanowski, G. J., Johnson, A. L., & Smith, C. W. (1995). Measurement of bite force in dogs: A pilot study. *Journal of Veterinary Dentistry*, *12(2)*, 49–52. doi:10.1177/089875649501200202

Mcculloch, C., Lekic, P., & Mckee, M. (2000). Role of physical forces in regulating the form and function of the periodontal ligament. *Periodontology 24(1)*, 56–72. doi:10.1034/j.1600-0757.2000.2240104.x

Milella, L. (2013). Letter to the editor. *Veterinary Times*. Retrieved from: https://www.vettimes.co.uk/.

Miura, J., Maeda, Y., Nakai, H., & Zako, M. (2009). Multiscale analysis of stress distribution in teeth under applied forces. *Dental Materials*, *25(1)*, 67–73. doi:10.1016/j.dental.2008.04.015

Nanci, A. (2013). Dentin-pulp complex. In: *Ten cate's oral histology* (8th ed., pp. 174–175). St. Louis: Elsevier.

Niemiec, B. (2005). Fundamentals of endodontics. *Veterinary Clinics: Small Animal Practice*, *35(4)*, 837–868. doi:10.1016/j.cvsm.2005.03.001

Quest, B. W. (2013). Oral health benefits of a daily dental chew in dogs. *Journal of Veterinary Dentistry*, *30(2)*, 84–87. doi:10.1177/089875641303000203

Soltero-Rivera, M., Elliot, M., & Hast, M. (2019). Fracture limits of maxillary fourth premolar teeth in domestic dogs under applied forces. *Frontiers in Veterinary Science*, *5*.

Soukup, J. W., Mulherin, B. L., & Snyder, C. J. (2013). Prevalence and nature of dentoalveolar injuries among patients with maxillofacial fractures. *Journal of Small Animal Practice*, *54*, 9–14. doi:10.1111/j.1748-5827.2012.01295.x

Soukup, J. W., Collins, C., & Ploeg, H. L. (2015). The influence of crown height to diameter ratio on the force to fracture of canine teeth in dogs. *Journal of Veterinary Dentistry*, *32(3)*, 155–163. doi:10.1177/0898756415032300302

Veterinary Oral Health Council (VOHC). 2019. Home page and Protocol and submissions. Retrieved from www.vohc.org.