Thermal Damage In Equine Power Dentistry: Myth or Reality?

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Horses' hypsodont teeth, though well-suited for continuous grazing, require regular dentistry work under modern conditions: confinement feeding and expectations of peak performance in sporting events. As a result we float more teeth today than ever, increasingly using motorized equipment. The practical advantages are obvious - but are there increased risks with modern instruments? This article focuses on the possibility of thermal damage when floating teeth.

Assessment of horses who do not receive regular dental care reveals a high incidence of soft tissue lesions. As Dr. Becker determined nearly a century ago, a horse with good teeth may save up to half a pound of grain a day.

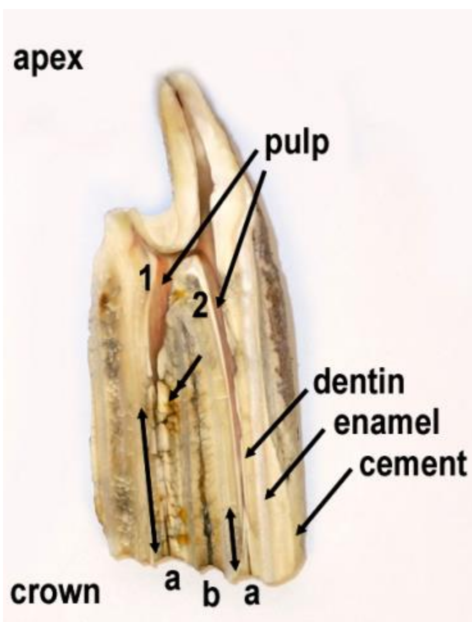
People have floated teeth with manual tools for hundreds of years, but motorized instruments have become the industry standard in the past decade. They allow greater precision for detailed work, reduce the incidence of soft tissue trauma and tooth fracture, and more effectively reduce sharp enamel points, long hooks, waves, and steps. However, with improved precision and efficiency comes increased risk: overfloating can result in pulp exposure as well as thermal damage. The danger of heat production during motorized dentistry is a recurring issue of debate among equine veterinarians at meetings and in online forums. But are all instruments and methods equally flawed? Can any preventative measures be taken to reduce heat production during motorized floating? I will explore these questions by reviewing contemporary findings specific to horses from both laboratory research and field practice.

The main area of concern for thermal damage is the pulp in teeth. However much of the recommendations made in equine dentistry stems from studies in human dentistry or other species with brachydont teeth. For example, one study cited frequently in current debate was performed on monkeys in the 1960s. In this study, a 5C degree increase in the temperature of the pulp resulted in irreversible pulp damage and tooth loss in 50% of the sample. But hypsodont equine teeth have a more complex and hardy physiology, and the ratio of tooth mass to grinding area is much higher compared to human teeth. Furthermore, hypsodont teeth have a reparative capacity by forming secondary or tertiary dentin.

One of the main factors determining thermal damage of vital structures within teeth is the distance between occlusal surface and pulp. Dixon, among others, has shown that in horses the distance between occlusal surface and pulp varies widely in individual animals, in different teeth of the same horse (incisors vs. cheek teeth, rostral vs. caudal, maxillary vs. mandibular), and even within different pulp horns in a single tooth. In addition, the distance may change with age. Definitive conclusions regarding the thickness of the protective layer of secondary dentin cannot be made.

Even though the larger maxillary cheek teeth of younger horses appear to have a greater distance between pulp and surface such that they can probably withstand more heat during floating, that information is inconsistent and of little practical consequence.

The next question is how the heat, generated by rasping on the occlusal surface, is conducted through, distributed within and



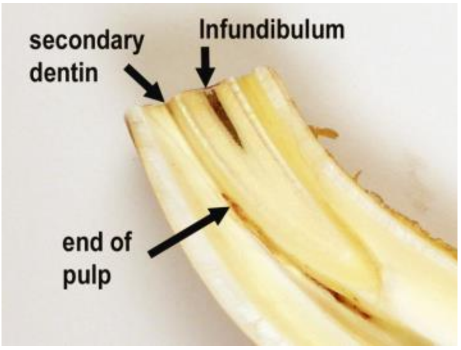
Picture 1:
Sagittal section through a maxiallary cheek tooth shows different tooth materials: cementum (outside and inside the infundibulum b), white enamel layers and dentin around the pulp. This tooth shows two pulp horns 1 and 2 with different distance (arrows) to the occlusal surface (a). When preparing the specimen the cutting wheel created enough heat to create micro fractures to some of tooth material (double arrow).

dissipated from the teeth. Unlike humans, who have relatively small teeth with central dentin surrounded by a sturdy layer of enamel, equine dental structures (dentin, enamel, cementum) are complexly folded within a much larger tooth. Recent studies in Germany show a great variation in the heat conductivity among different materials as well as along the three-dimensional orientation of these materials. Accuracy in laboratory simulations is difficult to achieve because the surfaces and folds of each individual tooth will absorb and release heat at a different rate. The most important finding from these studies are that heat is more easily conducted from the occlusal surface through the long axis of the tooth towards the apex, but the equine tooth's complex structure prevents the heat's escape on the lateral aspect of the tooth.

In practical terms, the tooth cools down at a much slower rate than it heats up.

Because equine teeth are continuously erupting, they produce secondary dentin with odontoblasts to fill in the receding pulp of aging teeth as well as generating tertiary dentin to repair damaged teeth. It is possible that this regenerative capacity makes equine teeth less susceptible to thermal damage than brachydont teeth. However, it is also possible that the pulpo-dentinal complex responsible for generating reparative dentin could be sensitive to and damaged by heat exposure. More studies are needed to accurately describe the equine specific pathophysiology of thermal damage in teeth including the aspect of blood flow in live horses' teeth that may carry away heat produced during grinding.

With the characteristics of equine teeth in mind, we can direct our inquiry to the specifics of the dental procedure. Heat production during motorized floating depends on several factors: which tooth (incisor or cheek tooth) is being abraded, and which surface; the amount of pressure applied; the type of instrument used; the speed at which the instrument is set; the type and sharpness of the grinding tool; the method of cooling used; and the length of time between procedures.



Picture 2:
Sagittal cut through the occlusal portion of an incisor tooth. While the tooth is abraded over time—a few mm each year, the pulp is filled in with secondary dentin, thus preventing pulp exposure. Odontoblasts around the pulp horn are responsible for the new dentin production. It is not known at what temperature the equine pulp is damaged irreversibly, or to what extent excessive heat affects the production of secondary dentin.

Picture 3:
Working on an incisor tooth with a Dremel cut-off wheel. The grinding area is glowing hot—while this may not heat up the entire tooth including the pulp, the high temperature creates cracks around the cutting area resulting in inferior quality dental structures.

An incisor tooth has a smaller relative mass that heats up more quickly, especially when working on its flat surface. A larger molar, on which typically only sharp points are being refined, is less prone to thermal damage. Hotter temperatures can occur on cheek teeth when floating larger surfaces like ramps, steps, or waves in an arcade. A smaller diameter tool, such as a diastema burr or a cutting wheel, typically has to run faster and produces more heat than a larger rotary float. In addition, the localized heat produced by a small instrument may result in localized hot spots that pose the risk of generating tiny cracks inside the tooth. Dull grinding discs and tools encrusted with dental debris produce more heat than clean, sharp instruments due to longer working time and sub-optimal conversion of tool energy into abrasive action. Pressure is also a significant factor: light pressure produces less heat, but also requires longer treatment time. One can only aim to achieve a happy medium. With all this in mind it is difficult to make accurate grinding time recommendations to the equine dentist. By reviewing the literature it appears that floating a particular tooth for less than two minutes should avoid thermal damage and by applying a 'one-minute floating rule' one should be safe.

Many publications support water cooling systems as the best method to reduce the risk of thermal damage. The benefits are two-fold. First, water (with a low rate of heat conduction but a high heat capacity, such that a lot of energy is required to change its temperature), is a cheap and effective cooling agent for the grinding instrument and tooth surface. In addition, it keeps the grinding burr or disc sharper by freeing it of dental debris.

In practice veterinarians recognize various problems with water cooling. The setup of grinding instruments with water irrigation is more cumbersome, and it is not favored much in cold climates. Continuous water flow poses an electric shock hazard for the user and the risk of water aspiration for the horse. In my opinion, these shortcomings can be avoided, and the risk of thermal damage reduced, simply by cleaning the grinding head frequently with water. In addition to preserving the sharpness (and thereby reducing the treatment time), the grinding periods are interrupted and the grinding instrument itself is cooled.

Armed with this knowledge, the informed and circumspect equine dentist can substantially reduce heat production by following this simple protocol shown in a separate table in this article.

Picture 4:
The Terafloat with an apple core burr is an example of a grinding instrument that does not pose a high risk of thermal damage to the tooth during dental work. The design of the instrument allows minimal reduction of sharp enamel points, leaving the occlusal surface intact.

In-vitro studies are interesting and instructive, but it is also important to respect the observations of veterinarians practicing in the field. After well over a decade of widespread motorized equine dentistry and millions of horses floated, there are no accounts of increased tooth decay calling for tooth extraction. On the contrary, veterinarians report improved dental health, performance, and quality of life in their patients. Being aware of the potential dangers of heat production is important, and, as such, motorized dentistry should be executed with skill and care by trained veterinarians.

By following best practices and using modern, well-maintained instruments, we have within our capacity as equine professionals the ability to safely mitigate the risks of heat production in motorized dentistry.

- Avoid overheating teeth to begin with, as horse teeth cool down more slowly than they heat up.
- Grinding for up to one minute in a single location is deemed to be safe.
- Checking the temperature of a grinding region manually is recommended when floating a larger tooth surface.
- Observe longer pauses when floating incisors, ramps, steps, waves, or diastemata to allow the teeth to cool donw.
- Use a large rotary grinding disc rather than a small cutting wheel.
- Select an instrument that is water-resistant (such as the Swissfloat or HDE) that allows you to clean the head with water at intervals during the procedure.
- Maintain the sharpness of the grinding disc by cleaning it thoroughly of debris. Replace dull discs early.
- Use moderate, even pressure.
- Use the instruments conservatively: only reduce sharp enamel points, and preserve the occlusal surface as much as possible.