Measurement of masticatory forces in the horse

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Introduction

An efficient mechanical disruption of the forage during mastication is essential to provide a sufficient uptake of energy in the horse (*Collinson* 1994). The mechanical disruption of the forage depends on:

- the properties of the food,
- the equine specific biomechanics of mastication,
- the dimension of generated masticatory forces.

Hitherto little is known about the actual occurring forces during mastication in the horse. However, such physical data will serve:

- to elucidate the features of equine mastication,
- to focus on properties and quality of food which stimulates
- masticatory activities,
- to yield data relevant in equine dentistry.

Material and Methods

Measuring equipment

Quartz crystal force sensor (Type 9132B, Kistler Inc., Winterthur, Switzerland) connected with a steel-tube hand grip (300

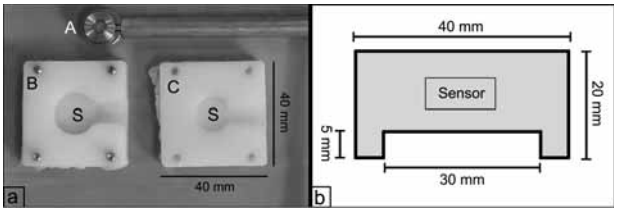

Fig 1 (a) Quartz crystal force sensor (A) to be placed between bottom (B) and cover (C) of a nylon capsule. S: cavity to take up the sensor. (b) Transverse section of the nylon capsule. A space of 30 mm is meant to fit on the occlusal surface of the tooth.

mm) which encases the wiring (Fig. 1a). The sensor was encapsulated in a nylon capsule (1a, 1b). One nylon capsule was used to examine two horses. Each sensor-capsule combination was calibrated before use.

Animals

12 horses (Warmblood, 6 female, 6 male, 5-27 years old).

Procedure

By means of the hand grip the sensor was placed on the second and third premolar tooth of the lower jaw (Triadan: 306, 307 or 406, 407). A regular chewing started after an adaptation phase of approx. 2 minutes. Measurements were firstly performed on the left jaw and afterwards on the right jaw. The measuring equipment recorded the generated forces along a time axis. The data measured during mastication were transferred to a computer which was equipped with an analysis software.

Results

The recorded force-time graph showed a periodical sequence of two peaks of masticatory forces (Fig. 2): 1) an initial minor peak of 295±107 N, duration 0.31±0.08 sec, 2) a major peak of 1100±139 N, duration 0.60±0.07 sec. One sequence of the two peaks was referred to as one chewing cycle. The horses chewed at a rate of 8±1 chewing cycles per 10 sec. The maximum chewing force measured was 1780 N.

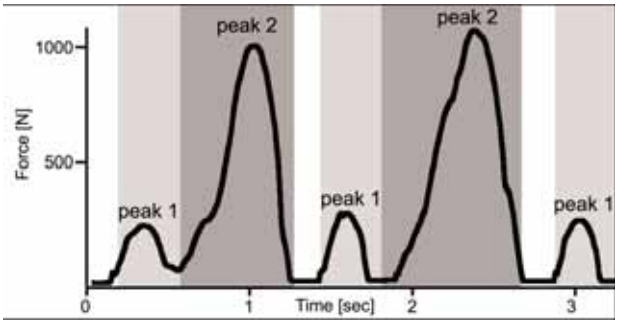

Fig 2 The recorded force-time graph had two peaks.

Discussion

The recording of the masticatory actions revealed two different periods of force generation (peak 1: 295 N; peak 2: 1100 N). This pattern reflects well the distinct masticatory motions of the jaw, which comprise three phases according to *Collinson* (1994) and *Tremaine* (1997):

- opening stroke,
- closing stroke (initial occlusion of the cheek teeth, equiva lent to peak 1),
- power stroke (laterolateral grinding, equivalent to peak2).

The chewing rate in our experiments (8±1 per 10 sec) was reduced as compared with chewing rates of horses fed on forage (11.5±0.4 per 10 sec, *Collinson* 1994). This effect might be ascribed to the hard consistency of the force sensor. Accordingly, it had been previously shown that an increase of the fiber content in the forage resulted in a decrease of the chewing rates (*Collinson* 1994).

Ritter (1953) used a mechanical measuring equipment that recorded forces while the lower jaw was moved into occlu-

sion. The values of his measurements on the second and third premolars (451 N and 628 N) ranged in between the values we recorded as peak 1 (closing stroke, 296±107 N), and as peak 2 (power stroke, 1100±139 N).

Conclusions

The horses showed regular chewing cycles during the measuring procedure. The sites of our measurement were restricted to the area of the second and third premolar tooth. The values of the recorded forces shall not be assumed to occur in the entire cheek tooth battery. We rather estimate that, according to mechanical principles, the masticatory forces are even higher in the caudal parts of the jaws. This will be subject to further investigations.

References

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