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Specialist information

from the Committee for Anaesthesia (GV-SOLAS)

Fasting in laboratory animals in the context of anaesthesia

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1. Reasons for withdrawal of food in laboratory animals

When food is withdrawn - often referred to as fasting - the intake of food is halted over a set period of time. A distinction is to be drawn between the withdrawal of food and/or withdrawal of water. Food intake may be stopped completely or may simply be restricted by feeding the animals reduced quantities of the usual water/food supply or only selected food components, feedstuffs, or dosage forms. As preparation for anaesthesia or a surgical procedure, special diets and medications (e.g. switching to liquid feed, combined with a laxative) may also be indicated for a brief period (usually ≤3 days).

In laboratory animals, the withdrawal of food or water may be necessary because of the experiment per se (experimental conditions) without this being related to anaesthesia. Examples of study-specific fasting are water deprivation in neuroscientific studies and food withdrawal for the purpose of standardization in the performance of measurements of relevance to the metabolism (e.g. glucose tolerance test or, insulin-resistance test).

The nature and duration of fasting for study-specific reasons may go hand in hand or accumulate with the requirements for the preparation of anaesthesia. Examples include studies that are conducted under anaesthesia (e.g. experiments and measurements in the gastrointestinal tract or metabolism studies under anaesthesia) or operations that require the maximum possible evacuation of the gut (e.g. surgical procedures that involve opening the gut). The basic conditions and requirements for the study-specific withdrawal of food and also of liquid/water without any relation to anaesthesia are diverse and cannot be expanded on here. However, they must be included in fasting plans for anaesthesia.

Further information on the withdrawal of food and also liquid/water, provided this is done not in the context of anaesthesia, but because of the study objective per se, can be found in the *Specialist information* of the *GV-SOLAS Committee for Animal Welfare Officers* on Food and Water Deprivation in Laboratory Animals.

The focus in what follows here is on the withdrawal of food and water in the context of anaesthesia in laboratory animals.

2. Advantages and disadvantages of fasting before anaesthesia

Food is withdrawn from animals before anaesthesia to ensure that the stomach and forestomach do not contain any food or at most only a minimal quantity of food. In some animal species, particularly in carnivores (e.g. dog, cat or ferret), insectivores (e.g. bats) and more uncommonly in primates and pigs, vomiting occurs especially when anaesthesia is induced and when the animals wake up from anaesthesia. Ruminants often regurgitate relatively large amounts of food from the forestomach in all stages of anaesthesia. If the stomach contents reach the oral cavity or the throat in anaesthetized animals, this can lead to tracheal, bronchial or pulmonary aspiration resulting from a slackening of the throat muscle and elimination of protective reflexes (swallowing and coughing). If the airways are not protected by means of intubation, this can lead to asphyxiation. The flow of stomach contents into the lower airways result in infections that are difficult to treat and usually run a fatal course (aspiration pneumonia).

In some animal species, the stomach or forestomach is not completely emptied even with relatively prolonged withdrawal of food (e.g. ruminants). The likelihood of vomiting and in particular of passive regurgitation in ruminants is decreased, however, by reducing the stomach or forestomach contents. Fasting also reduces the fermentation processes and prevents excessive bloating in the digestive tract, especially in the forestomach and stomach, as a result of stasis triggered by the anaesthesia. This not only makes surgical procedures in the abdominal region and the thorax difficult, it also compromises breathing and circulation resulting from a high diaphragm and pressure on large vessels. Besides the purely mechanical disturbance of inspiration, the compression of the lung lobes close to the diaphragm and the reduction of cardiac output creates disturbances of the pulmonary ventilation/perfusion ratio which can lead to life-threatening hypoxaemia and hypercapnia.

Despite the indisputable benefits of fasting, the following possible side effects of food or water deprivation over prolonged periods, particularly in conjunction with anaesthesia, must be taken into account: metabolic imbalance, electrolyte imbalance, hypovolaemia, hypotension/hypertension, and postoperative stasis of the gastrointestinal tract. In small laboratory animals, preoperative food withdrawal can result in hypoglycaemia. In carnivores, prolonged food withdrawal can lead to changes in the acid-base balance (metabolic acidosis). The effects of preoperative food withdrawal are further intensified by pain, stress and hypothermia (cooling). Precautions must be taken to ensure that side effects are monitored (e.g. as part of anaesthesia monitoring) and treated (e.g. administration of electrolytic infusion solutions during surgery).

With regard to stress, in the sense of an impairment of the animal's wellbeing as a result of fasting, there is hardly any reliable data in the literature that could lay claim to being universally applicable. It must nonetheless be assumed that prolonged fasting in some species can lead to stress (Erhardt, Henke & Haberstroh 2004). The degree of stress depends on how long (e.g. 8 hours vs 24 hours) and at what point fasting takes place in terms of the species-specific food intake times (e.g. greater when food for nocturnally active rodents is withdrawn in the evening/at night). The animal species (e.g. carnivores vs rabbits), age (e.g. newborns vs adults) and bodyweight/metabolic rate (e.g. 50 kg vs 50 g) affect the degree of stress caused by fasting.

In view of the advantages and disadvantages of food withdrawal, small mammals that are not able to vomit or regurgitate (mice, rats, hamsters, guinea pigs and rabbits) are not fasted as part of preparations for anaesthesia unless there are study-related reasons for doing so.

In many species, the advantages outweigh the disadvantages so that moderate preoperative food withdrawal should not be dispensed with. In this case, the nature and duration of fasting before anaesthesia should be adapted to the characteristics of the species, the general health of the animal and the nature of the research project; the duration should generally be kept as short as possible.

3. Species-specific details on fasting before anaesthesia

The following information (see Table, especially Column 2) refers to the complete withdrawal of food and water before anaesthesia. In some species, it is recommended first to withdraw the food and then, as the start of anaesthesia approaches, to withdraw water as well.

Species	Preoperative		Particularities
	food withdrawal	water withdrawal	
Small rodents (e.g. mice, rats and hamsters)	ø	ø	Pica behaviour post-anaesthesia, particularly likely in rats (see below).
Guinea pigs and guinea pig-like rodents	ø	ø	If possible, withdraw fermenting food before anaesthesia.
Rabbits	ø	ø	If possible, withdraw fermenting food before anaesthesia.
Dogs	6 h	0-2 h	Adult dogs: withdrawal of water unnecessary as a rule. Pups up to the age of eight weeks: no withdrawal of water, withdraw solid food for 6 h, no withdrawal of mother's milk.
Cats	6 h	ø	Pups up to the age of eight weeks: no withdrawal of water, withdraw solid food for 6 h, no withdrawal of mother's milk.
Ferrets	12 h	ø	
Pigs	8-12 h	ø	Remove bedding. Suckling pig: no withdrawal of water, withdraw solid food for 6 h, no withdrawal of mother's milk.
Sheep, goats	12-24 h	0-12 h	Remove bedding. Longer food withdrawal may be necessary depending on the research project. Withdrawal of water unnecessary as a rule. Infusions during water deprivation may be advisable depending on hydration status. Young animals: no withdrawal of water; withdrawal of solid food and milk formula for 12 h; no withdrawal of mother's milk
Non-human primates	12 h	2 h	In small species (e.g. common marmosets) only 6 h food withdrawal, no withdrawal of water.
Bats	With anaesthesia in the morning (i.e. at the end of the dark phase): 12 h, With anaesthesia in the evening (i.e. at the start of the dark phase): ø	ø ø	CAUTION in the case of repeated anaesthesia at short intervals, because the animals may not be able to make sufficient use of their nocturnal phases for food intake after the anaesthesia procedures.

Species	Preoperative		Particularities
	food withdrawal	water withdrawal	
Birds	0-2 h	ø	In larger birds (e.g. hen, pigeon, quail) 2 h withdrawal of food. In small birds (e.g. zebra finch) only 30 min withdrawal of food. In birds with a bodyweight below 100 g, food withdrawal can also be dispensed with.
Reptiles	Large snakes: 10 d	ø	Vomiting possible, but little risk of aspiration.
	Small snakes: 5 d	ø	
	Geckos: 24 h	ø	
	Herbivores Reptiles: 1-2 d	ø	
African clawed frogs	ø		Observations to date show that regurgitation as a result of anaesthesia does not cause any problems. Recommended: Time the anaesthesia according to the customary feeding regimen, i.e. do not anaesthetize African clawed frogs after feeding.
Fish	12 h		In the case of small species (e.g. zebrafish) also shorter duration of food withdrawal. Recommended: Time the anaesthesia according to the customary feeding regimen

4. Food intake after anaesthesia

In some species (e.g. rat, especially if high doses of buprenorphine were administered), anaesthesia has occasionally been followed by so-called pica behaviour, in which animals consume relatively large quantities of bedding, nesting materials, cellulose, paper, drapes, surgical under sheets and similar materials from their surroundings and may die as a consequence. In rare cases, the consumption of large quantities of water, feed or bedding after anaesthesia has also been observed among pigs, where the pelleted feed can result in oesophageal obstruction and gastric overload.

5. References

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Further reading

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