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Trichobezoars in praomys (mastomys) natalensis

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Introduction

Praomys (mastomys) nastalensis, referred to hereafter as mastomys, is intermediated in size between the mouse and rat. It belongs to the family Muridae as do the latter two species. The mastomys is found from the eastern Cape Province throughout Africa south of the Sahara and to Morocco in the far northwest. It was often called the multimammate mouse or "African wild rodent" (*Davies & Oettle* 1958) which indicates that the species has only short history of laboratory adaption. It was in South Africa in 1939 that initiation of laboratory breeding from wild strains first occurred, and thereafter mastomys have been distributed both to USA and Europe. The original scientific advantage of mastomys was their high and uniform susceptibility to plague and parasites (*Soga & Sato* 1978).

High incidence of spontaneous tumors in various organs and tissues have been rare in mammals other than mastomys (*Soga & Sato* 1978) and man. For this reason the mastomys has been the subject of oncological investigations as a possible experimental animal model for human tumors. Tumors occur spontaneously rather frequently in the glandular stomach, liver, adrenal gland, thymus, pituitary gland, prostatae and ovary (*Soga & Sato* 1978). Several additional organs and tissues (kidneys, pancreas, seminal vesicles, testicles, and mammary glands) have also been reported to produce tumors or tumor-like lesions, though with a lower incidence (*Hollander & Higgins* 1971). We have in a rat model during several years studied the role of the neuroendocrine cells in the regulation of gastric function and growth (*Brenna & Waldum* 1991, *Brenna et al.* 1992), and given indication for an important role of neuroendocrine cells even in human gastric carcinogenesis (*Waldum et al.* 1991a). The mastomys have the same distribution of gastric cells as in other mammals, and therefore we wanted to investigate if this species might be an useful model for our further studies.

Material and methods

Twelve adult pairs of mastomys were bought from the Medical Research Council, Park Crescent, London. Each pair was placed in separate transparent plastic boxes (35×58×19 cm) with a top cover of stainless netting and bottom covered by wood beddings (Beckay, GL-P). The animals were fed pelleted rat and mice feed (Ewos, 21 % crude protein, 2.8 % crude fibre) ad lib., and had also free access to water from water flasks. The room temperature was about 22°C, the relative humidity about 30–40 %, and the daylight regime 12 h. Infants were weaned three to four weeks postpartum.

Results

The reproduction was low. During a period of three years we got 76 adults from our breeding. Fifty-six animals were autopsied, either after being killed because of showing signs of illness, or they were found dead. Twenty-five mastomys had trichobezoars, one to three in the stomach or duodenum. The bezoars were oblong and up to the size of 1.6×0.8 cm, and obstruction from these was the cause of illness and death for many mastomys (Fig. 1). Tumors were recognized in the accessory sex glands, the lungs, kidneys and adrenals, but not in the stomach (Table 1).

Discussion

Trichobezoars are well known in cats, but are also found in rabbits (*Leary et al.* 1984), feedlot raised calves (*Herd & Cook* 1989) and captive non-human primates (*Gillin et al.*

Figure 1. Mastomys with trichobezoar filling up the stomach and leading to obstruction and dilatation of the oesophagus (arrow).

Table 1. The autopsy findings of 56 mastomys (found dead or killed because of signs of illness).

	n = number
Trichobezoars	
stomach	23
duodenum	2
Tumors	
accessory sex glands	8
lungs	1
kidneys	1
adrenals	9
Other findings	
stomach bleeding	2
uterus bleeding/dead during birth	3
cannibalism	2
dermatitis	3
emaciation	2

1990, *Gozalo et al.* 1990). In human trichobezoars often are found in psychologically disturbed individuals. Over centuries these bezoars have mainly been found in children. The classic pediatric case is that of a partially balding child with a mass in the stomach (*Jain et al.* 1987). It is, however, also noted that the incidence of bezoars in human patients has increased as a result of operative manipulation of the gastrointestinal tract (*Calabuig et al.* 1989).

The major complications of bezoars include intestinal obstruction, gastric perforation, gastric ulcers and gastritis, and anorexia with weight loss (*Calabuig et al.* 1989). Intestinal obstruction results from the passage and subsequent lodging of a bezoar or part of a bezoar in the distal small bowel. In human this complication is most commonly seen in a gastroectomized patient intact vagal nerves due to the increased gastric outlet size with an undisturbed innervated gastric remnant. In the individuals with vagectomized gastric remnants, the bezoar usually will remain in the stomach leading to gastritis, gastric ulceration, and possible gastric perforation.

Multiple factors are involved in the formation of bezoars. Truncal vagotomy and the associated gastric drainage operations results in diminished secretion and motility and are considered to play a major role (*Calabuig et al.* 1989).

Young cattle are particularly prone to bezoars, especially if deprived of dietary fibre (*Jubb et al.* 1985). Rabbits may also ingest their hair which accumulates in the stomach to form trichobezoars. Several antecedent factors have been proposed to contribute to the formation of trichobezoars in this species including dietary deficiencies of roughage, copper, magnesium, protein, barrier housing, cage boredom, abnormal grooming, long hair, and an inability to vomit. A survey of the stomachs of 208 healthy slaughter-rabbits revealed that 23.1 % had trichobezoars, which suggests that gastric trichobezoars are common in rabbits and that few animals with these foreign bodies develop anorexia. In

addition there appeared to be a high likelihood that trichobezoars recur few weeks after they are operatively removed in rabbits (*Leary et al.* 1984).

Despite the literature about diseases in mastomys is extensive, trichobezoars have not been described in this species. Our mastomys were kept in a dry environment which might be the reason why some of them got conjunctivitis, ring-tail (*Iglauer et al.* 1993) and dry fur. This could have induced excessive grooming (although it was not observed with certainty), which could be the reason why so many got trichobezoars. It should, however, be recalled that ECL (enterochromaffin like) cell derived tumors occur frequently in these animals (*Håkanson et al.* 1973), and that ECL cell hyperplasia in the rat induced reduced gastric emptying (*Waldum et al.* 1991b). Our mastomys were unfortunately not examined for ECL cell hyperplasia but it might be a factor in the production of bezoar in this species.

Summary

We have in a rat model studied the role of gastric neuroendocrine cells in the regulation of gastric function and growth and given indication for an important role of these cells in physiology and human carcinogenesis. Because of the high incidence of spontaneous tumors in the glandular stomach of mastomys (Praomys (mastomys) natalensis), we wanted to investigate if mastomys might be an useful model for our further studies.

Tumors were recognized in several organs of our mastomys, but not in the stomach. However, a high incidence of trichobezoars was observed in the stomach and intestine, and obstruction from these was the cause of illness and death for many of them.

Multiple factors are involved in the formation of bezoars, and these are discussed in relation to the occurrence in our mastomys colony.

Sammendrag

Vi har i en rottemodell undersøkt de neuroendokrine cellers rolle i reguleringen av magesekkens funksjon og funnet indikasjoner for at disse cellene kan spille en viktig rolle ikke bare fysiologisk, men også i den humane carcinogenese.

Det er beskrevet høy forekomst av spontane svulster i magesekken hos mastomys (Praomys (mastomys) natalensis), og vi ville derfor undersøke om mastomys kunne være en brukbar modell i våre videre studier. Det ble påvist spontane svulster i flere forskjellige organer hos våre mastomys, men ikke i magesekken. Imidlertid fant vi trichobezoarer i magesekken og tarmen på svært mange dyr. Disse forårsaket obstruksjon som førte til både sykdom og død.

Mange forskjellige faktorer er involvert i dannelsen av bezoarer, og disse er diskutert i relasjon til forekomsten blant våre mastomys.

Yhteenveto / K. Pelkonen

Olemme rottaa mallina käyttäen tutkineet mahalaukun neuroendokriinisten solujen osuutta mahalaukun toiminnan säätelyssä ja kasvussa ja saaneet näyttöä siitä, että niilä on tärkeä osuus fysiologiassa ja karsinogeneesissä ihmisellä. Halusimme selvittää voisiko moninisärotta mastomys olla käyttökelpoinen malli jatkotutkimuksiamme varten, koska sillä esiintyy yleisesti spontaaneja kasvaimia rauhasmahassa.

Meidän moninisärotissamme löytyi kasvaimia monista elimistä, mutta ei mahalaukusta. Mahalaukussa ja suolistossa esiintyi kuitenkin yleisesti karvapalloja ja näiden aiheuttama suolentukkeuma oli yleinen sairastumisen ja kuoleman aiheuttaja.

Karvapellojen muodostumiseen vaikuttavat tekijät ja näitä pohditaan tässä artikkelissa.

References

Brenna E & HL Waldum: Studies of isolated parietal and enterochromaffin-like cells from the rat. Scand. J. Gastroenterol. 1991, *26*, 1295–1306.

Brenna E, HL Waldum, AK Sandvik, B Schulze Sognen & A Kristensen: Effects on the rat oxyntic mucosa of the histamine $_2$-antagonist loxtidine and the H+, K+-ATPase inhibitor omeprazole. Aliment. Pharmacol. Ther. 1992, *6*, 335–349.

Calabuig R, S Navarro, I Carrió, V Artigas, J Monés & JP LaCalle: Gastric emptying and bezoars. Am. J. Surg. 1989, *157*, 287–290.

Davis DHA & AG Oettle: The multi-mammate mouse Rattus (Mastomys) natalensis. Smith: A laboratory adapted african wild rodent. Proc. Zool. Soc. (Lond.) 1958, *131*, 293–299.

Gillin AG, AF Phippard & JF Thompson: Harewood WJ, Waugh RC, Horvath JS. Gastric haemorrhage and perforation caused by a trichobezoar in a baboon (Papio hamadryas). Lab. Anim. 1990, *24*, 180–182.

Gozalo AS, E Montoya & TE Nolan: Trichobezoars in two saddleback tamarins (Saguinus fuscicollis). J. Med. Primatol. 1990, *19*, 151–153.

Herd RM & LG Cook: Hairballs in feedlot-raised calves. Aust. Vet. J. 1986, *66*, 373–73.

Hollander DF & J Higginson: Spontaneous cancers in Praomys (mastomys) natalensis. J. Natl. Cancer. Inst. 1971, *46*, 1343–1355.

Håkonson R, L-I Larsson, C Owmann, KC Snell & F Sundler: Fluorescence and electron microscopic histochemistry of endocrine-like cells in gastric mucosa and aragyrophil tumor of Praomys (Mastomys) natalensis. Analysis of 5-hydroxytryptamine, histamine, histidine decarboxylase, and aromatic amino acid decarboxylase. Histochemie 1973, *37*, 23–38.

Iglauer F, T Schlüter, S Holub & R Sachs: Ringtail disorder observed in cotton rats (Sigmodon hispidus). Scand. J. Lab. Anim. Sci. 1993, *20*, 119–121.

Jain K, S Chamania & JW Sabhaney: Recurrent Trichobezoar due to psychosocial stress. J. Indian. Med. Assoc. 1987, *85*, 363–364.

Jubb KVF, PC Kennedy & N Palmer: Pathology of domestic animals. 3rd ed. Orlanda, Fla, Academic Press 1985.

Leary SL, PJ Manning & LC Anderson: Experimental and naturally-occurring gastric foreign bodies in laboratory rabbits. Lab. Animal. Sci. Baltimo 1984, *34*, 58–61.

Soga J & H Sato: Praomys (mastomys) natalensis. The significance of their tumors and diseases for cancer research. Daiichi Printing Co, Niigata Japan 1978.

Waldun HL, OA Haugen, C Isaksen, R. Mecsei & AK Sandvik: Are difuse gastric carcinomas neuroendocrine tumours (ECL-omas)? Eur. J. Gastroenterol. Hepatol. 1991a, *3*, 245–249.

Waldum HL, T Lehy, E Brenna, AK Sandvik, H Petersen, B. Schulze Søgnen, S Bonfils & MJM Lewin: Effect of the histamine-1 antagonist astemizole alone or with omeprazole on rat gastric mucosa. Scand. J. Gastroenterol. 1991b, *26*, 23–35.