

Summary

As the frequency of feline obesity (25~50%) is considerably high, cats have characteristics to tend to be obese accompanying with insulin resistance. Glucose availability and insulin signaling in feline liver are lower, whereas hepatic gluconeogenesis ability from amino acids is higher in cats than that in dogs. Plasma adiponectin concentration, which improves insulin resistance, is lower in cat than that in dog. Prevention of obesity is most important for cats to avoid onset of serious metabolic disorders. Body condition score (BCS), as subjective parameter by each veterinarian, is a major criterion for obesity in clinical practice. Development of a reliable method for finding early stage of obesity is urgent for cats. The aim of this thesis is development of early diagnosis of obesity for cats. To make objective index for obesity of cat, plasma metabolite concentrations and some parts of body (measured anatomic sites) were measured.

1. Metabolic characteristics and obesity in cats

To investigate metabolic characteristics, 243 cats were collected from some veterinary clinics in Tokyo, Kanagawa, Saitama, Ibaraki prefecture and the laboratory in Nippon Pet Food Co., Ltd. They were divided into some groups based on sex, age, castration and obesity stages. Their body weights (BW), BCS, and plasma biomarkers were investigated.

BW, plasma total cholesterol (T-Cho) and insulin concentrations in the males were higher, and plasma adiponectin concentrations were lower than those in the females. These results suggest that the male cats showed higher tendency to become obese and insulin resistance than the female cats.

Activities of hepatic injury markers (aspartate aminotransferase, AST alanine aminotransferase, ALT) and concentrations of chronic kidney disease (CKD) markers (blood urea nitrogen, BUN and creatinine) also increased in cats with aging. Ectopic lipid accumulation in liver and CKD are often found in aged cat.

In cats with BCS2&3, BW, plasma glucose, triglyceride (TG), T-Chol concentrations in the castrated group were higher than those in the intact group. Castration seems to be one of risk factors for obesity. And in the obese (BCS4&5 group) cats, 4-fold higher plasma TG concentrations were found in the castrated group than those in the intact group. These suggest that castration induce the risk for hyperlipidemia in cats.

2. Effect of obesity induced by over-feeding on the biomarkers in cats

To investigate the effect of weight gain by over-feeding on plasma biomarkers in cats, 8 male neutered cats were divided into two groups; overfed (4) and control group (4). To induce weight gain, overfed group cats were fed on commercial diet with 2-fold amount of daily energy requirement (DER) for 4weeks. Changes in BW, BCS, food consumption and plasma biomarkers in the overfed group were compared to those in the control group. The overfed group maintained higher amount of food consumption than the control group during the experimented period. The overfed group cats increased 24% of their BW and become moderate obesity showing slight metabolic abnormality. Total protein concentrations increased in the overfed group after the experiment, which was thought to be an effect of over-feeding. There is strong positive correlation between plasma non-esterified fatty acid (NEFA) and BW. Increased plasma NEFAs are caused by accumulated adipose tissues

and ectopic accumulated fat in liver. Increasing in plasma ALT activities in the obese group seemed to be resulted from the ectopic hepatic fat accumulation. It is known that insulin resistance is caused by increased plasma TG, NEFA concentrations and sequenced ectopic hepatic fat accumulation. Increased plasma TG and NEFA concentrations induced by ectopic hepatic fat accumulation may induce insulin resistance.

3. Establishment of the index for obese of cat

To diagnose early stage obesity in cats, weight gain was induced by over-feeding for 4weeks. BW, BCS, head and body length (HBL), length from top of patella to end of calcaneus (PCL), neck girth (NG), chest girth, abdominal girth, and hip girth in the overfed group cats were compared to those in the control group cats. HBL and PCL were not affected by weight gain (99.8% and 98.3% homology, respectively). A new index for cat obesity (feline body mass index (fBMI)) was settled as $BW/PCL(kg/m)$. PCL is measured easily without sedative treatment for cats. fBMI increased significantly at the early stage obesity in cats, and correlated positively to BW, BCS, neck girth, and plasma NEFA concentrations. fBMI is suggested to be available as diagnostic index for early stage obesity. $fBMI \geq 28.0$ is decided as a criterion for overweight in cats.

4. Clinical application of feline body mass index to obese cats

The availability of fBMI for obese cats was investigated. 15 cats (overfed group) were fed on high-fat diet with overfeeding for 6weeks. Then, they fed on low-calorie diet for 4weeks to reduce their BW artificially. Control group cats (n=5) were fed on normal diet for 10weeks. BW, BCS, fBMI, plasma biomarkers were measured at 6weeks and 10weeks of experiment period.

fBMI changed sharply reflecting changes in BW, plasma TG, NEFA concentrations. And fBMI was confirmed as useful index for feline obesity. fBMI 28.0 was decided as overweight accompanying with plasma lipids increase. Measurement of fBMI does not need blood sampling from animals and specific tools except for simple tape measure. fBMI is very suitable index for veterinary medicine and can be available for early diagnosis of obesity before onset of metabolic syndrome.