

Characteristic of duodenal myoelectric activity in relation to food in piglets during the 3rd and 4th week of life

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Abstract

The relationship between duodenal myoelectric activity and liquid food intake was investigated in eight conscious piglets with bipolar electrodes implanted on the wall of the duodenum. Piglets were fed with commercial milk formula and the effects of volume and feed dry matter intake on duodenal myoelectric activity were measured by means of an analog–digital recording system.

The cyclic pattern of duodenal myoelectric activity, *i.e.* the migrating myoelectric complex (MMC), was preserved when piglets received small meals at regular intervals. The duration of the whole MMC cycle, as well as the duration of phase II of the MMC, were only weakly correlated ($r=0.2$, $P<0.05$ for both parameters, respectively) to the amount of ingested food. However, the increase of the amount of feed dry matter intake of a meal from 2.1 to 4.5 g kg⁻¹ of live body mass (LBM) as well as an increase of volume of a meal from 13 to 26 ml kg⁻¹ LBM significantly increased the duration of the MMC cycles ($P<0.05$) due to the elongation of phase II of the MMC ($P<0.05$).

The present study shows that in piglets fed with a liquid diet the upper gut motility response to food is similar to that previously observed in adult animals.

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1. Introduction

Weaning may be defined as the process by which mammals cease suckling and begin to ingest solid feed (Counsilman and Lim, 1985). In modern pig production, weaning frequently comprises an abrupt change of diet and feeding regime from the ingestion of small quantities of maternal milk up to 36 times per day (Puppe and Tuchscherer, 2000), to eating greater amounts of dry feed

a fewer times a day, *e.g.*, 8 times a day (Bruininx et al., 2002). Such dietary changes, together with the behavioural stress and resulting changes in the structure and functions of the gastrointestinal (GI) tract, are often manifested in reduced growth, the occurrence of post-weaning diarrhoea and increased mortality (Leibbrandt et al., 1975; Alexander, 1994).

Although structural development, GI secretion and absorption during postnatal period as well as the effect of weaning on secretory and absorptive physiology are well described in pigs (Marion et al., 2003; Hedemann et al., 2003; Boudry et al., 2004), the relationship between diet and GI motility in piglets around weaning

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is not fully understood yet (Lærke et al., 2000). Since the first observation by Szurszewski (1969) in fasting dogs, it has been well established in many animal species and humans (Wingate, 1981; Zenilman et al., 1992) that during the interdigestive state the small intestine exhibits a characteristic pattern of myoelectric and motor activity termed migrating motor complex (MMC). The MMC consists of a quiescent period (phase I) during which little or no electrical response activity (ERA) and thus little or no contractile activity is observed, followed by a period of intermittent electrical and mechanical activity (phase II), followed by phase III where each slow wave of electrical control activity (ECA) is associated with spike potentials of ERA and muscular contractions occur with the maximal rate (Szurszewski, 1987). The function of the MMC, and specifically the regular occurrence of phase III of the MMC is to propel luminal contents along the intestine, thereby promoting intestinal clearance and maintaining intestinal homeostasis (Code and Marlett, 1975). In many mammals, the MMC is disrupted by meal ingestion so as to produce a postprandial pattern (Read et al., 1984; Sarna, 1989). The postprandial pattern is characterized by an increase in the frequency of spike potentials of ERA and the lengthening of the time between two subsequent phases III periods (Code and Marlett, 1975; Di Magno et al., 1979) and resulting increase in the intestinal digesta flow (Girard and Sissons, 1992). In adult pigs, however, the MMC is interrupted when the animal is fed discrete, large meals, but not by *ad libitum* feeding with the same diet (Bueno and Ruckebusch, 1976). Other research has shown that the caloric load regulates the characteristics of the amplitude of contraction and the duration of the intestinal postprandial pattern in adult pigs (Gregory et al., 1986), dogs (Schang et al., 1978; Schmid et al., 1992) as well as in adult humans (Schönfeld et al., 1998). Furthermore, it was demonstrated in adult dogs that during enteral infusion of low caloric load, MMC persisted, apart from a lengthening of phase II and resulting increase in duration of the MMC cycles; only higher caloric load caused complete disruption of the MMC and appearance of postprandial pattern (Defilippi, 2003).

Published data on motility in neonatal piglets have shown that the consumption of cow's milk (Burrows et al., 1986) or dry solid feed (Lesniewska et al., 2000) three times a day disrupts the MMC, whereas the MMC was not disturbed in piglets of similar age that were nursed by their sows every 1.0–1.5 h (Lesniewska et al., 2000). There is no data available on the relationship between the MMC and the characteristic of ingested

feed (e.g., caloric load) in neonatal piglets, however based on the previously published observations in piglets (Burrows et al., 1986; Lesniewska et al., 2000) it could be hypothesized that the effect of feed on intestinal motility in piglets depends on caloric load and/or meal volume, as has been observed in adult pigs and dogs.

The aim of the present study was therefore to evaluate the characteristic of the intestinal motility in relation to the dry matter and volume of ingested milk formula in piglets during the 3rd and 4th week of life.

2. Materials and methods

The protocol used in the present study complied with the Danish Ministry of Justice, law no. 726 (9 December 1993) concerning animal experimentation and care of experimental animals.

2.1. Animal management

The experiment was carried out on eight neonatal piglets of both sexes from different litters in two experimental trials. All piglets were obtained from the pig herd at the Danish Institute of Agricultural Sciences, Research Centre Foulum, Denmark. Piglets, chosen according to their live body mass (LBM) in a range of 2 to 2.3 kg, were removed from their sows at two days of age and immediately moved to the intensive care unit at the Research Centre Foulum. The rearing system for neonatal piglets comprised one cage divided into four compartments, an electronic feeding system, Pig'oline (model Foulum, Boss produkter a.s., Ulstrup, Denmark) for separate feeding of four piglets, an electromagnetic stirrer and four heating lamps. The rearing system has been described in more details elsewhere (Hedemann and Lesniewska, 2003). On the day of removal from the sows, the piglets were kept together in one compartment of the cage. From the next day they were housed in individual compartments that allowed limited contact (visual but not physical) with each other. The room was lit artificially from 07:30 h to 22:30 h. Each piglet was weighed and had its body temperature measured every morning.

After five days of adaptation to the new environment, piglets were prepared for electromyography (EMG) of the gastrointestinal smooth muscle *in vivo* as described previously (Lesniewska et al., 2000). Briefly, a 4-cm long incision was made vertically from the right, last intercostal space, and the duodenum was localised. Silver, bipolar, serosal silicon based (Silastic, Dow Corning GmbH, Wiesbaden, Germany) electrodes were implanted on the wall of duodenum and oriented in the

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