

# Evaluation of Motility Hormones in Dairy Cattle with Omasal Impaction and Caecal Dilatation

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Article Code: KVFD-2015-13802 Received: 01.06.2015 Accepted: 21.08.2015 Published Online: 21.08.2015

## Abstract

The aim of this study was to evaluate the motility hormones levels in cattle with caecal dilatation (CD) and omasal impaction (OI). In this study, four cows with OI, four cows with CD (without volvulus) and ten healthy controls were used. Serum ghrelin, motilin, gastrin and leptin concentrations were determined using ELISA. Serum alanine aminotransferase (ALT), aspartate aminotransferase (AST), gamma-glutamyl transferase (GGT) activities and sodium (Na), potassium (K) and chloride (Cl) concentrations were measured using a spectrophotometer. Serum ALT, AST and GGT activities were higher in OI cows. Serum Cl concentrations were lower in OI cows than in CD cows. Higher gastrin and motilin levels in OI and lower leptin levels in CD cows were found. In conclusion, this study does not support the use of GI motility hormones agonists in cows suffering from omasal impaction and caecal dilatation. Leptin might be indicated in negative energy balance.

**Keywords:** Motility, Omasal impaction, Caecal dilatation, Leptin

## Sekum Dilatasyonlu ve Omazum Konstipasyonlu Sütçü Sığırlarda Motilite Hormonlarının Değerlendirilmesi

### Özet

Bu çalışmanın amacı, omazum konstipasyonlarında (OK) ve sekum dilatasyonunda (SD) sığırlarda motilite hormon düzeylerini değerlendirmektir. Çalışmada 4 OK, 4 SD (volvulus olmaksızın) ve 10 sağlıklı kontrol sığır kullanıldı. Serum ghrelin, motilin, gastrin ve leptin konsantrasyonları ELISA kullanılarak belirlendi. Serum alanine aminotrasferaz (ALT), aspartate aminotrasferaz (AST), gama glutamil transferaz (GGT) aktiviteleri ve sodyum (Na), potasyum (K) ve klor (Cl) konsantrasyonları spektrofotometre kullanılarak ölçüldü. Serum ALT, AST ve GGT aktiviteleri OK'lı sığırlarda yüksekti. Serum Cl konsantrasyonu ise OK'lu sığırlarda CD'lu sığırlardan düşüktü. OK'lı sığırlarda yüksek gastrin ve motilin seviyesi ve SD'lı sığırlarda düşük leptin seviyesi tespit edildi. Sonuç olarak, bu çalışma omazum konstipasyonu ve sekum dilatasyonlu sığırlarda GI motilite hormone agonistlerinin kullanımını desteklememektedir. Leptin negative enerji dengesini belirleyebilir.

**Anahtar sözcükler:** Motilite, Omazum konstipasyonu, Sekum dilatasyonu, Leptin

## INTRODUCTION

The motility hormones include ghrelin, motilin and gastrin. Ghrelin was discovered in 1999 in rat stomach and was observed to stimulate gastrointestinal motility in a manner similar to that of gastrointestinal peptides, such as motilin, cholecystokinin and gastrin. Leptin is a major regulator of hormones for food intake and energy homeostasis and acts in opposition to ghrelin<sup>[1]</sup>. Omazum constipation/impaction and caecal dilatation, which occurs in high producing dairy cows, are gastrointestinal tract diseases. Omazum is an important organ for water resorption. When the transition in the omazum is blocked,

water resorption can be hindered resulting in omasal content drying out. Drying of the content of the omazum generates mechanical pressure in the omasal mucosa and causes ischemia, necrosis and, eventually, omasitis in the lamina of the omazum<sup>[2]</sup>. The large intestine is made up of the caecum and colon, which are sacculated organs; they do not have villi or papillae, and they store waste materials. The sac contents can accumulate and slow the passage of digesta. Microorganisms present in the large intestine ferment any remaining available nutrients in the digesta, including cellulose and hemicellulose. They produce volatile fatty acids (acetate, propionate and butyrate) and microbial proteins. The volatile fatty acids produced in the



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large intestine can be absorbed and used by the animal [3]. CD without volvulus is a much less common disease, but it is a common cause of gastrointestinal dysfunction [4].

The aim of this study was to evaluate changes in motility hormones levels in cows with caecal dilatation and omasal impaction compared with healthy cows.

## MATERIAL and METHODS

A total of 18 Holstein-Friesian cows, 4 with omasal impaction, 4 with caecal dilatation without torsion and 10 clinically healthy adults, with no previous history of gastrointestinal disease (control group) were included in this study. The ages of the affected cows varied from 3 to 8 years (mean 5.5 years). They had been ill for an average of three days (2-10 days). The control animals were 2 to 5 years old dairy cows living in the same environmental conditions. The cows with CD were two months postpartum and had clinical signs of CD, including anorexia, decreased milk yield, scanty, pasty faeces and slight pain. The cows with OI were in their fourth pregnancy and had clinical signs of OI, including anorexia, scanty faeces or cessation of defecation, dullness, ruminal distension, moderate to severe dehydration in spite of polydipsia, and excess fluid in the forestomachs.

Clinical examinations were performed. The respiratory and pulse rates and body temperatures were recorded and were normal in all groups. Abdominal percussion and auscultation at the right rib cage, rectal examination and abdominal ultrasonography were conducted and used for the diagnosis of CD. OI was confirmed by clinical symptoms and feeding with dusty hay. In addition, the OI cattle were in their fourth pregnancy. The diagnosis of OI was confirmed by a response to medical therapy.

Blood samples were obtained from jugular venipuncture. The serum samples were separated by centrifugation at 1550 g for 10 min. The serum samples were measured by spectrophotometry according to the standard procedures using commercially available diagnostic kits (DiaSys Diagnostic Systems) for ALT, AST, GGT, Na, K and Cl analyses. Serum ghrelin (Phoenix-EK, 031/30), motilin (USCN-E, 90575), gastrin (Raybiotech-EIA-GAS-I) and leptin (DRG-EIA, 2395) concentrations were analysed using commercial ELISA test kits according to the manufacturer's instructions.

All data are presented as means  $\pm$  SEM, and SPSS software (version 18) for Windows was used for the statistical analyses. The Shapiro-Wilk test was used for evaluating the normal distribution of the variables. All data were normally distributed. One-way analysis of variance (ANOVA) was performed in a completely randomised design for the normal distributed parameters (motilin, gastrin, ghrelin, leptin, AST, ALT, GGT, Na, Cl, and K). A Bonferroni test was used to separate these differences as well.

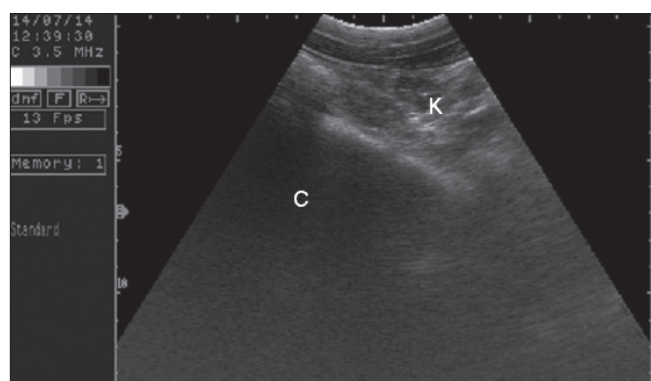
## RESULTS

Rectal palpation revealed that the rectum was empty or contained some constipated faeces in all cows with OI. CD was diagnosed by rectal touching, ultrasonography (Fig. 1), and clinical signs. In the simultaneous auscultation and percussion of the right paralumbar fossa, high-pitched resonant pings and splashing sounds were noticed over the last ribs. However, this sign is not specific for CD. All the OI and CD cows were afebrile with a normal pulse and respiratory rates; however, they did have a poor appetite, a sudden drop in milk yield, slight pain, little defecation and scanty, pasty faeces. The cattle with OI and CD recovered via medical treatment.

The serum biochemical and motility hormones levels are presented Table 1. The serum electrolyte analysis demonstrated that potassium and sodium were normal, and chloride were significantly ( $P < 0.05$ ) lower in cases of OI compared with the control and CD animals (Table 1). The biochemical analysis demonstrated a significant ( $P < 0.001$  and  $P < 0.05$ ) increase in the level of AST, ALT, and GGT in cows with OI. The CD cows showed differences ( $P < 0.05$ ) in ALT levels compared to other groups and GGT levels compared to control group. The serum motilin and gastrin concentrations were significantly higher ( $P < 0.001$ ) in the OI group compared with other groups. However, ghrelin concentrations were not significantly different between the groups. Leptin concentration was significantly lower ( $P < 0.05$ ) in the CD group, but fairly similar between the OI and control groups.

## DISCUSSION

Omasal impaction can be caused by poor-quality feed, excessive consumption of poorly digestible and small particle wheat straw, perforated phytobezoars, the restriction of animals to small barns without exercise, and the feeding of dry concentrate daily with limited access to water; it is also affected by other gastrointestinal



**Fig 1.** Ultrasonogram of caecal dilatation obtained at the right rib cage space, K: Kidney, C: Caecal gas

**Şekil 1.** Sağ kaburga alanında sekum dilatasyonunun ultrasonografik görüntüsü, K: Böbrek, C: Sekal gaz

**Table 1.** Concentrations of serum ghrelin, motilin, gastrin, leptin and other biochemical parameters in omasal impaction, caecal dilatation and control groups (Means±SEM)

**Tablo 1.** Omazum konstipasyonu, sekum dilatasyonu ve kontrol gruplarında serum ghrelin, motilin, gastrin, leptin ve diğer biyokimyasal parametrelerin konsantrasyonları (Means±SEM)

Parameters	Control (n:10)	Omasal Impaction (n: 4)	Caecum Dilatation (n: 4)	P-value
Gastrin (pg/ml)	139.33±8.58 <sup>b</sup>	228.50±22.01 <sup>a</sup>	124.9±9.49 <sup>b</sup>	0.000
Motilin (pg/ml)	226.70±6.56 <sup>b</sup>	328.75±23.89 <sup>a</sup>	240.50±19.79 <sup>b</sup>	0.000
Ghrelin (ng/ml)	113.30±4.99	129.50±21.15	120.25±14.77	0.581
Leptin (ng/ml)	3.66±0.07 <sup>a</sup>	3.45±0.09 <sup>ab</sup>	3.29±0.06 <sup>b</sup>	0.012
ALT (IU/l)	21.74±1.63 <sup>c</sup>	53.13±3.27 <sup>a</sup>	34.65±3.48 <sup>b</sup>	0.000
AST (IU/l)	99.82±6.32 <sup>b</sup>	134.40±14.98 <sup>a</sup>	86.53±4.42 <sup>b</sup>	0.013
GGT (IU/l)	28.13±2.24 <sup>b</sup>	51.73±2.56 <sup>a</sup>	40.83±3.92 <sup>a</sup>	0.000
Na (mmol/l)	140.24±2.34	140.40±4.43	125.75±9.00	0.086
Cl (mmol/l)	102.4±2.40 <sup>a</sup>	86.50±3.12 <sup>b</sup>	100.00±4.92 <sup>ab</sup>	0.012
K (mmol/l)	5.39±0.24	4.43±0.39	5.65±0.28	0.063

<sup>a,b,c</sup> mean values marked with different superscripts in the same line are significantly different from each other (P<0.05)

tract disorders [5]. The symptoms of OI include anorexia, scanty faeces or cessation of defecation, dullness, ruminal distension, moderate to severe dehydration, congested mucous membranes and reduced milk yield [6]. In this study, we observed similar symptoms. Cows with anamnesis were fed a diet that included in dusty hay and were in their fourth pregnancy; they did not have severe disease and responded to medical treatment.

El-Attar et al.[7] analysed some biochemical parameters in cows with OI. Their results showed a significant decrease in glucose level and an increase in AST, ALT, LDH, CPK, urea and creatinine levels. Serum Cl levels were lower in cows with OI. Hypochloreaemia could be attributed to fasting and long-standing anorectic status of the animals [2]. Chloride retention in rumen contents may caused low chloride level in omasal impaction [8]. In our study, serum Cl levels were lower because of fasting and retention in rumen. Serum ALT, AST, and GGT levels were higher in cows with OI but did not change in the control group. Non-lactating cows had mildly increased AST activity due to fatty liver, which resulted from dietary restriction and lipid infiltration in the muscle as well as the liver [9]. The elevation of GGT is associated with liver damage causing fatty liver syndrome in dairy cows [10].

The symptoms of simple CD without volvulus are not specific and include a drop in milk yield, reduced appetite and amount of faeces, and, occasionally, discrete signs of colic. The distended right paralumbar fossa, percussion (ping) and succession auscultation in the right flank are positive, extending from the tuber coxae to the last rib [11]. Our CD cases were diagnosed by clinical examination and ultrasonography (Fig. 1). In anamnesis, the cattle were fed a high concentrate diet.

The haematological and blood biochemical analyses in dairy cattle with CD, associated with partial or complete

interruption of the passage of intestinal contents, were not diagnostic [11]. Radostitis et al.[2] observed generalised fat mobilisation syndrome in late pregnancy and early lactation, particularly in high-yielding dairy cows. The laboratory findings of our study were similar to those of previous studies. However, serum ALT and GGT activities were slightly higher than control in the CD group but were not higher than those of the OI group. This increase was probably due to the periparturient period and metabolic changes in the cows. Other routine biochemical parameters were not changed.

Gastric motility hormones genes are differentially expressed in gastrointestinal tissues in humans and animals. Motilin and gastrin are synthesised in the upper gastrointestinal tract and have prokinetic activity on gastrointestinal motility [12]. Koenig et al.[13] reported a maximal concentration of motilin receptors in the duodenum, with decreasing numbers in the equine jejunum, large colon (i.e., pelvic flexure) and caecum [14]. Bunnett [15] found that cells containing gastrin immunofluorescence were confined to the mucosa of the abomasal antrum and the proximal small intestine and were not observed in the oesophagus, rumen, reticulum, omasum, abomasal fundus, ileum, large intestine, pancreas or gall-bladder. The ovine ghrelin gene was shown to be expressed in various tissues of the gastrointestinal tract, including the rumen, reticulum, omasum, duodenum, jejunum and ileum, although it was expressed primarily in the abomasums [16]. Another study found that ghrelin mRNA was not detectable in the reticulum, omasum, or rumen [14].

In our study, we observed that gastrin and motilin levels were higher in OI cows than in CD cows. Similar studies have shown that serum gastrin [17], ghrelin and motilin levels elevate the displacement of the abomasum in cattle [18]. This could be caused by omasal transport insufficiency. In addition, contents of the pre-stomach did

not pass the abomasum and produced gastrin and motilin. In contrast, caecal dilatation was not affected by motility hormones levels because motility hormones affect upper gastrointestinal tract diseases.

Serum ghrelin concentrations fluctuates relative to nutritional status, but prolonged fasting for three days has not changed ghrelin concentrations, suggesting that the eating-related changes are rather decreases after food intake than increases due to fasting [19]. It was recently reported that experimentally induced gastric outlet obstruction and abomasal displacement increased gastric ghrelin production and plasma ghrelin concentrations [18,20]. However, in our study, ghrelin level was not different between groups. The content of the pre-stomach was not passed to the abomasum because OI was occurring. As a result, gastric obstruction was not complete and the abomasum could continue to empty.

Leptin in CD was significantly ( $P < 0.05$ ) lower than in the control group, but leptin was similar between the OI and control groups. Block et al. [21] stated that leptin is negatively correlated with the amount of non-esterified fatty acids, which reflects the amount of fat mobilisation. Leptin can decrease during abomasal displacement [18], fasting or complete food deprivation, and a period of negative energy balance and can increase in cases of obesity [21]. The large intestine includes a population of microorganisms which produce volatile fatty acids. If this product is not absorbed and used by the animal, it can produce a large amount of substrate for volatile fatty acid production. High gas production is common in CD cases [11]. Similarly, in this study, increasing volatile fatty acids in cecum might have caused CD in postpartum cattle. In addition leptin levels might be decreased due to negative energy balance in the postpartum period.

The levels of the motility hormones motilin and gastrin were increased in cows with OI but were unchanged in cows with CD. It was explained that gastric motility hormones activated the upper gastrointestinal tract. In addition, the use of gastric motility hormones should be reconsidered for gastrointestinal diseases. Leptin level was decreased in cows with CD. According to the results of this study, leptin alone might be related with negative energy balance which has a role in the pathogenesis of gastrointestinal diseases in the postpartum period. In conclusion, further studies are needed to clarify whether the use of gastroprokinetic agents and motility hormones in different gastrointestinal diseases in dairy cattle are beneficial and what effects they have.

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