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INVITED REVIEW

Metabolic indicators and risk factors of left displaced abomasum in dairy cattle

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Öz

Sen I, Wittek T, Guzelbektes H. Sütçü sığırlarda sola abomasum deplasmanı için risk faktörleri ve metabolik indikatörler.

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Sığırlarda sola abomazum deplasman vakaları çoğunlukla doğum sonrası görülmektedir. Sola abomazum deplasmanlarının insidansı çiftliklere göre farklılık gösterebilir. Laktasyonun ilk haftasında görülen abomazum deplasmanı vakaları genellikle kuru dönemin iyi yönetilememesinden kaynaklanabilir. Fakat daha geç dönemlerde görülen abomazum deplasman vakaları ise kuru dönem ve/veya doğumu takiben ilk 2 ile 4 haftalık dönemde ki sığırların yönetimi ile ilgili olabilir. Bu derleme sığırlarda abomasum deplasmanları ile ilgili çeşitli risk faktörlerini, metabolik indikatörlerini ve önlenmesini içermektedir.

Anahtar kelimeler: Abomasum deplasmanı, risk faktörleri, β-hidroksibutirat, sütçü inek

Abstract

Sen I, Wittek T, Guzelbektes H. Metabolic indicators and risk factors of left displaced abomasum in dairy cattle.

Left displaced abomasum (LDA) is generally a disorder of post-partum cows. The prevalence of LDA varies widely among the affected farms. If LDA occurs after calving (within first week of lactation), this condition show to problems with dry cow management. But, if LDA occur later on it may be due to dry cow and/or fresh cow management. This review considers various risk factors, metabolic indicators, and prevention of displacement of the abomasum in cattle.

Keywords: Displaced abomasum, risk factors, β-hydroxybutyrate, dairy cow

Introduction

Displacement of the abomasum in dairy cattle is a gastrointestinal disease that was not widely recognized until the mid-twentieth century. Research initially focused on treatment and prognosis of the disease. Recently, research has focused more on risk factors, prevention, and prediction of this disease (Doll et al 2009, Constable et al 2012). An abomasal displacement is primarily an abnormal position of the abomasum within the abdominal cavity. Abomasal displacement can be subdivided into three distinct presentations of differing prevalence and severity. Left displaced abomasum (LDA) is the most common (85.3%) and least severe form in which the abomasum is displaced to the left dorsal abdominal quadrant between the rumen and left body wall. Right displaced abomasum (RDA) is an abomasal dilatation within the right abdominal cavity and occurs less commonly (8.8%) and is potentially more severe since this condition is rarely the precondition of the abomasal volvulus. Abomasal volvulus (AV) is the least common condition (5.9%) and typically the most severe form (Guard 1996). The volvulus of the abomasum results in mechanical ileus, sequestration of abomasal content and subsequently in severe disturbances of fluid and acid base homesostasis.

LDA occurs most commonly in 4- to 6-year-old Holstein cows during the first 6 weeks post-partum (Wallace 1975). Displaced abomasum (DA) is an economically severe problem of dairy cow in early lactation. The economic losses from the disease include treatment cost, milk production loss at the time of the illness (Raizman and Santos 2002) and increased culling rate (Geishauser et al 1998, Seifi et al 2011). Milk loss associated with DA in a lactation period (305 day milk yield) estimated approximately between7.5% to 11% (Radostits et al 2007). In comparison to healthy dairy cows, cows that develop LDA and had twins lost about 700 kg of milk, with the most dramatic loss in high yielding cows (Leblanc et al 2005). Estimates of mean yearly incidence rates for LDA in lactating dairy cattle range from 1.4 to 5.8% (Shaver 1997). In North America, prevalence of DA in lactating dairy cattle is estimated approximately between 3% and 5% (Grohn et al 1998, Leblanc et al 2005) whereas prevalence rate of DA ranges from 10% to 20% in individual herds (Dawson et al 1992). German Holstein herds' mean lactation prevalence is about at 1.6%, however, up to 7.5% in individual herds, in Germany (Doll et al 2009).

Periparturient period

The periparturient or transition period including 4 weeks before and 4 weeks after calving is characterized by greatly increased risk of diseases. The final 3 to 4 weeks of gestation are characterized by a period of rapid fetal growth, colostrogenesis and mammary development, and metabolic adjustments favoring mobilization of body fat and other nutrients; all in combination with declining dry matter intake (DMI) (Leblanc et al 2010, Serbester et al 2012). The periparturient period is characterized by before calving feed intake reduce and slow DMI ascent post-calving During the periparturient period, reduced feed consumption may be a risk factor for LDA though declined rumen fill and increased prevalence of other metabolic disorders. Decline rumen fill can offer superior opportunity for dislocation of the abomasum. Reduce of DMI is about 35% over the last week before calving and reasons augmented liver triglyceride instantly after calving (Bertics et al 1992). Negative energy balance (NEB) affects the postpartum dairy cows. In the early lactation, insulin and glucose blood levels reduce, whereas non-esterified fatty acid (NEFA) and β-hydroxybutyrate (BHB) level in the blood increase. A severe NEB has been associated with result in an increased risk for DA and other metabolic disease (Shaver 1997, van Winden and Kuiper 2003, Grummer et al 2004, Serbester et al 2012).

Etiology and risk factors

Many risk factors are linked to DA (Constable et al 1992) including high body condition score (BCS) at calving (Rukkwamsuk et al 1999, Duffield et al 1997), endotoxemia (Wittek et al 2004), early lactation (Constable et al 1992), stress (Constable 1991), parity (Rasmussen et al 1999), high gastrin level (Sen et al 2002) and metabolic disorders especially, milk fever, ketosis etc. (Correa et al 1990, Geishaser et al 2000). High milk yield associated with DA is not clear (Radostits et al 2007). It is reported that a low to moderate genetic merit can be considered for DA (Doll et al 2009). Specifically, Holstein–Friesian, Simmental–Red-Holstein cross, Swedish Holsteins and Guernsey have high risk for DA (Stengarde and Pehrson 2002, Doll et al 2009). A possible explanation for breed and familial differences of incidence of DA was recently provided by Sickinger et al (2008). The study described different patterns of vasoactive intestinal polypeptide, substance P and neurofilament 200 in the abomasal wall of Holstein Friesian and Simmental (German Fleckvieh) cows which could explain differences in the motility pattern and the prevalence of DA in these breeds.

Feeding factors associated with DA include components and low neutral detergent fraction in feed, total mixed rations (TMR), high concentrate rations and corn silage (Shaver 1997, Stengarde and Pehrson 2002). The risk for DA increases in overfed and obese cows during the dry period (Correa et al 1990, Rukkwamsuk et al 1999). Seasonal factors also affect occurrence of DA; i.e., more DA in winter (Constable et al 1992). A Swedish study (Stengarde et al 2012) reported that high milk yield in multiparous cows, large herd size, keeping all dry cows together, and dirty feeding platform are important risk factors for a high herd prevalence of DA. Cows with high BCS at parturition are more prone to LDA (Dyk 1995), prevalence rates increase as the BCS increases.

In recent years, functional disorders of the enteric nervous system within the abomasal wall have been in concern since abomasal displacement increases activity of neuronal nitric oxide synthase and decreases acetylcholine sensitivity (Geishauser et al 1998, Pfannkuche 2007, Niederberger et al 2010). Inhibition of abomasal motility may be major reason of DA. The prerequisite for DA is abomasal atony due to the accumulation of gas and fluid in the abomasum Michel et al 2003, Wittek et al 2005, Wittek et al 2008, Buehler et al 2008, Doll et al 2009). Displaced abomasa usually contain more methane (up to 70%) which is comparable to the rumen (Sarashina et al 1990, Doll et al 2009).

Studies have shown that the position of the abomasum within the abdomen changes during gestation and in the early postparturient period (Lagerlof 1929, Jones 1962, Sack and Svendsen 1970). A longitudinal study using ultrasonography determined changes in abomasal position in 6 cows for the first 6 weeks after calving (van Winden et al 2002). This study revealed that the left margin of the abomasum was permanently dislocated to the left during this period. However, since only the left margin of the abomasum was visualized, results do not provide a complete description of the change in abomasal position. A comprehensive longitudinal study examining the changes in abomasal position during the last trimester and first 3 months of lactation showed different results (Wittek et al 2007. This study also found an influence of pregnancy and parturition on the size and position of the abomasum. The pregnant uterus pushed the abomasum in a more left, cranial, bent and transverse position during late pregnancy. But immediately after parturition the abomasum returned to its normal right ventral position in all cows. Recently another study was reported (Sendag et al 2005) in which the position of the abomasum in 5 cows was determined ultrasonographically 5 days prior to and 5 days after parturition, where also no significant deviation to the left could be observed after parturition. Therefore these mechanical influences are thought not to be of major importance in pathogenesis of DA.

The more circle shaped abdominal circumference in beef cows and elliptical abdominal area in dairy cattle had been suspected to be one reason for the breed differences in occurrence of DA. Stober and Saratsis (1974) performed comparative measurements of the trunks in cattle which had or had not suffered from LDA. The chest circumference was similar for both groups; however, the abdominal circumferences in cows with LDA were significantly bigger and cows with LDA had a more elliptical shaped abdominal area in comparison to the healthy cows. Martin et al (1978) also mentioned the body capacity in 69 cows with LDA tended to be higher in comparison to 69 healthy control cows. During a 14 year study Mahoney et al (1986) compared the milk yield, reproductive performance, health status, and cost differences between two groups of Holstein cows of different body weight and shape (large cows, small cows). During the first lactation 6 of 220 large cows and 0 of 191 small cows developed LDA; the difference was significant. In a study Wittek et al (2007) found that compared with previous studies (Swett et al 1928, Swett et al 1937a, 1937b) the abdominal shape of modern Holstein cows has a significantly higher abdominal index than the cows 70 years ago, indicating that the abdominal depth has further disproportionately increased. This study also showed that cows which were previously diagnosed with LDA had an even higher abdominal index comparing to their herd mates. An increase in abdominal depth results in an increased distance between the abomasum and the transverse duodenum what requires the generation of a bigger pressure head by the abomasum to sustain emptying. Because the abomasum is a low pressure organ a disturbed abomasal emptying and an increased potential for abomasal displacement may be the consequence.

Metabolic indicators

The peripartum (transition) period is critical since it is associated with a peak incidence of disease, including those of metabolic, nutritional, or infectious (Otzel 2004, Leblanc et al 2005, Serbestler et al 2012). Up to 50% of dairy cows in the transition period may be affected by an infectious or metabolic disease (Leblanc 2010). Negative energy balance plays a critical role in many diseases that occur during the transition period (Herdt 2000). In the days before calving, cows experience a substantial decrease in DMI of up to 30% (Hayirli et al 2002). Immediately after calving, the homeorhetic drive to increase milk production coupled with inadequate DMI require the use of energy from body fat stores (Bauman and Currie, 1980). Janovick et al (2011) compared dry feeding regimes of over (150%) or under (80%) of energy requirements in late gestation and found that overfeeding resulted in higher NEFA and β-hydroxybutyrate (BHB) concentrations after calving, increased fatty liver and a higher incidence of both displaced abomasum and ketosis. Both long dry periods and overfeeding before calving are likely to result in overweight cows with a reduced appetite around calving (Hayirli et al 2002).

Increased blood concentrations of NEFA, BHB, haptoglobin, and increased enzyme activity of aspartate aminotransferase (AST) and glutamate dehydrogenase (Duffield et al 1997, Hirvonen and Pyorala 1998, Sen et al 2006, Leblanc et al 2010, Guzelbektes et al 2010), as well as decreased concentrations of total cholesterol (Rehage et al 1996) have been reported in cows having a DA. However, these studies do not allow to differentiate if the conditions had been causes or results of the DA.

High serum levels of BHB and AST have been identified as predictors of LDA occurrence when measured in the first and second week postpartum (Geishauser et al 1998, Sen et al

2006, Ospina et al 2010). Additionally, high serum NEFA levels during the pre-partum period have been associated with subsequent development of LDA (Leblanc et al 2005). Hypocalcemia with related abomasal atony may also be implicated (van Winden and Kuiper 2003). Serum concentrations of NEFA and BHB measure mobilization and oxidation of fat, respectively, and reflect the success of a cow in adapting to NEB (Herdt 2000). Serum calcium concentrations reflect the ability of a cow to replace extracellular calcium lost to colostrum and milk production by withdrawing calcium from bone and by increasing the efficiency with which dietary calcium is absorbed (Radostits et al 2007).

Dairy cattle with plasma NEFA >0.3 mEq/L during the last month of pregnancy may double the risk of subsequent development of DA (Cameron et al. 1998). Cows with serum BHB ≥1200 or ≥1400 μmol/L in the first 7 days post-partum the odds of LDA are 3 and 4 times greater, respectively, than in cows with BHB below the cut points (Geishauser et al 1997). BHB and NEFA concentrations in the first week of lactation found critical thresholds for DA prediction of ≥1200 μmol/L and ≥1.0 mEq/L, respectively (Leblanc 2010). β-hydroxybutyrate is more sensitive and specific as a predictor of DA than NEFA concentration in first week after calving (Leblanc et al 2005). Increased serum NEFA concentrations within 1 week pre-calving is associated with increased risk of DA post-calving (Chapinal et al 2012. Hypocalcemia (total serum calcium <7.9 mg/dL and serum ionized calcium <4.0 mg/dL) at parturition can increase the risk of DA, because of abomasal atony (Madison and Troutt 1988, Massey et al 1993, Goff and Horst 1997, Stengarde et al 2010).

Insulin-like growth factor-1 (IGF1) is a metabolic hormone, with circulating concentrations deriving mainly from the liver (McGuire et al 1992). IGF1 concentrations fall precipitously around the time of calving in high-yielding dairy cows to a minimum at about 1 week postpartum, before gradually increasing again (Taylor et al 2004). The circulating IGF1 concentration at this time correlates positively to the dry matter intake, BCS, and circulating insulin concentrations, and negatively with NEFA and BHB (Wathes et al 2007). Recently, a study has been showed that a low concentration of IGF1 in the peripartum period is an indicator for LDA in addition to elevated BHB and NEFA concentrations (Lyons et al 2014). IGF1 concentrations in postpartum cows change gradually rather than abruptly support the idea that lower IGF1 concentrations are likely to precede the development of LDA.

Mecitoglu et al (2012) reported that milk fat percentage and milk Protein/Fat ratios could be used for the prediction of LDA in early postpartum period and also that milk fat percentages greater than 5.29 and milk Protein/Fat ratios less than 0.63 are statistically significant and valuable for the prediction of LDA.

Prevention

Good feeding management before calving is associated with a decreased risk of LDA. Herd incidence rate of DA can be possibly reduced by avoiding NEB before calving, by avoiding obesity, and by optimal management of feed bunks during the late gestation. Planning calving seasons out of higher risk periods of the year may not be applicable in many farms. However, calving in the hot summer months can be avoided since DMI significantly declines. In the meantime, stress factors in pre-partum and early postpartum period should be decreased (Shaver 1997, Radostits et al 2007).

Conclusions

NEB in transition period is important factor in the pathogenesis of LDA. Monitoring of energy metabolism is crucial point in dairy farm. Increases in blood levels of BHB and NEFA in transition period are associated with the risk of DA. NEFA levels in the last week before expected calving and on BHB and IGF1concentration in the first week after calving should focus for prediction of LDA post-partum. Housing, management and feeding during transition period are very important in the prevention of LDA in dairy cows.

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