

Investigations on Etiology and Pathogenesis of Abomasal Displacement in Adult Cattle: Heritability, Fat:Protein Quotient, and Motility Disorders

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Summary

Heritability of abomasal displacement was estimated in 30 herds breeding German-Friesian cattle using similarity between mothers and daughters. Fourpoint correlation coefficients (r) were calculated from quadrant squares. Heritability ($h^2 = 2r$) of abomasal displacement was estimated as $h^2 = 0.24$.

Supply with energy-rich carbohydrates was estimated in 27 herds in which abomasal displacement occurred (case herds) and in 27 herds in which abomasal displacement was not diagnosed (control herds), using the fat:protein quotient of milk. In herds where abomasal displacement occurred the fat:protein quotient of milk in the year before the displacement was significantly higher than in herds not diagnosed with abomasal displacement, and also tended to be higher in the month before. This indicates that herds in which abomasal displacement occurred received less energy-rich carbohydrates than herds in which displacement was not diagnosed.

Muscle strips taken from the abomasal antrum of healthy cows and cows with LDA, RDA and AV were investigated using *in vitro* techniques. Muscular activity was recorded under basal conditions and after electrical nerve stimulation. The effects of acetylcholine and L-NAME, a blocker of the nitric oxide syntheses, on muscular activity were studied. Neuronal structures were investigated using immunofluorescence techniques. To estimate catalytic activity of nitric oxide synthesis the NADPH-diaphorase reaction was used. The findings suggest inhibited muscle activity during abomasal displacement due to lack of cholinergic excitation and/or predominance of nitroergic inhibition.

Introduction

Etiology and pathogenesis of abomasal displacement are poorly understood.⁷ Dairy cattle are at a higher risk of developing abomasal displacement than are beef cattle.¹ In Germany this disease is predominantly diagnosed in the German-Friesian breed.¹⁰ In this breed, individual and genetic predisposition to left displaced abomasum (LDA) exists.¹⁸ Feeding is thought to have an impact on the development of abomasal displacement, although the findings are not uniform.⁷ Ketosis, a disorder which often follows decreased energy supply is frequently diagnosed simultaneously with abomasal displacement^{1,4} and was diagnosed before abomasal displacement occurred.^{11,19} Ketosis is a risk factor for LDA.^{2,3,6,14} The rate of abomasal displacement in cows with ketosis was 39 times greater than in cows without ketosis, suggesting an etiopathologic link between abomasal displacement and ketosis.¹⁷ Abomasal motility disorders, gas accumulation and abomasal dilatation are prerequisites of abomasal displacement.⁴ Attempts were made to record motility disorders during and after correction of abomasal displacement.^{13,15,16} However, the character of motility disorders in abomasal displacement is unknown. The aims of our studies were to estimate heritability of abomasal displacement in German-Friesian cattle, to investigate energy supply prior to abomasal displacement, and to characterize motility disorders during abomasal displacement.

Heritability in German-Friesian Cattle

The degree of heritability of abomasal displacement was estimated in 30 Hessian herds breeding German-

Friesian cattle, in which displacement of the abomasum occurred. The estimation was made by investigating the similarity between mothers and daughters. 2,627 pairs were formed for this, under consideration of the absence or occurrence of abomasal displacement in the mothers and daughters. The fourpoint correlation coefficient (r) was determined for each herd using quadrant squares. The arithmetic means were then calculated from the correlation coefficients. The number of herds examined was limited by assuming the correlation coefficient to be stable when it varied by less than 0.02 units during the investigation of more than 15 herds. The correlation coefficient was stable after examining 15 herds. Heritability was calculated using the correlation coefficient ($h^2 = 2r$). The overall heritability in 30 herds was $h^2 = 0.24$.⁹

Fat: Protein Quotient of Milk

In dairy cattle the supply with energy-rich carbohydrates can be estimated by the fat:protein quotient of milk. High fat:protein quotient (> 1.4) points toward an energy deficit.^{5,12} The fat:protein quotient of milk was calculated for 27 herds in Hessia breeding German-Friesian cattle, in which abomasal displacement occurred (case herds) and in 27 similar herds, in which abomasal displacement was not diagnosed (control herds). This was measured for the year preceding the displacement as well as for the month in which displacement occurred. Control herds were selected which had the same milk yield (lbs), because milk yield impacts milk fat content. In herds where abomasal displacement occurred, the fat:protein quotient of milk in the year before the displacement was significantly higher than in herds not diagnosed with abomasal displacement, and also tended to be higher ($p = 0.06$) in the month before. This indicates that herds, in which displacement occurred, received less energy-rich carbohydrates than herds in which displacement was not diagnosed.⁸

Character of Motility Disorders

Motility of muscle strips taken from the abomasal antrum from cows diagnosed with left displaced abomasum (LDA), right displaced abomasum (RDA) and abomasal volvulus (AV) was investigated *in vitro*. Control preparations were taken from freshly killed cows. The preparation consisted of the longitudinal muscle and the attached myenteric plexus. Muscle activity was recorded under basal conditions and after electrical nerve stimulation.

Under basal conditions, all preparations exhibited regular phasic activity which did not significantly differ in frequency or amplitude between the various groups. In controls, nerve stimulation evoked a transient contrac-

tile response with an amplitude exceeding the basal contractile amplitude by 50%. This response was blocked by tetrodotoxin and atropine indicating both the neural origin of the response and its mediation by cholinergic mechanisms. No such response could be invoked in preparations from animals with displaced abomasum. In contrast to controls, the contractile activity was significantly inhibited during field stimulation in LDA, RDA and AV by 40%, 60% and 40% respectively. This inhibition could be reversed after treatment of the preparations with L-NAME, a blocker of the nitric oxide synthase (NOS). In L-NAME, LDA, RDA and AV preparations did now show contractile responses very similar to controls. Accordingly, inhibition of muscle activity after nerve stimulation could be induced in control preparations during superfusion of the nitric oxide-generating substance nitroglycerin, thereby mimicking the situation in LDA, RDA and AV. In addition to the changes in neurally-mediated muscle behaviour, the contractile response to exogenous acetylcholine was significantly smaller in LDA, RDA and AV compared to control as indicated by a right-shift of the dose response curve. To further characterize the mechanisms underlying the identified motility disorders, immuno-fluorescence techniques were used to establish possible changes in the innervation. Staining of all neural elements with antibodies against protein-gene-product did not reveal any significant differences. Choline acetyltransferase-immunoreactivity indicated intact cholinergic innervation in all preparations. To estimate catalytic activity of NOS, we used the NADPH-diaphorase reaction. Significant increase in NADPH-staining intensity did occur in abomasal displacement indicative of an augmented nitric oxide synthesis. The results suggest that motility changes during abomasal displacement are due to malfunction of neurally mediated reflexes. There appears to be a loss of excitatory and/or an increase in inhibitory tone. The lack of cholinergic excitation and the predominance of nitroergic inhibition leads to a decreased reflex activity.⁷

Conclusions

Our findings indicate that abomasal displacement is a moderately heritable trait in German-Friesian cattle. Our findings further indicate that herds in which abomasal displacement occurred received less energy-rich carbohydrates than herds in which abomasal displacement was not diagnosed. This is consistent with ketosis often occurring prior to^{11, 19} or simultaneously with abomasal displacement.^{1, 5} During abomasal displacement, abomasal muscle activity is inhibited due to lack of cholinergic excitation and/or predominance of nitroergic inhibition. However, whether this is cause or consequence of abomasal displacement needs further investigation. Our findings suggest that genetic selec-

tion and appropriate energy supply could reduce the incidence of abomasal displacement.

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Abstract

Bovine fat necrosis (Lipomatosis)

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Long term studies on bovine fat necrosis were carried out. The disease occurred more commonly in native and cross bred cattle than in foreign breed dairy cattle. Aged cows are more susceptible than young ones. Few reports had described its incidence in heifers and bulls.

Dietary factors and composition of the ration are to be considered in the occurrence of bovine fat necrosis. The disease is world wide and reported as single cases or herd problems in different countries. Clinical findings were recorded as a deposition of subcutaneous fat all over the body especially at the base of the tail, chest and back. Moreover, rectal examination is of great diagnostic importance by which the lesions in the form

of hard irregular masses around the kidney, mesentery and intestine are palpable.

Gastrointestinal upset in the form of tympany, constipation and diarrhea are constant findings. Severe emaciation has been observed in the chronic stage of the disease.

Selenium could be considered in the pathogenesis of bovine fat necrosis. Experimental therapy with sodium selenite in cows with fat necrosis indicated a variable degree of response. Cattle in the early stage of the disease could be improved after six months therapy, but completely unsuccessful in chronic cases.