

## Prognostic Judgment at Post-Surgery by Biochemical Parameters in Beef Cattle with Left Displaced Abomasum

Toshihiro ICHIJO<sup>1)\*</sup>, Hiroshi SATOH<sup>1)</sup>, Yuki YOSHIDA<sup>2)</sup>, Isao MURAYAMA<sup>3)</sup>, Kiyoshi TAGUCHI<sup>4)</sup> and Shigeru SATO<sup>1,2)</sup>

<sup>1)</sup>Cooperative Department of Veterinary Medicine, Faculty of Agriculture, Iwate University, Morioka 020-8550, Japan

<sup>2)</sup>United Graduate School of Veterinary Science, Gifu University, Gifu 501-1193, Japan

<sup>3)</sup>Veterinary Clinical Training Center, Miyagi Prefectural Federation of Agricultural Mutual Aid Association, Miyagi 981-3602, Japan

<sup>4)</sup>School of Veterinary Medicine, Rakuno Gakuenn University, Hokkaido 069-0836, Japan

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**ABSTRACT.** We examined whether the postoperative prognosis of beef cattle with left displaced abomasum (LDA) can be estimated from changes in laboratory parameters. Preoperatively, beef cattle with LDA showed increases in plasma glucose with decreased serum insulin in the glucose tolerance test compared to non-LDA cattle. Postoperatively, the cattle with LDA were retrospectively divided into two groups, good and bad prognoses. Although plasma glucose concentrations significantly increased either pre- or postoperatively, no difference was noted between the good and bad prognosis groups. Serum insulin concentrations in the bad prognosis group significantly decreased, compared to those in the good prognosis group. These findings suggest that beef cattle with LDA elicit disturbed glucose metabolite pre- and postoperatively, and serum insulin levels may predict their prognoses after surgery.

**KEY WORDS:** beef cattle, laboratory test, left displaced abomasum, prognosis

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The incidence of left displaced abomasum (LDA) in beef cattle has been increasing owing to overfeeding of starch [4, 5], although it is still lower than that in Holstein dairy cows [3]. Generally, surgery to correct abomasal displacement is radical therapy for cattle with LDA, and certain animals have a poor outcome. Although abomasal atony is thought to be related to LDA prognosis [7], certain clinical markers including laboratory tests to predict prognosis after surgery were not revealed. If the outcome could be predicted using preoperative laboratory parameters, this would help bovine practitioners.

Holstein cows with LDA were reported to cause altered glucose metabolism with ketonuria as a consequence of decreased feed intake, postpartum, retained placenta or metritis [6]. However, few studies have assessed the relationship between glucose metabolism and LDA in beef cattle. Therefore, we examined the results of the glucose tolerance test and other laboratory parameters pre- and postoperatively in beef cattle diagnosed with LDA. Retrospective data from crosses (F1, beef cattle) of Japanese Black and Holstein cattle raised on a breeding farm in Miyagi (Japan) were collected between 2006 and 2009. These cattle were fed a diet of rice straw (20–25%) and concentrates (75–80%) including starch (40–45%) from 10 months old after birth to 29 months at finishing. Cattle were diagnosed with LDA based on clinical

symptoms, such as a loss of appetite, a pinging sound in the left ventral abdomen, diarrhea and dehydration. Surgery to correct the abomasal displacement was performed via a right flank approach [9]. The prognosis was judged by improvement of appetite and physical conditions on removing the stitches. Animals with normal clinical signs, appetite, feces and urine excretions and serum biochemistry served as the corresponding non-LDA cattle.

The glucose tolerance test was used to compare the glucose metabolism between cattle with LDA (5 steers weighing  $509 \pm 69$  kg and aged  $24.6 \pm 1.1$  months) and non-LDA cattle (5 steers weighing  $510 \pm 34$  kg and aged  $24.7 \pm 1.6$  months). The test was performed according to a previously reported procedure [1] with a minor modification. The 25% glucose solution (ZENOAG, Fukushima, Japan) was administered intravenously via the jugular vein at 500 ml/animal (125 g/animal) at a rate of 50 ml/min. To measure the plasma glucose and serum insulin concentrations, blood samples (4 ml) were collected from the opposite jugular vein before and 60 and 90 min after the glucose load. The area under the concentration-time curve from 0 to 90 min ( $AUC_{0-90 \text{ min}}$ ) for plasma glucose and serum insulin was plotted using the linear trapezoidal rule with extrapolation.

Postoperatively, the cattle with LDA were retrospectively divided into two groups: the good (6 steers and 2 heifers weighing  $433 \pm 78$  kg and aged  $18.5 \pm 3.8$  months) and bad (7 steers and 1 heifer weighing  $458 \pm 53$  kg and aged  $18.4 \pm 2.9$  months) prognosis groups, respectively, based on clinical symptoms, such as a loss of appetite, diarrhea and/or dehydration. Peritonitis or abomasal perforated ulcer was not observed in both the good and bad prognosis groups during operation.

Age-matched clinically healthy cattle (7 steers and 1

\*CORRESPONDENCE TO: ICHIJO, T., Cooperative Department of Veterinary Medicine, Faculty of Agriculture, Iwate University, 3-18-8 Ueda, Morioka, Iwate 020-8550, Japan. e-mail: ichijo@iwate-u.ac.jp

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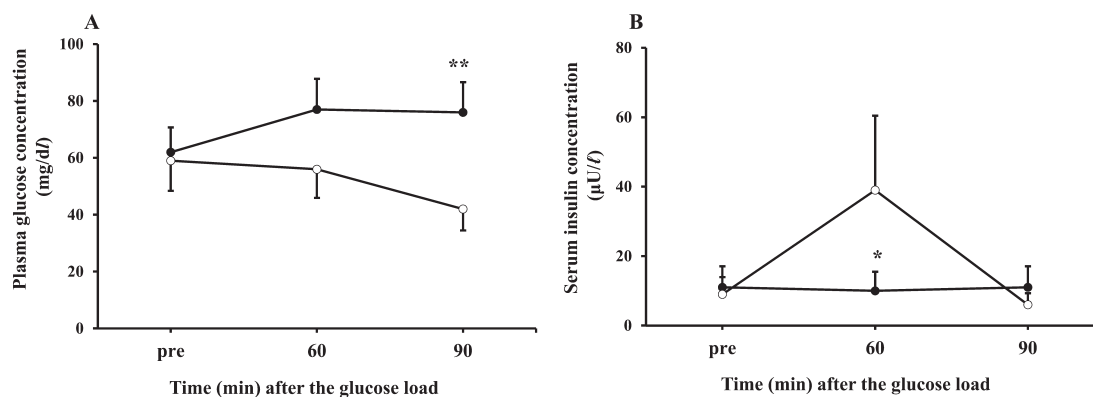


Fig. 1. Changes in plasma glucose (A) and serum insulin (B) concentrations of cattle with LDA (closed circles,  $n=5$ ) and non-LDA cattle (open circles,  $n=5$ ) in the glucose tolerance test ( $n=5$ ). The blood samples were collected preadministration and 60 and 90 min after an intravenous injection of glucose (125 g/animal). Values are expressed as means $\pm$ SD. \* $P<0.05$  or \*\* $P<0.01$  vs. non-LDA cattle (Student's  $t$ -test).

heifer weighing  $475 \pm 41$  and aged  $19.6 \pm 1.9$  months) were used as the corresponding healthy control group.

In the laboratory test, blood was collected from the jugular vein immediately before surgery and 10 days after surgery. Plasma glucose and serum total cholesterol (T-cholesterol), blood urea nitrogen (BUN), total protein (T-protein), albumin, calcium (Ca), inorganic phosphorus (iP), sodium ( $\text{Na}^+$ ), potassium ( $\text{K}^+$ ), chloride ( $\text{Cl}^-$ ), aspartate aminotransferase (AST),  $\gamma$ -glutamyl transpeptidase (GGT) and free fatty acid (FFA) levels were analyzed with an automated analyzer (DimensionRXL, Didebelling, Tokyo, Japan). Serum cortisol and insulin concentrations were measured using an 81600N Access2 (Beckman Coulter, Tokyo, Japan), and serum vitamin A and E levels were measured using high performance liquid chromatography (Shimadzu LC-10A, Kyoto, Japan).

Quantitative data are expressed as the mean  $\pm$  standard deviation (SD). The difference between pairs of groups was examined using Student's  $t$ -test, and the differences among the five groups were examined with the Kruskal-Wallis's test.  $P$ -value $<0.05$  and  $<0.01$  were considered statistically significant.

In the glucose tolerance test, cattle with LDA had significantly higher plasma glucose and lower serum insulin levels 90 and 60 min, respectively, after the glucose load, compared to non-LDA cattle (Fig. 1). The  $AUC_{0-90 \text{ min}}$  of plasma glucose was significantly higher in cattle with LDA ( $64.7 \pm 11.9$  vs.  $49.1 \pm 6.9$  mg $\cdot$ min/ml), while that for serum insulin was significantly lower in cattle with LDA ( $0.95 \pm 0.39$  vs.  $2.13 \pm 1.36$   $\mu\text{U}\cdot$ min/ml) than in non-LDA cattle. These findings suggest that beef cattle with LDA have altered glucose metabolism. In Jersey cows with metabolic acidosis, lower insulin levels were also reported with altered glucose metabolism [2]. Likewise, Japanese black cattle with ateliosis were shown to have lower plasma insulin responses during the glucose tolerance test [9]. In addition, insulin resistance and disordered abomasal motility have been reported in Holstein cattle with LDA [7]. Therefore, the disturbed glucose metabolism is likely to be related to the LDA condition.

Both the good and bad prognosis groups increased plasma glucose levels pre- or postoperatively compared to the healthy control group. Interestingly, the bad prognosis group elicited significantly decreased serum insulin levels compared to the good prognosis group either pre- or postoperatively (Fig. 2). The decreased serum insulin may be related to altered insulin release from the pancreatic islets and seems to be the result of a decrease in the number of beta cells of the pancreatic islets, as was the case with human type II diabetes. The absence of a difference in the plasma glucose level between the good and bad prognosis groups may be explained by deteriorated systematic conditions in the bad prognosis group. However, further studies are needed to clarify the inconsistent responses of glucose and insulin in beef cattle with LDA, since poor clinical conditions, including dysstasia, may result in the decreased serum insulin and reduced appetite. In a previous study, the glucose tolerance test showed that the pancreatic endocrine function recovered after repositioning the abomasum surgically [8]. Alternatively, a mechanism underlying the relationship among the increased plasma glucose, reduced serum insulin and pancreatic dysfunction in cattle with LDA remains unclear.

Although serum T-cholesterol, BUN, T-protein, albumin, Ca, iP,  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Cl}^-$ , AST, GGT, FFA, cortisol, vitamin A and vitamin E levels fluctuated sporadically throughout the study period, these alterations did not relate to the prognostic judgment of LDA at post-surgery (data not shown).

In conclusion, beef cattle with LDA had disturbed glucose metabolites pre- and postoperatively, and serum insulin levels may predict their prognoses after surgery, based on the retrospective data.

## REFERENCES

- Anderson, D. E., Monke, D. R., Silveira, F., Ayars, W. and Rings, D. M. 2000. Determination of serum insulin concentration during intravenous glucose tolerance testing of healthy bulls. *Am. J. Vet. Res.* **61**: 61–63. [Medline] [CrossRef]

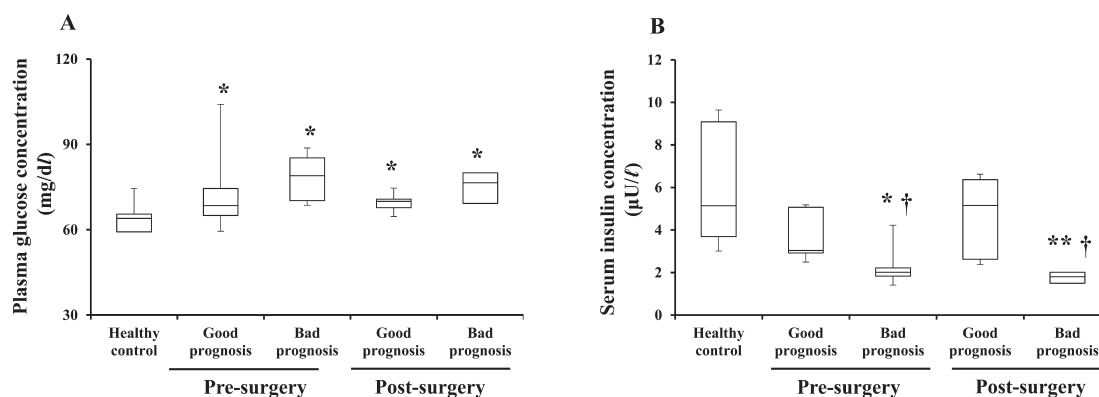


Fig. 2. Box plots showing effects of plasma glucose (A) and serum insulin (B) concentrations in the healthy control group (n=8) and the good and bad prognosis groups of cattle with LAD at pre- and post-surgery (n=8, respectively). Median and quartiles are displayed in the box. Upper and lower bars represent maximum and minimum values, respectively. \* $P < 0.05$  or \*\* $P < 0.01$  vs. healthy control cattle (Kruskal-Wallis's test). † $P < 0.05$  vs. healing group at pre- and post-surgery (Student's *t*-test).

- Bigner, D. R., Goff, J. P., Faust, M. A., Burton, J. L., Tyler, H. D. and Horst, R. L. 1996. Acidosis effects on insulin response during glucose tolerance tests in Jersey cows. *J. Dairy Sci.* **79**: 2182–2188. [Medline] [CrossRef]
- Constable, P. D., Miller, G. Y., Hoffsis, G. F., Hull, B. L. and Rings, D. M. 1992. Risk factors for abomasal volvulus and left abomasal displacement in cattle. *Am. J. Vet. Res.* **53**: 1184–1192. [Medline]
- Ichijo, T., Sato, S. and Taguchi, K. 2009. Clinical findings and blood profiles in fattened cattle with left-side displaced abomasum. *J. Jpn. Vet. Med. Assoc* **62**: 203–207 (in Japanese with English abstract).
- Ichijo, T., Matsuta, K., Takahata, S. and Sato, S. 2005. Incidence and clinical findings of displaced abomasum in fattened cattle. *Jpn. J. Vet. Clinics* **28**: 42–46 (in Japanese with English abstract).
- [CrossRef]
- LeBlanc, S. J., Leslie, K. E. and Duffield, T. F. 2005. Metabolic predictors of displaced abomasum in dairy cattle. *J. Dairy Sci.* **88**: 159–170. [Medline] [CrossRef]
- Pravettoni, D., Doll, K., Hummel, M., Cavallone, E., Re, M. and Belloli, A. G. 2004. Insulin resistance and abomasal motility disorders in cows detected by use of abomasoduodenal electromyography after surgical correction of left displaced abomasum. *Am. J. Vet. Res.* **65**: 1319–1324. [Medline] [CrossRef]
- Samanc, H., Stojic, V., Kirovski, D., Pudlo, P. and Vujanac, I. 2009. Glucose tolerance test in the assessment of endocrine pancreatic function cows before and after surgical correction of left displaced abomasum. *Acta Vet.* **59**: 513–523. [CrossRef]
- Weaver, A. D., StJean, G. and Steiner, A. 2005. Bovine surgery and lameness: 2nd ed., Blackwell Publishing Ltd., Oxford.