Effects of pain and nonsteroid anti-inflammatory drugs (NSAIDS) after abomasal displacement operations of cattle

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SUMMARY

Displacement of abomasum (DA) is one of the most common non-infectious disease in dairy cattle and multifactorial condition characterized by gas and fluid building up in the abomasum. A number of medical and mechanical technique are used for treatment of DA, but the most effective method is surgery. The aim of this study was to evaluate post-operative pain caused by DA operations and to compare the effects of ketoprofen, flunixin meglumine and acetaminophen. In total, 24 Holstein dairy cattle (3-8 years old; 5 ± 1.6 years) were used as subjects for this study. All animals were subjected to similar environments and feeding conditions. The cows were examined for postpartum diseases such as mastitis, retention secundinarium, hoof problems and ketosis and the animals diagnosed of these diseases were excluded. Right flank laparotomy was carried out on all subjects. In the pre and post-operavite periods, adrenaline, noradrenaline, cortisol, body temperature (BT), heart rate (HR), respiratory rate (RR) and rumen contraction (RC) were recorded. The statistical differences were evaluated for laboratory and clinical parameters. The significant differences were found in plasma adrenaline, noradrenaline and serum cortisol levels between groups' evaluations. Generally, the measured BT, HR, RR and RC values were higher in control group than study groups. In abdominal surgeries very little research has focused on the differences in type, magnitude and time course between somatic and visceral pain. In cattle the surgical treatment methods of DA include left flank, right flank and right paramedian approaches. Pain from these procedures can be similar to laparotomies, however the procedures require the manipulation and suturing of the abomasum or periabomasal tissue, which may cause additional pain. In this study, flunixin meglumine was found to be more effective than ketoprofen in postoperative pain control. As a result of this study, it was concluded that it is necessary to provide effective postoperative analgesia after DA operations in cattle for the animals' welfare and treatment of anormal physiological function.

KEY WORDS

Abomasum, cattle, displacement, pain.

INTRODUCTION

Displacement of the abomasum (DA) is one of the most common non-infectious disease in dairy cattle. DA is a multifactorial disease characterized by gas and fluid building up in the abomasum, and according to which side the abomasum moves, can occur as left displacement of the abomasum (LDA) or right displacement of the abomasum (RDA). DA has also been associated with other diseases such as retained placenta, metritis and ketosis[1-3]. A number of medical and mechanical technique are used for treatment of DA, but the most effective method is surgery. Pain is sensory process that results from tissue damage and has two components (sensory and emotional). A stimulus which causes deterioration of tissue integrity is defined as a noxious stimulus. Therefore, any surgical procedure in the living organism is a noxious stimulus[4,5]. In general, abdominal surgery on cattle is performed with local anesthesia. The short lasting effects of local anesthetic agents require the animals to be given drugs for postoperative pain control. Therefore, in order to decrease postoperative pain, drugs should be selected very carefully in the postoperative period.

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Nonsteroidal anti-inflammatory drugs (NSAIDs) are widely used in veterinary practice for postoperative pain control[6,7]. The analgesic effects of NSAIDs are dependent on the inhibition of the cyclooxygenase (COX) enzyme, which catalyzes the formation of prostaglandins and prostanoids (thromboxane and prostacyclin) from arachidonic acid. The COX enzyme has two isoforms: (COX-1 and COX-2). COX-1 regulates the renal blood flow and gastric mucus production and COX-2 allows the prostaglandins and prostanoids in damaged and inflamed tissues to occur [8-10].

Ketoprofen is a COX-1 inhibitor and has analgesic, antipyretic and anti-inflammatory effects. Flunixin meglumine is widely used in viseral and colic pains, inhibits both COX-1 and COX-2, but is more selective on COX-1[9,11,12]. Acetaminophen inhibits the COX-1 and COX-2 enzymes but the anti-inflammatory effect of it is poor. Given the low incidence of gastrointestinal side effects with acetaminophen, it is recommended to use this drug together with other NSAIDs to increase their analgesic effects [13,14].

Although many aspects of DA have been investigated, the pain and effects of NSAIDs have not been sufficiently investigated in the postoperative period. Studies carried out on pain and NSAIDs in cattle generally focus on lameness, liver biopsy and dehorning[12,15-17] . In the present study, various NSAIDs i.e. ketoprofen, flunixin meglumine and acetaminophen were ad-

ministred after DA operation, to control the postoperative pain and stress caused by DA operations and their effects were compared.

MATERIALS AND METHODS

Animals

The study was approved by the Local Ethics Committee of Selçuk University (Decision no: 2009/024). In total, 24 Holstein dairy cattle (3-8 years old; 5 ± 1.6 years) were included, consisting of 7 undergoing surgery for RDA and 17 for LDA. All animals were subjected to similar environments and feeding conditions. The cows were examined for postpartum diseases such as mastitis, retention secundinarium, hoof problems and ketosis and the animals diagnosed of these diseases were excluded. Routine physical examination and laboratory and specific DA tests (peritoneal and abomasal fluids analysis) were carried out before surgery carried out.

Experimental desing

Animals were randomly divided into four groups, with each group containing six cattle. Group I (GI) consisted of one animal with RDA and five animals with LDA, group II (GII) consisted of six animals with LDA, group III (G III) consisted of two with RDA and four with LDA and the control group (CG) consisted of four with RDA and two with LDA. After the preparation of the surgical field, 20 m*l* local anesthetic, 2% lidocaine (Adokain, Sanovel, Turkey) was infiltrated into the right paralumbar fossa of the animals and a right flank laparotomy was performed on all subjects.

During the operations conducted on the animals with LDA, gas and fluid contents were extracted from the abomasum, and omentopexy was performed on the right incision line with horizontal mattress sutures on the abdominal wall. After omentopexy, the abdominal cavity was closed routinely. During the operations conducted on the animals with RDA, the abomasal contents were aspirated and toggle pins were inserted into the abomasum and paramedian abomasopexy was performed 5 cm to the right of the ventral line. After the paramedian abomasopexy, the abdominal cavity was closed routinely. Intramuscularly (I.M.) penicillin-streptomycin (5 ml/100 kg, Rediepen-S, Ceva, Turkey) was administered for one week after surgery. All animals were housed in warm stalls with dry bedding. For rehydration and the correction of electrolyte imbalances, fluids were administered intravenously (I.V.) for 2 days when necessary. Feeding was initiated 24 h after surgery.

NSAIDs were not administered to animals in the CG. In the GI, after the extraction of gas and fluids, 50 mg/kg of diluted paracetamol was injected into the abomasum during the operation. In GII, after the extraction of gas and fluids, 50 mg/kg diluted paracetamol was injected into the abomasum during the operation, and 2.2 mg/kg of flunixin meglumine (Filumed, Alke, Turkey) was administered IM for three days after the operation. In GIII, after the extraction of gas and fluids 50 mg/kg diluted paracetamol was injected into the abomasum during the operation, and 3 mg/kg of ketoprofen (Ketobay, Bayer, Turkey) was administered IM for three days after the operation.

Before local anesthesia, a 20-gauge intravenous catheter was placed in the right jugular vein for blood sample collection. Blood samples of total volume of 11 mL were collected into heparinized (3 m*l*) and clot activator tubes (8 m*l*) at preoperative (PO), end of operation (EO), post-operative (POS) 1, 2, 4, 6, 24, 48 and 72 h periods. Body temperature (BT), heart rate (HR), respiratory rate (RR) and rumen contraction (RC) were recorded at the same times. The plasma and serum samples were centrifuged (Nüve, NF 200, Turkey) at 2349 *g* for 10 min at room temperature and stored at -18 °C until biochemical analysis.

Adrenaline and noradrenaline were measured from plasma samples using a high performance liquid chromatography method (Shimadzu, Prominence Modular LC20A HPLC, Japan), and cortisol was measured from serum samples using chemoluminescence method (ILAB 300 Plus, Italy).

Statistical analysis

All analysis were performed with the Minitab Release 12.1 package program. A Wilcoxon's rank test was used to assess the significances of difference in intra-group evaluations, and the Kruskal-Wallis followed by Mann-Whitney U tests were performed for camparison between groups. Values of $P < 0.05$ were considered statistically significant. Results were presented as the mean ± standard deviation (SD).

RESULTS

The plasma adrenaline values are shown in Table 1. In general, the adrenaline levels were increased at EO and POS 1 h. The highest values were seen in the CG at POS 1h. In intra-group comparison of adrenaline in CG, there were significant differ-

Table 1 - Plasma adrenaline concentration (Mean ± SD) (*p*g/m*l*) (n=6).

Time	CG	G I	G II	G III
PO	7.90 ± 1.87¥	11.10 ± 3.39*	5.50 ± 2.23**	10.80 ± 2.60*
EO	9.90 ± 10.31*	12.25 ± 3.24*	6.50 ± 1.02¥	14.75 ± 3.69* a
POS 1 h	18.65 ± 20.89* a	14.95 ± 5.78¥ a	7.80 ± 4.62 **a	14.80 ± 6.74¥ a
POS 2 h	12.35 ± 4.95¥ b	13.10 ± 3.79* a	5.20 ± 1.82*	10.65 ± 3.46
POS 4 h	6.75 ± 1.68¥	12.85 ± 4.34*	6.45 ± 0.87¥	10.90 ± 2.61*
POS 6 h	6.50 ± 8.06¥	13.90 ± 4.02*	4.60 ± 1.74**	14.00 ± 4.40* b
POS 24 h	6.75 ± 10.93	12.80 ± 7.45	6.40 ± 2.41	14.25 ± 2.67 a
POS 48 h	8.40 ± 15.08	11.75 ± 3.48	7.75 ± 3.12	12.35 ± 4.80
POS 72 h	8.95 ± 3.91	12.15 ± 4.41	6.30 ± 2.21	12.80 ± 5.02

PO; preoperative, EO; end of operation, POS; post-operative, a, b; in same column is the significant difference in groups ($P < 0.05$), *,¥,**; in same line is the significant difference between groups ($P < 0.05$).

Table 2 - Plasma noradrenaline level (Mean ± SD) (*p*g/m*l*) (n=6).

Time	CG	G I	G II	G III
PO	54.6 ± 27.2	35.45 ± 18.36	42.2 ± 32.9	45.75 ± 20.6
EO	50.1 ± 67.3	30.70 ± 23.96	30.6 ± 26.2 a	47.70 ± 19.3
POS 1 h	80.3 ± 10.43* a	52.00 ± 28.2$^{¥}$ b	30.2 ± 28.8** a	54.90 ± 44.2$^{¥}$ a
POS 2 h	73.2 ± 32.0* b	40.40 ± 19.17$^{¥}$	39.9 ± 15.73$^{¥}$	42.60 ± 29.9$^{¥}$
POS 4 h	60.0 ± 18.22* c	47.95 ± 10.50$^{¥}$ bc	35.6 ± 14.72**	25.70 ± 15.3
POS 6 h	61.6 ± 95.2 c	48.70 ± 13.96 bc	35 ± 16.20	34.40 ± 18.1
POS 24 h	58.3 ± 88.8	61.70 ± 238.0 a	32.8 ± 16.41	45.15 ± 20.9
POS 48 h	64.4 ± 96.6 c	46.85 ± 15.66 bc	33.5 ± 12.46	24.50 ± 45.4
POS 72 h	68.4 ± 71.6 c	43.30 ± 13.94 c	26.5 ± 4.92 a	59.00 ± 25.5 a

PO; preoperative, EO; end of operation, POS; post-operative, a, b, c; in same column is the significant difference in groups ($P < 0.05$), $^{*,¥,**,}$; in same line is the significant difference between groups ($P < 0.05$).

Table 3 - Serum cortisol level (Mean ± SD) (nmol/m*l*) (n=6).

Time	CG	G I	G II	G III
PO	1.21 ± 2.51	1.42 ± 1.91	0.36 ± 0.40	1.50 ± 2.22
EO	5.90 ± 4.68* b	5.52 ± 2.46* a	1.07 ± 8.59**	3.48 ± 6.24$^{¥}$ a
POS 1 h	9.58 ± 3.34* a	5.43 ± 4.34** a	1.80 ± 7.40 a	3.60 ± 5.28$^{¥}$ a
POS 2 h	4.60 ± 3.25* bc	3.33 ± 4.76* b	0.29 ± 4.29$^{¥}$	1.38 ± 2.09$^{¥}$
POS 4 h	3.36 ± 2.74* c	3.38 ± 3.08* b	0.48 ± 2.36	0.15 ± 4.13
POS 6 h	2.73 ± 2.62* d	1.58 ± 1.18	0.48 ± 1.21	0.66 ± 1.32
POS 24 h	0.79 ± 2.89	1.83 ± 1.63	0.34 ± 1.24	0.46 ± 0.38
POS 48 h	1.01 ± 2.52	0.94 ± 0.99	0.30 ± 2.47	0.91 ± 0.98
POS 72 h	0.80 ± 0.60	1.07 ± 0.41	0.27 ± 0.76	0.15 ± 1.54

PO; preoperative, EO; end of operation, POS; post-operative, a, b, c, d; in same column is the significant difference in groups ($P < 0.05$), $^{*,¥,**,}$; in same line is the significant difference between groups ($P < 0.05$).

ences detected between POS 1 and POS 2 h, and between POS 1h, 2 h and the other time points. In GI at POS 1h and 2 h, in GII at POS 1h and 2 h, in GIII at EO and POS 1, 6, 24 h values of adrenaline were different compared to other times. When comparing the groups to each other, signficantly higher values of adrenaline were found in GI and GIII than in the other groups at PO, EO, POS 1, 2, and 6 h.

Plasma noradrenaline values are presented in Table 2. In the CG, POS values were higher than those of PO and EO. Significant differences were recorded between POS 1h, 2 h and POS 4, 6, 48 and 72 h. In GI, significant differences were seen at POS 1, 24 and 72 h and between POS 4, 6 and 24 h. In GII, the plasma noradrenaline values of EO, POS 1 and 72 h were significantly lower than other times. In GIII, POS 1 and 72 h values were significantly higher than at the other time points. Between groups comparison of noradrenaline statistical differences were recorded at POS 1, 2 and 4 h in all groups.

Serum cortisol concentrations were significantly increased at EO and POS 1 h in all groups (Table 3). The highest value was seen at POS 1 h in the CG. Compared to the other time points, significant differences were recorded at EO, POS 1, 4 and 6 h in the CG. Significant differences of the cortisol concentration were found at EO, POS 1 h and POS 2, 4 h in GI, at POS 2 h in GII and at POS 1, 2 h in GIII. After POS 6 h the serum cortisol values decreased in all groups. In the comparison of serum cortisol levels between the groups, significant differences were observed at EO, POS 1, 2 and 4 h. At these times the serum cortisol levels of the CG and GI were higher than GII and GIII.

The HR of all groups are shown in Table 4. The EO, POS 1, 2 and 4 h values were significantly higher than the other times in the CG. In GI and GII, significant increases of the HR were observed at EO. In GIII, the measured values of HR at EO and POS 1 h were higher and significantly different than other time points. Between groups comparasion of HR, significant differences were detected at EO, POS 1, 2 h time points in CG, GI and GII, GIII, with CG and GI values higher than GII and GIII.

The RR values of the groups are shown in Table 5. The RR values of EO, POS 1, 2 and 4 h were significantly higher in the CG. There were no significant differences recorded in GI. In GII and GIII the values of EO were higher and different than other time points. There were no sitatistical differences recorded for BT and RC values in intra group and between group evaluations (Table 6, 7).

DISCUSSION

The stress hormones such as adrenocorticotropic hormone (ACTH), cortisol, adrenaline and noradrenaline are secreted from the pituitary gland, adrenal cortex, adrenal medulla and sympathetic nerve endings[18,19]. These hormones increase the adaptation power of living organisms to various stress factors. Pain is a stress in the post-operative period. An increase of stress hormone levels and metabolic changes are seen in this period[18-20]. The present study is the first to investigate the pain and the effects of NSAIDs' on the post-operative period after DA operations. In this study the changes in the stress hormone levels and the effects of

Table 4 - Heart rate (HR/min) (Mean ± SD) (n=6).

Time	CG	G I	G II	G III
PO	66.0 ± 6.05	77.0 ± 23.69	65.5 ± 12.04	64.5 ± 11.03
EO	77.5 ± 8.82 a*	82.0 ± 22.72 a*	69.0 ± 5.15 a	67.0 ± 6.09 a
POS 1 h	75.5 ± 10.84 a*	75.0 ± 14.63*	65.5 ± 4.94	67.5 ± 5.15 a
POS 2 h	73.5 ± 9.54 a*	77.0 ± 16.75*	66.5 ± 2.73	65.0 ± 3.71
POS 4 h	69.0 ± 13.64	71.0 ± 17.55	66.5 ± 13.86	60.0 ± 12.50
POS 6 h	68.0 ± 10.79	73.0 ± 11.29	69.0 ± 5.60	58.0 ± 4.90
POS 24 h	66.0 ± 9.11	77.0 ± 11.66	54.0 ± 4.28	54.5 ± 4.62
POS 48 h	58.5 ± 7.63	68.0 ± 10.27	57.0 ± 9.09	53.0 ± 8.85
POS 72 h	62.5 ± 6.43	61.5 ± 9.30	60.0 ± 10.45	55.0 ± 9.25

PO; preoperative, EO; end of operation, POS; post-operative, a; in same column is the significant difference in groups ($P < 0.05$), *; in same line is the significant difference between groups ($P < 0.05$).

Table 5 - Respiratory rate (RR/min) measurement (Mean ± SD) (n=6).

Time	CG	G I	G II	G III
PO	27.5 ± 6.26	33.0 ± 16.08	31.5 ± 7.00	25.0 ± 6.34
EO	41.0 ± 4.92 a *	36.0 ± 17.59	36.0 ± 5.51 a	34.0 ± 7.66 a
POS 1 h	40.0 ± 6.83 a *	35.5 ± 14.92	34.0 ± 4.73	31.0 ± 7.53
POS 2 h	37.5 ± 10.46 a	35.5 ± 16.99	32.0 ± 4.27	28.5 ± 5.06
POS 4 h	37.0 ± 7.69 a	32.0 ± 15.92	33.0 ± 4.86	27.0 ± 3.83
POS 6 h	33.0 ± 5.43	33.0 ± 10.25	31.0 ± 9.83	30.5 ± 5.62
POS 24 h	28.0 ± 4.88	29.0 ± 7.48	31.0 ± 6.11	29.0 ± 6.25
POS 48 h	28.0 ± 6.31	26.5 ± 6.40	31.0 ± 7.57	25.5 ± 7.29
POS 72 h	26.0 ± 3.95	25.0 ± 6.94	32.0 ± 5.24	24.0 ± 6.38

PO; preoperative, EO; end of operation, POS; post-operative, a; in same column is the significant difference in groups ($P < 0.05$), *; in same line is the significant difference between groups ($P < 0.05$).

Table 6 - Body temperature (BT, ^{o}C) measurement (Mean ± SD) (n=6).

Time	CG	G I	G II	G III
PO	38.45 ± 0.40	38.35 ± 0.70	38.60 ± 0.81	38.15 ± 0.73
EO	38.50 ± 0.39	38.40 ± 0.87	39.15 ± 0.83	38.60 ± 0.66
POS 1 h	38.57 ± 0.27	38.65 ± 0.95	39.00 ± 0.87	38.55 ± 0.70
POS 2 h	38.45 ± 0.12	38.50 ± 0.46	38.80 ± 0.67	38.30 ± 0.66
POS 4 h	38.42 ± 0.16	38.00 ± 0.85	38.65 ± 0.55	38.20 ± 0.74
POS 6 h	38.17 ± 0.39	38.35 ± 0.82	38.75 ± 1.67	38.10 ± 1.15
POS 24 h	38.20 ± 0.21	38.00 ± 0.56	38.65 ± 0.93	38.35 ± 0.84
POS 48 h	39.22 ± 0.35	39.00 ± 0.31	38.50 ± 0.59	38.70 ± 0.62
POS 72 h	38.20 ± 0.25	38.10 ± 0.89	39.00 ± 0.46	38.30 ± 0.77

PO; preoperative, EO; end of operation, POS; post-operative.

Table 7 - Rumen contraction (RC/5 min) measurement (Mean ± SD) (n=6).

Time	CG	G I	G II	G III
PO	3.0 ± 0.84	3.5 ± 1.26	3.5 ± 0.81	3.0 ± 0.83
EO	3.0 ± 0.89	3.0 ± 1.17	3.0 ± 1.63	3.0 ± 0.75
POS 1 h	3.5 ± 1.37	3.0 ± 0.98	3.0 ± 1.09	3.0 ± 0.41
POS 2 h	3.5 ± 0.81	3.0 ± 1.18	3.0 ± 1.09	3.0 ± 0.52
POS 4 h	3.5 ± 0.81	3.0 ± 1.23	3.5 ± 0.98	3.0 ± 0.75
POS 6 h	4.0 ± 0.75	3.5 ± 1.21	4.0 ± 0.75	3.0 ± 0.84
POS 24 h	3.5 ± 0.55	3.5 ± 0.81	4.0 ± 1.60	3.0 ± 0.52
POS 48 h	3.0 ± 0.63	3.5 ± 1.37	4.0 ± 1.03	3.0 ± 1.37
POS 72 h	4.0 ± 0.89	4.0 ± 0.75	4.0 ± 0.75	3.5 ± 0.98

PO; preoperative, EO; end of operation, POS; post-operative.

NSAIDs' on postoperative pain were detected in dairy cattle. NSAIDs create analgesic and anti-inflammatory effects by reducing prostaglandin synthesis through the inhibition of COX-1 and COX-2 enzymes in the peripheral tissue and central nervous system. The measurement of COX proteins after stimulus is the evidence of systemic delivered COX inhibitors. COX-2 inhibitors have rapid activity after surgical intervention. They show their antihyperalgesic actions by not requiring any induction after surgery. This observation argues for a site within the central nervous system wherein this isozyme is constitutively expressed[21]. The inhibition of COX enzymes due to NSAIDs may have more immediate impact on pain by inhibiting prostaglandin production in the periphery compared to the selective compounds of them[22].

Dopamine, adrenaline, noradrenaline and cortisol have been shown to be good indicators of stress and pain in animals[23,24]. Adrenaline and noradrenaline are amino acid-derived hormones that are increased in situations of fear and anxiety[19]. In the present study, adrenaline and noradrenaline levels increased at EO and POS 1 h in all groups. These increases were more evident in the CG than other groups. Using NSAIDs in GI, GII and GIII reduced the increases of the adrenaline and noradrenaline hormones. These data support the use of NSAIDs in the treatment of postoperative pain. However, after POS 2 h, the adrenaline and noradrenaline levels decreased with the most significant reductions occurring in GII and GIII. The stress hormone (adrenaline, noradrenaline and cortisol) values of GII were lower than GIII.

This suggests that flunixin meglumine is more selective and effective on the COX enyzmes than ketoprofen. Lees et al. (1996)[25] stated that the half-life of flunixin meglumine in cattle is 23 h. On the other hand, the half-life of ketoprofen was reported as 2-3 h by Grisneaux et al. (2003)[26] and Whay et al. (2005)[9]. At POS 1, 2, 4, 6, 24, 48 and 72 h, the adrenaline and noradrenaline values were higher in GIII than GII. These findings showed that the half-life of flunixin meglumine and ketoprofen may be different but the findings supported the powerful effectiveness of the flunixin meglumine on postoperative pain.

In the current study acetaminophen was used in GI without any other NSAID. The adrenaline values of GI were lower than the CG at POS 1 h, but higher at POS 4, 6, 24, 48 and 72 h. However, the measured noradrenaline values did not exhibit the same changes at the same time points. The noradrenaline values were higher in GI than the CG. These findings showed that the effect of acetaminophen on adrenaline and noradrenaline was not the same. The use of acetaminophen with other NSAIDs did not change the effects of them.

Cortisol is the main glucocorticoid hormone that is released in response to stress including pain. Cortisol has been measured in animals to estimate the effects of different procedures causing pain such as abdominal surgery[27]. Mudron et al. (2007)[15] operated on cattle with LDA using the omentopexy technique and measured serum cortisol levels before and 15, 30 and 60 min after the operation. They found statistical differences between the cortisol measurements taken before and after the operation. Milligan et al. (2004)[11] compared the effects of ketoprofen on the dehorning of calves and measured their cortisol levels. They detected lower cortisol levels in the ketoprofen groups. In the present study, the cortisol levels were found very high at POS 1 h compared to PO, and continued to increase at POS 6 h in the CG. In GI, the cortisol levels between EO and POS 24 h were higher than those at PO, and were statistically different at EO, POS 1, 2, 4 and 6 h. At the same times, the cortisol values were lower in GII and GIII compared to CG and GI. The decreases of cortisol levels were more evident in GII and the statistical difference was recorded at POS 1 h. The comparison of cortisol levels between GII and GIII confirmed that flunixin meglumine was more efficacious in reducing pain and stress parameters. The clinical responses to pain include changes in the cardiovascular and respiratory please zoom the 27 to system[27]. The assessment of physiological parameters is generally used in conjunction with behavioural assessment methods to assess postsurgical pain, although various studies have reported a poor correlation between physiological data[28]. Recent studies suggest to measure the HR for the assessment of sympathetic and parasympathetic activation[29]. Grøndahl-Nielsen et al. (1999)[30] found that the HR increased during 3.5 h, after hot-iron disbudding was conducted on calves without analgesic. Tachycardia, increased RR and ruminal hypomotility are the clinical symtoms of DA in cattle[31,32]. In the present study, HR and RR increased at EO and there was no statistical difference detected in RC. In the individual group evaluation significant differences were recorded at EO, POS 1 h, 2 h in the CG, and at EO in GI, GII and GIII. In the comparisons between groups statistical differences were found at the same times (EO, POS 1 and 2 h). HR and RR were high in the CG and GI compared to other groups. It was also found that the measured stress hormones were increased parallel to the increase of HR and RR. The reducing effects of NSAID on pain affects the clinical pain parameters such as HR, RR, RC. This situation was supported by the measurement values of GII and GIII.

Abdominal surgeries require the skin and abdominal muscles to be cut in order to access the peritoneal cavity, and manipulation or destruction of internal tissue. However, very little research has focused on the differences in type, magnitude and time course between somatic and visceral pain. In cattle the surgical treatment methods of DA include left flank, right flank and right paramedian approaches. Pain from these procedures can be similar to laparotomies, however the procedures require the manipulation and suturing of the abomasum or periabomasal tissue, which may cause additional pain[5]. Wittek et al. (2008)[33] observed an improvement in RC rate on the day after abomasal correction surgery in animals that received flunixin meglumine compared to the control group. However, there were no statistical differences found in BT and RC in the present study. This was thought to be caused by different surgical techniques and types of DA, as in the present study, cattle with LDA and RDA were operated on. Newby et al. (2013)[34] operated on cattle with LDA using the abomasopexy technique and applied ketoprofen during the postoperative period. They emphasized that the administration of ketoprofen following the operation did not appear to have any benefits for pain management. Flunixin meglumine was more effective compared to ketoprofen in postoperative pain control in the present study. In this aspect, this study supported the study of Newby et al. (2013)[34] with the difference being that the subjects of the present study were comprised of cattle with RDA as well as LDA in the ketoprofen group (GIII), and with LDA in the flunixin meglumine group (GII). Different operation techniques, animal species, types of DA, perioperative assessment, using preanesthetic agents and intra abomasal acetaminophen can change the values of pain parameters. The results of the present study were consistent with the literature[5,35,36].

CONCLUSION

In conclussion, flunixin meglumine was found to be more effective in postoperative pain control. A high increase in the pain parameters was seen between EO and POS 1 h period in all groups. Therefore, the timing of administration and the choice of NSAID should be well determined. As a result of this study, it was concluded that it is necessary to provide effective postoperative analgesia after DA operations in cattle for animals' welfare and treatment of anormal physiological functions.

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