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EFFECT OF LEFT OMENTOPEXY AMONG DAIRY COWS ON NORMAL BODY PARAMETERS

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ABSTRACT

Abomasal displacement is an important metabolic disorder that primarily affects exotic breeds of high-yielding dairy cows worldwide, causing significant economic losses to dairy herds. Indeed, the etiology and pathogenesis of bovine left displacement abomasum remain unclear. Therefore, this study was aimed to investigate the effect of left omentopexy among dairy cows on normal body parameters. Twenty-six cows were allocated into two groups: Control group-A (n=13) and Treatment group-B (n=13). LDA was confirmed by clinical assessment and ultrasonography and then surgically treated. Blood samples from both groups were collected on days 0, 7, 14, 21, and 28, respectively. Serum electrolyte profiles were evaluated by photometry, while the serum concentration of some biochemical parameters was evaluated by ELISA. The results indicated that serum levels of sodium, and potassium on days 0 to 14, while calcium, and chlorides on days 0 to 21 were lower (P=0.00) which increased to normal post-operatively in group-B than in group-A. Serum levels of blood urea nitrogen (P=0.00) on days 0 to 7; creatinine, Alanine aminotransferase (P=0.00) on days 0 to 21; aspartate aminotransferase, total protein, and globulin (P=0.00) on days 0 to 14 in group-B significantly increased (P<0.01) then it gradually decreased to normal (P>0.05) post-operatively compared with group-A. Serum levels of glucose, cholesterol, and triglycerides on days 0 to 14, while albumin (P=0.00) on days 0 to 21, significantly decreased (P<0.01) then gradually increased to normal (P>0.05) post-operatively in group-B than in group-A. The rectal temperature, pulse rate, and respiration rate of group-B increased (P=0.00) on days 0 to 7, then gradually decreased to normal (P>0.05) post-operatively than in group-A. The ruminal movement (P=0.00) on day 0 and the body condition score (P=0.00) on days 0 to 21 in group-B decreased (P<0.05) pre-operatively, then gradually increased to normal (P>0.05) post-operatively. In conclusion, LDA is associated with biochemical, physiological, and electrolyte profile changes that are rectified through surgical correction.

Keywords: Abomasum, cows, displacement, omentopexy, parameters

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INTRODUCTION

Abomasal displacement is one of the most important metabolic disorders of dairy cows, particularly in exotic breeds (Khalphallah *et al*., 2016a). The abomasum has a "pig ear"-like shape. The abomasum often lies horizontally on the right ventral midline. It begins with the xiphoid process and progresses to the 11th rib. From the ventral and lateral sides, it is surrounded by the abdominal wall and the ventral sac of the rumen. However, the liver covered it dorsally from the medial side. The abomasum is suspended by the omentum; it is not fixed to any other organ, while the bulky rumen provides the mechanical pressure to inhibit the abomasum from being displaced to the right or left side (Al-Iraqi 2020). Feeding a large amount of corn silage or concentrates to dairy cows during early postpartum causes abomasum motility to stop, resulting in gas accumulation, dilation, and atony, resulting in abomasal displacement. Once the abomasum is displaced, the gas production continues, causing the abomasum to be distended and displaced (Radostits *et al*., 2007 b; Ismael *et al*., 2018).

Clinically, an LDA-affected cow has decreased milk yield, restlessness, anorexia, fever, depression, scanty, pasty feces, and ruminal hypo-motility. On auscultation, a typical ping sound can be heard across the right flank area (Melendez *et al*., 2017). During early lactation, about 50% of all dairy cows displayed health

issues like displaced abomasum, ketosis, and hypocalcemia (Luo *et al*., 2022). Left displacement abomasum may develop due to the intake of a large number of concentrates during the dry period, stress conditions, metabolic disturbances, hypocalcemia, and too much weight at calving, endotoxemia, and reduction of the uterus immediately after delivery. Periparturient diseases like milk fever, fatty liver, ketosis, mastitis, retained placenta, and metritis are contributing factors for abomasal displacement (Basiri *et al*., 2013: Song *et al*., 2020). After the 4th week of parturition, about 50% of cows have fatty livers (Rizwan *et al*., 2022). LDA causes huge economic losses in the dairy industry due to the reduction of milk yield, culling risk, and treatment cost (Melendez *et al*., 2017; Song *et al*., 2020). About 50% of cases of displaced abomasum were diagnosed within the first and second weeks of parturition (Fiore *et al*., 2018).

Left displacement abomasum (LDA) is more frequent as compared to right displacement abomasum (Doll *et al*., 2009: Song *et al*., 2020). In dairy herds, displaced abomasum is a significant risk factor for postpartum culling (Van and Sniffen 2014). Changes in biochemical constituents associated with LDA harm post-surgical outcomes (Mokhber *et al*., 2013). The pathogenesis of LDA is unknown, but a few factors play an important role in its development. Hypocalcemia is an important factor in the development of LDA. Hypocalcemia is a metabolic disorder in which the normal concentration of calcium cannot be controlled by the homeostatic mechanism (Antanaitis *et al*., 2014; Yang *et al*., 2019). It is reported that 50% of Periparturient dairy cows suffer from clinical hypocalcemia. Clinical hypocalcemia causes a variety of postpartum diseases, including metritis, mastitis, retained placenta, and LDA (Aly *et al*., 2016b; Xinru *et al*., 2022).

During the transition period, liver function is reduced in dairy cows due to oxidative stress and inflammation. Approximately 50% of cows have fatty livers after four weeks of parturition (Osorio *et al*., 2014). In LDA cows, the concentration of albumin, cholesterol, and total protein decreased, and the concentration of blood urea nitrogen increased as compared to healthy cows (Cardoso *et al*., 2008). Moreover, the concentration of glucose decreased in LDA, and the concentration of electrolytes such as sodium and potassium decreased due to acid-base balance (Basiri *et al*., 2013). Right flank omentopexy, left paralumbar abomasopexy, right paramedian abomasopexy, and right flank paramedian laparoscopy are all surgical procedures used to correct left displacement of the abomasum. Surgical correction of LDA is favorable as it allows manipulating the abomasum to its normal anatomical position and reduces the chances of reoccurrence (Melendez *et al*., 2017). The right paralumbar fossa approach with omental fixation is the most commonly used surgical technique. Dirksen's technique has been shown to be more effective in LDA (Rohn *et al*., 2004).

To the best of our knowledge, various studies have been conducted to determine the effect of abomasal displacement on some biochemical parameters, especially those that could reflect the nutritional status of dairy cows during postpartum periods, but no studies have examined the changes in biochemical, physiological, and electrolyte profiles in dairy cows with left abomasal displacement pre- and post-operatively (omentopexy) in Pakistan. Therefore, the present study was designed to assess the changes in biochemical, physiological, and electrolyte profiles in dairy cows' serum with left abomasal displacement pre- and post-operatively (omentopexy). We hypothesized that LDA is associated with biochemical, physiological, and electrolyte profile changes that are improved by the Dirksen technique (right flank omentopexy) in dairy cows.

MATERIALS AND METHODS

Ethical Statement: This study and all the procedures were approved and conducted in accordance with the rules and regulations of the Ethical Review Committee **(Ethical Approval No. DR/01; Dated: 01/01/2019)** at the Department of Veterinary Surgery, University of Veterinary and Animal Sciences, Lahore, Pakistan.

Experimental Animals: The study was conducted on dairy cows, specifically Holstein Friesian, aged 4-6 years and weighing 400-500 kg with a left displaced abomasum (LDA), at various commercial dairy farms in and around Lahore, Pakistan. Twenty-six animals (n=26) were selected and divided into two equal groups: Control group-A (n=13) and Treatment group-B (n=13).

History and Diagnosis*:* In accordance with the telephonic intimation, various dairy farms were visited, and animals who had suffered from anorexia, dropped milk yields suddenly, refused concentrates, ate less than 50% of their feed, mild dehydration, metritis, retained placenta, ketosis, grain parts in scanty feces, or chronic indigestion were chosen. LDA was clinically diagnosed by auscultation and percussion. LDA was further confirmed by using a digital veterinary ultrasound scanner machine (Sono-scape Vet China) with a linear array transducer (5–10 MHZ). In cows, an ultrasonographic examination was performed between the 10th and 12th intercostals on the left side. A transducer held parallel to the ribs was used to examine the area ventro-dorsally until the abomasum could be imaged. After confirmation, LDA was surgically corrected by the Dirksen technique (right flank omentopexy).

Surgical Correction: Right flank Omentopexy was performed by adapting the Ghazy *et al*. (2016b) procedure. During pre-operative consideration, the right

flank region was clipped by the electrical trimmer, and for aseptic surgery, the area was scrubbed with Pyodine. Briefly, a 2% lignocaine solution was injected as a local anesthetic by practicing the Farquharson technique and the inverted L-block technique. A 15-cm parallel laparotomy incision was made 10 cm caudal to the last rib. The presence of a displaced abomasum between the rumen and the abdominal wall was confirmed. To deflate the inflated abomasum, a drip set was used. Its size shrank as the gas and fluid were removed, and it moved dorsoventrally. The abomasum was moved from the left side to the right ventral abdomen by pulling it from beneath the rumen. The pylorus was identified after the greater omentum was removed. The greater omentum was easily grasped in the direction of the incision. Two stay sutures were placed, one on the cranial side and the other on the caudal side of the incision. The absorbable 2-0 suture material was used to tightly suture the greater omentum using a continuous suture pattern. The skin incision was stitched together using non-absorbable suture material No. 2 in accordance with the ford interlocking suture pattern (**Fig. 1**).

For animal welfare, postoperative treatment such as inj. loxin (flunixin meglumin) @ 2.2 mg/kg, I/M; inj. marbcidal 20% (cefoparazone, marbofloxacin) @ 15mL/100 kg body weight; Inj. Hepasel (phenoxy-2-methyl-2-Propionic Acid) @ 10 mL/100 kg body weight itramusculeterly for 5 days and inf. ringer lactate 1000 mL; inf. dextrose 2000 mL; inj. amivicom 50 mL; Inj. B. complex 50 mL; inj. flagyl (metronidazole) @ 15 mg/kg intravenously for 3 days was given to each animal. For supportive treatment such as MILFONE-C 300 mL (calcium gluconate 1.00 gm; calcium D-saccharate 1.00 gm; magnesium hypophosphite 5.33 gm; magnesium chloride 2.00 gm; dextrose 20 gm; boric acid 4.33 gm/kg body weight) were administered to animals. All animals were kept in hygienic conditions with limited exercise.

Clinical Examination: All the cows under investigation were physically examined thoroughly, as described by Constable *et al*. (2013). The rectal temperature of all cows in both groups (treated and healthy) was measured weekly using a digital thermometer (Check Germany). The pulse rate was determined at the head of the tail by the coccygeal artery with fingertips for 60 seconds. To check the health status of the cows, the respiratory rate was determined visually on a weekly basis. The ruminal movement was measured weekly in both groups using the fist test. In addition, simultaneous auscultation and percussion revealed a location of high-pitched tympanic resonance (ping) at the line extending from the tuber coxae to the elbow on the left side. The body condition score of the cows was measured according to Ferguson *et al*. (1994).

Blood Sampling: Blood samples for the assessment of biochemical and electrolyte profiles were collected from each animal's coccygeal vein in a plain vacutainer on days 0 and 7, 14, 21, and 28 post-operatively. The blood samples were transferred to the laboratory in the Department of Physiology, Faculty of Bio-Sciences, University of Veterinary and Animal Sciences, Lahore, Pakistan. The blood samples were centrifuged at 3000 rpm for 15 min at 4˚C by a centrifuge machine (HARRIER 18/80). The serum was separated and stored at -20˚C for further analysis.

Electrolytes Examination: Analysis of serum concentrations of sodium, potassium, and calcium was performed by multi-channel flame photometry (UK, AFP, 100). The analysis of serum chloride concentration was carried out using a calorimetric method kit (Biolabo; ref. 80005; France).

Biochemical Examination: The determination of serum concentration of BUN (mg/dL) was analyzed using a commercial ELISA kit (Biosystem; Spain, Lot No. 336xA). For the analysis of serum concentration of creatinine (mg/dL), a commercial ELISA kit (Human; Lot No. 16018; Creatinine Liquicolor; Germany) was used. The serum concentration of total protein (TP; g/dL) was analyzed with the help of a portable refractometer (MR512ATC). The serum concentration of glucose (mg/dL) was examined by using a commercial ELISA kit (Biosystem; Spain). For serum concentration of cholesterol (mg/dL) analysis, a commercial ELISA kit (Human; Lot No. 17014; Germany) was used. For the determination of serum concentration of AST (U/L), a commercially available ELISA-based kit (Human; Catalog; E4319; Germany) was used. For the determination of serum concentration of ALT (U/L), a commercially available ELISA kit (Human, Catalog; MBS 264333; Germany) was used. For the analysis of serum albumin, an ELISA kit, albumin liquicolor (Human; Lot No. 17006; Germany), was used. The serum globulin concentration was calculated using the direct formula: "Serum globulin = total protein - albumin." For the analysis of serum concentration of triglycerides (mg/dL), a commercially available test kit (Triglycerides Liquicolor, Human; Lot No. 19004; Germany) was used.

Statistical Analysis: The data from the LDA and healthy cows between the groups were analyzed by one-way ANOVA with post-hoc Tukey test within the time points using SPSS statistical software version 20 with a 5% significance value. All values were indicated as mean ± standard deviation (Mean ± SD).

RESULTS

Clinical Examination: The rectal temperature, pulse rate, and respiration rate of group B increased ($P<0.01$) on days 0 to 7, then gradually decreased and returned to normal ($P>0.05$) post-operatively compared to group A.

In comparison to group-A, The ruminal movement on day 0 and the body condition score on days 0 to 21 in group-B decreased (P<0.01) pre-operatively, then gradually increased to normal (P>0.05) post-operatively (**Table 1, 4)**.

Serum Electrolytes Evaluation: Serum levels of sodium and potassium were lower on days 0 to 14, while serum levels of calcium and chlorides on days 0 to 21 were lower (P<0.01), then increased and returned to normal (P>0.05) post-operatively in group-B than in group-A. The results of serum electrolytes in dairy cows are given in (**Table 2, 5**).

Serum Biochemical Evaluation: Serum levels of blood urea nitrogen on days 0 to 7; creatinine, alanine aminotransferase on days 0 to 21; aspartate aminotransferase, total protein, and globulin on days 0 to 14 in group-B significantly increased (P<0.01) then it gradually decreased to normal (P>0.05) post-operatively than in group-A. Serum levels of glucose, cholesterol, and triglycerides on days 0 to 14, while albumin on days 0 to 21, significantly decreased (P<0.01) then gradually increased to normal (P>0.05) post-operatively in group-B compared with group-A (**Table 3, 6**).

Table 1. The changes in physiological parameters between the LDA and control groups at differ rent time points

Parameters	Days	Control (Means±SD)	Treated Group (Means±SD)	F-value	*P*-value
Rectal Temperature	0	101.53 ± 0.32	103.7±0.41	220.59	0.000
	7	101.38 ± 0.46	101.98 ± 0.51	9.86	0.004
	14	101.41 ± 0.41	101.66 ± 0.55	1.75	0.198
	21	101.33 ± 0.41	101.53 ± 0.35	1.89	0.181
	28	101.30 ± 0.49	101.38 ± 0.38	0.20	0.656
Pulse Rate	0	64.46 ± 1.61	75.15 ± 1.41	324.72	0.000
	7	63.69 ± 1.70	70.15 ± 1.4	111.42	0.000
	14	64.61 ± 2.39	65.92 ± 1.03	3.25	0.084
	21	64.53 ± 2.43	64.23 ± 0.72	0.19	0.66
	28	63.15 ± 1.34	62.53 ± 0.87	1.91	0.18
Respiration Rate	0	22.46 ± 1.33	28 ± 0.81	163.70	0.00
	7	22.92 ± 1.11	25.15 ± 1.14	25.35	0.00
	14	23.23 ± 0.92	23.92 ± 0.75	4.33	0.048
	21	22.61 ± 1.04	22.23 ± 0.83	1.079	0.30
	28	22.76 ± 0.92	22.23 ± 0.92	2.19	0.152
Ruminal Movement	0	3 ± 0.00	1.84 ± 0.37	122.72	0.00
	7	3 ± 0.00	2.84 ± 0.37	2.18	0.157
	14	3 ± 0.00	3 ± 0.00	-	-
	21	3 ± 0.00	3 ± 0.00	-	-
	28	3 ± 0.00	3 ± 0.00	-	-
Body Condition Score	0	3.38 ± 0.5	2.23 ± 0.43	38.57	0.000
	7	3.30 ± 0.48	2.15 ± 0.37	46.55	0.000
	14	3.38 ± 0.5	2.30 ± 0.48	30.94	0.000
	21	3.38 ± 0.5	2.61 ± 0.5	15.00	0.001
	28	3.46 ± 0.51	3.07 ± 0.64	2.83	0.105

Table 2. The changes in serum electrolyte profile between the LDA and control groups at different time points

Parameters	Days	Control (Means±SD)	Treated Group (Means±SD)	F-value	*P*-value
Sodium	0	139.86 ± 2.15	115.90 ± 7.13	134.35	0.00
	7	139.93 ± 3.37	125.98 ± 3.54	105.33	0.00
	14	140.42 ± 2.35	134.89 ± 2.83	29.28	0.00
	21	140.01 ± 2.58	136.82 ± 3.59	6.73	0.016
	28	142.78 ± 1.26	141.04 ± 2.86	4.00	0.057
Calcium	0	2.48 ± 0.16	1.56 ± 0.28	98.45	0.00
	7	2.46 ± 0.14	1.67 ± 0.31	66.94	0.00
	14	2.46 ± 0.12	1.92 ± 0.31	33.39	0.00
	21	2.47 ± 0.13	2.15 ± 0.29	13.13	0.001
	28	2.45 ± 0.13	2.30 ± 0.27	2.87	0.103
Potassium	0	3.78 ± 0.21	3.17 ± 0.08	90.57	0.00
	7	3.75 ± 0.14	3.37 ± 0.16	39.92	0.00
	14	3.77 ± 0.12	3.55 ± 0.18	12.21	0.002
	21	3.76 ± 0.13	3.68 ± 0.13	2.21	0.150

	28	3.79 ± 0.07	3.78 ± 0.09	0.06	0.80
Chlorides	0	102.30 ± 0.76	89.30 ± 2.55	307.68	0.00
	7	102.35 ± 1.55	93.21 ± 0.85	345.44	0.00
	14	102.33 ± 1.23	98.70 ± 2.09	28.97	0.00
	21	102.37 ± 0.64	101.63 ± 0.46	11.11	0.003
	28	102.40 ± 0.33	102.12 ± 0.65	11.97	0.17

Table 3. The changes in serum some biochemical profile between the LDA and control groups at different time points.

Parameters	Days	Control (Means±SD)	Treated Group (Means±SD)	F-value	*P*-value
BUN	0	43.13 ± 3.64	53.44 ± 4.13	45.54	0.00
	7	44.06 ± 2.79	50.68 ± 3.97	24.09	0.00
	14	45.04 ± 2.74	46.89 ± 2.1	3.74	0.06
	21	44.7 ± 2.03	46.16 ± 2.1	2.87	0.10
	28	45.1 ± 2.44	43.73 ± 1.98	2.85	0.10
Creatinine	0	1.20 ± 0.123	1.42 ±0.44	39.18	0.00
	7	1.11 ± 0.15	1.41 ±0.02	45.65	0.00
	14	1.09 ± 0.16	1.38 ±0.02	40.11	0.00
	21	1.09 ± 0.15	1.33 ±0.03	28.51	0.00
	28	1.16 ± 0.15	1.16 ± 0.53	0.52	0.52
AST	0	85.44 ± 6.78	128.48 ± 12.39	120.68	0.00
	7	85.18 ± 7.24	115.52 ± 11.11	67.96	0.00
	14	85.16 ± 6.13	102.60 ± 9.40	31.37	0.00
	21	84.33 ± 6.45	90.78 ± 7.13	5.83	0.02
	28	85.67 ± 7.47	82.44 ± 8.09	1.12	0.30
ALT	0	35.36 ± 2.33	55.53 ± 2.72	410.19	0.00
	7	35.03 ± 2.06	51.65 ± 2.25	385.77	0.00
	14	34.87 ± 2.41	49.06 ± 1.80	288.46	0.00
	21	34.70 ± 2.02	46.25 ± 2.33	181.37	0.00
	28	35.90 ± 2.69	37.44 ± 1.08	3.64	0.06
Total Protein	0	6.89 ± 0.51	9.21 ± 0.37	172.29	0.00
	7	6.91 ± 0.51	8.58 ± 0.46	74.74	0.00
	14	6.98 ± 0.49	8.06 ± 0.41	36.84	0.00
	21	6.94 ± 0.53	7.25 ± 0.27	3.33	0.80
	28	6.91 ± 0.51	6.79 ± 0.29	0.50	0.48
Globulin	0	3.46 ± 0.18	6.65 ± 0.41	630.76	0.00
	7	3.45 ± 0.17	5.69 ± 0.42	310.22	0.00
	14	3.46 ± 0.16	4.93 ± 0.40	149.94	0.00
	21	3.43 ± 0.07	3.55 ± 0.18	4.25	0.05
	28	3.44 ± 0.15	3.33 ± 0.29	1.44	0.24
Glucose	0	53.51 ± 3.22	31.29 ± 1.35	523.00	0.00
	7	53.67 ± 3.79	42.12 ± 1.77	98.82	0.00
	14	53.59 ± 3.36	45.98 ± 1.07	60.37	0.00
	21	54.09 ± 4.08	51.99 ± 0.77	3.31	0.81
	28	54.89 ± 4.67	53.32 ± 1.43	1.33	0.260
Cholesterol	0	106.92 ± 9.91	86.98 ± 3.95	45.35	0.00
	7	106.35 ± 8.31	94.91 ± 2.89	21.96	0.00
	14	106.04 ± 7.37	100.60 ± 1.96	6.59	0.00
	21	105.18 ± 5.77	102.98 ± 5.12	1.05	0.31
	28	104.65 ± 4.85	108.34 ± 12.49	0.98	0.33
Albumin	0	3.76 ± 0.27	2.56 ± 0.18	410.19	0.00
	7	3.72 ± 0.25	2.88 ± 0.09	385.77	0.00
	14	3.73 ± 0.25	3.13 ± 0.13	288.46	0.00
	21	3.74 ± 0.24	3.63 ± 0.06	181.37	0.00
	28	3.76 ± 0.27	3.72 ± 0.06	3.64	0.06
Triglycerides	0	26.87 ± 3.97	17.02 ± 1.43	60.67	0.00
	7	25.66 ± 2.83	19.11 ± 1.34	56.49	0.00
	14	25.57 ± 1.90	21.26 ± 1.33	44.64	0.00
	21	25.76 ± 2.36	24.48 ± 1.34	2.89	0.10
	28	26.98 ± 2.01	25.87 ± 1.30	2.81	0.10

Table 4. The changes of physical parameters within time points under post-hoc Tukey test.

Parameters	Day 0 as Control	Days	*P*-value
Temperature	0	7	0.000
		14	0.000
		21	0.000
		28	0.000
Pulse Rate	0	7	0.002
		14	0.000
		21	0.000
		28	0.000
Respiration	0	7	0.041
Rate		14	0.001
		21	0.000
		28	0.000
Ruminal	0	7	0.000
Movement		14	0.000
		21	0.000
		28	0.000
Body	0	7	0.983
Condition		14	0.999
Score		21	0.663
		28	0.013

Table 5. The changes of serum electrolyte profile within time points under post-hoc Tukey test.

Parameters	Day 0 as Control	Days	*P*-value
Sodium	0	7	0.009
		14	0.000
		21	0.000
		28	0.000
Calcium	0	7	0.981
		14	0.172
		21	0.002
		28	0.000
Potassium	0	7	0.418
		14	0.003
		21	0.000
		28	0.000
Chloride	0	7	0.095
		14	0.000
		21	0.000
		28	0.000

Table 6. The changes of serum of some biochemical profile within time points under post-hoc Tukey test

Parameters	Day 0 as Control	Days	*P*-value
BUN	0	7	0.88
		14	0.13
		21	0.04
		28	0.002
Creatinine	0	7	0.41
		14	0.027
		21	0.00
		28	0.00
AST	0	7	0.268
		14	0.001
		21	0.000
		28	0.000
ALT	0	7	0.298
		14	0.014
		21	0.000
		28	0.000
Total Protein	0	7	0.41
		14	0.027
		21	0.00
		28	0.00
Globulin	0	7	0.101
		14	0.000
		21	0.000
		28	0.000
Glucose	0	7	0.001
		14	0.00
		21	0.00
		28	0.00
Cholesterol	0	7	0.467
		14	0.039
		21	0.015
		28	0.000
Albumin	0	7	0.419
		14	0.013
		21	0.000
		28	0.000
Triglycerides	0	7	0.977
		14	0.293
		21	0.00
		28	0.00

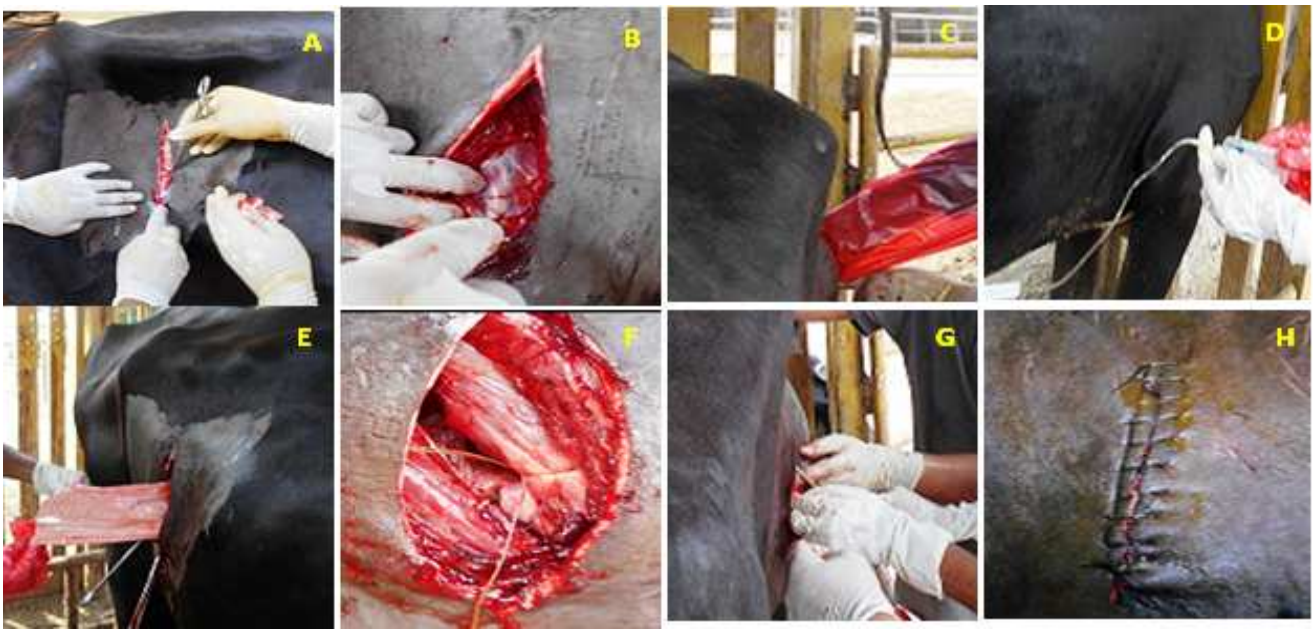

Fig.1. Surgical Procedure: Para-lumbar Laparotomy incision in skin during the right flank Omentopexy (A); Internal Abdominal Rectus Muscles during right flank Omentopexy in LDA cow (B); Exploration of Displaced Abomasum through exploratory Laparotomy (C); Evacuation of the accumulated gas and fluid from the Displaced Abomasum through drip set (D); Pulling out the greater omentum of abomasum for the fixation with abdominal wall (E); Fixation of greater Omentum with abdominal wall (F); Fixation of the greater Omentum with the abdominal wall through absorbable suture material (G); Ford interlocking suture pattern after the completion of right flank Omentopexy surgery (H).

DISCUSSION

Left displacement abomasum is an important multifactorial disease causing a lot of economic losses in dairy herds. The etiological agent of this disease is unknown, but a lot of contributing factors such as metabolic disorder, ketosis, milk fever, concurrent diseases (mastitis, retained placenta, metritis), age, breed, and anatomical position play an important role in the pathogenesis of the displaced abomasum. Therefore, the aim of this study was to explore the effect of left omentopexy among dairy cows of Pakistan on normal body parameters.

The sodium level was significantly decreased in cows with left abomasum displacement at day 0 as compared to the control group. The serum Na level in the healthy group increased after the surgical techniques were applied until the day 21, when it returned to normal. Alterations in minerals and electrolytes in serum and left abomasum displacement were well documented. The present study confirmed the findings of Ozturk *et al*. (2013), in which animals with left abomasum displacement had lower serum levels of sodium. Hyponatremia might be due to the excessive loss of sodium through the renal system during the early stage of alkalosis. Hyponatremia was also detected by Shahinduran and Albay (2006), Kalaitzakis *et al*. (2010), and Maden *et al*. (2012) in cows with left abomasum displacement as compared to the healthy animals. Hyponatremia may be related to an acid-base imbalance and anorexia, according to several researchers (Abdelaal 2014c; Aly *et al*. 2016b; Ismael *et al*. 2018). Potassium levels were also significantly decreased in left abomasum displacement at day 0 as compared to the control group. After performing the surgery, the serum potassium level was tending to increase until day 21, when it returned to normal in the healthy group. During the early stages of alkalosis, potassium is shed through the kidney, and a reduction of potassium in the blood results. Our results supported the findings of Maden *et al*. (2012), Dezfouli *et al*. (2013), El-Deen and Abouelnasr (2014a), and Ismael *et al*. (2018), which assessed that hypokalemia developed in LDA. Other researchers have found hypokalemia in left-displaced abomasum due to reduced intake of potassium-rich feeds or forages (Constable *et al*., 2013; Ghazy *et al*., 2016a; Al-Rawashdeh *et al*., 2017a). The serum calcium level decreased significantly in the cows with left abomasum displacement at day 0 as compared to the control group. Following the surgical procedures, the serum calcium level increased until day 28, when it returned to normal for the healthy group. Hypocalcemia reduced abomasum motility, which was a risk factor for left displacement abomasum. In highly milk-producing cows, hypocalcemia is a risk factor for the development of abomasal displacement. In lactating cows,

hypocalcemia is common in postpartum dairy cows, and is a major predisposing factor for left displacement abomasum (Ozturk *et al*., 2013; Antanaitis *et al*., 2014; Al-Rawashdeh *et al*., 2017a; Tschoner *et al*., 2022). Aly *et al*. (2016b) explained that puerperal hypocalcemia played a key role in the development of left displacement abomasum, as it exerted a negative effect on the tone of the abomasum wall, resulting in the incidence of left displacement abomasum in cows that are hypocalcemic at calving. The serum chloride level was significantly decreased in left abomasum displacement at day 0 than the control group. Serum chloride levels tend to rise after surgery until the 21st, when they return to normal. A previous study revealed that cows suffering from left displacement abomasum had metabolic alkalosis (Basoglu *et al*., 2014). The loss of chloride is related to the loss of potassium. This condition is known as hypochloremic and hypokalemic alkalosis (Abdelaal, 2014c; Constable *et al*., 2013). The findings of Maden *et al*. (2012) and Ozturk *et al*. (2013) supported our findings that hypochloremia was associated with left displacement of the true stomach. This may be due to chloride trapping in the rumen and abomasum.

Serum blood urea nitrogen was increased in cases of left abomasum displacement at day 0 as compared to the healthy control group. After performing the surgery, it decreased gradually and tended to become normal by the 14th day. Reduced renal blood flow due to hypovolemia leads to increased blood urea (Ismael *et al*., 2018). In addition, ruminal absorption of ammonium is increased due to the inability of microbial proteins to be transported to the duodenum (Cardoso *et al*., 2008; Basiri *et al*., 2013). Additionally, hypovolemia and renal insufficiency caused a considerable rise in blood urea nitrogen in displaced abomasum cows (Abdelaal, 2014c; Aly *et al*., 2016b). A previous study reported that creatinine levels decreased due to dehydration and hypovolemia in cases of left displacement abomasum (El-Attar *et al*., 2008; Ismael *et al*., 2018). The findings of (Guzelbektes *et al*., 2010a; Abdelaal, 2014c) supported our findings that serum creatinine levels were significantly increased in left displacement abomasum. The serum aspartate aminotransferase level was significantly increased in the left displaced abomasum at day 0 than the control group. After performing the surgery, the serum aspartate aminotransferase level was decreased until the day 28, when it returned to normal. Recent studies have shown that an increased serum level of aspartate aminotransferase (AST) is an important risk factor for displaced abomasum during the transition period. Aspartate aminotransferase is an enzyme that is elevated during hepatic damage, hepatic lipidosis, and endotoxemia. The metabolic imbalance has a strong impact on liver function (Ozturk *et al*., 2013; El-Deen and Abouelnasr, 2014a). All these findings were similar to those recorded by (Dezfouli *et al*. (2013), Klevenhusen *et al*. (2015), and Ghazy *et al*. (2016). Khalphallah *et al*. (2018) found that the serum aspartate aminotransferase level increased in the left abomasum, which supported the current study. Similarly, the serum alanine aminotransferase level was significantly increased in the left abomasum displacement on day 0 than the control group. After the surgery, the serum alanine aminotransferase level tends to decrease until the 28th, when it returns to normal in the healthy group. The serum level of alanine aminotransferase was significantly increased; it might be due to endotoxemia, hepatic lipidosis, and hepatic damage (Mamak *et al*., 2013b; Ozturk *et al*., 2013; El-Deen and Abouelnasr, 2014a). A significant increase in the hepatic enzyme alanine aminotransferase showed the hepatic cell injury that is associated with hepatic lipidosis; these results were in agreement with (Ghazy *et al*., 2016a; Al-Rawashdeh *et al*., 2017a; Ismael *et al*., 2018).

Serum total protein decreased in the cows with left abomasum displacement compared to healthy cows. In the present study, after applying the surgical techniques, the total protein level improved and returned to normal post-operatively. Hypoalbuminemia occurs due to low feed intake and disturbed liver metabolism. Previous studies (Basiri *et al*., 2013; Abdelaal, 2014b; Ismael *et al*., 2018) indicated that total protein decreased in the left displacement abomasum due to hypoalbuminemia. Cardoso *et al*. (2008) reported that total proteins decreased in the left displacement abomasum due to alimentary poverty. It can also be explained that the animals suffer a long period of feed restriction that harms their protein metabolism. Similarly, on day 0, the serum glucose concentration in the affected cows were lower than in the control group. The serum glucose concentration increased and tends to return to normal post-operatively. Glucose is the primary metabolic fuel in ruminants, and it is essential for the proper functioning of the vital organs, milk production, and fetal growth. In short, it plays a central role in metabolism. Ismael *et al*. (2018) reported that the serum glucose level decreases in the left displacement abomasum due to negative energy balance and starvation. Some factors that contribute to low serum glucose concentration, such as reduced feed intake during disease, lead to low production of insulin and glucose. Increased ketones from body products such as beta-hydroxybutyric acid decrease the glucose level (Van Winden *et al*. 2003). Many researchers have reported that the serum glucose level increased in the left displacement abomasum due to decreased motility of the rumen, which increased the level of insulin and glucose. The exact mechanism of hyperglycemia is unknown (Guzelbektes *et al*., 2010a; Basiri *et al*., 2013; Dezfouli *et al*., 2013; Khalphallah *et al*., 2016a; Al-Rawashdeh *et al*., 2017a). The serum cholesterol level was significantly decreased in the left displaced abomasum at day 0 than the control group.

After performing the surgery, serum cholesterol levels increased and tend to return to normal by the 21st day. Recent studies have explained that ruminants depend on their cholesterol synthesis, which is mostly synthesized in the liver. A low level of serum cholesterol indicates the failure of liver function (Cardoso *et al*., 2008; Basiri *et al*., 2013; Aslan *et al*., 2022). In current study, the serum cholesterol level was significantly lower in the left displacement abomasum. These results were in agreement with those of (Guzelbektes *et al*., 2010a; Aly *et al*., 2016b; Ghazy *et al*., 2016a).

Serum albumin levels were significantly lower in the left abomasum displacement group at day 0 than the control group. The serum albumin level in the healthy group increased after the surgery until the 21st, when it returned to normal. The findings of Aly *et al*. (2016b) reported that in cases of left displacement of the abomasum, serum albumin levels decreased and increased post-operatively. The serum albumin level was decreased in the left displacement abomasum supported by (Guzelbektes *et al*., 2010a; Abdelaal, 2014c; Al-Rawashdeh *et al*., 2017a). Hypoalbuminemia occurred due to anorexia, decreased feed consumption, and decreased albumin synthesis in the liver. Endotoxemia was a major contributor to the development of hypoalbuminemia in patients with concurrent disease. Endotoxins in the blood increased capillary permeability, causing globulin to shift outside the capillaries and, as a result, decrease globulin in the left displacement abomasum (Aly *et al*., 2016b; El-Deen and Abouelnasr, 2014a; Ismael *et al*., 2018). Serum triglyceride levels decreased significantly in left abomasum displacement at day 0 than the control group. Serum triglyceride levels tend to rise after surgery until the 21st, when they return to normal in the healthy group. Recent research found that serum triglycerides were lower in patients with left displacement abomasum (Ghazy *et al*., 2016a; Ismael *et al*., 2018). It might be due to the disturbance of protein and lipid metabolism, associated with hepatic dysfunction, which led to hepatic lipidosis. During the early lactation stage, most animals experienced negative energy balance due to increased feed demand compared to available feed intake, resulting in the transfer of stored body fat to the liver to meet energy requirements. Excessive fat accumulation in the liver resulted in hepatic lipidosis. These results were in agreement with (Civelek *et al*., 2006; Cardoso *et al*., 2008; El-Attar *et al*., 2008; Basiri *et al*., 2013; Mamak *et al*., 2013b). The findings of (Ismail *et al*., 2018: Ghazy *et al*., 2016 a) supported to our results that the temperature, pulse rate, respiration rate increased while the ruminal movement decreased in left displaced abomasum. Wang *et al*. (2019) found that the body condition score decreases in left displacement abomasum, which supported our findings.

In conclusion, LDA was associated with biochemical, physiological, and electrolyte alterations. Most of the biochemical parameters can be relieved after the 21st day of surgical correction. The alteration in pattern of biochemical constituents throughout the study shows the significant effect of the surgical operation and the recovery of the affected cow.

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