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Clinical characteristics, hematology, and biochemical analytes of primary omasal impaction in bovines

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Abstract: This study was conducted on 11 animals (7 buffaloes and 4 cows) diagnosed with primary omasal impaction. In all the cases, laparorumenotomy was performed and omasal impaction was confirmed based on the consistency of the omasal contents along with an empty abomasum. Signalment, history, clinical signs, clinic-pathologic findings, and treatment were determined. Clinical examination was found to be helpful in subjective assessment of omasal impaction but could not aid in definitive diagnosis. Pain on palpation of the omasal area along with rectal findings could be a diagnostic feature. Neutrophilic leukocytosis was observed in a majority of animals. Total bilirubin, glucose, lactate, BUN, and fibrinogen, as well as activities of aspartate aminotransferase, alkaline phosphatase, and gamma-glutamyltransferase were significantly high in the primary omasal impaction group compared to the control group. Albumin, fibrinogen ratio, calcium, and chloride were significantly low in the primary omasal impaction group. The negative prognostic signs were neutrophilic leukocytosis with marked left shift and toxic changes in neutrophils, chloride levels below 70 mmol/L, potassium below 2 mmol/L, lactate above 9 mmol/L, and highly distended omasum on rumenotomy. Primary omasal impaction should be included in the differential diagnosis of diseases associated with cessation of defecation and abdominal pain.

Key words: Primary omasal impaction, bovine, hematology, biochemistry, diagnosis, prognosis

1. Introduction

The omasum is the 3rd compartment of the bovine stomach, located toward the right of the median plane and opposing the 7th to 11th ribs (1). Omasal leaves provide a large surface area for the absorption of volatile fatty acids, electrolytes, and water (2). The omasum also acts to reduce the size of feed particles (3). In tropical countries omasal impaction is prevalent in cows (4) and buffaloes (5). The omasum is secondarily involved in forestomach disorders after primary involvement of other compartments of the forestomach (6,7). Feeding of rough fibrous feed during fodder scarcity periods and feeding of machine-made wheat straw have been reported as the causes of omasal impaction (5,8). The clinical differentiation of omasal impaction from other gastrointestinal problems is difficult and often exploratory rumenotomy is required for confirmation of the diagnosis (9). The clinical signs of omasal impaction observed by earlier researchers (4,5,8,10,11) include anorexia, moderate to severe dehydration, dullness, abdominal distention, ruminal hypomotility or atony, no palpable abnormalities of intestine, and an empty rectum with cessation of defecation.

Due to increased occurrence of omasal impaction in our state, Punjab, India, it was felt necessary to observe whether or not the omasum is primarily involved in bovine gastrointestinal disorders. No reports were available on the features of primary omasal impaction in cows and buffaloes. We describe the clinical features and hemobiochemical alterations of primary omasal impaction in cows and buffaloes.

2. Materials and methods

2.1. Animal selection

The study protocol was performed in compliance with institutional guidelines. All owners gave consent for cattle and buffaloes to be included in the study and undergo the testing procedures. The 11 animals that were finally included in the study (from a total of 268 (173 buffaloes and 95 cattle) initially referred) fit the definition of primary omasal impaction. None of them had a history of musculoskeletal injury or showed evidence of other disease. The tentative diagnosis of the cases was made on the basis of clinical examination and hemobiochemical evaluation, and confirmed by left flank laparorumenotomy

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and ascertaining the consistency of the organ by palpation during rumenotomy. The clinical outcome of these 11 animals was determined on the 7th postoperative day.

2.2. Signalment and anamnesis

Data collected when the animals were examined included age, parity, time (days) from the onset of clinical signs, pregnancy status, and lactation status. A detailed history of feed intake, water intake, type of feed, any recent change in feed, rumination status, defecation, calving status, reduction in milk yield, tympany, symptoms of regurgitation, fever, pain, and any prior treatment given were noted in every case.

2.3. Physical examination

Each animal was subjected to a general physical examination and special examination of the gastrointestinal system. Each animal was thoroughly evaluated for its general condition, rectal temperature, heart rate, respiration rate, inspection of mucous membranes, hydration status, and signs of pain. Special examination of the gastrointestinal system included: observation of abdominal contour; rumen motility; palpation of the xiphiod region, omasum area (7th–9th intercostal space on the right side) or wither pinch test for eliciting signs of pain; auscultation and percussion of the abdomen for presence of fluid in the intestines or abdominal cavity and rectal examination.

2.4. Hematology

Blood samples (2 mL) were collected aseptically from the jugular vein in ethylenediaminetetraacetic acid (EDTA) coated vials (Accuvote-PLUS, Quantum Biologicals Pvt. Ltd. Chennai, Tamil Nadu, India). Immediately after collection, the blood was used for determination of hemoglobin, packed cell volume (PCV), total leukocyte (WBC) count, and differential leukocyte count as described by Jain (12). Further, a thorough examination of a stained blood smear was also done to determine any left shift and toxic changes in neutrophils.

2.5. Clinical biochemistry

For serum biochemical analysis, blood samples were collected from the jugular vein in acid-free glass vials without any anticoagulant. After clotting, serum was separated by centrifugation and transferred to a dry clean vial for storage at –20 °C until further evaluation. For glucose and fibrinogen estimation blood samples were collected in sodium fluoride and sodium citrate coated vials (Accuvote Disposables), respectively. VITROS DT60 II chemistry system (Ortho-Clinical Diagnostics, Johnson and Johnson Company, New Brunswick, NJ, USA) was used to determine the serum activities of aspartate aminotransferase (AST), alkaline phosphatase (ALP), gamma-glutamyltransferase (GGT), total bilirubin, blood urea nitrogen (BUN), creatinine, calcium, phosphorus, magnesium, sodium, potassium, chloride, cholesterol, and plasma glucose. Plasma fibrinogen was estimated by heat precipitation method using a hand-held refractometer (13). The concentration of total globulin was calculated by subtracting the albumin concentration from the total protein concentration (14). Fibrinogen ratio was calculated by subtracting the fibrinogen concentration from the total protein concentration and then dividing that value by total protein concentration (13).

2.6. Rumen liquor analysis

Rumen liquor samples were collected using a 16-gauge, 10-cm-long needle inserted perpendicularly into the left paralumbar fossa or at the time of laparorumenotomy. Rumen liquor samples were evaluated for pH levels. Rumen chloride concentration was estimated after filtering the rumen liquor through a double layer muslin cloth and then through centrifugation using Bayer diagnostic kits (colorimetric method) with the help of a Microlab Autoanalyzer (Merck).

2.7. Control group

The reference range for hematological and biochemical variables evaluated in the study was determined using blood samples from 10 healthy Holstein Friesian crossbred cows and 10 buffaloes from the university dairy farm. The selected animals had no history of disease for the current lactation period and were clinically healthy at the time of sampling. All of the variables were measured using the same methods used for the diseased animals.

2.8. Statistical analysis

The quantitative data were expressed as mean and standard error. Student's t-test was used to analyze the significance of difference between the groups. Significance level was kept at $P \leq 0.01$ and $P \leq 0.05$.

3. Results

Primary omasal impaction was diagnosed in 11 cases out of the total 268 cases of abdominal disorders presented to our clinics based on clinical examination and laparorumenotomy. The animals suffering from an omasal impaction had mean age of 6.70 ± 0.65 years with age ranging from 2.5 to 12 years. The buffaloes were Murrah (5) and Niliravi (3) breeds and cows were crosses of Holstein Friesian. The duration of the illness ranged from 5 to 20 days with a mean of 9.55 ± 4.74 days. Machine-made wheat straw was mainly fed to 9 animals (Table 1) and reaper-made straw was fed to the other 2 animals in the study. The straw had been recently (<20 days back) introduced in the diet of 7 animals and the remaining 4 animals were fed with this straw for about 2 months. Of the animals, 7 (63.64%) were dull and depressed at the time of presentation and had a dry muzzle, while the others appeared alert. Two cows had recently parturated and 1 cow was a nonpregnant heifer, 4 buffaloes were 5–7 months pregnant, while the other 4 buffaloes were in different stages of lactation. Seven animals had been

Table 1. Historical findings in 11 animals with primary omasal impaction.

Characteristic	Findings	Number of animals
Feeding pattern[a]	Green fodder and wheat straw	2
	Wheat straw	7
	Wheat straw and green fodder	2
Feed intake	Reduced	2
	Absent	9
Water intake	Normal	6
	Moderately reduced	4
	Severely reduced	1
History of abdominal pain	Present	9
	Absent	2
History of fever	Present	4
	Absent	7
History of tympany	Recurrent	1
	Once	1
	Persistent	2
	Absent	7
Defecation	Reduced	1
	Scanty	5
	Absent	5

[a] Type of feed/fodder being fed to the animals in the decreasing order.

treated unsuccessfully with antibiotics, rumenotorics, and laxative agents, while in the remaining 3 animals (2 buffaloes and 1 cow) no treatment had been given. Six (54.5%) animals were passing hard feces and 5 animals had complete loss of defecation. The majority of the animals did not show any tympany (63.64%), while 2 animals had persistent tympany and recurrent tympany was observed in 1 animal. One animal had a single episode of tympany. Regurgitation was observed in 1 case.

The historical findings and physical examination and rectal examination parameters are presented in Tables 1–3. Rumination was absent in 10 animals, while 1 animal was ruminating irregularly. No rumen motility could be appreciated in 5 animals, while in 6 animals the rumen was hypomotile (1–2 contractions/2 min) with reduced strength of ruminal contractions. Radiographic examination of the reticulum performed in right lateral recumbency revealed no abnormality.

Left flank laparorumenotomy was performed in all 11 animals and primary omasal impaction was confirmed in all cases based on the consistency of omasal contents along with an empty abomasum. In 10 cases the contents of the rumen and reticulum were normal, while in 1 animal the contents of the rumen and reticulum were mushy. Polythene material, sand deposits, and metallic objects were not detected in the rumen, reticulum, or reticulo-omasal orifice nor was a diaphragmatic hernia observed. The omasum was distended with impacted feed materials in 6 animals and impacted in the remaining 5 animals without distension. A long pipe of about 2.5-cm diameter was introduced through laparorumenotomy into the omasum via the reticulo-omasal orifice. Water under pressure was used to flush the omasal contents with the help of a tube. Gentle kneading of the impacted omasum helped to soften and break up the impacted mass. Gradual flushing continued until a satisfactory emptying of omasum was achieved. The omasoabomasal opening was also flushed to establish a clear pathway between the reticulum and abomasum. Rumen and laparorumenotomy incisions were sutured in a routine manner. Postoperatively balanced fluids (for 3 days) and broad spectrum antibiotics were administered. Defecation was noted after 36–48 h of operation. Seven out of 11 animals showed uneventful recovery after surgery. On the next 2 days after surgery the general health of 4 animals deteriorated, they became recumbent, and eventually succumbed. On rumenotomy, nonsurvivors had a highly distended omasum as compared to survivors.

3.1 Hemobiochemical findings

The mean hematologic and biochemical values for the control group and animals with primary omasal impaction are shown in Table 4. There was a significant increase in

Table 2. Clinical examination results of 11 animals with primary omasal impaction.

Characteristic	Findings	Number of animals
General condition	Moderately disturbed	4
	Severely disturbed	3
Visual examination	Alert	4
	No abnormality	10
	Moderately distended on left side	1
Mucous membrane	Normal	4
	Congested	6
Dehydration	Anemic	1
	Mild	4
	Moderate	6
	Severe	1
Temperature	Normal (37.2–38.9 °C)	8
	Increased (>38.9 °C)	3
Heart rate/min	Normal (60–80)	8
	Low (<60)	1
Respiration rate/min	Slightly increased (81–90)	1
	Moderately increased (91–100)	1
	Normal (15–25)	1
	Slightly increased (>26–35)	5
	Moderately increased (36–45)	4
	Severely increased (>45)	1
Rumen motility	Reduced (<3/2 min)	6
	Absent	5

the number of WBC ($P \leq 0.01$) and neutrophils ($P \leq 0.01$) and a decrease in the number of lymphocytes ($P \leq 0.05$) of the primary omasal impaction group compared to the control group. WBC was 9500–21,650, being >12,000 in 7 animals, and 8000–12,000 in 4 animals. Toxic changes in neutrophils were observed in 5 animals (mild to moderate in 4 and severe in 1). Left shift was mild to moderate in 3 and marked in 3 animals. WBC > 15,000/µL with marked left shift and toxic changes in neutrophils was a consistent finding in nonsurvivors.

There was a significant increase in the concentration of total bilirubin ($P \leq 0.05$), BUN ($P \leq 0.05$), glucose ($P \leq 0.05$), lactate ($P \leq 0.01$), and fibrinogen ($P \leq 0.05$) as well as serum activities of AST, ALP, and GGT ($P \leq 0.05$) in the primary omasal impaction group compared to the control group. The concentrations of albumin, fibrinogen ratio, calcium, and chloride were significantly ($P \leq 0.05$) lower in the primary omasal impaction group compared to the control group. The concentrations of potassium and phosphorus were lower than the reference values but did not differ significantly from the respective control values. In all the 11 animals, pH of the rumen fluid was within the reference range of 6.2 to 7.2. The mean rumen chloride concentration was 38.11 ± 3.78 mEq/L.

4. Discussion

To the authors' knowledge this is the first study in which historical findings, signalment, clinical signs, hemobiochemical findings, diagnostic procedures, treatment, and outcome were investigated in a series of cases of primary omasal impaction. One of the aims of the study was to investigate the occurrence of primary omasal impaction. The prevalence of primary omasal impaction was 4.10%, which may be actually higher than in the general population of cows and buffaloes, owing to inclusion of only those cows and buffaloes that were confirmed to have gastrointestinal dysfunction. Most of animals were presented during the months of fodder scarcity (May–June) and were being fed with machine-made wheat straw. The consumption of wheat straw, which is low in both digestible proteins and energy, may contribute to the cause. This machine-made straw was very fine as compared to manually made straw and contained soil particles because of the low height of machine blades from the ground, which introduced dust into feed. It seems that this fine straw and soil became entrapped between the omasal leaves, leading to omasal impaction. Earlier studies (5,8) have also implicated finely cut machine-made wheat straw as a possible cause of omasal impaction in bovines.

Table 3. Rectal exploration findings in 11 animals with primary omasal impaction.

Characteristic	Findings	Number of animals
Rumen consistency	Doughy	10
	Mushy	1
Rumen size	Normal	8
	Moderately distended	2
	Severely distended	1
Intestines	Normal	9
	Mild distension	1
	Moderate distension	1
Rectal mucosa	Normal	6
	Sticky	5
Hindered hand movements	No	7
	Yes	4
Fecal quantity in rectum	Scanty	5
	Negligible	3
Feed consistency	Absent	3
	Normal	1
	Feces Absent	3
	Pelleted	2
	Hard	3
	Pasty	2
Presence of mucus	Mucus only	3
	Mucus and feces	5
	Absent	3

However, it is hard to draw firm conclusions regarding seasonality because of the low number of cases. The most common initial owner complaints (decreased or absent fecal output, anorexia, and pain) and clinical signs were consistent with abdominal disease and similar to those reported previously (5,8).

There was a history of mild to moderate pain in 9 animals, which was observed for the first 1–2 days only in 7/9 animals. It was interesting to note that 8 out of these 9 animals showed signs of pain as the right abdominal wall (7th–9th intercostal space) was palpated, which undoubtedly was due to impacted omasum, as no other cause of pain was identified during surgery. This pain response was characterized by tenderness of muscles and flicking with the hind limb. Radostits et al. (7) also reported that in cases of omasal impaction pain may be elicited on deep pressure on the 7th to 9th intercostal space on the right side. Initial mild to moderate pain along with complete loss of defecation and pain on palpation of the omasal area could be a diagnostic feature for omasal impaction. The correlation of omasal impaction with tympany is variable. Nayak and Suresh Babu (15) reported that omasal impaction may give rise to chronic tympany, while Randhawa et al. (10) and Umakanthan (11) reported omasal impaction without tympany.

Transrectal abdominal palpation is a valuable diagnostic procedure in examination of bovine abdominal diseases. Only mucous or mucous with a few pellets of feces in the rectum along with slippery or sticky rectal mucosa, unappreciable intestines, and a doughy normal-sized rumen were consistent findings on rectal examination and this could be a diagnostic feature for primary omasal impaction in bovines along with pain on palpation of omasal area (7th–9th intercostal space on the right side). No evidence of abomasal displacement or intestinal obstruction was seen.

In the majority of animals neutrophillic leukocytosis was observed. Primary omasal impaction appears to elicit an inflammatory reaction even in the absence of other complications (e.g., peritonitis). Hematological results were compatible with an inflammatory process that was attributable to inflammatory complications of impacted feed material. Decreased lymphocytes could be due to release of corticosteroids as a result of stress

Table 4. Hematological and biochemical analytes of blood from 11 animals with primary omasal impaction (mean ± SEM).

Measurement	Omasal impaction	Control (n = 20)	Reference range
Hb (g/dL)	10.74 ± 0.62	10.65 ± 0.46	8–15
PCV (%)	36.95 ± 2.27	32.72 ± 1.69	24–46
WBC(/μL)	14350 ± 1492.46**	9733 ± 1106.80	4000–12,000
Neutrophils (/μL)	9962 ± 1340.06**	3636 ± 993.8	600–4000
Lymphocytes (/μL)	4125 ± 507.51*	5860 ± 376.38	2500–7500
Monocytes (/μL)	121.26 ± 37.72	61.0 ± 27.97	25–840
Esinophils (/μL)	17.27 ± 60.39	164.21 ± 44.79	0–2400
Neutrophil/lymphocyte ratio	2.61 ± 0.67*	0.63 ± 0.58	0.3–0.6
Total bilirubin (mg/dL)	1.76 ± 0.56*	0.09 ± 0.42	0.01–0.5
AST (U/L)	348.91 ± 87.16*	101.05 ± 64.80	78–132
ALP (U/L)	127.36 ± 34.98*	89.55 ± 25.99	27–107
GGT (U/L)	93.09 ± 34.68*	39.15 ± 25.72	15–39
Total protein (g/dL)	7.43 ± 0.32	7.47 ± 0.24	5.7–8.1
Albumin (g/dL)	2.97 ± 0.17*	3.41 ± 0.13	2.1–3.6
Globulin (g/dL)	4.46 ± 0.27	4.07 ± 0.20	2.9–4.9
BUN (mg/dL)	33.40 ± 7.23*	17.20 ± 5.36	6–27
Creatinine (mg/dL)	2.09 ± 0.79	1.19 ± 0.59	1–2
Glucose (mg/dL)	94.54 ± 15.97*	60.10 ± 11.84	45–75
Lactate (mmol/L)	7.21 ± 1.46**	1.51 ± 1.08	0.6–2.2
Cholesterol (mg/dL)	65.65 ± 18.33	84.40 ± 13.59	65–200
Fibrinogen (g/dL)	0.65 ± 0.13*	0.33 ± 0.96	0.20–0.70[A]
Fibrinogen ratio	12.44 ± 3.47*	25.35 ± 2.57	>15[A]
Sodium (mmol/L)	133.55 ± 3.35	139.00 ± 2.49	132–152
Potassium (mmol/L)	3.56 ± 0.34	4.15 ± 0.25	3.9–5.8
Chloride (mmol/L)	83.36 ± 3.97*	101.70 ± 2.94	97–111
Calcium (mmol/L)	8.18 ± 0.47*	9.80 ± 0.35	9.7–12.4
Phosphorus (mmol/L)	4.73 ± 0.56	5.88 ± 0.42	5.6–6.5
Magnesium (mmol/L)	2.36 ± 0.21	2.36 ± 0.27	1.7–3

*and **indicate significant difference from healthy group at $P \leq 0.05$ and $P \leq 0.01$, respectively.
Reference ranges: [A]from Jain (12) and others from Radostits et al. (7).

(12). Moreover, Mohamed et al. (16) mentioned that the hematology of a cow with omasal leiomyoma showed leukocytosis and neutrophilia, suggesting the presence of chronic inflammatory disease that resulted from omasal impaction. Neutrophillic leukocytosis with marked left shift and toxic changes in neutrophils was associated with a poor prognosis.

The main function of the omasum is to absorb water and electrolytes; failure to do so leads to dehydration. The increased BUN and creatinine levels could be attributed to decrease in renal blood flow as a part of compensatory mechanisms to maintain circulation in hypovolemia associated with dehydration, leading to azotemia (17). Hepatic failure as indicated by increased liver enzymes with decreased lactate uptake may have induced the hyperlactatemia (18) and elevated fibrinogen level (19). Moreover, hypoperfusion due to dehydration could be the cause for an increased lactate level (20). The normal fibrinogen ratio in bovines is 18.2 (12) and this ratio gives a more realistic picture of increased fibrinogen in inflammatory conditions and rules out any alterations due to dehydration. The lower fibrinogen ratio indicated a marked increase in fibrinogen. The significantly lower albumin concentration may be ascribed to chronic starvation or failure of the liver to synthesize adequate amounts of protein, and hyperglycemia could be due to the glycogenolytic effect of released adrenocorticosteroids as a result of stress in digestive disorders (17). The low chloride level may be attributed to chloride retention in rumen contents, which was evident by increased rumen chloride concentration (>30 mEq/L). Hypocalcemia, hypokalemia, and hypophosphatemia may be due to less assimilation of

feed materials (21,22). Chloride levels below 70 mmol/L, potassium levels below 2 mmol/L, and lactate levels above 9 mmol/L were consistent findings in nonsurvivors.

Little is known of the efficacy of the treatment for primary omasal impaction. Therapy should be rumenotomy (5,8) or medicinal (4). The objective of treatment should be to relieve the impaction. Moreover, electrolyte imbalance must be assessed to avoid complications associated with hypokalemia, hypochloremia, and hypocalcemia. Results of this study suggest that the prognosis for cows and buffaloes with primary omasal impaction is good. Survival rate after surgery was similar to that reported earlier (5).

Primary omasal impaction should be suspected in cattle and buffaloes with historical and clinical findings indicative of abdominal disease. Primary omasal impaction was characterized by complete anorexia, absence of defecation or scanty feces, mild to moderate dehydration, reduced or no rumen motility, initial abdominal pain, pain on palpation of the omasal area, characteristic rectal findings, neutrophillic leukocytosis, reversal of neutrophils, lymphocyte ratio, reduced electrolytes, deranged liver and kidney function tests, and the recent introduction of finely chopped wheat straw as the only forage in the ration. Differences in the clinical manifestations could be due to differences in the owner observations and pathophysiology of the disease. Neutrophillic leukocytosis with marked left shift and toxic changes in neutrophils along with lower chloride (<70 mmol/L) and potassium (<2 mmol/L) levels, increased lactate (>9 mmol/L), and highly distended omasum on rumenotomy were indicators of poor prognosis. Attempt for evacuation of impacted omasum by flushing seems to be the most satisfactory way of handling such cases. The results of this study indicate that primary omasal impaction causes significant hematological and biochemical alterations in dairy animals. A prospective study still needs to be conducted to document omasal impaction in bovine gastrointestinal disorders.

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