Comparative ultrasonographic morphometry of reticulum from six windows in water buffaloes with diaphragmatic hernia

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SUMMARY

The study was aimed to compare the ultrasonographic morphometry of the reticulum (reticular wall thickness, reticular wall depth from body wall, type and amplitude of reticular motility) via six windows (chest, lateral and ventro-lateral abdomen from either side) on B and B+M modes in 61 water buffaloes (60 females and one male) suffering from reticular diaphragmatic hernia. The morphometry was compared to predict the side of herniation and severity of reticular adhesions in the chest.

Among 61 buffaloes, ultrasonography confirmed the side of herniation in 53 buffaloes (86.89%); 51 buffaloes had herniation on the right side (83.61%) and 2 had on the left of hemi-diaphragm (3.28%), whereas, in 8 buffaloes (13.11%) the site of herniation could not be ascertained, ultrasonographically. The significantly ($p \leq 0.01$) less depth of reticular wall in the right chest (3.84 ± 1.12 cm) in comparison to the left chest (11.81 ± 2.78 cm) was diagnostic for right-sided herniation and it was vice versa for the left; however, in buffaloes (n=8) with reticular wall close to thoracic wall from both right and left sides were inconclusive for the side of herniation.

The reticular wall was recorded as thickest (0.99 ± 0.46 cm) from the left chest window. The absence of reticular motility (41.93% buffaloes) and reduced amplitude of the 2nd phase of reticular motility (2.58 ± 1.78 cm) was also recorded in maximum per cent cases via left chest window.

In conclusion, ultrasonography can diagnose the side of reticular herniation, using a criterion of comparative superficial scanning of the reticulum on the respective side using chest window. Besides, the severity of adhesions on the herniated reticulum can be predicted using ultrasonography based on; wall thickness, type and amplitude of the reticular motility in the chest.

KEY WORDS

Diagnosis, diaphragmatic hernia, reticular wall, water buffalo.

INTRODUCTION

Diaphragmatic hernia (DH) is a common surgical ailment encountered in female water buffalo[1]; also described as the reticular diaphragmatic hernia[2] as the hernial content is always reticulum, though other abdominal organs like liver[3] or abomasum[4] may also be herniated. A few studies on cows[5,6] and male buffaloes[7] are also reported with this condition.

Reticulography in right recumbent position[8,9] was the only non-invasive method to diagnose DH in buffaloes, but, it had the limitation of casting an advance pregnant or bloated buffalo. Besides, the non-availability of high powered x-ray machine for reticular radiography at the field level is another limitation. With the advent of B mode ultrasonography as the non-invasive and portable diagnostic technique for DH in buffaloes[2,6], these limitations overcame.

Ultrasonography can assess the individual parameters of the reticular wall in a refined way[10], which can't be done on radiography. Ultrasonographic diagnosis of DH has already been described in literature through various windows in bovines[11]. The ultrasonographic morphometry of reticulum in apparently healthy buffaloes has also been described[12]. But, the comparative ultrasonographic morphometry of the reticulum from various windows has not been described in the literature for buffaloes suffering from reticular DH.

The reticulum in DH is mostly herniated with the rent present in the right hemi-diaphragm, but a few cases of left sided herniation are also reported[1].

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The herniated reticulum forms strong adhesions with the rent margins in the diaphragm and cranially in the chest with the pleura/heart/lungs. Blind breaking of these adhesions is required during herniorrhaphy to reposition the herniated reticulum back into the abdominal cavity. The act of breaking such adhesions plays an important role in the prognostic outcome of surgery[13].

The objectives of the study were to evaluate the reliability of ultrasonography in predicting the side of reticular herniation (right or left of hemi-diaphragm) and to assess the severity of reticular adhesions in buffaloes suffering from DH.

It was hypothesized that the depth of reticular wall scanning from the thoracic wall in the chest might have role to ascertain the side of herniation. The ultrasonographic morphometry of the reticular wall such as its thickness, type and amplitude of contractions might be influenced by the severity of adhesions of the herniated reticulum in the chest.

MATERIALS AND METHODS

The study was prospective and was a part of postgraduate research work. It was duly approved by the Institutional Animal Ethics Committee with protocol number GADVASU/2020/IAEC/54/04. The study included 61 domestic water buffaloes (one male and 60 females) presented for treatment (as clinical cases by the farmers) to the faculty of Veterinary Surgery and Radiology, GADVASU during the period of January 2020 to May 2021. These cases were diagnosed for DH based on radiography or ultrasonography.

Reticulography was considered positive for DH when a round to oval soft tissue opacity (occasional honey comb pattern) and radio-opaque foreign bodies was seen cranial to diaphragm[9]. In buffaloes, where reticulography was not diagnostic; standing ultrasonography was done to diagnose DH. The presence of motile reticular wall at right 4th Intercostal space (ICS) at the level of elbow was diagnostic of DH, ultrasonographically[2]. Ultrasonography of all the 61 buffaloes was done in standing position without sedation from both right and left sides, restrained in a cattle crate. The 2-5 MHz multi-frequency curvilinear transducer of GE Healthcare LOGIQ F8 system was used for the transcutaneous B and B+M mode reticular ultrasonography.

In a healthy buffalo, the reticulum could be seen from 4 ultrasonographic windows[12] and is not seen in chest at 4th ICS[9]. The presence of reticular wall could be confirmed based on the topographic position and the typical biphasic reticular motility pattern[2].

The intercostal spaces were counted from the last ICS (between the 12th and 13th rib as 12th ICS) and counting down cranially. The whole of the reticulum was not seen in one view, instead the half-moon/linear shape reticular wall with an acoustic shadow (due to luminal contents) was observed.

The reticular wall in DH affected buffaloes can be visualized from six ultrasonographic windows (3 each on the right and left sides) (Figure 1a);

1. In the chest, at 4th ICS in the region of heart or medial to elbow joint,
2. Laterally, in the abdomen at 6th ICS (at the level of elbow) and
3. Ventro-laterally, in the abdomen at 6th ICS (slightly ventral to elbow).

For ultrasonography of the reticular wall in the chest at 4th ICS, the respective forelimb was pulled slightly forward using a rope tied at the fetlock region (Figure 1b). This was required to scan the herniated reticulum, which is topographically placed medial to the elbow along/overlapping heart at 4th ICS or more cranially in the chest.

Figure 1 - Photograph of a standing DH buffalo from right side (**a**) with right limb stretched forward with the help of rope on fetlock region (black arrow) and showing the 3 ultrasonography windows; 1: In the chest, at 4th ICS in the region of heart or medial to elbow joint, 2: Laterally, in the abdomen at 6th ICS (at the level of elbow), 3: Ventro-laterally, in the abdomen at 6th ICS (slightly ventral to elbow). The close up photo of the site during USG (**b**).

The ultrasonographic parameters recorded from the six windows and measured using an inbuilt calliper in the USG machine software included:

I. The reticular wall thickness (in cm). It was measured in the B+M mode (Figure 2).
II. The depth of the reticular wall (in cm) was recorded in resting position (when reticulum not in motility). The reticular wall depth was the distance between the serosal margin of the reticular wall and the skin/transducer on the body wall (Figure 3). Based on the depth of reticular wall from the right and left sides, the data was classified into 3 groups.
    - o Group 1: where the reticular wall in chest (4th ICS) was seen superficially from right side and medial to heart from left side.
    - o Group 2: where the reticular wall in chest (4th ICS) was seen superficially from left side and medial to heart from right side.
    - o Group 3: where the reticular wall in chest (4th ICS) was seen superficially from both the right and left sides.
III. The motility pattern/type of the reticulum (Figure 2). A healthy reticular motility was defined as biphasic where, the reticular wall is seen moving away from the transducer to a certain depth and coming back to some extent and then again going further deep12. The reticular wall motility may be triphasic (if ruminating) or folding type at a few sites12. The motility pattern can be well appreciated on B+M mode with 2 waves seen for biphasic motility and one for monophasic. In this study, the type of motility pattern was recorded as monophasic, biphasic, folding type, nil (no motility) and reticular wall not visualized.
IV. The amplitude (in cm) of reticular motility in the 1st and 2nd phase from the baseline. The baseline was defined as the neutral position of the reticulum when not seen in motility. The amplitude of the reticular motility was defined as the depth of reticular wall when in any phase of motility. This amplitude was measured in B+M mode of USG (Figure 2).

Rumenotomy:

The DH in buffaloes is surgically treated in 2 stages[6] with the consents of the client. The 1st stage of treatment is rumenotomy, where the ruminal and reticular contents are emptied completely and the foreign bodies present in the reticulum or rumen are removed. The size and site of the diaphragmatic rent, the side and type of adhesions are assessed through reticulum at this stage.

The size of the diaphragmatic rent was measured in finger's width (approx. one finger width equals 1 inch), the side of the rent was assessed based on the relative position in respect to cardia and the adhesions were assessed by slightly pulling the herniated reticular wall from all sides back into the abdomen. If the adhesions were less, it could be pulled back easily, but if adhesions were more it could not be pulled.

The 2nd stage of surgical repair (was not a part of this study) includes the herniorrhaphy done under general anesthesia and in ventro-dorsal position.

In the present study, out of 61 buffaloes, 20 clients gave consents for the surgical treatment. The side of herniation and adhesions of the reticular wall were assessed during rumenotomy in these 20 buffaloes and were correlated with the USG findings.

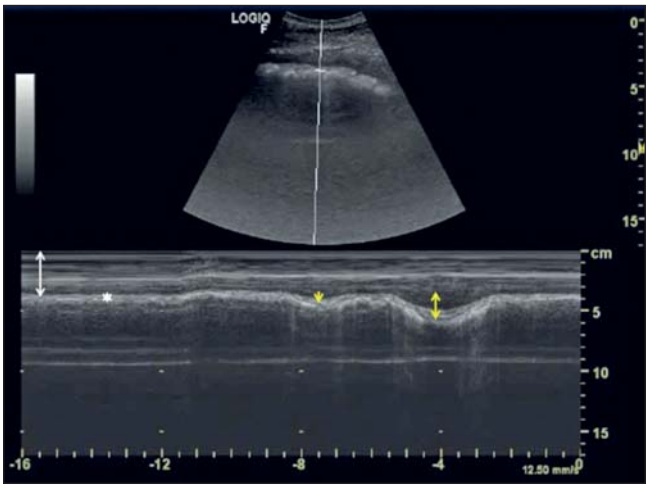

Figure 2 - Ultrasonogram in B+M mode showing the parameters recorded in DH buffaloes; depth of the reticulum (white line), wall thickness of the reticulum (white star), amplitude of 1st phase of the reticular motility (yellow ray) and amplitude of 2nd phase of the reticular motility (yellow line).

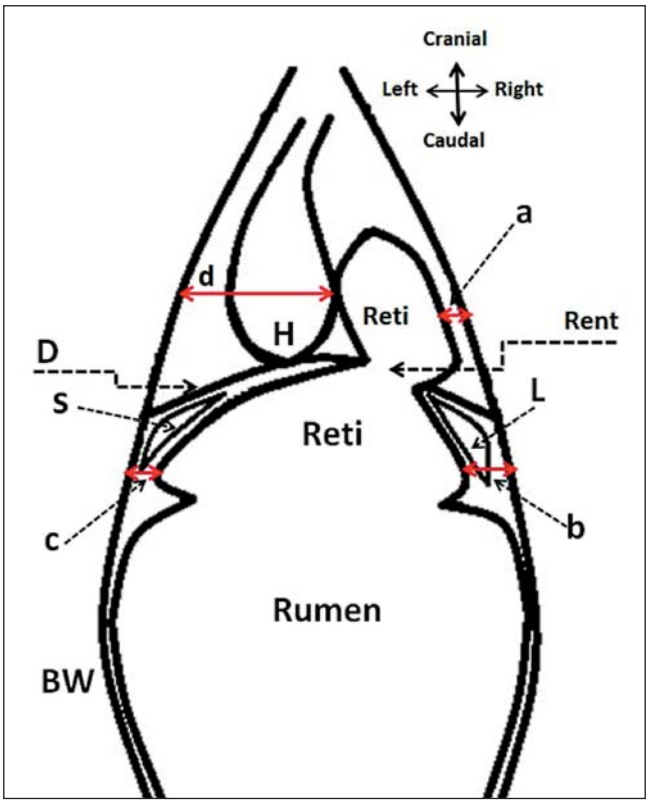

Figure 3 - Schematic diagram from the dorsal view of a DH positive buffalo showing the position of various organs (H: Heart, Reti: reticulum, D=diaphragm, BW: body wall, S= spleen, L=liver) and the reticular wall depth (red line) in chest ('a' on right side and 'd' on left) and in abdomen ('b' on right side and 'c' on left).

Statistical Analysis

The data generated were subjected to statistical analysis using Microsoft Office Excel, 2007. The mean and the standard deviation of all the numerical parameters were calculated in all the buffaloes. The student t-test was applied to test the significance of differences in the ultrasonographic parameters at six different windows at 5% or 1%.

RESULTS

I. Reticular wall thickness

(Table 1, Figure 2 and 4)

While comparing the reticular wall thickness among the 3 sites of the right side, the reticular wall on the lateral window in the abdomen was recorded to be 0.87 ± 0.32cm (0.29-1.75) and was significantly thicker ($p \leq 0.05$) than that on the ventro-lateral window (0.73 ± 0.30 cm). No significant difference was recorded in the reticular wall thickness in the chest window (0.80 ± 0.31) in comparison to the lateral and ventrolateral window. On the left side, the reticular wall thickness in the chest was recorded to be 0.99 ± 0.46 cm and was significantly thicker than that in the lateral (0.76 ± 0.31cm, $p \leq 0.01$) and ventro-lateral (0.72 ± 0.27cm, $p \leq 0.01$) abdominal window. However, no significant difference was recorded between the thickness of lateral and ventral reticular walls on the left side.

Among the right and left sides, the reticular wall thickness in the chest was significantly thick ($p \leq 0.05$) on the left side in comparison to that on the right side. However, while comparing the lateral walls of both sides, the right side reticular wall was significantly (p=0.02) thicker than the left side lateral wall.

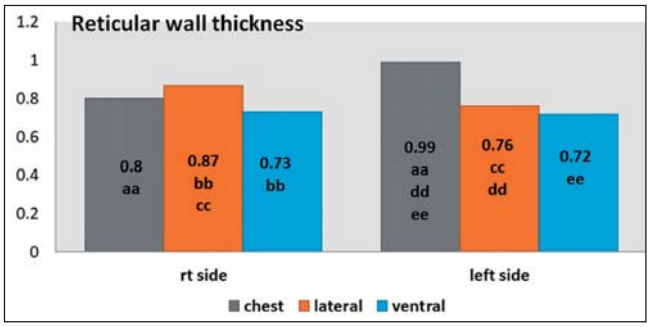

Figure 4 - Bar Graph showing the reticular wall thickness from various windows on either side. Similar double alphabets show the significant difference at 1% level of significance.

II. Reticular wall depth

B-mode USG findings in Group 1 (Figure 5a , 5b, 6a) (Table 1): In 51 buffaloes, the reticular wall was seen superficially i.e close to the thoracic wall from right side and deep/medial to heart from the left side. On the right side, the depth of the reticular wall visualized in the chest was significantly less in comparison to that visualized from the lateral ($p \leq 0.01$) and

Table 1 - Table showing the reticular wall thickness (in cm) and depth (in cm) from 6 windows.

Parameters	Side	Site	Mean ± SD (Range)
Reticular wall thickness (n=61)	Right side	*Chest*	0.80 ± 0.31 (0.3-1.71)^{aa}
		Abdomen lateral	0.87 ± 0.32 (0.29-1.75)$^{bb\ cc}$
		Abdomen ventro-lateral	0.73 ± 0.30 (0.26-2)^{bb}
	Left side	*Chest*	0.99 ± 0.46 (0.27-2.53)$^{aa\ dd\ ee}$
		Abdomen lateral	0.76 ± 0.31 (0.2-1.59) $^{cc\ dd}$
		Abdomen ventro-lateral	0.72 ±0.27 (0.33-1.34)^{ee}
Group 1 (n=51)	Right side	*Chest*	3.84 ± 1.12 (1.73-7.17)$^{f\ hh\ ii\ nn\ s}$
		Abdomen lateral	5.46 ± 1.90 (2.39-9.59)$^{hh\ j\ oo}$
		Abdomen ventro-lateral	6.51 ± 2.21 (3.0-12.35)$^{ii\ j}$
	Left side	*Chest*	± 2.78 (7.35-17.71)$^{gg\ kk\ ll\ nn\ tt}$
		Abdomen lateral	4.53 ± 1.33 (2.59-7.37)$^{kk\ mm\ oo}$
		Abdomen ventro-lateral	6.16 ± 2.53 (1.86-14.92)$^{ll\ mm}$
Group 2 (n=2)	Right side	*Chest*	14.89 ±1.57 (13.78-16)$^{f\ u}$
		Abdomen lateral	5.38 ± 2.80 (3.4-7.37)
		Abdomen ventro-lateral	7.21 ± 4.65 (3.91-10.5)
	Left side	*Chest*	2.63 ± 0.16 (2.52-2.72)$^{gg\ vv}$
		Abdomen lateral	5.15 ± 1.33 (4.2-6.1)
		Abdomen ventro-lateral	7.35 ± 1.89 (6.01-8.69)
Group 3 (n=8)	Right side	*Chest*	3.14 0.75 (2.05-4.5)$^{p\ q\ s\ u}$
		Abdomen lateral	5.26 2.27 (2.22-8.49)^{p}
		Abdomen ventro-lateral	6.88 3.31 (3.9-13.48)^{q}
	Left side	*Chest*	3.61 0.56 (3.06-4.68)$^{r\ tt\ vv}$
		Abdomen lateral	5.16 2.33 (2.22-9.62)
		Abdomen ventro-lateral	6.14 2.22 (3.93-10.15)^{r}

The values with similar superscripts represent significant differences (single superscript at p<0.05 and double at p<0.01) between each other.

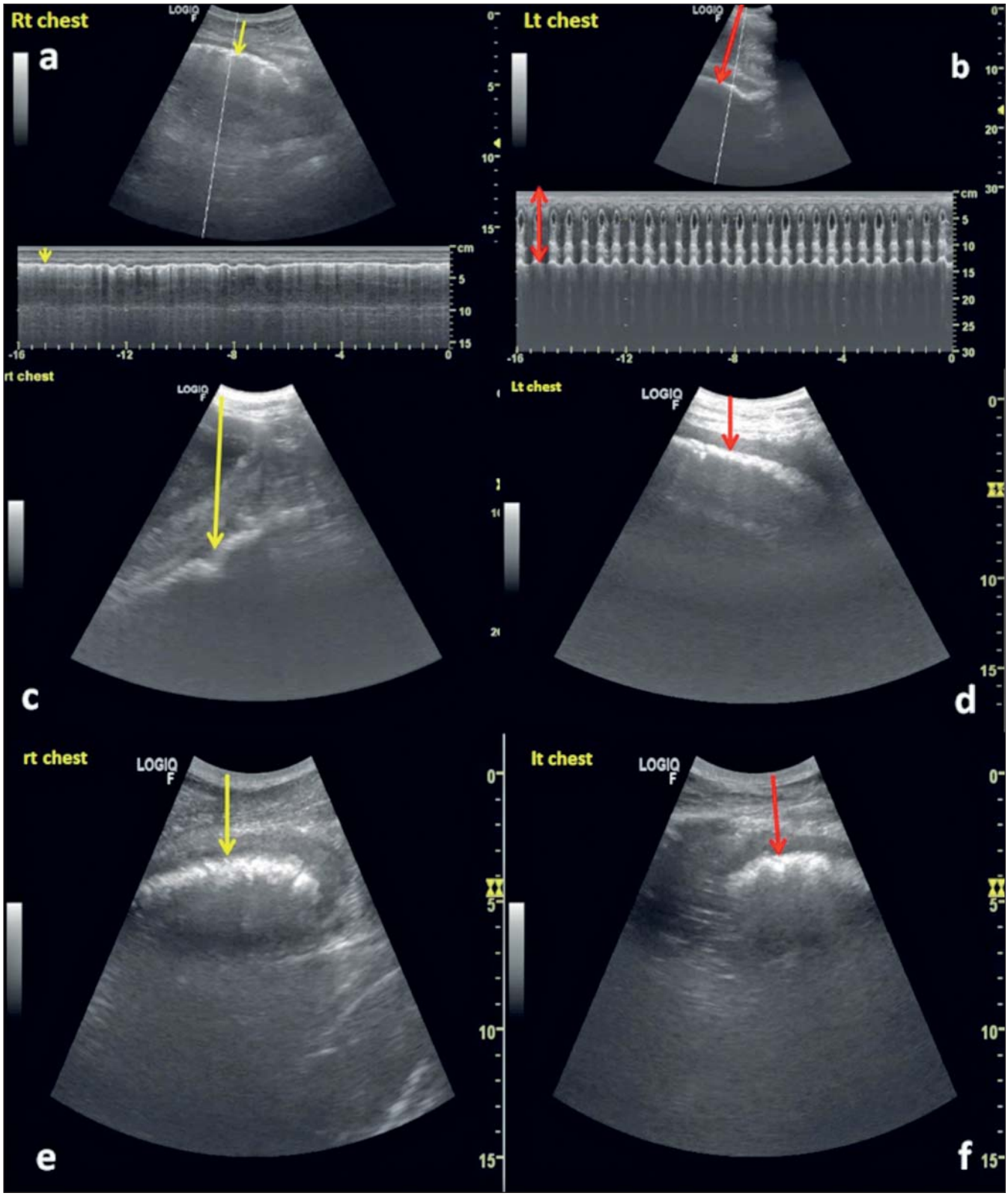

Figure 5 - Ultrasonogram showing the reticular wall close to the thoracic wall from the right chest window (**a**) and away from the left chest (**b**) in Group 1 buffalo. The reticular wall is seen away from the thoracic wall from the right chest window (**c**) and close from the left chest (**d**) in Group 2 buffalo. The reticular wall is seen close to the thoracic wall from both the right (**e**) and the left (**f**) chest windows in Group 3 buffalo.

ventro-lateral ($p \leq 0.01$) windows of the abdomen. Among the lateral and ventro-lateral windows, the depth was significantly ($p \leq 0.05$) more on the ventro-lateral window.

In contrast to the right side parameters, while comparing the reticular wall depth on the left side at different windows, the depth in the chest was significantly more in comparison to that visualized on the lateral ($p \leq 0.01$) and ventro-lateral ($p \leq 0.01$) windows of the abdomen. Among the lateral and ventro-lateral windows, the depth was significantly more from the ventro-lateral window ($p \leq 0.01$).

While comparing the depth of the reticular wall from the right and left sides:

The depth was significantly ($p \leq 0.01$) more at the left chest window in comparison to the right chest.

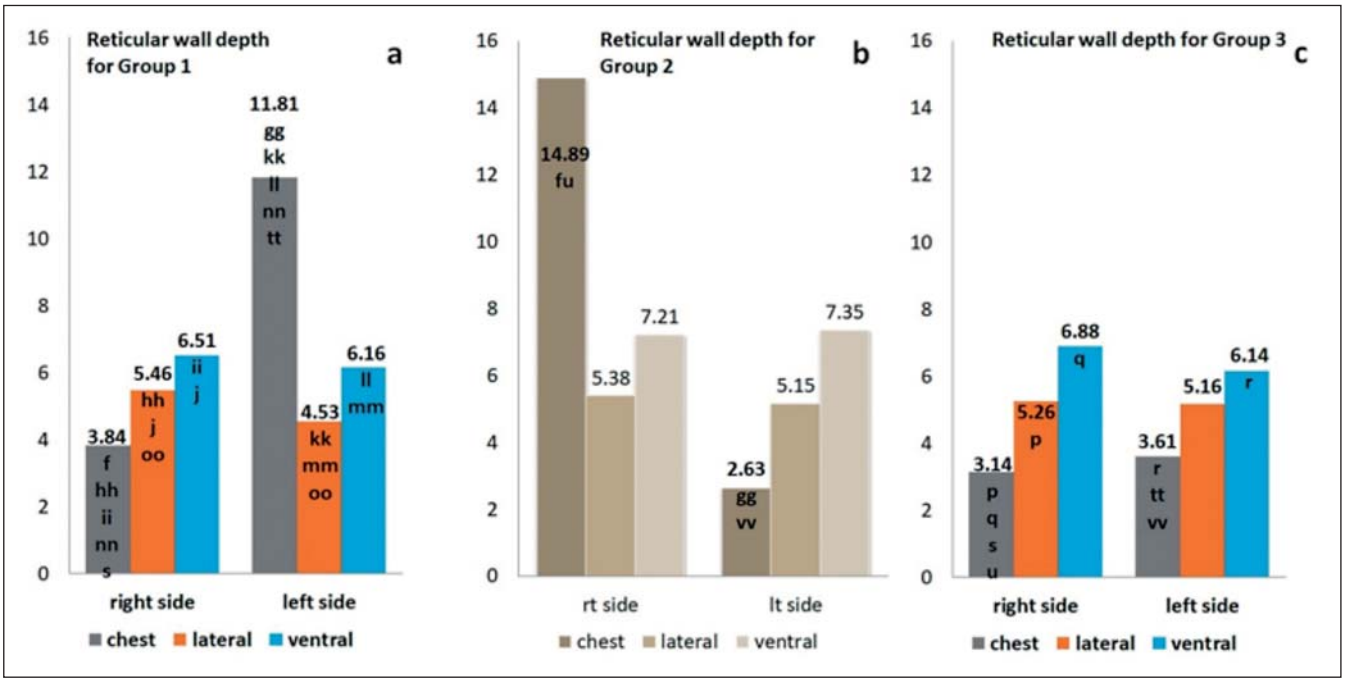

Figure 6 - Bar graphs showing the depth of reticular wall from various windows in Group 1 (**a**), Group 2 (**b**) and Group 3 (**c**). The small alphabets in the bars are from Table 1.

Among the lateral windows, the depth was significantly ($p \leq 0.01$) more on the right window than on the left.
No significant difference was recorded on the two sides in the ventro-lateral abdominal window.

B-mode USG findings in Group 2 (Figure 5c , 5d, 6b):

In 2 buffaloes, the reticular wall was seen superficially i.e close to the thoracic wall from left side and deep/medial to heart from the right side.
The depth of the reticular wall was significantly ($p \leq 0.05$) more at the right chest window in comparison to the left chest.

B-mode USG findings in Group 3 (Figure 5e, 5f, 6c):

In 8 buffaloes, the reticular wall was seen close to the thoracic wall from both right and left side chest windows.
The depth of the reticular wall was maximum on the ventro-lateral window from both right and left sides. And it was significantly more in comparison to the chest window from both right ($p \leq 0.05$) and left side ($p \leq 0.05$). On the right side, the reticular wall depth was significantly ($p \leq 0.05$) more on the lateral window also in comparison to the chest.

Comparison of reticular wall depth in chest window for Group 1 and 2:
At the right chest window, the depth was significantly ($p \leq 0.05$) more in Group 2 in comparison to Group 1. Reversely, at the left chest window, it was significantly ($p \leq 0.01$) more for Group 1 in comparison to Group 2.

Comparison of reticular wall depth in chest window for Group 1 and 3:
The depth of reticular wall was significantly more on both right ($p \leq 0.05$) and left ($p \leq 0.01$) chest windows in Group 1 in comparison to Group 3.

Comparison of reticular wall depth in chest window for Group 2 and 3:
The depth of reticular wall was significantly ($p \leq 0.05$) more in the right chest in Group 2 in comparison to Group 3. However, it was significantly ($p \leq 0.01$) less in the left chest window for Group 2 in comparison to Group 3.

III. Type of reticular motility
(Table 2, Figure 7 and 8)

Most of the buffaloes had biphasic reticular motility on the right side. The absence of reticular motility was recorded in 19.35% buffaloes in the right chest and right ventral windows each and 8.06% buffaloes in the right lateral abdominal window. In 8.06% of buffaloes, the reticular wall was not seen from the right ventral side.

Table 2 - Table showing type of reticular motility on USG (n=61, %=n/61).

		Mono phasic	Biphasic	Folding	Nil	Reticular wall not visible
Right	Chest	0	49=80.33%	0	12=19.35%	0
	Lateral	1=1.61%	54=88.52%	0	5=8.06%	1=1.61
	Ventro-lateral	2=3.22%	42=68.85%	0	12=19.35%	5=8.06
Left	Chest	0	35=57.38%	0	26=41.93%	0
	Lateral	4=6.45%	29=47.54%	20=32.25%	7=11.29%	1=1.61
	Ventro-lateral	0	43=70.49%	0	14=22.58%	4=6.45

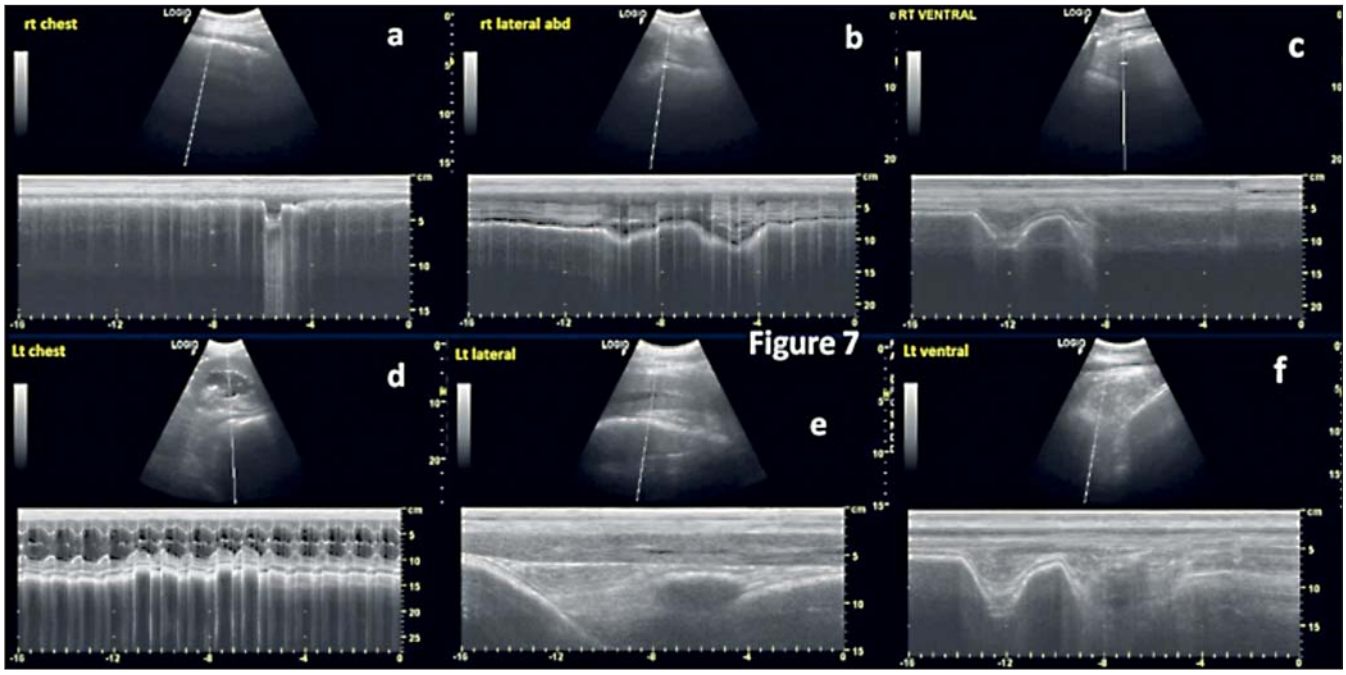

Figure 7 - Ultrasonogram showing various type of reticular motility from various windows on the right {monophasic (**a**), biphasic (**b** and **c**)} and left side {monophasic with heart beat (**d**), folding (**e**), biphasic (**f**)}.

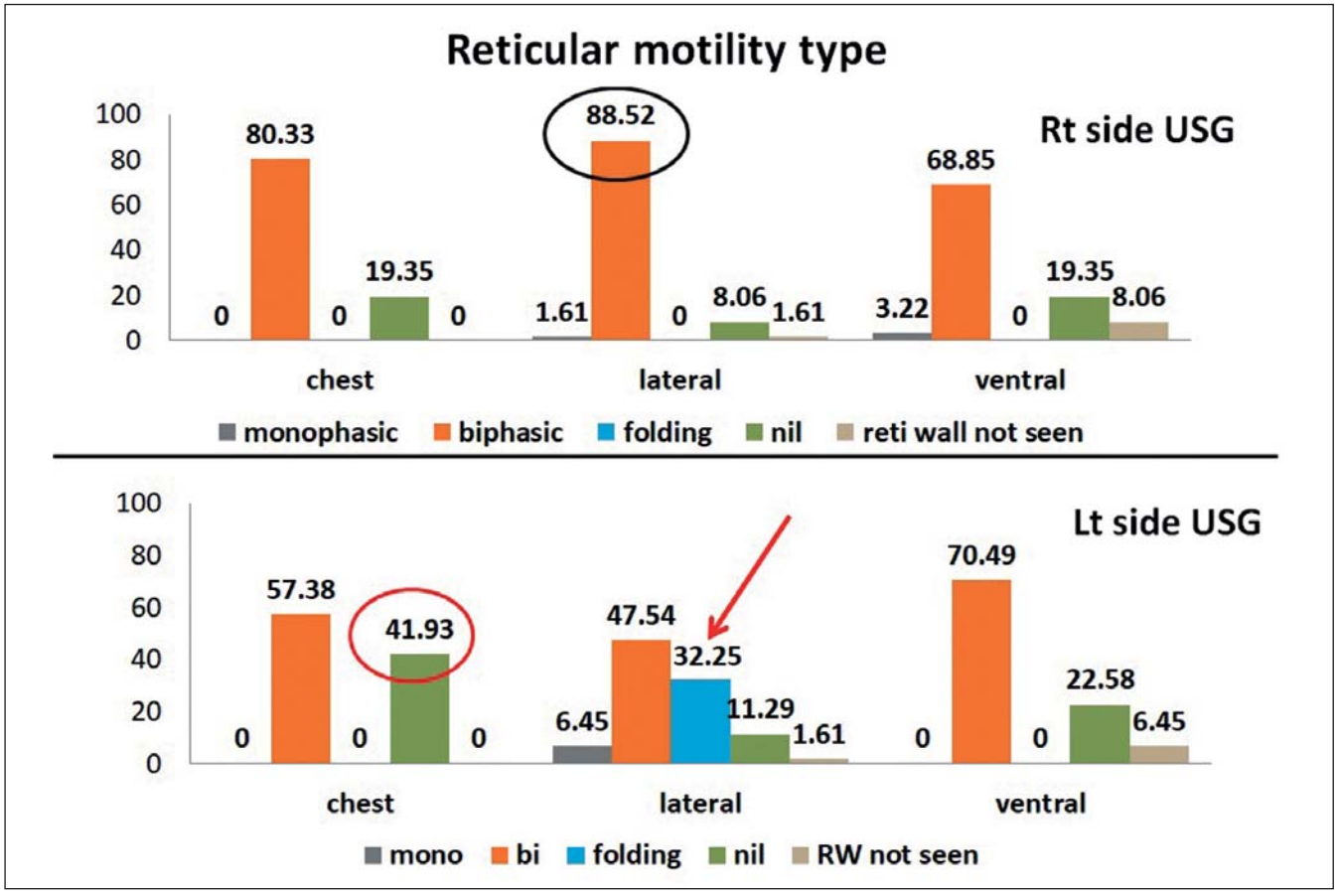

Figure 8 - Bar graph showing percentage of buffaloes with various type of reticular motility through 6 windows on right and left side USG. The maximum absence of motility in chest was recorded on left side (red circle) and the maximum motility on the right lateral window (black circle) and the maximum folding motility on left lateral window (red arrow).

On the left side windows, maximum motility was seen on the lateral abdominal window (biphasic in 47.54% and folding in 32.25%) and the absence of motility was maximum recorded in the chest (41.93%).

The reticulum in the left lateral abdomen showed folding motility in 32.25% buffaloes. Similar to the right side, the reticular wall was not visible in 6.45% buffaloes on the ventral abdominal scan on the left side.

IV. Amplitude of reticular motility
(Table 3, Figure 9)

In the first phase of motility, the amplitude was minimum at the right chest window and maximum at the right ventral-lateral abdominal window.

In the first phase of reticular motility from both right and left sides, the amplitude was significantly reduced in the chest window in comparison to lateral ($p \leq 0.01$) and ventro-lateral ($p \leq 0.01$) abdominal windows.

In the second phase of reticular motility, the amplitude was minimum in the left chest window and maximum in the right ventro-lateral abdominal window.

In the 2nd phase, on the right side, the amplitude from the chest window was significantly ($p \leq 0.01$) less than that in lateral and ventro-lateral abdominal windows. However, on the left side, the amplitude was significantly ($p \leq 0.01$) lower on the ventro-lateral abdominal window only. The overall amplitude was reduced in all the 3 windows on the left side in comparison to the right side.

Table 3 - Table showing the amplitude of reticular motility (in cm) on USG from all 6 sites.

N=61		1st phase	2nd phase
Rt side	Chest	1.74 ± 1.72^{ccee}	3.43 ± 2.26^{ddff}
	Lateral	3.75 ± 2.54^{cc}	5.66 ± 3.26^{aadd}
	Ventro-lateral	4.44 ± 1.96 ^{ee}	6.26 ± 2.77^{bff}
Lt side	Chest	2.11 ±0.97 ^{gghh}	2.58 ± 1.78^{ii}
	Lateral	3.36 ± 2.11^{gg}	3.45 ± 2.43^{aa}
	Ventro-lateral	4.16 ± 2.71^{hh}	4.58 ±2.93^{bii}

Values with similar superscripts represent significant differences (single at p<0.05 and double at p<0.01) between each other.

RUMENOTOMY FINDINGS (N=20)

Out of 51 buffaloes of Group 1, 14 underwent rumenotomy and all 14 had ring on the right hemi-diaphragm. Similarly, both the buffaloes of Group 2 underwent rumenotomy and the ring was on the left hemi-diaphragm in relation of cardia.

Among the 8 buffaloes of Group 3, the rumenotomy was done in 4 buffaloes. In these 4 buffaloes, 3 had a rent on the right side of the hemi-diaphragm and one buffalo had a large herniation and the herniated reticular wall could be felt touching the thoracic wall from both right and left sides.

Severe herniated reticular adhesions were felt on the left side in 55% buffaloes (n=11) and the reticulum was not retractable from the left side, while 20% of buffaloes (n=4) had adhesions all around the rent. The 25% buffaloes had no significant adhesions cranially in the chest and the whole of the reticulum could be retracted in the abdomen (though adhesions on the rent were always present).

DISCUSSION

The reticular wall thickness in healthy buffaloes is thicker on the lateral window in comparison to ventro-lateral and is thickest from the left lateral window[12]. The reticular wall thickness may be correlated to the severity of adhesions present in the

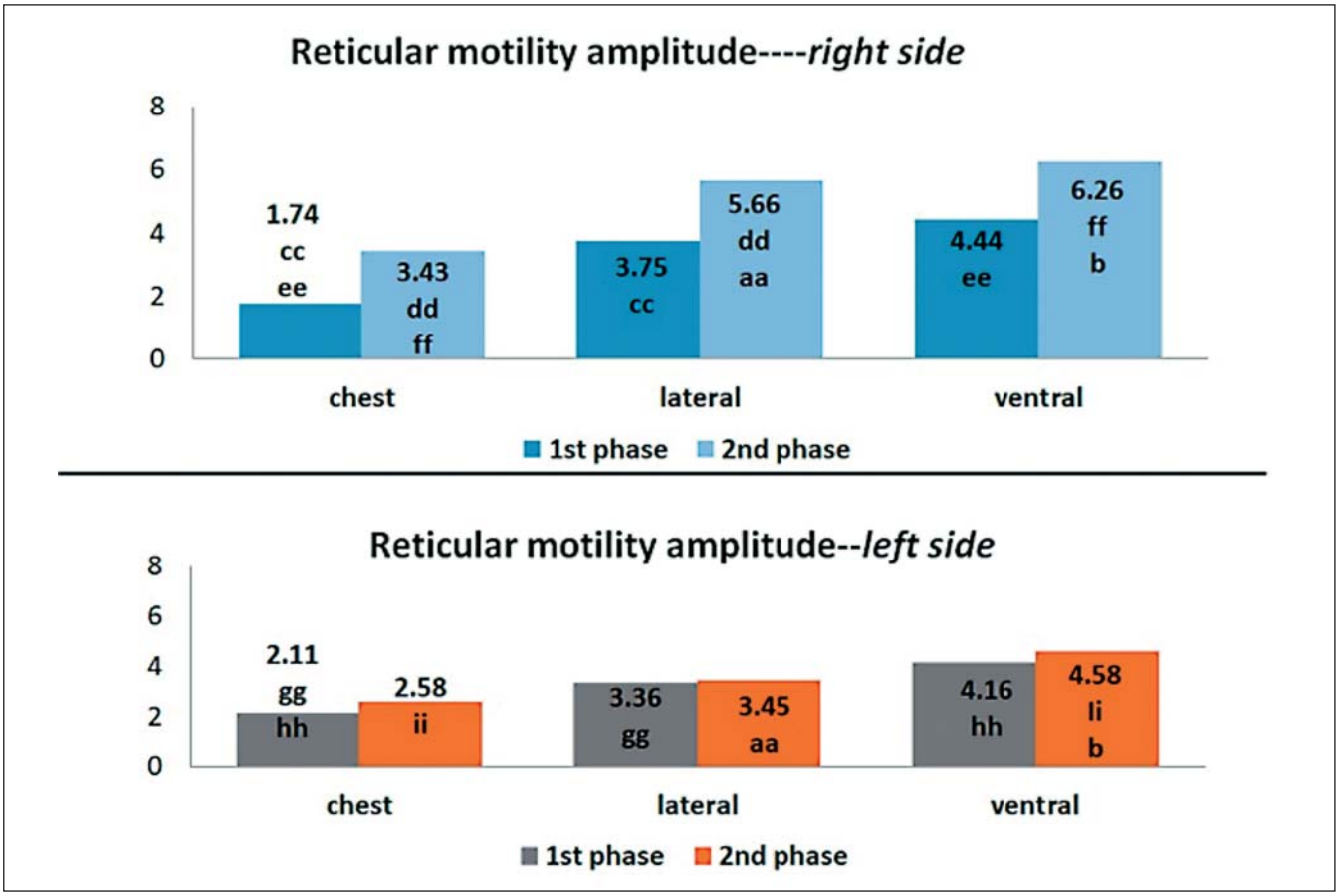

Figure 9 - Bar graph showing the amplitude of reticular motility from the right and the left sides. Similar alphabets show the significant difference at 1% (double alphabets) and 5% (single alphabet) level of significance.

herniated reticulum to the pleura or other chest organs. In the present study, the reticular wall in the left chest showed maximum thickness and on rumenotomy also left side of the herniated reticulum had maximum adhesions. However, in traumatic reticulo-peritonitis (TRP) affected buffaloes, no significant difference in the reticular wall thickness has been reported on the site of adhesions[12].

Buffaloes are mostly reported to have a right sided diaphragmatic herniation[1-3,6,9,11], followed by central and in the least cases on the left side[1,14]. Though radiography is the primary diagnostic modality for the DH in bovines, it cannot diagnose the site of reticular herniation on the diaphragm.

Ultrasonography as a diagnostic modality can define the reticular wall characteristics including wall thickness, depth, motility type and amplitude. On USG, the reticulum in DH bovines can be visualized from 3 windows on each side (right and left); chest, lateral and ventro-lateral abdomen. The depth of the reticulum in the chest window can be utilized to assess the side of herniation. As, in right side herniation, the depth of reticulum has been reported to be more in the left chest in comparison to the right chest, and the reverse findings hold for a left side herniation[11].

While scanning the reticulum from the right lateral side in the abdomen, a lobe of the liver is seen lateral to the reticulum in healthy buffaloes. Similarly, from the left lateral side, the spleen is visualized[12]. In healthy buffaloes; the depth of reticulum has been reported to be highest from the left lateral abdominal window in comparison to right lateral or ventro-lateral windows of either side due to the presence of more thick spleen lateral to it on the left side[12]. However, in this study, the ventro-lateral window showed the maximum depth of reticulum irrespective of side and among lateral abdominal windows, the right lateral showed more depth in comparison to the left. This could be because when the reticulum got herniated into the chest, it got lifted from the ventral position and move medially from lateral positions. This movement will be more from the right side in a right side herniation. This could also be the reason for the non-visualization of the reticular wall from the ventro-lateral window of either side in a few buffaloes.

The presence of motility in the herniated reticulum plays an important role in the diagnosis of DH in buffaloes[2]. The typical biphasic motility is characteristic of the reticulum[2,9]. The motility of the reticulum in DH buffaloes is mostly hyper due to the presence of recurrent bloat[1], and thus, quick motilities are usually seen on screen which is helpful in the diagnosis. However, the amplitude of reticular motility in the chest may be very less and a closer view or B+M mode might be required to appreciate the presence of mild biphasic motility in DH.

The amplitude of reticular motility may or may not vary in TRP affected bovine[12,15,16]. In DH affected buffaloes, the amplitude in the chest was significantly reduced, in comparison to other acoustic windows, which was correlated to reticular adhesions in chest.

The interpretation of ultrasonographic detection of the reticular wall close to the thoracic wall from both right and left sides in the chest had not been explained in the published literature. The current study reported similar characteristics of the reticular wall in 13.11% of DH affected buffaloes, but, being a clinical work, it was not possible to confirm the reason due to lack of client's consents for surgery. So the smaller data on rumenotomy findings in DH affected buffaloes was a limitation of this study. The possible reasons for it could be the presence of a central ring or a larger herniation which require subsequent investigations.

CONCLUSIONS

The study concludes that:

1. Ultrasonography can diagnose the side of reticular herniation, using a criterion of comparative superficial scanning of the reticulum on the respective side using chest window.
2. The severity of adhesions on the herniated reticulum can be predicted using ultrasonography; based on wall thickness, type and amplitude of the reticular motility in the chest.

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