Ultrasonographic assessment of change in omasal position during the last month of gestation and first month of lactation in buffaloes

S. A. Hussain[1], S. K. Uppal[2], S. T. Singh[2]

[1]Division of Veterinary Clinical Medicine Ethics & Jurisprudence, Faculty of veterinary Sciences and Animal Husbandry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, India; [2]Department of Veterinary Medicine, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, India.

Ultraschalluntersuchung zur Lageveränderung des Blättermagens bei Murrah Büffeln während des letzten Trächtigkeits- und des ersten Laktationsmonats

Das Ziel dieser Studie war es, die Auswirkung einer fortgeschrittenen Trächtigkeit auf die Topographie und Größe des Blättermagens bei 22 gesunden Murrah Büffeln zu bestimmen. Der Blättermagen wurde 15 bis 20 Tage vor und nach Geburt ultrasonographisch untersucht. Die dorsalen und ventralen Ränder des Blättermagens wurden in jedem Interkostalraum (ICS) des zu untersuchenden Tieres identifiziert und markiert. Die dorsalen und ventralen Grenzen bis zur dorsalen Mittellinie wurden ausgemessen. Der Blättermagen wurde im 6. bis 11. ICS während der fortgeschrittenen Trächtigkeit und im 7. bis 11. ICS nach der Geburt ultrasonographisch untersucht. Unabhängig von der Trächtigkeit befanden sich die dorsalen und ventralen Ränder des Blättermagens im 6., 7. und 11. ICS weiter entfernt von der Wirbelsäule. Mit Ausnahme eines Büffels wurde der Blättermagen während der fortgeschrittenen Trächtigkeit in vier aufeinanderfolgenden ICS lokalisiert. Nach der Geburt wurde der Blättermagen in vier und fünf aufeinanderfolgenden ICS in 17 bzw. fünf Büffeln lokalisiert. In jedem ICS stiegen die mittleren dorsalen und ventralen Grenzen des Blättermagens signifikant in der postpartalen Periode im Vergleich zur fortgeschrittenen Trächtigkeit an ($P<0,05$). Nach der Geburt nahm die Grösse des Blättermagens im 10. ICS signifikant zu ($P<0,05$), während Blättermagen in der Trächtikeit dorsocranial gedrückt wurde. Unabhängig von der Trächtigkeit war im 8. und 9. ICS die Distanz zwischen Blättermagen und Wirbelsäule die geringste Variation. In der vorliegenden Studie eignete sich der 8.–9. ICS als optimalen Ort für die Ultraschalluntersuchung des Blättermagens bei gesunden Büffeln. Obwohl die Befunde in Bezug auf die Grösse des Blättermagens für Tiere mit unterschiedlichem Körperge-

Summary

This study was aimed to determine the effect of advanced pregnancy on the topography and size of the omasum in 22 healthy Murrah buffaloes. The omasum was scanned 15–20 days before and after parturition, as per the standard procedure. The dorsal and ventral margins of the omasum were identified and marked at each intercostal space (ICS). The dorsal and ventral limits up to the dorsal midline were measured. The omasum was scanned in 6^{th} to 11^{th} ICS during advanced pregnancy and 7^{th} to 11^{th} ICS after the parturition. Irrespective of the pregnancy, the dorsal and ventral margins of the omasum were located farther dorsal and close to the spine in the 6^{th}, 7^{th} and 11^{th} ICS. Except in one buffalo, the omasum was scanned in four consecutive ICS during the advanced pregnancy. After parturition the omasum was scanned in four and five consecutive ICS in 17 and five buffaloes, respectively. The mean dorsal and ventral limits of the omasum increased significantly ($P<0,05$) in each ICS during post parturient period as compared to the advanced pregnancy. After parturition, the omasal size increased significantly ($P<0,05$) in the 10^{th} ICS only while the omasum was pushed dorsocranially during the advanced pregnancy. Irrespective of the pregnancy status, the omasal distance from the spine showed the least variation in the 8^{th} and 9^{th} ICS in all the buffaloes. In summary, we advocate the $8–9^{th}$ ICS as the optimum location for the ultrasonographic evaluation of the omasum in healthy buffalos. Although, the findings of the omasal size may or may not hold true for animals with different body weights, the present findings can be extrapolated to other bovine species and can be used as a reference for evaluating the effect of pregnancy on the omasum.

Key words: Buffalo, omasum, pregnancy, topographic anatomy, ultrasonography

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wicht variieren können, können die vorliegenden Befunde auf andere Rinderarten übertragen und als Referenz für die Auswirkung der Trächtigkeit auf den Blättermagen verwendet werden .

Schlüsselwörter: Büffel, Omasum, Trächtigkeit, topografische Anatomie, Sonographie

Introduction

The omasum is almost a spherical organ with slightly flattened sides and lies on the right floor of the intra-thoracic part of the abdominal cavity.[7] The main function of the omasum is the absorption of water, dissolved minerals and short-chain fatty acids and anorexia due to any cause may reduce the size of the omasum. The primary diseases of the omasum, such as omasal impaction and omasitis, are documented to be rare.[15] However, as compared to other parts of the world, the incidence of omasal impaction is higher in bovines of Punjab, India[9] with higher incidence in buffaloes as compared to cattle.[10]

The basic anatomy and physiology of gastrointestinal tract is similar for cattle and buffaloes except a few minor differences with respect to diaphragm, caecum and liver.[17] The buffalo diaphragm is thinner than the diaphragm of cattle and hence diaphragmatic hernia occurs more frequently in buffaloes than cattle.[16] In cattle, the blind end of the caecum is free, but in buffaloes mesentery is attached at this end and hence buffaloes are not predisposed to caecal torsion.[17] In the buffalo, the liver is comparatively more round, large and thick.

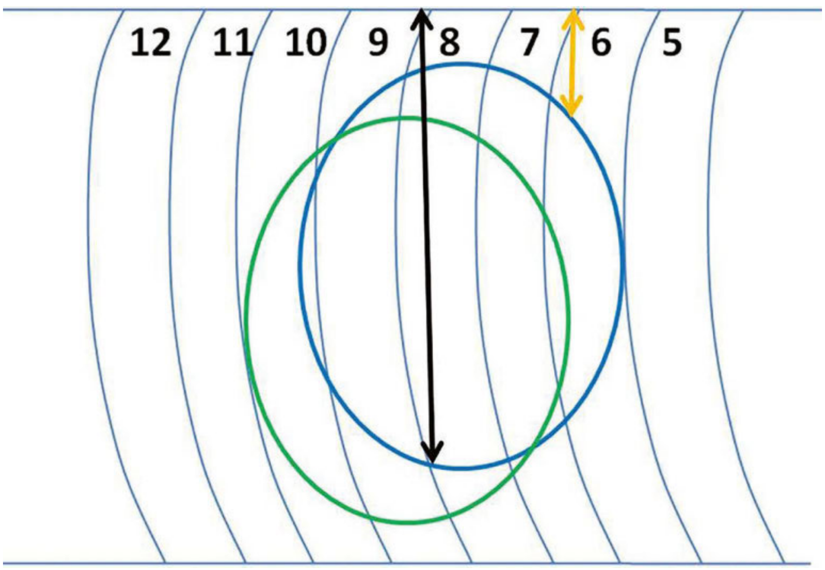

Figure 1: Diagram representing the left thoracic and abdominal wall for the topographic location of the omasum during the last month of pregnancy (blue circle) and within one month of parturition (Green circle) in Murrah buffaloes. The numerals represent the intercostal spaces.
The omasal size in each intercostal space=length of the black arrow on animal body-length of the orange arrow on animal body

Owing to almost similar gastrointestinal tract, the same protocol has been applied for the clinical examination of the digestive system and abdominocentesis in cattle and buffaloes in different studies.[1,9,11] The reticular wall thickness (measured ultrasonographically) is reported to be similar for cattle and buffaloes, but the reticular motility pattern is reported to be slightly different between the two species.[13] Also the ultrasonographic windows for the examination of liver and spleen were similar for cattle and buffaloes. However, the signs of pain and systemic reactions are more commonly observed in pericarditis affected cattle compared to that in buffaloes[1] and it is difficult to induce pain response in buffaloes compared to the cattle.[9]

The omasum is inaccessible for most methods of the clinical examination[7] except deep palpation.[9] So, ultrasonography has been applied as a non-invasive diagnostic aid for the evaluation of the omasum in cattle and buffaloes.[3,14] Some reports describe ultrasonography as a useful tool for differentiating the healthy and impacted omasum[14] while other reports suggest that ultrasonography cannot be reliably used to diagnose omasal impaction.[12] However, the results of these studies cannot necessarily be applied to the pregnant animal because the size and topography of the omasum in the pregnant animal may be different to that of the non pregnant animal. During pregnancy, especially in the advanced stage, there is a change in location of various abdominal organs and the effect on size and topography of the abomasum and liver has been evaluated ultrasonographically.[4,18] However, it is not known whether the advanced pregnancy can affect the size and location of the normal or impacted omasum in bovids, if so, these changes could be seen ultrasonographically. Further, the size and topography of the omasum has not been studied in healthy or diseased buffaloes. The aim of this study was to determine the size and topography of the omasum in healthy buffaloes, and to evaluate the effect of the advanced pregnancy on the size and location of the omasum. These results could then be applied to healthy and diseased buffaloes and other bovids.

Material and Methods

The study was conducted on Murrah buffaloes at dairy farm of Guru Angad Dev Veterinary and Animal Science University, Punjab, India. All the animals were maintained under similar environmental conditions and managemental practices. Initially 30 buffaloes of the same age group (5–6,5 years) were included in the study with an expected parturition within 15–20 days. On the basis of the clinical evaluation and metabolic profile testing, eight buffaloes were excluded from the study as they were suffering from subclinical or clinical ketosis (n=5) and fat cow syndrome (n=3). The study protocol was approved by the Institutional Animal Ethics Committee of the Guru Angad Dev Veterinary and Animal Science University, Punjab, India.

Ultrasonography of the Omasum

The omasum in each buffalo was scanned during the last month of the pregnancy (15–20 days before parturition) and 15–20 days after parturition. Ultrasonography was carried out by a portable ultrasound (SonoSite M-turbo) using a 2–5 MHz convex transducer. Ultrasonography was done in standing animals, restrained in a cattle crate without any sedation. The lateral aspect of the thoraco-abdominal wall [4^{th} to 12^{th} intercostal space (ICS)] on the right side was shaved (whenever necessary) and washed with water. Acoustic coupling gel was applied liberally for optimal transmission of the ultrasound waves and the normal omasum was scanned between 5^{th} to 12^{th} ICS as per the previously described procedure.[3] Each ICS was scanned, beginning dorsally and progressing ventrally, with the transducer held parallel to the ribs. The dorsal and ventral ultrasonographic margins of the omasal wall in each ICS were identified and marked with a chalk on the body of the animal. Distances between the spine, and the dorsal and ventral margins in each ICS were measured in centimetres with the help of a measuring tape (Fig. 1). The size of the omasum in each ICS was calculated as the difference between the ventral and dorsal limits from the spine.

Statistical Analysis

The normal distribution was tested by Shapiro-Wilk test. All data was normally distributed and is presented as mean ± standard deviation (S. D). The mean values of different omasum parameters in the advanced pregnancy and after parturition were compared by paired t-test. For all statistical procedures a value of $P<0,05$ was considered significant, assuming the conventional alpha level of 0,05.

Results

The omasum was easily identified and clearly visible on the ultrasonograms due to its position (adjacent to the costal part of the right abdominal wall). The wall of the omasum appeared as a crescent shaped thick echogenic line, similar to wall of the rumen. The medial wall of the omasum could not be visualized on the ultrasonograms. The liver was frequently scanned lateral to the dorsal border of the omasum (Fig. 2) while the gall bladder was seen at the dorso-lateral border of the omasum. In some animals, the attachments of the omasal laminae were visible as short echogenic cone-shaped structures

Table 1: Distances of the omasal margins (in cm) from the dorsal midline measured ultrasonographically in different intercostal spaces in healthy buffaloes

ICS	Omasal margin	During the last month of gestation		During the first month of lactation	
		N	Mean ± S. D	N	Mean ± S. D
11^{th}	Dorsal	3	46,93 ± 2,23	9	51,49 ± 2,64*
	Ventral	3	75,3 ± 2,76	9	76,91 ± 2,64*
10^{th}	Dorsal	18	38,17 ± 2,89	22	45,23 ± 3,78*
	Ventral	18	84,92 ± 4,20	22	90,59 ± 4,00*
9^{th}	Dorsal	22	37,4 ± 3,22	22	43,54 ± 3,44*
	Ventral	22	91,12 ± 3,61	22	98,49 ± 3,42*
8^{th}	Dorsal	22	45,86 ± 3,44	22	50,93 ± 3,46*
	Ventral	22	84,38 ± 3,38	22	89,17 ± 3,81*
7^{th}	Dorsal	18	49,36 ± 4,85	18	53,99 ± 5,42*
	Ventral	18	70,26 ± 3,76	18	74,71 ± 4,34*
6^{th}	Dorsal	4	49,25 ± 0,99	–	
	Ventral	4	66,12 ± 2,33	–	

ICS-intercostal space; N indicate the number of animals in which omasal wall was visible in the corresponding intercostal space
*Corresponding mean values in a row differ significantly

protruding from the inner wall of the omasum (Fig. 3). The omasal motility was not recorded in this study.

The frequency with which the omasum was visible in the different intercostal spaces did not differ significantly between the peri-parturient and the post parturient period (Table 1). Irrespective of the pregnancy the omasum was visualized in the 8th and 9th ICS in all the buffaloes. During the peri-parturient period the omasum was scanned in four consecutive ICS in 21/22 buffaloes and the omasum was scanned in three consecutive ICS in one buffalo only (8th to 10th ICS). The omasum was scanned in the 7th to 10th ICS in 14/21 buffaloes, in the 6th to 9th ICS in four and in the 8th to 11th ICS in three buffaloes. After the parturition the omasum was scanned in four consecutive intercostal spaces in 17/22 animals (13/17: 7th to 10th ICS; 4/17: 8th to 11th ICS) while in five buffaloes the omasum was scanned in five consecutive ICS (7th to 11th ICS). Irrespective of the pregnancy, the dorsal limit of the omasum was visible as a semicircle running from cranial to caudal and was located farther from the spine in the 6th, 7th and 11th intercostal spaces. The ventral limit appeared as the lower half of the circle running from cranial to caudal, so the distance between the ventral limit of the omasum and spine was shortest in 6th, 7th and 11th intercostal spaces. After parturition, both the dorsal and ventral limits of the omasum from the spine increased significantly ($P<0,05$) as compared to the advanced stage of the pregnancy in each ICS (Table 1)

During the advanced pregnancy the mean omasal size ranged from 16,87 ± 1,51 cm (in 6th ICS) to 53,72 ± 2,85 cm (in 9th ICS) while in post parturient period its mean size ranged from 20,71 ± 5,40 cm (in 7th ICS) to 53,26 ± 2,76 cm (in 9th ICS) (Table 2). Irrespective of the pregnancy the omasum appeared largest in the 9th ICS and decreased in size both cranially and caudally. After parturition, the omasum became significantly ($p<0,05$) larger in the 10th ICS only (Table 2).

Discussion

The ultrasonographic examination of the omasum has been standardized in cattle[2] but not in buffaloes. To the authors' best knowledge, this is the first study to determine the topographic location and the size of the omasum in healthy buffaloes, irrespective of the breed. Scanning of the omasum has been carried out in healthy buffaloes of the same region as our study.[14] This study had some limitations: First, the number of the subjects in that study was limited to two animals. Second, the omasum was scanned in the 8th and 9th intercostal spaces only, although the omasum could have been scanned in the other intercostal spaces also, as was observed in the present study. Similar to the present study the omasum has been scanned in 6th to 11th ICS in healthy cattle[3] and 5th to 11th ICS in cattle with different gastrointestinal disorders.[2] Third, the population of the diseased buffaloes was not uniform and exact measurements, such as the distance of the omasal margins from the spine and the omasal size, were not evaluated. Due to these limitations, the results cannot be extrapolated to the general population of buffaloes. We report the ultrasonographic features of the omasum and the influence of the advanced pregnancy on the topography of the omasum in healthy buffaloes.

On the ultrasonograms, the wall of the omasum appeared similar to that of the rumen. However, the rumen wall is normally imagined from the left side of the abdomen and extends to the right side only in vagal indigestion.[2] Also, the omasum does not contract while rumen contracts at regular intervals.[5] Non-visualization of the medial omasal wall may be attributed to gas within the omasum[3] and the large distance between the medial wall and the body surface. The omasum-liver interrelationship was similar on the ultrasonograms to previously described findings.[3]

The distance of the dorsal and ventral margins from the spine and the overall size of the omasum in each ICS

Table 2: Size of the omasum (in cm) measured ultrasonographically in different intercostal spaces in healthy buffaloes

ICS	During the last month of gestation		During the first month of lactation	
	N	Mean ± S.D	N	Mean ± S.D
11th	3	28,37 ± 1,58	9	25,42 ± 2,80
10th	18	46,75 ± 3,25	22	47,05 ± 3,95*
9th	22	53,72 ± 2,85	22	53,26 ± 2,76
8th	22	38,52 ± 2,99	22	38,25 ± 3,08
7th	18	20,89 ± 5,02	18	20,71 ± 5,40
6th	4	16,87 ± 1,51		

ICS-intercostal space; N indicate the number of animals in which omasal wall was visible in the corresponding intercostal space
*corresponding mean values in a row differ significantly

was lower than reported for healthy Swiss Braunvieh cows and other cattle breeds with various gastrointestinal disorders.[2] However, the size was larger than that reported for Indian Red Sendhi cows.[12] Three findings of the present study indicated that the omasum was lifted dorsally and pushed cranially during the advanced pregnancy: 1) by the statistically significant difference of the dorsal and ventral limits of the omasum in each intercostal space during advanced pregnancy and the post parturient stage, 2) by the visualization of the omasum in the 6th intercostal space during advanced pregnancy only and, 3) by the localization of the omasum in five consecutive ICS in five buffaloes only after the parturition. The change in position of the omasum may be attributed to the change in position of the abomasum during advanced pregnancy or possible cranial push by the gravid uterus. The omasum is joined to the abomasum by the omaso-abomasal opening and change in the position of the abomasum could change the position of the omasum. Although the omasum was pushed dorsally and cranially, the overall size differed significantly in the 10th ICS only.

In the present study, the appearance of the dorsal and ventral limits of the omasum was similar to the previously reported for the non-pregnant cattle.[3] The findings of the pregnant stage could not be compared to other studies due to lack of available literature on ultrasonography of the omasum in the pregnant animals.

Irrespective of the pregnancy status, the omasum was scanned in four consecutive ICS in majority of the buffaloes, the common location being 7th to 10th ICS. The size of the omasum and the distance of the omasal margins from the dorsal midline showed least variation in 8–9th ICS, revealed by lower standard error. Further, the omasum was visible in all the buffaloes in these two intercostal spaces only. In summary, we advocate these intercostal spaces as the optimum location for the ultrasonographic evaluation of the omasum in healthy buffaloes. Similar to present findings, the 8th and 9th ICS have been reported to be optimal locations for scanning of the omasum in cattle.[2]

The buffaloes are mainly found in South Asia but that does not limit the scope of this manuscript to transfer the knowledge/findings from the buffaloes to other bovids. The extrapolation of the present findings to other bovids can be justified by some statements and facts. First, the digestive system of cattle and buffaloes is similar and the same protocol for the clinical examination of the omasum[9] and other digestive organs has been employed for both cattle and buffaloes. Furthermore, in some previous studies, the same protocol has been used for the ultrasonographic evaluation of the omasum, reticulum and other digestive organs in both catt-

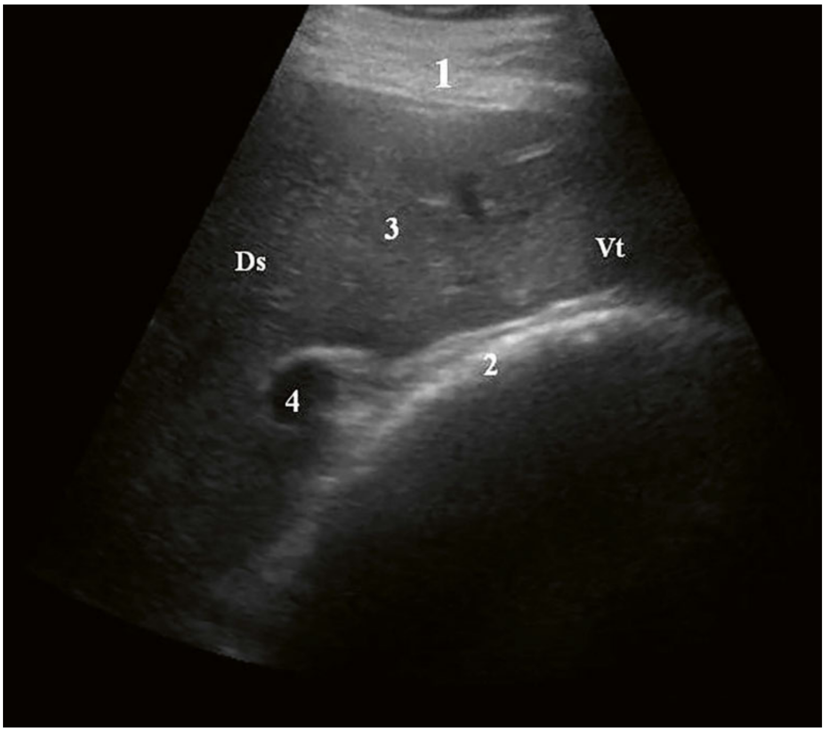

Figure 2: Ultrasonogram showing omasum and liver in 9th ICS in a Murarah buffalo: The omasal wall appears as a curved echogenic line and the liver is situated dorsolateral to the omasum.
1. Costal part of the abdominal wall, 2. Omasal wall, 3.liver, 4. Portal vein, Ds: dorsal, Vt: ventral

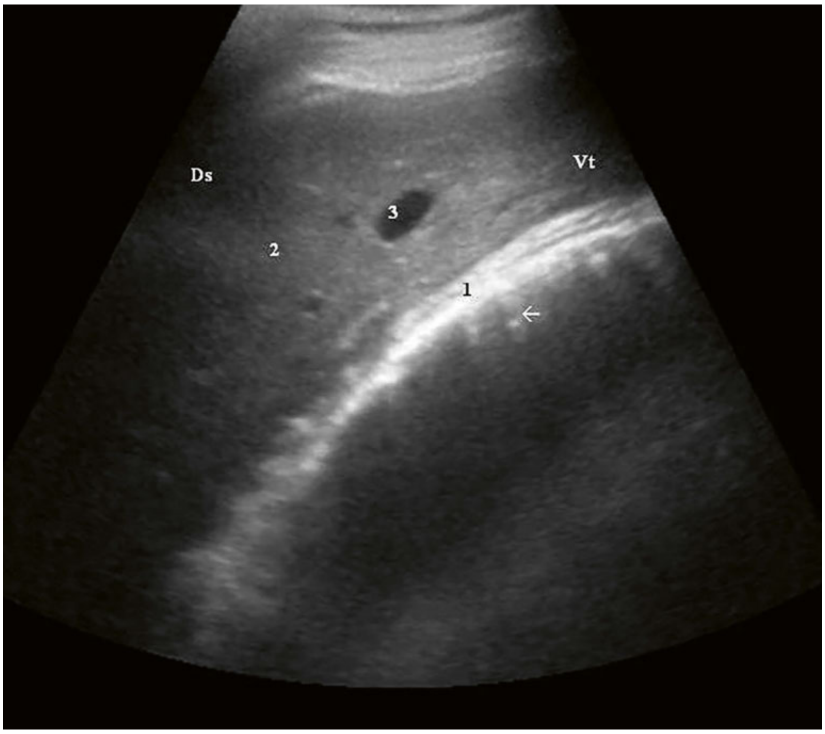

Figure 3: Ultrasonogram showing omasum with short omasal laminae in 10 ICS in a Murrah buffalo: 1. Omasal wall, 2.liver, 3. Hepatic vessel, Ds: dorsal, Vt: ventral, white arrow: omasal laminae

le and buffaloes.[1,14] Second, the protocol for the ultrasonographic examination of the bovine digestive system was standardized in cattle (Prof. U. Braun) and then in due course of time these protocols were extrapolated to cattle as well as buffaloes and goats in different countries.[1,6,12,14] Third, the standard protocol for ultrasonographic examination of the omasum in cattle[3] was adopted in this study. Similarly the present findings can be extrapolated to other bovids like cattle, and can be used as a reference for evaluating the effect of pregnancy on the omasal size and location in cattle as well as buffaloes.

Feeding could have affected the size and location of the omasum in this study. In order to minimize this variation all the buffaloes were examined at least 2 hours after the morning feeding. The animals were of the same breed and similar age group in order to minimize the variation affecting the location of the omasum.

Most of the studies have limitations, which may be known to authors at the time of study or become apparent with better understanding and advancement in the technology. Our study had limitations. First, the distance between the omasum and the peritoneum of the lateral body wall was not determined for any of the intercostal spaces. This parameter could be also affected by the advanced pregnancy and needs to be evaluated in further studies. Second, it was difficult to estimate the exact time before parturition because of the inability to predict the exact date of the parturition. So, all the buffaloes were not truly evaluated at the same time before parturition. The reliability of the results may be further evaluated by repeated examinations of the buffaloes, two-three consecutive times for each animal within one month before and after the parturition. In this study, the repeated examinations were not undertaken; as this was a preliminary study to evaluate the effect of pregnancy on the size and topography of the omasum. We wanted to establish whether there is any effect of pregnancy on the size and topography of the omasum or not. Moreover, interassay coefficient of variation should be calculated for each measurement. As previously mentioned by Braun and Jacquat,[6] the repeated examination provides accurate result only when the animals are examined under the same conditions. The omasal size would be correlated to body weight of animals. So, another limitation is that currently we do not know whether the findings of omasal size will hold true for animals with different body weights or not, especially in calves. However, we believe that the established effect of the pregnancy on the omasal location and size will be true for cattle also and can be confirmed in future studies.

Conclusion

The size of the omasum did not change significantly with the advanced pregnancy except in the 10th intercostal space. The omasum was pushed dorsally and cranially during the advanced pregnancy. The result of this study could be used as a reference for the omasal examination in the healthy buffaloe, changes in the organ's size or position as a result of illness, and for the evaluation of effect of the pregnancy on the size and topography of the omasum in cattle and buffaloes. However, the size of the omasum may not be similar in animals of the different age groups due to difference in the body weight and size. The present findings can be extrapolated to other bovid species for evaluating the effect of pregnancy on the omasum.

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Évaluation échographique du changement de position de l'omasum au cours du dernier mois de gestation et du premier mois de lactation chez les buffles

Cette étude visait à déterminer l'effet d'une gestation avancée sur la topographie et la taille de l'omasum chez 22 buffles de Murrah en bonne santé. L'omasum a été scanné 15 à 20 jours avant et après la parturition, selon la procédure standard. Les marges dorsale et ventrale de l'omasum ont été identifiées et marquées au niveau de chaque espace intercostal (EIC). Les limites dorsale et

Esame ecografico dei cambiamenti della posizione dell'omaso durante l'ultimo mese di gestazione e il primo mese di lattazione nelle bufale

Lo scopo di questo studio è di determinare l'effetto della gravidanza avanzata nella topografia e le dimensioni dell'omaso in 22 bufale Murrah sane. L'omaso è stato scansionato 15–20 giorni prima e dopo il parto, come procedura standard. I margini dorsali e ventrali dell'omaso sono stati identificati e marcati su ogni spazio intercostale (ICS). Sono stati misurati i limiti dorsali e ventrali fino alla linea mediana. L'omaso è stato sottoventrale jusqu'à la ligne médiane dorsale ont été mesurées. L'omasum a été scanné du 6ème au 11ème EIC pendant la gestation avancée et du 7ème au 11ème EIC après la mise-bas. Indépendamment de la gestation, les marges dorsale et ventrale de l'omasum étaient situées plus loin dorsalement et plus près de la colonne vertébrale dans les 6ème, 7ème et 11ème EIC. Sauf chez un buffle, l'omasum a été scanné dans quatre EIC consécutifs au cours de la gestation avancée. Après la mise-bas, l'omasum a été scanné dans quatre et cinq EIC consécutifs chez 17 respectivement 5 buffles. Les limites dorsales et ventrales moyennes de l'omasum ont augmenté de manière significative (P<0,05) dans chaque EIC pendant la période post-partum par rapport à la gestation avancée. Après la mise-bas, la taille de l'omasum a augmenté de manière significative (P<0,05) dans le 10ème EIC seulement, alors que l'omasum était poussé en direction dorso-crâniale pendant la gestation avancée. Indépendamment de l'état de gestation, la distance de l'omasum à la colonne vertébrale a montré la variation la plus faible dans les 8ème et 9ème EIC chez tous les buffles. En résumé, nous préconisons les 8–9ème EIC comme emplacement optimal pour l'évaluation échographique de l'omasum chez les buffles en bonne santé. Bien que les résultats de la taille de l'omasum puissent ou non être exacts pour des animaux de poids corporel différents, les présents résultats peuvent être extrapolés à d'autres espèces bovines et peuvent être utilisés comme référence pour évaluer l'effet de la gestation sur l'omasum.

Mots clés: buffle, omasum, gestation, anatomie topographique, échographie

posto a ecografia dal 6° all'11° ICS durante la gravidanza avanzata e dal 7° all'11° ICS dopo il parto. Indipendentemente dalla gravidanza, i margini dorsali e ventrali dell'omaso sono stati localizzato più verso il dorso e vicini alla spina dorsale nel 6°, 7° e 11° ICS. L'omaso è stato scansionato in quattro ICS consecutivi durante la gravidanza avanzata eccetto per un bufalo. Dopo il parto, l'omaso è stato sottoposto a ecografia in quattro e cinque ICS consecutivi in 17 risp. 5 bufali. I limiti medi dorsali e ventrali dell'omaso sono aumentati in modo significativo (P<0,05) per ogni ICS durante il periodo post partum rispetto alla gravidanza avanzata. Dopo il parto le dimensioni dell'omaso sono aumentate significativamente (P<0,05) solo nel 10° ICA mentre l'omaso è stato spinto in posizione dorso-craniale durante la gravidanza avanzata. Indipendentemente dallo stato della gravidanza, la distanza dell'omaso dalla spina dorsale ha mostrato le minori variazioni nell'8° e 9° ICS in tutti i bufali. Per concludere noi riteniamo che la posizione migliore per una valutazione ecografica dell'omaso nei bufali sani si situa tra l'8° e il 10° ICS. Anche se i risultati delle dimensioni dell'omaso possono o non possono essere concludenti per degli animali di peso corporeo differente, i presenti risultati possono essere estrapolati per altre specie bovine e possono essere utilizzati come riferimento per una valutazione dell'effetto della gravidanza sull'omaso.

Parole chiave: Bufalo, omaso, gravidanza, anatomia topografica, ecografia

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Korrespondenzadresse

Syed Ashaq Hussain
Division of Veterinary Clinical Medicine Ethics & Jurisprudence, Faculty of veterinary Sciences and Animal Husbandry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir
Shuhama, Alusteng, Srinagar
India-190006 Jammu and Kashmir
Telefon: +91 700 659 68 47
E-Mail: draashiqhussain@gmail.com