Australian Journal of Basic and Applied Sciences, 5(8): 701-706, 2011
ISSN 1991-8178

Hepatic Ultrasonography of Dairy Cattle in Postpartum Period : Finding the Sonographic Features of Fatty Liver Syndrome

[1]M. Mahdi Komeilian, [2]Mehdi Sakha, [2]M. Gholi Nadalian, [3]Abbas Veshkini

[1]Resident of Large Animal Internal Medicine, Specialized Veterinary Sciences, Science and Research Branch, Islamic Azad University, Tehran, Iran,
[2]Department of Large Animal Internal Medicine,Faculty of Specialized Veterinary Sciences, Science and Research Branch, Islamic Azad University, Tehran, Iran,
[3]Department of Radiology and Sonography, Faculty of Specialized Veterinary Sciences, Science and Research Branch, Islamic Azad University, Tehran, Iran,

Abstarct: Ultrasonography of the liver of 63 Holstein- Friesian cows in postpartum period (7-14 days) from an industrial dairy farm was performed. Different features of possible fatty liver were considered. Of 63 animals, 28 (44.44%) had normal and 35 (55.55%) had fatty liver features in their hepatic ultra-sonograms. Among fatty liver suspected cases, 15 (23.60%), 7 (11.11%) and 13 (20.63%) cows had mild, moderate and severe features of the disease respectively, up to our created classification. The portal vein, hepatic veins and caudal vena cava were seen in 49 (77.77%), 50 (79.63%) and 6 (9.52%) cases, respectively.

Key words: Cattle, Fatty Liver Syndrome, Sonographic Features, Ultrasonography.

INTRODUCTION

Fatty liver syndrome or hepatic lipidosis is a major metabolic disease of dairy cattle in early lactation and is associated with decreased health status and reproductive performance. Also, the varying degrees of fatty infiltration in dairy cows has been associated with different conditions including abomasal displacement (Gerloff and Herdt, 1984; Holtenius and Niskanen, 1985; Aslan *et al.*, 1998), retained placenta (Holtenius and Niskanen, 1985; Aslan *et al.*, 1998), metritis (Gerloff and Herdt, 1984), ketosis (Holtenius and Niskanen, 1985; Aslan *et al.*, 1998), hypercalcemia (Aslan *et al.*, 1998), indigestion (Aslan *et al.*, 1998) and infertility (Rowlands and Reid, 1982). Several methods have been devised to detect the fat or determine the extent of fatty infiltration in the liver (Andrews, 1998; Bobe *et al.*, 2004). Although the liver biopsy is the most reliable method of detecting fatty liver, aggressiveness of this method has made it unpleasant for clinicians and farmers (Holtenius and Niskanen, 1985; Joy *et al.*, 2003). Ultrasonography has markedly enhanced the diagnosis of hepatic disease in cattle and various hepatic diseases e.g., hepatic abscess, hepatic lipidosis, fascioliasis and caudal vena cava (CVC) thrombosis can be diagnosed through ultrasonography and ultrasound-guided liver biopsy (Braun *et al.*, 1996; Sleeter and Step, 2007). Studies in cattle and human have demonstrated that the presence of ultrasonographic features of hepatic fatty infiltration is a reliable indicator of hepatic lipidosis (Acorda *et al.*, 1994; Sleeter and Step, 2007; Bobe *et al.*, 2008; Thijssen *et al.*, 2008). Acorda et al. (1995) showed that hepatic ulrasonography is a more sensitive and specific method than biochemical analysis for diagnosis of fatty liver in the cattle (Acorda *et al.*, 1995).

The liver is imaged on the right lateral abdomen below the diaphragmatic attachment from the 5^{th} to 12^{th} intercostal space and just caudal to the 13^{th} rib. The normal liver has a homogenous hypoechoic texture. The hepatic vasculature is imaged as anechoic circular to tubular structures. The portal vein and its branches are characterized by a thin hyperechoic wall, whereas the walls of the hepatic veins are not imaged. The CVC has a triangular shape and is located more dorsal and medial than the portal vein, which is circular. Normally, arteries and intrahepatic bile ducts are not imaged in a hepatic ultrasonogram (Braun, 1996; Sleeter and Step, 2007). Hepatic lipidosis results in increased hepatic size, rounding of liver margins, increased of coarseness of echoes, increased echogenisity of the liver parenchyma near the abdominal wall, weakening of echo as distance increases from abdominal wall and poor or no visualization of hepatic vessels (Braun *et al.*, 1996; Sleeter and Step, 2007). Since the last three features are more specific for fatty infiltration of the liver, we

Corresponding Author: M. Mahdi. Komeilian, Large Animal Internal Medicine, Specialized Veterinary Sciences, Science and Research Branch, Islamic Azad University, Tehran,Iran,
Tel: 00989126097252; E-mail: komeilianmahdi@yahoo.com

used them as the indicators in this study.

This study was conducted to determine the prevalence of ultrasonographic features of hepatic lipidosis in postpartum period (7-14 days) of dairy cattle and define an ultrasonographic grading system for grading of fatty infiltration of the liver.

MATERIALS AND METHODS

Sixty-three Holstein-Friesian dairy cattle, aged 2-9 years old, from a dairy farm with population of 2000 cows near to Tehran, were selected. The cows had calved 7-14 days before the study. The site for ultrasonography was prepared by shaving the 15-20 cm long areas of 10^{th} and 11^{th} intercostals space of the right flank that its center was the boundary between the upper and middle one-third of the rib. Aquasonic coupling gel (Salem ultrasonic gel, Abzar Darman Co., Iran) was applied and B-mode ultrasonography performed using a grey-scale equipment (Aquila Pro VET, Esaote, Italy) with a 3.5 MHz transducer and a convex array electronic scanner. Several hepatic B-mode ultrasonograms were recorded as static images on the SD memory equipped on the instrument. After viewing all the ultrasonograms several times, ultrasonographic features of hepatic lipidosis were noted. Final judgement was done according to the following system:

Normal- Bright pattern of liver and absence of vessel blurring (Figure 1)

Grade 1 (mild)- Bright pattern of the liver and presence of vessel blurring but absence of marked deep attenuation (Figure 2)

Grade 2 (moderate)- Bright pattern of liver, vessel blurring and presence of marked deep attenuation; the diaphragm could been seen but blur (Figure 3).

Grade 3 (severe)- a) Bright pattern of liver, vessel blurring and presence of marked deep attenuation; the diaphragm was invisible (Figure 4) or b) There is hyperechogenisity of the nearfield and a dark shadow behind it (Figure 5)

Then the prevalence of each feature and group and visibility of different hepatic veins were calculated.

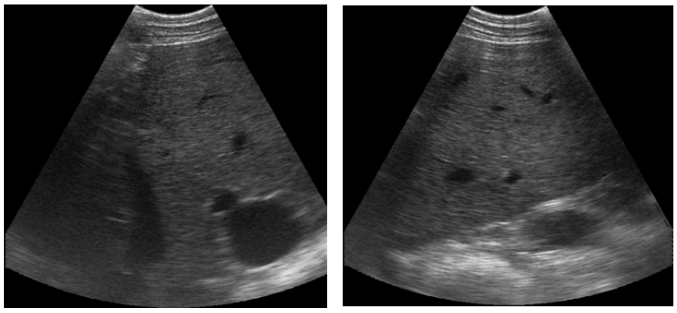

Fig. 1: Ultrasonograms of normal liver; note the homogenous granular echotexture of parenchyma and sharp obvious margins of vessels (imaged through ICS 11).

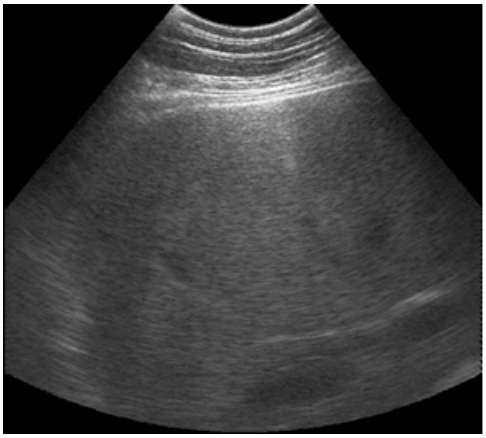

Fig. 2: Ultrasonogram of grade 1 fatty infiltration; bright pattern and vessel blurring are present, but deep attenuation is not marked (imaged through ICS 11).

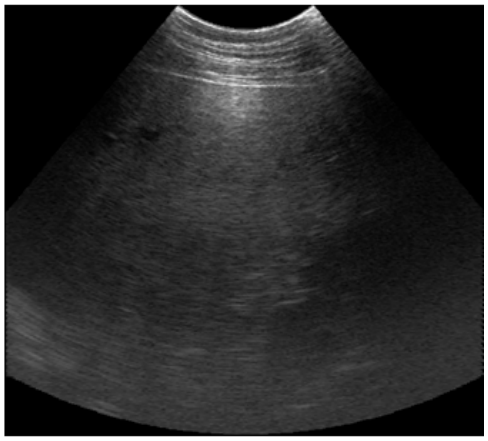

Fig. 3: Ultrasonogram of grade 2 fatty infiltration; bright pattern, vessel blurring and deep attenuation are present but diaphragm is blurly visible (imaged through ICS 11).

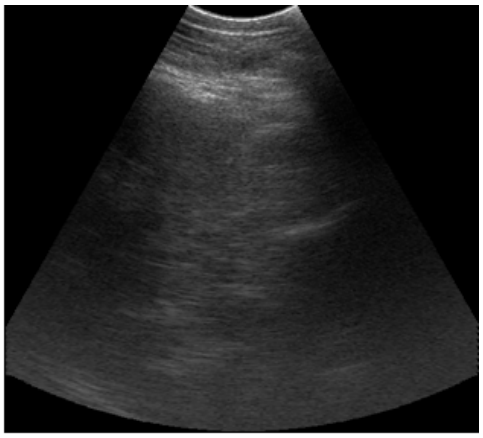

Fig. 4: Ultrasonogram of grade 3 fatty infiltration; bright pattern, vessel blurring and deep attenuation are present and diaphragm is invisible (imaged through ICS 11).

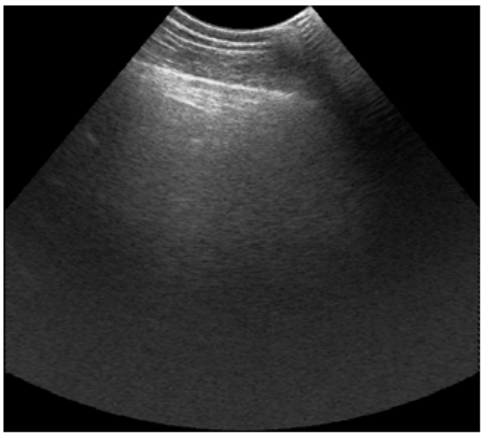

Fig. 5: Ultrasonogram of grade 3 fatty infiltration; hyperechogenisity of nearfield and a dark shadow behind it are present (imaged through ICS 11).

RESULTS AND DISCUSSION

Of 63 animals examined, 28 (44.44%) had normal features of the liver and 35 (55.55%) had ultrasonographic features of fatty liver. Among the latter 15 (23.60%) had grade 1, 7 (11.11%) had grade-2

and 13 (20.63%) had grade-3 ultrasonographic signs of fatty liver. Based on our definition of sign grading of hepatic ultrasonograms of fatty liver, the signs "bright pattern" and "vessel blurring" were present in all fatty liver cases. Visual grading of the sign "bright pattern" determined that the 7 (11.11%), 18 (28.57%) and 10 (15.87%) animals had the mild, moderate and severe degrees of this sign, respectively. The sign "deep attenuation' was seen in 20 (31.74%) of the cases, 7 (11.11%) cows could be seen but was blur and 13 (20.63%) cows the diaphragm was invisible. In the 11 (17.46%) cows, hyperechogenisity of the nearfield and the dark shadow behind it was seen. Of 63 cows, the portal veins and its branches, the hepatic veins and its branches and caudal vena cava were seen in the 49 (77.77%), 50 (79.36%) and 6 (9.52%) cases, respectively. The portal and hepatic vein but not CVC were seen in the 43 (68.25%) cases. In one (1.52%) case only the hepatic vein could be seen. In the 6 (9.52%) cows all three veins were seen. In the 13 (20.63%) cases no veins (vessels) could be seen.

Discussion:

Accumulation of fat in the liver of dairy cattle starts from 2-3 weeks before parturition and continues to 1 week postpartum because of the negative energy balance. Then the fat begins to leave the liver (Andrews, 1998). Early and safe determination of fatty infiltration in the postpartum period prevents the detrimental effects of fatty liver on the health, production and reproduction (Bobe *et al.*, 1994). In the evaluation of fatty infiltration of the liver in dairy cattle, analysis of hepatic ultrasonograms can be more reliable than biochemical analysis and less invasive than liver biopsy. Fatty changes in the liver cause specific changes in the ultrasonograms (Acorda *et al.*, 1994). The high echogenisity of fat is due to its lower acoustic impedance in contrast with that of the normal liver tissue (Braun, 1996). B-mode ultrasonograms of fatty infiltration of the liver in human and cows are characterized by increased parenchymal echo (bright pattern) and coarseness of echoes, decreased echo penetration at deeper areas of the hepatic tissue (deep attenuation) and vessel blurring (Kimura, 1989; Braun, 1996). These signs are used in this study as indicators of fatty infiltration, although the combination of the first and third signs have been known to be sufficient for the diagnosis of the disorder. In human, it has been reported that ultrasound will detect 60% of patients with fatty infiltration of the liver as a major diagnosis, the sensitivity of detection being related to the degree of infiltration. detection increases to 90% in moderate and severe fatty infiltration (Foster *et al.*, 1979). In a recent study, the sensitivity and specificity of ultrasound for detection of hepatic lipidosis were 71.1% and 72.9% (≥ 5% fat), and 85.7% and 60.4% (≥ 30% fat), respectively (Chen *et al.*, 2008). In this study, the prevalence of ultrasonographically normal and fatty livers were 44.44% and 55.55%, respectively, that means more than half the animals studied had sonographic features of fatty infiltration. Prevalence of moderate and severe fatty liver in different studies reviewed by an author, ranged between 5% to 65% (Bobe *et al.*, 2004). So, the prevalence in our study among of the highest prevalences reported from other studies. In an abattoir study in Iran, near the 80% of cows in one month postpartum period had a moderate or severe fatty liver (Rezai-Saber *et al.*, 2007).

Based on our knowledge about published researches, there is no information about grading fatty infiltration using ultrasonography in veterinary medicine. There is a study in human that graded ultrasonograms by visual examination and designed scoring, using three major parameters : A) bright liver and hepatorenal echo contrast, B) deep attenuation and C) vessel blurring. Summation of the score of A (0-3), B (0-2) and C (0-1) is the total score, if the score of A is more than one; total score is zero, if the score of A is zero (Hamagouchi *et al.*, 2007). In dairy cattle, liver-kidney contrast can not be recommended to detect the hepatic fatty infiltration (Acorda *et al.*, 1994). In this study bright pattern of liver and vessel blurring were considered the fixed criteria (present in all cases of fatty infiltration) and the sign "deep attenuation" was used for grading the abnormal cases. This sign was seen in 31.74% of all cases and 20/35% of fatty liver cases. Among them in 11.11% of cows the diaphragm could be seen blurly and in 20.63% of cases it was invisible. Severe deep attenuation causes the hyperechoic nearfield and the dark shadow behind it. This sub-criterion was seen in 17.46% of cases. In a study, using bright pattern of liver as determined by digital analysis of hepatic ultrasonogram as the as the diagnostic criterion for fatty for fatty infiltration, the overall sensitivity was 38.5% and specificity was 88.5%. Using deep attenuation as a criterion, the sensitivity and specificity were 65.4% and 84.6%, respectively. Using both bright pattern and deep attenuation theses parameters were 38.5% and 100%. For severe fatty infiltration, the sensitivities for bright pattern, deep attenuation and both of them were 83.3%, 100% and 83.3%, respectively (Acorda *et al.*, 1994). Sensitivity of ultrasound images for detecting fat increases with degrees of lipidosis (Joy *et al.*, 2003). Results of another study suggested that bright pattern had a 90.8% specificity and 70.3% sensitivity for detection of fatty infiltration. These parameters were 99.4% and 56.8% for deep attenuation, and 95.1% and 62.2% for vessel blurring, respectively (Acorda *et al.*, 1994).

There is no data about visualization of different veins in hepatic ultrasonograms. In this study, the portal veins, the hepatic veins and CVC were seen in 77.77%, 79.36% and 9.52% of cases. The low possibility of CVC visualization is related to deep situation of this vein in a hepatic ultrasonogram. In 20.63% of cows no veins could be seen because of fatty infiltration or superimposition of kidney on the liver.

In conclusion, attempting to find a non-invasive and reliable diagnostic method for detection of fatty infiltration of the liver, alternate to liver biopsy, ultrasound scanning, gives a high degree of certainty and is a reasonable alternative for liver biopsy in certain circumstances, specially transition period. The current study suggests a qualitative grading system based on the criterion "deep attenuation" for detecting the degree of fatty infiltration. Evaluation of this grading system needs more clinical and biochemical comparisons in future studies.

REFERENCES

Acorda, J.A., M.H. Yamada and S.M. Ghamsari, 1994. Evaluation of fatty infiltration of the liver in dairy cattle through digital analysis of hepatic ultrasonograms. Veterinary radiology and ultrasound, 35(2): 120-123.

Acorda, J.A., M.H. Yamada and S.M. Ghamsari, 1994. Ultrasonographic features of diffuse hepatocellular disorders in dairy cattle. Veterinary radiology and ultrasound, 35(3): 196-200.

Acorda, J.A., M.H. Yamada and S.M. Ghamsari, 1994. Ultrasography of fatty infiltration of the liver in dairy cattle using liver-kidney contrast. Veterinary radiology and ultrasound, 35(5): 400-404.

Acorda, J.A., M.H. Yamada and S.M. Ghamsari, 1995. Comparative evaluation of fatty infiltration of the liver in dairy cattle by using blood and serum analysis, ultrasonography and digital analysis. Veterinary radiology and ultrasound, 17(1): 12-14.

Andrews, T., 1998. Ketosis and fatty liver in cattle. In practice, 20(9): 509-513.

Aslan, V., R. Ast, M. Nizamlioglu, T. Tekeli, A. Basoglo and U. Demirci, 1998. The fatty liver syndrome in cows associated with some puerperal disorders. Veteriner facultesi dergisi, Selcul universitesi, 4: 43-51.

Bobe, G., J.W. Young and D.C. Beitz, 2004. Pathology, etiology, prevention and treatment of fatty liver in dairy cows. Journal of dairy science, 87: 3105-3124.

Bobe, G., V.R. Amin, A.R. Hippen, P. She, J.W. Young,and D.C. Beitz, 2008. Non-invasive detection of fatty liver in dairy cows by digital analyses of hepatic ultrasonograms. Journal of dairy research, 75: 84-89.

Braun, U., 1996. Ultrasonographic examination of the fatty liver and gallbladder in cows. Part 1. Normal findings. Compendium. 18, supplement food animal medicine and management: S61-S72.

Braun, U., N. Pusterla and K. Wild, 1996. Ultrasonographic examination of the fatty liver and gallbladder in cows: Abnormal findings. Compendium, 18(11): 1255-1269.

Chen, C.H., S.T. Lin, C.C. Yang, Y.H. Yeh, C.L. Kuo and C.K. Nien, 2008. The accuracy of sonography in predicting steatosis and fibrosis in chronic hepatitis C. Dig. Dis. Sci., 53: 1699-1706.

Foster, K.J., K.C. Dewbury, A.H. Griffith and R. Wright, 1979. The accuracy of ultrasound in the detection of fatty infiltration of the liver. Br. J. Radiol., 53: 440-442.

Gerloff, B.J. and T.H. Herdt, 1984. Hepatic lipidosis from dietary restricting cows. JAVMA, 185: 223-224.

Hamagouchi, M., T. Kojima, Y. Itoh, Y. Harano, K. Fuji, T. Nakajima, T. Kato, N. Takeda, J. Okuda, K. Ida, Y. Kawahito, T. Yoshikawa And T. Okanoue, 2007. The severity of ultrasonographic findings in nonalcoholic fatty liver disease reflects the metabolic syndrome and visceral fat accumulation. American journal of gastroenterology, 102: 2708-2715.

Holtenius, P. and R. Niskanen, 1985. Fatty changes of liver cells in cows with abomasal displacement. Dtsch. Tierarzt. Wochenschr., 92: 398-400.

Joy, D., V.R. Thava and B.B. Scott, 2003. Diagnosis of fatty liver disease: is biopsy necessary? European journal of gastroenterology, 15: 539-543.

Kimura, S., 1989. Quantitative estimation of the liver parenchymal echo pattern using acoustic intensive histogram (echo-histogram) analysis in diffuse liver diseases. Japanese journal of medicine, 78: 1-7.

Rezai-Saber, A.P., M. Nouri, A. Shahriari, A. Rasouli And R. Fatemi-Tabatabai, 2007. Hepatic trigelicerides and plasma non-esterified fatty acids and albumin levels in cross breed cows in Ahvaz City of Khuzestan Province of Iran; An abattoir study. Pakistan journal of biological science, 10(17): 2940-2944.

Rowlands, G.J. and I.M. Reid, 1982. The link betweem fatty liver, blood metabolites and fertility in dairy cattle. Proc 12th world congress on diseases of cattle, the Netherlands, 533-536.

Sleeter, R.N. and D.L. Step, 2007. Diagnostic ultrasonography in ruminants. Veterinary clinics of North America: Food animal practice, 23(3): 541-574.

Thijssen, J.M., G. Weijers, A. Haudum, K. Herzog, P. Wohlsein, J. rehage and C.L. De Korte, 2008. Computer aided B-mode ultrasound diagnosis of hepatic steatosis: A feasibility study. IEEE transactions on ultrasonics, ferroelectrics and frequency control, 55(6): 1343-1354.