Evaluation of gallbladder volume and contraction index with three-dimensional ultrasonography in healthy dogs

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Abstract. Three-dimensional (3D) ultrasonography has been shown to be an accurate and appropriate tool for measurement of gallbladder volume in humans. Therefore, we applied this novel technique for the first time to study fasting and postprandial gallbladder volume in 10 healthy dogs and compared the results with those of 2-dimensional (2D) ultrasonography. Fasting gallbladder volumes determined by 3D ultrasonography were significantly higher than corresponding volumes determined by 2D ultrasonography (P<0.01). Additionally, gallbladder volumes were significantly decreased in the postprandial state compared with the fasting state using 3D ultrasonography (P<0.001), but 2D ultrasonography showed no significant difference (P=0.189). The Gallbladder contraction index was higher in 3D ultrasonography than 2D ultrasonography; however, it did not reach statistical significance (P=0.25). In conclusion, 3D ultrasonography was able to measure gallbladder volume in healthy dogs in this study. It is suggested that 3D ultrasonography can be used to accurately estimate gallbladder volume and contractility.

Keywords: canine, gallbladder contraction index, gallbladder volume, ultrasonography


Normally, mechanical cleansing of the gallbladder has an important protective effect against the accumulation of stagnant biliary debris [22]. At meal time, neurohumoral mechanisms stimulate the contraction of the gallbladder muscular wall that coordinates with relaxation of the sphincter of Oddi [19, 22]. Structural changes or inflammation of the gallbladder can reduce gallbladder motility and impair emptying, which result in the accumulation of bile in the lumen of the gallbladder [9, 18, 22]. Due to impairment of gallbladder emptying, the gallbladder epithelium is exposed to concentrated bile acids for a long time, which is believed to play a role in the pathophysiology of biliary tract diseases, such as gallbladder mucocoele, cholecystitis and cholelithiasis [27, 32]. Since impaired gallbladder emptying may eventually lead to several gallbladder diseases, evaluation of gallbladder motility requires an accurate and appropriate methodology.

Among the methods that have been used to measure gallbladder volume, real-time ultrasonography is an accurate, reproducible, noninvasive, cheap, relatively easy, and widely available method for studying gallbladder volume variations [7, 12, 19–21]. In dogs, 2 dimensional (2D) ultrasonography has been used widely to determine gallbladder volumes, mostly by the ellipsoid method [1, 3, 8, 22, 23, 27]. However, 2D ultrasonography is operator dependent, and deviations of gallbladder shape could affect the results [25, 26]. Three-dimensional (3D) ultrasonography is an emerging technology that has been developed to estimate gallbladder volumes. This method has been shown to be an accurate and appropriate tool for the measurement of organ volume in both dogs and humans [2, 6, 13–16, 24, 29, 30]. A potential advantage of 3D ultrasonography for measuring gallbladder volume is that a sagittal section of the gallbladder at its maximal diameter is not required, which may be useful in patients with irregular gallbladder shapes. Thus, the 3D ultrasonography technique may better take into account variations in gallbladder shape [17, 25]. To the best of our knowledge, thus far there have been no reports about using 3D ultrasonography for measuring gallbladder volume in healthy dogs or dogs suffering from gallbladder diseases. Therefore, the aim of this study was to assess the effect of ingestion of full-fat milk on gallbladder volume and gallbladder contraction index (GBCI) using 2D and 3D ultrasonography in healthy dogs.

Ten healthy mixed-breed dogs (4 intact males and 6 intact females) were included in this study. The dogs' body weights ranged from 18 to 33 kg (mean 26.7 kg), and their ages ranged from 2 to 5 years (mean 2.7 years). They were fed a standard diet, had free access to water and were housed under optimum condition. Health status of each dog was determined based on history, physical examination, complete blood count, serum biochemistry and ultrasonography assessment. All dogs were handled in accordance with the Guidelines for the Care and Use of Laboratory Animals as adopted by the Ethics Committee of the Faculty of Veterinary Medicine of the University of Tehran.

The dogs were fasted, but had free access to water for 12 hr (overnight) prior to the experiment. Each of the dogs was placed in dorsal recumbency, and the hair was clipped from the cranioventral abdomen; between the xiphisternum and the umbilicus and extending several centimeters on each side of the midline. Ingestion of full-fat milk (3% fat, 3.3%