Liver Biopsy in Cattle

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Introduction

A technique to safely obtain liver samples from living cattle has application in toxicology, nutrition, metabolic and infectious disease research, and in diagnostic procedures. Numerous literature reports on liver biopsy in cattle describe techniques employing needles that are modifications and variations of a technique used in sheep (1). The biopsy needles are from commercial sources or custom made. The needles are often adapted to a plastic syringe, and negative pressure is used to hold the biopsy in the needle. Liver samples collected are approximately 50 to 500 mg (wet weight) and are used in research on trace mineral metabolism and diagnostic testing. The techniques estimate the location in the liver to be biopsied.

A technique to view the liver site to be biopsied and to collect liver samples large enough for vitamin A—carotene analysis—usually 2 to 5 gm was previously described (2). The technique was used to obtain repeated biopsies for information on vitamin A—carotene metabolism in cattle during reproduction and lactation (3,4). While satisfactory liver samples were obtained, improvements in the biopsy instrument were desired. This report is on the improvements of the instruments to collect 2 to 8 gm (wet weight) samples and a technique to view the liver site and adjacent region before biopsy. Progress reports on the technique have been made (5,6).

Biopsy Instrument

In collecting liver biopsies that are larger than 0.5 to 1 gm in cattle it can be difficult to sever the liver sample at the distal end of the core—even using negative pressure from an attached syringe or suction device. The larger biopsies require cutting the liver at the distal end and maintaining it within the instrument while removing the instrument from the abdominal cavity.

The biopsy instrument (Figure 1) is constructed of stainless steel and fabricated by Stanley Smydra.[a] It is designed for use in conjunction with a fiber optic-adapted sigmoidoscope[b] used as a continuous light source to view the site to be biopsied and as a cannula for the biopsy instrument. The biopsy cylinder or "head" of the instrument is 1.5 cm in diameter and 5 cm long and has a sharp cutting edge. This size head enables one to obtain a 2 to 8 gm biopsy depending on how deeply it is inserted into the

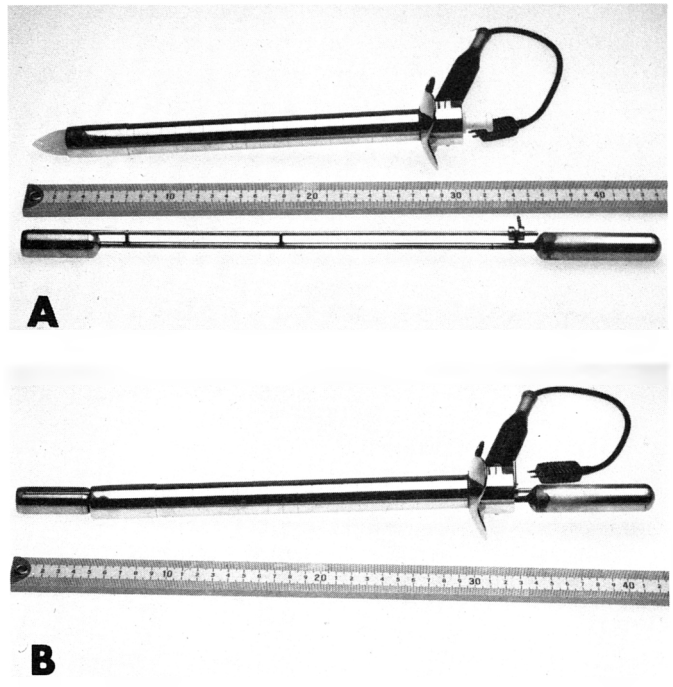

FIGURE 1. Liver biopsy instruments. A. The 27 mm x 25 cm, Welch Allyn fiber optic-adapted sigmoidoscope (above) is used to penetrate the abdominal cavity, locate and view the site on the liver to be biopsied and as a cannula for the biopsy instrument (below). The end of the trocar on the sigmoidoscope has been sharpened to a diamond shaped point to penetrate the abdominal cavity. The stainless steel biopsy instrument has a lever at the handle end that is on a rod that controls a knife at the distal end of the cylinder or "head." By means of a ratchet on the lever, the knife is maintained in an open or closed position. B. The biopsy instrument fits inside the sigmoidoscope and the lever on the biopsy instrument is a guide as to the depth the biopsy instrument penetrates the liver. The maximum depth is 5 cm.

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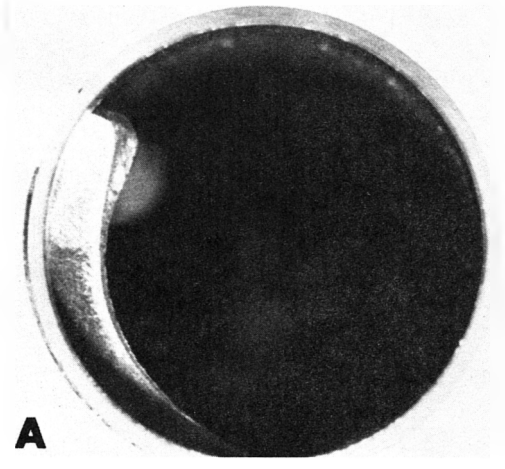
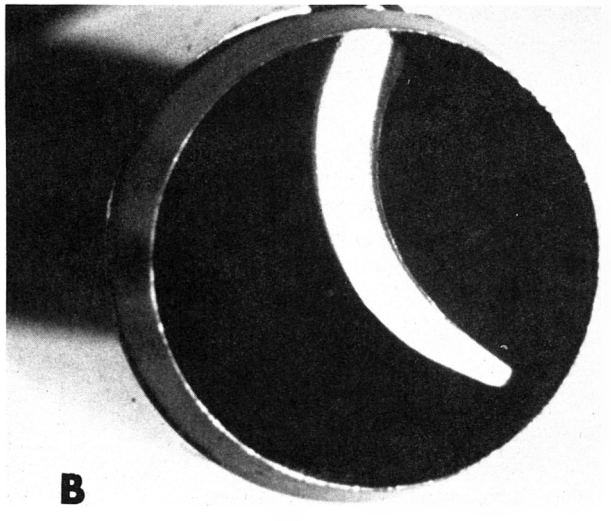
liver. At the distal end of the cylinder a knife is recessed in a slot in the cylinder. The knife is attached to a rod and operated at the handle end of the instrument. The rod is in a slot in the longitudinal wall of the cylinder which allows air in the head to escape while the head penetrates the liver. The rod is attached to a lever on the handle that maintains the knife in an open or closed position by a ratchet. When open, the blade is recessed in the slot in the wall of the cylinder and when closed extends more than one-half way across the cylinder to cut and hold the liver sample (Figure 2). The length of the instrument is such that when inserted in the fiber-optic cannula the head of the instrument does not penetrate the liver beyond 5 cm. The depth of penetration (and size of sample) can be estimated by the distance between the top of the cannula and the lever on the biopsy instrument.

FIGURE 2. A. In the open position the knife is recessed in a slot in the cylinder wall while the head penetrates the liver. B. In the closed position the knife is more than one-half way across the cylinder and by turning the instrument, the core at the distal end is severed and maintained in the head while the instrument is removed.



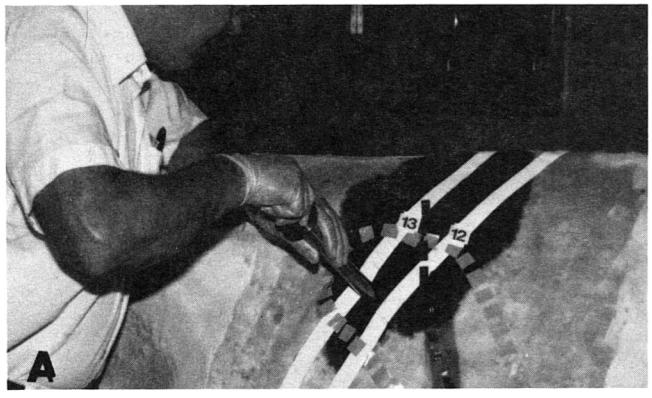


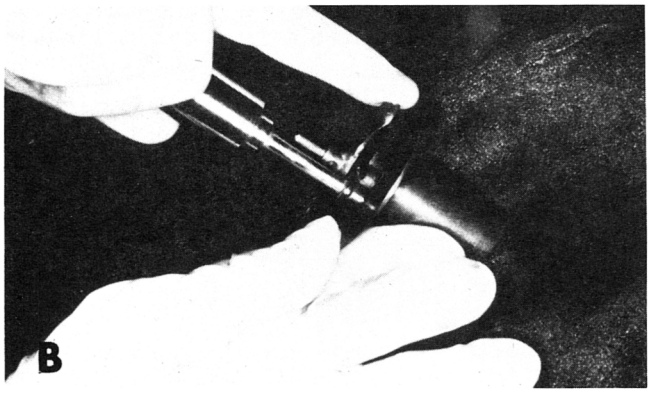
Technique

The most suitable restraint for cattle for liver biopsy is the standing position in a squeeze type chute with a minimum amount of physical restraint (Figure 3). The preferred surgical site is the right 12th intercostal space, approximately 30 cm from the dorsal midline (Figure 4). Following appropriate surgical preparation of the area and local or regional anesthesia, a 4 cm incision is made in the intercostal space. The fiber optic adapted sigmoidoscope (with trocar) is placed in the incision and with a sharp thrust is directed slightly caudally and ventrally through the abdominal wall and peritoneum. The trocar is removed, the sigmoidoscope is directed forward, and the dorsal ligament of the liver is visualized. The preferred biopsy area is anterior and approximately 6 cm ventral to the triangular ligament. The sigmoidoscope is gently pressed against the liver while the biopsy instrument is inserted through the cannula. The biopsy instrument is placed on the site and with a clockwise twisting movement the liver parenchyma is penetrated. When the depth of the liver is penetrated to obtain the desired amount of tissue, the lever at the handle is closed and the instrument rotated several times to completely cut the core at the distal end. The instrument with the core is then removed. The cannula is maintained at the biopsy site, and if hemorrhage is present a piece of gelfoam may be placed where the sample was taken. The sigmoidoscope is removed followed by appropriate suturing and dressing the incision.

FIGURE 3. The standing position is preferred for liver biopsy in cattle. A squeeze chute or simple stall is sufficient, when local or regional anesthesia is used.

FIGURE 4. A. The location for biopsy is at the 12th intercostal space, approximately 30 cm lateral and ventral from the dorsal midline. At first the sigmoidoscope is directed slightly caudally and ventrally to avoid lacerating the liver. The long dotted lines indicate the approximate attachment of the diaphragm and the short bars the liver. B. When the liver is penetrated to obtain the size of sample desired, the lever is changed to the closed position, rotated to completely sever the sample, and maintain it in the cylinder while the instrument is removed.





Experimental Application

Liver values for vitamin A were determined before and after vitamin A was given orally or intramuscularly to cows. Six nonpregnant cows were used. Previous to and during the experiment, they were each fed the same amount of total ration, which consisted of timothy hay and a concentrate mixture of corn, soybean meal, and a complete mineral mixture. A liver biopsy and serum sample were initially collected from each cow. Three cows were each given 5,000,000 I.U. of vitamin A palmitate by one injection into the triceps femoralis muscle. The three other cows were each given 5,000,000 I.U. of vitamin A palmitate orally in a gelatin capsule. One week after the first biopsy a second biopsy and serum sample were collected. The results of the changes in the content of vitamin A in the liver and serum are summarized (Table 1). While the data are limited, they suggest that intramuscular injection of vitamin A increases liver values more than when the same amount was given orally. Serum values were influenced only slightly.

TABLE 1. Vitamin A, liver and serum values before and after administration orally or intramuscularly.

Method of Administration	No. Cows	Value at 1st Biopsy	Value at 2nd Biopsy*	% Change
Mean Liver Values (Total) (ug/gm) Dry Wt**				
Intramuscular	3	205	302	+47.5
Orally	3	178	231	+29.7
Mean Serum Values (Total) mg/ml				
Intramuscular	3	261	270	+3.4
Orally	3	251	236	-5.9

* One week after 1st biopsy.
** Total = palmitate + retinol form of vitamin A.

Discussion

Satisfactory, 2 to 8 gm, liver samples were obtained in 112 liver biopsies involving 49 cows used in experiments on vitamin A metabolism, starvation, and the fat cow syndrome (6). Single to as many as 4 biopsies were obtained from cows over a period of 8 weeks. The 12th intercostal approach for biopsy of the liver avoids the undesirable effects of penetrating the diaphragm and pleural cavity. The advantage of avoiding penetration of these tissues have been mentioned in a previous report (7). The fiber optic-adapted sigmoidoscope with a continuous light source allows a clear view of the site to be biopsied and areas to be avoided such as the kidney, vena cava, duodenum, gallbladder, previous biopsy sites, and any possible abscesses. An improvement would be if it had a diameter of 2.5 cm as it would enhance vision in the abdominal cavity and more easily accommodate the biopsy instrument. Additional information on anatomical considerations may be obtained (2,8). The intercostal approach using the fiber optic-adapted sigmoidoscope would seem to also have advantages when using the needle type biopsy in that injuries would be reduced and samples of liver could be collected from the same area. The location is somewhat more ventral than that suggested previously (2) in that it avoids the right kidney, vena cava, and duodenum. There is also less subcutaneous tissues and musculature at the more ventral location. The biopsy instrument was effective in severing the distal core and obtaining non-mutilated liver samples. The stainless steel structure provided durability, allowed sterilization and maintained a sharp cutting edge. The size of the cylinder head could be modified depending on the size of liver sample required. The described size was a compromise in that if it was longer it might penetrate

too deeply into the liver and sever large vessels. Thus, the larger diameter cylinder was used to collect sufficient tissue and be less injurious than a longer one. The site on the liver for biopsy was an area with a minimum amount of large blood vessels (9) and approximately 9 cm thick.

There has been concern as to whether one biopsy sample is representative as to the nutrient content of the entire liver. In this, and in previous studies, one sample was a reliable indication of the vitamin A content of the whole liver (3,4,6). Taking the sample at the same location of the liver in all cattle would tend to minimize the concern as to any variability of substance in different locations in the liver. The application of the technique to vitamin A metabolism suggests the liver is a better indicator of the vitamin A nutritional status of cattle than blood values. This finding is in agreement with previous reports (4,10). This might be true of other nutrients and metabolic products. Serum or plasma values are perhaps more of a reflection of dietary intake.

The technique to use will depend on the size of liver sample required, age of animal, design of the experiment, and other factors. The technique described is used to obtain rather large biopsies in a specific location in the liver. Repeatability or taking samples from the same area of the liver at intervals of time in the same animal would have advantages in experimental work. Satisfactory results have been reported in collecting smaller liver samples using needle biopsy techniques (11,12). Some of the complications using needle biopsy and estimating the location of the liver have been mentioned (12). In a comprehensive review (13) it was emphasized that a liver biopsy technique can be a useful and informative procedure in cattle to confirm the presence and etiology of liver disease.

Summary

Liver biopsy can be a safe, simple, and reliable technique to obtain information on the liver content of nutrients, drugs, chemicals, and metabolic products. The technique is suitable for a wide variety of research and diagnostic application in cattle. The additional information obtained could contribute to improved and efficient cattle production.

References

1. Dick, A.T. 1952. Improved apparatus for aspiration biopsy of the liver in sheep. Aust. Vet. J. 28:234. 2. Whitehair, C.K., D.R. Peterson, W.J. VanArsdell et al. 1952. A liver biopsy technique for cattle. J.A.V.M.A. 121:285. 3. VanArsdell, W.J., C.K. Whitehair and R. MacVicar. 1951. A liver biopsy technique and observations of its use in vitamin A studies with beef cattle. J. Ani. Sci. 10:1064. 4. Baker, F.H., R. MacVicar, L. Pope and C.K. Whitehair. 1953. Placental and mammary transfer of vitamin A and carotene by beef cows. Proc. Soc. Exp. Bio. & Med. 83:571. 5. Ames, N.K., R.B. DaSilva and C.K. Whitehair. 1980. Instrumentation and technique for obtaining percutaneous liver biopsies suitable for chemical analysis in cattle. Proc. XI Int. Cong. on Diseases of Cattle 1438. 6. DaSilva, R.B. 1981. A liver biopsy technique and its use in cattle disease research. Ph.D. Thesis, Michigan State University. 7. Garner, R.J. 1950. Aspiration biopsy of the liver in cattle. Vet. Rec. 62:729. 8. Getty, R., S. Sisson and J.D. Grossman. 1975. Anatomy of Domestic Animals, 5th Ed. W.B. Saunders Co. Phil 1211. 9. Julian, L.M. and K.B. DeOme. 1949. Studies on the subgross anatomy of the bovine liver I. The distribution of the blood vessels and bile ducts as revealed by the vinylite-corrosion technique. A.J.V.R. 10:331. 10. Martin, F.H., D.E. Ullrey, E.R. Miller et al. 1971. Vitamin A status of steers as influenced by corn silage harvest date and supplemental vitamin A. J. Ani. Sci. 32:1233. 11. Herdt, T.H., L. Goeders, J.S. Liesman and R.S. Emery. 1983. Test for estimation of bovine hepatic lipid content. J.A.V.M.A. 182:953. 12. Smart, M.E. and M.J. Northcote. 1985. Liver biopsies in cattle. The Comp. on Continuing Ed. 7:S327. 13. Pearson, E.G. and A.M. Craig. 1980. The diagnosis of liver disease in equine and food animals. Modern Vet. Pract. 233 & 315.