Development of a bovine liver biopsy training model

*Filipe Silva and Isabel Pires**

Abstract

In veterinary medicine, liver biopsy is a standard diagnostic procedure for studying liver disease in animal species, including cows. Some common indications for liver biopsy in cattle include clinical signs of liver disease (e.g., anorexia, jaundice, lethargy), unexplained weight loss, and monitoring of health and nutritional status. This technique comes with certain risks, such as haemorrhage, infections, and lesions of other organs, so it should only be carried out by a trained and experienced veterinarian. The Clinical Skills Laboratory is a structured teaching laboratory that provides hands-on experience to veterinary medicine students in a safe, controlled environment. The laboratory focuses on developing practical competencies in various veterinary procedures. This paper presents the development of a model for performing liver biopsy in cattle and discusses the importance of the skills lab in veterinary medicine learning. This model enables students to learn how to perform a liver biopsy in cattle and the basic rules of sampling and fixation of the specimen for histopathological examination. It is accompanied by detailed work instructions and illustrations to assist the student in performing the procedure. This kind of laboratory is indispensable in veterinary medical training, as it helps students strengthen their skills and confidence, preparing them for a successful career in veterinary medicine. In addition, it allows for the execution of techniques that would not be practised on a live animal during classes.

Key words: *models; skills lab; bovine; liver biopsy*

Introduction

The liver plays a crucial role in cattle metabolism, detoxification, and immune response. Understanding and ensuring liver health is essential for the animal wellbeing, particularly on farms. Liver diseases in cattle can significantly impact their productivity and welfare. Typical problems involve infections, toxic reactions to feed contaminants and metabolic disorders. Early and accurate diagnosis is crucial for effective treatment and management.

Liver biopsies are a tool that could be crucial to this diagnostic process by allowing direct examination of liver tissue. This technique is often necessary for clinical indications such as clinical signs of liver disease (e.g., anorexia, jaundice, lethargy) or unexplained weight loss in cattle. A specific focus is on conditions like Fatty Cow Syndrome, frequently observed in postpartum cows and known for its challenging prognosis. Liver biopsies play a pivotal role in the diagnostic process,

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formulating effective therapeutic strategies. Bovine liver biopsy can also be used as a potentially standard method of monitoring the health and nutritional status of dairy cows, such as measuring levels of trace minerals like zinc, selenium, copper, and manganese (Braun, 2009; Imran et al., 2011; Loeffler, n.d).

Despite its usefulness, there are risks associated with liver biopsy procedures in cattle. Intrahepatic haematoma (Conn, 1974), haemorrhaging, potential infections such as peritonitis pneumothorax, damage to adjacent organs, and death (Babb and Jackman, 1989; Mølgaard et al., 2012)are some of the complications that have been reported after the procedure. Thus, the biopsy must be carried out by veterinarians who are not only skilled but also experienced.

Addressing the need for knowledge and training for clinical practice, the Clinical Skills Laboratories have emerged as innovative and structured teaching solutions within veterinary education. These kinds of laboratories are designed to offer hands-on, practical experience to veterinary students in a controlled, risk-free environment. Emphasising the development of practical competencies, the labs facilitate learning and mastery of a range of essential veterinary procedures (Al-Elq, 2010; Bugaj and Nikendei, 2016; Sam et al., 2023).

This paper describes the development of a training model designed explicitly for performing liver biopsies in cattle. This model is a crucial educational tool, enabling students to learn the procedural aspects of conducting a liver biopsy and the fundamental principles of specimen sampling and fixation for subsequent histopathological examination. Accompanied by comprehensive work instructions and supported by illustrations, this model empowers students to perform the procedure independently, thereby reinforcing their learning experience.

The Bovine Liver Biopsy Model

The model simulates the right-side flank of cattle and includes a Tru-Cut® type biopsy needle and other relevant equipment. It allows students to practice identifying the biopsy site and the technique of inserting the needle and collecting liver samples.

Material

This model consists of a sponge, a polyethene foam sheet moulded in wood, where the last ribs and the tuber coxae are represented in relief using a mouldable plastic material (such as hot glue or silicon). The model is then covered with a skin-like leather material. On the opposite side, a rigid polyurethane floral foam brick is mounted at the appropriate location to represent the liver (Figure 1).

Tru-Cut® Needle: The Tru-Cut® needle is characterised by its unique dual-part mechanism, which facilitates precise tissue sampling.

External Polyurethane Floral Foam Brick: This external sponge is a practical and safe medium for training. It simulates the resistance and texture encountered in actual medical procedures.

Recipient with water: This is used to simulate the fixation of the sample post-biopsy.

Procedure and Execution

Step 1: Training on an External polyurethane floral foam brick

First, students practice on a foam brick to familiarise themselves with the needle's operation.

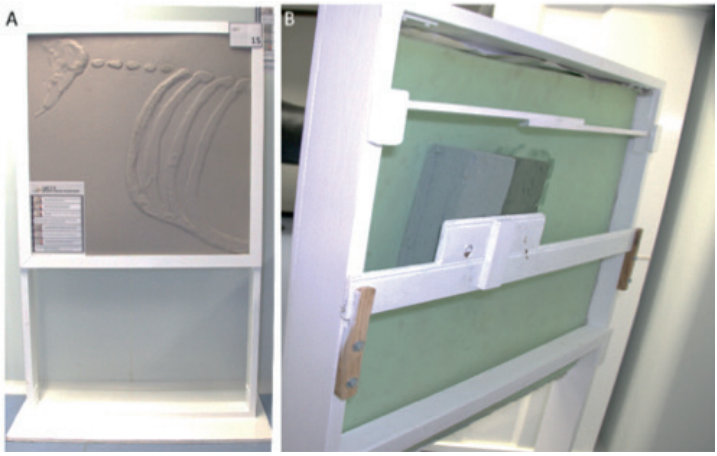

Figure 1. Image of the Liver Biopsy Model: A: Front view; B: Back view

The technique involves careful insertion of the closed Thru-Cut needle into the external foam brick. Insertion depth varies between 3 to 20 centimetres, depending on the training scenario. This step simulates the initial penetration into tissue during a biopsy (Figure 1). In the second step, the practitioner advances the needle's inner part while maintaining the outer part's stability with the other hand. This action mirrors the coordination required in actual veterinary procedures.

Subsequently, the outer part of the needle is advanced, while the inner part is held steady. During this phase, the Thru-Cut needle performs its essential function – cutting and securing the tissue sample. This step is critical as it closely simulates the biopsy sampling process. After sampling, the needle is withdrawn from the foam brick. Observing the tissue fragment within the needle is crucial for understanding the efficacy of the sample collection technique. The obtained sample is then placed in a container with a 10% buffered formalin fixative. This step is vital for preserving the sample for subsequent histopathological examination, mirroring the post-procedure handling in clinical settings. The technique is outlined in Figure 2.

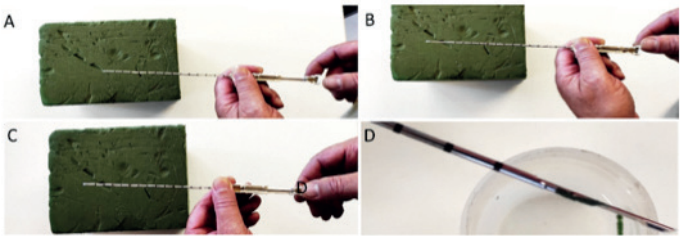

Figure 2. Summary of the Liver Biopsy Procedure on the External foam brick: A: Insertion of the closed Thru-Cut needle. B: Advancing the needle's inner part while stabilizing the outer part. C: Advancing the outer part of the needle, keeping the inner part steady. D: Needle withdrawal and placement of the sample in a fixative.

Step 2: Training on the model of the flank and right back of cattle

The steps include identifying the biopsy site, preparing the site, and using the correct technique for inserting the biopsy needle and collecting the liver sample.

Initially, identify the 10th or 11th intercostal space on the bovine subject to ascertain the correct site for insertion of the biopsy needle. This specific space is located by counting backwards from the final intercostal gap, given that cattle have a total of 13 ribs and consequently, 12 intercostal spaces. Therefore, the 10th space is counted as the third space from the last.

Then, conceptualise an imaginary line from the tuber coxae (also known as the hook bone) leading towards the elbow. The point where this line intersects with the 10th or 11th intercostal space presents a viable site for needle insertion. As an alternative, you can also visualise a line emanating from the greater femoral trochanter, extending horizontally. The meeting point of this horizontal line with the 10th intercostal space is another landmark that can be used for needle insertion.

Typically, within this 10th or 11th intercostal space, a suitable biopsy area emerges, approximately two inches in

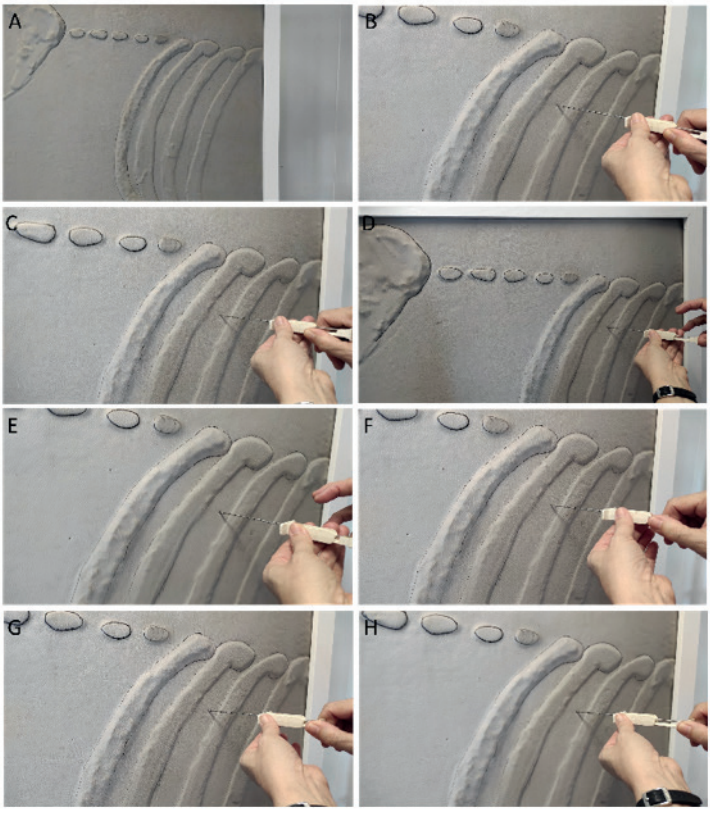

Figure 3. Execution of Hepatic Biopsy Training on the Model: A, B: First, locate the 10th or 11th intercostal space. C, D: Insert the needle. E, F: Advance the needle's inner part while stabilizing the outer part. G, H: Advance the outer part of the needle, keeping the inner part steady performing the cutting action.

width, nestled between these two hypothetical lines. To ensure precision, this methodology should be mirrored on the external flank of the cattle, as depicted in Figure 3.

Discussion

The liver biopsy is a crucial diagnostic tool, offering deep insight into liver health and aiding in the early detection and management of liver diseases. These procedures are indispensable in assessing trace mineral levels in cattle, including zinc, selenium, copper, and manganese, essential for continuous health monitoring and diagnosing conditions like Fat Cow Syndrome. However, performing liver biopsies requires skill to minimise animal and operator risks. Consequently, real-world training opportunities for such procedures are limited.

To address this, the authors present a model, innovatively designed and crafted by the author (FS), which has been instrumental in developing these skills among students. The importance of this training model in a veterinary skills laboratory setting is profound. It is a fundamental component of contemporary veterinary education, seamlessly integrating theoretical knowledge with practical skills. This model provides a safe, ethical environment for practice, eliminating the need for initial training on live animals and adhering to ethical standards in veterinary education.

This hands-on approach in the skills lab significantly enhances the confidence and competence of aspiring veterinarians. It equips them for real-world challenges, ensuring they can perform intricate medical procedures like liver biopsies with precision and care. Additionally, the model is crucial for deepening student understanding of animal anatomy, disease pathology, and the complexities of veterinary surgical procedures, thus playing a key role in developing well-rounded, proficient veterinarians ready to contribute significantly to animal health and welfare. The bovine liver biopsy training model is an invaluable addition to veterinary education. It enhances the learning experience, ensures ethical treatment of animals, and prepares future veterinarians for successful careers.

In conclusion, developing a bovine liver biopsy training model in a Clinical Skills Laboratory marks a notable advancement in veterinary medical training. It exemplifies the harmonious blend of innovative teaching and practical skill development, preparing the next generation of veterinarians to be adept, ethical, and ready for the challenges of the veterinary field. This model is especially beneficial for diagnosing and monitoring liver diseases in cattle.

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Razvoj modela za uvježbavanje izvođenja biopsije jetre goveda

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U veterini, biopsija jetre standardni je dijagnostički postupak za proučavanje bolesti jetre u životinja, uključujući krave. Neke od najčešćih indikacija za biopsiju jetre u goveda uključuju kliničke znakove bolesti jetre (npr. anoreksija, žutica, letargija), neobjašnjeni gubitak tjelesne mase i praćenje statusa zdravlja i uhranjenosti. Ova tehnika donosi određene rizike, poput krvarenja, infekcija i lezija drugih organa, stoga bi ju trebao izvoditi uvježban i iskusan veterinar. Laboratorij za stjecanje kliničkih vještina je strukturirani edukativni laboratorij koji osigurava praktično iskustvo studentima veterine u sigurnom, kontroliranom okruženju. Laboratorij je usredotočen na razvijanje praktičnih kompetencija u različitim veterinarskim postupcima. U ovom članku, autori predstavljavljaju razvoj modela za izvođenje biopsije jetre u goveda i raspravlja o značaju laboratorija za stjecanje vještina u veterinarskom obrazovanju. Ovaj model omogućuje studentima naučiti kako obaviti biopsiju jetre u goveda, kao i osnovna pravila uzorkovanja i fiksiranja uzorka za patohistološku analizu. Popraćen je detaljnim uputama za rad i ilustriran slikama tako da student može sam obaviti postupak. Ova vrsta laboratorija neophodna je za edukaciju u veterini i pomaže studentima ojačati njihove vještine i samopouzdanje, pripremajući ih za uspješnu karijeru u veterinarstvu. Uz to, dopušta izvođenje tehnika koje se ne bi uvježbavale na živim životinjama tijekom predavanja.

Ključne riječi: *modeli, laboratorij za stjecanje vještina, govedo, biopsija jetre*