Use of B-Mode, Linear Array Ultrasonography for Evaluating the Technique of Bovine Artificial Insemination

W. E. BEAL, R. B. EDWARDS, III, and J. M. KEARNAN
Department of Animal Science
Virginia Polytechnic Institute and State University
Blacksburg 24061

ABSTRACT

B-Mode, linear array ultrasonography was used to evaluate the site of semen deposition in live cows. The insemination sheath was modified to hold a brass bead that was deposited at the simulated site of semen deposition. The position of the bead was identified by ultrasonography and the bead was recovered by pulling a nylon line that was attached to the bead. An ultrasound technician identified placement of the bead in the site designated for semen deposition by a skilled inseminator in 24 of 25 cases. This procedure improves methods for inseminator training by providing a method of evaluating insemination technique using live animals rather than excised reproductive tracts. The ultrasound equipment used for inseminator evaluation is affordable, portable, and does not pose a human health risk.

INTRODUCTION

The site of deposition of extended semen is critical to the success of AI of cattle (3). Graham (2) described a technique for the use of dye infusion into excised bovine reproductive tracts to evaluate insemination technique. Cembrowsic (1) demonstrated a significant correlation (r = .63) between inseminator performance with dye infusion and 60- to 90-d nonreturn rates. Peters et al. (5) used a radiographic technique that went beyond the dye technique and allowed direct observation of the tip of the inseminating rod and distribution of simulated inseminate infused into excised tracts. Results of radiographic evaluation of inseminator technique were not correlated with nonreturn rates achieved prior to evaluation. However, following radiographic evaluation and retraining, 13 of 20 professional inseminators improved their nonreturn rates.

A major limitation of both the dye infusion and radiographic techniques is the use of excised tracts. Although Peters and Senger (4) described a device that placed the excised tract in a position simulating the organ’s position in vivo, insemination of an excised tract does not duplicate in vivo experience. A further limitation of the procedure for radiographic evaluation is the human health safety risk imposed by potential x-ray exposure.

The purpose of this study was to devise a method for evaluating the rectovaginal insemination technique using live animals and B-mode, linear array ultrasonography. This method was specifically designed to evaluate the simulated site of semen deposition.

MATERIALS AND METHODS

To identify the simulated site of semen deposition with ultrasonography, we modified a standard insemination rod sheath such that a brass bead could be deposited at the intended site of semen deposition. French-style plastic sheaths (Nasco, Fort Atkinson, WI) designed for insemination rods utilizing .5-ml French straws were modified to hold 4-mm x 5-mm ellipsoid beads. Each bead had a hollow core and 50 cm of nylon line (2.7 kg test monofilament; K-Mart Corp., Troy, MI) was attached to the bead. Approximately 6 mm of the tapered end of the plastic sheath were removed. The brass bead was pressed into the cut end of the sheath such that the nylon line remained free. The sheath was then fitted over the inseminating rod and secured with a plastic O-ring (Figure 1A).

Received October 24, 1988.
Accepted February 6, 1989.

1Present address: College of Veterinary Medicine, University of Georgia, Athens 30602.
Cows that were exhibiting normal estrous cycles were selected at random without regard to stage of estrous cycle. The inseminating rod tip with its modified sheath containing the brass bead was passed through the vagina and into the cervix, uterine body, or uterine horns. During the simulated insemination process, the nylon line attached to the bead was held gently along the shaft of the inseminating rod or allowed to hang free from the ventral opening of the vulva. When the inseminator had placed the tip of the inseminating rod at the proposed site
of semen deposition, the plunger of the gun was depressed and the bead expelled from the sheath (Figure 1B). The insemination rod was removed carefully so that the nylon line was not manipulated and the position of the bead was not disturbed.

The position of the brass bead in the female reproductive tract was determined using a B-mode, linear array ultrasound machine (Model LS-300; Tokyo Keiki Ltd., Tokyo, Jpn). After the inseminator had removed the inseminating rod and retracted his arm from the rectum of the cow, a 5-MHz ultrasound transducer was inserted into the rectum by the ultrasound operator (Figure 1C). The reproductive tract was scanned as described by Pierson and Ginther (6) to locate the brass bead. Care was taken to avoid manipulating the reproductive tract, which might have caused movement of the bead. The ultrasound image of the bead was video recorded.

After detecting and recording the location of the brass bead, the bead was removed from the tract by pulling the nylon line attached to the bead. The path of the bead during removal could be followed by leaving the ultrasound transducer in the transrectal position. Movement through the cervical rings was obvious and was used to verify the location in which the bead had been deposited. The beads and nylon lines were disinfected and reused. After removal of the bead, cows were reused for additional simulated inseminations.

To evaluate the accuracy of the procedure, beads were repeatedly placed in the reproductive tract and located by ultrasonography. Five cows were used to evaluate 25 simulated inseminations (five per cow). Beads were placed in the right (n = 5) or left (n = 5) uterine horn, cervix (n = 5), or vagina (n = 5) in random order by a skilled AI technician. The ultrasound technician identified the location of each bead placement but was prevented from observing the simulated inseminations and was not apprised of the accuracy of his performance until the trial was completed.

RESULTS AND DISCUSSION

Visualization of the brass bead placed in the reproductive tract was accomplished easily due to the inordinately high echogenicity of the bead compared with that of the surrounding tissue (Figure 2). The bead appeared as a brilliant white spot with an echogenic shadow extending down the screen of the monitor. The brightness of the spot was due to the complete reflection of sound waves by the brass bead. The trailing signal was an artifact of sound waves reverberating between the surface of the bead and the adjacent surface of the reproductive tract before returning to the receiver within the transducer.

Location of the bead and identification of the simulated site of insemination was possible when the bead was placed in either uterine horn, the uterine body, the cervix, or the vagina. The cervix was identified readily by ultrasonography; however, the exact location of the anterior edge of the cervix was not distinguished easily. Its location was derived from that of the anterior-most cervical ring that was imaged more easily. Similarly, the exact junction of the uterine horns and uterine body was not as distinct as that described using radiographic methods of evaluating excised tracts (4). For these reasons, fixing the location of the bead within the uterine body was less precise than that described using the radiographic technique. Conversely, identification of the bead placed in the miduterine horn, cervix, or vagina was clearly identifiable.

The ultrasound technician identified the bead in the site assigned for deposition by a skilled inseminator in 24 of 25 cases during the accuracy trial. In one case, the ultrasound technician reported that the bead was in the left uterine horn near the bifurcation when the designated site of deposition was the uterine body.

Use of ultrasonography allows for the identification of the site of simulated semen deposition in vivo. This is similar to the evaluation of syringe tip placement in excised tracts as described by Peters and Senger (4). Ultrasound evaluation does not allow evaluation of distribution of the inseminate volume similar to that which can be measured using radiographic (4) or dye insemination technique (2).

The most pronounced barrier to utilizing this technique successfully is the need for an experienced ultrasound operator who can interpret the video images of anatomical structures in the reproductive tract. Development of such a skill requires training and experience. A second problem encountered was the high echogenicity
of cervical mucus in animals used for insemination that were exhibiting estrus (Figure 3). In these animals the echogenic signal cast by cervical mucus was remarkably similar to that of the metal bead. When this occurred it was more difficult to locate the bead and it was necessary to view the ultrasound image of the moving bead to verify its location.

This procedure for evaluating the technique of artificial insemination can be used to improve methods for inseminator training. The use of live animals for the simulated insemination is more desirable than the use of excised tracts. The ability to evaluate site of semen deposition by depositing a recoverable brass bead and to reuse the animals and beads provides an efficient method for evaluating a group of inseminators. The ultrasound equipment necessary for such a procedure is between $10,000 and $15,000, portable (<15 kg), and does not pose the human health risks associated with x-ray techniques. The procedure requires an ultrasound operator skilled in interpreting images of the reproductive tract and it cannot be used to evaluate the distribution of the inseminate. Whereas the use of such a procedure extends the methods for inseminator training, it is likely to be most beneficial when used in conjunction with current training procedures.
Figure 3. Ultrasound image of vagina of estrual cow. Note echogenicity of cervical mucus (*) in vaginal lumen.

ACKNOWLEDGMENTS

Appreciation is extended to G. L. Johnson, C. E. Marshall, J. L. Meador, and R. L. Nebel for direct participation or suggestions regarding the development of these procedures.

REFERENCES

2 Graham, E. F. 1966. The use of a dye indicator for testing, training, and evaluating technicians in artificial insemina-