Theriogenology for Fun and Profit*

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1.0 Introduction

The practice of theriogenology has changed considerably over the years since The Society for Theriogenology (then The Rocky Mountain Society for the Study of Breeding Soundness of Bulls) was founded in 1954, a half century ago. Obvious from its name, the original intent of the Society was to develop methods and criteria for evaluating the breeding ability of range bulls but the scope of the Society's interest was officially expanded in 1966 to include female cattle and the name was changed to The American Veterinary Society for the Study of Breeding Soundness to reflect that modification.[1] Fortunately, the Society has since been able to expand its purview and its membership and now embraces the study of both genders of food- and fiber-producing and companion animals. As Dr. Hill noted in his address prepared for delivery to the Society in 1979, we are "an organization of … scientifically oriented people whose fun in life is the attempt to unravel the secrets of reproduction and bring these facts down to practical, every-day use." It would seem, therefore, that there is plenty of room in the society for both fun and science. The purpose, then, of this paper is to present a series of ideas and opinions that may serve, if not to make the practice of theriogenology more fun, at least easier. Without doubt, there is more than one correct way to do almost everything, thus members of the Society are encouraged to share in some forum their unique solutions to common tribulations

2.0 Palpation per rectum

Perhaps the most common procedure performed by equine and food-animal practitioners is palpation per rectum.

2.1 Occupational injury

A specific syndrome affecting veterinarians who repetitively perform multiple rectal examinations was described by a Canadian physician.[2] He found that painful arm, neck, and shoulder conditions were common among large animal veterinarians. In addition, neurological deficits in the median, ulnar, and radial nerves were observed. In this series of cases, multiple diagnoses of shoulder and arm pain were specifically related to calving and rectal examinations with shorter veterinarians being perhaps at higher risk. The repetitive nature of performing multiple examinations appears to lead to a traction type injury of the roots of cervical spinal nerves 5 to 7 as they exit the cervical foramina. Traction of the cervical plexus also occurs during the examination when the examiner's head is bent laterally towards the opposite shoulder. Thus, symptoms occur on the opposite side because the neck is bent to that side for prolonged periods of time.

Clinical management of this syndrome ideally includes rest of the nerves involved. However, this is not practical when rectal examinations are required for the affected

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veterinarian to continue to earn a living. The following modifications of the examination position were suggested:

1. Keep the examining arm with the shoulder flexed forward 20 to 25 degrees.
2. Flex the neck forward rather than laterally, if possible, during the examination.
3. For larger animals, consider using a stool or platform.

2.2 Lubricant

A variety of lubricants are available for use when conducting rectal examinations. The use of commercially available lubricants is economical for solo or small group practices, but for institutional (and perhaps large group practice) use, large volumes are required and considerable savings can be realized with homemade lubricant. The primary ingredient is sodium carboxymethylcellulose[†] suspended in hot tap water. The powder is introduced into a Venturi tube and stored in a suitable bulk container (50 gallon plastic drum). Some experimentation may be necessary to achieve suitable viscosity but a general rule is to pour the sodium carboxymethylcellulose powder into the Venturi as rapidly as possible without plugging the mixing chamber. Thicker is better than thinner as the suspension can always be diluted. A handpump capable of delivering a high viscosity liquid is required to dispense the lubricant. The pump tube should be plastic as a metal tube will corrode over time and discolor the lubricant. This lubricant is suitable for rectal palpation in cows and mares, insertion of progesterone-releasing intravaginal devices, and brief vaginal examinations. However, it is not ideal for extensive obstetric manipulations or extraction of fetuses after placental fluids have been lost.

2.3 Palpation restraint

Restraint facilities for examining cows varies widely among farms and preferences vary widely among veterinarians and dairy producers. Headlocks are convenient and can be used for management procedures other than palpation such as tail-chalking and BST injections. However, headlocks may require use of long extension cords if ultrasound examinations are conducted without a battery-operated unit and may be inconvenient in some facilities. One memorable outdoor facility featured a roof over the headlocks that adequately protected the feed manger and the cow but directed rainwater directly down the back of the examiners' necks as they stood to the rear of the animal. Palpation rails or management rails (also known as herringbone rails) offer a number of advantages. Multiple animals can be presented for examination in a compact area and several examiners can work simultaneously. Large numbers of animals can be examined efficiently. Occasionally, an animal will be encountered that does not stand quietly for examination in a palpation rail and it may have to be moved to a headcatch which can be incorporated into the design of the facility. The most significant disadvantage of a palpation rail is that it is inconvenient to administer injections in the patient's neck and sometimes managers are tempted to give injections into the gluteal muscles. Other examiners find palpation rails objectionable because they are less able to escape fecal soiling.

[†] Sodium carboxymethylcellulose, Aqulon Division of Hercules Incorporated, 111 Hercules Road, Hopewell, VA 23860-0271.

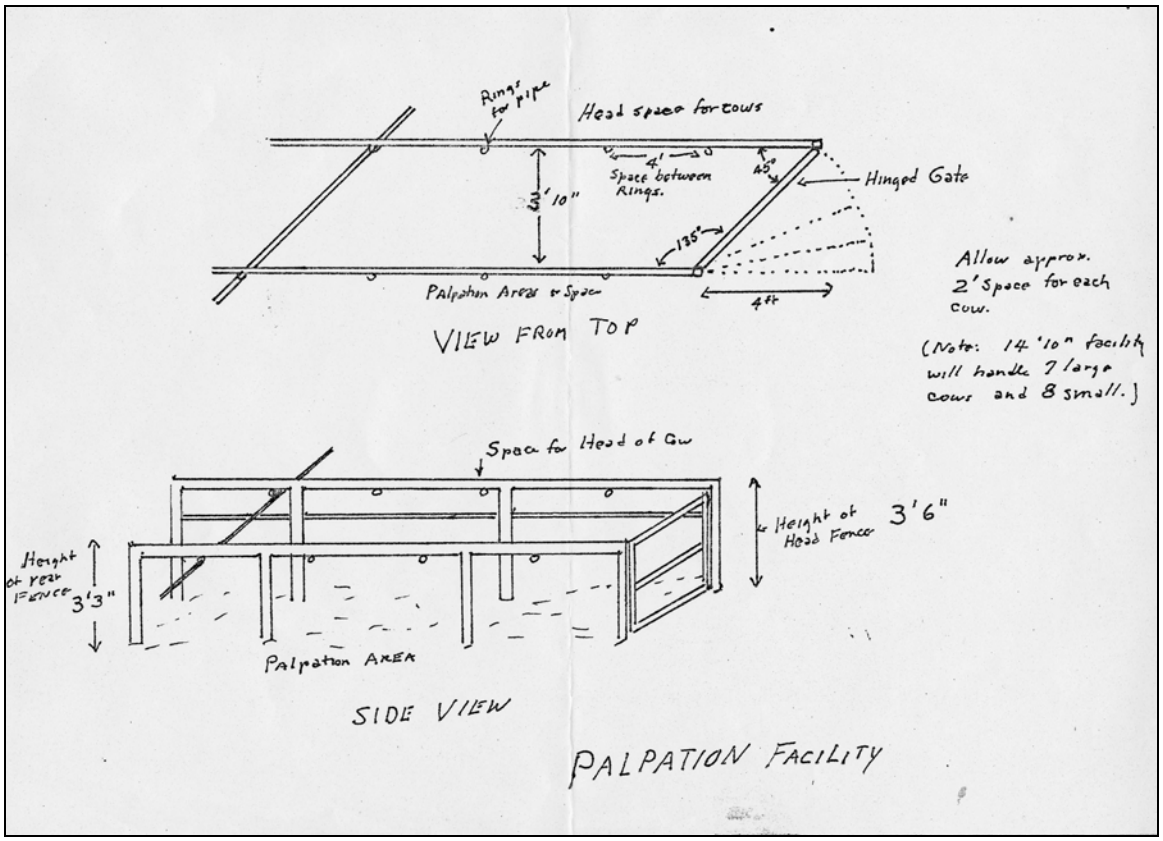

Figure 1. Drawing of a palpation facility used at Foremost Dairy, University of Missouri.

A useful suggestion for design of a palpation rail is that the floor at the rear of the palpation rail where the examiner stands be higher (about 4 inches) than the floor where the cows stand to make palpation easier. Plans for palpation rails are available from facility design services.[‡]

3.0 Prolapses

3.1 Vaginal prolapse

Vaginal prolapse is most commonly encountered during the past several months of gestation or during the immediate post-partum period. Thus, most cases are concentrated around the spring and fall calving seasons. The condition rarely endangers the life or health of the animal but is a challenge to manage if the calf is to be salvaged. In the 1971 edition of Professor Roberts' classic text, he described 16 techniques to control vaginal prolapse but in the 1986 edition, he had reduced the list by 4.[3] Review of other literature would likely disclose several more. It would seem that whenever there are so many methods of attempting to correct the same problem, none are likely to be very satisfactory. Control of pre-partum prolapses is especially challenging if the cow is to be

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allowed to calve because in most cases, the control method must be modified to allow delivery of the fetus. In our practice, we have settled on two methods to treat cases of vaginal prolapse that have generally been satisfactory.

Post-partum prolapses and some pre-partum prolapses are routinely treated with a hidden purse-string suture first described by Bühner[4] and later by others.[5] After epidural anesthesia, the prolapsed tissue is washed and replaced. If the vagina and cervix are edematous, massage with anhydrous lanolin or other emollient lubricates the tissue and facilitates replacement. The perineum is scrubbed with a surgical soap in an attempt to provide an aseptic surgical field. A stab incision is made with a number 22 blade through the skin on the midline immediately below the ventral commissure of the vulva. A second stab incision is made between the dorsal commissure of the vulva and the anus. These incisions serve to guide insertion and exit of the needle. A Bühner needle[§] is inserted through the lower incision and guided through the tough perivulvar tissue. The surgeon's hand can be placed in the vestibule to guide the needle. Caution must be exercised as the sharp needle can easily pierce the hand should it be misdirected. After the eye of the needle exits the dorsal incision, the eye is threaded with Bühner tape. The tape is coated with an antibiotic ointment (mastitis infusion tubes are convenient). The needle is then pulled ventrally and exits the lower incision, leaving the tape buried along one side of the vulva. The unthreaded needle is re-inserted into the ventral incision and is guided again through the perivulvar tissue on the opposite side. When the eye again exits the dorsal incision, it is threaded with the free end of the tape and again pulled ventrally (figure 2). Tension is applied to the free ends of the tape at the ventral commissure of the vulva and the purse-string-like suture is pulled tight leaving an opening approximately two to three fingers in width. If the cow has calved or is to be salvaged, a square knot or surgeons' knot can be tied and the knot disappears beneath the skin. If the cow is to be allowed to calve under supervision, a tape can be secured with a bow knot. When calving is imminent, the bow knot can be untied and the calf delivered. If prolapse is anticipated after calving, the tape can be re-tightened and secured with a square knot.

In pre-partum cases, the technique may be modified to make management of calving easier. Rather than one incision at the ventral commissure, two are made each approximately 1 inch lateral to the midline. When the bow knot is tied, it lies on top of the bridge of skin and is much easier to retrieve and untie prior to calving. It must be remembered that if cows are allowed to calve unsupervised and the knot is not untied, the cow may deliver the calf through the suture and *extreme damage* to the perineal tissue will ensue. After calving, the cow can join the herd and nurse the calf to weaning. Natural service can occur with the Bühner suture in place. However, it is recommended that the cow be culled after the calf is weaned because prolapse is likely to complicate subsequent gestations.

[§] Jorgensen Laboratories, Inc., 1450 N. Van Buren Ave, Loveland, CO 80538

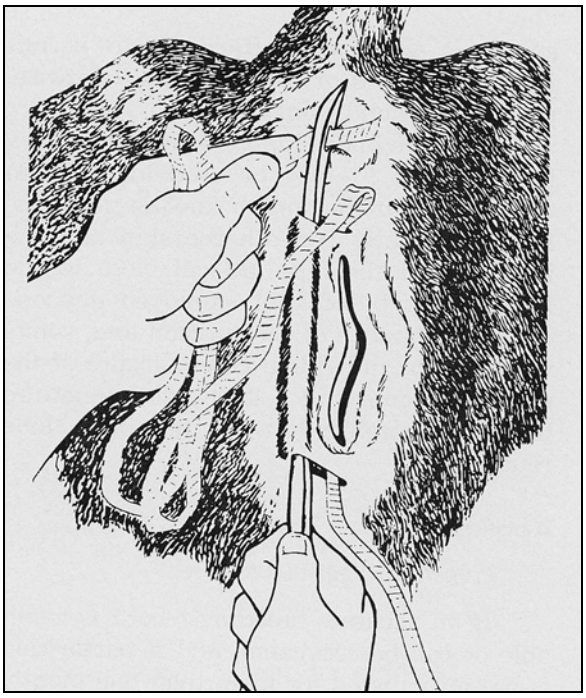

Figure 2. Bühner method for control of vaginal prolapse in cows.

Frequently, the owner is unable or unwilling to closely supervise calving and induced parturition is not indicated because an accurate breeding date is not known. In those cases, an alternative to the Bühner method is useful. A variety of sutures have been used to close the vulvar cleft and retain the prolapse. Care must be taken to place any sutures lateral to the vulva at the hairline. Sutures placed in or near the vulvar lips are irritating and may stimulate tenesmus, frequently followed by damage to the tissue involved and recurrence of the prolapse. One useful technique is a bootlace pattern of umbilical tape. Four or five loops of doubled ¼" or 3/8" umbilical tape are placed at equal intervals in the tough skin lateral to the vulva. After the loops are in place, gauze bandage or umbilical tape can be used to close the vulvar cleft much in a manner similar to lacing a boot (figure 3).

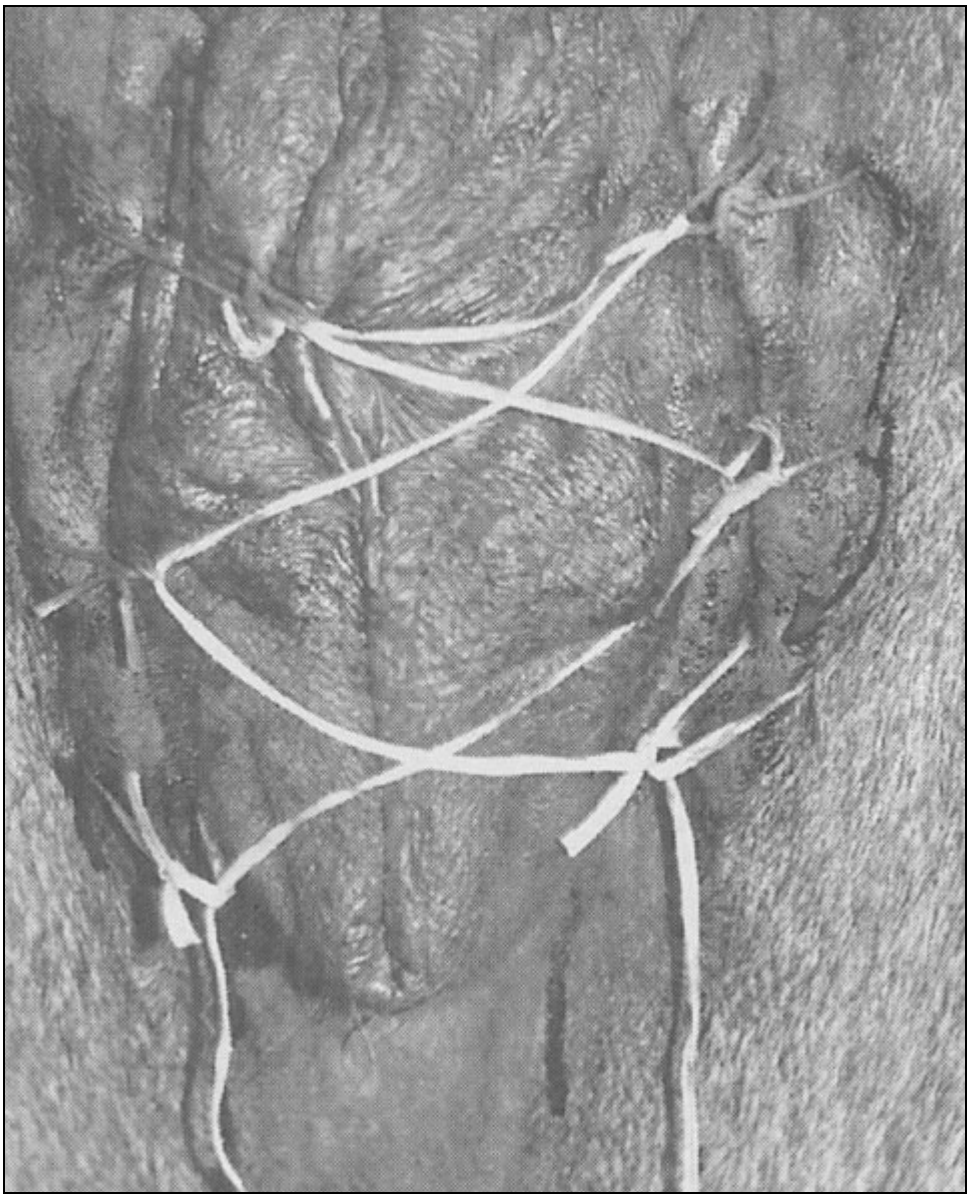

Figure 3. Bootlace suture used to control pre-partum vaginal prolapse.

A similar result can be obtained if copper hog rings are used in place of umbilical tape loops but hog rings tend to be less secure and may tear out prematurely.

The gauze or umbilical tape used to occlude the vulvar cleft can be untied or cut to permit delivery and re-tied after calving. If the calving date is misjudged, the suture can be replaced. If the cow should calve without supervision, the umbilical tape loops (or hog rings) can tear away with minimal damage or the calf can frequently pass through the vulva above or below the bootlace and in many cases is safely delivered with minimal damage to the cows perineum. After calving, the bootlace suture can be replaced with a more permanent method of control such as a Bühner suture.

3.2 Uterine prolapse

Prolapse of the uterus is a sporadic condition encountered during the first few hours after calving. Some are relatively easy to reduce, but difficulty can be encountered when attempting to replace the prolapse in a standing cow. One method that has been found to be successful is to place the patient in sternal recumbency (head downhill if possible). Epidural anesthesia at a dose sufficient to interfere with motor function of the hindlimbs may be required to induce recumbency. After the patient is positioned in sternal recumbency, the hindlimbs are pulled caudally with the hooves directly behind the animal. This position reduces intra-abdominal pressure, tilts the pelvis, and places the prolapsed tissue in a more accessible position. The operator then kneels behind the patient and places the prolapsed uterus in his/her lap. This allows the prolapsed mass to be positioned above the vulva and replaced more easily. The most significant disadvantage of this procedure is that the operator is awash in fluid and blood that escapes from the prolapsed tissue. This situation can be ameliorated of the operator opens a heavy gauge large plastic bag (contractors' bag), steps inside, and pulls the bag up around his/her waist. Then, the operator can hold the prolapsed mass in his/her lap and apply pressure to the tissue while his/her clothes remain relatively dry.

Heavy gauge plastic bags can also be used to protect the operator when attempting replacement of a prolapse in a standing patient. Using a scissors or pocket knife, a hole is cut in the middle of the bag's bottom seam to allow passage of the operator's head and holes are cut in the lateral seams on each side of the bag to allow passage of the arms. The bag is then worn as a gown to protect the operator as pressure is applied with the arms and chest to replace the prolapse. Large plastic bags have also been found useful as emergency raingear when doing herd work in an uncovered corral. While not the height of fashion in rainwear, plastic bags have made otherwise miserable days at least bearable.

4.0 Ovariectomy

Ovariectomies are performed on a large scale when heifers are spayed for feeding purposes, but occasionally ovaries are removed from individual animals. Indications might include the occasional pet cow that the owner does not wish to come into estrus or reproduce and removal of a neoplastic ovary.

4.1 Laparotomy

Ovaries can be removed through a standing left-flank laparotomy. In heifers, the length of the broad ligament does not allow either ovary to be exteriorized making hemostasis and excision difficult. Plastic umbilical cord clamps have been used to securely occlude the blood supply to the ovary and provide reliable hemostasis.[6] The ovary is located and the clamp applied with both of the operator's hands within the abdominal cavity. In the case of an enlarged ovarian attachment, the mesovarium can be bluntly divided in half and two clamps applied if necessary. After the clamp has been securely attached, the ovary can be carefully excised with surgical scissors. The clamps have been found to be inert and few post-surgical adhesions complicate the surgery. Thus, if a unilateral ovairectomy is performed, the prognosis for future reproduction is fair to good.

4.2 Colopotomy

Ovaries of moderate size can be removed from adult cows that have delivered at least one calf through an incision in the cranial vagina. A knife with a guarded blade[**] is introduced into the vagina and a stab incision made caudal to the cervix at the 10 or 2 o'clock position. The operator's hand is bluntly forced through the vaginal wall into the peritoneal cavity. The ovary is located and pulled into the vaginal canal. While the ovary is held in position with one hand, an umbilical cord clamp is carried into the vagina with the second hand and secured around the ovarian attachment. The ovary is then excised with surgical scissors and removed. The vaginal incision is allowed close spontaneously and in most cases is not sutured. A colpotomy is not a suitable approach for removal of large neoplastic ovaries.

5.0 Cesarean Section

Cesarean section is frequently performed to relieve dystocia when vaginal delivery of a fetus is impossible. The most common indication for cesarean section in cattle is fetopelvic disproportion (either relative or absolute). Among the other indications are: fetal malposture that cannot be corrected in a reasonable amount of time, fetal monsters, uterine torsion, malformation of the pelvis, incomplete cervical dilation, stricture of the birth canal, and uterine rupture. Numerous approaches have been described with the patient standing or in lateral or dorsal recumbency. Incision sites include: the paralumbar fossa, ventrolateral aspect of the abdomen, paramedian, or the ventral midline.[7] Each has its advantages and disadvantages depending upon the situation and the preferences of the surgeon.

5.1 Left oblique celiotomy

An incision site that we have found useful is the left oblique celiotomy.[8] This approach allows entry into the abdominal cavity in the immediate area of the uterus and facilitates exteriorization and reduces the degree of abdominal contamination. The fetus can be delivered by pulling it mostly in a lateral direction and does not require lifting the fetus. Surgeons of shorter stature find this to be an advantage.

5.2 Uterine closure

Closure of the hysterotomy incision is critical to preserve future fertility of the dam. Adhesions between the incision site and surrounding organs or body wall are associated with infertility following cesarean section. The uterus is closed with a continuous infolding suture pattern using an absorbable material. Commonly used methods include the Cushing and Lembert patterns. A modified Cushing pattern known as the Utrecht uterine suture method offers the advantage of burying the knots and is associated with minimal adhesion formation and reduction in fertility.

[**] Olfa Rotary Cutter, Olfa Corp, Osaka, Japan

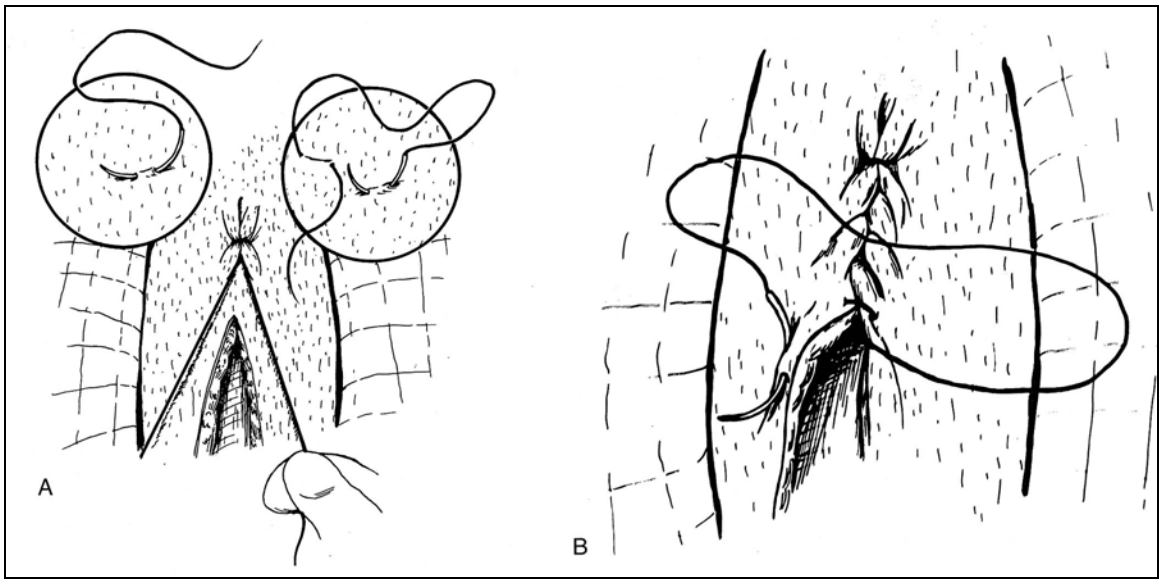

Figure 4. A. Knot buried to initiate the closure pattern. B. Incision is closed by directing the needle at a slight angle toward the incision. Needle does not penetrate the uterine lumen.

6.0 Percutaneous Fetotomy

If delivery by traction is not possible without danger to the dam or fetus, the veterinary obstetrician must consider the option of fetotomy or cesarean section. There are few procedures in veterinary obstetrics in which the need for experience and proper equipment are as essential as in fetotomy. Advantages of fetotomy over cesarean section include higher milk production and better post-surgical fertility. Among the disadvantages of fetotomy is the requirement for an able assistant. In many cases, a partial fetotomy is sufficient to permit delivery of a fetus but a complete fetotomy includes the following operations: amputation of the head, amputation of the most accessible foreleg, amputation of the opposite forelimb, amputation of the neck and cranial thorax, amputation of the trunk, division of the ribcage, and division of the pelvis.[9] Modifications of a complete fetotomy that can make the procedure more efficient in some cases have been described.[10]

7.0 Opportunities and Challenges for the Future

Despite all of the advances in technology that members of the Society and their clients have enjoyed over the past 5 decades, some significant challenges remain. Significant declines in pregnancy rates of dairy cows have occurred in concert with significant improvements in milk production since the widespread adoption of artificial insemination with proven sires.

7.1 Postpartum anestrus[11]

Resumption of normal estrous cycles following calving is necessary for maintenance of reproduction in both year-round and seasonally calving herds. Traditionally, lactating dairy cows have been expected to have their first postpartum ovulation by 19 days after calving (may not be accompanied by signs of estrus). After a shorter than normal luteal phase, subsequent ovulations are more likely to be accompanied by signs of estrus.

However, it is not an uncommon clinical observation to find an increasing percentage of cows that remain anovulatory for longer periods of time after calving.

Follicular growth can be detected by ultrasound examination of the ovaries within 1 or 2 days after calving. A single dominant follicle is present by 10 to 14 days which may ovulate, become atretic and be replaced by a subsequent dominant follicle, or continue to grow and become a follicular cyst. Ovulation of the dominant follicle occurs when its production of estradiol is sufficient to induce a preovulatory surge of LH and FSH. In turn, estradiol production is dependent upon sufficient LH pulse frequency. The first postpartum ovulation is frequently not accompanied by signs of estrus and is also followed by a shorter than normal luteal phase owing to premature release of PGF_2alpha from the uterus. This short exposure to elevated progesterone concentrations is essential for expression of estrus and normal length of subsequent estrous cycles.

Prolonged interval to the first postpartum ovulation occurs when the normal increase in the release of LH is delayed by suckling, low energy intake, low body condition, increased partitioning of energy to milk production, or increased stress from postpartum diseases or elevated ambient temperatures.

Treatment options for cows with prolonged postpartum anestrus include management changes and hormonal treatments. Hormonal treatments can synchronize estrus and facilitate use of artificial insemination. When a period of progesterone treatment is included in the protocol, more cows display signs of estrus and the subsequent luteal phase is usually of normal duration. Ovulation synchronization protocols can be used without detection of estrus but pregnancy rates after timed artificial insemination tend to be lower than those following insemination at observed estrus. Response to treatment varies with other factors such as body condition, parity, and days in milk that influence the depth of anestrus.

7.2 Re-synchronization of estrus

Several protocols have been described to synchronize estrus and/or ovulation in an attempt to improve pregnancy rates and reduce the requirement for visual detection of estrus.[12,13,14] All of these programs focus, however, on the first postpartum ovulation and few center on the larger percentage of cows that do not become pregnant at that ovulation. Progesterone-releasing intravaginal inserts alone or in combination with estrogen have been used in an attempt to synchronize the estrus and ovulation subsequent to the first AI.[15,16,17] Also, GnRH administration seven days prior to pregnancy diagnosis (first injection of the OvSynch protocol) has been used. Cows diagnosed not pregnant when examined are then administered PGF_2alpha (second injection of OvSynch) and GnRH (third injection of OvSynch) prior to timed artificial insemination. While these protocols have met with moderate success, there may be opportunity for continued improvement and refinement of these protocols.

7.3 Heat stress

Heat stress is a significant cause of reproductive inefficiency in dairy cows throughout the world and has been the subject of several reviews.[18,19] Hormonal treatments and

management modifications have been used to alleviate heat stress have been described but reproductive performance cannot be restored to the level typical of cooler months.

Two pathways appear to lead to heat stress related infertility. Hyperthermia directly affects the reproductive axis by altering follicular dynamics, impairing oocyte quality, and increasing embryo mortality. Indirect effects of heat stress are related to suppression of appetite and dry matter intake.

Options to reduce summer infertility include the use of cooling systems (fans and water misters) which are beneficial but do not restore normal fertility. Other management techniques include provision of high quality forage and feed to overcome the negative energy balance and by the use of hormonal treatments to induce estrous cycles and ovulation.

In addition, there appears to be a genetic component of susceptibility to heat stress.[20] It may be possible to simultaneously select for milk production and heat tolerance.

7.4 Embryonic death

Embryonic death has long been a concern of veterinarians and their clients. A variety of infections, hormonal, genetic, and environmental factors have been incriminated as causes.[21,22] There appears to be an increase in embryonic death but whether or nor this increase is real or apparent due to ability to diagnose pregnancy earlier in gestation is not obvious. Factors that have been associated with pregnancy loss are twin pregnancy, reduced body condition after the previous parturition, and the sire used for insemination.[23] Estrus synchronization, milk production, disease, and changes in body condition score did not have an effect on embryo loss. Some management procedures directed toward reduction of embryonic loss have been described.[24]

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