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Welfare aspects of theriogenology: Investigating alternatives to electroejaculation of bulls

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Abstract

Evaluation of the breeding soundness of bulls is an important management tool. Electroejaculation has been a reliable method of obtaining a semen sample for the purpose of evaluating breeding soundness, but is considered by some to be inhumane on the grounds that it is painful. This paper provides a review of studies conducted to find ways to both measure, as well as lessen, pain associated with electroejaculation, and to explore alternatives to electroejaculation in bulls.

Changes in heart rate, serum cortisol, serum progesterone, relative aversion, and degrees of vocalization, struggling and lying down have been used to assess the pain associated with electroejaculation. Transrectal massage and artificial vaginas, and oxytocin and cloprostenol have been investigated as alternatives to, and facilitators of electroejaculation, respectively. Epidural, intravenous and topical anesthetics have been used to ameliorate the pain associated with electroejaculation.

Serum progesterone and degrees of vocalization are useful for measuring the pain associated with electroejaculation in bulls. Transrectal massage and artificial vaginas are not as efficacious as electroejaculation for obtaining a semen sample and drugs used to facilitate or decrease pain associated with electroejaculation have not been efficacious enough to warrant use. Transrectal massage of the ampullae may be of some use as an alternative to electroejaculation in docile bulls and may be also be used to decrease the duration of subsequent electroejaculation.

Pain associated with electroejaculation may be influenced by operator technique; therefore, operators of electroejaculator equipment must strive to apply electrical stimulation as gently as possible.

Keywords: Bulls; Electroejaculation; Pain measurement; Animal welfare; Alternatives to electroejaculation

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1. Introduction

Cattle producers should consider bull fertility to be of the utmost importance and should submit all breeding bulls for an annual breeding soundness evaluation (BSE). To pass a BSE; bulls must have satisfactory semen quality, be physically sound and must be able to complete service. Obtaining a semen sample must be an integral part of every BSE and every effort should be made to obtain semen samples of the highest quality possible. Failure to do so, may lead to erroneous conclusions concerning the bull's breeding potential.

There are essentially four ways to collect semen from a bull: aspirate from the vagina of a recently bred cow; utilize an artificial vagina (AV); transrectal massage (RM) of the accessory sex glands; and electroejaculation (EEJ). For the last half-century, EEJ has been a very effective method of collecting semen from range bulls. This technique does not require mount animals, is not physically demanding and is easily adaptable to most cattle handling facilities. In recent years, a variety of automated electroejaculators have been developed. These machines are particularly useful for those unaccustomed to the manual technique of applying electrical stimulation and tend to be very reliable in terms of their ability to induce semen emission. A distinct disadvantage of EEJ, however, is that it is considered to be painful to bulls [1]. Electroejaculation without anesthesia has been discouraged in the UK (Michael McGowan, Personal Communication, 2004) and banned in several European countries [1]. In North America, EEJ is still considered an acceptable procedure by most animal welfare committees, but is becoming increasingly controversial. For many years this controversy was fueled by a lack of critical evidence to define the reaction of bulls to EEJ. It has been stated that since EEJ without anesthesia is very painful to humans [2,3] it, therefore, must be painful to bulls [1]. The remainder of the paper is a review of recent research conducted to find ways to both measure and lessen pain associated with EEJ, and to explore alternatives to EEJ.

2. Electroejaculation

Electroejaculation of domestic animals was first reported in 1936 [4,5]. Most modern electroejaculators utilize a sine-wave pulse at a frequency of 20–30 cycles/s [6,7]. Other wave forms and frequencies have proven to be inferior, often requiring more electrical stimuli to achieve ejaculation [6]. Increased electrical intensity tends to cause unnecessary muscle contraction [5]. The maximum voltage of the Lane Pulsator IV (Lane Manufacturing, Denver, CO, USA), a relatively new and popular electroejaculator model, is 16 V, with a maximum current of $<$900 mA. With most bulls, ejaculation occurs with electrical impulses $<$8 or 9 V (Tom Chambers, Technician, Lane Manufacturing, personal communication, 2004).

Bulls should be suitably restrained for EEJ. Once transrectal examination of the bull's ampullae, seminal vesicles, prostate, pelvic urethra, and inguinal rings has been completed, there is usually a massage over these areas lasting from 10 to 60 s. The massage is intended to sexually excite the bull and cause relaxation of the anal sphincter prior to probe insertion. After the probe is in place, electrical stimulation is carefully applied while observing the response of the bull. Once there is an indication that the bull has felt the stimulation, such as

a slight contraction of the muscles of the hindlimb, the stimulation may be removed. With each successive stimulation, the intensity of the voltage is steadily increased and held for 1–2 s, followed by 0.5–1 s of rest. Stimulation is continued through penile protrusion, erection and finally collection of semen.

Rectal probes typically have three ventrally oriented electrodes. Older probes utilized circumferential electrodes which tended to cause unnecessary stimulation of nerves dorsal to the rectum. With the older design, contractions of the thighs, legs and back could occasionally be severe enough to result in bruising and stiffness lasting for several days [3]. Under most circumstances, a probe with a diameter of 6.5–7.5 cm will suffice. Older and often larger bulls may require a 9.0 cm probe [8]. Larger probes ensure better contact with the rectal mucosa and an enhanced response to electrical stimulation [8]. In recent years, probes have been developed in which the ventrally oriented electrodes have been divided into three segments, each containing two or three electrodes. These are referred to as segmented probes. There are three caudal electrodes, three middle and two at the cranial end; each segment can be activated independently as needed. The intent of this probe design is to enable electrical stimulation to be directed towards the desired nerves with minimal stimulation of non-target tissue. The caudal segment is used to produce penile protrusion and erection. Once erection is obtained, the middle segment may be activated to induce ejaculation. In yearling bulls, ejaculation may occur with the use of the caudal segments only; whereas, activation of the cranial segments may be required to induce ejaculation in mature bulls [8].

2.1. What is the bull's reaction to electroejaculation?

It cannot be denied that the reactions of conscious animals to EEJ is a welfare concern. The intense muscle contraction, struggling, vocalization and occasional recumbency associated with EEJ in bulls are all indicative of discomfort. There is no doubt that veterinarians should be at the forefront of initiatives to alleviate the pain and suffering of animals. Evaluating a semen sample is an integral part of the bull BSE, but unless a proactive approach is taken towards measuring and alleviating pain associated with EEJ, it will become increasingly difficult to defend the BSE as an important management tool.

What is pain? Baillière's Comprehensive Veterinary Dictionary defines pain as "a feeling of distress, suffering or agony, caused by the stimulation of specialized nerve endings" [9]. The definition found in Dorland's Illustrated Medical Dictionary reads as "a more or less localized sensation of discomfort, distress, or agony, resulting from the stimulation of specialized nerve endings" [10]. Pain, especially in animals, is very difficult to understand and it is apparent from these definitions that more appealing synonyms may be substituted. However, for the remainder of this paper, pain will be used when referring to the nociceptive response of bulls to EEJ.

Numerous techniques have been used to evaluate pain associated with EEJ in animals. All have their strengths and weaknesses. Experiments with rams showed that EEJ tended to be slightly less aversive than being restrained for partial shearing [3]. In those studies, rams moved through a chute to a pen in which the respective treatment (partial shearing, EEJ or free-movement) was to occur twice a day for 4 days [3]. The relative aversiveness to the respective treatment was reflected in the time it took to move through the chute to the pen.

Transit times for both EEJ and partial shearing were both significantly higher than when the rams were simply allowed to move through a chute to a holding pen. The transit times for EEJ were actually slightly less than those for partial shearing [3]. This time–aversiveness relationship is known as ''conditioned suppression'' [11]. The degree of suppression, or in this case aversiveness, would be expected to increase with the intensity of the pain associated with the procedure [11]. Observations of bulls subjected to EEJ two or three times a week for several weeks suggested that bulls also seem to develop little aversion to the technique [12]. Personal experience has included watching bulls in similar scenarios line up in a chute and exhibit preputial or even penile protrusion, seemingly in anticipation of EEJ. Does this apparent lack of aversion indicate that EEJ is not painful? Probably not; in studies using rats, the degree of aversion was influenced by the intensity and duration of the electrical shock and was not linear [11]. However, aversion is definitely evident when the electrical shock is very intense or of long-duration [11]. Extrapolating this information to the electrical stimulation associated with EEJ merely suggests that the intensity or duration of the discomfort was not enough to result in the development of substantial aversion.

Early attempts to use cortisol to measure the response to pain associated with electroejaculation have been unreliable [1]. It appears that even relatively innocuous procedures such as im injection or venipuncture have resulted in substantial elevations in blood cortisol concentrations [13]. Profiles of mean cortisol concentration were similar between groups of bulls when a rectal probe was inserted and when a probe was inserted and electrical stimulation applied [14]. Subsequent research showed that adrenal progesterone was a more sensitive indicator of the pain associated with EEJ than cortisol [13]. Transrectal massage of the internal sex organs for 2 min significantly elevated progesterone concentration 25 min after treatment compared to restraint in a chute or saline epidural administration. At the same time after treatment, progesterone concentrations were also significantly higher in bulls exposed to conventional EEJ compared to those in the transrectal massage group. Cortisol concentrations were unaffected by these treatments [13]. Another study supported these findings; progesterone concentrations were significantly lower at 5 and 20 min following EEJ in bulls administered a lidocaine epidural anesthesia compared to those receiving no pretreatment [15]. Again, cortisol concentrations remained unchanged [15].

Changes in heart rate have been used to evaluate the pain associated with EEJ in bulls [1]. Elevations in heart rate associated with EEJ were assumed to be due to a combination of both muscle contraction and pain. If the pain was reduced, or eliminated, then any change in heart rate should have been caused by the muscle exertion alone. An experiment was designed to evaluate six different treatments: transrectal massage of the seminal vesicles; conventional EEJ; lidocaine applied intrarectally prior to EEJ; iv xylazine prior to EEJ; lidocaine epidural anesthesia prior to EEJ; and xylazine epidural anesthesia prior to EEJ. Heart rates were recorded just prior to treatment, immediately after treatment and every 2 min until 10 min after EEJ. All six treatments resulted in an elevation of heart rate, with no significant differences among groups. In all cases, the heart rates returned to baseline within 2 min of cessation of electrical stimulation. Mean changes in heart rate ranged from 9.2 to 21.8 beats/min for the various treatments. The rapid return to baseline heart rates seemed to suggest that the pain associated with EEJ was not severe. Hearts rates tended to be lower after iv and epidural xylazine, and lidocaine epidural treatments.

However, hind end muscle exertion was also noted to be diminished with these treatments. The reduction in muscle exertion confounded the assessment of pain associated with EEJ and indicated that heart rate was not an ideal measure of pain [1].

When the intensity of electrical stimulation is severe, bulls often vocalize, struggle or lie down [13]. Vocalization is a good behavioral indicator of pain [16] and may be considered more useful than either heart rate or cortisol when studying acute pain [17]. Grandin suggested that vocalization of cattle be used an indicator of acceptable or unacceptable welfare standards in slaughter plants; the greater the number of animals vocalizing during pre-slaughter handling and stunning, the greater the pain or fear being experienced [18]. Not all animals can be expected to vocalize in response to pain, but more painful procedures tend to elicit vocalization from a higher proportion of animals. The response is immediate; therefore, the ability to elicit vocalization may also be used for indicating which parts of the operation are the most painful [16]. In an experiment designed to evaluate the behavioral response to EEJ, 62 yearling bulls received either conventional EEJ or EEJ following lidocaine epidural anesthesia on an alternate basis as they entered the chute [13]. Three behavioral responses, vocalization, struggling and lying down in response to EEJ, were graded [13]. All responses were scored as 0, 1, 2, or 3 according to the severity of the response. The majority of bulls did not vocalize during either the conventional EEJ (74.2%) or lidocaine epidural EEJ (93.5%) and the difference was not significant. However, 25.8% versus 0% of bulls exhibited what was considered to be a moderate degree of vocalization (score of 2; 2 or 3 obvious, moderately loud bellows) during the conventional EEJ and lidocaine epidural EEJ, respectively; this difference would have been obvious to a bystander and likely would have been significant had the scoring system been modified. There were no differences between groups in the numbers of bulls struggling or lying down [13]. From this initial work, it appeared that vocalization was indeed a reasonable indicator of pain associated with electroejaculation [13]; however, in later studies, none of the bulls vocalized when conventional EEJ was employed [15]. The lack of agreement between studies is most likely due to EEJ technique. When very high levels of electrical stimulation are used, many bulls will vocalize, and if the stimulation persists they will actually become recumbent [13]. The lack of vocalization did not imply a lack of pain, but suggested that the severity of pain was less than that of the first experiment.

The ability of conventional EEJ to elicit vocalization and cause an elevation in serum progesterone has demonstrated that there is pain associated with electroejaculation. Some of the differences noted between studies suggested pain may be reduced by altering the EEJ technique.

3. Alternatives to conventional ejaculation

3.1. Artificial vagina

Artificial vaginas (AV) were used to obtain semen from bulls long before the invention of the electroejaculator [7]. Collecting semen using this method requires the active participation of the bull and very closely approximates a natural breeding situation, enabling the evaluation of libido or mating ability, a distinct advantage over EEJ.

Unfortunately, bulls often must be trained to serve an AV. Training requires time and is obviously not suitable for bulls unaccustomed to human handling. In the 1990s, IMV Technologies, France marketed a portable ''dummy cow'' designed to enable semen collection from untrained bulls. This device consisted of an AV mounted at the caudal end of sturdy frame on wheels, with a cowhide overlying the frame. A similar device without wheels was built within our laboratory, but attempts to entice bulls to mount and serve were unsuccessful. Treated hides representing the colors of various breeds were used, but not even the application of estrus cow urine could entice the bulls to mount.

Libido and serving capacity testing was first evaluated in the 1970s [19]. These tests are unreliable in yearling bulls [20], but are considered to be useful indicators of breeding performance of mature bulls [8]. Cows used in these tests do not need to be restrained or in estrus; however, when testing only one or two bulls it is advisable to increase sexual stimulation using an estrus cow. The most practical test protocol utilizes restrained cows and a 20 min observation period. [8].

A natural extension of the serving capacity test was to restrain a cow adjacent to a fence and as the bull mounted, an operator reached through the fence and deflected the penis into an AV. Bulls unaccustomed to handling and serving an AV would not mount the cow with a person standing close by, so drapes were used to conceal the operator while the bull mounted and semen was collected. Initial results were very promising: five of six Charolais and 15 of 16 Hereford bulls (all >2 years) served the AV (Barth, unpublished 1999); however, when the study was repeated using 24, 2–3-year-old, predominantly Hereford bulls of medium to low libido, only two served the AV. Bulls seemed to sense the presence of a human behind the curtain or were distracted by the presence of the curtains. Other disadvantages of this system were the requirement for several AV's, an incubator to warm the AV's, and a great deal of patience (Palmer, unpublished, 2002).

Over a 5-year period, a device designed to fit within the vagina of a live cow called the internal AV (IAV), was developed [21]. The IAV enabled the evaluation of serving capacity as well as collection of a semen sample. Placing the AV within the cow's vagina eliminated the need for incubators, curtains and intense human involvement. The IAV consists of a wire-frame designed to support a length of 7.5 cm rubber tubing. A plastic specimen bag is taped to the cranial end of the tubing then folded in an accordion-like fashion. Suitable cows are restrained in stocks and lightly sedated. Nonspermacidal lubricant is applied sparingly to the interior of the IAV and the exterior is lightly lubricated prior to insertion into the cow's vagina [21]. The effectiveness of the IAV as an alternative to EEJ was evaluated over two seasons using both the IAV and EEJ to collect semen from 165 range bulls. Up to five bulls at a time were allowed into a paddock with two mount cows, and each bull was allowed a maximum of 20 min to serve a cow. In year 2, bulls that failed to serve a cow within 20 min were moved to a second pen, out of sight of the first, and allowed an additional 20 min alone with a restrained cow in estrus. Fifty of 96 (54.2%) and 48 of 69 (69.6%) bulls served the IAV in years 1 and 2, respectively versus a 100% success rate when EEJ was employed. There was very little difference in the quantity and quality of semen samples collected by either the IAV or EEJ, and the IAV enabled the detection of 8 of 165 (4.8%) bulls that were found to be unable to serve a cow due to physical abnormalities. These abnormalities would have been missed if only EEJ were employed. None of the bulls

allowed an additional 20 min served the cow [21]. In year 1, the breeding activity of 15 bulls that served the IAV and 15 that did not serve the IAV was observed at pasture. Bulls were placed with cows at a ratio of 1:30 in two pastures and observed every other day for 4 h in the morning and 4 h in the evening, for a 22-day period. A great number of bulls that did not serve the cows with IAVs were observed serving cows at pasture, but were less efficient breeders. Fewer were observed serving cows (40% versus 80%), and those that served tended to mount less frequently [21].

The IAV proved to be useful for identifying bulls unable to complete service due to physical abnormalities, but was not as efficacious as EEJ for collecting semen from range bulls. Other concerns with the use of the IAV include the spread of venereal disease and the welfare of the mount animals. Mount cows are restrained for long periods of time and served by multiple bulls.

3.2. Transrectal massage

Transrectal massage just prior to insertion of the electroejaculator probe has long been thought to provide sexual stimulation and encourage semen emission. A number of veterinarians have reportedly employed RM to cause semen emission; however, for many years there was only one critical report of its use in the literature. Out of 100 attempts to obtain semen by RM from 18 bulls, success was achieved 81 times from 15 of the bulls [22]. More recently, experiments have been conducted to reevaluate RM as a sole means of obtaining a semen sample from bulls, and to determine the influence of RM on EEJ. Twenty-two, 1- and 2-year-old Hereford and two, 1-year-old Charolais bulls were presented for semen collection by RM and EEJ 3 d/wk for 6 weeks. Transrectal massage, consisting of only a vigorous back and forth motion of the hand over the area of the pelvic urethra, prostate and ampullae for 2 min was ineffective at inducing semen emission. Semen was obtained in only 1 of 96 attempts, compared to 93 of 96 attempts for EEJ [23]. Transrectal massage, conducted by holding the thumb and little finger in direct apposition with the ampulla and applying a gentle anterior to caudal motion, was much more successful. Semen was obtained in 280 of 288 attempts, compared to 285 of 288 attempts for EEJ. The mean $\pm$ S.D. time to semen emission was 67.5 ± 54.2 and 73.5 ± 37.0 s for RM and EEJ, respectively [23]. A disadvantage of RM, however, was that semen samples generated contained significantly fewer motile ($63.5 \pm 24.0\%$ versus $74.5 \pm 16.8\%$) and live ($78 \pm 14.8\%$ versus $83.1 \pm 11.7\%$) sperm than those obtained by EEJ. This was thought to be due to the tendency of bulls to dribble semen during RM, thereby exposing the sperm to cool temperatures for a longer interval [23]. Nevertheless, the results of these experiments were promising; however, much of the success of RM was attributed to the docile nature of the bulls [23]. Two more experiments were designed to evaluate the effectiveness of RM in range and yearling bulls [24], both of which can be difficult to handle. Ampullary RM or EEJ was performed on 137 range bulls aged 3–9 years and 39 yearling bulls. This time, in an attempt to improve semen sample quality, semen collection tubes were suspended in a 500 mL collection container containing 37 °C water. Semen was obtained in 80.9 and 100% of attempts by RM and EEJ, respectively, in the range bulls. In the yearling bulls, RM was considerably more effective. Semen was obtained in 94.9% of attempts by RM, compared to 97.4% by EEJ [24]. The yearling bulls had been handled

frequently and once again, much of the success of RM was attributed to their relative docility [24]. No differences in percent motile sperm were observed between collection methods in the yearling bulls, but RM samples contained fewer live sperm (76% versus 85%). In the range bulls, the percent motile (50% versus 60%) and live (67% versus 78%) sperm were again significantly less in RM samples compared to EEJ samples [24].

Penile protrusion did not occur during semen collection by RM in many of the range and yearling bulls; 54.4 and 15.4%, respectively, whereas, the number exhibiting penile protrusion during EEJ represented a respective 91.5 and 89.7% of the range and yearling bulls. The lack of penile protrusion and consequent exposure of semen to the hostile preputial environment was thought to have contributed to the poor quality of the semen samples collected by RM [24].

Although it may be physically taxing, these data suggest that ampullary massage may be a viable alternative to EEJ in docile bulls. The differences in percent live and motile sperm between collection methods were not extreme, but caution is advised as poor sample quality and an inability to examine the penis are likely to reduce the quality of the BSE [24].

3.3. Segmented probe

The segmented probe, as described in the previous text, has been commercially available for over a decade. In an experiment designed to compare conventional and segmented probes, full penile protrusion was much easier to obtain with a conventional probe, but both probes were equally effective for obtaining semen emission [15]. In that experiment, the electroejaculator settings were predetermined so that the intensity, frequency and duration of electrical stimuli were similar between the conventional and segmented probes. Each bull received 27 electrical stimulations. When the segmented probe was used, the caudal three segments were active for the first 15 stimuli, then the middle three segments were added for the final 12 stimuli. The cranial segments were not utilized. The segmented probe, as used in that experiment, offered no advantage over the conventional probe, in terms of blood concentrations of cortisol and progesterone [15].

3.4. Drugs to facilitate semen collection by electroejaculation

Oxytocin concentrations in the blood rise in many species in association with semen collection and ejaculation [25–28]. Oxytocin treatment prior to semen collection has resulted in increased numbers of sperm in the ejaculate of bulls collected with an AV [29] or by EEJ [30]. Prostaglandin $F_{2\alpha}$ increases the smooth muscle contractility in the male and may be involved in the ejaculation process [31]. Administration of $PGF_{2\alpha}$ prior to semen collection resulted in increased sperm output in stallions [32], dogs [33], buffalo [34], and in bulls collected using an AV [35]. Sperm output was apparently unaffected when $PGF_{2\alpha}$ was used in bulls undergoing semen collection by EEJ [36].

Two experiments were designed to evaluate the effect of oxytocin and cloprostenol, a more potent analog of $PGF_{2\alpha}$, on the time and number of EEJ stimuli required to cause semen emission [23]. In both experiments, the dosages of oxytocin and cloprostenol were

100 IU and 1 mg, respectively. In the first experiment, bulls received saline, oxytocin or cloprostenol 10 min prior to 2 min of RM, followed immediately by EEJ. The control group received saline only prior to EEJ. Transrectal massage consisted of a vigorous back and forth motion over the accessory sex glands as described above. The protocol in the second experiment was similar to the first, except that ampullary RM was used for a maximum of 5 min or until at least 0.5 mL of semen was obtained. All bulls in the second experiment, including the control group, received RM just prior to EEJ [23].

Cloprostenol had no effect on the time to semen emission, sperm output or the number of electroejaculator stimuli required [23]. For the oxytocin-treated bulls, the time to semen emission following EEJ was significantly less (11.5 s) than the control group in the first experiment, but not in the second. In both experiments, oxytocin treatment did not influence the number of electroejaculator stimuli required to achieve semen emission nor did it increase the number of sperm in the ejaculate [23]. Transrectal massage in bulls reportedly results in a release of oxytocin, with peak concentrations 6–9 min after the onset [26]. In the first experiment, the control group did not receive any RM, but this was not the case in the second experiment. Every treatment group in the second experiment received RM prior to EEJ, therefore, all of the EEJ semen collections were influenced by endogenous oxytocin. In fact, oxytocin concentrations would have been steadily rising just before the onset of EEJ. This may be the reason that oxytocin did not appear to have an effect in the second experiment and may explain why ampullary massage decreased the time (−8.7 s) and the number of electrical stimuli (−2.5 impulses) required for semen emission by subsequent EEJ in the second experiment compared to the first [23]. This endogenous oxytocin effect suggests that ampullary massage may be beneficial to subsequent EEJ and is something that may be easily incorporated into an EEJ protocol. Massage consisting of only a vigorous back and forth motion appears to be of little use other than to facilitate probe insertion.

3.5. Anesthetics and sedatives

Various anesthetic protocols have been used in attempts to measure and reduce the pain associated with EEJ in bulls. Caudal epidural anesthesia with 2% lidocaine has been studied extensively [1,13,15]. Unlike many of the sedatives, lidocaine epidural anesthesia has been found to have no adverse effects on penile protrusion or semen emission [1] and elevations in both serum cortisol [13] and progesterone [13,15] were reported to be less following EEJ with lidocaine epidural anesthesia. The change in heart rate also tended to be less in bulls administered a lidocaine epidural anesthesia prior to EEJ than in those receiving no anesthesia. Unfortunately, in all of the studies, the reduction in pain attributable to lidocaine epidural anesthesia was not significant [1,13,15]. The benefits of lidocaine epidural anesthesia prior to EEJ do not appear to outweigh the inconvenience associated with administering the anesthetic [13,15]. Other treatments, such as narcotics in combination with lidocaine, may be more useful in reducing the pain associated with EEJ [13] and should be investigated. Both intravenous xylazine and especially xylazine epidural anesthesia, were also found to be somewhat effective at diminishing heart rate and muscle exertion [1]. Unfortunately, ataxia and recumbency limited the practical application of xylazine treatments [1] and further research was discontinued.

4. Conclusion

The ability to elicit vocalization and cause significant elevations in serum progesterone indicates that there is pain associated with conventional electroejaculation. Discrepancies noted between experiments, particularly with regard to the degree of vocalization associated with electroejaculation, may be due to EEJ technique. The more intense the electrical stimulation is, the more likely it is to be painful.

Several alternatives to electroejaculation have been evaluated. All offer certain advantages, but none of them are as reliable as EEJ for obtaining a high quality semen sample. Transrectal massage of the ampullae may be useful as alternative to EEJ in docile bulls and may be also be used to decrease the duration of subsequent electroejaculation. Further research is warranted.

If electroejaculation is to remain as an acceptable procedure, operators must strive to collect semen by applying electrical stimulation in the gentlest possible way.

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