Electro-ejaculation in ruminant livestock: A welfare issue

Contents

Introduction

The beef, mutton, wool and mohair industries generate billions of Rands annually. To obtain optimal production in the livestock, these industries rely largely on sound fertility in the animals, especially the male animals. Therefore, determination of breeding soundness is a prerequisite for acquiring and utilising the male animal. Examination for breeding soundness involves a complete assessment of sperm production and quality, which requires obtaining a semen sample. Semen collection can be achieved in various ways and Palmer et al. (2005) describe four ways which have varying degrees of success: electroejaculation (EE), artificial vagina (AV), aspiration of a sample from a recent ejaculation in the female animal and transrectal massaging of the accessory sex glands.

Transrectal massage prior to insertion of an electroejaculator probe provides sexual stimulation and encourages semen emission (Palmer, 2005). This technique requires a specific level of expertise and is applicable to bulls only. Aspiration of recent ejaculates in the vulva is an easy, non-invasive technique that does not cause discomfort to the animals. It requires that female animals in oestrus are available in a small enclosure in order to obtain the sample directly after serving. This technique allows for the assessment and presence of live sperm only.

EE and AV are the most frequently used techniques (Damian and Ungerfeld, 2010; Palmer, 2005). According to Palmer (2005), the AV method of obtaining semen from domestic animals was in use long before the invention of the electroejaculator. The AV method is perceived to be a less painful and stressful alternative to EE, but requires training of the bull, buck or ram. The training is time-consuming and not all animals are suitable for training. During the training, the rams or bucks have to be isolated from the flock which is a separate stressor (Al-Qarawi & Ali, 2005). Female animals in oestrus or dummies are also required for AV. When a live animal is used as a "dummy", the welfare concerns transfer from the male to the female animal.

The EE method in domestic animals has been in practice for decades (Dziuk et al., 1954; Marden, 1954). The EE method is widely considered to be an effective method that does not require any training of animals or a female animal/dummy to be mounted, and which can be adapted to the handling facility. The procedure is, however, contentious since it is associated with discomfort to the animal during electrical stimulation. In recent years, welfare organisations have begun placing increasing pressure on producers to stop the use of EE. The Animal Welfare Requirements of the Responsible Wool Standard certification scheme, an independent, voluntary scheme, prohibits EE as a method for semen collection. In the United Kingdom, EE may only be carried out by a veterinary surgeon and the use of anaesthesia for the procedure is encouraged (Palmer, 2005). Some European countries have banned the use of EE. The Canadian Veterinary Medical Association advised that only experienced individuals should perform the procedure. In South Africa, EE is not regulated, but some superficial provision is made in the Animal Protection Act (Act No.71 of 1962) for unnecessary suffering. "(f) *uses on or attaches to any animal any equipment, appliance* or vehicle which causes or will cause injury to such animal or which is loaded, *used or attached in such a manner as will cause such animal* to be injured or become diseased or *to suffer unnecessarily*." The EE procedure is, however, considered an acceptable procedure by most animal welfare organisations in South Africa, but it is becoming increasingly controversial. This article aims to review recent research concerning the effect of EE on rams, bucks and bulls.

Electroejaculation in bulls, rams and bucks

The use of EE as a method of obtaining a semen sample was reported as early as 1936 (Palmer, 2005). Recent procedures and methods for EE have been refined with specially designed equipment. Modern electroejaculators for bulls achieve ejaculation with electrical impulses < 8 or 9 volts (Palmer, 2005) of sine-wave pulse at a frequency of 20-30 cycles. The modern electroejaculator segmented probes are designed with three caudal electrodes, three middle and two probes at the cranial end. These segments can be activated independently as needed. This allows for electrical stimulation of desired nerves with little or no stimulation of non-target tissues. The purpose of the caudal segment is to produce an erection. The middle segment is then activated to induce ejaculation. Palmer (2005) describes the technique used in bulls that involve transrectal massage over the ampullae, seminal vesicles, prostate, pelvic urethra and inguinal rings for 10 to 60 seconds. The intention of the massage of those areas is to stimulate the bull sexually with subsequent relaxation of the anal sphincter prior to insertion of the electroejaculator probe. With the probe in place, electrical stimulation should be applied carefully while observing the response of the bull. Slight contraction of the muscles of the hind legs is an indication that the bull feels the stimulation. The stimulation should then be briefly stopped. Successive stimulations are then applied with a steady increase in voltage intensity, maintained for 1-2 seconds. This should be followed with 0.5 to 1 seconds of no stimulation to rest. Stimulation continues through penile protrusion, erection and finally ejaculation whereby the semen is collected. (Furman et al., 1975). Comparing the aversive experience between bulls and rams or bucks towards EE is not justified. Semen collection by means of EE in bulls involves having the bull standing in a handling chute without physical constraints. The effect of isolation stress is thus not as relevant as would be the case in small stock that requires physical restraint in lateral recumbency.

Various commercially manufactured EE probes exist for use in rams or bucks. These probe types usually deliver stimulation of 10-15 volts of 30 – 50 sine or square waves. (Shipley et al., 2007). In contrast to bulls, EE procedures in rams or bucks require the animal to be constrained in lateral recumbency and physically held down by handlers. The penis is massaged out of the sheath, grasped behind the glans with sterile gauze and directed into the collection vial. Similar to cattle, gentle massaging of the accessory glands with either the fingers or the probe for 10 to 15 seconds will stimulate the ram sexually to ease semen collection. Electrical stimulation is applied with the probe for 3 to 5 seconds with a rest period of 5 to 15 seconds while applying gentle pressure downwards towards the pelvic floor. The movement of the probe during the on-off sequence stimulates the animal and helps with the collection. Individual rams or bucks may vary in their response to stimulation, but ejaculation usually occurs between 3 to 5 stimulations. The preparation of a ram or buck for EE semen collection is usually longer than the electrical stimulation itself and may contribute more to the discomfort the animal is experiencing than the electrical stimulus. It is strongly recommended that the equipment used for EE and the competency of the operators be regulated to align South Africa to international standards and to improve the welfare of the animals earmarked for EE procedures. Consultation with professional bodies such as the South African

Veterinary Council (SAVC), South African Veterinary Association (SAVA), South African Council for Natural Scientific Professions (SACNASP) and the Livestock Welfare Coordinating Committee (LWCC) would be of value in establishing such regulations.

Electroejaculation and pain

Based on animal behaviour in response to EE, the procedure has the potential to cause pain, discomfort and stress to the animal (Abril-Sánchez et al., 2017; Damian and Ungerfeld, 2010; Palmer, 2005; Orihuela et al., 2009; Costa et al., 2018). There seems to be a consensus among scientists and researchers that EE has the potential to cause pain in bulls, bucks and rams. They do however differ in their description of the pain associated with EE. Palmer (2005) states that it is *considered* to be painful to bulls. Abril-Sánchez et al. (2018) describe EE in rams as stressful and *probably* painful. Baiee et al. (2017) and Damian and Ungerfeld (2010) state that EE in rams *may* be associated with pain. Abril-Sánchez et al. (2017) describe EE as a procedure that provokes muscular damage and *probably* pain.[1]

This reluctance to state conclusively that EE causes pain may be because animal and human experiences of pain, in response to a similar stimulus, may not be identical. Humans tend to report pain and seek help while animals will hide signs of pain because such signs may provoke an attack from predators or subordinate members of the group (Bayne, 2000). Humans can articulate a pain sensation. Ohl et al. (2001) reported humans who could not tolerate electrical stimulation during EE procedures due to pain. In contrast to human articulation, animals present with behavioural signs in response to pain stimuli. Ruminant animals are widely recognised as sentient beings and therefore it can be accepted that they will also experience pain and discomfort during EE. According to the Cambridge Declaration on Consciousness (Low et al., 2012):

> The absence of a neocortex does not appear to preclude an organism from experiencing affective states. Convergent evidence indicates that non-human animals have the neuroanatomical, neurochemical, and neurophysiological substrates of conscious states along with the capacity to exhibit intentional behaviours. Consequently, the weight of evidence indicates that humans are not unique in possessing the neurological substrates that generate consciousness.

The U.S. Government Principles for Utilization and Care of Vertebrate Animals Used in Testing, Research, and Training (IRAC, 1985) states that "unless the contrary is established, investigators should consider that procedures that cause pain or distress in human beings may cause pain or

[1] The author added emphasis to these quotes.

distress in other animals." (Bayne, 2000). One must, however, be cautious not to anthropomorphise and assign an animal's pain response equal weight to a human pain response. Humans are cautioned for anticipated pain, are thus more sensitised to it and may then exaggerate the sensation.

To complicate the matter more is the difficulty in defining pain. The Oxford Dictionary defines pain as a "highly unpleasant physical sensation caused by illness or injury." The Merriam-Webster dictionary describes it more elaborately as "a basic bodily sensation induced by a noxious stimulus, received by naked nerve endings, characterised by physical discomfort such as pricking, throbbing, or aching, and typically leading to evasive action." Baillière's Comprehensive Veterinary Dictionary defines pain in animals as "a feeling of distress, suffering or agony, caused by the stimulation of specialised nerve endings." The behaviour of an animal in response to painful stimuli is obvious and recognisable and does not need a definition to identify it. Prunier et al. (2013) describe four types of pain indicators in mammals: behavioural, physiological, lesional and production related. This article will discuss the behavioural and physiological indicators of pain.

Behaviour as an indicator of pain

Vocalisation is widely recognised as a more accurate indicator of pain during EE when compared to other behavioural responses (Falk et al. 2001). It is an immediate response to pain and indicates the stage in the procedure where the electrical stimulus is most painful. Vocal behaviour differs between species, for example, the mere restraint of a goat will result in the animal being vocal, which is normal behaviour for a goat. In contrast to this, abusive restraint in a sheep will not elicit a vocal response. This does not mean that vocalisation is not an indicator of pain. Vocalisation during electrical stimulation and being silent in-between stimulations can be considered an indicator of pain.

Grandin (2010) refers to unpublished data (Voisinet and Grandin, 1997), where vocalisation responses in bulls in three treatments (restraint, restraint with low voltage EE and restraint with high voltage EE) differed significantly. Whitlock et al. (2012) published similar results with significantly more vocalisations in bulls during electrical stimulation compared to the control group with no stimulation. If vocalisation can thus be accepted as an indicator of pain, then these results support the argument that EE is a painful procedure. However, according to Bayne (2000), vocalisation alone is not a sufficiently sensitive measure in the assessment of pain.

Molony and Kent (1997) describe more types of responses to pain, besides vocalisation. One of these is the modification of the animal's behaviour by learning, which enables the animal to avoid a recurrent experience. In Molony and Kent's (1997) experiment, sheep were moved through a handling chute to a pen for different treatments:

(i) partial shearing
(ii) EE
(iii) free movement

The aversive behaviour to the respective treatments was reflected in the time it took the sheep to move through the chute later on in the trial. Transit times for both EE and partial shearing were significantly higher than for the free movement pen. Personal experience by the author has witnessed similar behaviour of Zulu sheep rams where semen was collected by EE twice a week. When the sheep recognised the semen collection team, they refused to move into or through the handling chute. The same rams would, however, move freely through the handling chute when the regular handler who fed the sheep was at the chute. This time-averse relationship, known as “conditioned suppression” (Rushen, 1986) is indicative of pain associated procedures. This is, however, not the same in all animal species. Bulls subjected to EE twice a week for several weeks developed little aversion to the procedure. Bulls who were lining up in the chute and exhibited preputial and even penile protrusion, seemingly in anticipation of EE (Palmer, 2005). This lack of aversive behaviour may be interpreted as EE not inflicting pain in bulls. The degree of aversion is however influenced by the intensity and duration of the electric shock. Aversive behaviour was more evident if the electric stimulation was intense or of a long duration (Rushen, 1986). The lack of aversive behaviour may imply that the EE procedure can be performed without causing major discomfort or pain in bulls, provided that the intensity and duration of the electrical stimulus are tolerable for the bulls. This further supports the motivation to use proper standardised equipment and competent operators to perform the technique.

From the available literature, there seems to be a more pronounced aversive experience noticed in rams in contrast to bulls. As mentioned earlier, there is a significant difference in the execution of the procedure between the two species. Restraint of bulls for EE merely involves the bulls standing in a chute. Even though the technique in both species involves a disturbance of the homeostasis, it is worse for rams that need to be restrained physically in lateral recumbency in contrast to bulls allowed to be free standing. More research needs to be conducted on the differences in the anatomy, physiology and psychological factors of ejaculation between cattle and small stock to understand the difference in aversive behaviour for the procedure.

Physiological indicators of pain

According to the Merck Veterinary Manual:

> Pain is a complex, multidimensional experience with sensory and affective elements. All mammals process the neuroanatomic and neuropharmacological components involved in

transduction, transmission, and perception of noxious stimuli; therefore, it is expected that animals experience pain even if they cannot exactly perceive or communicate it in the same way people do.

According to Prunier et al. (2013), the nociceptive withdrawal reflex is the simplest form of avoidance and defensive behaviour. Defensive behaviour such as leg and body movements (as if the animal was trying to escape the painful stimuli) were observed during EE in rams and bucks restrained in lateral recumbency even before electrical stimuli. It can thus not be considered nociceptive withdrawal reflex behaviour. Any sheep or goat will attempt to escape restraint in a normal position and even more so in an abnormal position. All the current methods available to determine pain in animals are prone to errors of under- or overestimation. The way in which the animal is coping with the pain further complicates an accurate estimation of pain in the animal.

Physiologic parameters such as changes in rectal temperature, heart rate and respiratory rate (Boussena et al*.,* 2013) indicate responses to acute noxious (painful) stimuli, but moderate stress levels due to handling and restraint have a similar effect on those parameters. Boussena et al. (2013) report significant changes in rectal temperature, heart rate and to a lesser degree respiratory rate, in rams during EE procedures. The increase in heart rate described by Boussena et al*.* (2013) that occurred during EE is ascribed to a combination of pain and muscle contractions. However, an increase in heart rate as an indication of pain is contradicted by Mosure et al (1988) with the argument that normal sexual activity also leads to an increase in heart rate. The heart rate in bulls was evaluated after six different treatments for EE in an experiment by Mosure et al (1988):

(i) transrectal massaging of the seminal vesicles
(ii) conventional EE
(iii) intra-rectal lidocaine prior to EE
(iv) intra-venous xylazine prior to EE
(v) epidural lidocaine prior to EE
(vi) epidural xylazine prior to EE.

During the experiment, heart rates were recorded prior to treatment, immediately after treatment and every two minutes for up to ten minutes after EE. All six treatments presented with increased heart rates, with no significant difference among the groups. In all the treatments, the heart rates returned to the baseline within two minutes of cessation of electrical stimulus. The rapid return of the heart rate to the baseline suggests that pain associated with EE was of very short duration and furthermore that heart rate cannot be utilised as a reliable measure of pain in bulls. Pain is a powerful stressor that stimulates the release of hormones from the hypothalamus-pituitary-adrenal axis (HPA-Axis) (Prunier et al., 2013). Many studies have examined cortisol concentrations in blood samples after painful interventions such as castration in calves and lambs (Cohen et al*.,* 1990; Lester et al*.,* 1991). Elevated cortisol concentrations are, however, an unreliable indicator of pain during EE, because it is elicited by activities requiring energy mobilisation, including normal sexual activity (Moberg, 2000). According to Palmer (2005), early attempts to use cortisol to measure the response to pain associated with EE have been unreliable. Routine handling procedures involving no pain and very little stress, such as drenching and subcutaneous vaccination have resulted in significantly elevated blood cortisol concentration for up to 60 minutes (Kruger et al*.,* 2016). Profiles of mean cortisol concentration were similar between groups of bulls when a rectal probe was inserted without electrical stimulation and when a rectal probe was inserted with electrical stimulation applied (Welsh and Johnson, 1981). These results indicate that activation of the HPA-Axis can result from the handling of the animal and not necessarily from a painful stimulus.

Orihuela et al*.* (2009) report contradictory results in a similar study with sheep. In the study involving rams that had previously undergone EE, the effect of EE on blood cortisol was evaluated. Two treatments were applied: first with only a rectal probe inserted without electrical stimulus and second, a rectal probe inserted with electrical stimulus. An untreated control group was also incorporated into the study. Blood cortisol concentration was significantly higher in the group of rams where EE was applied compared to the group that experienced probe insertion without electrical stimulus. There was no difference in blood cortisol concentrations between the probe without stimulus group and the untreated control group. The sheep in the study were not restrained in lateral recumbency and the procedure was conducted in the rams' home pen. With the lack of such external stress factors, the results of this study do indicate EE to be a painful procedure with the potential to cause elevated cortisol concentration. A study by Ortiz de Montellano et al*.* (2007) in bucks reported similar results. Increased cortisol concentration can thus be considered a result of painful stimuli in sheep and goats but not necessarily in cattle. Similar results between cattle and sheep were reported concerning aversive behaviour where cattle did not present with "conditioned suppression" (Rushen, 1986) but sheep did (Molony and Kent, 1997; Palmer, 2005).

Although there are variations in the results of trials conducted with EE, regarding the perception of noxious stimuli, or how animals experience and respond to pain and how to estimate the intensity of pain, there is evidence to indicate that EE is a painful procedure. The reaction of conscious animals (rams, bucks and bulls) to electrical stimulation presents with intense muscle contraction, struggling and vocalisation, all of which are indicative of discomfort (Palmer, 2005). This behavioural data, in particular vocalisation and learned aversive behavior, supports the notion of a painful procedure. In addition, epidural anaesthetic has proven to reduce pain responses to EE (Etson et al*.* 2004).

Contributory factors to the pain response associated with EE have been identified, such as the duration and intensity of the electrical shock (Falk et al*.,* 2001) and operator technique (Palmer, 2005).

Electroejaculation and stress

Selye (1973) states that "everybody knows what stress is but nobody really knows." Defining stress is no less complex than defining pain because it is such a highly subjective phenomenon that defies definition. Where pain elicits an immediate response such as muscle contractions and vocalisation, stress does not present with immediate clinical symptoms. A short and concise description of stress is the non-specific response of the body to any demand made upon it (Selye, 1973). Selye (1973) states very clearly that stress is not anxiety. Stress associated with EE has been extensively studied (Abril-Sánchez et al*.*, 2017; Palmer, 2005; Stafford, 1995; Ungerfeld et al*.*, 2016; Costa et al*.*, 2018). As stated earlier, the stress experienced by an animal during EE cannot be ascribed to EE alone. Zulkifli (2013) states that any disruption of an animal's homeostasis that requires a response to maintain its psycho-physiological integrity has the potential to elicit a stress response in the animal. EE qualifies as a disturbance in the homeostasis of an animal, as it is an artificial procedure designed by humans and may thus cause stress in the animal on which it is performed (Stafford et al*.*, 1996; Orihuela et al*.*, 2009). However, the steering of the animals to the handling facility, confinement, handling and restraint all disturb the homeostasis of the animal and would also have the potential to elicit a stress response. While this is true, animals become habituated to repeated stimuli of the same stressors (Grissom and Bhatnagar, 2009), for example weighing of animals. According to Thompson and Spencer (1966), habituation is a form of simple non-associative learning in which the magnitude of the response to a specific stimulus decreases with repeated exposure to that stimulus. Damian and Ungerfeld (2010) have characterised the stress response to EE in frequently electroejaculated rams (every 15 days since 45 days of age) and concluded that although rams had been subjected to frequent EE, they constantly suffered from stress. The study characterised stress by describing changes in heart and respiratory rates and increased cortisol concentrations. The results suggest that rams did not habituate to frequent EE.

Page (2017) coined the term "anticipation stress", where the Hypothalamus- Pituitary- Adrenal- Axis (HPA – Axis) is activated as soon as the animals are steered towards the handling chute for a procedure. Kruger et al*.* (2015) reported elevated cortisol concentrations in goats at zero minutes after a "low stressor" procedure such as deworming, confirming the theory of anticipation stress. Stress is thus a continuum of experience that presents in different degrees according to the procedure performed. Short-term mild stress results in short term physiological responses on the part of some animals with slight or no behavioural adjustment. Moderate stressors evoke behavioural adjustment with physiological recovery and adaptation by the animal. Severe stressors or distress is a state where the animal is unable to adapt to the stressor and the animal may even exhibit maladaptive behaviour (Bayne, 2000).

According to Whitlock et al. (2012) increased vocalisation in bulls after the first electrical stimulus resulted in a peak in plasma cortisol concentration after ten minutes. The mean plasma cortisol and progesterone concentration following EE were higher in EE bulls compared to control bulls with a rectal probe inserted with no electrical stimulus or no manipulation. The cortisol concentrations in the EE bulls returned to the basal level concentrations after 45 minutes. This correlation between the electrical stimulation of EE and cortisol concentration motivates the argument suggesting that EE causes stress. There was, however, no difference in the mean plasma substance P concentration between EE bulls and control bulls. Substance P is a neurotransmitter that stimulates pain receptors in the body. If substance P levels are elevated, the perception of pain may be exaggerated (Lubbers et al., 2009). This lack of difference between the EE bulls and control bulls indicates a lack of pain associated with nociception and may explain the lack of aversive behaviour in bulls exposed to repeated EE procedures as stated by Palmer (2005).

In a similar study by Costa et al (2018) with rams, the serum cortisol concentration peaked 20 minutes after the application of an electrical stimulus and only returned to the basal level concentration after 60 minutes. The total plasma protein concentration increased significantly from the beginning of the electrical stimulus up to 120 minutes, after which it returned to baseline concentrations. Costa et al. (2018) suggest, based on the results of previous studies on rams (Orihuela et al., 2009), the use of anaesthesia prior to EE in order to reduce the observed pain symptoms.

As mentioned earlier, any disturbance of the homeostasis has the potential to stimulate the HPA-Axis with subsequent release of stress hormones such as cortisol. Cortisol is a gluco-corticoid hormone that may compromise the immune system and is implicated as contributing to the early stages of the pathogenesis of pneumonia caused by *Mannheimia haemolytica* (Pillai et al., 2018; Taylor et al., 2010; Rice et al., 2007). Almost all studies on EE associate the procedure with stress. There are no practical alternatives for semen collection other than AV or EE. Refinement of the equipment and technique should be investigated and regulated as a practical solution.

Alternatives to EE

The animal welfare implications associated with EE are a concern raised by retailers and consumers. Therefore, alternatives to EE or refining of the EE technique, especially in small stock, should be explored and developed, not only for practical application, but also to carry the approval of animal welfare organizations. (Costa et al., 2018; Damian and Ungerfeld, 2010; Falk et al., 2001; Etson et al., 2004).

Artificial vagina

The use of artificial vagina (AV) as a method to collect semen existed long before the invention of the electroejaculator (Salisbury et al., 1978). The procedure requires the active participation of the male animal and closely approximates a natural breeding situation with the advantage that it also allows for libido and mating ability evaluation. The procedure, however, has the disadvantage that the bull, buck or ram needs to be trained. This is time-consuming and animals unaccustomed to handling do not train well to the procedure (Palmer, 2005). The reticence of a bull to mount a cow in the presence of humans led to the development of the internal artificial vagina (Barth et al., 2004). The internal AV requires the restraining of a cow and the bull introduced to serve her. The success rate of obtaining semen with this technique is however not as high as that achieved with EE (Barth et al., 2004). This technique is also only applicable to cattle and not small stock, for which alternatives or refinement is required. The artificial vagina technique used in small stock involves additional potential stressors as mentioned before i.e. isolation, restraint and human interaction. Restraint is a distinct disturbance of the homeostasis and has the potential to cause stress and discomfort to the animal. The intention of relieving stress to the ram or buck with the use of AV is not a practical solution because the stressor is transferred to the ewe or doe.

Transrectal massage

Transrectal massaging whereby the thumb and little finger are held in direct apposition with the ampulla, and gentle motion anterior to the caudal is applied has had success in obtaining a semen sample. In a trial by Palmer (2005), semen was obtained in 280 of 288 attempts compared to 285 of 288 attempts for EE. The semen samples obtained this way had significantly fewer motile (63.5 ± 24.0% versus 74.5 ± 16.8%) and live (78 ± 14.8% versus 83.1 ± 11.7%) sperm than those obtained by EE. This technique is only applicable to bulls with a docile nature and the quality of the sperm is not as good as compared to EE and is thus not a practical alternative to EE

Drugs to facilitate semen collection by EE

In the continued exploration of alternatives to EE, two experiments investigated the effect of oxytocin (a peptide hormone associated with sexual reproduction) and cloprostenol (a synthetic analogue of prostaglandin), on the time and number of EE stimuli required to cause semen emission (Palmer et al., 2004). Cloprostenol had no effect on the time to semen emission, sperm output or the number of electroejaculator stimuli required (Palmer et al., 2004). Oxytocin decreased the time to semen emission and tended to decrease the number of EE stimuli to semen emission but it did not increase the number of sperm in the ejaculate (Palmer et al., 2004). The results of oxytocin show some potential in refining the EE technique, but it is a scheduled drug for use by veterinarians only. If the EE procedure can be regulated to allow properly trained persons only, then the use of Oxytocin may be explored further.

Anaesthesia/sedatives

The use of anaesthetics and sedatives in an attempt to reduce the discomfort and stress associated with EE has been extensively studied for decades (Mosure et al., 1998; Etson et al., 2004; Falk et al., 2001; Palmer, 2005; Stafford 1995; Pagliosa et al., 2015). According to Palmer (2005), lidocaine epidural anaesthesia had no adverse effects on penile protrusion or semen emission with less elevation in serum cortisol and progesterone. The heart rate of bulls receiving lidocaine epidural anaesthesia prior to EE was also lower than untreated bulls. The reduction in pain attributable to lidocaine epidural anaesthesia was, however, not significant (Mosure et al., 1998; Falk et al., 2001; Etson et al., 2004). Caudal epidural anaesthesia requires appropriate clinical training and practical experience far more advanced than that required for EE, and may only be performed by veterinarians. The harm versus benefit of lidocaine epidural anaesthesia in an attempt to relieve discomfort during EE is questionable, with the inconvenience associated with administering the anaesthetic outweighing the benefits of the procedure (Palmer, 2005). Abril-Sánchez et al (2018) studied the use of anaesthetics and sedatives to reduce the potential of stress associated with EE. The use of sedatives is regarded as having a lower risk than anaesthetics.

Goat bucks were divided into three treatment groups:

(i) EE in untreated control
(ii) EE under sedation
(iii) EE under general anaesthesia

They were compared to one another regarding their physiological and behavioural responses associated with stress and pain, as well as the semen quality of the three treatments. The results showed that the untreated bucks vocalised more frequently when compared to sedated or anaesthetised bucks. The rectal temperature, heart rate, total protein, albumin and haemoglobin concentrations were higher in the untreated bucks compared to the sedated or anaesthetised bucks. The serum cortisol concentration increased after EE with no differences between procedures. The study concluded that general anaesthesia and sedation decrease stress and probably also pain during EE with an added advantage of improved quality of semen in sedated bucks (Abril-Sánchez et al., 2018). Similar to the caudal epidural anaesthesia technique, the sedation and general anaesthesia of animals requires specific skills, expertise and training and can only be performed by registered veterinary professionals. The use of anesthetics or sedatives in an attempt to alleviate the pain or stress involved with EE is impractical and does not warrant any further investigation.

Modified EE technique

Baiee et al*.* (2017) explored a modified EE technique with the aim to reduce the discomfort associated with the normal EE procedure. The trial involved three stages of graduated electrical stimulation. The results of the modified technique showed that intensive muscle spasms, struggling and arched backline posture were reduced, as well as the time of penile protrusion and semen emission compared to the normal EE method. The time to collect the sample was the same for both methods and there was no difference in the semen parameters such as sperm volume, motility, morphology, viability and concentration. The authors concluded that the modified EE procedure with the gradation of electrical stimulation into three stages could reduce the discomfort associated with the normal EE method. The procedure as tested by Baiee et al. (2017) is a practical and drug free refinement of the EE technique. It does require proper training of the operators and the use of standardized equipment, further emphasizing the need for regulation of EE equipment and training of operators. The modified technique was performed on bulls only and further studies should be explored on small stock too.

Equipment & Operator factors affecting pain response during EE

Etson et al*.* (2004) investigated the influence of probe type used during EE, with and without epidural lidocaine anaesthesia, on blood cortisol and progesterone concentrations in bulls. The results indicated the use of segmented over non-segmented probes was not effective in reducing pain during EE (Etson et al*.,* 2004). The rest interval between stimuli influenced the level of pain response observed (Stafford 1995). A ten second stimulus rest interval significantly reduced the physical response of rams to EE compared with a stimulus rest interval of five seconds (Stafford, 1995). Palmer (2005) recommends applying stimuli based on close monitoring of bull's behaviour during EE. This involves removal of the stimulus for 0.5 - 1 seconds once the bull starts reacting by struggling, muscle spasms and arched back. The voltage is then steadily increased with each successive stimulation of one to two seconds. The correct placement and orientation of the probe are also important to minimise the pain response to EE (Stafford, 1995).

The variations and differences reported between studies on pain and stress indicators caused by EE may stem from variations in operator technique. Regulation with regard to standardised equipment and properly trained operators is practically implementable and if the technique is applied correctly, it may cause a reduction in pain responsive behaviour associated with EE.

Electro ejaculation and Role Players in South Africa

Animal and animal product production in South Africa must conform to international standards with regard to animal welfare if it wants to be competitive on the international market. To achieve this it is necessary for South Africa to introduce specific laws and regulations to the use of semen collection techniques. Since EE involves animals, veterinary skills are required to ensure suitability, proper health, restraint and monitoring animal responses for signs of discomfort. The South African Veterinary Council (SAVC) should thus introduce such laws and regulations in consultation with all relevant role players such as South African Veterinary Association (SAVA), Ruminant Veterinary Association of South Africa (RUVASA), National Society for the Prevention of Cruelty to Animals (NSPCA), South African Council Natural Scientific Professions (SACNASP), South African Veterinary Semen and Embryo Group (SAVSEG), South African Semen and Embryo Group (SASEG) and the Livestock Welfare Coordinating Committee (LWCC). Current artificial practitioners, with or without SAVC registration, should either register as a veterinarian (Assisted Reproduction Professional) or as a para-veterinary professional, (Assisted Reproduction Operator), with a regulatory body such as the SAVC. Training facilities for any of the assisted reproduction procedure courses must also have an accredited syllabus to be registered with and quality assured audited by SAVC.

Conclusion

Semen collection is a procedure practiced worldwide to obtain semen samples. Various techniques exist for obtaining semen samples with varying degrees of discomfort to the animal, which means that the procedures must conform to animal welfare standards.

Research results have proven that EE is the preferred technique for obtaining a semen sample. It is a quick and effective method that can be applied to animals without prior training, only involves the male animal and provides a semen sample of good quality. It is an aversive procedure with the potential to cause pain and stress in the animal. However, if the technique, especially the electrical stimulation, is refined and correctly applied by trained operators and conducted with proper equipment, there should be less pain and discomfort associated with EE. Despite the concerns raised by animal welfare groups, EE should remain as an ethically acceptable technique for obtaining a single semen sample and regular semen samples, provided that the procedure is regulated essentially as a veterinary procedure only to be performed by properly trained operators.

The most common and practical alternative to EE is AV. The procedure is not painful and may be less stressful to the trained male animal. The technique, however, requires restraint of the female animal and the welfare concerns shift from the male to the female animal and it is thus not a practical solution. With trained male animals and a female animal habituated to act as a “dummy” for the AV technique, the technique could be considered the preferred option for regular semen collection. Similar to the EE technique, the AV technique should also be regulated to be performed by properly trained operators only.

Other alternatives such as the use of sedatives or anaesthetics are not recommended for farm animals under normal conditions because of various risks involved. They are also impractical and do not justify any further investigation.

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