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The Jarvis Beef Stunner: Effects of a prototype chest electrode

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ABSTRACT

The Jarvis Beef Stunner electrically induces a stun, cardiac arrest and spinal discharge in adult cattle by three consecutive cycles. Concerns over varying incidences of cardiac arrest and some meat quality problems prompted this study to investigate the effect of replacing the conventional brisket electrode (T1) with a prototype chest electrode, with (T2), and without (T3) spinal discharge in 287 animals in a commercial abattoir. Repositioning the electrode did not significantly affect electrical parameters in any of the cycles. All animals received a cardiac arrest as assessed by electrocardiogram. Most post-stun/kill responses were unaffected. No difference was found in the incidence of a broken femur between treatments, but haemorrhages in the sirloin were significantly reduced by the prototype electrode (left: 51.1% (T1) vs. 30.3% (T3); right: 57.6% (T1) vs. 36.4% (T3)). The chest electrode was therefore efficient at causing cardiac arrest, did not significantly affect post-stun/kill responses and reduced haemorrhaging in the high-value sirloin.

1. Introduction

It is a legislative requirement in the UK that animals must be stunned before slaughter (WASK, 1995) with an exemption for religious slaughter. In adult cattle, pre-slaughter stunning is usually carried out using the percussive effect of a captive bolt device, but electrical stun/kill systems have been introduced. The system used at present in the UK is the Jarvis Beef Stunner, which was first developed in New Zealand for use as a head-only electrical stunning method for cattle to supply the halal market. The Jarvis Beef Stunner when configured for halal operation is operated in conjunction with post-stun, low voltage electro-immobilisation, to control post-stun convulsions, which is contra to the EU welfare directive (Council Directive 93/119/EC). Subsequently it was modified for the European market to include an additional current application that causes a cardiac arrest in the animal. The major welfare advantage of this system is that if the circulation is successfully stopped, perfusion of oxygenated blood to the periphery and to the brain quickly ceases and the animal cannot recover consciousness. Consequently the accuracy of the sticking method used and the time to sticking (severance of the major blood vessels) becomes irrelevant, as the initiation of the death process is not reliant on exsanguination. Peripheral nerve hypoxaemia resulting from the lack of oxygen distribution around the body, reduces the severity of physical activity post-kill. In addition, the application of a third and final current application is designed to exhaust the spinal cord, resulting in a still carcass that is easier to handle with enhanced operator safety.

The application of current in the Jarvis stun box is between a combination of electrodes, in three separate but consecutive cycles:

(i) Three second stun cycle, with current applied between the nose-plate and neck yoke electrodes.
(ii) Fifteen second cardiac arrest cycle, with current applied between the nose-plate and brisket electrodes.
(iii) Four second spinal discharge cycle, with current applied between the nose-plate and a point of contact between the animal and the metalwork of the box.

Electrical current (sinusoidal AC) is applied to the animal at 550 V, 50 Hz, through a current limiting choke that limits the current to a maximum of 3.5 A (Wotton, Gregory, Whittington, & Parkman, 2000). Water is applied to the electrodes and the animal, to reduce contact impedance.

Concerns have been raised about the proportion of animals in which a cardiac arrest is successfully induced. Heavy contamination of the brisket area has been reported to act as an electrical insulator and prevent sufficient current transfer to the heart. As a result such animals would not be subject to successful ventricular fibrillation (Gregory, 1993a). Clean cattle are therefore a requirement for the successful operation of the Jarvis system. There has been a requirement in the UK since 1997 (the Clean Livestock Policy, CLP) for clean cattle to be delivered to abattoirs, for hygiene reasons (MHS, 1997). EC Regulation 853/2004 (H2) provides the current hygiene control requirements for slaughter and states that

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all animals should be 'clean' before being accepted onto the slaughterhouse premises. This policy should prevent poor electrical contact due to contamination between the brisket electrode and the animal.

However, seasonal variation in the incidence of ventricular fibrillation has been reported for cattle. Research suggested that 89% of cattle were reported as successfully fibrillated in one plant during the summer, but this fell to 69% during the winter (Moreno, 2004). It was proposed that the cause of the problem could lie in the current pathways produced during the cardiac cycle, with wet dirty routes of low impedance produced by water from the neck yoke electrodes running down the neck and brisket of the animal. A proportion of the current applied between the brisket electrode and the nose-plate electrode could therefore flow preferentially across the surface of the neck and bypass the heart, and the animal would not be subject to a cardiac arrest.

Problems with carcass quality have also been reported, for example, a broken femur and petechial haemorrhaging (bloodsplash) in the hindquarters. These conditions could be caused by abnormal contractions of muscles during the passage of current. When current is applied, muscle fibres are simultaneously stimulated to contract maximally. Maximal contraction of opposing muscle groups does not occur physiologically, where as one set of muscles contract the opposing set relax to allow movement. The excessive forces generated through electrical stimulation can result in broken bones with associated bruising, and ruptured blood capillaries within the tissues. The overshoot in blood pressure that follows electrical stunning (Leach & Warrington, 1976) can subsequently force blood out of the damaged capillaries into the muscle, which results in an unsightly haemorrhage (bloodsplash) in the meat.

If the downgrading conditions described above are brought about by either the cardiac arrest or spinal discharge cycles, repositioning the brisket electrode to the side of the chest may reduce the incidence of these problems. Contamination is less likely to occur in this area of the animal, and it is very unlikely that a wet route or, route of low resistance could form between the nose-plate electrode and the prototype electrode on the chest. In addition, current penetration to the heart should be enhanced. In an effectively stunned animal there is a sudden loss of inhibitory signals, which originate in the brain. Removal of these inhibitory impulses before the spinal cord becomes exhausted results in convulsive activity through enhanced spinal reflexes (Gregory, 1993b). The spinal discharge cycle is designed to reduce this convulsive activity and may become redundant if the cardiac cycle applied from this new position results in reduced post-kill activity. Removing this cycle may also prove to be an advantage in reducing the incidence of bloodsplash by reducing the exposure of the prime cuts to unregulated current.

This study investigated the effects of repositioning the brisket electrode to the chest in a commercial Jarvis Beef Stunner, on the incidence of cardiac arrest, post-stun/kill movement and carcass and meat quality.

2. Materials and methods

2.1. Experimental design

Initially, two treatment groups were used to compare the conventional brisket electrode (T1) with the prototype chest electrode (T2), in the cardiac arrest cycle of the normal three cycles. A third treatment group applied the prototype chest electrode following the head-only cycle without the addition of a final spinal discharge cycle (T3). This third treatment group was included to investigate the effect of the application via the chest electrode on post-kill responses. Beef cattle ($n = 207$) from the normal throughput of a commercial abattoir were alternately allocated to T1 and T2 treatment groups, and an additional 80 consecutive animals were assigned to T3.

2.2. Modification of the Jarvis stun box

The Jarvis box was modified prior to the experiment to include the prototype chest electrode. A proud, stainless steel electrode (Fig. 1) was mounted on a plastic base, fixed to the flank pusher and connected to a water supply so that the surface of the electrode was wet during use. The flank pusher was extended automatically during the stun cycle and made good contact with the chest of the animal, regardless of animal size, ready for the start of the cardiac arrest cycle. A manually operated electrical switch was used to switch the stunner output voltage from the brisket (T1) to the chest electrode (T2 and T3) as required.

2.3. Operation of the Jarvis stun box

Each animal was moved into position in the box and restrained using the neck yoke. A vertically moving, pneumatically operated chin-lift, raised the chin of the animal to facilitate contact between the nose and the horizontally-moving nose-plate electrode. Current was applied between the nose-plate and the two neck yoke electrodes, acting as a common electrode, and the animal was stunned. The cardiac arrest cycle was initiated consecutively, with high voltage current applied between the nose-plate and either the brisket electrode (T1) or the prototype chest electrode (T2). The third, spinal discharge cycle involved current flow between the nose-plate electrode and any contact point between the animal and the metalwork of the box. The spinal discharge cycle was disconnected for the final 80 animals (T3), where the prototype chest electrode was used.

2.4. Electrical parameters

The current and voltage profiles of each cycle were measured using RMS current and voltage probes, and recorded onto a Nicolet "Vision" data acquisition system. A PR 30 (LEM HEME Ltd.) current probe was clamped around the live output from the stunner control panel to the nose-plate electrode, which was common to each cycle and measurements were made with a resolution of 1 mA. Three differential voltage probes were used (MX 9003, Metrix) to record the voltage between the nose-plate and neck yoke electrodes for the stun cycle; nose-plate and brisket/chest electrodes

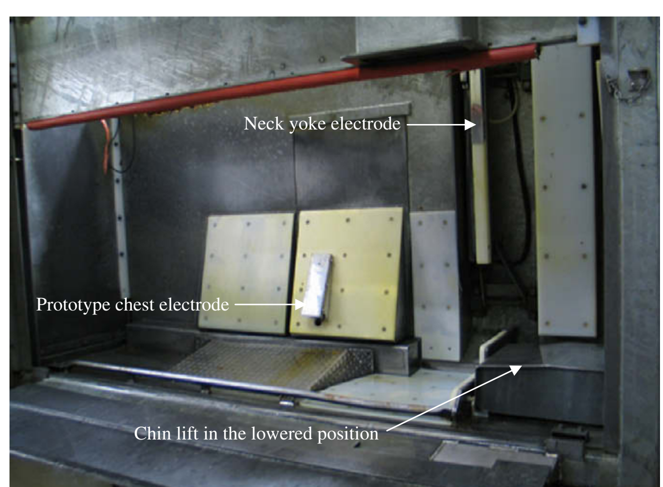

Fig. 1. Jarvis Beef Stunner with the ejection door raised showing the size and position of the prototype chest electrode.