EVALUATION OF ELECTRICAL STUNNING IN COMMERCIAL RABBITS

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Abstract - Electrical stunning was evaluated in commercial slaughter rabbits. Different voltage applications with varying current duration were tested in recovery experiments in 71 animals. Stunning parameters and duration of insensibility were measured and analysed for assessing stunning effectiveness. A minimum stunning current of 140 mA which can be achieved with application of 100 V was recommended.

INTRODUCTION

It is estimated that around 500 000 commercial rabbits per annum are slaughtered for meat consumption at three abattoirs in the UK. Welfare of commercial rabbits is protected under the latest legislation document, the Welfare of Animals at Slaughter (Slaughter or Killing) Regulations (MAFF, 1995). In the past, mechanical stunning was commonly used prior to rabbit slaughtering and processing (Commercial Rabbit, 1982). Commercial slaughter rabbits are usually transported a short distance which does not seem to cause problems in meat quality such as PSE or DFD conditions associated with handling and transport (JOLLEY, 1982). Preslaughter stunning of rabbits is now usually carried out by the preferred method of employing electrical currents.

Even though it is stipulated by legislation that sufficient currents are required, there are no specific figures for minimum levels laid down by law.

This investigation was undertaken to provide information and guidelines on minimum effective currents for successful induction of electrical stunning as well as on duration of insensibility.

MATERIAL AND METHODS

Commercial white rabbits of mixed sex, weighing between 1.7 and 3.1 kg, were used.
This experiment was divided in two parts :

Part 1 : Electrical stunning with different voltages for average duration (a minimum of three seconds)

The animals were allocated to the following treatment groups :

1. V head-only application, n = 10
2. V head-only application, n = 10
3. V head-only application, n = 10.

The above voltage settings were chosen to cover a wide range of voltage applications including a minimum level of 50 V. A wall mounted 'V' shaped metal electrode, with serrated edges for optimum contact, was used as the stunning electrode. The electrodes were attached to a variable transformer which in turn was attached to an Electronic Timer. Therefore, it was possible to stun the animal while limiting the current flow.

Stunning was applied by a 50 Hz Alternating Current with a sinusoidal waveform. Duration of current applied varied between 3.9 and 4.6 seconds. One of the output cables of the electrical stunner was connected to a sensing box for measuring stunning current. This box incorporated current sensing circuitry interrupting each stunning current for obtaining a DC output. This output was then recorded onto a magnetic tape using a Teac R-71 high frequency tape recorder. Average RMS current values were calculated from the recordings using a Gould 420 Digital Storage Oscilloscope. In addition, actual applied voltage and resistances were also determined.

Following the stunning application the animal was placed on a table and its reactions to the stun were recorded on video film until signs of recovery were recognisable. Then each animal was restunned and killed by exsanguination. Duration of spontaneous physical activity during the epileptiform activity and the times to return of reflexes were measured using the video recordings. The recognisable physical signs of a successful stun exhibited were observed and used as the basis. The signs indicative of recovery monitored were: the time to return of rhythmic breathing (more than 18 breaths per minute), presence of a corneal reflex, responsiveness to painful stimuli, return of head righting and postural reflexes. The corneal reflex was elicited by fingertip contact of the eyeball. Following the return of reflexes, the animals were challenged with repeated nose pricks to determine the response to painful stimuli. The normal response was withdrawal of the head. Return of the head righting reflex was determined when the animal was able to hold its head. Animals' ability to balance on hind legs and look around indicated full recovery.

Part 2: Applications of short current duration (one and two seconds) for instantaneous stunning

On completion of the first part, it was decided to proceed with stunning using short current duration to establish whether instantaneous stuns were possible. Therefore, a total of additional forty rabbits were used as allocated to the following treatment groups :

1. 100 V head-only application for 1 s, n = 10
2. 100 V head only application for 3 s, n = 10
3. 50 V head-only application for 1 s, n = 10
4. 50 V head-only application for 3 s, n = 10

The animals were stunned, allowed to recover and killed in the same way as those used in part one when observations were completed. Similarly, results were obtained from the Teach-R-71 tape and video recordings.

All the results were subjected to statistical analysis including multivariate analysis.

RESULTS

Table 1 shows the results of the Part 1 experiments in which three voltages were applied. One animal was failed to be stunned following a 75 V application, hence duration of insensibility could not be measured in this rabbit. Therefore, an additional rabbit was used increasing the total number to eleven in this group. As expected, average current values were elevated with increasing voltage applications. However, there were no significant differences between the different voltages in terms of the duration of apparent insensibility.

Table 1 : Effects of electrical stunning in rabbits

Target voltage	100 V	75 V	50 V
Stunning parameters (Mean (min-max))			
Actual voltage	94 (88-100)	69 (65-75)	48 (46-49)
Average current (mA)	216 (154-279)	178 (138-211)	105 (92-122)
Duration (s)	4.6 (4.1-5.2)	4.4 (4.0-4.9)	4.1 (3.5-4.4)
Duration of spontaneous physical activity (s) (mean ± SD)			
Tonic phase	17 ± 2.6	17 ± 3.8	16 ± 2.3
Clonic phase	17 ± 6.4	14 ± 6.0	17 ± 6.4
Time to return of reflexes (s) (mean ± SD)			
Rhythmic breathing	38 ± 5.0	37 ± 6.1	41 ± 3.2
Corneal	26 ± 5.0	26 ± 5.4	26 ± 2.6
Response to nose prick	54 ± 13.8	56 ± 10.8	55 ± 7.2
Time to return of righting reflexes (s) (mean ± SD)			
Head	62 ± 9.2	64 ± 10.8	60 ± 7.4
Hindleg posture	75 ± 14.6	70 ± 13.5	71 ± 7.8

Durations are from the beginning of stun application except for physical activity which are absolute values. Spontaneous physical activity and times to return of reflexes not significantly different with three voltages. Average currents significantly increased ($p<0.001$) with higher voltages.

Results of the Part 1 experiments are presented in Table 2 which also includes values for the 50 and 100 V applications from the first set of experiments for comparison.
Average mean current range was from 70 to 216 mA. Analysis showed that return of breathing and sensibility to painful stimuli occurred significantly later with the lower voltage.

Table 2 : Comparative effects of voltage and duration of current during electrical stunning in rabbits

Stunning voltage	100 Volts			50 Volts			Statistical significance		
Stunning duration (s)	1	2	4.6	1	2	4.1	Voltage	Duration	Interaction
Stunning parameters (mean ±SD)									
Actual voltage	92 ± 4.7	97 ± 4.9	94 ± 4.1	48 ± 1.1	48 ± 0.1	48 ± 0.1	***	***	***
Mean current (mA)	143 ± 65.6	158 ± 38.6	216 ± 48.1	77 ± 12.8	70 ± 11.6	105 ± 11.3	***	***	NS
Duration of spontaneous physical activity (s) (mean ±SD)									
Tonic phase	15 ± 3.4	14 ± 3.5	17 ± 2.5	17 ± 1.7	16 ± 1.3	16 ± 2.3	NS	NS	NS
Clonic phase	8 ± 2.4	12 ± 5.4	10 ± 6.4	10 ± 3.5	12 ± 3.5	17 ± 6.4	NS	***	NS
Time to return of reflexes (s) (mean ±SD)									
Rhythmic breathing	35 ± 11.1	34 ± 5.5	38 ± 4.9	40 ± 6.2	35 ± 5.7	41 ± 3.2	*	NS	NS
Corneal reflex	26 ± 9.8	25 ± 5.0	26 ± 5.0	25 ± 4.9	24 ± 4.0	26 ± 2.6	NS	NS	NS
Response to nose prick	44 ± 17.9	44 ± 6.0	54 ± 13.8	55 ± 14.6	46 ± 8.5	55 ± 7.2	NS	**	NS

NS = not significant ; * = P < 0.05 ; ** = P < 0.01 ; *** = P < 0.001

Induction of a stun failed in some animals (one and two animals following 100 and 50 V applications, respectively). The lowest current measured in the satisfactorily stunned animals was 140 mA. Some animals did not exhibit the expected, usual spontaneous activity observed during an epileptiform insult: five rabbits showed no tonic and clonic phase becoming flaccid and one recovered in eight seconds after 100 V applications. Similarly, 2 rabbits were flaccid with the 50 V applications.

DISCUSSION

Following the successful induction of a stun, an epileptiform activity occurs and the animals will collapse. This is characterised by cessation of breathing, salivation and increased motor activity, also termed the tonic (rigid) and clonic (kicking) phase (ANIL, 1991). Although most rabbits in this experiment showed these signs, some did not. In some cases there was either no rigidity or no clonic phase, but instead a state of flaccidity. CROFT (1952 b and c) published recordings of brain activity in the Electroencephalogram. However, she did not relate any of that to observed spontaneous physical activity.

CROFT (1952a) studied the effects of electrical stimulation of the nervous system in rabbits and concluded that a threshold value of 30 mA was required for inducing unconsciousness. It is not clear, however, whether this was the figure for instantaneous induction and/or based on recording high amplitude, low frequency brain activity which is characteristic of an epileptiform insult. In addition, CROFT employed square wave pulses, from a laboratory stimulator, whereas we used the mains sinusoidal alternating waveform from a stunner mimicking industrial practice.
Therefore, the current values expressed by CROFT's paper and the present study may not be comparable. Our experiments suggest that a higher amperage level of 140 mA may be required for ensuring an instantaneous, unequivocal stun in rabbits. It would appear that current practice in rabbit slaughterhouses which use 110 V applications, based on our observations at a commercial rabbit abattoir, can provide the required levels for effective stunning. In order to provide a minimum current level of 140 mA, applications with 100 V will be sufficient. We have calculated that application of 100 V for 3 s will provide an average current value of 216 mA, with a minimum of 182 and a maximum of 251 mA. An average current of 143 mA can also be obtainable by 1 s application with 100 V.

In Part 1 of the investigation there were no significant differences in the duration of insensibility between the three voltage levels (Table 1). Comparison of periods of insensibility following different current duration when Part 2 was completed, however, showed some differences (Table 2). Return of rhythmic breathing, the first, early sign of imminent recovery occurred later following 50 V application than with a higher voltage of 100 V.

Similarly, the responsiveness to painful stimuli also returned later after 50 V applications. CROFT (1952 b and c) first reported on pain response following electrical stunning in rabbits. Using cardiac pain response, she concluded that a prolonged (more than on a minute) analgesia was achieved. However, the use of this technique can be questioned as heart rate can respond to other physiological changes not only specifically to pain stimulus. Furthermore, most of the rabbits used in our experiments seemed aware of their surroundings and appeared fully conscious within one minute. However, interestingly, the recovered animals seemed to be hypersensitive even after recovery which agrees with CROFT's report. The slightly longer insensibility following the lower voltage (Table 2) may be attributable to the early current rise time observed when the data for current profile was examined and therefore be coincidental. In any case, although a lower voltage seems to be more advantageous for a prolonged stun, induction of a successful stun would not always be possible with 50 V. Besides, a prolonged stun is probably not as important for rabbit slaughtering as it is for larger species. Because following stunning, commercial rabbits are shackled immediately and exsanguination is carried out very quickly, within 10 seconds during the tonic phase, thereby preventing any risk of recovery.
In a follow up study, to substantiate the above findings, electrophysiology work examining brain function following electrical stunning in rabbits was also carried out.
Application of 100 V for 1 s resulted in the induction of a stun in seven rabbits as demonstrated by the electrocorticogram trace. Examination of the periods for which the SERs (somatosensory evoked responses) were lost showed that insensibility was provided for at least 71 s.

In conclusion, this study has shown that electrical stunning can be achieved using currents in excess of 140 mA in commercial slaughter rabbits. A minimum voltage application of 100 V should provide this current level and produce an instantaneous stun. Observations made in stunned rabbits indicated that most rabbits exhibited the manifestations of electroplectic activity during a stun. However, some animals did not go through these generally recognised signs. Results have also shown that electrical stunning can provide sufficient duration of insensibility making it a suitable method for use in slaughter rabbits.

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