THE EFFECT OF HIGH FREQUENCY ELECTRICAL STUNNING OF PIGS ON THE IMMEDIACY AND DURATION OF EPILEPSY AND TIMES TO RECOVER OF BRAIN FUNCTION.

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Introduction

The primary requirement of any pre-slaughter stunning system is to render the animal insensible to pain until death supervenes. A secondary requirement is that the stunning system does not directly result in any deleterious carcass or meat quality outcomes. Traditional electrical systems are based on a 50Hz frequency but these can be associated with high levels of blood splash and broken bones (Hatton and Ratcliff, 1973). We demonstrated that frequencies greater than 1000 Hz, eliminated broken bones and significantly reduced blood splash (Simmons, 1989). However, some studies have claimed that higher frequencies do not reliably induce immediate insensibility nor epilepsy (Hoenderken, 1978). Therefore, the aims of the following experiments were to determine if high frequency stunning could produce epilepsy (*Experiment 1*) and the threshold currents needed to ensure insensibility and epilepsy using a range of high frequency stuns (*Experiment 2*).

Materials & Methods

Experiment 1. A total of 80 pigs (boars & gilts) weighing between 90-100kg were slaughtered in batches of 20 on one day per week over 4 consecutive weeks. On arrival, each group of 20 pigs were randomly allocated to either a 50 Hz (control) or 1500, 3000, 5000 or 7000Hz treatment group. The stunner was set to deliver a 3 second stun at a constant 250V, generating a current of between 1.6 to 2.3 Amps. Under restraint, scissor type tongs (Anachem Ltd) were applied across the head of the pigs, at the base of the ears. The electroencephalogram (EEG) was recorded using subcutaneous needle electrodes inserted immediately following the stun, positioning each recording electrode approximately 2cm each side of the midline and an earth electrode along the midline. The EEG signal was amplified using a Siemens EEG10 and recorded on an instrumentation tape for analysis. Simultaneously, the time to return of brain stem reflexes and signs of recovery were recorded until the pigs were overtly conscious. The EEG was later digitalised at 200 Hz and analysed using a signal processing package (DaDISP, DSP Development Corporation) to define the duration of the high amplitude spike activity characteristic of epilepsy.

Experiment 2. The restraint of the animals, the recording procedures and the stunning equipment were identical to those used in Experiment 1. The stun was preset to 1 second and the voltage was initially set at 250 volts, then reduced until a level was reached which failed to produce hypersynchronous activity in the EEG recording (epilepsy). The data were tested for significance using an ANOVA (Statview v. 1.0).

Results

Experiment 1. The amplitude of the synchronised epileptic activity was invariably more than 5 times the control signal and the dominant frequency dropped from around 10 to 3-5Hz, and termination of the epilepsy was abrupt and readily identifiable. The duration of the measured epileptic activity did not differ significantly between the 50Hz and treatment groups (Table i). Although the duration could vary from 17 to 36 seconds, the mean values between the groups did not differ. Similarly, the resumption of brain stem reflexes, the response to a nose prick and head righting reflexes did not differ between stun treatments.

Table i.. The effect of high frequency stunning for 3 seconds at 250 V on the average duration of epilepsy and the return of brain stem reflexes

Hz	Epilepsy duration	Time to breathing resumption	Time to return of corneal reflex	Time to return of response to nose prick	Time to return of head-righting reflex
50	24.1	36.6	44.5	48.7	61.1
1500	25.0	33.0	41.3	47.3	59.3
3000	23.0	37.1	43.3	47.2	60.5
5000	27.1	38.2	46.3	45.9	65.3
7000	22.9	33.8	45.3	45.9	62.9
sed	3.20	4.02	4.86	3.44	3.83

Significance	ns	ns	ns	ns	ns

Times are given as seconds from the end of the stun.

Experiment 2

The effect of stunning frequency on the immediacy of onset of insensibility was evaluated using a short duration 1 second stun; insensibility was determined by overt behavioural signs or by the presence of the epileptic condition.

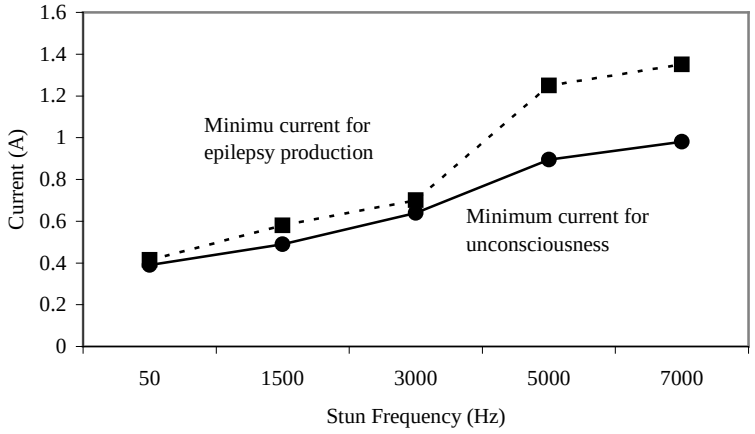

Figure i. The electrical stunning current levels required to produce unconsiousness and epilepsy using a range of high frequencies

Failure to stun was evident as an electric shock and vocalisation. Insensibility was identified as recumbency and, either, flaccid immobility which was maintained until recovery, or, the characteristic tonic and clonic activity characteristic of epilepsy. Apnea and loss of corneal reflexes for a period following the stun was an invariable behavioural feature of insensibility. The figure above shows the minimum currents needed to produce behavioural insensibility and the minimum currents needed to produce epileptic activity in the EEGs. In both cases, the threshold was raised as the frequency increased. Thus at 50 Hz, behavioural insensibility was present in all animals at current levels above 410 mA, but the required current level was more than 3 times this value – 1350 mA - at 7000 Hz. However, the threshold for insensibility without epilepsy was very close to the threshold for epilepsy at 50 Hz and the condition of insensibility without epilepsy was difficult to illicit at this frequency. In contrast, at frequencies greater than 3000 Hz, the thresholds for producing epilepsy diverged markedly from the threshold required to produce insensibility without epilepsy and by 7000 Hz, the threshold for epilepsy was approximately 50 % greater than the threshold for insensibility. The duration of behavioural insensibility without epilepsy was less than insensibility with epilepsy – average 17.2 seconds versus 24.4 seconds. At 50 Hz, epilepsy was assured at currents greater than 410 mA, but to guarantee epilepsy production at 7000 Hz, 1.35 amps was needed

Discussion

The primary purpose of these experiments was to determine whether the use of high frequency stunning currents in any way compromised the welfare of the animals being stunned. This was evaluated in two separate ways: firstly, by determining whether the induction of the stun was instantaneous; and secondly, by determining whether the epilepsy produced by a high frequency stun differed in any way from that found following a conventional 50 Hz stun. It is evident that, provided a correction is made for the threshold current needed to induce epilepsy, a high frequency current will produce as effective a stun as a 50 Hz current. The duration of the insensibility appears to be equivalent, as judged by a number of criteria: the duration of the epileptic condition; the duration of loss of brain stem reflexes; behavioural signs of unconsciousness; and the duration of unresponsiveness to painful stimuli. These results justify the use of high frequency electrical waveforms for the preslaughter stunning of livestock.

References

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