

Meat Research Report

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HALAL SLAUGHTER OF CALVES:
A REPORT BASED ON ABATTOIR
INVESTIGATIONS AND LABORATORY
EXPERIMENTS

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SUMMARY

On the basis of both abattoir investigations and laboratory experiments, it is concluded that Halal slaughter of calves is not intrinsically inhumane. For the method to be humane it is essential for both carotid arteries to be cut. Experiments suggested that under laboratory conditions poor bleeding can still occur in some animals even when this is done; but there was no evidence that this led to resumption of consciousness.

INTRODUCTION

In Australia, Halal slaughter of calves consists of head only electrical stunning followed within 10 sec by a gash (ear to ear) neck cut. In determining the humaneness of this method, it has to be established whether any of the calves regain consciousness before they die. Two questions have to be answered in deciding whether or not resumption of consciousness could occur: a) How long does the stun last? b) How long does it take for consciousness to be lost when calves are correctly stuck?

Blackmore and Newhook (1982) reported that calves regained consciousness within 45 seconds of electrical stunning. This was determined at a commercial abattoir where calves were subjected to about 1 amp head only stunning, and then taken off the line and placed on the floor. Recovery was assessed as the onset of head righting behaviour. Lambooy and Spanjaard (1982) examined the electrocorticogram (ECoG) of calves (liveweight, approximately 120 kg) subjected to either 300 V or 600 V head only stunning. The shortest period of electroplectic activity in the ECoG for any of the calves was 21 seconds. Electroplectic activity in the ECoG following electrical stunning can be taken as the period for which we are confident that the animal is unconscious. Recovery of consciousness occurs sometime after the electroplectic phase has ended; but the exact stage is not known. Putting these two studies together it is concluded that calves start to regain consciousness at some time between 21 and 45 seconds after electrical stunning. It must be noted however that this estimate is based on a limited number of animals.

The onset of loss of consciousness following sticking is less clear. When cattle are stuck without any form of prior stunning, the time taken to die varies between animals. This is evident in their physical behaviour, spontaneous electroencephalogram (EEG) and evoked responses in the ECoG (Blackmore 1984; Newhook and Blackmore 1982; Daly *et al.* 1987). Loss of righting behaviour after cutting the carotids in unstunned free-standing cattle occurs between 20 and 47 seconds (Blackmore 1984) and the EEG can indicate that there is activity which is greater than 10 μ V and less than 35 μ V for up to 123 to 323 seconds after carotid severance. Interpretation of these observations is open to debate. At worst, they suggest that sustained unconsciousness may not occur until 5.4 minutes after sticking, but this presupposes that 10 μ V and 35 μ V amplitude activity are accurate measures of the interfaces between conscious and unconscious brain activity. There is no means of knowing whether this is true nor can we assess the accuracy of the estimates for each animal.

Devine (personal communication) has argued that the above method of assessing whether consciousness recurs following Halal slaughter is wrong. He is of the opinion that it ignores the fact that electrical stunning prior to sticking causes hypoxaemia in the brain and that this will reduce the duration for potential consciousness following sticking. This effect is seen in reduced values for the partial pressure of oxygen in the arterial blood (PaO₂) after electrical stunning and this reduction is sustained if the

animal is promptly stuck. The reduction in PaO_2 is said to be due to the increased metabolism that occurs during and following passage of the current plus the inhibition of breathing during the epileptiform phase of the fit. Devine has also suggested that blood flow in the brain is brought to a prompt standstill after sticking, as witnessed by the quick reduction in arterial blood pressure and the rapid curtailment of flow from the severed jugular veins. Blood passing to the brain via the vertebral arteries is thought to be diverted through the calf's occipito-vertebral anastomoses and thence flows out of the cranial cut end of the carotids. The essence of these arguments is that a drop in PaO_2 of about 26 mm Hg within 50-65 seconds coupled with a reduced brain blood flow following sticking are sufficient to sustain unconsciousness. However, a fall in PaO_2 of 26 mm Hg in the absence of exsanguination is not sufficient to induce unconsciousness in the rabbit (Hattingh *et al.* 1986). Therefore, the explanation put forward by Devine can be looked upon as a theory which has yet to be proven. The fact that most of the blood leaving the head drains from the cranial portion of the carotid arteries instead of the jugular veins does not prove that some blood does not enter the brain to fill dilating vessels. Nor does it override the fact that consciousness will be sustained for some (unknown) period by the brain's reserves of oxygen.

In summary, it can be said that there is uncertainty as to whether there is adequate flow of sufficiently oxygenated blood to the calf's brain after Halal slaughter to allow the animal to regain consciousness. Making measurements of PaO_2 and blood flow into the brain at this time will not necessarily give a definitive answer, as they fail to determine the period for which consciousness could be sustained.

If there is a real problem with Halal slaughter in calves, it is likely that it would be particularly evident in those calves that bleed poorly at sticking. It has been suggested that the position of the cut in the neck is important in ensuring a good bleed-out (Devine *et al.* 1987). The cut should be made high up the neck allowing the head to articulate freely at the atlanto-occipital axis. This is said to be important in calves that are bled horizontally instead of being hoisted to bleed whilst suspended vertically. If the cut was made lower down the neck blood flow might be impaired. With Halal slaughter of bobby calves in Australia, the animals are suspended vertically whilst they are bled out. Experiments were designed to test the effects of various sticking and stunning methods on the rate of blood loss in vertically suspended calves. Details of these experiments are given in Meat Research Record B/88 (Section B).

It is well recognised that unstunned calves which bleed poorly can take a long time to die. For example, Blackmore (1984) found that the time to loss of righting behaviour can last for more than 5 minutes when bleeding was impaired. In the case of Halal slaughter poor bleeding is said to result in a sustained period of normal amplitude activity in the EEG (Devine *et al.* 1987). Taken together this implies that if retarded bleeding occurs in Halal slaughtered calves, it could lead to sustained brain function, if not recovery of consciousness, following the stun. To test whether this occurred in practice, Halal slaughter was examined in 3 plants in Australia. Resumption of consciousness and brain stem function were assessed on line, and potential causes of poor bleeding were investigated. The results of these investigations have been published in Meat Research Record B/88 (Section A).

It sometimes happens in both Halal and non-Halal slaughter that only one carotid artery is cut at sticking. This will also lead to a delay in the onset of loss of brain function. In order to get an appreciation of the magnitude of this effect, an experiment involving the recording of EEGs of anaesthetised calves, before and after unilateral or bilateral sticking, was conducted. Details and results of this experiment have been published in Meat Research Record B/88 (Section C).

ABATTOIR INVESTIGATIONS AND LABORATORY EXPERIMENTS

The results of 3 separate studies on stunning and sticking of calves have been published in Meat Research Record B/88. The titles and summaries of the 3 sections of this publication are given below.

Section A. Halal slaughter of calves : Abattoir investigations.

Summary

The presence of head righting behaviour, eye reflex and normal rhythmic breathing movements was examined in 486 calves and sheep slaughtered by the Halal method in three Australian abattoirs. In addition, the carotid arteries were examined for the presence of swelling with blood at their cut caudal ends in 160 calves and sheep. Only one of the calves showed symptoms of consciousness following stunning and this animal was found to have only one carotid artery cut. Calves, however, were more susceptible than lambs to developing large clots at the cut ends of the carotids and in some instances this may have contributed to sustained brain stem function.

Section B. The effects of different methods of stunning and sticking on blood loss in calves.

Summary

Three experiments were conducted to determine the rate and amount of blood loss occurring with different stunning and sticking methods in calves. In experiments 1 and 2, captive bolt stunning was used: in experiment 3 either captive bolt or electrical stunning was used. In experiment 1, there were 2 methods of sticking: (i) thoracic stick and (ii) bilateral incision of carotid and jugular vessels at the head end of the neck (Halal high). In experiment 2, there were an additional 2 sticking methods: (iii) bilateral incision of carotid and jugular vessels at the brisket end of the neck (Halal low) and (iv) unilateral incision of the carotid and jugular vessels. In experiment 3, all animals were stuck using the Halal high method.

In experiments 1 and 2, the average rate of blood loss following the thoracic stick was greater than that following the bilateral stick. There was no evidence that the location of the bilateral stick on the neck had any effect on rate of blood loss. There was considerable variation between animals in rate of blood loss following the bilateral stick. While many individual animals had a rate of blood loss similar to that recorded from the thoracic stick animals, there were some individuals that bled slowly.

In experiment 3, it was found that calves stunned electrically bled faster than those stunned with the captive bolt. Electrically stunned calves stuck by the Halal method bled as fast as, or faster than, those slaughtered by any of the other methods.

Section C. Blood loss and electroencephalogram activity following unilateral and bilateral sticking of anaesthetised calves.

Summary

The effect of cutting one carotid artery was compared with cutting both carotids in terms of the time to isoelectric EEG in pentobarbitone anaesthetised calves. The spontaneous activity of the EEG continued at least three times as long when one artery, as compared to when both arteries were cut. In one case, when only one carotid artery was cut, EEG activity continued for over 5 minutes. There is a strong possibility that sensibility could recur when electrically stunned calves are unilaterally stuck.

DISCUSSION

Halal slaughter as practised in Australia, i.e. electric stunning followed by neck slash, has three effects which help to induce or sustain unconsciousness. Firstly, there is the direct effect of electrical stunning on the brain. Secondly, cutting the carotid arteries leads to cerebral ischaemia and therefore hypoxia, and thirdly, electrical stunning results in a degree of augmentation of brain hypoxia by causing apnoea. The studies of Newhook and Blackmore (1982), Blackmore and Newhook (1982), and Blackmore (1984) have indicated that cutting the carotids without prior stunning does not induce a rapid enough loss of consciousness in calves relative to the period of unconsciousness produced by an electrical stun. Thus ischaemia alone is not thought to be a means of causing rapid loss of consciousness in calves. Devine *et al.* (1986) measured the degree of hypoxia induced in calves by electrical stunning, and the values they obtained are not considered to be sufficient to sustain unconsciousness in their own right (Kerem and Elsner 1973; Hattingh *et al.* 1986). The conclusion, therefore, is that neither the ischaemic nor the hypoxic effects of Halal slaughter would be sufficient in themselves to induce a prompt loss of consciousness.

In practice, however, Halal slaughter depends on the combined effect of ischaemia and apnoea-induced hypoxia, as well as the direct action of the current on the brain. Very few experiments have actually looked at the combined effect of electrical stunning plus exsanguination on brain function in calves. Devine *et al.* (1987) examined the EEG following electrical stunning plus sticking and, judging from the traces presented in that paper, the EEG returned to a normal pattern before the animal died. It must be emphasised, however, that the signal was heavily filtered (10 Hz lower filter) and it was derived from EEG rather than ECoG electrodes.

In order to clarify whether resumption of consciousness is likely in practice, Halal slaughter was examined at three commercial abattoirs in Australia. At two of these plants the sticking was performed by licensed Halal slaughtermen and at the third plant it was performed by experienced non-Halal slaughtermen. Only one of the calves examined showed obvious signs of conscious behaviour. In this one exception, only one carotid had been cut. It was therefore concluded that Halal slaughter was not associated with any overt signs of consciousness when the cut was performed properly.

This leads to the question; how often is only one carotid artery cut, and is resumption of consciousness inevitable when only one carotid is cut? The incidence of unilateral cutting was low. For instance, a little under half of the calves had sustained brain stem reflexes following Halal slaughter, and only two percent of such animals had just the one carotid artery cut. The importance of this in terms of brain function was demonstrated in a laboratory experiment with anaesthetised calves where it was found that the time to an isoelectric EEG was at least three times longer if only one carotid artery was cut.

It would be unwise to conclude that these findings apply in every case of Halal slaughter. Firstly, the performance of the slaughterman could have been raised to a high standard because of the presence of the observers who were evaluating the effectiveness of the procedure. In addition, it would have been more satisfactory to evaluate signs of conscious behaviour in calves which had been taken from the line and placed on the floor. In spite of these limitations, it is concluded that Halal slaughter can be satisfactory when it is performed properly, but what constitutes "proper" Halal slaughter?

Failing to cut one of the carotid arteries is an obvious cause of improper sticking and should be brought to the attention of the slaughterman. Besides this, it became clear during the course of laboratory experiments that the operator can influence the variation in the rate of bleeding following sticking in other ways. Careful consideration led the authors to believe that three mechanisms could be important in

contributing to this variation. Firstly, there is occlusion of the severed artery by surrounding tissues, and in this respect it should be noted that the artery is elastic and has a tendency to spring back into its connective tissue sheath on being cut. Secondly, it was found that platelets aggregate at the cut end of the carotid, and this leads to the rapid production of a white clot which can plug the artery. Thirdly, when the cut is made, the artery can go into an annular spasm. All three factors will tend to impede blood flow from the cut carotid, and together they could help to produce a ballooning effect in the severed vessel. In this situation blood infiltrates into and distends the connective tissue sheaths surrounding the artery. In a separate study involving captive bolt stunned or pentobarbitone anaesthetised calves, in which the skin of the neck had been opened and retracted prior to sticking, thus allowing inspection of the artery as soon as it was cut, it was found that the caudal ends of the cut carotids could balloon up within 5 sec of sticking. In one calf, only one of the carotids ballooned up, and blood flow from that artery stopped well before that from the contralateral artery. From the abattoir investigations it was thought that such effects could be sufficient to sustain brain stem function following sticking. However, since it was found that swelling of the cut arteries is a common phenomenon in calves, even in those that do not show overt signs of consciousness, it is felt that the ballooning effect does not have a strong bearing on the humaneness of Halal slaughter.

The position at which the neck was severed did not appear to have an effect on bleeding rate, but there was a sizeable effect from the stunning method. Electrical stunning resulted in a faster bleed out in comparison with the captive bolt when the Halal cut was used, and this should favour the rapid onset of hypoxaemia in the brain.

CONCLUSION

On the basis of the experiments conducted in this study it is suggested that Halal slaughter is not intrinsically inhumane as a method of slaughter. The main cause for concern occurs when only one carotid artery is cut. The only reservation that can be placed on this conclusion is if one assumes the following:

- impaired bleeding did not occur at the time of our visit to the three abattoirs, and yet
- impaired bleeding does sometimes occur in Halal slaughter, allowing resumption of consciousness. DPIE veterinarians should be made aware of this possibility and should report any instances of regained consciousness in Halal slaughtered calves.

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