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# AUTOMATIC ELECTRIC STUNNING IN A BAND RESTRAINER FOR SLAUGHTER PIGS

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## INTRODUCTION

Early in this century the use of electrical current for stunning of farm animals for slaughter was first explored. It's use became widespread in the 1930's (Warrington, 1974). In practice the current is delivered via electrodes which are positioned:
(1) on both sides of the head between the eye and the ear;
(2) on the back of the head: or
(3) on the head and body (withers, loin, back and fore or hind leg).
In case of the head-body position a cardiac arrest may occur.

Several automatic electric stunning methods are currently available for slaughter pigs. At the end of the V-type restrainer the electrodes are positioned on the head or head and body and the current passed through (Müller, 1981; Grandin, 1986). Recently a band restrainer for slaughter pigs was developed. It was observed that the pigs walk easily into the band restrainer and remain lying down on it without any problem (Lambooij *et al.*, 1992).

On this band restrainer an experimental stunning device for automatic electric stunning was constructed. The aim of this study was to examine the reaction of the pig on stunning by the automatic electric device and to determine the effects on meat quality post-mortem.

## MATERIALS AND METHODS

A band restrainer (Stork RMS, Lichtenvoorde, The Netherlands; Lambooij *et al.*, 1992) equipped with an automatic electronic stunning device was placed in a commercial slaughterhouse, which uses normally automatic electric stunning in a V-type restrainer. At the end of the band restrainer the nose of the pig interrupts a light beam which initiates the electrodes. The electrodes are positioned between the eye and ear and on the body in the heart region. During stunning the pigs are transported out of the restrainer and fall on a moving top table.

Slaughter pigs (live weight approximately 100kg) from the same producer were at random distributed over an experimental and control group of each 27 animals. The experiment was performed twice on successive days. The experimental pigs were automatically and electrically stunned while lying in the band restrainer; the controls were automatically and electrically stunned in the V-type restrainer (Müller, 1981). Both experimental and control pigs were exsanguinated within five seconds after stunning while lying on a moving top table, before slaughtering.

At 45 minutes post-mortem, the acidity ($pH_1$), temperature ($T_1$) and colour (Fiber Optic Probe; $FOP_1$) were measured in the ***longissimus muscle*** (LD) and the rigor mortis ($R_1$) of the ***semimembranosus muscle*** (SM). Ultimate pH ($pH_2$), temperature ($T_2$) and the colour ($FOP_2$) of the LD were measured at 18 hours post-mortem.

The day after slaughter, carcasses were dissected and the left (50%) or right (50%) ham, loin and shoulder of both groups were collected. A cut was made between the thoracal and lumbar part of the loin to score drip loss according to the filter paper test (Kauffman *et al.*, 1986), and to measure the colour (L*, a*, b*) using the Minolta Chromameter II. The hams and shoulders were derinded and deboned. Cuts were made between and within muscles in order to detect

haemorrhages. Haemorrhages were examined for their anatomical position (muscle), the tissue involved (connective or muscle tissue) and the seriousness of the haemorrhage (score: 0=no haemorrhage; 1=minor and 2=major haemorrhage).

Means of meat acidity, rigor mortis, temperature, colour and the filter paper test of the experimental and control groups were statistically tested by the Student t-test. The differences between both groups as to frequency of haemorrhages in muscles and connective tissues were tested by the $X^2$-test (Pearson's, $P \leq 0.05$).

## RESULTS AND DISCUSSION

As expected from previous results (Lambooij *et al.*, 1992) the band restrainer appeared to be very useful to restrain pigs in a slaughterhouse. Originally, this type of restrainer was designed for use in a production line for ritual slaughter of sheep and calves. It was found that these animals experienced less stress when slaughtered in a double rail system (Giger *et al.*, 1977). A similar system was constructed to restrain cattle for stunning by captive bolt, which is in use in some slaughterhouses (Grandin, 1986). For ritual slaughter in sheep and calves it appeared easy to fix the head for cutting and exsanguination (Giger *et al.*, 1977). In the present experiment at the end of the restrainer the head of the pig was detected and the electrodes were found to be positioned in a correct way, namely between the eye and ear.

The meat quality parameters of carcasses of pigs stunned by a scissor model stunning tong in the band restrainer showed the characteristics of an electrostimulation effect compared with pigs stunned in a pen or in the V-type restrainer (Lambooij *et al.*, 1992). In sheep, "head to body" electrical stunning may result in a more rapid pH fall and in a lower ultimate pH when compared with other stunning methods. This effect may be related to a direct stimulation of the muscles (Petersen *et al.*, 1986). When "head to body" electrically stunned with the automatic device in the band restrainer, this phenomenon did not occur. Since no differences between treatment groups were observed in acidity, rigor mortis, temperature, colour and drip loss (Table 1). After stunning the animals did not show convulsions and could be stuck within five seconds.

It has been found that haemorrhages are caused by rupturing of blood vessels, which may result from supercontractions and/or movements between muscles during violent contractions, while the animal is in an unnatural position in a V-type restrainer (Gilbert and Devine, 1982; Lambooij and Sybesma, 1988). The incidence of haemorrhages varies between muscles, which indicates a predisposition of certain muscles to blood splashes (Lambooij and Sybesma, 1988). In the shoulder of pigs stunned in the band restrainer less haemorrhages were found compared to those stunned in the V-type restrainer (Lambooij *et al.*, 1992). When stunned automatically in the band restrainer, significantly more haemorrhages were found in the muscles around the *caput humeri* and significantly less haemorrhages were found in the *m.triceps brachii* and the connective tissue of the *m.supraspinatus,* compared with the V-type restrainer (Table 2a). In the loin a very low incidence of haemorrhages was observed in the band restrainer (Table 2b). In the ham the differences between the two stunning methods were less prominent (Table 2c), which may be due to the low incidence of haemorrhages in both types of restrainers. In the connective tissue of the *m.semimembranosus* significantly less haemorrhages were observed when stunned in the V-type restrainer, while the opposite was observed in the *m.semitendinosus*, however, to a higher extent (Table 2c).

## CONCLUSIONS

Automatic electric stunning in a band restrainer can be recommended, because the pig is well restrained and the stunning procedure is correctly performed. In comparison with automatic electric stunning in a V-type restrainer, no significant differences were observed in any of the meat quality parameters. However, with the band restrainer the incidence and seriousness of haemorrhages was lower at various locations investigated from the shoulder, ham and particularly the loin.

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Table 1. Mean (± s.d.) values of the stunning procedure and the meat quality characteristics of the *longissimus dorsi* (LD) muscle at 45 minutes ($_1$) and/or 18 hours ($_2$) post mortem. (Significant difference: $P \leq 0.05$; $P \leq 0.01$, according the t-test; ns: not significant).

| | Electrical stunning | | |
|---|---|---|---|
| Characteristic | V-type restrainer (n=54) | Band restrainer (n=53) | P |
| Stunning voltage (V)<br>brain<br>heart | 650 ± 24 | 408 ± 82<br>127 ± 27 | 0.01 |
| Stunning current (A)<br>brain<br>heart | 18.5 ± 3.0 | 1.8 ± 0.1<br>0.3 ± 0.0 | 0.01 |
| Stunning time (s)<br>brain<br>heart | 2.3 ± 0.1 | 1.3 ± 0.0<br>1.6 ± 0.0 | 0.01 |
| $pH_1$ LD | 6.57± 0.21 | 6.56± 0.23 | ns |
| Rigor mortis$_1$ | 6.7 ± 2.8 | 7.4 ± 3.3 | ns |
| Temperature$_1$ LD (°C) | 39.6 ± 0.9 | 39.7 ± 0.6 | ns |
| Fiber Optic Probe$_1$ LD | 2.9 ± 2.3 | 3.1 ± 3.3 | ns |
| $pH_2$ LD | 5.86± 0.15 | 5.82± 0.12 | ns |
| Temperature$_2$ LD (°C) | 3.7 ± 0.3 | 3.7 ± 0.3 | ns |
| Fiber Optic Probe$_2$ LD | 18.9 ± 6.5 | 17.8 ± 7.5 | ns |
| Cie lab$_2$ LD: L*<br>a*<br>b* | 53.4 ± 3.1<br>12.2 ± 0.9<br>3.6 ± 0.8 | 53.8 ± 3.0<br>12.3 ± 1.1<br>3.6 ± 0.7 | ns<br>ns<br>ns |
| Filter Paper Test$_2$ LD | 0.7 ± 0.9 | 0.8 ± 1.1 | ns |

Table 2. Percentage and seriousness of the observed haemorrhages. (0=no; 1=minor; 2=major; m=muscle; c=connective tissue) in the left (50%) and right (50%) shoulders, loins and hams of slaughter pigs electrically stunned in a V-type or band restrainer. (Significant difference: $P \leq 0.05$; $P \leq 0.01$, according the $X^2$-test; ns: not significant).

Table 2a: Haemorrhages in the shoulder.

| | Electrical stunning | | |
|---|---|---|---|
| | V-type restrainer (n=54) | Band restrainer (n=53) | p |
| Score | 0 1 2 | 0 1 2 | |
| *supraspinatus* | | | |
| *lateral* m | 70.4 25.9 3.7 | 84.9 11.3 3.8 | ns |
| c | 18.5 68.5 13.0 | 37.7 56.6 5.7 | 0.06 |
| Muscles around *caput humeri* | | | |
| m | 85.2 11.1 3.7 | 43.4 37.7 18.9 | 0.01 |
| c | 88.9 7.4 3.7 | 47.2 41.5 11.3 | 0.01 |
| *M. triceps brachii* | | | |
| m | 37.0 48.1 14.8 | 50.9 39.6 9.4 | ns |
| *lateral* c | 55.6 44.4 | 58.5 41.5 | ns |
| *M. triceps brachii* | | | |
| m | 59.3 40.7 | 96.2 3.8 | 0.01 |
| head c | 33.3 53.7 13.0 | 73.6 24.5 1.9 | 0.01 |
| Between *m.triceps* and *infraspinatus* | | | |
| m | | | |
| c | 55.6 44.4 | 52.8 47.2 | ns |
| | 25.9 64.8 9.3 | 18.9 71.7 9.4 | ns |
| Rest m | 98.1 1.9 | 100.0 | ns |
| c | 98.1 1.9 | 100.0 | ns |

Table 2b. Haemorrhages in the loin.

| | Electrical stunning | | |
|---|---|---|---|
| | V-type restrainer (n=54) | Band restrainer (n=53) | p |
| Score | 0 1 2 | 0 1 2 | |
| M. longissimus | | | |
| Thoracal part | | | |
| m | 25.0 25.0 50.0 | 80.4 17.6 2.0 | 0.01 |
| c | 51.9 36.5 11.6 | 86.3 13.7 | 0.01 |
| Lumbar part | | | |
| m | | | |
| c | 86.5 11.5 1.9 | 92.2 7.8 | ns |
| | 42.3 50.0 7.7 | 86.3 13.7 | 0.01 |
| Cut at last rib | | | |
| m | 51.9 34.6 13.5 | 92.2 7.8 | 0.01 |
| c | 94.2 3.8 1.9 | 100.0 | ns |
| Rest | | | |
| m | 94.2 5.8 94.2 3.8 1.9 | 98.0 2.0 | ns |
| c | | 100.0 | ns |

Table 2c. Haemorrhages in the ham.

| | Electrical stunning | | |
|---|---|---|---|
| | V-type restrainer (n=54) | Band restrainer (n=53) | p |
| Score | 0 1 2 | 0 1 2 | |
| M. quadriceps femores | | | |
| m | 57.4 33.3 9.3 | 56.9 37.3 5.9 | ns |
| c | 85.2 14.8 | 88.2 11.8 | ns |
| M. semimembranosus | | | |
| m | 72.2 24.1 3.7 | 72.5 25.5 2.0 | ns |
| c | 98.1 1.9 | 88.2 11.8 | 0.05 |
| M. biceps femores | | | |
| m | 87.0 5.6 7.4 | 90.2 7.8 2.0 | ns |
| c | 94.4 5.6 | 98.0 2.0 | ns |
| M. semitendinosus | | | |
| m | 63.0 33.3 3.7 | 84.3 13.7 2.0 | 0.05 |
| c | 70.4 29.6 | 82.4 17.6 | ns |
| M. gastronemius | | | |
| m | 79.6 20.4 | 82.4 13.7 3.9 | ns |
| c | 75.9 24.1 | 80.4 19.6 | ns |
| M. gluteus medius | | | |
| m | 77.7 20.4 1.9 | 88.2 9.8 2.0 | ns |
| c | 96.3 3.7 | 98.0 2.0 | ns |
| Rest m | 100.0 | 100.0 | ns |
| c | 96.13 3.7 | 100.0 | ns |