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General anaesthesia, analgesia and pain associated with the castration of newborn piglets

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Approximately 100 million male piglets are castrated every year in the European Union for the purpose of meat production. Castration is a painful surgical intervention and should, according to public opinion and animal welfare organisations, be performed under anaesthesia. Due to economical priorities and lack of suitable methods, the animal welfare legislation in most European countries allows castration up to seven days of age without anaesthesia. Castrations are performed by a "competent person" (citation Swiss legislation) on awake, non anaesthetized animals. The predominant method of castration is surgical incision of the scrotum to reveal the testes which are then removed by tearing, cutting or twisting. Castration is justified on the grounds that it improves the animal's overall welfare and the economic benefits outweigh the welfare costs. Castration is performed to increase meat quality by avoiding boar taint, indiscriminate breeding and to maintain general control of stock.

The current situation is not satisfactory from an animal welfare perspective and there is increasing consumer sensitivity toward ethical aspects of food animal production. The increasing knowledge of pain perception in newborn individuals [1] has to be considered as well. It was initially concluded, based on early studies of neurologic development, that neonatal responses to painful stimuli were decorticate in nature and that perception or localisation of pain was not present. The International Association for the Study of Pain defines pain as an unpleasant sensory and emotional experience associated with an actual or potential tissue damage, however, the evaluation of pain in animals is very difficult because pain is generally defined as a subjective phenomenon.

The density of nociceptive nerve endings in the testis and the scrotum of the piglets is assumed to be similar to other species. They are stimulated by mechanical, thermal or chemical stimuli produced by castration. Both the enkephalinergic and the endorphinergic systems may modulate pain transmission at spinal and supraspinal levels. Experiments carried out in piglets clearly indicate that surgical castration induces endocrine responses [2,3]. A 40-fold increase in Plasma ACTH peaking 5 minutes after castration is followed by a 3-fold increase in plasma cortisol 15 to 30 minutes post surgery. There are, however, problems associated with the method used by these authors due to the stress experienced by the animals during birth. Endogenous opioids are released in the fetus at birth and in response to fetal and neonatal distress and reach adult values after 5 days in humans [4]. Intra- and postoperative pain symptoms have been assessed by different groups [2,5-10]. The symptoms have partially been related to increased levels of plasma cortisol, ACTH, β -Endorphine, Pterines, Glucose, LDH and CK [9,11,1].

Observation of behaviour has been performed in several studies to compare castrated and non-castrated or anaesthetised animals. Factors like less suckling, tail wagging or inactive behaviour have been used [2,6,13].

Taylor and Weary [14] recorded vocalisation in piglets during castration and demonstrated that piglets call at a higher frequency during the procedure, especially during cutting of the spermatic cord. Castration has negative effects on behaviour and weight gain. Castration leads to reduced suckling, reduced standing and increased lying times. However if castration occurred at the age of 14

days, the piglets were heavier at weaning with a higher weight gain during lactation compared to castration at one day of age [6].

The directive 2001/93/EC states, that "if castration is practiced after the seventh day of life, it shall only be performed under anaesthetic and additional prolonged analgesia by a veterinarian".

Surgical castration can be either performed under general or local anesthesia. The choice of method should result in a significant reduction or elimination of pain and stress for the piglets.

Additionally, the following conditions should be met:

- short induction and recovery periods
- acceptable costs
- no negative ecological impact
- no residuals
- the method should be easy to perform
- large therapeutic range of used drugs

In the EU veterinarians treating food-producing animals have limited access to a number of anaesthetics which could be suitable for anaesthetizing piglets. Drugs used in these animals are subjected to the MRL regulation, which means they can only be used if maximum residue levels have been established for the specific drugs (Annex I) or that the drugs are not subject to these limits (Annex II) in this particular species.

Although some efforts have been made in a search for an adequate anaesthetic regimen for painfree castration, the drugs used rarely have this MRL tag. Injectable anaesthetics have been used in some studies but the prolonged induction and recovery periods remain a problem. Waldmann [5] and his group performed a study including tiletamin/zolazepam, thiopentone and propofol in piglets 4 to 13 days of age. They demonstrated that tiletamin/zolazepam (10 mg/kg) intramuscularly and propofol intraabdominally (4 mg/kg) did not produce enough relaxation and anaesthetic depth and piglets experienced a long and difficult recovery. Thiopentone intraabdominally (30 mg/kg) produced good anaesthesia but the death rate was 9.5% due to crushing of the piglet by the sow.

McGlone and colleagues [2] studied the effect of the combination of ketamine, xylazine and guaifenesin given

intravenously in two and seven week old piglets. The death rate of the two week old animals was very high (five of eighteen animals) and the recovery period of the surviving animals was very long.

Pain killers (NSAID's and butorphanol) given 30 minutes before castration in eight week old piglets showed no beneficial effect in the postoperative period [6].

Inhalation anaesthesia was suggested to give better results because of the speed of induction and the fast recovery.

Carbon dioxide (CO₂), applied in different concentrations with oxygen was studied by Lauer [15], Körtel [11], Kohler et al. [10], Steenblock [16] and Thurmon et al. [17]. The authors describe a very fast induction and a complete analgesia for a short intervention together with a fast recovery. Unwanted side effects consisted of hyperventilation and agitation during induction and gasping during castration. These findings, together with increased stress hormone levels, have made this method questionable [10].

Inhalation of 5% halothane, applied by a simple mask in oxygen through a simple breathing system induced anaesthesia within two minutes, together with an uneventful recovery and the method seemed to fulfil the main requirements for a painfree castration [18]. In a field study, evaluating time and costs, the method has proven to be suitable for routine castration of piglets up to two weeks of age [19]. The time required for castration under anaesthesia was one minute longer per piglet (2,3 min vs 1,3 min/piglet) compared to castration without anaesthesia and costs were considerably higher. Discussion with representatives of the pork industry revealed strong opposition against this technique due to the health hazards of exposed personnel, complicated technical instruments and high costs. Shortly afterwards halothane was withdrawn from the European market.

The study was therefore repeated with isoflurane (iso) and isoflurane/N₂O (iso/N₂O) in 85 piglets [20]. This method was shown to be fast, safe and practical. The study included involvement of the Swiss Office of Secure Working Environments (SECO) and a special mask was developed. It consisted of a double mask, applying the anaesthetic gas in the inner mask with any leaks scavenged by means of a pump. Pollution could thus be reduced to a minimum. The mask was also equipped with a valve to allow gas flow only when in contact with the animals snout. Induction of anaesthesia proved to be smooth and the palpebral reflex disappeared within 36.5 seconds in the iso/N₂O group and within 51 seconds in the iso group. Anaesthesia and analgesia were sufficient (mean total anaesthesia time 128 (30–390) seconds in the iso group;

123 (70–220) seconds in the iso/N20 group). The method was very safe and no deaths occurred. Beta-endorphins and ACTH were measured but did not show any significant differences between the groups. Venipuncture was performed directly after castration in both groups and therefore the measurements may have been performed too early to identify any differences between groups (anesthetized and non-anesthetized).

An ongoing study in the University of Berne compares intramuscular vs. intranasal administration of ketamine, azaperone and clonazepam and preliminary results indicate that both routes produce a good and safe anaesthesia with short recoveries [21]. Intranasal application of anaesthetics in children has proved to be easily performed and very effective [22]. The study will continue to determine stress hormone levels and behaviour observation.

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