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SHORT COMMUNICATION

Analgesia and/or anaesthesia during piglet castration – part II: practicability of farm protocols, resource efficiency and economic implications

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ABSTRACT

Pain alleviation associated with castration of piglets is a debated welfare issue. This study compares practical aspects, resource efficiency and economic implications of two protocols involving both analgesia and anaesthesia compared to a control group: conventional castration without pain relief (CTRL); joint administration of azaperone and meloxicam (AZA-MEL), i.m.; procaine (PROC-MEL), s.c., and meloxicam, i.m. A total number of 356 male piglets (56 L), was involved. Labour, mortality during the lactation period and costs for procedures were analysed. The total amount of labour required for each single male piglet and the risk of recording at least one dead piglet during lactation in litters were significantly higher in AZA-MEL and PROC-MEL groups than in CTRL group (labour: 02:04 and 02:04 *vs.* 01:18 min, respectively, $p < .001$; mortality risk: (RR = 1.48; CI 95% = 1.02 − 2.16; $p = .029$). The cost estimated for the castration of each male piglet in CRTL group was 0.32 €, whereas was 3.14 € for AZA-MEL group and 3.30 € for PROC-MEL group. The results suggest that adopting analgesia and anaesthesia showed notable cost increases for farmers. This might be expected and justifiable when the management is improved to reach a higher standard quality, such as in the case of welfare-friendly surgical castration, but might be questionable when also considering the result of increased piglet mortality in the lactation period.

HIGHLIGHTS

- To use meloxicam + azaperone or + procaine on farm during piglets castration, increases labour of workers by 76.8 and 56.5%, respectively.
- At the same time, also piglets mortality risk increases by 48% during lactation.
- Total costs for each male piglet castrated with meloxicam + azaperone or + procaine increased by 3.14 and 3.30 €, respectively.

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Analgesia; anaesthesia; piglet; castration; pig production costs

Introduction

Surgical castration without pain relief is increasingly perceived as a practice to be banned in the near future within the European Union as it is considered a violation of the animal's wellbeing and integrity, even if it is still permitted by the regulation in force when the animal is less than 7 d old (Council Directive 2008/120/EC). At the moment, the European Commission succeeded in securing only a voluntary agreement (European Declaration on Alternatives to Surgical Castration of Pigs 2010) with major stakeholders in the pig industry that required analgesia and/or anaesthesia for surgical castration at any age as of 1 January 2012, inviting to entirely cease castration by 1 January 2018. While castration has already been abolished in some Countries and is declining in others (Backus et al. 2014), a derogation for pig meat registered under guaranteed traditional specialties, with geographical indications, and pig meat produced for traditional high-quality products was introduced by the European declaration to meet current quality standards, so these productions should continue to castrate piglets even after the 2018 deadline. With the likely continuation of surgical castration in that productions, methods of pain relief that are both effective and practical to apply on farms are needed. The complexity of the subject poses an enormous challenge to

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all concerned: public opinion, pig producers, animal welfare organisations and consumers. Considering that pig meat taste and odour is a very important aspect that consumers take into account when buying pork and that meat from entire males might have an unpleasant boar taint, castration becomes a drastic market-driven choice, not a producer's decision. On addition to involve many different parties in the pork supply chain, the practical aspects are complex and multi-faceted. Investigations on the effects of analgesia and anaesthesia administered together are limited in literature (Hansson et al. 2011; Bonastre et al. 2016; Burkemper et al. 2020) and do not consider the practical aspects related to the modification of the stockmen's work. For example, Viscardi and Turner (2019) described the challenge of practically administering multiple injections during castration procedures; among zootechnical aspects, the rapid recovery of the piglet after the intervention and prompt suckling activity are desired to increase chances of life and growth until weaning.

Aim of this study was to assess practical aspects, resource efficiency and economic implications regarding the stockyard procedures, timing, labour requirements and costs of two experimental castration protocols in the field, which efficacy in pain relief has been described in our companion paper (Scollo et al. 2021).

Materials and methods

This study was conducted under field conditions during routine animal management and procedures observing the EU Directive 2008/120 laying down minimum standards for the protection of pigs. The study took place between February and April at a commercial farm in Italy. The farrowing unit hosting the study was a 1200 sow site located in Pralboino (Brescia, Italy) with six identical rooms involved in the study. Each room held 10 farrowing crates (1.5 × 2.0 m) divided by a central corridor (five on the right and five on the left) with fully slatted floors made of wire mesh covered with rubber and a creep area in the left corner close to the corridor, heated by a 150 W radiant infra-red heat lamp (Philips, Milan, Italy) and with shredded paper as bedding material. Sows' heads were oriented towards the external wall. Ventilation and temperature were automatically controlled by fans and air heating to keep room temperature constant at 21 ± 2 °C; the light/dark cycle was 8/16 h. The piglets were of commercial hybrid genotype (75% Large White and 25% Belgian Landrace). Immediately after farrowing, fostering was performed between litters according to litter size and piglet BW. At the time of data collection, the piglets were 4 d old and had not been exposed to any previous husbandry procedures, such as tail docking or tooth resection.

Experimental design and treatments

This experiment compared the two protocols fully described and tested in our companion paper (Scollo et al. 2021) involving both analgesia and anaesthesia. Briefly, three treatments were applied: a control of castration without pain relief nor any other treatment (CTRL), as usually performed by the hosting farm; castration was carried out after two intramuscular injections, one of meloxicam (0.2 mL/piglet dose; Metacam® 5 mg/mL, Boehringer Ingelheim Vetmedica GmBH, Ingelheim, Germany), the other of azaperone (AZA-MEL) (0.1 mL/piglet dose; Stresnil® 40 mg/mL, Elanco, Sesto Fiorentino, Italy); castration was carried out after an intramuscular injection of meloxicam and a subcutaneous injection of procaine hydrochloride and adrenaline tartrate (PROC-MEL) (0.3 mL/piglet dose; Aticain®, 40 mg/mL, 0.036 mg/mL, Ati, Bologna, Italy).

A total number of 356 male piglets undergoing surgical castration, spread over 56 L (mean = 6.3 ± 1.5 male piglets per litter) was divided by room (two rooms per treatment) in the three protocol groups: CRTL) 121 male piglets from 20 L; AZA-MEL) 114 male piglets from 18 L; PROC-MEL) 121 male piglets from 18 L.

Male piglet surgical castration procedures were executed in all experimental groups by three farm employees following the farm's standard routine. In order to avoid any influence accounted to an increasing acquired knowledge of each experimental procedure during the data collection, the three farm employees had been previously trained on experimental protocols for one week period. The day of experimental data collection, employee 1 and Employee 2 (veterinarian) started procedures by closing all the nest's first litter piglets (male and female) near a guillotine door. Then, they individually restrained each piglet for iron and antibiotic injections and, in male piglets of groups AZA-MEL and PROC-MEL only, they performed the relative drug administration protocol: Meloxicam and azaperone injections were given intramuscularly in the neck (21 G × 12.7 mm needle), procaine injection was made subcutaneously in the scrotal area with a double-needle syringe overlaying each testicle. After processing, females were returned to the sow's crate, and males to the closed nest until gathered for castration. The two operators then

moved to the next litter until all the litters in the six rooms were submitted to the procedures. Surgical castration of male piglets was carried out by Employee 3, who processed litters directly after the colleagues in CRTL group, and around 10 min later in groups AZA-MEL and PROC-MEL. The castration procedure began with the restraint of the piglet in head-down position and immobilising it between the legs of the operator. A 1 cm-long incision was made over the first testicle using a scalpel, the testicle was pulled from the scrotum and exteriorised. The spermatic cord was severed by cutting. The same steps were then repeated for the second testis. Chlorhexidine antiseptic was then applied to the wound site. After castration, CRTL piglets were immediately returned to the sow's crate and the nest's door was removed, whereas AZA-MEL and PROC-MEL litter nests were opened 20 min later to reduce the risk of sow crushing due to anaesthesia.

Labour

Two assistants with a chronometer for time recording accompanied farm employees during the procedures, indicating the procedure time required by each of the three employees on a notepad while recording the same time for Employees 1 and 2 given that they worked together. When recording the procedure time for each sow, the chronometer was started when each employee entered the farrowing crate and stopped when the employee left.

Mortality before weaning and cost estimation

Mortality within each litter was recorded the day of weaning at 28 d of age. Only causes of death suggested as connected to surgical castration were included: complications (e.g. haemorrhage, infection, excessive swelling, prolapse of the intestines due to undiscovered inguinal hernia; Taylor and Weary 2000; Fredriksen and Nafstad 2006; Morales et al. 2017), crushing and starvation/hypothermia (Bonneau and Weiler 2019). Other causes of death (e.g. infectious diseases) were not included in the investigation. To allow an adjunctive analysis on mortality and body weight, all the piglets were individually weighed at castration immediately after the end of all experimental procedures.

For each group, total costs were calculated as previously suggested by Tariq et al. (2015), considering: a) direct drug consumption costs based on the average list price in Italy (meloxicam 1.06 €/mL; azaperone 0.47 €/mL; procaine hydrochloride and adrenaline tartrate 0.34 €/mL); b) labour, expressed as employee working time based on the standard hourly wage for farm work (estimated 14.70 €/h in 2020 for technicians in Italy, Coldiretti Lombardia; 45.00 €/h for swine veterinarians, Ministerial Decree n. 165 of 19 July 2016); c) any increase in piglet mortality during lactation (recorded at weaning, 28 d after birth; average market price in 2020 for a weaned piglet in Italy: 45 €).

Statistical analysis

In order to quantify the labour required to apply each protocol, the total time spent by all employees involved in castration procedures was summed (Scollo et al. 2019) using a modification of the Farm Labour Force calculation used in the European agricultural sector. Data were analysed by a non-parametric Kruskal–Wallis approach. Frequency data regarding mortality were processed using a Chi-square test. Every litter was grouped according to four classes of mortality: 0 (no piglet dead), 1 piglet dead, 2 piglets dead, and 3 or more piglets dead. Mean piglet body weight was analysed using a one-way ANOVA considering the effect of the mortality class in each treatment.

Results

Labour

The total amount of labour required was significantly higher in AZA-MEL and PROC-MEL groups than in CTRL group (Figure 1), considering both the labour required to process the entire litter (13:21 and 11:49 *vs.* 07:33 min, respectively; i.e. +76.8%, and +56.5% of time compared to CTRL group; $p < .001$) and the processing of the single male piglet (02:04 and 02:04 *vs.* 01:18 min; i.e. +59.0% of time for both treatments; $p < .001$).

Mortality before weaning and cost estimation

No complications after surgery caused the death of any piglet involved in the study, so the mortality was entirely represented by crushed and starved/hypothermic animals. Main results and details on partial cost calculation by item are reported in Table 1. Frequency of litters with no mortality during lactation was higher in CTRL than in both treatment groups (CTRL = 40.00% *vs.* AZA-MEL = 11.11% and PROC-MEL = 11.11%; $p = .041$). On the other hand, the risk of recording at least one dead piglet during lactation in litters treated with the experimental protocols AZA-MEL and PROC-MEL was higher than in the CTRL

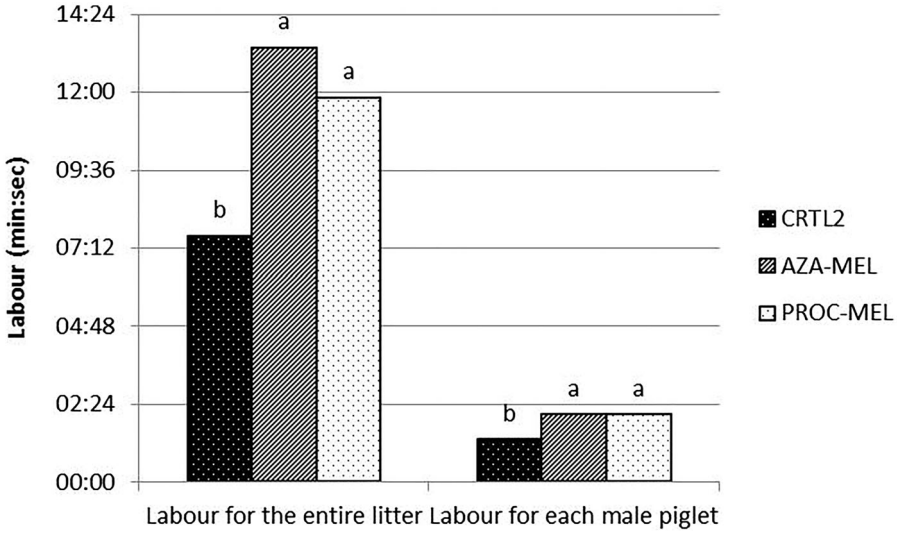

Figure 1. The effect of treatment on labour of workers during piglets castration. CTRL: a control of castration without pain relief, as usually performed by the hosting farm; AZA-MEL: castration was carried out after two intramuscular injections, one of meloxicam, the other of azaperone; PROC-MEL: castration was carried out after an intramuscular injection of meloxicam and a subcutaneous injection of procaine hydrochloride and adrenaline tartrate. Different letters (a, b) mean significant differences ($p < .001$) between values.

Table 1. Labour, mortality and costs estimation related to the treatment group, expressed for each processed litter and for each male castrated piglet.

Item	CTRL	AZA-MEL	PROC-MEL	*p* Value
For each processed litter				
Labour, min:sec	07:33	13:21	11:49	<.001
Labour increase compared to CTRL, min:sec (%)	–	+05:48 (+76.8)	+04:16 (+56.5)	
No mortality in the litter, %	40.0	11.11	11.11	.041
For each male piglet				
Labour, min:sec	01:18	02:04	02:04	<.001
Labour increase compared to CTRL, min:sec (%)	–	00:46 (59.0)	00:46 (59.0)	
Costs estimation				
Farm employees, €	0.32	0.34	0.33	–
Veterinarian, €	–	0.51	0.54	–
Drugs, €	–	0.26	0.31	–
Mortality, €[a]	–	2.02	2.11	–
Total, €	0.32	3.14	3.30	–
Costs increase compared to CTRL, €	–	+2.82	+2.98	–

CTRL: a control of castration without pain relief, as usually performed by the hosting farm; AZA-MEL: castration was carried out after two intramuscular injections, one of meloxicam, the other of azaperone; PROC-MEL: castration was carried out after an intramuscular injection of meloxicam and a subcutaneous injection of procaine hydrochloride and adrenaline tartrate.
[a]Increase in mortality compared to CRTL group as reference parameter.

group (RR = 1.48; CI 95% = 1.02 − 2.16; $p = .029$). As regards weight in the analysis of mortality, only AZA-MEL showed a significantly increase in mortality with the reduction of live weight of the piglet ($p = .048$, Figure 2).

The cost estimated for the castration of each male piglet in CRTL group was 0.32 € (not counting mortalities; the mean CRTL mortality = 9.0 ± 10.2% was taken as the reference parameter for the other two treatment groups), whereas the cost was 3.14 € for AZA-MEL group (i.e. +2.82 € compared to CRTL group; mean mortality = 13.5 ± 13.9%) and 3.30 € for PROC-MEL group (i.e. +2.98 €; mean mortality = 13.7 ± 9.1%). The involvement of a veterinarian in surgery procedures resulted in the costs increase of 0.34 and 0.36 € for each male piglet for AZA-MEL group and PROC-MEL group, respectively.

Discussion

The total cost farmers adopting a pain relief protocol involving both analgesia and anaesthesia seem necessarily required to incur is 3.14 € for AZA-MEL treatment and 3.30 € for PROC-MEL treatment for each male piglet against the 0.32 € cost per piglet castrated without any protocol. It is understandable that introducing an adjunctive practice in welfare-friendly facilities linked to higher quality standard procedures and

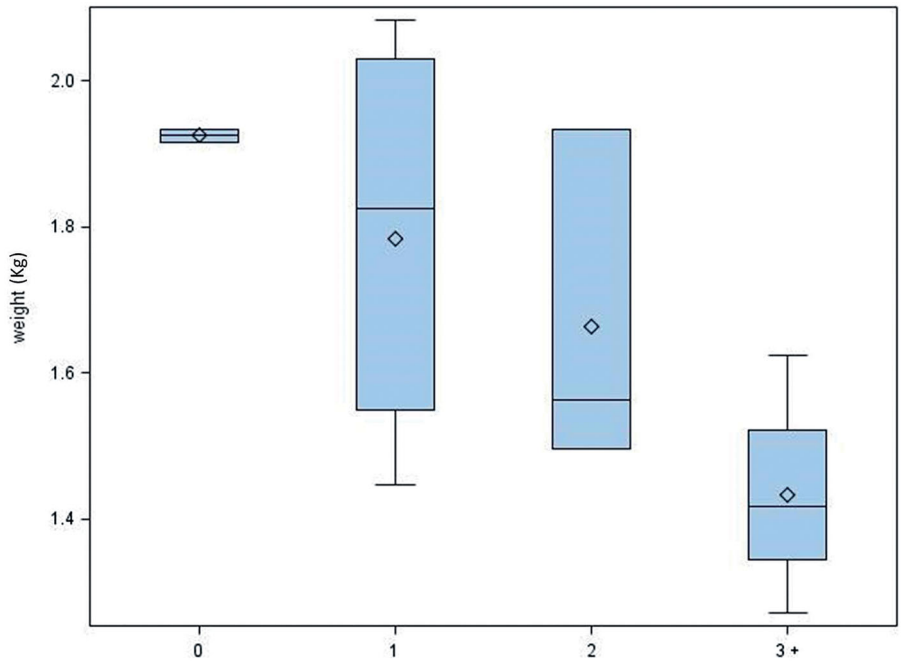

Figure 2. Average body weight (kg) for each class of mortality during lactation of piglets in litters castrated after two intramuscular injections, one of meloxicam, the other of azaperone (AZA-MEL group). 0 (no piglet dead), 1 piglet dead, 2 piglets dead, and 3 or more piglets dead. $p = .048$.

management might raise the costs of processing the entire litter, primarily due to significant increases in labour and time (i.e. +76.8% and +56.5%, respectively, for the AZA-MEL and PROC-MEL groups), to higher than those of conventionally castrated groups, in addition to the extra costs related to drug consumption. The estimates of labour with local anaesthesia and analgesia were previously evaluated by Eijck et al. (2007) and De Roest et al. (2009), that, respectively, reported the increase of 01:14 and 00:58 min of workload per each male piglet castrated. However, it should be considered that the lower labour recorded in the present work (increase of 00:46 min for both treatments) compared to literature might be related to the herd size and the frequency of castration. In agreement with De Roest et al. (2009), if castration is practised once a week, additional costs related to the workload are lower on farms with more than 400 sows that on farms with less than 100 sows, because two stockmen are needed for castration in order to avoid waiting periods of more than 20 min between drug administration and castration, reducing waste of time.

Doubts of economical and welfare nature arise from the increased risk of recording at least one dead piglet during lactation in litters treated with the experimental protocols compared to control litters, in particular considering the relevance showed by risk of mortality in the total costs estimation. This result in the AZA-MEL group might be quite easily attributed to the general sedative effect on piglets undergoing castration after treatment with azaperone that could have increased the probability of being crushed by the sow after release from the nest 20 min later. The hypothesis might be confirmed by the increased mortality recorded in lower weight piglets compared to heavier ones, for which the standard dosage of azaperone might have led to a more profound sedation due to the lower live weight/dosage ratio. The increase of mortality risk in PROC-MEL group was more surprising to authors, and also in disagreement with literature (Hansson et al. 2011; Bonastre et al. 2016). However, some results descripted for this experimental group in the companion paper (Scollo et al. 2021), such as the increase of pain-related behavioural signs and decreased sensitivity, might suggest a partial reduction of proprioception that played a part in the inability to fully avoid a crush risk.

The following considerations ensue: it would be desirable to set the dosages of anaesthetic agents exactly for each piglet before castration on the basis of individual weight. This practice might be very difficult to perform on large scale in the field, however, and would require other costs probably difficult to sustain in practice. A second consideration regards the timing of the opening of the nest used in this study, which seems insufficient to guarantee the safe reawakening of the piglets, bearing in mind, however, that a

longer time of restraint might present side effects related to a consequently longer piglet fasting potentially detrimental at such early age. The final consideration regards the mandatory presence of a veterinarian whenever a protocol with anaesthetic agents is applied on the farm in several EU Countries (e.g. Italy, specified by the law in force: Decreto 28 July 2009, 09A11522, Gazzetta Ufficiale Serie Generale n.230 published on 3 October 2009) that does not permit such administration to the animals by technicians (Viscardi and Turner 2019). This prescription increases the costs of the presence of such professional figure during routine castration of 0.34 – 0.36 € per male piglet, confirming results showed by Eijck et al. (2007) and De Roest et al. (2009) on the hypothesis that visiting fees and labour costs of the veterinarian represent additional costs for the procedure, estimated on a range between 0.30 and 0.35 € per male piglet.

This study is limited by the absence of data on practicability in the field of the protocol involving meloxicam only, which provided the best results in the companion paper (Scollo et al. 2021). The authors did not plan to run this option due to the initial expectation of finding a more welfare-friendly solution using both analgesia and anaesthesia, and, therefore, other studies are suggested to complete the findings in field conditions. However, literature reports that castrating piglets using only analgesia or only anaesthesia is less expensive compared to using both anaesthesia and analgesia. The difference is due to the decreased cost for the purchase of pharmaceuticals and to the reduced workload for farmers who have to apply only analgesia, which generates an estimated total cost drop of 0.22 – 0.30 € per male piglet (De Roest et al. 2009). Moreover, costs related to piglets mortality linked to the administration of anaesthetic agents might be expected to be lower in a protocol with analgesia alone. Another lacking investigation regards cost evaluation of immunocastration, that might represent an appropriate alternative (FVE 2019); other studies considering also labour of immunocastration administration on the field would be needed to achieve a complete pan of castration procedures.

Conclusions

Both protocols adopting analgesia and anaesthesia showed notable cost increases for farmers. This might be expected and justifiable when the management is improved to reach a higher standard quality, such as in the case of welfare-friendly surgical castration, but might be questionable when also considering the result of increased piglet mortality in the lactation period, that represented a relevant item in the cost estimation of this study. The lack of anaesthetic agents specifically registered for swine and easily administered on large scale limited the investigation of several other protocols in the field.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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