SHORT COMMUNICATION

Stomach cannulation of pregnant gilts for nutrition studies during lactation

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[1]*Department of Agricultural, Food and Nutritional Sciences, University of Alberta, Edmonton, Alberta, Canada T6G 2P5;* [2]*Animal Science (Faculty of Agriculture), University of Western Australia, Nedlands, W.A., 6907, Australia.* *Received 20 June 1995, accepted 31 July 1995.*

Pluske, J. R., Williams, I. H., Cegielski, A. C. and Aherne, F. X. 1995. **Stomach cannulation of pregnant gilts for nutrition studies during lactation.** Can. J. Anim. Sci. **75**: 497–500. The design, manufacture and insertion of a cannula into the stomach of first-litter gilts to facilitate superalimentation during lactation is described. Anaesthesia, surgery, and the presence of cannulas had no detrimental effects on birth parameters or on the gilts' ability to lactate and suckle their young. Stomach cannulation enabled us to infuse 37% more food into gilts during a 28-d lactation, and is an excellent research tool for manipulating nutrition during lactation.

Key words: Gilts, lactation, surgery, stomach cannulation, superalimentation

Pluske, J. R., Williams, I. H., Cegielski, A. C. et Aherne, F. X. 1995. **Fistulisation stomacale des cochettes gestantes, comme auxiliaire dans les études nutritionnelles durant la lactation.** Can. J. Anim. Sci. **75**: 497–500. Les auteurs décrivent la conception, la fabrication et l'insertion d'une fistule dans l'estomac de cochettes de première mise bas pour faciliter la suralimentation en cours de lactation. L'anesthésie, l'opération chirurgicale et la présence de fistule n'avaient pas d'effets négatifs sur les paramètres de mise bas, ni sur l'aptitude des truies à produire suffisamment de lait pour allaiter leurs petits. La fistulisation stomacale nous permettait d'infuser 37% plus d'aliments dans l'estomac des cochettes durant les 28 jours de lactation. En outre, elle se révèle un outil de recherche excellent pour manipuler la nutrition durant la lactation.

Mots clés: Cochettes, lactation, intervention chirurgicale fistulisation stomacale, suralimentation

The voluntary food intake of most gilts during lactation is low and insufficient to balance the losses in milk. Consequently the energy balance of these animals is negative and they lose both bodyweight and backfat. A small number of gilts can be coaxed to eat sufficient food to maintain their energy balance but it is very rare that intakes are high enough to stimulate a positive energy balance during lactation. This makes it difficult to study how food intake might affect milk production. To overcome this problem we adapted the technique of Matzat et al. (1990a) and put stomach cannulas into gilts so that exact amounts of food could be given at any time. This enabled us to override the normal physiological mechanisms which limit food intake during lactation, and allowed us to manipulate the level of energy intake and keep gilts in negative or positive energy balance as required. This note outlines modifications made to the cannulation technique and presents data on animal performance.

Thirty-six gilts (PIC, Camborough × Canabrid) from the University of Alberta swine herd were used. They were artificially inseminated at their second oestrus when they weighed 123.4 ± 2.50 kg (mean ± SEM). Between 60 and 70 d after mating they were moved to large individual pens (total measured area of 7.7 m^2) with sawdust bedding. Gilts were fed 2.0–2.35 kg d^{-1} of a gestation diet (13.3% crude protein, 12.7 MJ DE kg^{-1}) once daily at 08:00 h, and were allowed free access to water. Cannulas were inserted in all gilts at about day 75 (± 5) of pregnancy when gilts weighed between 160 and 180 kg.

The experiment was reviewed and approved by the University of Alberta Animal Care Committee to ensure adherence to Canadian Council on Animal Care guidelines.

Cannulas (barrel i.d. = 16 mm, o.d. ≈ 22 mm) were made by moulding polyvinyl chloride (PVC) ('Plastisol'; CA-1098 Clear, F. H. Lees and Sons, Rexdale, ON) over a stainless-steel mould (Fig. 1). The mould was first smeared with high-vacuum grease (to facilitate removal of the cannula after heating), heated for 20 min in an oven set at ≈ 280°C, removed and dipped into the PVC for about 2 min and then returned to the oven to allow the PVC to cure for between 45 and 90 s. Care was taken not to burn the PVC. Depending on the thickness of PVC required, this procedure was repeated once or twice. After final curing in the oven the mould with the hot PVC was plunged into cold water (15°C) and allowed to cool. The bottom of the

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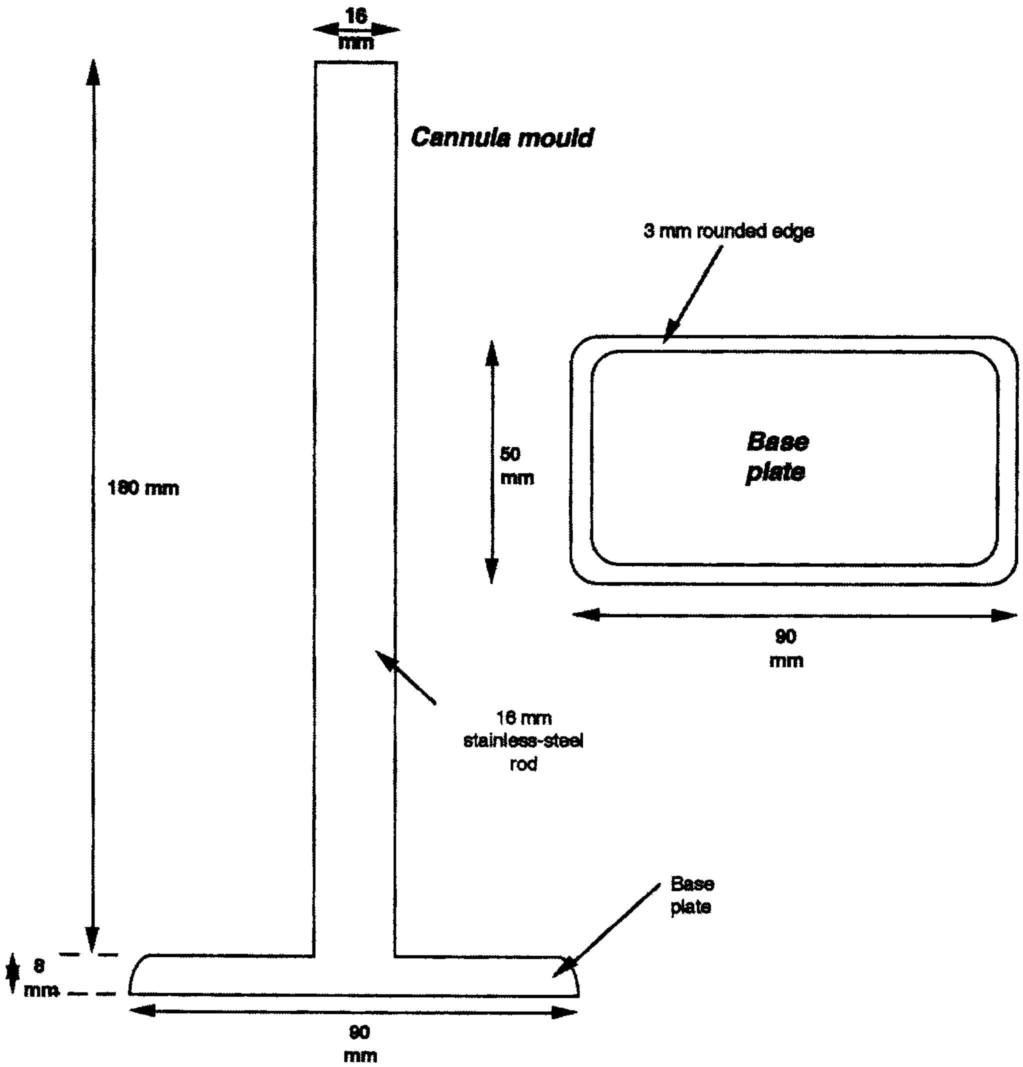

Fig. 1. Illustration showing design and specifications of the cannula and base plate mould.

cannula was cut away to allow the base and barrel of the cannula to be removed as a single piece, and it was then trimmed. A metal insert was forced into the barrel of each cannula so that it was located about 30 mm from the cannula opening. This ensured that a hose clamp could be tightened sufficiently without restricting the flow of food through the cannula.

The technique for insertion of a cannula into the stomach was adapted from that described for pregnant multiparous gilts by Matzat et al. (1990a). Gilts were not fed on the morning of surgery, and water was withheld for 14 to 16 h. Anaesthesia was induced with Intraval (5% solution of 5-ethyl-5-[1-methyl-butyl]-2-thiobarbituric acid; MTC Pharmaceuticals, Cambridge, ON) administered at a dose rate of 0.17 ml kg^{-1} body weight via a catheter in the ear vein. The gilt was then winched onto an operating table having a slight curve to allow the animal to lie comfortably on its right hand side. Anaesthesia was maintained with 100% oxygen and 2.5 to 3% fluothane ('Halothane BP'; Wyeth-Ayerst Canada Inc., Montreal, PQ).

The left abdominal wall of the gilts was clipped, scrubbed with an iodine solution (70%), doused with alcohol (95% wt/vol), sprayed again with iodine solution, and prepared for surgery from rib 7 to the tuber coxae, and from the dorsal midline to 60 cm from the ventral midline. All ribs were located and marked clearly on the gilt before surgery commenced. An incision was made in the 11th intercostal space, beginning ≈ 20 cm from the dorsal midline and extending approximately 20 cm caudo-ventrally. Muscle layers were separated by sharp dissection, and any extraneous fat on top of the peritoneum was removed. The peritoneum was then clasped with a set of haemostats, a small incision was made in it using a scalpel, and it was then cut carefully with scissors to prevent tearing. The spleen was visualised through the incision and moved caudally. The stomach was located, grasped, and exteriorised by hand through the incision. At this point some care had to be taken not to confuse the stomach with the uterus. On one or two occasions rib retractors had to be used to exteriorise the stomach. To help prevent excessive dryness of the stomach wall and contaminaton of the peritoneal cavity, swabs soaked in 0.9% NaCl were packed around the portion of the stomach that was exteriorised.

A purse-string structure ≈ 4 cm wide of No. 1 polyglycolic acid was placed in the stomach wall in the least vascular portion of the dorsal area of the greater curvature. A 14-gauge needle was inserted within the purse-string suture to allow gas to escape, and any stomach contents were removed with a 50-mL syringe. Within this purse string an incision extending 5–7 cm was made. Bleeding was controlled with haemostats. The base of the cannula was then inserted into the lumen of the stomach, and the purse-string suture was secured firmly. A second purse-string suture was then used to ensure a tight seal and to make certain that the stomach wall was fully inverted so that it would adhere firmly to the body wall. Adherence of the stomach to the body wall was encouraged by scarifying the stomach wall with a scalpel and applying 1–2 mL antibiotic ('Borgal'; Hoechst Canada Inc., Regina, SK).

The cannula was exteriorised through the 10th intercostal space by boring a hole ≈ 20 mm in diameter through the skin and muscle layers, and then making a small incision in the peritoneum. Care was taken to ensure that the hole bored through the layers was the same size and not bigger than the cannula, and that there was no intestine or omentum located between the stomach and body wall. In this way the stomach was positioned in contact with the peritoneum to allow formation of adhesions between the gastric wall and abdominal wall. Caution was exercised if the diaphragm lay in the 10th intercostal space. Under these circumstances, the cannula was exteriorised between the 11th and 10th rib to avoid tearing the diaphragm.

In most cases the exit through the peritoneum was at least 5 cm from the primary incision to allow the abdominal cavity to be closed more easily. The abdominal wall was closed in five layers, beginning with the peritoneum (continuous suture with 2–0, Type C, absorbable catgut), then each of the two muscle layers (continuous suture with chromic catgut), the layer of subcutaneous fat (continuous suture with braided No. 0 polyglycolic acid–Dexon Plus), and last, the skin, with braided No. 0 polyglycolic acid (Dexon Plus) using an interlocking pattern. The surgical site was then sprayed with antiseptic and astringent spray ('Boroform'; Hoechst Canada Inc., Regina, SK) and elastoplast bandage was placed on the sutures.

Finally the cannula was pulled upwards to ensure firm contact between the stomach, peritoneum, and body wall. A PVC ring ≈ 8 cm in diameter was placed over the cannula, seated firmly against the skin, and prevented from sliding over the cannula with a hose clamp. The barrel of the cannula was then cut so that ≈ 10 cm protruded from the ring. The cannula opening was blocked with a rubber stopper secured with surgical tape.

Immediately after surgery all pigs were administered (i.m.) a long-acting antibiotic ('Oxyvet 200 LA'; Sanofi-Sante Animal Health, Victoriaville, Quebec, Canada) at a rate of 1 mL 10 kg^{-1} liveweight, and an analgesic ('Torbugesic'; Ayerst Laboratories, Saint Laurent, PQ) at a rate of 0.2 mg kg^{-1} liveweight. Sows were moved back to their pens and offered fresh food and water. All pigs were closely monitored during recovery and their cannulas checked for leaks at least twice daily for the first 10 d, and daily thereafter. We used food intake as a guide to animal recovery and, with the exception of two gilts that ate very little (0.1 to 0.3 kg d^{-1}) for 10 d, all gilts had returned to their pre-operative intake within 72 h of surgery. Cannulas were not checked for patency (unless there was bleeding) until at least 2 wk after surgery, at which time sutures were removed from the initial incision.

Table 1. Comparison of sow performance between nutritional treatments[z]

	Treatment			
	Restricted	Ad libitum	Superalimented	SED[y]
No. of sows[x]	10	11	9	—
Lactation length (d)	27.9	28.4	27.9	0.49
Food intake (kg d^{-1})	2.9	5.2	7.2	0.18*
Liveweight (kg)				
Farrowing	176	180	174	4.92
Weaning	138	166	186	5.86*
Liveweight change	−38	−14	+12	5.77*
Backfat (mm)[w]				
Farrowing	18.2	18.1	17.1	0.76
Weaning	9.5	14.4	18.8	1.33*
Backfat change	−8.7	−3.7	+1.7	1.09*

[z]Least-squares, one-way analysis of variance means.
[y]Standard error of difference.
[x]See text for details.
[w]Depth of backfat measured at a site 65 mm from the dorsal midline at the last rib. (P_2).
*$P < 0.001$.

After farrowing, gilts were allocated to one of three nutritional treatments: (i) restricted — they were fed ≈ 50% of their estimated ad-libitum intake in three meals per day; (ii) ad libitum — they were encouraged to eat as much food as possible by filling up their feeder when it was low or devoid of food; and (iii) superalimented — they were infused seven times daily through their cannulas to achieve at least a 25% increase in food intake in excess of that attained by gilts fed on an ad-libitum basis. We estimated that this amount of food was required to keep gilts in zero or positive energy balance. Superalimentation of gilts commenced within 3 d of farrowing and continued until weaning at ≈ 28 d of age.

A high-quality diet (18.5% crude protein, 15 MJ DE kg^{-1}) was fed to all gilts. Initial attempts at infusing the diet (mixed in water at a ratio of 1:2) into the stomach of superalimented gilts failed because of separation of diet and water. To facilitate infusion, we first added 0.5% xanthan gum (a suspension agent) to the diet and then added water in a ratio of approximately 2:1 to create a gruel. Food was then infused into gilts by means of a durable plastic strip (6.2 cm wide) connected with elastic bands to the spout of a 2-L plastic container. To the other end of the plastic strip was attached (using elastic bands) a copper elbow fitting (i.d. 16 mm, o.d. 20 mm) that sat tightly in the cannula opening. After further mixing the gruel was then poured into the plastic container and gravity-fed into the stomach. Care was taken to ensure the copper fitting sat tightly in the opening of the cannula to prevent loss of the fitting from the opening and spillage of food. Occasionally the diet became blocked in the copper elbow. In these instances the fitting was removed, the rubber stopper was replaced in the opening, and the blockage was removed. Blockages were commonly the result of inadequate mixing of the gum and diet and/or insufficient addition of water.

Surgery did not cause any gilts to abort, and all gilts farrowed successfully. Twenty-nine gilts and their litters completed the experiment. Three gilts were withdrawn from the study because piglets developed severe diarrhoea soon after birth and were considered aberrant. One gilt was withdrawn as she only gave birth to three piglets. Three superalimented gilts were withdrawn from the experiment, one because of a rectal prolapse that occurred on day 23 of lactation, another because of a persistent elevated temperature (>40.5°C) associated with metritis, and the third gilt because of complications associated with surgery (day 26 of lactation) for insertion of a cephalic vein catheter.

Fitting stomach cannulas during pregnancy had no negative effect on birth parameters. On a litter basis, total number of piglets born, number of piglets born alive, number of stillborns, number of mummified piglets, and average birth weight (kg) were, respectively, 10.03, 9.39, 0.64, 0.48 and 1.51, and are within the normal range for gilts. Similarly, there was no negative effect on litter growth since piglets sucking superalimented gilts grew comparably to those sucking gilts that also achieved high levels of energy intake during lactation (Mullan et al. 1989). Stomach cannulation enabled us to provide 37% more food to the gilt during lactation compared to gilts fed ad libitum ($P < 0.001$, Table 1). Consequently gilts in this treatment remained in positive energy balance and accrued liveweight (12 kg) and body fat (1.7 mm) during lactation (Table 1). These data concur with those reported by Matzat et al. (1990b) in multiparous sows, although animals in that study were given half as much food (≈ 18%) in comparison to ad libitum-fed sows.

First-litter gilts fed in excess of ad libitum in lactation were made anabolic without any apparent disruption to normal physiological function. This technique is an excellent research tool for manipulating the gilt's metabolic state during lactation to answer questions relating to gilt nutrition and effects on milk production and subsequent reproduction. We suggest that (i) the cannulas were easy to maintain and seemingly caused no discomfort to the gilts, (ii) it would he easy to insert the cannula even earlier during pregnancy when there is less fat and hence a thinner body wall with less fat over the peritoneum, and (iii) cannulas could be maintained for more than one reproductive cycle.

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