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*J Anim Sci* 1998. 76:1433-1436.

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# Technical Note: A Technique for Inserting a T-Cannula into the Distal Ileum of Pregnant Sows<sup>1,2,3</sup>

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**ABSTRACT:** Our objective was to develop a technique for cannulating the terminal ileum in pregnant sows and to evaluate the usefulness of this procedure in digestibility studies in pregnant and lactating sows. A simple T-cannula was inserted into the terminal ileum approximately 15 cm cranial to the ileo-cecal valve in a total of 15 multiparous sows at d 40 ( $\pm$  5 d) of pregnancy. All cannulated sows recovered quickly after the surgery and within 3 d they were eating normally. Elevated body temperatures were not registered in any sows, and clinical problems related to the surgery were not observed. At farrowing, normal litters were born, and number of stillborn pigs, number of live born pigs, and daily

litter weight gain were not affected by the cannulations ( $P > .05$ ). Of the 15 sows originally cannulated, 11 sows were used for collection of digesta during gestation and the following lactating period. Eight sows were rebred after weaning, and five sows were rebred after the second lactation period and kept for another cycle. Blockage of the cannulas never occurred, and no serious problems were associated with digesta collections. The experiment demonstrated that pregnant sows can be prepared with a simple T-cannula in the distal ileum and that the cannula can be maintained in sows throughout the reproductive cycle. Hence, the procedure provides a tool for obtaining digesta from pregnant and lactating sows for nutrition studies.

Key Words: Sows, Cannulation

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J. Anim. Sci. 1998. 76:1433–1436

## Introduction

The need for collecting ileal fluid from swine for calculating apparent ileal nutrient digestibility is well recognized (Low, 1980; Fuller, 1991). A simple T-cannula inserted 10 to 20 cm anterior to the ileo-cecal valve is one of several techniques often used for ileal collections (Sauer and de Lange, 1992). Accuracy and a minimal trial-to-trial variation in the values obtained by using this technique are the main reasons for its popularity (Knabe et al., 1989).

Surgical procedures for inserting a T-cannula into the distal ileum of young pigs (Walker et al., 1986; Li et al., 1993) and growing pigs (Furuya et al., 1974; Decuyper et al., 1977; Gargallo and Zimmermann, 1980; Kesting et al., 1986) have been described. Likewise, ileal cannulation of nonpregnant, breeding-age gilts has been reported (Hamilton et al., 1985; Mroz and Tarkowski, 1991). However, to the best of our knowledge, a technique for cannulating the distal ileum in pregnant sows has never been described, and we are aware of no experiments in which prececal nutrient digestibilities for pregnant or lactating sows have been reported. It was the objective of the present experiment to develop and evaluate such a technique.

## Materials and Methods

### Preparation of the Cannulas

Simple T-cannulas were produced from type 304 stainless steel (Figure 1). The cannula had a gutter-shaped, 6 cm long  $\times$  2.5 cm wide flange. Corners were rounded, and a circular hole (1.9 cm in diameter) was drilled in the middle of the flange. A tubular barrel

<sup>1</sup>Financial support for this experiment was provided by Heartland Lysine Inc., 8430 West Bryn Mawr, Suite 650, Chicago, IL 60631.

<sup>2</sup>The authors wish to thank Theresa M. Parr, Bill A. Fisher, Dale C. Alexander, Russell M. Borchers, and John M. Temples for assistance and care in animal handling.

<sup>3</sup>Presented in part at the 1996 ASAS Annu. Mt. (J. Anim. Sci. 74[Suppl. 1]:190 [Abstr.]).

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Received June 30, 1997.

Accepted January 7, 1998.

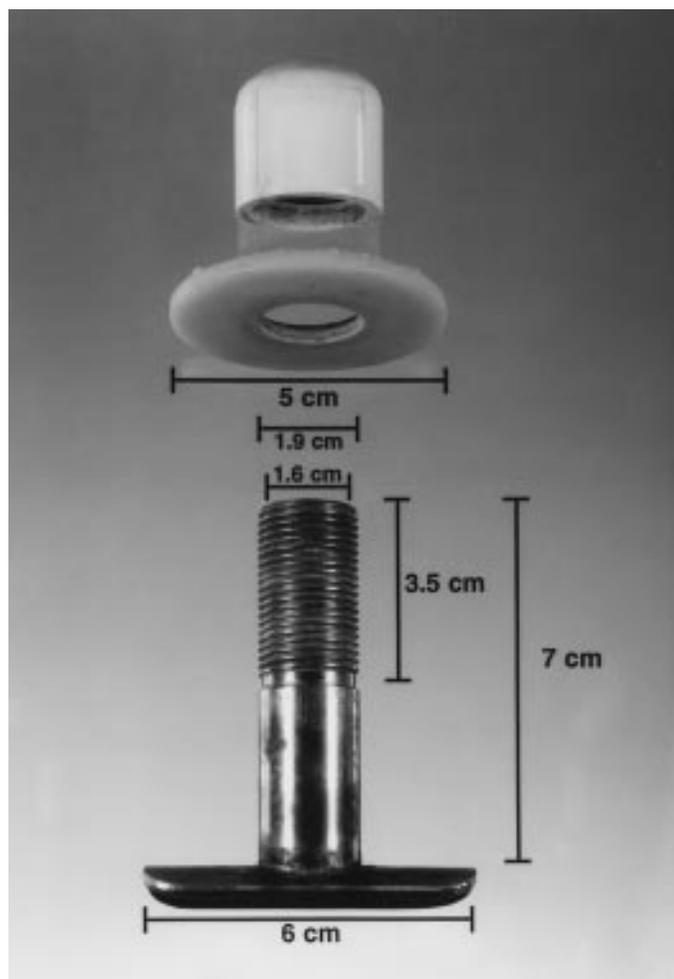


Figure 1. Cannula used in the experiment.

with an outer diameter of 1.9 cm and an inner diameter of 1.6 cm was inserted into the hole of the flange, and the two pieces were welded together. The barrel was 7 cm long and the distal 3.5 cm of the external surface was threaded (National fine, 16 threads/2.54 cm). A nylon washer with an outer diameter of 5 cm and a central hole (1.9 cm diameter) was prepared. The hole was internally threaded so that it could be screwed onto the cannula barrel. A nylon cap with internal threads and an internal diameter of 1.9 cm was used to close the cannula.

#### *Animals and Surgical Procedures*

A total of 15 multiparous (parity 3 to 6) sows (PIC, Camborough 15, Pig Improvement Company, Franklin, KY) were used in the experiment and subjected to surgery on d 40 ( $\pm 5$  d) of pregnancy after being deprived of feed for 24 h. Sows were anesthetized with 1.5 mL of TKX (Telazol<sup>®</sup>; telatamine HCl; zolazepam HCl; Fort Dodge Laboratories, Fort Dodge, IA) diluted with 2.5 mL of ketamine HCl (100 mg/mL) and 2.5 mL of xylazine HCl (100 mg/mL) diluted in 5 mL of physiological saline and administered through an ear

vein. Anesthesia was maintained with 2 to 3% halothane and oxygen-nitrogen mixture in a closed-circuit system administered through nasal intubation. Surgical procedures and the insertion of the cannula were adapted from previously reported guidelines (Furuya et al., 1974; Decuypere et al., 1977; Gargallo and Zimmerman, 1980; Hamilton et al., 1985). Throughout the surgery, care was taken not to interfere with or disturb the uterus. Each surgery lasted approximately 60 min.

Following surgery, sows were moved to recovery pens outside the surgery room and observed for 2 to 3 h after the surgery or until fully awake. The following morning, they were moved to the experimental barn where they were penned individually in 1.82-  $\times$  1.82-m pens with fully slatted concrete floors. The barn temperature was maintained at a minimum of 20°C. The initial 3 wk after surgery was considered a recovery period. During this period, cannulas were opened daily to confirm that digesta were flowing correctly, cannulas and wounds were cleaned, and wounds were treated with a nitrofurazone ointment (Sanofi Animal Health, Overland Park, KS) to support healing. Sows were treated with an antibiotic (Naxel; ceftiofur sodium, 5 mg/mL; Pharmacia & Upjohn, Kalamazoo, MI) as a prophylactic measure for the first 4 d after surgery, and body temperatures were monitored daily for 1 wk after surgery.

The experiment was approved by the University of Illinois Laboratory Animal Care Committee (protocol no. A3S-164).

#### *Digesta Collection*

Following the recovery period, sows were fed experimental diets (2 kg/d) until they reached d 105 of gestation. A new test diet was fed each week, and the initial 5 d of each feeding period was considered an adaptation period to the diet. During the last 2 d of each feeding period, digesta were collected through the cannulas for 12 h. The caps were removed from the cannulas, and a 225-mL plastic bag (Gerber baby bottle bag, Gerber Products Company, Fremont, MI) was attached to the outer part of the cannula barrel with an autolocking cable tie. Bags were removed and immediately frozen as soon as they were filled with digesta or at least once every 30 min. To prevent skin irritation from digesta that were spilled on the sow, a layer of petroleum jelly was applied to the area around the cannula before the start of each collection. At the end of the 12-h collection period, sows were cleaned and ointment was applied to the area around the cannula.

#### *Farrowing and Rebreeding*

Approximately 5 d before farrowing, sows were moved to the farrowing barn and placed in regular farrowing stalls (.66  $\times$  2.13 m) on a plastic-coated

expanded-metal floor. The farrowing barn was environmentally regulated and the temperature was maintained at approximately 22°C. A lactation diet (corn-soybean meal, 15% CP) was provided until d 4 after farrowing. Experimental diets were fed for the remaining part of the lactation period, and ad libitum access to feed and water was permitted during this period. Digesta were collected as previously described. During collections, care was taken to prevent the pigs from chewing on the collection bags or otherwise interfering with the collection procedure.

Pigs were weaned 4 or 5 wk postpartum, and sows were rebred when detected in estrus. After pregnancy was confirmed, sows were again fed experimental diets, and digesta were collected according to the aforementioned procedure.

### Calculations and Statistical Analysis

The 15 cannulated sows were chosen at random from a group of 22 multiparous sows that were bred within a 2-wk period. The seven sows that were not cannulated were used as control animals. Farrowing performance of the cannulated sows was compared to that of non-cannulated control sows by analysis of variance using the Proc GLM procedure of SAS (1989). Normality of data was confirmed using the univariate procedure in SAS.

## Results and Discussion

The procedure for cannulating pregnant sows was adapted from published reports on cannulation of growing pigs. However, due to the growing uterus in pregnant sows, some modifications had to be made. Most importantly, the site of the laparotomy was moved closer to the dorsal midline to avoid contact with the uterus. The intestines were typically found dorsal to the uterus, but the location of the distal ileum in pregnant sows is less predictable than in growing pigs. Therefore, it was necessary to prepare a larger laparotomy in sows than what is usually done in growing pigs. This allowed us to put a hand inside the body cavity to grasp the terminal ileum if necessary. Moving the incision closer to the dorsal midline made it necessary to cut through three layers of muscle, as opposed to only two muscle layers in growing pigs.

All sows recovered after surgery, and they usually started eating the next morning. No sows experienced postoperative elevation in body temperature. During lactation, sows were allowed ad libitum access to feed, and average daily feed intake was 5.3 kg, indicating that rate of passage and other digestive processes were normal. This is in agreement with Easter and Tanksley (1973), who reported that ADFI of growing pigs prepared with re-entrant cannulas was 5% of BW.

In this experiment, no sows suffered immediate ill health as a result of the surgery, giving support to the

Table 1. Farrowing data from cannulated and non-cannulated sows

Item	Cannulated sows	Control sows	SEM
n	11	7	—
Born alive	11.9	11.2	.93
Stillborn	.63	.71	.34
Birth weight, kg	1.53	1.56	.07
Weaned	9.7	8.9	.39
21-d Litter wt, kg	48.3	48.0	2.62

hypothesis that surgery and installment of the T-cannula in pregnant sows does not harm the sows. This is in agreement with the work by Marple et al. (1982) and Holzgraefe et al. (1985), who reported that a cecal fistula could be maintained for at least 6 mo in adult nonpregnant sows. Excellent health was also reported in pregnant and lactating sows prepared with a stomach cannula (Matzat et al., 1990; Pluske et al., 1995).

Of the 15 sows cannulated, one sow aborted on d 16 after the surgery, and the cannula was removed. No specific reason for the abortion was detected. Cannulas were removed from two sows 3 wk after surgery because digesta stopped flowing through the cannulas. Examination of these sows revealed that the reason for the cessation of flow was that a small loop of the ileum had slipped through a hole in the peritoneum and attached to the muscles in the body wall, which had caused it to degenerate. It is not possible to determine whether an inadequate closure of the peritoneum during the surgery or a disruption of the peritoneum after the surgery had caused this. However, the importance of a complete closure of the peritoneum and the correct positioning of the cannula within the body cavity should be noted.

The remaining 12 sows were used successfully for collections during the first pregnancy, and all of them farrowed. However, one sow developed peritonitis shortly before parturition, and this sow was not used for collections during lactation. The remaining 11 sows farrowed and nursed their litters normally, and no differences ( $P > .05$ ) in pig birth weight, the number of stillborn, or the number of live born pigs were observed between cannulated and nonexperimental sows (Table 1). Following weaning, three sows were culled for reasons unrelated to the experiment. Eight sows were rebred on d 5 after weaning. Two sows developed peritonitis during the second gestation period and had to be removed, but the remaining six sows were successfully used for collections during pregnancy as well as the following lactation period. After weaning the second litter, two sows were culled and four sows were rebred on d 5 or 6 after weaning. These sows were fed experimental diets and used for collections during their third gestation period after cannulation. One of these sows developed peritonitis

## Literature Cited

shortly before parturition, but the remaining three sows were also collected during the third lactation period.

In total, four sows developed peritonitis during the three cycles sows were kept with their cannulas. Decuyperre et al. (1977) reported that in long-term experiments with cannulated growing pigs, they had lost a total of five pigs due to acute circulatory failures. However, we are not aware of any reports in which peritonitis was described as a major problem in cannulated growing pigs. In three of the sows that developed peritonitis, it occurred shortly before parturition, and it is likely that the growing uterus at this time had pushed against the intestines, which were fixed by the cannula, and caused a rupture. To avoid this problem, it may be necessary to exteriorize the cannula more dorsal to the point we used, thus allowing more space for the uterus.

Dislodgment of cannulas in growing pigs has been reported (Easter and Tanksley, 1973; Decuyperre et al., 1977; Hamilton et al., 1985). In this experiment, no cannulas were lost; this may be because the cannulas were produced from stainless steel and were less flexible than the plastic or polyethylene tubing used in other experiments.

Collection of digesta was not associated with any problems, and the dimensions of the cannula seemed to allow the digesta to flow freely. However, only diets relatively low in fiber were fed during this experiment. High-fiber diets have been reported to cause blockage of intestinal cannulas (Easter and Tanksley, 1973; Fuller, 1991). Hence, if high-fiber diets are fed, it may be necessary to increase the diameter of the cannula barrel.

To ensure close proximity of the cannula to the body wall, the washer was adjusted as sows advanced in gestation, to allow more space between the expanding body wall and the washer. During lactation, the washers were closed more tightly as the sows lost weight. The length of the barrel and the portion that was threaded were sufficient for these adjustments.

## Implications

This technique for cannulating the distal ileum of pregnant sows allows for the sampling of ileal digesta from pregnant and lactating sows, thus providing a tool for measuring apparent ileal nutrient digestibilities in sows.

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