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A field investigation of intra-cervical insemination with reduced sperm numbers in gilts

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Abstract

A novel insemination catheter with a smaller polyurethane tip for deeper insertion into the cervix of gilts was compared with the conventional catheter. The novel catheter could be inserted 31.4 mm deeper than the conventional catheter into the gilt cervix, but the difference diminished with parity until the sixth parity when there was no difference in penetration depth between the catheters. In Experiment 1, cyclic gilts were inseminated upon display of oestrus (back pressure test) in the presence of a boar (0 h) and 24 h later. The control group ($n = 300$) were inseminated with 2×10^9 total spermatozoa and the treatment group ($n = 300$) with 1×10^9 total spermatozoa per inseminate, in both cases utilising the novel insemination catheter. No significant differences were observed for farrowing rate and litter size, the values of which were those expected for natural mating. In Experiment 2, 66 cyclic gilts were subjected to the same heat detection and service regime as for Experiment 1 but were served with $<1 \times 10^9$ total sperm cells per inseminate using the new device. Conception rates and embryo counts were recorded. Conception rate declined with $<500 \times 10^6$ spermatozoa, and number of embryos (a reflection of potential litter size) was significantly reduced. Use of the new catheter for gilts with 1×10^9 total sperm cells per inseminate will achieve commercially acceptable fertility and fecundity levels, and offer substantial commercial benefits with more rapid genetic gains.

Keywords: Swine; Inseminating catheter; Sperm dose; Cervix; Sperm transport

1. Introduction

During copulation in the pig, spermatozoa are deposited within the cervix, and despite insemination of large numbers only a relatively small number of them reach the oviducts [1,2]. Spermatozoa have entered the oviduct within 15–30 min after mating to form a sperm reservoir in the caudal 1–2 cm of the oviductal isthmus [2]; this region of the oviductal isthmus has favourable storage conditions for sperm cells and regulates the release of capacitated, hyperactivated sperm cells to the site of fertilisation [3]. This rapid sperm transport is believed to be due to the contractile activity of the uterus [4,5].

With artificial insemination, the aim has been to maximise conception and litter size while reducing the number of spermatozoa in the inseminate. Two to three billion spermatozoa are required to achieve consistently high fertility with the current accepted practice of inseminating into the posterior region of the cervix. Our own studies utilising a trans-cervical insemination in sows, with one billion cells inseminated twice 24 h apart, revealed acceptable fertility and fecundity rates [6]. This insemination catheter consisted of an inner extension tube which protruded 200 mm beyond the tip of the conventional device and which permits semen to be introduced into the uterus

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of the sow without traumatic injury to the mucosa. Several attempts were made to penetrate the cervix of gilts with this instrument but damage to the mucosa was histologically evident in 43 of the 68 gilts at slaughter (Behan, unpublished).

The cervix of the gilt clearly represents a major barrier because of its smaller dimensions. The conventional insemination catheter is therefore often difficult to place deep into the cervical folds of the gilt cervix. For this reason, gilt insemination is not as widely practised as the insemination of sows. However, a novel gilt-specific insemination catheter has been engineered to facilitate deeper placement within the cervix of the gilt. In this paper we report a field trial conducted under commercial conditions to test the ease of use of this insemination device and to explore the benefits of reduction in inseminate sperm numbers allowing potential production gains.

2. Materials and methods

The novel inseminating catheter (the Golden-Gilt; IMV Technologies, L'Aigle, France) consisted of the standard polypropylene tube (7 mm O.D.) but, instead of the usual 25 mm sponge tip, it had a 17 mm expanded polyurethane sponge tip with a shape tapering towards the tip (Fig. 1). This allowed it to be firmly inserted into the cervix of even the smallest gilt reproductive tract.

A preliminary study was conducted comparing the depth of insertion of the novel catheter into the cervix with that of the standard Golden Pig catheter in gilts and sows of a range of parities. The gilts and sows were investigated at the time of insemination at a normal oestrus, with insemination twice with a 24 h interval. The order of insertion was randomised between the two insemination times and the depth of insertion recorded with calibrated devices. All measurements were performed by the same individual, using a standard insemination technique for placing the catheter. Following lubrication with KY Jelly (Johnson and Johnson, New Brunswick, USA) the catheter is inserted through the vulva to the anterior vagina, where a penetration resistance is detected when the tip is engaging the cervix. The catheter is then inserted to its final location by a firm twist on the catheter while applying a forward pressure. The depth of penetration to the nearest 0.5 cm was read off from the calibrations on the shaft of the catheter at the point where it entered the vulva. The difference of depth between the two inseminations was calculated as the data of interest.

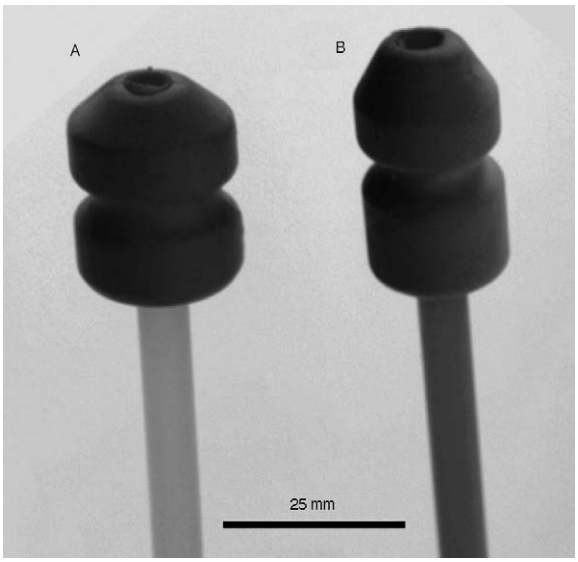

Fig. 1. The polyurethane sponge tip of the conventional catheter (A) and the smaller tapered tip of the gilt catheter (B). Bar is 25 mm.

The insemination trial (Experiment 1) examined the fertility and fecundity of gilts inseminated with 2×10^9 total sperm cells (control) compared with the test group inseminated with 1×10^9 total sperm cells, in both cases using the gilt catheter. (A conventional catheter cannot always be used in gilts in a commercial setting; often very low fertility is experienced.) The inseminations were repeated after a 24 h interval. The smaller sperm dose (1×10^9 total sperm cells) was calculated to yield lower fertility if placement of semen was inadequate [6].

Gilts involved in the trial were PIC Camborough 23 genotype that had at least one recorded oestrous period and fulfilled the following criteria: live-weight >130 kg, age >220 d and a recorded back fat measurement of between 17 and 22 mm. Sixty animals per week were allocated randomly to treatment through a simple randomisation procedure. The test group and the control group consisted of 300 animals each. These numbers were chosen to identify a $>5\%$ difference in conception rate and 0.4 standardised difference in litter size.

Ten PIC 225 Large White/Yorkshire boars, randomly selected within line, each provided semen for a total of 60 gilts each (30 per treatment). Boars were collected no more than twice per week and the entire ejaculate (minus gel) was collected. A minimal quality of ejaculate was imposed (volume, >150 ml; concentration of spermatozoa, $>200 \times 10^6$ cells/ml; motility, $>80\%$; total abnormalities, $<20\%$; agglutination, <3 agglutination points per microscope field at a magnification of $100\times$). To be certain of accurate sperm cell concentration in all insemination doses, sperm numbers