The Effects of Variable AI Techniques on Porcine Female Reproductive Efficiency

Rhett Pursley

Oklahoma State University

Honors College Thesis

Fall 2021

ABSTRACT

The reproductive science of swine is a field of study that has been researched and refined for years since the inception of agricultural animal husbandry. One of the more crucial, if not the most, developments in swine reproductive technologies was the creation of artificial insemination. Swine reproduction continues to evolve with new innovations within the field of swine artificial insemination (AI). This literature review is intended to find research that shows what is the most effective AI method and more specifically, which AI catheter is the best choice. This review will conclude that increased pregnancy and farrowing rates in swine is directly correlated to the location of semen deposition within the reproductive tract.

KEYWORDS: Swine, Artificial Insemination, Catheter, Conventional AI, Intrauterine AI, Post-Cervical AI

INTRODUCTION

Artificial insemination (AI) in swine is a common technique used in breeding gilts and sows. The elimination of natural service allows for a lower risk of disease transmission. AI also allows breeders to take advantage of genetics they may not already have on their farm (Penn State Extension, 2021). The extensive use of more superior boars through AI allows for improvement of genetics on farm and more consistent offspring (Estienne, 1999). Most breedings in the swine industry are tied to AI, as it benefits producers in numerous ways.

The process of AI includes the use of a spirette or catheter to mimic natural service. This tool is what delivers the semen from the bottle to the gilt or sow at service (Sterle & Safranski, 2018). Many different AI catheters have been invented to increase the efficiency of AI in swine. This study seeks to determine which AI technique offers the highest reproductive efficiency. To answer this question, research begins with exploring the different AI catheters that are available for swine producers and what techniques are in practice for each.

The first technique that is used with artificial insemination is known as conventional AI. In this technique, semen is deposited into the cervix and must work its way into the uterine horn. This process is usually most effective when performed while the female is in a standing heat for a live boar or some other external stimulation. Most all catheters that have been used and are currently utilized can follow some variation of this technique. Of the catheters that are available, the first type that implemented this process is known as the Melrose catheter. This catheter served as one of the most popular designs during the primordial period of AI. This catheter was the first to implement the spiral design at the end, meant to mimic the boar's penis, and is made of rubber which can be cleaned and reused for each subsequent breeding. While this catheter is used rarely, on occasion, innovations in AI technology have diminished its need in the United States swine industry today (Cerdos, 2018).

Although the Melrose set the mold for modern AI catheters, there was one element that it was missing: convenience. Producers needed a catheter that was still effective yet did not need cleaned after each use. This demand made way for the disposable "spirette." Much like the Melrose, the disposable spirette implemented the spiral tip and its inexpensive, plastic design. This meant that it could be used once and then disposed of, thus removing the step of cleaning between services, and eliminating the chance of bacteria spreading from sow to sow when breeding. As with the Melrose, the correct procedure when using the spirette is to insert it into the cervix in a counterclockwise motion and the semen is deposited directly into the cervix (Cerdos, 2018).

The next innovation came in the form of the foam tip catheter, which offered the lowest cost and simplest design on the market. Differing from the spirette, the foam tip design lacks the spiral tip, and as its namesake suggests, has a rounded foam tip at the end. The difference in design means that the technique when using this catheter is slightly different as well. Since these catheters are not modeled after the natural shape of a boar's penis, they do not require the counterclockwise, twisting motion of the spirette. The opening for semen to flow through the foam tip is at the very end, meaning semen is rarely blocked by the cervical ridges and allows for faster and simpler insemination (Cerdos, 2018).

A similar design is found in another catheter known as a soft disposable catheter. This type of catheter takes the same shape as the foam catheter but uses soft plastic rings rather than foam. Both follow the same insertion process, but the plastic can be more costly (Cerdos, 2018).

In the late 1990s, a different design was created to usher in yet another innovation in swine reproductive technology. A new device called an intra-uterine (IU) or post cervical catheter (PCAI) was created that enabled an AI technician to pass through the cervix and deposit semen directly into the uterine body. This allowed for the possibility to use substantially less semen because the sperm had less distance to travel to unite with the female's ovulating egg. Two main styles of catheters have diverged from the original idea of PCAI, the first being a balloon style catheter. This design typically has a foam tip but then has a rubber extension on the end. The extension deploys whenever pressure is applied to the bottle of semen creating a balloon like effect. In theory, semen from the bottle can be placed directly into the uterus, although any malfunctions with this catheter's balloon apparatus can cause varying results with respect to success rate (Cerdos, 2018).

The second PCAI design has proven to be the more popular of the two and is known as a cannula style. This method first requires a catheter of a breeder's choosing which might include one of the aforementioned types such as a spirette, foam tip, or soft disposable. Once that catheter is locked into the female's cervix, there is a thinner, accessory piece known as a cannula that is passed through the catheter and deeper into the reproductive tract. The goal is to reach past the cervix and into the uterus. Once both the catheter and cannula are inserted, the semen bottle is attached to the cannula opening and semen is inserted right into the uterine body. Interestingly, this is the only breeding technique that discourages the use of any extra stimulation or the presence of a live boar. This also includes any pressure on the females back that is often used to make them "lock-up" in a standing heat. The reason for this is because stimulation will cause the female's cervix to tighten making it much more difficult for the cannula to pass through the cervix and into the uterine body. Due to these factors, it is recommended to not stimulate the female until after semen is deposited into the reproductive tract and the catheter has been removed (Cerdos, 2018). There are many options for AI catheters, but how they each perform regarding reproductive efficiency is yet to be revealed.

LITERATURE REVIEW

The next step in the study was to understand the differences in efficiency of various types of techniques and catheters to determine the best option for swine breeding within a herd. With respect to the different AI techniques, a study performed by Cane et al. (2019) in Argentina compared IU insemination and conventional artificial insemination (CAI). In the study, 560 sows who had already experienced multiple parities were inseminated with semen from three different boars of very similar motility and morphology. In this work, a cannula-style catheter was used for the IU method, and sows were inseminated with a 50-milliliter dose of semen. A standard spirette catheter was used for the CAI method and those sows were dosed with 100 milliliters of semen. Each style of catheter was implemented with differing techniques based on the recommended strategy to use them. Little to no semen backflow was observed while using the IU method. Additionally, the sows who were inseminated using the CAI technique were in standing heat and exposed to a live boar.

Interestingly enough, the study found the cannula-style catheter and IU method produced impressive results, outperforming the average farrowing rate of the CAI method by approximately 13% while producing very comparable data in terms of live pigs born. However, it was reported that the IU method did slightly increase the number of stillborn and mummified piglets born. This study is very good evidence suggesting the cannula-style intrauterine catheter does increase the reproductive efficiency of sows while using less semen, when compared to a conventional style spirette (Cane et al., 2019).

In terms of gilts who have not yet had a litter, it is believed a smaller catheter, such as a spirette, must be used due to a gilt's much smaller cervix and reproductive tract. A group in Spain tested some new technology called deep cervical artificial insemination (Dp-CAI) which uses a multiring-tip catheter with an inner cannula piece that extends further into the cervix. In this study, there were 1,296 gilts that were inseminated: 130 using the standard conventional artificial insemination (CAI) and 1,166 that were inseminated using the deep cervical artificial insemination. Results from this study showed the Dp-CAI insemination method resulted in a slight increase in both pregnancy and farrowing rates, as well as a lower abortion rate. Once again, in this study the CAI insemination method showed a slight advantage in terms of total number born and number born alive (Llamas-Lopez et al., 2019).

Will et al., (2019) also tested the IUAI and CAI methods in 504 gilts. In this study there were four subgroups that differed in their insemination methods. The first group consisted of 158 gilts that were inseminated with the CAI method using a 50 ml dose of semen containing 1.5 billion sperm cells. The second group of 159 gilts were inseminated using the CAI method using an 80 ml dose of semen containing 2.5 billion sperm cells. The third group of 90 gilts were inseminated with the IUAI method using a 50 ml dose of semen containing 1.5 billion sperm cells. Finally, the fourth group of 97 gilts were inseminated with the IUAI method using an 80 ml dose of semen containing 2.5 billion sperm cells (Will et al., 2019). It was found that the pregnancy rate, farrowing rate, total born, and total born alive were not substantially different between the two methods of insemination. However, differences were found between the methods in insemination time and ability to insert the AI catheter. When using the CAI method, a shorter time was needed to complete insemination. The IU method became more efficient when only time for infusion was considered. Similar to a previous study (Cane et al., 2019) little semen backflow was observed in either method. Finally, Will et al. (2020) notes that older, heavier weight sows, with a higher body condition score allowed for increased insertion of the insemination cannula.

Another study conducted by Suarez-Usbeck et al. (2019) took place in Spain and focused on how different AI techniques affected the insemination experience and reproductive efficiency of gilts. In this study, a total of 644 young gilts of superior genetic lines, with respect to prolificacy and reproductive efficiency, were successfully inseminated. Hailing from two different farms, these gilts were penned individually until pregnancy status was confirmed and were then placed into a group pen system with about ten gilts per pen. Additionally, these gilts had been fed a very standard commercial sow ration and were given unlimited access to water prior to insemination and during gestation. In terms of semen quality, the semen used for this study was produced by 35 different Pietrain boars who had greater than 80% motility and less than 25% abnormalities. It's also important to note that prior to insemination, these gilts had already been detected of two previous estrus cycles and were synchronized with an altrenogest treatment.

Of the gilts utilized in this study, 324 were inseminated using the CAI technique and were bred with a foam tip catheter. The remaining 320 gilts were inseminated with the PCAI technique and a specialized PCAI probe which is like the inner piece of a cannula style catheter without the foam tip outer piece. In order to compare tradeoffs between the two methods, pregnancy, farrowing, total born, and born alive statistics were considered. Observations were taken while these gilts were inseminated to determine if any problems occurred. These problems could include whether the PCAI probe successfully passed through the cervix and if any semen backflow or bleeding was present. These factors were described as qualitative data points (Suarez-Usbeck et al., 2019).

In their findings, it was discovered there were approximately 10% less problems observed in the PCAI technique as compared to the CAI technique, but at the same time, there was a 10.6% unsuccessful probe passage rate associated with the PCAI. Semen backflow was not observed very often (<10%) but happened about two times more in the CAI method than in the PCAI method. Additionally, bleeding occurred in 0.6% of CAI serviced gilts and 1.1% of PCAI serviced gilts. With respect to the reproductive efficiency of these gilts, there was a very small difference in pregnancy rate and farrowing rate, however, PCAI had a slight edge in both. PCAI had a pregnancy rate of 92.3% and farrowing rate of 88.7%, while CAI was 91.4% and 85.8% respectively. Also, PCAI had a slightly higher total born (18.46 ± 4.380) and total born alive (16.51 ± 4.158) than did CAI (18.28 ±4.430 and 16.20 ±3.938). Their study's results suggested PCAI is a more favorable method than CAI (Suarez-Usbeck et al., 2019).

The IU method proves to be the most difficult technique (Ulguim et al., 2018). The breed of the gilt or sow could play a factor in the success of the method used. Ulguim et al. (2018) recommends using this method in swine with larger body sizes. The kind of semen used can also play a large role in conception rates when using IU insemination. Conception rates were higher when using fresh-extended semen when compared to frozen-thawed semen (Chanapiwat et al., 2014). In the same study, fresh-extended semen also led to increased number born alive than frozen-thawed semen.

CONCLUSION

Based on much of the research that has been conducted, there is not sufficient evidence or data that can perfectly pinpoint what is the best all-around insemination procedure and breeding tools for the AI of swine. Rather, the data suggests that there are differing methods and equipment that works in different scenarios. It can be empirically stated that the further semen is deposited into the porcine reproductive tract, the higher pregnancy and farrowing rates become. That is the most important fact that can be deduced from various findings. Additionally, it is important to understand that not all females are the same. The anatomical differences between gilts and sows with respect to the size and development of the reproductive tract is an important factor to take note of. What might work for one gilt or sow does not necessarily work for all. It is vital for AI practitioners to use proper situational analysis to choose the best and most effective AI technique for the scenario. Furthermore, artificial insemination is an ever-growing biotechnology that must continue to advance in order to increase the reproductive efficiency of breeding females within the swine industry so that the increasing global demand for pork can be properly met.

LITERATURE CITED

Advantages to Using Artificial Insemination in Swine Breeding Programs. Available from: https://www.sites.ext.vt.edu/newsletter-archive/livestock/aps-99_09/aps-0123.html#:~:text=AI%20offers%20producers%20numerous%20benefits,be%20illustrated%20in%20an%20example

Artificial Insemination (Swine Home Study Course). Swine Home Study Course (Penn State Extension). Available from: https://extension.psu.edu/programs/courses/swine/reproduction/breeding-management/artificial-insemination

Breeding Basics - Catheter Types. Cerdos, LLC. Available from: https://www.cerdosllc.com/darinspigpen/2018/2/12/breeding-basics-catheter-types

Cane, F., N. Pereyra, V. Cane, M. Patricia, and J. M. Teijeiro. 2019. Improved farrowing rate using intrauterine insemination in sows. Rev Mex Cienc Pecu. 10:583–594. doi:10.22319/rmcp.v10i3.4772.

CHANAPIWAT, P., E.-O. OLANRATMANEE, K. KAEOKET, and P. TUMMARUK. 2014. Conception Rate and Litter Size in Multiparous Sows after Intrauterine Insemination Using Frozen-Thawed Boar Semen in a Commercial Swine Herd in Thailand. J Vet Med Sci. 76:1347–1351. doi:10.1292/jvms.14-0069. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4221167/

Llamas-Lopez, P. J., R. Lopez-Ubeda, G. Lopez, E. Antinoja, and F. A. Garcia-Vazquez. 2019. A new device for deep cervical artificial insemination in gilts reduces the number of sperm per dose without impairing final reproductive performance. Journal of Animal Science and Biotechnology. 10:1–9. doi:10.1186/s40104-019-0313-1.

Sterle, J., and T. Safranski. Artificial Insemination in Swine: Breeding the Female. Available from: https://extension.missouri.edu/media/wysiwyg/Extensiondata/Pub/pdf/agguides/ansci/g02312.pdf

Suarez-Usbeck, A., O. Mitjana, M. T. Tejedor, C. Bonastre, D. Moll, J. Coll, C. Ballester, and M. V. Falceto. 2019. Post-cervical compared with cervical insemination in gilts: Reproductive variable assessments. Animal Reproduction Science. 211:1–8. doi:10.1016/j.anireprosci.2019.106207.

Ulguim, R. da R., C. M. Vier, F. B. Betiolo, P. E. Sbardella, M. L. Bernardi, I. Wentz, A. P. Mellagi, and F. P. Bortolozzo. 2018. Insertion of an intrauterine catheter for post-cervical artificial insemination in gilts: a case report. Semina: Ciências Agrárias. 39:2883–2888. Available from: https://www.redalyc.org/journal/4457/445759861047/html/

Will, K. J., D. F. Silveira, M. N. Musskopf, A. P. G. Mellagi, F. P. Bortolozzo, R. Kummer, and R. da R. Ulguim. 2021. Reproductive performance in gilts following applications of different insemination doses and techniques. Theriogenology. 160:26–32. doi:10.1016/j.theriogenology.2020.10.030. Available from: https://www.sciencedirect.com/science/article/pii/S0093691X20305781