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Keywords

Prolapse, Breeding Herds, Sow

Disciplines

Agricultural Economics | Agriculture | Animal Sciences

Comments

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Prolapse Incidence in Swine Breeding Herds Is a Cause for Concern

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Abstract

Beginning in the fall of 2014 there has been a general and widespread increase in the incidence of prolapse in the U.S. swine herd. The purpose of this manuscript is to review the incidence, causative factors and treatment of rectal, vaginal, uterine and preputial prolapses. Rectal and vaginal prolapses are most common in swine when compared to other prolapse types. The cause of prolapses supports a fixation mechanism failure overcome by pressure on or weakening of support tissue. The fundamental factors affecting the incidence for prolapses are many and include factors related to nutrition, physiology, hormones, genetics, environment and other disease factors such as chronic diarrhea, cough, and dystocia. Treatment of prolapsed swine includes surgical and therapeutic management that can lead to complete recovery. However, in most cases, euthanasia is the final result. Economic loss was calculated at approximately \$5220 dollars/year/1000 sows.

Keywords

Prolapse, Breeding Herds and Sow

1. Introduction

Commercial swine production systems with low replacement rates are the most profitable [1]. However, yearly average sow culling, and mortality rates from PigCHAMP® dataset have increased in the past five years [2]-[7]. Sows remaining in the breeding herd for fewer parities are likely to produce fewer pigs in their lifetime, compared to sows that remain in the breeding herd for a longer period of time and the predominant reason sows are removed from the breeding herd is reproductive failure; including failure to cycle, inability to conceive, and other reproductive disorders in the U.S. [1]. Similarly, the authors reported that

the most common removal reasons were reproductive disorders (26.9%), including anoestrus, return to oestrus, and prolapse in Swedish commercial herds [8]. In Denmark, 15.2% of complicated parturitions included uterine prolapse [9]. An incidence of rectal prolapse in 7 pregnant sows from a 200-sow farrow-to-finish pig farm in Greece was noted [10]. In late 2012, a U.S. commercial company had increased sow prolapse cases. Prolapses can occur in the rectum, vagina, uterine, and prepuce. These incidences increased sow mortality, lead to a loss of piglets, and increased preweaning mortality [11]. Moreover, [12] reported average prolapse incidences in the northern region of the U.S. in 2016 increased 4 times when compared with 2008 and the large peaks of prolapse incidences (3% - 4%) were found from 2014 to 2016. The main prolapse problems were in uterine (30.8% - 45.6%), rectal (32.7% - 41.0%), and vaginal (21.2% - 28.2%). Although, prolapses have been recorded in all animal species, few studies have been conducted in sows. The devastation and loss of productivity caused by prolapse points to the need for an in depth study of prolapse prevention, and could potentially have a substantial economic impact on U.S. pig production. The objective of this manuscript is to provide a review of the current scientific knowledge regarding prolapse in swine.

2. Clinical Observation and Incidence

Diagnosing of prolapse types is relatively simple and based primarily on the identifying an exteriorized portion of the closely related organs (Table 1). It is therefore important that efforts should be made to find out if the prolapse adversely affected the anatomical position, structural and/or functional integrity of other surrounding tissue or organs [13] [14].

The highest rectal prolapse incidences are in young pigs between 6 and 16 weeks of age and varies from 0.7% to 15% [15] [16]. Rectal prolapse incidences

Table 1. Comparison the differences among prolapse types.

	Prolapse types			
	Rectal Prolapses	Vaginal prolapses	Uterine prolapses	Preputial prolapses
Target organs	Rectum	Vagina	One or both uterine horns	Penis
Event timing	After farrowing or peak of lactation	Prepartum	After or within several hours of parturition,	Trauma to the penis
Possible etiology	Weakness of rectum muscles	Straining urinate or defecate	Dystocia or/and trauma with swelling and inflammation in the birth canal	Mating activities or/and administration azaperone overdose
Clinical observation	Rectal mucosa becomes everted through the anus.	Vagina protrudes through the vaginal lips with external cervix visible.	The cervix is open, and the horn(s) of the uterus becomes everted.	Penis may be traumatized once exposed outside the prepuce.
References	[13] [14] and [17]	[15] [16] and [20]	[22] and [27]	[16] and [22]

in sows varies between 0.5% and 1% and two-thirds of the cases occur around parturition [17]. Although rectal prolapse (**Figure 1**) is not a common mortality cause, it is a significant cause of morbidity in sows [10]. Rectal prolapse is the most common clinical condition in sows, occurring primarily in first litter gilts and occasionally in second litter sows during peak of lactation [14]. Rectal prolapse may be seen as early as 7 days but more typically observed 10 to 18 days post-farrowing [18]. In older sows, rectal prolapse is observed during parturition and the first two weeks of lactation. The rectum is held in place by a complex array of tissues including fascia, muscles, ligaments and collagen fibers [15]. The perineal area connective tissue is more flexible and edematous following parturition compared to during gestation [19].

Rectal prolapses may result from structures surrounding the rectum becoming weak, or be secondary to any condition that may result in rectal straining. Moreover, rectal prolapses often occurs following coughing induced by respiratory infections, when the supporting tissue around the anus becomes unable to retain the rectum. This occurs because the anal supporting tissue is naturally weak or there is excessive fat deposition in the pelvis [15]. The prolapses may be mild, with only a small amount of mucosa protruding through the anus, or severe, with extensive amounts of mucosa being permanently protruded [16] [17]. Rectal prolapses in sows can occur together with vaginal prolapse (12%) and vesical flexion (31.2%) at parturition [17]. **Figure 2** shows rectal and vaginal prolapses together.

Vaginal prolapses were largely observed in multiparous sows and most frequently occur during the last trimester of pregnancy [21]. They reported that



Figure 1. An example of a rectal prolapse in a sow [20].



Figure 2. A sow with both rectal (upper) and vaginal (lower) prolapses [20].

6.3% of vaginal prolapse appeared within a week before parturition during the third pregnancy. Similarly, [17] stated that vaginal prolapses occur as a prepartum event. The vaginal prolapse may be secondary to other causes of tenesmus, such as a rectal prolapse, retroversion of the bladder and cystitis [22] [23]. Sows with lateral deviation of the bladder, difficulty or inflammation during urination, cystitis, and urethritis may develop vaginal prolapses because they must strain when urinating [22].

Uterine prolapse (**Figure 3**) can occur in any species; however, it is most common in dairy and beef cows, ewes and less frequently in sows [23]. Regardless of species, uterine prolapse invariably occurs immediately after or within several hours of parturition, when the cervix is open, and the uterus lacks tone. In ruminant animals, it is common for both uterine horns to completely prolapse [17] [24]. In sows, one horn may become everted while unborn piglets in the other prevent further prolapse. Compared to vaginal prolapses in sows, uterine prolapses are large, longer, and deeper red in color and uterine prolapses are considered a medical emergency [17]. In cows, if the affected animal is not treated quickly, she could go into shock or die from blood loss [25].

Preputial prolapses occur with penile prolapses or results from preputial injury and resulting swelling. It leads to the prepuce repositioning within the sheath in bulls [17] [26] but no incidence is reported in boars. Prolapses of the penis in the boar are uncommon. Preputial prolapses in boars may follow damage to the penis sustained during mating activities and might be observed in some boars following azaperone overdose [23].

Prolapse can occur in all domestic livestock species, and causes great economic inefficiency to industry due to high culling and mortality rates [27]. The fundamental factors for rectal prolapses are excessive abdominal strain resulting



Figure 3. Close up of a complete uterine prolapse in the sow shortly after parturition [20].

from many clinical conditions [16]. Rectal prolapses in sows can occur together with vaginal prolapses, and vesical flexion in some cases. The incidences occur regularly in sows and growers.

3. Factors Affecting Prolapses

3.1. Nutritional Factors

Nutrition is commonly listed as a factor contributing to the prevalence of prolapses. More specifically, poor quality forage, high concentrate levels, high estrogenic-content feeds, and hypocalcaemia have all been associated with the pathology [28]. Estrogen plays a role in vaginal prolapse pathogenesis. There is a logical step to link feeds high in phytoestrogens with vaginal prolapse occurrences [29] [30]. Phytoestrogens are plant derived compounds that structurally or functionally mimic mammalian estrogen [29]. The diversity of this plant can be partially attributed to the ability of phytoestrogens to act as both estrogen agonists, and antagonists causing either an estrogenic or anti-estrogenic effects [30]. It has been suggested that endogenous estrogen levels contribute to determining the phytoestrogen actions in livestock species evaluated [30] [31]. Indeed, phytoestrogens compete with endogenously available estrogen [31]. Studies in the scientific literature is available concerning phytoestrogens and their ability to affect both sheep and goat but no reports are available in swine [29]. In cattle, phytoestrogens can cause the pelvic ligaments, and the surrounding soft tissues to weaken by similar mechanisms [32]. More specifically, the toxin zearalenone found in corn, wheat, and barley has been linked to estrogenism and vulvovaginitis in ruminant animals in the scientific literature [33]. Zearalenone and its metabolites bind to estradiol-17- β receptors [33] [34]. This toxin produces outward physiological signs identical to those observed when an over administration of estrogen occurs such as vulva swelling, vaginal, uterine and/or

rectal prolapses as well as reproductive dysfunctions [34]. Not only mycotoxins but also high density diets, vitamin deficiency, and lack of adequate water are the main causes for sow prolapses in a U.S. commercial sow farm [11]. Additionally, [35] reported an association between vitamin D deficiency and pelvic floor disease in postmenopausal women, but no research has reported similar finding in scientific literature was found for vitamin deficiency affecting prolapses in livestock animals. They concluded that obesity was correlated with the occurrence of vaginal prolapses in ewes [33].

3.2. Physical Factors

Injury to the rectum or urethra from service by the boar may also lead to tenesmus and prolapses [19]. Gradual pelvic diaphragm weakening may arise as sow's age or during pregnancy as the abdominal contents become heavier. Prolapse was observed when sows were confined in stalls or in tethers with an excessive slope to the floor [27]. The author reported that when the fall was greater than 1 in 20, increased intra-abdominal pressure may overcome the resistance of one or more pelvic diaphragm structures, especially as the abdominal contents increase in weight as pregnancy progresses. A rectal and vaginal prolapse outbreak occurred in a herd where dry sows were tethered in stalls with solid floors. The floors were shorter than usual and there was a 13 cm drop from the solid lying area to the dunging area. Complete prolapse were prevented by moving affected animals to a "sick pen" with a level solid floor [27].

3.3. Hormonal Factors

Hormones associated with prolapse consist of estrogen, progesterone, and relaxin [32] [36]. These hormones are important in the parturition processes and are found in the soft tissues and ligaments in several mammalian species [32]. Hormonal alterations were the primary factor in facilitating vaginal prolapse in sheep and cattle [37]. Estrogen plays an important role in preparing the genital tract and surrounding tissues for parturition and research has linked insufficient estrogen levels to dystocia [38]. The importance of estrogen during gestation is found in its action on the pelvic ligaments and surrounding soft tissue structures [29]. Relaxation of the pelvic ligaments and surrounding soft tissue structures gradually occurs during pregnancy, but it becomes more pronounced toward the end of gestation due to rising estrogen concentrations in combination with increased relaxin production [39].

3.4. Genetic Factors

Genetic predisposition is a risk factor for prolapses in pure lines or breeds, but a clear case for genetic influence cannot be documented [11]. The strongest argument against a genetic influence is the widespread incidence across pork production companies, swine genetic companies, and multiple bloodlines [11]. In both cattle and sheep, vaginal prolapse occurrence has a genetic foundation [11]

[14]. This assumption is based on the more frequent observation of prolapse in certain breeds and bloodlines [14]. Vaginal prolapse in cows, is an inherited trait and a recurring problem [25]. If a vaginal prolapse occurs and is repaired, the cow has a higher probability to prolapse at her next calving. Moreover, daughters from cows that have had vaginal prolapse have an increased likelihood of suffering vaginal prolapse themselves [25]. An in depth study of genetic factors or candidate genes for prolapses was not reported, but [40] [41] identified the gene responsible for the genetic foundation that plays a part in many vaginal prolapse cases in sheep and cattle. The gene was LAMC-1 and it codes for a subunit of the laminin protein that contributes to the extracellular matrix structural integrity [40] [41]. A few publications have reported a biomolecular analysis relating vaginal prolapse in ewes and cows. Vaginal prolapse occurrence in several ewes could also be linked to alternations in vaginal connective tissue from biomolecular analysis between with and without vaginal prolapse [36]. The average mRNA synthesis of the collagenolytic metalloproteinase 1 (MMP-1) was greater and the tissue inhibitor of MMP-1 (TIMP-1) was lower in affected ewes compared to healthy, pregnant ewes. They recognized that the increased MMP-1 expression and the decreased TIMP-1 expression were indicative for an increased collagen catabolism [36].

3.5. Environmental Factors

Seven cases of rectal prolapse in pregnant sows from a 200-sow herd were reported [10]. None of these sows suffered from disease that would have cause severe coughing and/or diarrhea. Moreover, laboratory examinations during the last trimester did not reveal *Leptospira spp.* or mycotoxins at detectable levels. These researchers concluded that the main cause for the rectal prolapses was the gestation stalls used at this farm. These stalls had a rear retaining gate consisting of parallel bars, predisposing rectal prolapse in this sows herd. The sows rested with the tail over the back of the parallel bars on the retaining gate that resulted in pressure being applied on the anus. According to [15], poorly designed farrowing crates that have sloping floors causes increased pressure on the anal sphincter. Moreover, the piglets may bite the prolapse, causing tissue damage and hemorrhage on a sow during lactation requiring immediate treatment of sows that prolapse.

3.6. Other Factors

Rectal prolapse often occurs following coughing which is induced by respiratory infections [11] [18]. The supporting tissue around the anus becomes unable to retain the rectum because the supporting tissue is naturally weak or due to excessive fat deposition in the pelvis. Chronic diarrhea and persistent cough may be predisposing factors for rectal prolapse in swine [23].

4. Treatment and Prevention

In the case of rectal prolapse, the red colored mucosa protrudes from the anal

sphincter, at onset and may relapse on its own. Rectal prolapse diagnosis is based primarily on identifying exteriorized portions of the rectum [13] and may occasionally compromise closely related organs [15]. Various techniques for replacing rectal prolapses have been used in livestock. The simplest and most commonly employed procedure for correcting rectal prolapse is repositioning and applying a purse string suture [15] [19] [42]. Immediately after rectal prolapse presentation, the animal is sedated with triflupromazine [43]. Caudal epidural analgesia is achieved with 3 ml of 2% lignocaine hydrochloride and the prolapsed mass is thoroughly cleaned with 2% potassium permanganate lotion. Cold fomentation is applied over the congested and prolapsed mass. The hardened and necrotic mass are resected carefully and the prolapsed rectum is repositioned inside the animal. Post-operatively, the animal is treated with streptopenicillin and metronidazole or other antibiotics for 3 days to reduce the risk for secondary bacterial complications and an analgesic is given for pain relief. Another method used to correct prolapse is called Gerlach's Needle modified by Bühner. This method is commonly used for treatment of vaginal prolapse in cows [44] [45]. The size of the needle is sufficient to reach the base of the prolapsed rectum from the inside. Two fibers are passed through each needle perforation and all tissue without breaks is ligated. Thus, the ligature prevents any bleeding [45].

Vaginal prolapse protrudes through the vaginal lips with the external cervix visible [17]. The primary cause should be treated in addition to repositioning the vagina back into the pelvic cavity [23]. Sedation and epidural anaesthesia using lignocaine and xylazine is recommended. These investigators mentioned that the prolapse should be cleaned and lubricated before gently pushing the prolapse back through the vulva lips. Bühner's purse string suture is placed subcutaneously around the vulva and tightened to reduce the orifice. In the prepartum sow, this must be removed when farrowing is imminent. In the postpartum sow, it is removed 7 - 10 days following the procedure and antibiotics may be administered in order to reduce infection risks.

Treating of uterine prolapses was reported only in cows. Treatment involves removing the placenta (if still attached), thoroughly cleaning the endometrial surface, and repairing any lacerations [28]. Rubbing the uterine surface with glycerol helps reduce edema and provides lubrication. The uterus is then returned to its normal position [46]. The author suggested that an epidural anesthetic should be administered first. In sows and small animals, the uterus may be repositioned by simultaneously manipulating it from outside with one hand and through an abdominal incision with the other hand [27]. Resecting of the uterus is indicated in longstanding cases where tissue necrosis has occurred [19]. Once the uterus is in its normal position, oxytocin is administered to increase uterine tone [46]. Uterine prolapse in sows is a problem that requires immediate attention [47]. The everted organ can easily be torn or chewed on by another sow or pen mates so the affected female must quickly be isolated and her physical movement restricted. If the uterus is cleaned and undamaged, it can be inserted

by pushing it gently back into the genital opening and birth canal. The chance of successful uterine horn replacement that prolapsed before all the offspring are delivered or parturition is complete.

General anesthesia is recommended for preputial prolapse in boars [23]. The authors suggested that the penis should be cleaned with an antiseptic solution and swabs. If the penis is extensively damaged, then surgical repair may be necessary before replacement. Lubricating of the penis and massaging the prepuce assists in returning the penis to its normal position within the preputial sheath [19]. In mild cases, the prolapse can be replaced then retained in position with purse string suture around the preputial orifice. The suture should be removed 10 days following correction [17]. Any breeding activity in a boar having a prepuce prolapse should be delayed for an additional 14 days if the penis was traumatized. In severe cases, amputation of the prolapsed mucosa is the treatment of choice [23].

Successful prolapse treatment for either sows or boars, and thus survivability and return to normal reproductive performance, depends strongly on stress and organ damage [17]. Obviously, swine with a small and/or short duration prolapse that have successful replacement accomplished without added stress and environment change have the best chance for full recovery. In the authors's opinion, severe prolapses in sows should be culled or euthanized because of the long recovery time, unclear future prolapse risk, ease to manage for barn workers and reduced economic returns to the owner.

5. Economic Impact of Sow Prolapses

5.1. Assumptions

To estimate the economic impact that prolapses have on commercial sow operations the following assumptions were based on publically available information from 2010 to 2016: 1) average cull sow weight 2) average cull salvage value 3) percentage of sows with prolapse. These average values were 481 pounds, 0.51 dollars/pound, and 2%, respectively. The parity to complete to recover total original cost of gilt was 3 [12] [48] [49].

5.2. Estimated Economic Impact

Consider that if the sow does not reach her 3rd farrowing she will not have recovered her initial purchase cost the following hold true. If the sow is lost between 1st mating and 1st farrowing all of the 250 to 322 dollars initial cost is lost. If she reaches parity 1, then she has recovered 1/3 of her initial value, followed by 2/3 if parity 2 is achieved and then full value if parity 3 is finished. Assuming all sows with prolapse are euthanized, the potential salvage value for the animals is a complete loss.

The loss of cull sow value per 1000 sows in the breeding herds is as followed = average weight (by year) * value/live weight (by years) = cull sow value loss due to prolapse (by year) * % prolapse occurrence (by year). From these values a year change in the economic impact for sow prolapse were calculated (**Table 2**). The

Table 2. Economic impact to sow prolapses.

Year	Average culled sow weight (pounds) [48]	Average cull values (dollars/pounds live weight) [49]	Average prolapse incidences (%) [12]	Values (dollars/year)
2010	467	0.51	1.2	2858.0
2011	466	0.55	1.2	3075.6
2012	464	0.47	1.3	2835.0
2013	460	0.60	2.1	5796.0
2014	464	0.72	2.6	8686.1
2015	476	0.47	2.5	5593.0
2016	482	0.50	3.2	7712.0
Means \pm SD*	468.4 \pm 7.7	0.55 \pm 0.1	2.0 \pm 0.8	5222.3 \pm 2399.9

*SD = standard deviation.

database in 2016 [12] [48] [49], if average cull sow weight 482 pounds is lost and average cull sow value is 0.50 dollars/pounds. At 3.2% incidence on a 1000 sow herd, that is 32 sows per year * 238 dollars/loss = 7712 dollars lost opportunity/year. However, this value is an underestimate of the true costs for sow prolapses because costs of piglet loss, sow housing cost, sow feed costs, labor, and treatment due to prolapses are not accounted because there are no good estimates for these expenses based on the actual prolapse event.

6. Conclusion

This review points to the fact that few studies have been directly related to the incidence of any prolapse types in swine. Rectal and vaginal prolapses are more common in sows compared to uterine prolapse. They have been associated with many predisposing factors including phytoestrogens, mycotoxins, vitamin deficiency, sow physiology, genetics, farrowing and gestation crate structure, acute diarrhea, severe cough and dystocia problems. Uterine prolapse occurs during parturition or within several days of parturition and are much more common compared to penile prolapses. In many cases, sows with rectal-vaginal prolapse and uterine prolapse are found dead as a result of hemorrhaging. This can cause large economic losses to the swine industry because of poor sow longevity and therefore reduced sow productive lifetime. The conventional method to manage chronic prolapse involves using either purse string suture or Gerlach's needle for rectal prolapse. Economic impact of prolapses depends on average cull sow weight, average cull sow salvage values and incidence percentage of sow with prolapses. This review suggests that additional research is needed in U.S. commercial farm settings to further elucidate causative factors and methods of mitigation. The studies should investigate the important factors contributing to prolapses that result in increased culling and mortality (including euthanized sows) rates in the U.S. swine industry.

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