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Review

# Ovarian cysts in sows: causes, frequency of occurrence – A review

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***Abstract.*** *The article presents the causes and frequency of occurrence of ovarian cysts in sows. The literature indicates that the pathogenesis of ovarian cysts is a complex process linked to dysfunction of the mechanisms responsible for ovarian follicle development and ovulation. Disturbances in hormonal interactions often originate in stress situations associated with difficulties in adaptation. According to many authors, large-scale farming places a substantial burden on animals, leading to disturbances in the homeostasis of the organism and thereby contributing to the occurrence of reproductive disorders. The authors of this paper have presented literature data and their own observations pertaining to the frequency of occurrence of ovarian cysts in herds of sows. They have described the symptoms accompanying this type of disorder and presented diagnostic methods, emphasizing the key role of post-slaughter evaluation of the reproductive organs of sows.*

**Keywords:** sows, ovarian cysts, frequency, pathogenesis

## Introduction

In addition to normal structures, i.e. follicles from 1 to 8 mm and corpora lutea, hemorrhagica, or less often albicantia, pathological formations may also be found on the ovaries, which is defined in the literature as polycystic ovarian degeneration (POD) or a single cyst (S.C.). Ovarian cysts are fluid-filled structures with a diameter of at least 11 mm, although the diameter may exceed 60 mm. Three basic types of cysts are distinguished: follicular, luteal and corpus albicans cysts (Dimitrov et al., 2000; Szulańczyk, 2009, Vargas et al., 2009).

Follicular ovarian cysts are derived from ovarian follicles which did not undergo ovulation but continued to grow, attaining a diameter of 11 mm or more (Vargas et al. 2009). Ovarian cysts originating in ovarian follicles contain fluid and their size can reach even several centimetres. Their structure is similar to that of an ovarian follicle with a thickened wall. Cysts can also be derivatives of corpora lutea with a granular structure (Pribul, 1968).

Ovarian cysts may occur on one or both ovaries and be single or multiple. They differ in size and in the degree of luteinization, and thus in the thickness of their walls. Usually several types of cysts are present at the same time; rarely is only one type of cyst observed on an ovary. Two types of ovarian cysts can be distinguished in pigs: polycystic degeneration (more than 10 cysts on the ovaries) and oligocystic degeneration (up to 10 cysts on the ovaries) (Fitko, 1963). Both types are subject to changes and can change into yet another form (Mencel, 2008; Szulańczyk-Mencel and Bielas, 2010).

Cysts can vary in size, number and form, and may occur alone or alongside normally developing ovarian follicles and corpora lutea. Single cysts in a normally functioning ovary do not significantly affect the fertility of sows. Reproductive disorders occur only when cysts prevent the functioning of the entire ovarian surface of the glands. Such cysts attain a substantial size, even up to 5 cm in diameter, and cause the entire ovary to take on unusual dimensions (Kotowski and Kotowski, 2008).

Cystic formations on the ovaries can be present not only in sterile sows but also in fertile or even pregnant ones. The aetiology of the disorder is little known, but it is believed to be linked to functional disorders of the endocrine system (Kozłowska et al., 2013).

Some authors distinguish three types of ovarian cysts in multiparous sows: single, small multiple and large multiple cysts. Single cysts reach a diameter of 2-3 cm and occur in the presence of corpora lutea. They probably originate from a follicle that has failed to ovulate, and are not causally linked to infertility. Small multiple cysts occur in large numbers on one ovary. They do not cause destruction of the membrana granulosa, but they lead to endometrial hyperplasia (Peters, 2005; Kotowski and Kotowski, 2008). A significant link has been demonstrated between the presence of ovarian cysts and histological changes in the ovaries, Fallopian tubes and endometrium which cause reproductive dysfunction. If this condition persists, it can lead to permanent changes in these organs and thereby cause permanent infertility in females (Szostak and Sarzynska, 2006).

A clinical symptom associated with small multiple cysts is pronounced irregularity of the occurrence of libido, with intensive but inconstant symptoms of oestrus. Large multiple cysts occur fairly often, with diameters of even about 5 cm. There may be 2-5 cysts on one ovary. In such sows oestrus generally does not occur (Peters, 2005; Kotowski and Kotowski, 2008).

### Causes of ovarian cysts

Studies on the pathogenesis of ovarian cysts must consider

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many potential contributing factors (Fitko et al., 1995, 1996; Kozłowska et al., 2013; Pierre et al., 2016). Overcrowding of animals in the pen and the room in which they are housed, long battles between females for position in the herd, excessive noise levels, zootechnical and veterinary procedures, and improper treatment of animals by personnel are the main causes of stress, which results in impairment of ovary function. Disturbances in hormonal interactions often originate in stress situations associated with difficulties in adaptation. Large-scale farming places a substantial burden on animals, leading to disturbances in the homeostasis of the organism and thereby contributing to the occurrence of reproductive disorders. Particularly in stress situations of long duration, secretion of luteinizing hormone (LH) is inhibited, which is conditioned by a high level of Adrenocorticotropic Hormone (ACTH) or catecholamine (stress hormones). This leads to impairment of ovarian follicle development, lack of ovulation, and thus the appearance of cysts on the ovaries (Turner et al., 2002; Madej et al., 2005). Cystic degeneration in the ovaries may also result from hormonal injections (Pregnant Mare Serum Gonadotropin - PMSG and Human Chorionic Gonadotropin - HCG) used in sows after the piglets have been weaned in order to synchronize oestrus and ovulation (Hall et al., 1993). If used at the wrong time, they can cause disturbances in ovarian follicle development (Nissen et al., 1995). This leads to overlapping of the activity of exogenous and endogenous hormones during follicle growth and to disturbances in the ovulation process. According to Kozłovska et al. (2013) cysts in the ovaries may be formed after the injection of dexamethasone at the middle of oestrus. This state can also be induced by high doses of progestogens, because they exert an inhibitory effect, via a feedback mechanism, on the anterior lobe of the pituitary gland, blocking the release of follicle-stimulating hormone (FSH) and luteinizing hormone (LH) – factors essential for the normal growth, maturation and ovulation of ovarian follicles (Nissen et al., 1995). There is also a tendency for cystic ovarian syndrome to occur in sows with hypothyroidism, as the thyroid plays a key role in ovarian activity, steroidogenesis, and the differentiation and maturation of ovarian follicles (Fitko et al., 1995, 1996). A predisposition associated with the age of sows has been found as well (higher occurrence of the disorder in multiparous sows). Cysts may also be caused by contaminated feed, e.g. by mycotoxins (Szulanczyk-Mencel and Bielas, 2010). The rhythm of reproductive cycles and fertility can also be negatively affected by excessive amounts of protein and legumes (plant oestrogens) in the diet or goitrogenic and antithyroid fodders (rapeseed oilcakes, rutabaga or marrow-stem kale) (Fitko, 1963).

Similar causes of the appearance of ovarian cysts are reported by other authors (Pribul, 1968), who believe that they are induced by factors independent of the animal itself, including diet (e.g. zearalenone in feed), infectious diseases, and frequent use of hormonal preparations. The mechanisms of the effect of diet on reproduction can be explained by inhibition of GnRH pulses. Moreover, dietary factors can directly influence ovary function. Restrictive feeding of sows during lactation has been found to delay oestrus and reduce the number of ovulating follicles. However, it is generally presumed that in the case of cystic ovarian degeneration in pigs improper diet does not significantly influence the development of the disease (Szulańczyk, 2009).

Abnormalities in systems regulating ovarian function may result in hypergonadism or hypogonadism. Hypergonadism is manifested as accelerated maturation and ovulation of follicles (superovulation), overproduction of oestrogens and androgens and transformation of preovulatory follicles into functional or hormonally inactive follicular cysts, and following their complete or partial luteinization, luteal cysts. In this state more pronounced symptoms of oestrus and the shortening or absence of reproductive cycles often occur. Hypogonadism is most often caused by secretory hypofunction of the hypothalamic-pituitary-adrenal axis and a deficiency of some nutrients in the diet (protein, vitamins or mineral salts). This is manifested as a decrease in the weight of the ovaries and development of follicles and the absence of ovulation and reproductive cycles. Ovarian function is also subject to other external stimuli, mainly environmental, such as lighting or temperature (Kotowski, 2012, httm//www.portalhodowcy.pl).

Cystic ovarian degeneration (COD) in sows results from disturbed hormonal equilibrium after parturition and during heightened lactation. The cause of these changes is abnormal negative feedback of the low level of ovarian oestrogens to the neurosecretory nuclei and receptors in the hypothalamus, which disturb the rhythm of the release of GnRH from the hypothalamus, and then cause similar disturbances in secretion of LH from the pituitary gland. Disruptions in GnRH and LH pulses cause a substantial decrease in preovulatory LH secretion, which leads to impairment of follicle development, failure to ovulate, disturbances in steroidogenesis in the ovaries and the appearance of cysts. A distinctive characteristic of pigs is that cysts are easily formed in the ovaries as a result of natural stress or following the use of stress hormones – Adrenocorticotropic hormone (ACTH) and glucocorticoids (Kust and Schaetz, 1972; Close and Liptrap, 1975; Almond and Richards, 1991; Ebbert et al., 1993; Moriyoshi et al., 1996; Rajska, 2004; Almond, 2007; Martinat-Botté et al., 2010; Knox, 2015).

Functional impairment of the thyroid is linked to a wide range of reproductive problems. Regulatory disturbances on the ovarian-adrenal-thyroid axis result in significant abnormalities in serum concentrations of sex hormones and elimination of characteristic fluctuations and peaks in the secretion of these hormones in the perioestrous period. Thyroid hormones, as well as gonadotropins and steroid hormones, have important roles in the regulation of the porcine ovarian follicle function (Maruo et al., 1987; Gregoraszczuk et al., 1998) and are found in porcine ovarian follicular fluid (Stankiewicz et al., 2008). It has been reported that thyroid hormones increase the effect of follicle stimulating hormone on functional differentiation of cultured porcine granulosa cells (Maruo et al., 1987). However, exactly how thyroid hormones contribute to the pathogenesis of ovarian cysts is unknown and might be based on interactions in the ovaries and the central or peripheral interrelations (Stankiewicz, 2017). It is possible that such interactions with thyroid hormones involve a bone morphogenetic protein 15 (BMP-15) and growth differentiation factor 9 (GDF-9), which belong to the transforming growth factor β (TGF-β) superfamily. It is supposed that BMP-15 and GDF-9 are involved in hormonal regulation of the hypothalamic–pituitary–ovary axis (Paulini and Melo, 2011). These factors, depending on the stage of follicular development, may increase or weaken the influence of gonadotropins on the ovarian follicle (Knight and Glister, 2006; Crawford and McNatty, 2012). Recent work has suggested a role for BMP-15 and GDF-9 in the pathogenesis of follicular cysts in gilts and sows (Stankiewicz and Błaszczyk, 2014, 2016).

Analysis of the effect of the duration of lactation on the occurrence of ovarian cysts showed that they appear considerably more frequently when piglets are suckled for less than 14 days. Ovarian cysts were observed more often in sows separated from piglets within hours of their birth (Castagna et al., 2004).

Persistent ovarian cysts that would disrupt reproductive cycles for long periods and cause long-term infertility do not generally occur

in pigs. In the aetiology of COD in pigs, unlike in cattle, no genetic basis for the disease has been found. On the other hand, age-dependence of susceptibility to cysts has been shown in pigs, as they occur more often in multiparous sows (Fitko, 1998).

The length of the weaning-to-oestrus interval also influences the occurrence of ovarian cysts. The disorder is more likely to develop in sows in which oestrus has appeared less than 3 days after weaning. The increased risk of ovarian cysts in sows in which lactation lasts less than 14 days or the weaning-to-oestrus interval is less than 3 days is linked to the development of ovarian follicles to pre-ovulation size and their production of oestrogens in an amount sufficient to induce oestrus. Inadequate levels of LH in these sows inhibit ovulation, leading to the transformation of unovulated follicles into cysts. At the time of weaning, sufficient frequency of LH pulses together with the ability of ovarian follicles to react to this hormone is essential for the normal growth and ovulation of follicles (Szulańczyk, 2009).

The literature contains suggestions of seasonal occurrence of ovarian cysts (Karvaliene et al., 2007). Research on the existence of a link between the occurrence of ovarian cysts and the time of year indicate that the problem increases in the spring, which would be linked to the increase in ambient temperature and photoperiodism (Fitko, 1963; Kurzok, 2001). Not all authors, however, support the view that the incidence of ovarian cysts is correlated with the season of the year.

**Research on the frequency of ovarian cysts in sows**

Bostedt and Ebbert (1999) research was conducted in the conditions of a large-scale farm, on representative material consisting of 495 sows awaiting culling due to infertility. After slaughter the ovaries and uterus were removed and examined macroscopically. In this way 79 sows (15.95%) with varying degrees of cystic ovary syndrome were identified. The ovaries were measured and the number of cysts was determined. The results of the study are presented in the tables.

The macroscopic anatomical examination by the authors cited showed that cysts were present in varying numbers (Table 1).

**Table 1.** Distribution of the frequency of follicular cysts (≤15 mm in diameter) on the ovaries of sows (by Bostedt and Ebbert, 1999)

| | Number of cysts | | | | |
|---|---|---|---|---|---|
| Criterion | 1 - 10 | 11 – 20 | 21 – 30 | 31 – 40 | 41 – 50 |
| Sows (n = 79) | 29 | 24 | 16 | 6 | 4 |
| % | 37 | 30 | 20 | 8 | 5 |

The sows were divided into those with and without corpora lutea co-occurring with the cysts. During the examinations it was observed that in the case of simultaneously occurring cysts and corpora lutea cysts were less frequent (1-10) than in the case of cysts alone (> 21 cysts) – Table 2.

**Table 2.** Occurrence of corpora lutea alongside ovarian cysts in sows (by Bostedt and Ebbert, 1999)

| Criterion | With corpora lutea | Without corpora lutea |
|---|---|---|
| Sows (n=79) | 50 | 29 |
| % | 63 | 37 |

Cysts of varying size and with contents of varying colour were observed on the ovaries. The size distribution, however, was independent of the criterion 'presence or absence of corpora lutea' (Table 3).

In addition, in all cases analysed morphologically, functional corpora lutea were distinguished from those with limited function, concerning their structure and the intensity of colour. Based on the macroscopic differentiation, a dependency was observed between the cyclic activity of the ovaries and the number of cysts present. During the retrospection a regular or disrupted cycle was recorded in animals with fewer cysts (≤10 cysts/animal) and active corpora lutea (p≤0.01), while the animals with more cysts (>10 cysts/animal) and poorly functioning corpora lutea exhibited no outwardly recognizable oestrus or oestrous cycles.

**Table 3.** Size distribution of ovarian cysts in sows with co-occurring corpora lutea and without corpora lutea (by Bostedt and Ebbert, 1999)

| Criterion | Diameter of cysts, mm | | |
|---|---|---|---|
| | Only ≤ 1.5 | Only ≤ 1.5 | Only ≤ 1.5 |
| Sows with corpora lutea (n=50) | 3 | 33 | 14 |
| % | 6 | 66 | 28 |
| Sows without corpora lutea (n=29) | 3 | 17 | 9 |
| % | 10 | 59 | 31 |

**Our observations**

Observations were carried out in 2013-2014 on 120 gilts and 30 older sows from large-scale farms. The animals were slaughtered in the Meat Processing Plant, town of Tomaszów Lubelski (Poland). Immediately after slaughter the reproductive organs were collected and transported to the Department of Animal Keeping and Breeding in Zamość to undergo morphometric evaluation and examination for the presence of ovarian cysts. The post-slaughter evaluation of the ovaries in the population of gilts revealed seven cases of occurrence of ovarian cysts, which was 5.5% of all animals tested. Ovarian cysts were observed in three (10%) of the 30 sows tested (Table 4).

**Table 4.** Frequency of occurrence of cysts on the ovaries of gilts and sows

| Specification | Number | % |
|---|---|---|
| Number of gilts with cysts on one ovary | 4 | 3.3 |
| Number of gilts with cysts on two ovaries | 3 | 2.5 |
| Total | 7 | 5.8 |
| Number of sows with cysts on one ovary | 2 | 6.7 |
| Number of sows with cysts on two ovaries | 1 | 3.3 |
| Total | 3 | 10 |

**Figure 1.** Large ovarian cysts in sows filled with serum

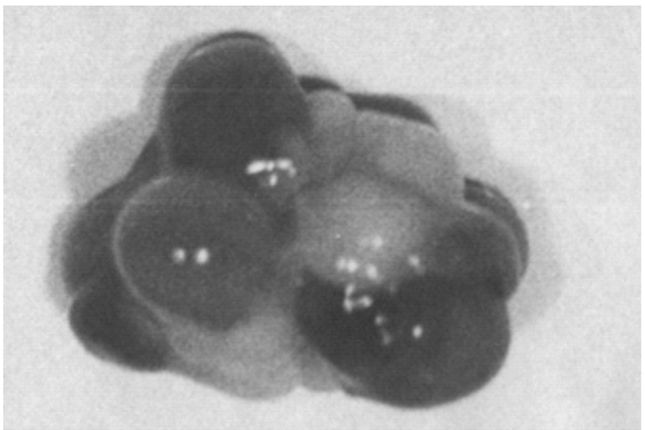

**Figure 2.** Ovarian cysts in sows filled with blood

The data obtained from our own observations pertaining to the frequency of occurrence of cysts on the ovaries of gilts and older sows are within the range reported by other authors (Fitko, 1963; Bostedt, 1996; Kurzok, 2001). In another of our own studies on the state of reproductive organs of gilts raised in different farming systems, we found that ovarian cysts occurred twice as often in gilts from large-scale farms (3.2%) than in gilts from small farms (Silvia et al., 2002).

As in other studies, the frequency of ovarian cysts was higher in older sows than in young gilts. The cysts observed were of various sizes and were present in varying numbers and forms, as illustrated by the photographs (Figures 1 and 2).

**Animal breeding problems resulting from the presence of ovarian cysts**

Many authors (Close and Liptrap, 1975; Szostak and Sarzynska, 2006; Cech and Dolezel, 2007; Vasilev, 2013) write that the lack of symptoms is one reason for the difficulty of diagnosing cystic ovarian degeneration in pigs. This problem is accompanied only by non-specific symptoms, such as absence of oestrus (anoestrus), regular or irregular repetition of oestrus and prolonged oestrous cycles. The interoestrus interval in the case of irregular cycles lasts 25 days or more. It is likely that a substantial number of clinically diagnosed cases of irregular oestrus are due to the presence of ovarian cysts.

Sows with a small number of cysts on the ovaries can remain fertile and exhibit normal oestrous cycles. However, in this case as well the size of individual litters and fecundity in the entire herd may be reduced, which indicates a negative influence of the presence of even a small number of ovarian cysts on reproductive results in pigs (Close and Liptrap, 1975).

The presence of cysts need not interfere with the ovulation of healthy ovarian follicles, but it may reduce the number of ovulating follicles (Ryan et al., 1991; Cech and Dolezel, 2007). Behavioural changes may be observed in sows, such as nymphomania and phantom pregnancy. Abortions, believed to be caused by an elevated level of oestrogens produced by ovarian cysts, may occur as well (Almond and Richards, 1991). Luteal cysts are thought to inhibit oestrous behaviour (anoestrus), while follicular cysts cause intensified oestrous behaviour (nymphomania).

A link has been demonstrated between the number of cysts on the ovaries and the occurrence of oestrus on the basis of macroscopic evaluation of the ovaries and the oestrous behaviour of sows with this disorder. Sows with a few single cysts (<10 cysts/animal) had a regular or disrupted cycle, while those with many cysts (>10 cysts/animal) displayed no externally recognizable cycles. Researchers studying this problem suggest that sows with cystic ovaries may exhibit normal oestrous cycles and become pregnant (Cech and Dolezel, 2007).

Reproductive disorders, particularly prolongation of the weaning-to-oestrus interval, are the dominant problems on pig farms and one of the reasons for post-slaughter evaluation of the reproductive organs of sows removed from the herd. Post-slaughter evaluation of reproductive organs is a means of monitoring reproductive problems on the farm (Pribyl, 1968). Reproductive disorders are the reason for culling in about 1/3 of cases. However, problems of the reproductive organs are rarely diagnosed based on clinical examination and females are sent to slaughter with the cause of their infertility undiagnosed (Rajska, 2004). Based on post-slaughter evaluation of reproductive organs in sows, the ovaries were found to be active in 67.8% of the animals. This leads to the conclusion that many females are eliminated from reproduction for undiagnosed causes or based on misdiagnosis of the cause of the absence of oestrus (Pribyl, 1968). This is because in farm conditions it is very difficult to clinically assess the condition of the reproductive organs of sows. Hence, a potential source of information concerning reproductive problems is material obtained after slaughter. Varied and atypical symptoms of cystic ovarian degeneration and limited possibilities for clinical examination of the reproductive organs of sows make it difficult to diagnose the disorder while the sows are alive. Methods such as rectal examination of the ovaries, transrectal ultrasonography of the ovaries, laparoscopy or laparotomy may be used for diagnosis of ovarian cysts, but these methods are of little use in the general practice of the zooengineers and veterinarian on pig farms (Cech and Dolezel, 2007).

Of these methods only transrectal ultrasonography is suitable for showing the condition of the ovaries in pigs. However, the most useful means of diagnosing the state of the ovaries in sows is ultrasound evaluation of these organs through the abdominal wall (Rajska, 2004). By using ultrasonography it is possible to determine the size of the ovarian follicles and to assess whether they have undergone ovulation or have persisted and are continuing to grow, transforming into ovarian cysts (Almond and Richards, 1991). Ultrasonography is a good diagnostic method for early detection of ovarian cysts and for making decisions about this sow (Waberski et al., 1999; Vargas et al., 2009).

In recent years, the ultrasound method has been increasingly used to diagnose pregnancy in pigs. Ovarian cysts can be detected while the sows are being examined for pregnancy. However, the use

of ultrasonography in diagnosing pathological states of the reproductive organs of pigs is still rare (Rajska, 2004; Kauffold and Althouse, 2007; Cech and Dolezel, 2007; de Jong et al., 2009).

It is very difficult to find ovarian cysts on the basis of hormonal blood tests, because the blood concentration of progesterone, oestradiol, LH and cortisol in sows with cystic degeneration of the ovaries is similar to the concentration of these hormones in sows in the dioestrus stage of the oestrous cycle. However, it is thought that determination of the progesterone level in the blood in combination with ultrasound examination of the ovaries makes it possible to definitively ascertain the presence of ovarian cysts. Artificially induced cysts have been found to be accompanied by high levels of oestrone, progesterone, androstenedione and testosterone and low levels of oestradiol and LH in the peripheral blood. Abnormal hormone levels in animals with ovarian cysts indicate impaired steroidogenesis accompanying this disorder (Kauffold et al., 2005).

When there are many sows with cystic ovary syndrome it is not possible to distinguish pregnancy from ovarian dysfunction. Vaginoscopy is also not a clear indicator. Using sonography, however, the functional state of the ovaries can be precisely determined, and in the case of oligo- or polycystic ovary syndrome a growth resulting from the merging of multiple cysts can be recognized. This state serves as a definitive diagnosis of cystic ovary syndrome. Despite expanded analysis and attempts to present causal relationships in cystic ovary syndrome, treatment has not yet proven effective. Reported attempts to restore a regular cycle in sows with ovarian cysts using $PGF_{2\alpha}$ have not been successful in animals with polycystic syndrome. It has only been possible to regulate the cycle of sows with oligocystic syndrome with active corpora lutea (Bostedt and Ebbert, 1999).

## Conclusion

Changes in the sexual organs of sows are rarely diagnosed based on clinical examination. Diagnosis of the cause of infertility is usually based on external symptoms, which often leads to a misdiagnosis. One means of monitoring problems associated with reproduction in sows is post-slaughter evaluation of their reproductive organs, which can be a potential source of information about reproductive problems on the pig farm. While ovarian cysts do not always result in a lack of oestrus and permanent infertility, they may reduce fertility in sows, leading to deterioration of reproductive indicators and in consequence to economic losses in pig farming.

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CONTENTS 1 / 2

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## Agriculture and Environment



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**Thesis:**

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