Anovulation and Ovarian Cyst Conditions in Dairy Cattle

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Abstract
Infertility in postpartum dairy cows represents a significant challenge for farm profitability, with anovulation and ovarian cyst formation being among the primary contributing factors. Anovulation in cattle is broadly defined as the failure of ovulation to occur during the typical 21-day estrous cycle, a process that is critical for successful breeding and overall herd productivity. Ovarian cysts, a specific type of anovulatory condition, are characterized by the presence of ovarian structures that exceed 20 mm in diameter in the absence of a corpus luteum. These cystic structures may disrupt the normal hormonal balance, often leading to prolonged anestrous. There are key differences between anovulation and ovarian cysts: anovulation specifically refers to the inability of an ovarian follicle measuring less than 17 mm in diameter to release an oocyte. In contrast, ovarian cysts involve the failure of larger follicles (greater than 20 mm) to release an oocyte, with these structures persisting on the ovary for more than 10 days. Anovulation can manifest in three primary types: a) anovulation with follicular growth reaching only the emergence stage; b) anovulation with follicular growth reaching deviation, but failing to attain ovulatory size; c) anovulation with follicular growth reaching ovulatory size. In conclusion, while both anovulation and ovarian cysts negatively impact reproductive efficiency, they represent distinct disorders. Recognizing these subtle distinctions is critical for effective reproductive management. Promptly identifying and addressing the underlying causes of anovulation can lead to improved fertility outcomes within the herd, thereby contributing to greater overall efficiency of dairy cattle management. Anovulation is marked by a complete absence of ovulation, whereas ovarian cysts involve abnormal follicular or luteal structures that interfere with normal ovarian function and hormone regulation. Therefore, for optimal herd management, it is essential to distinguish between these conditions and to implement targeted interventions aimed at improving reproductive success and overall herd profitability.

Keywords: anestrous, anovulation, dairy cow, herd profitability, hormonal imbalance, ovarian cyst

1. Introduction

Anovulation and ovarian cysts are two significant ovarian pathologies that can contribute to reproductive failure in dairy cows. Although these conditions may present similar clinical signs, they require different diagnostic approaches and treatment strategies in veterinary practice. Anovulation refers to the failure of the ovaries to release an oocyte during the estrous cycle, which can result from various factors, including hormonal imbalances, nutritional deficiencies, or underlying systemic disorders. In contrast, ovarian cysts are fluid-filled structures that develop on the ovaries and may disrupt normal ovarian function by preventing ovulation or affecting the hormonal milieu.

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Understanding the distinctions between these two conditions is essential for effective reproductive management and therapeutic intervention. Anovulation often requires strategies aimed at restoring endocrine balance and correcting systemic health concerns, whereas ovarian cysts typically requires specific treatments focused on either cysts aspiration or regulation of the estrous cycles.

Anovulation occurs when an oocyte is not released from the ovary within the expected time frame, usually approximately 13.57 ± 0.68 hours following the onset of estrus, particularly during the metestrus phase. Research have shown that heifers tend to ovulate approximately 3.04 hours earlier than multiparous cows, as noted by Brewster and Cole [1]. In general, dairy cows experience ovulation around 28 to 32 hours after the onset of estrus [2]. The period of optimal fertility of the oocyte is critical, ranging from 6 to 12 hours post-ovulation, during which successful fertilization is most likely to occur [3]. Although anovulation and ovarian cysts may often be confused in veterinary practice due to overlapping clinical signs, it is essential to recognize the distinct characteristics and implications of each condition. Anovulation primarily involves a disruption of the normal ovulatory process, while ovarian cysts represent a more complex condition, where large fluid-filled structures develop on the ovaries, potentially affecting hormone secretion and compromising reproductive performance. Thus, this article aims to clarify the differences between these two conditions, emphasizing the importance of accurate diagnosis and appropriate therapeutic approaches in order to improve reproductive outcomes in dairy herds. A thorough understanding these pathologies is essential for optimizing herd management, improving fertility outcomes and, promoting overall herd health.

2. Postpartum anovulation

In various studies, it has been observed that high-yielding dairy cows often experience a delay in the resumption of estrous cyclicity during the postpartum period, especially within the first two months following calving [4]. This phenomenon, commonly referred to as anovulation, affects approximately 25% of dairy cows within the first 65 days postpartum [4, 5]. Notably, in certain dairy herds, this percentage may increase to as high as 40% when inappropriate management practices are employed [4, 5].

The occurrence of anovulation in dairy cows is closely associated with several factors, including the presence of diseases such as mastitis and metritis, inadequate dry matter intake during the early postpartum period, and negative energy balance, a condition in which the energy output exceeds energy intake. Additionally, low body condition scores, indicating insufficient body reserves, may further exacerbate this issue [6]. Addressing these underlying factors is critical for improving reproductive performance and overall dairy herd productivity.

Calving without complications, along with normal uterine involution and the subsequent return to ovarian cyclicity, represent essential physiological milestones during the postpartum period in dairy cows. Although this process may appear straightforward in principle, the resumption of cyclicity is regulated by a complex sequence of events, involving multiple molecular and cellular signaling pathways, together with hormonal secretion withinh the hypothalamic-pituitary-ovarian axis [7].

During the postpartum period, it is common for dairy producers to implement a voluntary waiting period before initiating artificial insemination, even when cows exhibit signs of estrus. This practice allows sufficient time for complete uterine involution, defined as the process by which the uterus returns to its pre-pregnancy size and status. Ensuring an optimal uterine environment is imperative for supporting subsequent pregnancies and improving reproductive efficiency. The voluntary waiting period usually ranges from 60 to 80 days postpartum, although it may vary depending on specific farm management practices and individual herd requirements. During this timeframe, it is important to monitor the health status and well-being of the cows, as well as their nutritional balance and overall management strategies. Research indicates that approximately 20 to 30% of cows may be anovular during this period, indicating delayed resumption of normal ovarian activity and reduced capacity to produce viable oocytes. Anovulation may lead to decreased conception rates at first artificial insemination, resulting in prolonged days open, defined as the interval between calving and successful conception. Consequently, understanding the dynamics of the postpartum period and

appropriately managing the timing of insemination can substantially influence overall productivity and the economic performance of dairy farms [8].

Uterine involution, the process by which the uterus returns to its pre-pregnancy size and condition, is a critical component of the postpartum period that significantly influences the resumption of ovarian cyclicity in cows. This process is closely associated with the effective clearance of uterine contamination that may occur during or after calving. In cases where cows experience retained fetal membranes, normal uterine involution process may be impaired, leading to various reproductive disorders. Puerperal metritis also poses serious risks to reproductive health. Furthermore, delayed involution may result from these complications, thereby prolonging the interval required for the cow to return to normal estrous cyclicity. The documentation of these reproductive issues highlights the importance of careful monitoring and appropriate management of the postpartum recovery period to ensure optimal reproductive performance in dairy cattle [9-14].

Clinical endometritis and subclinical endometritis are significant reproductive health issues in cows that may adversely affect their postpartum fertility and the resumption of ovarian cyclicity. Clinical endometritis is characterized by the presence of purulent vaginal discharge, which becomes evident in affected cows more than 21 days after calving. This condition is often associated with various pathogens that may colonize the uterus during the postpartum period, leading to inflammation and infection. In contrast, subclinical endometritis may not exhibit obvious clinical signs, but it can be diagnosed based on abnormal endometrial cytology findings. Even in the absence of visible symptoms, this condition may disrupt the normal reproductive function and compromise fertility in dairy cows. Both forms of endometritis can lead to significant economic losses in dairy herds by negatively affecting calving intervals and overall reproductive performance [9, 15].

Cows diagnosed with cytological endometritis exhibit a significantly prolonged duration of postpartum anovulation, with an odds ratio of 1.52 compared with cows that do not have this diagnosis [16]. This finding suggests that cytological endometritis may have a considerable impact on ovarian function. In a comprehensive evaluation involving 1,569 cows from three countries, researchers assessed the individual and combined effects of anovulation and cytological endometritis on reproductive performance. Ovarian cyclicity was determined through serial transrectal ultrasonographic examinations performed at 35 and 49 days in milk. Cows that lacked a corpus luteum at both evaluations were classified as anovular, indicating a failure to return to normal estrous cyclicity. Among the findings, it was observed that cows diagnosed with cytological endometritis and exhibiting anovulation had a first service pregnancy rate per artificial insemination (P/AI) of only 21.3%. In contrast, healthy cyclic cows achieved a notably higher P/AI rate of 46.7%. Additionally, it was noted that even healthy cows classified as anovular showed a lower P/AI rate of 37.9%, underscoring the detrimental reproductive consequences associated to both anovulation and cytological endometritis [15]. Moreover, the study indicated that cows characterized by anovulation, whether or not they had been diagnosed with cytological endometritis, experienced a greater number of days open compared with healthy cyclic cows. These findings further emphasize the negative impact of these conditions on fertility and overall reproductive efficiency in dairy herds [15].

3. Large ovarian syndrome and anovulation

Large ovary syndrome (LOS) encompasses a range of conditions that may lead to anovulation, specifically in cows. This syndrome includes various ovarian abnormalities, such as cysts, abscesses, hematomas, and neoplasms. Among cases of LOS referred to veterinary clinics for evaluation and treatment, it has been observed that approximately 60% of these cases have been reported to be associated with granulosa theca cell tumors (GTCT). These tumors can disrupt normal ovarian function, leading to reproductive complications, and highlight the importance of prompt diagnosis and appropriate intervention in affected animals [17].

Granulosa theca cell tumors of the ovary, although uncommon, represent the most frequently diagnosed ovarian neoplasm in cattle. These tumors are clinically significant because they may induce anovulation through the continuous excessive secretion of hormones such as anti-Müllerian hormone (AMH), inhibin, and estradiol. The production of these hormones interferes with normal follicular development in the affected ovary and may also negatively influence the contralateral

ovary. This occurs through a feedback mechanism involving the hypothalamus and pituitary gland, ultimately resulting in suppression of gonadotropin secretion. As a result, the normal reproductive cycle of the animal can be severely affected, posing challenges for fertility management in cattle [18].
Unilateral ovariectomy, may result in positive reproductive outcomes for dairy cows, particularly in terms of restoring fertility. Studies indicate that a significant proportion of dairy cows undergoing this procedure may regain their reproductive function. However, it is important to note that the presence of concurrent reproductive health issues may complicate the prognosis. For instance, conditions such as pneumovagina or urovagina may represent significant challenges. These reproductive comorbidities can adversely affect overall reproductive performance and may ultimately lead to decisions regarding culling, whereby animals are removed from breeding programs due to reproductive or health-related concerns [17].

4. Classification of anovulation in dairy cows

In the literature, three distinct types of anovulation in dairy cows have been identified. Anovulation is characterized by the absence of ovulation resulting from disruptions in hormonal regulation. Affected cows exhibit abnormal follicular development, in which ovarian follicles fail to mature properly or do not reach ovulatory size. Consequently, estrous cyclicity may become irregular, leading to inconsistencies in estrous behavior expression and reduced fertility rates. Understanding these variations in anovulation is essential for improving reproductive efficiency and overall herd health in dairy production systems.

A. Anovulation with follicular growth limited to the emergence stage.
This condition is relatively rare and may arise from a variety of underlying factors. One potential cause is a genetic issue, particularly involving chromosomal abnormalities that interfere with normal reproductive development [19]. Additionally, such cases may occur in animals that are severely malnourished, as inadequate nutrition can significantly impair reproductive health.
Complete ovarian hypoplasia refers to the underdevelopment or incomplete development of the ovaries, which is characterized by the presence of a reduced number of primordial follicles, representing the resting stage of ovarian follicles. This condition may result from a specific autosomal recessive gene that exhibits incomplete penetrance, meaning that not all individuals carrying the gene express the condition [20]. According to Roberts [19], affected animals exhibit a markedly diminished ovarian reserve, which may adversely affect reproductive performance and general health status.

B. Anovulation with follicular growth limited to the deviation stage.
Anovulation characterized by the development of follicles that do not reach ovulatory size is frequently observed, particularly in prepubertal animals and in cows during the postpartum period. This condition is associated with specific features, such as reduced ovarian size, primarily due to the absence of a corpus luteum or the presence of follicles that fail to reach the diameter required for ovulation. Despite the apparent lack of ovulatory activity, recent studies involving daily ultrasound evaluations of the ovaries in anovulatory cows have revealed the occurence of follicular waves. These waves are critical indicators that, although ovulation does not occur, a certain degree of ovarian activity and hormone regulation is still maintained. Interestingly, research has shown that heifers may exhibit follicular waves as early as two weeks of age, highlighting the complexity of ovarian function even at such a young age. This phenomenon suggests that the reproductive system is capable of initiating follicular development, even in the absence of complete reproductive maturity [20].
Follicular waves are physiological cycles of ovarian follicular development that persist throughout the entire duration of pregnancy in cows. Following calving, these waves do not cease immediately; rather, the first postpartum follicular wave typically begins approximately four days following parturition. Although it is possible for the first dominant follicle emerging after calving to ovulate, this is not commonly observed. In most cases, the first postpartum ovulation occurs approximately 33 days after calving. This timing is important for understanding reproductive physiology and breeding management strategies in dairy herds [20].

C. Anovulation with follicular growth reaching ovulatory size.

Anovulation may occur when a follicle grows to an ovulatory size or larger, resulting in a condition known as an ovarian cyst. This condition refers to ovarian cysts, which are fluid-filled structures that develop on or within the ovaries. Over the years, veterinary researchers have proposed various definitions and classifications systems for ovarian cysts, taking into account characteristics such as size, structure, and associated clinical symptoms. Understanding the different types of ovarian cysts and their potential effects on reproductive health is essential for accurate diagnosis and appropriate treatment. Research indicates that each occurrence of cyst formation may increase the calving interval by approximately 22 to 64 days, thereby affecting not only the productivity of individual cows but also having significant implication for dairy herd management and overall farm profitability.

The definition of ovarian cysts has evolved over time. However, there is still no universal consensus regarding a precise characterization of the condition. Historically, ovarian cysts were defined as enlarged anovulatory follicular structures exceeding 25 mm in diameter and persisting for at least 10 days [19, 21]. In 2002, Silvia et al. [22] proposed a more restrictive definition, specifying that these follicular structures should measure at least 17 mm in diameter and persist on the ovary for more than 6 days in the absence of a corpus luteum, thereby disrupting normal ovarian cyclicity. Later, ovarian cysts were defined as follicular structures measuring at least 20 mm in diameter located on one or both ovaries, likewise in the absence of any functional luteal structure and having significant impact on normal ovarian function [23].

Our recent classification characterizes ovarian cysts, whether follicular or luteal, as anovulatory ovarian structures with a fluid-filled cavity exceeding 20 mm in diameter in the absence of a corpus luteum [24]. Furthermore, the distinction between follicular and luteal cysts is based on wall thickness: follicular cysts have a wall thickness less than 3 mm thick, whereas luteal cysts exhibit a wall thickness greater than 3 mm [25].

Understanding the implications of ovarian cysts is essential for developing effective management strategies aimed at reducing their impact on reproductive performance in dairy cattle.

5. Conclusions

Anovulation and ovarian cysts are important conditions affecting the reproductive health of dairy cows. Although these ovarian pathologies may present similar clinical signs, it is essential to distinguish between them because of their differing pathophysiological and clinical implications. Anovulation represents a disruption of the normal ovulatory process, which may compromise fertility. In contrast, ovarian cysts involve the development of large fluid-filled ovarian structures, leading to more complex endocrine and reproductive disturbances. These cysts may alter hormone secretion and interfere with the overall reproductive performance. Understanding these distinctions is fundamental for accurate veterinary diagnosis and specific therapeutic management.

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